APPLICATION OF DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER ON HYBRID RICE

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree
of
MASTER OF TECHNOLOGY
in
IRRIGATION WATER MANAGEMENT

By

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CANDIDATE'S DECLARATION

I hereby declare that the dissertation titled " **APPLICATION OF DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER ON HYBRID RICE** " which is being submitted in partial fulfillment of the requirement for the award of Degree of **Master of Technology in Irrigation Water Management** at Water Resources Development Training Center (WRDTC), Indian Institute of Technology, Roorkee is an authentic record of my own work carried out during the period of 1-06-2003 to 30-06-2004 under the supervision and guidance of **Dr. S.K. Tripathi, Professor** , WRDTC IIT, Roorkee.

I have not submitted the matter embodied in this dissertation for the award of any other degree.

Place: Roorkee.

Dated: 30-6-2004

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Rama Nand Prasad Yadav

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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SYNOPSIS

Rice (***Oryza sativa L.***) is the second most important crop of the world. More than 90% of world rice production is from Asia. India has world 's largest growing area with about 43 million ha. In terms of importance of food crop rice provide more calories per ha than any other cereal crops. It is estimated that 40% of the world population use rice as major source of calories. The biomass produce of rice is not only used as food grain but also used as fodder, fuel and fiber. To meet the ever-increasing demand of food, fodder, fuel, and fiber the growth rate of rice production has to be increased to maintain self-sufficiency through intensive cultivation and introducing hybrid varieties. At present India has also entered era of hybrid rice.

Rice cultivation in the world extends from 39° S latitude (Australia) to 50^0 N latitude China. In India it stretches from 8 °N latitude to 34 °N latitude. Rice is also grown even in area below sea level as in Kuttanad region of Kerala. The highest altitude at which rice is grown is in Nepal's Jumla vally in the far western Himalayan. Rice seedling from the nursery bed can be transplanted to the field when the mean daily temperature is about 13-15^0 C. Weather variables affect the crop growth differently in different phenophases during its growth.

Crop models are developed to predict total biomass of harvestable yield of a crop under the effect of various management practice and climate changes. The development of crop growth simulation model is developed out of intense scientific research. At present there are many teams and organizations around the world building crop growth simulation models for predicting yield of crops. The Decision Support System for Agro-technology Transfer **(DSSAT)** is one of them. DSSAT has been in use for more than 15 years by researchers in over 100 countries worldwide. DSSAT is a microcomputer software program combining crop soil and weather databases and programs to manage them, with crop models and application programs, to simulate multi-year outcomes of crop management strategies. As a software package integrating the effects of soil, crop phenotype, weather and management options, DSSAT allows users to ask ***"what if"*** questions and simulate results by conducting, in minutes on a desktop computer, experiments which would consume a significant part of an agronomist's career. So DSSAT is a collection of computer programmes integrated in to a single software package in order to facilitate the application of crop simulation model in research.and decision-making. This software package was developed by IBSNAT (International Benchmark Sites Network for Agro technology Transfer) project. It was designed to help the acceleration of process of knowledge dissemination to the decision-makers. The DSSAT vs 3.5 (Tsuji et al.1994) is an excellent example of a management tool that enables individual farmers and researchers to match the biological requirements of a crop to the physical characteristics of the land to obtain a specified objective. This dissertation entitled **"Application of Decision Support System for Agrotechnology Transfer on Hybrid rice"** is an effort to run the **CERES-RICE** model for validation and prediction of yield and yield attributes under different agronomic management practice. The study has been carried out with the following objective.

- To generate base data for use in **DSSAT CERES-RICE** model developed by **IBSNAT.**
- To validate the actual field results with **DSSAT CERES-RICE** model
- To predict grain yield and yield attributes, nitrogen uptake, nitrogen leaching, evapotranspiration, soil moisture condition using validated **DSSAT-RICE** model under different agronomical management conditions of rice cv HR-6444.

Field experiment during kharif season 2003 was conducted in Randomized Block Design with four treatment of organic manure (F0=0kg/ha, F1=4000 kg/ha, F2=8000kg/ha, F3=12000kg/ha) and 3 replications. Irrigation was applied uniformly and total amount applied was 880mm at different phonological development stages, at **Demonstration Farm of WRDTC, IIT Roorkee**, to generate the base data required for the use in **DSSAT vs 3.5 CERES- RICE** model. The crop was transplanted on 2nd July. Seedlings were 28 days old. Crop was harvested on 23 rd October 2003. There were four organic manurering treatments viz. F0, F1, F2, & F3. Other practices were common at all the treatments. The minimum input data required from the field experiments are plot details, treatments, cultivars, fields, soil analysis, initial condition, planting detail, irrigation and water management, fertilizers detail residue and other organic materials, harvested details simulation control, automatic management, weather data grain yield and yield attributes. The DSSAT was run and the result validated.

The validation of DSSAT revealed that the predicted and actual grain yield measured was (5993 kg/ha and 5841 kg/ha), (6506 kg/ha and 6461 kg/ha), (6911 kg/ha and 6881 kg/ha), and (7067 kg/ha and 6960 kg/ha) respectively at the given treatment of F0, F1, F2, and F3 respectively. The data was tested using T-test and the result was significantly no different. The other variables like flowering daps, physiological maturity, wt per grain, grain number per m2, biomass at harvest maturity, harvest index are also with in acceptable limit. The simulated overview result also showed there was no stress of water through out the crop period except minimum stress of nitrogen at some phonological stage of crop growth

The validated DSSAT was also extended to predict the grain yield and yield attributes, nitrogen uptake, nitrogen leached, cumulative evapotranspiration, cumulative runoff, cumulative drainage etc under different agrotechnical condition (3 level of irrigation and 4 levels of organic manuring). The total no. of treatments tried were 12. the rainfall recorded during the crop season was 602mm.

DSSAT predicted result on yield revealed that by increasing the irrigation up to 440mm increased the grain yield and cumulative evapotranspiration but further increase in irrigation recorded, reducing grain yield, cumulative evapotranspiration and nitrogen uptake but increased the nitrogen leaching. The total drainage increased with increased in irrigation depths, but the seasonal run-off however remains unaffected. Also by increasing the dozes of organic manure recorded increased the grain yield, nitrogen uptake but nitrogen leaching, cumulative evapotranspiration, seasonal run-off, and total drainage however remained unaffected.

Keeping in view the above findings, it is concluded that DSSAT can satisfactorily predict the yield of hybrid rice cv HR 6444 in the soil climate condition of Roorkee. However further studies with different aspects of management can be carried out at different sites to validate the accuracy and reliability of the crop model.

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ABBREVIATIONS USED*

CERES	Crop Estimation through Resources and Environment Synthesis
cv	Cultivar
DSSAT	Decision Support System for Agrotechnology Transfer
DBMS	Data Base Management System
DLV	Day Length Variation
DTT	Thermal time or degree day time
FAO	Food and Agricultural Organization
FYM	Farmyard Manure
HR	Hybrid Rice
HI	Harvest Index
IIT	Indian Institute of Technology
IBSNAT	International Benchmark Site Networks for Agrotechnology Transfer
JDATE	Julian Date
LL	Lower Limit of plant extractable soil water
LAT	Latitude
LS	Level of significant
MDS	Minimum Data Set
SW	Soil Water content
TOPWT	Total Plant Weight
TEMPMN	Minimum Temperature
TEMPMX	Max. Temperature
TBASE	Temperature threshold
USAID	United States Agency for International Development
WRDF	Water Resources Development Farm

*Note: Abbreviations used other than DSSAT data code

CHAPTER-1

INTRODUCTION

1.1 Hybrid rice:

Rice *(Oryza sativa L.)* is the most important crop of India and second most important crop of the world. In India rice is grown on 31 % of the total area under food grains. More than 90% of the world rice production is from Asia. It is also one of the important cereals both for human and animals consumption. India has world's largest growing area with about 43 million ha. In terms of important of food crops rice provides more calories per ha than any other cereals crop. It is estimated that 40% of the world population use rice as major source of calories. Now adays rice has become the symbol of cultural identity and global unity. The year 2004 is declared as "RICE YEAR" by FAO. To meet the ever-increasing demand of food, fodder, & fuel and fiber the growth rate of rice production has to be increased to maintain self-sufficiency, which is only possible through intensive cultivation and introducing hybrid varieties. At present India has also entered hybrid era. Hybrid rice occupies a special status owing to its high yield, excellent cooking and eating qualities. Besides its domestic requirement it also has a great export potential. Rice hybrids were first commercialized in the late 1970's in China. During the past decade Vietnam, India, the Philippines, Bangladesh, and the United States have also begun the commercial production of hybrid rice.

1.2 Cultivation of Hybrid rice:

1.2.1 Climatic requirement of hybrid rice

Rice cultivation in the world extends from 39^0 S latitude (Australia) to 50^0 N Latitude China. In India it stretches from $8\ ^0$ N Latitude to 34^0 N latitude. Rice is also grown even in area below sea level as in Kuttanad region of Kerala. The highest altitude at which rice is grown is in Nepal's Jumla valley in the Far Western Himlayan (Shahi and Hue 1979). Rice seedling from the nursery can be transplanted to the field when the mean daily temperature is about $13^0 - 15^0$ c. Weather variable affect the crop growth differently in different phenophase during its growth. Temperature between $20^0 - 30^0$ c is required for good growth at all stages but during flowering and yield formation small difference between day and night temperatures are required for good yield. The total growing period normally varies between 90 – 150 days depending on variety, temperature and sensitivity to day length. Optimum daytime air and water temperature for growth of rice are in the range of 28^0-35^0 C.

1.2.2 Soil

A wide range of soils is suitable for cultivation of rice but heavier soils are preferred due to low percolation losses. The crop has high tolerance to acidity with optimum pH between 5.5–6. Rice is moderately tolerant to salinity. For rice cultivation, soils of fine to medium texture are most commonly used.

1.2.3 Water Requirements

Water requirement of paddy rice for evapotranspiration are between 450 –700 mm, depending on climate and length of total growing period. Evaporation loss tend to become somewhat smaller at shallow submersion or when the topsoil partially dries out. Evapotranspiration increases upto vegetative growth is highest just before flowering to early yield formation after which it declines. Total water requirement includes water needed to raise seedlings, prepare land and to grow a crop of rice from transplanting to harvesting. The amount is determined by many factors, those include soil type, topography, proximity to drain, depth of water table, fertility of both top and sub soil, field duration of crop, land preparation method, and most of all evaporation demand of growing season thus it is estimated that 150 – 200 mm of water is needed for nursery preparation and 200 – 300 mm is needed for raising seedling. Sowing of 20 kg hybrid seeds in 400-m2 seedbed is sufficient for transplanting one hectare of land with 1-2 seedling at a distance of 20x15 cm during dry season and 20 x 20 during wet season. The amount of water needed for land preparation is about 200-350 mm and for field irrigation from transplanting to harvest is between 800 – 1200 mm with a daily consumption of 6-10 mm (Kung and Atthayodhin 1968).

1.2.4 Growth Stages of Rice

The growth stages of rice take 3-6 months, depending primarily on temperature and genetics characteristics with regard to photo period sensitivity and thermo- sensitivity. Because of weather factor specially temperature day length and genetics interactions, growth duration is highly site and season specifics. During the growth cycle rice completes three major phonological stages.

1. Vegetative Stage
2. Reproductive Stage
3. Ripening Stage

The phonological events characterizing the vegetative stages are germination, emergence, juvenile growth and panicle initiation. Root growth, active tillering, leaf initiation, leaf emergence and increase in leaf area characterize the vegetative stage. Duration of vegetative stage varies among cultivars and largely determined total growth duration. The duration has minimum and maximum limits. The minimum is relatively constant for a cultivar and is called the basic vegetative phase. The period between the minimum and maximum limits is the photo period sensitive phase. Duration of photo period sensitive phase depend on photoperiod and cultivar sensitivity to photo period. Photoperiod is a function of latitude and day of year.The phonological events characterizing the reproductive and ripening stages are heading, grain filling and physiological maturity. The reproductive and ripening stages are characterized by root growth, stem elongation, increase in plant height, panicle development, panicle emergence, decline in tiller formation, grain growth and leaf senescence. Duration of these two stages varies only slightly among cultivars.

1.2.5 Harvesting

Harvesting is done at the end of ripening stage and generally when 80 – 85 % of grains are matured. Delay in harvesting may lead to grain shattering, Too early harvesting produce immature chalky grain that breaks easily during milling. To minimize losses and deterioration of grain quality threshing should be done immediately and storing of grain is done at 14 % of moisture content.

1.3 Crop modeling

Crop is a group of plants grown on a unit area with objective of getting economic return and the plant is a photosynthetic factory, which converts carbon dioxide (CO_2) and water H_2O) in presence of Chlorophyll and sunshine into biomass (carbohydrate), which is source of energy for living beings. Thus whole agricultural process can simply be explained as a biomachine, which converts solar energy into carbohydrate by utilizing the atmospheric CO2 and soil nutrients. The water present in the soil acts as a carrier of nutrients and finally goes back to the atmosphere through evaporation and transpiration.

Crop modeling and systems analysis have become important tools in modern agricultural research. A crop model synthesizes our insights into the physiological and ecological processes that govern crop growth into mathematical equations. Our understanding of crop performance is tested by comparing simulation results with experimental observations, thus making the gaps in our knowledge explicit. Experiments can then be designed to fill these gaps. Modeling, especially crop simulation models for rice explains this process by quantifying each process of the system. A model is a set up mathematical equations describing the physical systems (soil, plant and atmosphere). As crop models are proto- types, they are based on assumptions that the state of the system at any moment can be quantified and the changes in the state can be described by mathematical equations, which lead to the model. The model simulates the behavior of a real crop by predicting the growth components such as leaves, roots, stems and grains. Crop growth simulation models not only predicts the final states of total biomass or harvest yield, but also contains quantities information's about major processes involved in the growth and development of a crop. The development of crop growth simulation model is a natural progression of scientific research.

1.4 DSSAT (Decision Support System for Agro-technology Transfer):

The Decision Support System for Agrotechnology Transfer (DSSAT) has been in use for more than 15 years by researchers in over 100 countries worldwide. DSSAT is a microcomputer software program combining crop soil and weather databases and programs to manage them, with crop models and application programs, to simulate multi-year outcomes of crop management strategies. As a software package integrating the effects of soil, crop phenotype, weather and management options, DSSAT allows users to ask "*what if*" questions and simulate results by conducting, in minutes on a desktop computer, experiments which would consume a significant part of an agronomist's career. So DSSAT is a collection of computer programmes integrated in to a single software package in order to facilitate the application of crop simulation model in research and decision-making. This software package was developed by IBSNAT (International Benchmark Sites Network for Agrotechnology Transfer) project. The IBSNAT was a collaborative programme of USAID with university of Hawaei, Honolulu (U.S.A). The DSSAT product represents the collective outputs of number of scientists involved in IBSNAT's global network collaborators. It was designed to help the acceleration of process of knowledge dissemination to the decision-makers. The DSSAT it self is a shell that allows to organize e and manipulate crop, soil, and weather data and to run crop models in various ways and analyze their outputs. Validation of DSSAT and its crop models was accomplished through global networks of benchmark sites involving systems users operating in diverse biophysical and socioeconomic environment. Thus DSSAT also provide validation of crop model outputs, thus allowing users to compare simulated outcomes with observed results. Inputting the users minimum data set, running the model and comparing the outputs accomplish crop model validation. The models available in DSSAT are

1. **Cereals Model (CERES)**: Barley, Maize, Millet, Sorghum, Rice, Wheat
2. **Grain legume model (CROPGRO)**: Soybean, Peanut and Dry bean
3. **Root crop model (SUBSTOR):** Cassava, Aroid, and Potato
4. **Others**: Sunflower, Sugarcane, Cotton, Tomato, Sunflower ,Pasture

The Decision Support System constitutes of the following

- Data base Management System (DBMS) to enter, store and retrieve the "**minimum data sets"** and need to validate, list and use the crop model for solving the problem
- A set of validated crop models for simulating process and outcome of genotype by environment interaction.
- An application programme for analyzing and displaying outcomes of long term simulated agronomic experiments.

A major milestone was achieved by IBSNAT with the integration of crop models databases for weather, soil and crops and agrotechnology transfer application programmes and their incorporation in to a single computer software package. The CERES-Rice model **(Tsuji et.al 1994)** is a process oriented crop growth simulation model that simulates soil water balance and nitrogen balance on daily incremental basis during the crop life cycle.

The model simulates the transformation of seeds, water, and fertilizers in to grains and straw through the use of land, energy (solar, chemical, biological) and management practice subject to environmental factors such as solar radiation, max/min air temp. Precipitation, day length variation, soil water properties and soil water condition.

1.5 Minimum Data Required

The minimum data set (MDS) refers to a minimum set of data required to run the crop models and validate the outputs. Validation requires site weather data for the duration of the growing season, Site soil data, and Management and experimental data for the experiment.

a) MDS Weather Data

The minimum required weather data includes: Latitude and longitude of the weather station, Daily values of incoming solar radiation (MJ/m^2-day), Maximum and minimum air temperature (°C), and Rainfall (mm). The length of weather records for validation must, at minimum, cover the duration of the experiment and preferably should begin a few weeks before planting and continue a few weeks after harvest so that "what-if" type analyses may be performed.

b) MDS Soil Data

Soil data includes soil classification (SCS), surface slope, color, permeability, and drainage class. Soil profile data by soil horizons include: Upper and lower horizon depths (cm), Percentage sand, silt, and clay content, 1/3 bar bulk density, Organic carbon, PH in water, Aluminum saturation, and Root abundance information.

c) Management and Experiment Data

Management data includes information on planting date, dates when soil conditions were measured prior to planting, planting density, row spacing, planting depth, crop variety, irrigation, and fertilizer practices. This data are needed for both model validation and strategy evaluation. In addition to site soil and weather data, experimental data includes crop growth data, soil water and fertility measurements. This data are needed for model validation.

1.6 Potential use of DSSAT:

Information needs for agricultural decision making at all levels are increasing rapidly due to increased demands for agricultural products and increased pressure on land, water and other natural resources. The gap between world food supply and demand is fast widening with time. The efficient use of climatic resources, early monitoring of weather and its impact on food production are some of the factors, which could help to decrease this gap to a certain extent. A pre harvest forecast of crop yield could be of immense use to planners. It will enable the government to take policy decision on advance planning of internal food distribution, relief measures, and grain storage and even providing alternative employment in drought prone areas. The crop simulation models are proposed as tool for agricultural risk analysis in order to explain the potential cropping location and appropriate farming system. Hence potential use of DSSAT is

1. As **a teaching and training tool** by providing interactive response to " ***what if*** " question related to improve understanding of the influence of season (weather), location (site and soil), and management on growth process of plants.
2. As **a research tool**, to derive recommendation concerning crop management and to investigate environmental and sustainability issues
3. As **a business tool**, to enhance profitability and improve input marketing
4. As **a policy tool**, for yield and area forecasting and land use planning.

1.7 Objective of Study:

In view of above a study entitled "**Application of Decision Support System for Agro-technology Transfer on Hybrid rice**" was undertaken with the following objectives:

1. To generate field base data for use in DSSAT CERES-RICE model developed by IBSNAT.
2. To validate the actual field results with DSSAT CERES-RICE model.
3. To predict grain yield and yield attributes, nitrogen uptake, nitrogen leaching, evapotranspiration, soil moisture condition using validated DSSAT-RICE model under different agronomical management practices of rice cv. HR-6444.

CHAPTER-2

REVIEW OF LITERATURE

Balasubramanian (2002) conducted a field experiment during the rainy (kharif) season of 1998 and 1999 to study the effect of levels (0, 150,200 and STCR-based N) and time of application (3 or 4 splits) of nitrogen on 'CoRH 1' hybrid rice (Oryza sativa L.). Hybrid rice recorded good response to N up to 256.7 kg/ha (STCR-based N). Higher levels of N improved the growth and yield of rice. The STCR-based N applied in 4 splits (basal, active tillering, panicle initiation and panicle emergence) registered the maximum grain yield, followed by 200 kg N/ha applied in 4 splits. Based on benefit: cost ratio and nitrogen-use efficiency application of 200 kg N/ha in 4 splits (basal, active tillering, panicle initiation and panicle emergence) was found to be superior to the other treatments

Bali and Uppal (1995) conducted an experiment during Kharif (monsoon) season of 1989 and 1991 to study the response of rice cv. Basmati-370 to initial submergence duration (5, 10, 15 or 20 days), irrigation (2 or 4 days after disappearance of ponded water) and transplanting dates (10 or 30 July) on a non-cracking soil at Ludhiana, India. Transplanting on 10 July Improved growth and yield attributes favorable and gave 8.4% higher grain yield than transplanting on 30 July. Initial continuous submergence for 15 days after transplanting Increased grain yield by 11.5 and 4.1% compared with 5 and 10 initial submergence duration, respectively. Irrigation 2 days after disappearance of ponded water increased growth and yield attributes thereby causing significant increase in grain yield by 7.6% compared with irrigation 4 days after disappearance of ponded water. Increase in initial submergence and Irrigating at shorter intervals Increased water use and leaf water potential but decreased canopy temperature.

Bandyopadhyay (1997) studied and conducted a field experiment during 1989-90 and 1990-91 on sandy loam soil of Memari, West Bengal, to study the effect of various moisture regimes on the dynamics of evapotranspiration for winter wheat based on various components of the field water balance. Irrigation of

50 mm depth applied at 1.2 depth of irrigation water: cumulative pan evaporation gave the maximum the maximum grain yield (3111kg/ha) and yield attributes and showed highest water use efficiency (12.93 kg/ha/mm) and actual evapotranspiration (239.08mm). Water uptake was found maximum (56.5%) from the 0-15 cm layer and it gradually changed with soil depths. A higher rainfall and its good distribution during 1989-90 resulted in sizeable deep drainage and non-significant yield response to irrigation regimes.

Beldar. et al. (2004) studied and reported that with decreasing water availability for agriculture and increasing demand for rice, water use in rice production systems has to be reduced and water productivity increased. Alternately submerged– nonsubmerged (ASNS) systems save water compared with continuous submergence (CS). However, the reported effect on yield varies widely and detailed characterizations of the hydrological conditions of ASNS experiments are often lacking so that generalizations are difficult to make. We compared the effects of ASNS and CS on crop performance and water use, at different levels of N input, in field experiments in China and the Philippines, while recording in detail the hydrological dynamics during the experiment. The experiments were conducted in irrigated lowlands and followed ASNS practices as recommended to farmers in China. The sites had silty clay loam soils, shallow groundwater tables and percolation rates of 1–4.5mm per day. Grain yields were 4.1–5.0 t ha.1 with 0 kgNha.1 and 6.8–9.2 t ha.1 with 180 kgNha.1. Biomass and yield did not significantly differ between ASNS and CS, but water productivity was significantly higher under ASNS than under CS in two out of three experiments. There was no significant water x nitrogen interaction on yield, biomass, and water productivity. Combined rainfall plus irrigation water inputs were 600–960mm under CS, and 6–14% lower under ASNS. Irrigation water input was 15–18% lower under ASNS than under CS, but only significantly so in one experiment. Under ASNS, the soils had no ponded water for 40–60% of the total time of crop growth. During the non submerged periods, ponded water depths or shallow groundwater tables never went deeper than .35 cm and remained most of the time within the rooted depth of the soil. Soil water potentials did not drop below 10 kPa. We argue that our results are typical for poorly drained irrigated lowlands

Bisht et al. (1991) tested the performance of the newly released varieties Pusa Basmati 1, Kasturi and HKR228 was compared with the local control Basmati 370 at 60, 90 and 120 kg N/ha. Urea was applied in 3 splits: 1/2 basal, 1/4 at tillerlng and 1/4 at 1 week before panicle initiation. The basmatl varieties, Pusa, Basmatl 1 and Kasturi, showed no differential response to N but had higher yields than the control. Kasturl Control HKR228 produced almost similar mean yields (3.3 and 3.4 t/ha, respectively) which was significantly higher than those of Pusa Basmatl 1 (3 t/ha), N response was significant up to 90 kg N/ha.

Bodruzzaman et al. (2002) studied and reported that the integrated use of chemical fertilizers with organic matter can help for a sustainable and environmentally sound agriculture production in soils low in organic matter. A 3-years study with rice and wheat cropping pattern was conducted on a sandy loam soil at the Wheat Research Centre, Nashipur, Dinajpur, Bangladesh to investigate the direct, renewed and residual effect of organic manures in combination with chemical fertilizers on crop productivity and soil fertility. The experiment was laid out with nine treatments in a randomized complete block design. The treatments were: I) absolute control (no fertilizers, no manures), 2) 100% NPKSZn of recommended dose, 3) 75% NPKSZn of recommended dose, 4) 75% NPKSZn+ farm yard manure (FYM) applied in wheat (a direct effect for wheat and residual effect. for rice), 5) 75% NPKSZn+FYM applied in both wheat and rice (a renewed effect for both continuing crops), 6) 75% NPKSZn+FYM applied in rice (a direct effect for rice and a residual effect for wheat), 7) 75%NPKSZn+ poultry manure (PM) applied in wheat (a direct for wheat and a residual effect for rice), 8) 75% NPKSZn+PM applied in both wheat and rice (a renewed effect), 9) 75% NPKSZn+PM applied in rice (a direct effect for rice and a residual effect for wheat). The results indicated that a wheat yield-increasing trend was observed for the PM treatment both as direct and residual. However, a yield-declining trend was observed in the control. There was no definite wheat yield trend for the other treatments. No definite rice yield trend was observed irrespective the treatments. The results showed that organic manures had direct and residual effects on both rice and wheat yields, but the effect of PM was dominant Plots with FYM: plus 75% NPKSZn produced equivalent yields as plots applied 100% NPKSZn indicating that FYM can substitute for 25% of the inorganic fertilizers. Organic manure application in dry land winter crops like wheat performed better than organic manure application in wetland summer crop like rice. The results also showed that OM application in both crops was not encouraging. The highest mean yield of wheat and rice was recorded in PM treatment as direct in wheat and rice, respectively. However, the total (wheat+rice) highest yield was 8,055 kg ha-' year-I recorded in PM treatment when applied in wheat. The soil analyses data indicated that pH was unchanged in control and inorganic fenilizers treatments, but increased in plots with added organic manures with dominant trend in PM plots over the 3-years' study. Percent reduction of OM in plots with inorganic fertilizers treatments was observed and the range varied from 13 to 19%. However, the increasing trends of OM was observed in plots organic manures receiving treatments in the ranged of 7 to 39%. An increasing trend was prominent in PM application treatments. Percent total N was unchanged in integrated use of OM with inorganic fertilizers, but reduced in control and inorganic fertilizers receiving plot treatments. The content of available P was increased dramatically in PM applied plot treatments. It was unchanged in 100% NPKSZn and FYM plots, but reduced in control and in 75% NPSSZn. Exchangeable K was reduced in control and inorganic fertilizer treatment, but was sustained in others. The available S was sustained irrespective the treatments.

Dawe et al. (2003) reported that opinions differ as to the importance of organic amendments (OA) for sustaining crop productivity in the intensive, irrigated rice systems of Asia. Our objectives were to (1) quantify the effects of farmyard manure (FYM) and straw incorporation on yield trends in long-term experiments (LTEs) with rice–rice (R–R) (Oryza sativa L.) and rice–wheat (R–W) (Triticum aestivum L.) systems and (2) assess the potential effects of OA on profitability, taking into account long-term effects on yield. We analyzed yield trends in 25 LTE (seven R–R, 18 R–W systems) across a wide geographical range in Asia. Three main conclusions emerged from this analysis. First, application of either manure or straw did not improve grain yield trends in R–R and R–W cropping systems. Second, depending on socio-economic conditions, use of manure or straw in these cropping systems may be profitable, provided these OA are used as a complement to a recommended dose of inorganic NPK (i.e. organic materials should not be used as the primary nutrient source). Third, current experimental designs to assess the suitability of OA need to be improved in order to allow a better comparison of the relative advantages of inorganic and organic fertilizers. The major shortcoming of current designs is that they do not properly adjust mineral fertilizer rates in the inorganic treatments to account for the macronutrient input from OA. Thus, our tentative estimates of the profitability of OA may be overstated.

Eitzingera et al. (2002) studied the effect of water balance parameters and water stress on winter wheat production in a specified environment and under different climate changes scenarios using the CERES (Crop Environment Resource Synthesis) Wheat model. For the study, two tests sites with similar climatic conditions and soil water storage potential but with (site B) and without (site A) groundwater impact in a semi-arid agricultural area in central Europe (southeast of the Czech Republic and northeast of Austria) were chosen. For the current climatic conditions, the impact of groundwater to the rooting zone at site B caused a rain-fed yield level close to the potential yield (6772 kg ha_1), whereas at site A the rain-fed yield reached only 49% of the potential yield level of 6552 kg ha_1. Although potential yields also increased at both sites in the range of 17–24%, rain-fed yields came closer to potential yields under all applied climate scenarios (47–61% of potential yield at site A and 55–75% of potential yield at site B, depending on the climate scenario). The most yield-sensitive simulated growing stage at both sites was found during the grain filling period. Despite higher yield levels, crop transpiration and water stress dropped significantly compared with current conditions through the simulated increase in water use efficiency and reduced total potential evapotranspiration (caused by shortened growing period) under the applied 2_ CO2 climate scenarios. Up to 42% (194 mm) of evapotranspiration was provided by groundwater at site B under present climate and only 126 mm was used for the worst-case scenario ECHAM. For both locations, however, the availability and management of soil water reserves will remain an important influence on the attainment of the Agricultural Water Management potential yield level of winter wheat under climate change scenarios, especially when extreme events such as droughts occur more frequently and annual soil and groundwater recharge decrease.

Eitzinger et al. (2003) studied and compared the CERES, WOFOST and SWAP models in simulating soil water content during growing season under different soil conditions. A lysimeter experiment was conducted on three soil types in a main agricultural production region of Austria in Marchfeld (latitude 48.12 -N, longitude 16.34-E and altitude 150m above sea level), was used to test the performance of the three widely used crop models, CERES, SWAP and WOFOST. The soils included chernozem, sandy chernozem and fluvisol with a 2.0m profile depth. Daily measurements of the soil water content were taken using TDR probes (one per 0.3m of depth) in six replicates for each soil type. The analysis was carried out for winter wheat and spring barley grown on the site during seasons 2000 and 2001 and included a detailed comparison of the simulated and measured soil water contents as well as an analysis of seasonal soil water balances, root front velocities and an evaluation of the modeled crop yields. CERES and SWAP, in contrast to WOFOST, simulated the grain yield of barley and wheat well. All three models simulated soil water content in the profile with similar results. The root mean square error (RMSE) range of soil water content was 0.71–4.67% for barley and 2.32–6.77% for wheat, depending on the model and soil type. None of the models simulated total soil water content in the profile significantly better, but there was a general tendency for the models to overestimate soil water depletion. Both CERES and SWAP mimicked the soil water content dynamics well in the top 0.3m of the soil. The study shows that the multiple layer approach models (SWAP or CERES) including more sophisticated estimation methods for root growth and soil water extraction should be preferred in comparable environments. Further adjustments of evapotranspiration subroutines to the local conditions should be considered prior to the model use for drought impact assessment, yield forecasting or climate change impact studies.

Faria et al. (2003) studied the performance of the soil water balance module (SWBM) in the models of DSSAT v3.5 and evaluated it against soil moisture data measured in bare soil and dry bean plots, in Parana, southern Brazil. Under bare soil, the SWBM showed a low performance to simulate soil moisture profiles due to inadequacies of the method used to calculate unsaturated soil water fux. Improved estimates were achieved by modifying the SWBM with use of Darcy's equation to simulate soil water flux as a function of soil water potential gradient between consecutive soil layers. When used to simulate water balance for the bean crop, the modified SWBM improved soil moisture estimation but under predicted crop yield. This was corrected by replacing empirical coefficients with measured values of soil hydraulic conductivity at different depths. So it is concluded that the original SWBM of DSSAT v3.5 showed a low performance to simulate soil moisture profiles for bare and cropped soil because of inadequacies in the methods used to calculate soil water flux and root water absorption which was modified with the introduction of Darcy's equation to calculate soil water flux significantly.

Gijsman et al. (2002) reported that in low input system, where most nutrients become available from soil organic matter (SOM) and residue turn over, the applicability of DSSAT crop simulation models is limited because

1. It recognizes only one type of SOM (i.e. humus) and recently added, but not yet humified, residue.
2. It does not recognize a residue layer on top of the soil.
3. Newly formed humus is given fixed C/N ratios of 10.
4. Only one litter pool is recognized for N although three are recognized for C.
5. For residue with C/N ratio <25, the three litter pools for C decompose at a rate that is independent of the residue's N concentration;
6. SOM and residue flows are independent of soil texture;

A SOM residue module from the CENTURY model was incorporated in the DSSAT crop simulation model models, and a residue layer was added on the top of the soil. Modifications were also made in the senescence module of CROPGRO, a model with in DSSAT, so that senesced material is now added daily to the soil. Evaluation of the model, using a data set of 40 yr. of base fallow, showed an excellent fit between simulated and measured values for SOM-C soil N from decomposing SOM and residues was evaluated with data from a Brazilian experiment with seven leguminous residue types. By incorporating the CENTURY SOM- residue module, DSSAT crop simulation models have become more suitable for simulating low-input systems and conducting long-term sustainability analysis.

Hariom et al. (1997) A field experiment on rice hybrid 'PMS 2A1IR 31802' was conducted during rain season 1993 and 1994 to study the effect of 5 nitrogen levels (0, 50, 100, 150 and 200 k/ha) and 3 seed rates in nursery (20, 40 and 60 g/m2). There was significant increase in plant height; dry-matter accumulation, productive tillers/m2, panicle weight and grain yield with an increase in level of nitrogen from 0 to 150 kg/ha. Further increase in N rate up to 200 kg/ha could not show significant increase. Straw yield was found significant up to 200 kg N/ha. The lowest seed rate of 20 g/m2 recorded the highest grain yield, followed by 40 and 60 g/m2, Similar trend was observed for growth attributes, panicle weight and straw yield.

Hariom et al. (1998) A field study was undertaken in hybrid rice (Oryza sativa L.) with 5 nitrogen levels (0, 50, 100, 150 and 200 kg/ha) and 3 methods of nursery raising puddled and dry sowing in hybrid 'ORI 161' ('PHS 71 ') and dry sowing in hybrid 'PMS 2A' x 'IR 31802']. There was significant increase in grain yield up to 200 kg N/ha in 1993, whereas up to 150 kg N in 1994. Straw yield increased significantly up to 200 kg N/ha. Panicle weight increased up to 150 kg N in 1993 and 100 kg N/ha in 1994. N and P uptake in grain and straw was affected significantly up to the highest level of N application. Hybrid 'ORI 161' registered 9.9 q/ha (puddled sowing) and 8.5 q/ha (dry sowing) increase in grain yield over hybrid 'PMS 2A' x 'IR 31802' (dry sowing). Panicle weight and straw yield also followed the similar trend. Plants were more taller in hybrid 'ORI 161' than in 'PMS 2A' x 'IR 31802'.

Hartkamp et al. (2002) Velvet bean (Mucuna pruriens (L) DC cv group utilis) is widely promoted as GMCC for tropical regions. Reports of insufficient biomass production in certain environments and concerns over seed production, however, suggest a need for a more complete description of growth and development of velvet bean under different production scenarios and environments. Process based simulation models offer the potential for facilitating an assessment of management strategies for different environments, soils and production systems. The objective of this study was to review the physiology of velvet bean and using the generic legume model. CROPGROW, to provide a structured and quantitative framework for describing crop response to management and environment. Model coefficients used to described growth and development of soybean served as initial reference value. Information on velvet bean from published sources was then used to revise the functions and parameters of the model. Phenology, canopy development, growth and partitioning were calibrated for two velvet bean varieties using experimental data from three sites in Mexico. Compared to soybean, velvet bean has a much longer growth cycle, allowing a very large numbers of nodes to form. Velvet bean has larger, thinner leaves than soybean, resulting in more rapid leaf area development, and larger seeds, which affects germination, early season growth and pod development. A modification to velvet bean appears to be similar to other tropically adapted legumes. The new model, incorporates as part of DSSAT, version 3.5 suite of crop simulation models, has potential for evaluating management strategies in specific environments and to identify potential regions for introduction of velvet bean as a green manure cover crop.

Hundal and Kaur (1999) reported that Crop Growth Simulation Model are quantitative tools based on scientific knowledge that can evaluate the effect of climatic, hydrologic and agronomic factors on crop growth and yield. Several computer simulation models have been developed in recent years to predict the growth on daily basis for estimating large area crop production there is a need to assess the productivity potential of wheat in different agro climatic zones of the country. Several wheat models e.g., CERES- Wheat have been developed out side India. Fields studies at Ludhiana (Punjab) were conducted for the validation of wheat crop simulation model (CERES -WHEAT). The result revealed that this model can be used to estimate the potential production of wheat under different environments in the central irrigated plains of Punjab. The model predicted crop phenology, growth and yield satisfactory over the eight test crop seasons. The model predicted grain yields from 80 to 115 % (mean 97.5 %) of the observed grain yields. This model is being applied to predict yield of wheat crop before harvest in Punjab for the purpose of agro- advisories.

Jame et al. (1996) reported that the Decision Support System for Agrotecnology Transfer (DSSAT) allows users to combine the technical knowledge contained in crop growth models with economic considerations and environmental impact evaluation to facilitate economic analysis and risk assessment of farming enterprises .He concluded that thus DSSAT is a valuable tool to aid the development of a valuable and sustainable agricultural industry. The development and validation of crop models can improve our understanding of the under lying process, pinpoint where the understanding is inadequate and hence support strategic agricultural research. The knowledge based system approach offers great potential to expand the ability to make good agricultural management.

Jones et al. (2003) reported that the Decision Support System for Agrotechnology Transfer (DDSAT) has been in use for the last 15 years by researchers worldwide. This package incorporates models of 16 different crops with software that facilitates the evaluation and application of the crop models for different purposes. Over the last few years, it has become increasingly difficult to maintain the DSSAT crop models, partly due to fact that there were different sets of computer code for different crops with little attention to software design at the level of crop models themselves. Thus, the DSSAT crop models have been re-designed and programmed to facilitate more efficient incorporation of new scientific advances, applications, documentation and maintenance. The basis for the new DSSAT cropping system model (CSM) design is a modular structure in which components separate along scientific discipline lines and are structured to allow easy replacement or addition of modules. It has one Soil module, a Crop Template module which can simulate different crops by defining species input files, an interface to add individual crop models if they have the same design and interface, a Weather module, and a module for dealing with competition for light and water among the soil, plants, and atmosphere. It is also designed for incorporation into various application packages, ranging from those that help researchers adapt and test the CSM to those that operate the DSSAT_ CSM to simulate production over time and space for different purposes. Crop models have been used for various applications. The benefits of the new, re-designed DSSAT-CSM will provide considerable opportunities to its developers and others in the scientific community for greater cooperation in interdisciplinary research and in the application of knowledge to solve problems at field, farm, and higher levels.

Kurry (1998) conducted the field trial on Pusha Basmati 1 taking different levels of irrigation and fertilizer doses and tested the evapotranspiration, growth development, yield and yield attributes and Et_c and reported that increasing the level of irrigation increased the grain yield. Improving the fertilizer dose increased the production. Lysimeter with higher doses of fertilizer recorded increased evapotranspiration and crop coefficient at different growth stages.

Lars et al. (2002) conducted an experiment in which a field lysimeter study was used to evaluate leaching of manure-derived nitrogen over a 3 y period. Barley (Hordeum vulgare L.) was seeded in mid-May each year in the Iysimeters (0.3 m diam. and I m deep) containing an undisturbed, well-drained, sandy soil. Manure labeled with N (poultry excreta), which was either fresh or had been decomposed under aerobic or anaerobic conditions, was applied in May during the first year at a rate corresponding to 100 kg total N ha-'. For comparison, labeled NH4; N03 (100 kg ha-I) was applied simultaneously to additional lysimeters while others were left unfertilized (NO). During the 2nd and 3rd year, all lysimeters, except the unfertilized ones, received unlabeled NH4~N03 at a rate of 100 kg N ha-I. Based on the difference method, leaching of total N during the first year was not significantly different ($P > 0.05$) between lysimeters treated with NH4N03, fresh manure and anaerobic manure, but lower from those with aerobic manure (of added N, 22.5, 23, 15.1, and 6.0 % leached from the respective treatment). Regarding leaching of residual manure- and fertilizer derived N estimated with the N method, there was a significant difference ($P < 0.05$) between the NH4N03 fertilized and manured lysimeters. As much as 19,28 and 26% leached in the treatments with fresh, anaerobically and aerobically decomposed manure, respectively, whereas only about 3% leached in the NH4N03 fertilized lysimeters in the two subsequent years.

The available literature on leaching of No3-N from organic farming, in which only manures are used as N-source, and conventional farming systems showed that both the sequence and type of crops grown, and the input intensity of N was different in the two systems. Organic farming systems had on average a lower N input and more legumes in rotation. Average leaching of NO3-N from organic farming systems over a crop rotation period was somewhat lower than in conventional agriculture. If the different input intensities of N between organic and conventional systems were taken into account and corrected for, no differences in leaching losses between systems were found. Furthermore, if the goal is to maintain the same crop yield levels as in conventional farming, we could not find any evidence that N03 leaching will be reduced by the introduction of organic farming practices. Reduction of NO3 leaching is not a question of organic or conventional farming, but rather of introduction and use of appropriate counter measures. This insight should guide our thinking when developing environmentally friendly and sustainable cropping systems.

Li et al. (2004) studied and reported about controlled irrigation and fertilizing strategies under rainwater-harvesting technology in semi-arid areas. Effects of the amounts of applied water and fertilizer on water use and yield of spring wheat were determined. The experiment included four water treatments during the spring wheat growth period. The four treatments were (total water applied): rich water (RW), 400 mm; moderate water (MW), 300 mm; low water (LW), 100 mm, and natural water (NW), 212 mm. (In the first three situations, rainfall was excluded from irrigation plots while in the fourth only natural rainfall was utilized.) Four nutrition conditions were set up for each water treatment: high fertilizer (HF) 372 kg ha.1, moderate fertilizer (MF) 248 kg ha.1, low fertilizer (LF) 124 kg ha.1 and without fertilizer application (CK). Each water–fertilizer treatment was replicated three times. Both soil water content and water use efficiency (WUE) (in terms of grain yield) increased with increasing applied water. The mean WUE were 6.37, 5.61, 5.08 and 4.40 kg ha.1 mm.1 in RW, MW, NW and LW, respectively. WUE increased increasing applied and P fertilizer. Compared with LW treatment, MW and RW resulted in stronger seedlings, larger and deeper root system, and higher leaf area index (LAI). For RW, MW and NW, the maximum of root biomass increased 96.4, 56.6 and 21.6%, respectively, compared with that for LW. The value of LAI increased 95.6, 66.9 and 40.9%, respectively. The values of leaf area duration (LAD) in RW, MW and NW were remarkably higher than that in LW. Under RW, MW, NW and LW condition, the mean grain yield for the four fertilizer treatments were 3290, 2347, 1665 and 964 kg ha.1, respectively. The mean grain yield in RW, MW and NW increased 241, 143 and 73%, respectively, compared with that in LW. Yield components analysis indicates that the quality and quantity of spikelets and floccules played critical role in grain formation of spring wheat. Statistical analysis of experiment results indicates that the minimum coefficient of water-consumption (0.110 mm/(kg ha.1)) occurred in RW, and the relevant optimal fertilizer application amount was 377 kg ha.1. In various water–fertilizer treatments, WUE was the highest (8.733 kg ha.1 mm.1) under rich water with high fertilization, while grain yield was consistently the highest (4514 kg ha.1). This indicates that rich water with high fertilizer is the most efficient way in the experiment. These results may offer help to controlled irrigation and fertilization in agricultural water management in semi-arid regions.

Manish et al. (2003) conducted an experiment consisting of 13 treatments at Pantnagar, during 1999 and 2000, to assess the effect of crop residue, nitrogen doses and FYM applied to rice *(Oryza sativa* L.). Wheat *(Triticum aestivum* L. emend. Fiori & paol.) straw @ 5 or 10 tones/ha resulted in higher values of yield attributes (panicle length, filled spikelets/panicle and 1,000-grain weight) and grain and straw yields of rice compared to the control. Increasing dose of nitrogen increased yield attributes and grain yield of rice significantly, wherein, application of 100% recommended dose of N recorded more panicle length filled spiklets/panicle and 1000 grain weight and consequently grain yield and NPK uptake. FYM @ 20 tones/ha also resulted significantly higher values of yield attributes, grain yield and nutrient uptake of rice over the control and wheat straw applied @ 5 or 10 tones/ha as well as 50% N used alone. Integrated use of wheat straw @ 10 tones/ha + 100% recommended dose of N resulted in maximum values of yield attributes, grain yield as well as, NPK uptake by rice. Use of organic sources helps in maintaining soil fertility, whereas with chemical fertilizers a significantly decline was observed.

Meena et al. (2002) conducted a field experiment to study the response of hybrid rice (Oryza sativa L.) to nitrogen and potassium application at the research farm of the IARI, New Delhi, during the rainy seasons of 1998 and 1999. The application of nitrogen significantly increased the effective tillers, length and weight of panicles, number of grains and filled grains, 1,000-grain weight, grain and straw yields and NPK uptake by hybrid rice up to the level of 200 kg N/ha. With the fitting of quadratic equation, it was found that 165.5 kg N/ha as an economic dose for the hybrid rice ('PA 6207') and 75 kg K201ha applied in 2 equal splits half at transplanting + 1/2 at maximum tillering to get maximum economic yield of rice crop.

Nain et al. (1999) studied and reported about the issue of real time assessment of the direction and quantum of variability in wheat yields is addressed. A simple technology trend model in conjunction with crop simulation model (CERES-Wheat in DSSAT environment) was used for early wheat yield prediction at six locations representing the six major wheat-growing states, which contribute about 93% of national wheat production. A three-step approach, viz. (a) prediction of technological trend-based yields, (b) quantification of weather-induced yield variability using Crop Simulation Model (CSM), and (c) final yield prediction combining the previous two steps (a) and (b), was applied. A simulation model when run on a common set of soil properties, genetic coefficients and agronomic practices, is supposed to capture inter-annual yield variability due to year-to year varying weather conditions. Deviation in observed wheat yield from its technology trend and deviation in simulated wheat yield from its trend/ average showed positive relationship ($r = 0.57$, $P > 0.05$). An overall RMSE of 0.158 t ha–1 (5.619%) with R2 0.97 was found against mean wheat yield of 2.815 t ha–1. Real time weather data up to February and normal onward were used, for early wheat yield assessment at six locations. The study has significance in issuing an early 'national wheat' production forecast using in-season weather data up to February and normal weather data for the rest of the period.

Pang et al. (1997) reported that the combined effects of irrigation and N management on crop yield and NO3- leaching have not been extensively investigated. The objective of this study was to quantify the relationships between irrigation management (including uniformity) and N management on corn (Zea mays L.) yield and NO3- leaching. Yield and N leaching were simulated using the CERES-Maize (version 2.10) model for various combinations of irrigation amounts and uniformity and N amount and timing of split N applications for semiarid conditions typical of Tulare County in California. Simulated grain yield increased, reached a plateau, and then decreased with increase in applied water under uniform irrigation. The amount of applied water above that yields decreased was higher for the higher N application rate and the later simulated split N application. The simulated amounts of N leached were consistent with the yield results. The higher water applications that lead to reduced yields were associated with higher N leaching for a given N application amount. The effects of irrigation were simulated assuming Christensen's Uniformity Coefficient (CUC) of 100, 90, and 75. The results were only slightly affected by CUC = 90 compared with 100. A CUC of 75 caused a reduction in yield and increase in N leaching compared with uniform irrigation. The lowest CUC required a higher N application to achieve the same yield as uniform irrigation. Under non-uniform irrigation, it is impossible to manage either water or N application in a manner to achieve high yields without considerable NO3- leaching. High yield and low NO3- leaching are compatible goals and can be achieved by appropriate irrigation and fertilizer management for irrigation systems that have a CUC of 90 or greater.

Saren et al. (1999) conducted a field experiment during summer season of 1990 and 1991 on intercropping maize and groundnut on a well-drained sandy loam soil under 4 levels of irrigation. Inter crop maize gave slightly higher yield (3.2-5.8%) compared with sole maize; 1146 and 946 kg/ha extra kernel yield of inter crop groundnut at 1:2 and 2:3 row ratio respectively. Intercrop of groundnut yielded lower than the sole groundnut. Irrigation increased the yield of maize, groundnut and total yield in terms of maize equivalent, consumption use of sole maize, sole groundnut and their mixture of 1:2 and 2:3 ratio were 29.6,28.8,30.0 and 31.2 cm respectively. Consumptive use efficiency was greater in intercropping system than sole crop. Inter cropping increased NPK uptake by maize+groundnut was also greater in intercropping system. Irrigation increased NK uptake in maize stover and augmented NPK uptake in different parts of groundnut plants except NK uptake in stalk. Total NPK uptake by maize+ ground nut increased with irrigation and maximum NP uptake at 2 irrigation and K uptake at 1 irrigation.

Saseendran et al. (1998) reported that CERES-RICE vs. 3.0, a physiological based rice crop model included in Decision Support system for Agrotechnology Transfer (DSSAT), simulates the effect of weather, cultivar, management practice, soil water and N fertilizer on rice growth, development and yield. The rice cultivar Jaya was selected for the study because of its wide use in Kerala State. Calibration of the model was accomplished with date from 19993 on Jaya under rain fed condition furnished by Kerala University ($12^0 12'$N, $75^0 10'$E). In four experiments using different transplanting date during virippu season (June-Sept) under rainfed condition (no irrigation), the flowering date was predicted with an error of four days and date of crop maturity with in an error of two days. The model was found to predict the phonological events of the crop fairly well. The grain yield predicted by the model was with an error of 3% for all the transplanting dates, but the straw yield prediction was with an error of 27%. The high accuracy of the grain yield prediction showed the ability of the model to simulate the growth of the crop in agroclimatic condition of Kerala. It can be concluded for this study that the model can be used for making various strategic and tactical decisions related to agricultural planning in the state.

Sexton et al. (1996) studied and reported about the study that was conducted on a Verndale sandy loam soil (coarse loamy over sandy, mixed, frigid Udic Argiboroll) during 1991 and 1992 at Staples, MN, to asses the influence of irrigation scheduling and N source and rate on corn (Zea mays L.) yield and nitrate leaching. Nitrogen sources were urea and turkey manure. Soils were irrigated to field capacity (i) at a fixed trigger deficit throughout the season, or (ii) at a variable trigger deficit based on crop growth stage. Leaching losses were calculated from measured daily fluxes of water percolation and soil water NO3-N concentrations and from a seasonal N mass balance. Based on yield response curves, maximum corn grain yields were obtained at 202 and 234 kg N ha-1 urea in 1991 and 1992, respectively. This resulted in growing season leaching losses of 72 and 55 kg N ha-1 in 1991 and 1992, respectively. The rate at 95% of the maximum crop yield is suggested to substantially reduce nitrate leaching past the root zone. Using this guideline, nitrate leaching would be reduced by 35% compared with nitrate leaching at the maximum yield. When a variable available water deficit was used to schedule irrigation compared with a fixed deficit schedule (at 95% of maximum yield N rate), nitrate leaching was reduced 46%. At equivalent N rates, turkey manure produced equal or greater crop yields as that from urea applications; however, nitrate leaching was equal to or less than urea.

Sharma et al. (1998) conducted a field experiment during 1994-95 and 1995-96 to evaluate some locally available organic plant residue as supplementary source of nutrients in maize-wheat cropping system. Grain yield, nutrients uptake by maize increased significantly with increase in levels of NPK. Response to 100% NPK was 1.51 and 1.36 tonnes/ha over control yield of 1.87 and 1.62 tones/ha in maize and wheat crops respectively. Integration of 75% N through chemical fertilizers+25 %N through organic sources gave equal yield to 100%NPK.Among different organic sources, farmyard manure proved inferior source of N substitution. The water holding capacity, organic carbon, available nitrogen and phosphorus increased with increase in organic residues while available K and bulk density decrease. The values were more evident in integration of 50% N from chemical fertilizer +50% N through organic sources, viz. farmyard manure, white popinac leaves and black gram straw.

Sharma et al. (2002) reported that the DSSAT (Decision Support System for Agrotechnology Transfer) developed by IBSNAT (International Benchmark Sites Network for Agrotechnology Transfer) is a pool of crop models. One of such models embedded in this is CERES for various cereal crops. For rice crop, it is RICER.The DSSAT was tried to predict the grain yield of rice cv IR 64 grown under two nitrogen and three irrigation levels for the soil climatic conditions of Roorkee. The observed and predicted grain yield results under different treatments were statistically compared and found to be significantly not different. Comparing the overall averages of the six treatments the DSSAT was found to overestimate the grain yield by 2.69% only. Thus the DSSAT predicted result could be treated as satisfactory and the model may be accepted as validated for the soil climatic conditions of Roorkee.

Shivay et al. (2003) conducted a field experiment during the rainy *(kharif season* (July-October) of 2000 and 2001 at Indian Agricultural Research Institute, New Delhi, to study the effect of planting geometry and nitrogen levels on growth, yield attributes, yield and nitrogen-use efficiencies of 'PRH 10' scented hybrid rice *(Oryza sativa* L.). Planting geometry did not influence growth; yield attributes, yields and nitrogen-use efficiency. However, each unit increase in N leveled to significant increase in growth, yield-attributing characters, and yield of rice. The maximum grain yield (65.5 q/ha) was recorded with highest level of N. The maximum response was observed at 75 kg N/ha and thereafter it decreased with the increase in N level. The nitrogen-use efficiency (NUE), apparent recovery (%), nitrogen efficiency ratio (NER) and physiological efficiency index of absorbed nitrogen (PEIN) were significantly higher at lower level of N and decreased significantly with increasing N levels.

Singh et al. (1999) studied and reported that in rainfed agriculture, climatic variability has profound effects on the performance of management systems in improvements of productivity and use of natural resources. A field study was conducted on a Vertic Inceptisol during 1995 -1997 seasons at the ICRISAT Center, Patancheru, India, to study the effect of two landforms, i.e., broadbed-and-furrow (BBF) and flat, and two soil depths (shallow and medium-deep) on crop yield and water balance of a soybean-chickpea rotation. Using two seasons experimental data, a soybean-chickpea sequencing model was evaluated and used to extrapolate the results over 22 years of historical weather records. The simulation results showed that in 70% of years total runoff for BBF was greater than 35 mm (range 35-190 mm) compared to greater than 60 mm (range 60-260 mm) for flat on the shallow soil. In contrast on the medium-deep soil it was greater than 70 mm (range 70-280 mm) for BBF compared to greater than 80 mm (range 80-320 mm) for the flat landform. The decrease in runoff on BBF resulted in a concomitant increase in deep drainage for both soils. In 70% of years, deep drainage was greater than 60 mm (range 60-390 mm) for the shallow soil and ranged from 10 to 280 mm for the medium-deep soil. In 70% of years, the simulated soybean yields were greater than 2200 kg ha¡1 (range 2200-3000 kg ha¡1) and were not influenced by landform or soil depth. In the low rainfall years, yields were marginally higher for the BBF than for the flat landform, especially on the shallow soil. Simulated chickpea yields were higher for the medium-deep soil than for the shallow soil. In most years, marginally higher chickpea yields were simulated for the BBF than for the flat landform on both soil types. In 70% of years, the chickpea yields were greater than 500 kg ha¡1 (range 500-1500 kg ha¡1) for the shallow soil, and greater than 800 kg ha¡1 (range 800-1960 kg ha¡1) for the medium-deep soil. Total productivity of soybean-chickpea rotation was greater than 3000 kg ha¡1 (range 3000-4150 kg ha¡1) for the shallow soil and greater than 3450 kg ha¡1 (range 3450-4700 kg ha¡1) for the medium-deep soil in 70% of years. These results showed that in most years BBF, landform increased rainfall infiltration into the soil and had marginal effect on yields of soybean and chickpea. Crop yields on Vertic Inceptisols can be further increased and sustained by adopting appropriate rain water management practices for exploiting surface runoff and deep drainage water as supplemental irrigation to crops in a watershed setting.

Slattery et al. (2002) studied and reported that the addition of carbon to soil in the form of composted organic matter in the field, eg. an organic fertilizer, was shown to add carbon to the humus pool, but is likely to result in significant losses via carbon dioxide respiration. In this study, 68% of the applied carbon as stabilized composted bovine manure was lost from the soil, presumably as carbon dioxide. However, soil carbon increased by 1% in the surface 10 cm soil layer in an acid soil after a single addition of 109 t ha-I of dried stabilized composted bovine manure. This increase was sustained for a period of six years and represents an accumulation of stabilized soil carbon. This suggests that a fertilizer product that is largely humic acid in its structural form will, once stabilized within the soil matrix, continue to contribute to the long-term accumulation and stabilization of soil carbon and will become a sink for newly degraded organic matter. The addition of other organic amendments to the same soil in a pot experiment including humic acid, fulvic acid, lime and brown coal did not produce the same results and resulted in plant root growth suppression in the case of humic acid. This indicated that a detailed understanding of the structural nature of the carbon source is essential in determining its potential as both a source of nutrients for plant growth and as a sink for soil carbon sequestration.

Surek et al. (1999) The objectives of this study were to examine the effects of water stress on grain and total biological yield, and harvest index and to evaluate the water stress tolerance of the rice varieties. Five irrigation treatments were applied to create water stress; (1) irrigation at four-day inteval after tillering initiation, (2) irrigation at eight-day interval after tillering initiation, (3) irrigation at four-day interval after panicle initiation, (4) irrigation at eight-day interval after panicle initiation, (5) continuous flooding irrigation with full water control. All treatment plots were irrigated practicing continuous irrigation method until treatment application. Twenty rice cultivars were used in this experiment. Experiment was conducted in a split plot design with two replications in 1995 and 1996. The main plot was irrigation treatment and the subplots were cultivars. Each plot consisted of two 5-m rows and 25 cm apart. Observation taken includes grain yield, total biological yield, harvest index, and some other agronomic traits. Also, the evaluation was done to determine water stress tolerance of the varieties. The water stress affected all the characters examined. The lowest values were obtained from irrigation at eight-day interval after tillering initiation, while the highest values were observed at continuous flooding irrigation. The reasons for grain yield reduction with water stress mainly were decreases in the number of filled spikelets per panicle and 1000 grain weight. The cultivars, Sandora, Karmina, HS-96, Krasnodarsky-424, Ana/Mar, HS-1 had good tolerance to water stress, and Altýnyazý, TR-648, Meriç, Prometeo, Ergene had moderate tolerance. On the other hand, Sürek-95, Rocca, TR-489, Osmancýk-97, TR-475, Trakya, Serhat-92, TR-765, and Lap/PG had poor tolerance.

Surekha et al. (1999) A field experiment was conducted in 2 wet seasons of 1994 and 1995 in a Vertisol (Typic Pellustert) to study the differential responses of recently released rice hybrids to NH4 -N and NH4 + N03 -N sources (through urea and calcium ammonium nitrate respectively) and split application of N (as 3 and 4 equal splits). Four newly released rice hybrids ('MGR 1', 'KRH 1', 'APRH 1' and 'APRH 2') using 2 checks ('Rasi' and 'laya ') were tested. Between the 2 N sources tested, more stable NH4-N was found to be superior to unstable and leachable N03-N reaction in CAN in terms of both yield (6.40 and 5.44 ha/ha with NH4-N in 1994 and 95 and 5.73 and 4.59 ha/ha with NH4 + N03-N in 1994 and 1995 respectively) as well as nutrient uptake. N application in 4 splits, coinciding the last with flowering, improved the grain yield as well as nutrient uptake. Among the hybrids, 'MGR 1' belonging to short duration group (115-120 days) emerged as the most promising by out yielding the check 'Rasi' to the extent of 18.5 and 20% more in 1994 and 1995 respectively.

Timsina et al. (1998) reported by conducting experiments that were conducted at two sites in Bangladesh to look at the effect of fertilizer (fertilizer based on soil-test based recommendation, farmers' fertilizer management, and zero N), legume residues (grains and residues removed, grains removed residues retained), and maize cropping on the wheat-rice-mungbean/maize sequences. The first year results indicated no effect of legume residues on the subsequent rice yield. There was however a fertilizer effect on wheat but not on rice. Total system yield was higher under high N at one site, but under zero N it was higher at a second site. Contribution of nitrogen from soils, especially to rice and to the total system productivity, which was manifested in grain yield, was evident in both sites. The results demonstrate increased system productivity from the rice-wheat sequence. These data will be used to validate and apply simulation models in Australia and Bangladesh.

Yoon et al. (2003) performed a field experimental study during the growing season of 2001 to evaluate water and nutrient balances in paddy rice culture. Three plots of standard fertilization (SF), excessive fertilization (EF, 150% of SF), and reduced fertilization (RF, 70% of SF) were used and the size of treatment plot was 3,000 m^2, respectively. The hydrologic and water quality was field monitored throughout the crop stages. The water balance analyses indicated that approximately half (47–54%) of the total outflow was lost through surface drainage, with the remainder consumed by evapotranspiration. Statistical analysis showed that there was no significant effect of fertilization rates on nutrient outflow through the surface drainage of rice field. Reducing fertilization of rice paddy may not work well to mitigate the non-point source nutrient loading in the range of normal farming practices. Instead, the reduction in surface drainage could be important to controlling the loading. Suggestive measures that may be applicable to reduce surface drainage and nutrient losses include water-saving irrigation by reducing ponded water depth, raising the weir height in diked rice field, and minimizing forced surface drainage as recommended by other researchers. The suggested practices can cause some deviations from conventional farming practices, and further investigations are recommended.

Zaman et al. (2002) examined and reported about the effect of rice straw, Sesbania, mungbean residue, poultry manure and dung manure coupled with 30% or 50% reduction of the recommended NPKS fertilizers (100%) on crops in a T.Aman (autmn)-Boro (winter) rice cropping sequence at two locations of Bangladesh over three years (1998-2001). The experiment was laid out in a randomized complete block design with three replications. Each year, organic manure and crop residues were applied to T.Aman rice (1st crop) and the residual effect was evaluated on Boro rice (2nd crop). Effectiveness of different manures and crop residues with respect to crop yields followed the order of poultry manure (3 t ha-I) > mungbean residues (10 t ha-') > Sesbania (15 t ha-I) > dung manure (5 t ha-I) > rice straw (5 t ha-I). An application of 70% NPKS fertilizers plus 3 t ha-I poultry manure gave the highest grain yield, which was identical to 100% NPKS fertilizers with no use of manure or crop residues. The same treatment resulted in the highest N, P, K and S uptake by the crops. The lowest crop yield was always recorded in unfertilized control plots. An appreciable increase in soil organic matter was observed due to combined use of fertilizer and manure.

Zhang et al. (2004) studied and reported that in the North China Plain (NCP), excessive groundwater pumping is a serious problem. In this study, different groundwater irrigation schedules were applied. A simple soil water balance approach was introduced to evaluate crop evapotranspiration (ET) and water use efficiency (WUE). Under normal irrigation scheduling, groundwater mining occurs at a rate of over 200mm per year from a rapidly depleting aquifer system. Severe soil water deficit (SWD) decreases grain yield (GY) of wheat (Triticum aestivum L.) and maize (Zea mays L.), while slight SWD in a growth stage from spring green up to grain-filling winter wheat did not evidently reduce GY and WUE. A severe or slight SWD significantly reduces ET, which mainly depends on irrigation amounts. Thus, it is possible to reduce ET somewhat without significantly decreasing GY. ET was correlated to GY in a parabolic function, and maximum yield for winter wheat occurred when optimal ET for winter wheat was about 447 mm. It was important for wheat and maize to be irrigated before sowing.

CHAPTER-3

METHODOLOGY

3.1 MINIMUMM DATA SET (MDS) GENERATION

For the minimum data set generation, to be used in DSSAT *vs.* 3.5 CERES-RICE model validations, a field study was conducted during kharif season of 2003 on DEMONSTRATION FARM (Photograph Plate no 1-10), WRDTC, IIT Roorkee. The experiment comprised of cultivation of hybrid rice *cv* HR6444 under 4 treatments of organic manure. This experiment provide crop management data such as planting date, soil initial condition measured date, planting details, planting density, row spacing, planting depth, crop cultivars, irrigation, fertilizer, tillage, growth characteristics, yield and yield attributes. The weather data recorded from Demonstration farm weather station Roorkee were daily max. and min. air temp,rainfall,pan-evaporation, ground water table, relative humidity, wind velocity, sunshine hours. The soil data required for the DSSAT was retrieved from existing soil file of Demonstration farm.Genetics coefficient of hybrid rice HR6444 is calculated with GEN-CAL, of genetic data base system of DSSAT vs. 3.5. The details of generated base data for use in DSSAT vs3.5 are described in the forth-coming paragraph.

3.2 Experiment Details

Field experiment during kharif season 2003 was conducted in Randomized Block Design with four treatment of organic manure (F0=0kg/ha, F1=4000 kg/ha, F2=8000kg/ha, F3=12000kg/ha) and 3 replications. Irrigation was applied uniformly and total amount applied was 880mm at different phonological development stages, at **Demonstration Farm of WRDTC, IIT Roorkee**, to generate the base data required for the use in **DSSAT vs 3.5 CERES- RICE** model. The crop was transplanted on 2nd July. Seedlings were 28 days old. Crop was harvested on 23 rd October 2003. There were four organic manurering treatments viz. F0, F1, F2, & F3. Other practices were common at all the treatments. The minimum input data required from the field experiments are plot details, treatments, cultivars, fields, soil analysis, initial condition, planting detail, irrigation and water management, fertilizers detail residue and other organic materials, harvested details simulation control, automatic management, weather data grain yield and yield attributes. The details are given as below.

3.2.1 PLOT INFORMATION

	HEADER	INPUT DATA
Gross plot area, m2	PAREA	75.0 m2
Rows per plot	PRNO	5 no.
Plot Length,m	PLEN	25 m
Plot spacing, cm	PLSP	100 cm
Harvest area, m2	HAREA	40 m2
Harvest row no.	HRNO	10
Harvest row Length, m	HLEN	20
Plot layout	PLAY	RBD
Harvest method	HARM	Manual

3.2.2 TREATMENTS

Treatment	Given in **Table 3.1**	
Cultivar Level	CU	1
Field Level	FL	1
Soil Analysis Level	SA	1
Initial Condition Level	IC	1
Planting Level	MP	1
Irrigation Level	MI	1 (I=880mm)
Fertilizer Level	MF	1
Residue Level	MR	1
Tillage/Rotation	MT	1
Environmental modification Level	ME	1
Harvest Level	MH	1
Simulation Control Level	SM	1

3.2.3 CULTIVARS

Crop Code	CR	RI
Cultivar Identifier	INGENO	WR002
Cultivar Name	CNAME	HR-6444

3.2.4 FIELDS

Field ID	IDFIELD	DEMOFARM
Weather station code	WSTA	WRDF
Drainage Type Code	FLDT	DR000
Soil Texture	SLTX	SALO
Soil Depth,cm	SLDP	90 cm
Soil ID	ID SOIL	WR00730001
Elevation, m	ELEV	252.0m
Total area, m2	AREA	990 m2
Slope Length, m	SLEN	22m
Field Length width Ratio	FLWR	2.0

3.2.5 SOIL ANALYSIS

Analysis Date (Julian days) (Year+days from Jan-1)	SADAT	73136*(31-05-2003)
pH in buffer determination method code	SMHB	SA001
Phosphorus determination method code	SMPX	SA001
Potassium determination method code	SMKE	SA001
Depth, base layer, cm	SABL	20 cm
		40 cm
		30 cm
Bulk density, g/cm3	SADM	1.45
		1.46
		1.47
Organic carbon g/cm3	SAOC	0.3
		0.1
		0.01
Total nitrogen g/kg	SANI	0.08
		0.02
		0.01
pH in water	SAHW	7.5
		7.5
		7.5
Phosphorous, extractable mg/kg	SAEX	15
		5

		1
Potassium, exchangeable mg/kg	SAKE	30
		15
		1.5

3.2.6 INITIAL CONDITIONS

Previous Crop code	PCR	WH
Initial condition date	ICDAT	73181(31-05-03)
Root wt. From previous crop kg/ha	ICRT	20
Nodule wt. From previous crop kg/ha	ICND	0
Rhizobia number (o-1) default=1	ICRN	1
Rhizobia effectiveness, o-1 scale (default=1)	ICRE	0
Initial Crop Residue (kg/ha)	ICRES	25
Initial Residue N content, %	ICREN	0.08
Initial Residue P content, %	ICREP	0.05
Initial Residue Incorp. %	ICRIP	100
Initial Residue Incorp.Depth, %	ICRID	15
Initial ground water depth, cm	ICWD	490
Depth, base of layer, cm	ICBL	20 cm
		60 cm
		90 cm
Water cm3/cm3* 100 volume %	SH2O	0.242
		0.248
		0.261
Ammonium Kcl g elemental N/mg soil	SNH4	0.2
		0.5
		0.5
Nitrate Kcl, g/mg of soil	SNO3	12.20
		0.8
		0.8

3.2.7 PLANTING DETAILS

Planting date, (Yr+day from jan.1)	PDATE	73183(02-07-03)
Emergence date	EDATE	-99 (not obseved)
Plant population at seedling, plants/m2	PPOP	33

Plant population at emergence, plants/m2	PPOE	33
Planting method, T= transplant	PLME	T
Planting distribution, H= Hill	PLDS	R
Row spacing, cm	PLRS	20
Planting Depth, cm	PLDP	3.0
Planting Material, drywt kg/ha	PLWT	80
Transplant age,days	PAGE	28
Temp. of transplant environment,0c	PENV	25.0
Plants per hill	PLPH	1

3.2.8 IRRIGATION AND WATER MANAGEMENT

Irrigation application efficiency, fraction	EFIR	1
Management Depth for automatic application	IDEP	10 cm
Threshold for automatic appl., %of max.		
Available	ITHR	-99
End point for automatic appl. of max		
Available	IEPT	-99
End of application, growth stage code	IOFF	GSOO6
Method for automatic application code	IAME	IR006
Amount per irrigation, mm	IAMT	80.0mm
Irrigation date (Yr+day)	IDATE	11 applications
		73198 (17-07-03)
		73207(26-07-03)
		73212 (31-07-03)
		73216 (04-08-03)
		73232 (20-08-03)
		73237 (25-08-03)
		73254 (11-09-03)
		73256 (13-09-03)
		73262 (19-09-03)
		73272 (29-09-03)
		73279 (06-10-03)

3.2.9 FERTILIZERS (INORGANIC)

Fertilizer application level	MF	1

Fertilization date, Julian days	FDATE	73183, (02-07-03)
		73195, (14-07-03)
		73232 (20-08-03)
Fertilizer material code	FMCD	FE006, FE005
Fertilizer Application code	FACO	AP002
Fertilizer Application depth,cm	FDEP	1
N in applied fertilizer, Kg/ha	FAMN	24
		31
		62
P in applied fertilizer, Kg/ha	FAMP	57
		0
		0
K in applied fertilizer, Kg/ha	FAMNK	0
Ca in applied fertilizer, Kg/ha	FAMC	0
Other element in applied fertilizer, Kg/ha	FAMO	80
Other fertilizer code	FOCD	FEO18

3.2.10 RESIDUES AND OTHER ORGANIC MATERIALS

Incorporation date, (Yr+days)	RDATE	73182
Residue Material, code	RCOD	RE003
Residue Amount, kg/ha	RAMT	F0=0, F1=2000
		F2=4000,F3=6000
	RESN	0.43
	RESP	0.15
	RESK	0.3
	RINP	100
	REDP	15
	RMET	AP002

3.2.11 TILLAGE AND ROTATION

Tillage date (julian days)	TDATE	73166(00-00-03)
		73176(00-00-03)
		73182(00-00-03)
Tillage implements	TIMPLE	TI010,TIO22

Tillage Depth ,cm	TDEP	15

3.2.12 ENVIRONMENTAL MODIFICATION

Modification date, (Julian date)	ODATE	-99
Day length adjustment factor	E	A

3.2.13 HARVEST DETAILS

Harvest Level	HL	1
Harvest date,(Julian date)	HDAT	73296(23-10-2003)
Harvest Stage	HSTG	GS006
Harvest component code	HCOMC	H
Harvest size group code	HSIZE	A
Harvest percentage code	HPC	100%
Harvest Byproduct, %	HBPC	48.5

3.3 WEATHER DATA

Site+ country name	WRDF (INDIA)	WRDF7301.WTH
Latitude, degree	LAT	29.50^0 N
Longitude,^{0}	LONG	77.50^0E
Elevation, m	ELEV	252.0
Ht. of wind measurement	WMHT	2.0
Julian days	DATE	73181-73254
Solar radiation, MJ/m2/day	SRAO	Table3.2
Air temp. in 0.c	TMAX.	Table3.2
Precipitation, mm	RAIN	Table3.2

3.4 TOTAL WATER USE (Irrigation+Rainfall)

Total water use during the crop period is shown in **Table 3.3**

3.5 YIELD AND YIELD ATTRIBUTES

Yield and yield attributes was measured after maturity of crop as presented in **Table 3.4.**

Table3.1: INPUT DATA FILE

EXP.DETAILS: RNRA7301RI R.N.P.YADAV
(From Field Experiment)

```
*GENERAL
@PEOPLE
 R.N. YADAV
@ADDRESS
 WRDTC,IIT ROORKEE
@SITE
 DEMOFARM,WRDTC,IIT ROORKEE
@ PAREA  PRNO  PLEN  PLDR  PLSP  PLAY HAREA  HRNO  HLEN HARM...........
   75.0    15  25.0   -99   100 RBD    40.0    10  20.0  MANUAL
@NOTES
 A PART OF M.TECH. DESSERTATION
 TOPIC: APPLICATION OF DSSAT ON HYBRID RICE

*TREATMENTS                        -------------FACTOR LEVELS------------
@N R O C TNAME.................... CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 0 0 0   F0 (80*0)                1  1  1  1  1  1  1  1  0  1  0  1  1
 2 0 0 0   F1 (80*4000)             1  1  1  1  1  1  1  2  0  1  0  1  1
 3 0 0 0   F2 (80*8000)             1  1  1  1  1  1  1  3  0  1  0  1  1
 4 0 0 0   F3 (80*12000)            1  1  1  1  1  1  1  4  0  1  0  1  1

*CULTIVARS
@C CR INGENO CNAME
 1 RI WR0002 HR 6444

*FIELDS
@L ID_FIELD WSTA....  FLSA  FLOB  FLDT  FLDD  FLDS  FLST SLTX   SLDP ID_SOIL
 1 DEMOFARM WRDF       0.0     0 DR000     0     0 00000 SALO     90 WR00730001
@L ...........XCRD ...........YCRD .....ELEV .............AREA .SLEN .FLWR .SLAS
 1         0.00000         0.00000    252.00             990.0    22   2.0   0.0

*SOIL ANALYSIS
@A SADAT  SMHB  SMPX  SMKE
 1 73151 SA001 SA001 SA001
@A  SABL  SADM  SAOC  SANI  SAHW  SAHB  SAEX  SAKE
 1    20  1.45  0.30  0.08   7.5 -99.0  15.0  30.0
 1    40  1.46  0.10  0.02   7.5 -99.0   5.0  15.0
 1    30  1.47  0.01  0.01   7.5 -99.0   1.0   1.5

*INITIAL CONDITIONS
@C   PCR ICDAT  ICRT  ICND  ICRN  ICRE  ICWD ICRES ICREN ICREP ICRIP ICRID
 1    WH 73181    20     0  0.00  0.00 490.0    25  0.08  0.05   100    15
@C  ICBL  SH2O  SNH4  SNO3
 1    20 0.242   0.2  12.2
 1    60 0.248   0.5   0.8
 1    90 0.261   0.5   0.8

*PLANTING DETAILS
P PDATE EDATE PPOP PPOE PLME PLDS  PLRS  PLRD  PLDP  PLWT  PAGE  PENV  PLPH  SPRL
 1 73183 -99  33.0  33.0  T     R    20     0   3.0    80    28  25.0   1.0  10.0

*IRRIGATION AND WATER MANAGEMENT
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 1  1.00    10   -99   -99 GS006 IR006    80
@I IDATE  IROP IRVAL  IIRV
 1 73198 IR006    80     0
 1 73207 IR006    80     0
```

```
 1 73212 IR006     80      0
 1 73216 IR006     80      0
 1 73232 IR006     80      0
 1 73237 IR006     80      0
 1 73254 IR006     80      0
 1 73256 IR006     80      0
 1 73262 IR006     80      0
 1 73272 IR006     80      0
 1 73279 IR006     80      0

*FERTILIZERS (INORGANIC)
@F FDATE  FMCD  FACD  FDEP  FAMN  FAMP  FAMK  FAMC  FAMO  FOCD
 1 73183 FE006 AP002     1    24    57     0     0    80 FE018
 1 73195 FE005 AP002     1    31     0     0     0     0 -99
 1 73232 FE005 AP002     1    62     0     0     0     0 -99

*RESIDUES AND OTHER ORGANIC MATERIALS
@R RDATE  RCOD  RAMT  RESN  RESP  RESK  RINP  RDEP  RMET
 1 73182 RE003     0  0.00  0.00  0.00     0     0 AP002
 2 73182 RE003  4000  0.43  0.15  0.30   100    15 AP002
 3 73182 RE003  8000  0.43  0.15  0.30   100    15 AP002
 4 73182 RE003 12000  0.43  0.15  0.30   100    15 AP002

*TILLAGE AND ROTATIONS
@T TDATE TIMPL  TDEP
 1 73166 TI010    15
 1 73176 TI010    15
 1 73182 TI022    15

*HARVEST DETAILS
@H HDATE  HSTG  HCOM HSIZE   HPC  HBPC
 1 73296 GS006 C     A     100.0  48.5

*SIMULATION CONTROLS
@N GENERAL     NYERS NREPS START SDATE RSEED SNAME....................
 1 GE              1     1     I 73181  2150 YIELD OF HYBRID RICE
@N OPTIONS     WATER NITRO SYMBI PHOSP POTAS DISES  CHEM  TILL
 1 OP              Y     Y     N     N     N     N     N     N
@N METHODS     WTHER INCON LIGHT EVAPO INFIL PHOTO HYDRO
 1 ME              M     M     E     P     S     R     R
@N MANAGEMENT  PLANT IRRIG FERTI RESID HARVS
 1 MA              R     R     R     R     R
NOUTPUTS FNAME OVVEW SUMRY FROPT GROUT CAOUT WAOUT NIOUTMIOUTDIOUTLONG CHOUT
OPOUT
 1 OU     Y     Y     Y     1     Y     N     Y     Y     N     N     N     N
N

@  AUTOMATIC MANAGEMENT
@N PLANTING    PFRST PLAST PH2OL PH2OU PH2OD PSTMX PSTMN
 1 PL          73176 73190    40   100    30    40    10
@N IRRIGATION  IMDEP ITHRL ITHRU IROFF IMETH IRAMT IREFF
 1 IR             30    50   100 GS000 IR001    10  1.00
@N NITROGEN    NMDEP NMTHR NAMNT NCODE NAOFF
 1 NI             30    50    25 FE001 GS000
@N RESIDUES    RIPCN RTIME RIDEP
 1 RE            100     1    20
@N HARVEST     HFRST HLAST HPCNP HPCNR
 1 HA              0 73296   100     0
```

Table 3.2 Daily Weather Data of Cropping Period of Hybrid Rice

(From 01-06-2003 to 22-10-2003)

Weather station: Water Resources Development Training Centre, Demonstration Farm (WRDF)

Latitude	:	29.52^0 N	Longitude	:	77.52^0 E
Elevation	:	252 m	TAV	:	23.8^0
AMP	:	5 m	REFHT	:	2 m
WNDHT	:	2m			

Month-June

Date	Julian Day	T. max. ^{0}C	T. min. ^{0}C	Solar Radiation MJ/m^2 day	Rainfall mm	Sunshine Hrs.
1/06/03	73152	41.5	25	28.1	0	12
2/06/03	73153	43	25	28.8	0	12.3
3/06/03	73154	42.5	24.5	28.8	0	12.3
4/06/03	73155	41	27	28.8	0	12.3
5/06/03	73156	38.5	24.5	25.1	0	10
6/06/03	73157	39	27.5	28.1	0	12
7/06/03	73158	40	26	28.1	0	12
8/06/03	73159	38	26.5	26.6	0	11
9/06/03	73160	37.5	24.5	25.1	0	10
10/06/03	73161	39.5	29	25.1	0	10
11/06/03	73162	41	26	23.6	0	9
12/06/03	73163	41	28.5	26.6	0	11
13/06/03	73164	41	27	26.6	0	11
14/06/03	73165	40	26	27.4	0	11.3
15/06/03	73166	39.5	26.5	28.1	0	12
16/06/03	73167	39	26	28.1	0	12
17/06/03	73168	37	26.5	28.1	0	12
18/06/03	73169	28	22	26.6	24	11
19/06/03	73170	33	22.5	14.8	0	3
20/06/03	73171	29	27	14.8	0	3
21/06/03	73172	29.5	25	25.1	0	10
22/06/03	73173	30	24.5	26.6	0	11
23/06/03	73174	30	23.5	28.1	13	12
24/06/03	73175	35.5	26.5	20.7	0	7
25/06/03	73176	34.5	25.5	26.6	0	11
26/06/03	73177	37	27	26.6	0	11
27/06/03	73178	32	24	27.3	5.6	11.3
28/06/03	73179	31.5	22	26.6	6.4	11

29/06/03	73180	32	23	23.6	0	9
30/06/03	73181	32.5	25	22.1	9.4	8

Month: JULY

Date	Julian Day	T. max. ^{0}C	T. min. ^{0}C	Solar Radiation MJ/m^2 day	Rainfall mm	Sunshine Hrs.
1/07/03	73182	35.5	26	20.6	0	7
2/07/03	73183	34.5	25	27.3	4.2	11.3
3/07/03	73184	36	28	27.3	0	11.3
4/07/03	73185	36.5	27.5	28	0	12
5/07/03	73186	36	26	10.2	82	4
6/07/03	73187	35	26.5	16.2	12.2	3
7/07/03	73188	34	22	14.7	0	3
8/07/03	73189	35	28	20.6	0	7
9/07/03	73190	29	27	21.3	0	7.3
10/07/03	73191	29	24	20.6	11.2	7
11/07/03	73192	25.5	23	13.2	20.8	2
12/07/03	73193	27	22	10.2	22	1
13/07/03	73194	28	24.5	13.1	19	2
14/07/03	73195	34	24	20.5	0	7
15/07/03	73196	34	26.5	26.4	0	11
16/07/03	73197	34.5	27.5	25.7	1.2	10.3
17/07/03	73198	34.5	27.5	22	0	8
18/07/03	73199	34.5	27.5	23.4	3	9
19/07/03	73200	29.5	27	20.4	0	7
20/07/03	73201	30	28	21.9	0	8
21/07/03	73202	28.5	23.5	21.9	0	8
22/07/03	73203	33.5	24.5	14.5	0	3
23/07/03	73204	33.5	28	26.3	0	11
24/07/03	73205	33.5	28	21.8	0	8
25/07/03	73206	36.5	29	24.8	0	11
26/07/03	73207	34	26.5	26.2	0.6	11
27/07/03	73208	36	28.5	23.3	0	9
28/07/03	73209	34.5	27.5	26.2	0	11
29/07/0	73210	33	25	26.2	4.8	11
30/07/03	73211	33	25.5	20.2	0	7
31/07/03	73212	28.5	25.5	21.7	1.4	8

Month: AUGUST

Date	Julian Day	T. max. ^{0}C	T. min. ^{0}C	Solar Radiation MJ/m^2 day	Rainfall mm	Sunshine Hrs.
1/08/03	73213	31	23.5	15.8	21	4
2/08/03	73214	32	25.5	17.2	0	5
3/08/03	73215	32.5	25	12.8	0.6	5
4/08/03	73216	32	26.5	14.2	0.6	3
5/08/03	73217	35.5	26.5	21.5	1.2	8
6/08/03	73218	35	26.5	25.9	0	6
7/08/03	73219	36.5	27	21.5	0	8
8/08/03	73220	37	28	25.9	0	11
9/08/03	73221	31	23.5	22.9	21	9
10/08/03	73222	29	23	20.7	53	8
11/08/03	73223	33	26.5	18.4	0	6
12/08/03	73224	33	24.5	20.6	12.6	7.3
13/08/03	73225	32	25	21.3	0	8
14/08/03	73226	30.5	26	18.3	11.2	6
15/08/03	73227	28	25	18.3	0	6
16/08/03	73228	32	24.5	15.3	13.8	4
17/08/03	73229	34	26	18.2	10	6
18/08/03	73230	35	28	24	0	10
19/08/03	73231	31	25	21	0	8
20/08/03	73232	31	22	22.4	0	9
21/08/03	73233	32	23.5	23.8	33	10
22/08/03	73234	33	25.5	20.9	23	8
23/08/03	73235	34.5	25	22.3	0	9
24/08/03	73236	34.5	25.5	23	0	9
25/08/03	73237	34	26	25.1	0	11
26/08/03	73238	33	26.5	23.6	0	10
27/08/03	73239	34	26	23.5	0	10
28/08/03	73240	34.5	26	23.5	0	10
29/08/0	73241	27	25.5	20.5	32.4	7
30/08/03	73242	28	23.5	17.6	48	6
31/08/03	73243	30	23.5	20.4	1.4	8

Month: SEPTEMBER

Date	Julian Day	T. max. ^{0}C	T. min. ^{0}C	Solar Radiation MJ/m^2 day	Rainfall mm	Sunshine Hrs.
1/09/03	73244	32	25	17.5	0.2	4
2/09/03	73245	30.5	26	14.6	54	8
3/09/03	73246	28	24.5	14.6	0	2
4/09/03	73247	27	24.5	11.7	0	3
5/09/03	73248	33	27.5	13.1	5.8	10
6/09/03	73249	33.5	29.5	22.9	0	8
7/09/03	73250	32	24.5	20	0	5
8/09/03	73251	33	24.5	14.3	0	8
9/09/03	73252	32	26	19.9	0	4
10/09/03	73253	27	25	12.8	0.2	2
11/09/03	73254	30	25	10.4	0	2
12/09/03	73255	30.5	25	9.9	0	3
13/09/03	73256	30	25.5	19.6	0	8
14/09/03	73257	31	24.5	20.9	0	9
15/09/03	73258	29.5	23	12.5	13.4	3
16/09/03	73259	28	23	13.9	0	4
17/09/03	73260	30.5	24	12.4	0	7
18/09/03	73261	32	23.5	20.6	0	8
19/09/03	73262	33.5	24.5	21.9	0	9
20/09/03	73263	32	25.5	20.4	0	9
21/09/03	73264	30	25	20.4	0	8
22/09/03	73265	31	26	20.3	54	6
23/09/03	73266	29	21.5	16.1	0	5
24/09/03	73267	31	21.5	14.7	0	7
25/09/03	73268	26.5	22	17.3	0	7
26/09/03	73269	32	22	17.3	0	10
27/09/03	73270	31	23	21.2	0	9
28/09/03	73271	31	22	19.8	0	8
29/09/0	73272	31.5	22.5	20.1	0	7
30/09/03	73273	33	20	17.6	0	8

Month: OCTOBER

Date	Julian Day	T. max. ^0C	T. min. ^0C	Solar Radiation MJ/m^2 day	Rainfall mm	Sunshine Hrs.
1/10/03	73274	32	20	19.5	0	9
2/10/03	73275	32	18	20	0	9.3
3/10/03	73276	31	18.5	20.6	0	10
4/10/03	73277	32	19	20.5	0	10
5/10/03	73278	31	18.5	20.4	0	10
6/10/03	73279	33	19	20.3	0	10
7/10/03	73280	33	14.5	20.2	0	10
8/10/03	73281	33	19.5	18.8	0	9
9/10/03	73282	33	19.5	19.1	0	9
10/10/03	73283	33	19	17.4	0	8
11/10/03	73284	32	16.5	18.6	0	9
12/10/03	73285	32	18	18.5	0	9
13/10/03	73286	32.5	19	18.4	0	9
14/10/03	73287	32	15	18.3	0	9
15/10/03	73288	33	15.5	18.2	0	9
16/10/03	73289	32.5	16	16.8	0	8
17/10/03	73290	33	16	17.1	0	8.3
18/10/03	73291	32	17.5	17.3	0	8.5
19/10/03	73292	33	17	17.2	0	8.5
20/10/03	73293	32.5	15	17.7	0	9
21/10/03	73294	32	14.5	17.6	0	9
22/10/03	73295	32	14.5	17.5	0	9

Table 3.3: Total water use (Irrigation+ Rainfall) in hybrid rice cv HR 6444

Period	Total water use (mm)			
	F0	F1	F2	F3
73181-73197 (30/06/03-16/07/03)	173	173	173	173
73198-73206 (17/07/03-25/07/03)	83	83	83	83
73207-73211 (26/07/03-30/07/03)	85	85	85	85
73212-73215 (31/07/03-3/08/03)	104	104	104	104
73216-73231 (4/08/03-19/08/03)	203	203	203	203
73232-73236 (20/08/03-24/08/03)	136	136	136	136
73237-73253 (25/08/03-10/09/03)	222	222	222	222
73254-73255 (11/09/03-12/09/03)	80	80	80	80
73256-73261 (13/09/03-18/09/03)	93	93	93	93
73262-73271 (19/09/03-28/09/03)	134	134	134	134
73272-73278 (29/09/03-5/10/03)	80	80	80	80
73279-73296 (6/10/03-23/10/03)	80	80	80	80
TOTAL	**1482**	**1482**	**1482**	**1482**

Total Irrigation @ 80 mm per irrigation = 80*11=880 mm

Total Rainfall ………………………………………….=602 mm

Total =1482 mm

Table 3.4: YIELD AND YIELD ATTRIBUTES OBSERVED FROM KHARIF RICE 2003 CV HR-6444 AT DEMOFARM, WRDTC, IIT ROORKEE

S.N	Treatment (Organic manure)	Grain yield (kg/ha)	Straw Kg/ha	Total Biomass (kg/ha)	No of ear (head/ sqm)	Dry wt. /earhead (g)	Grain Wt/100 grain (g)	Grain Length (mm)	Grain Width (mm)	Kernel Length (mm)	Kernel Width (mm)	Harvest Index	Hauling (%)
1	F0	5841	8363	14205	252.53	2.49	2.11	8.86	2.25	6.147	2.017	0.43	81.80
2	F0	6461	9643	16104	270.39	2.67	2.22	9.15	2.35	6.193	2.043	0.40	81.80
3	F2	6882	9919	16800	275.67	2.84	2.23	9.21	2.43	6.427	2.070	0.41	82.23
4	F3	6980	10036	16996	292.00	3.27	2.26	9.45	2.58	6.667	2.090	0.41	81.3
Test of significant		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	N-sig.	Sig.
Critical difference at 5% LS		2.71	8.21	9.34	9.645	0.245	0.03	0.206	0.064	0.076	0.027	0.035	1.462

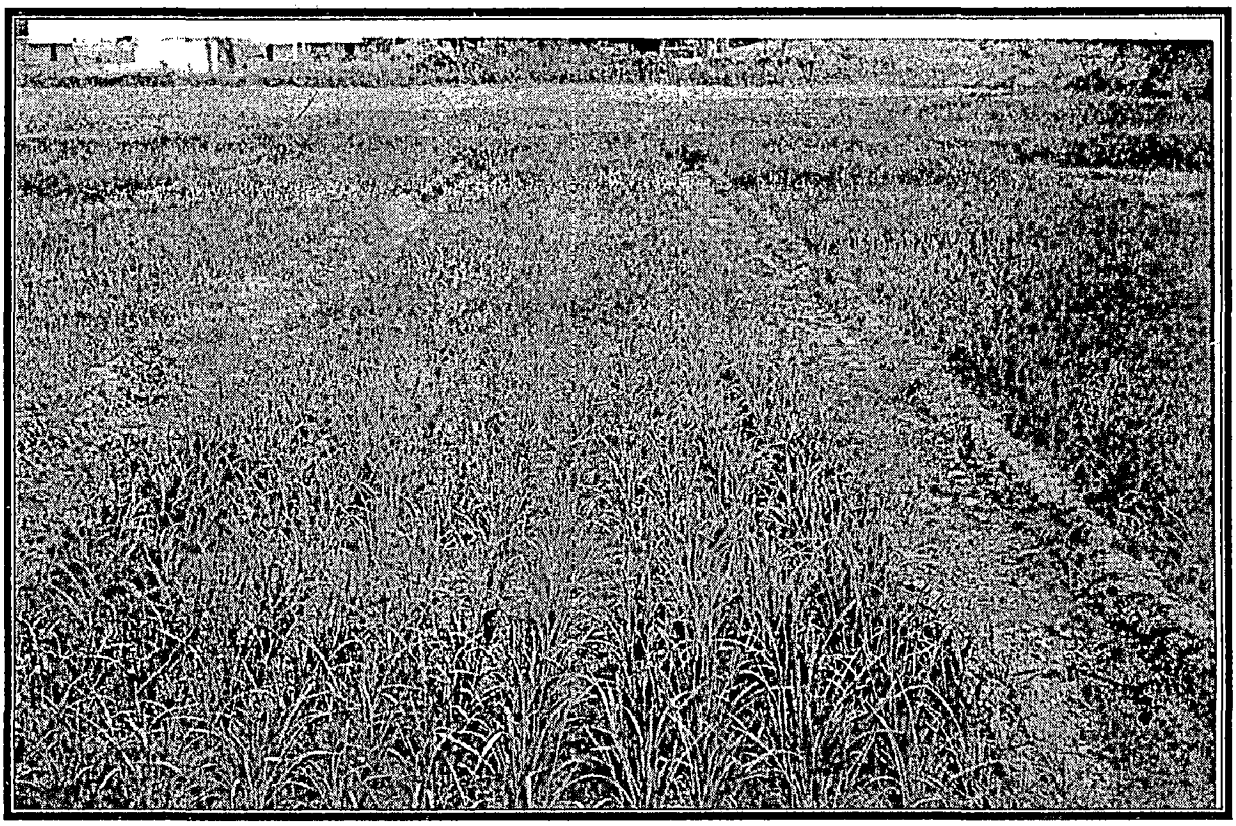
Note: F0=0 kg/ha, F1=4000 kg/ha F2= 8000kg/ha F3= 12000kg/ha

Different Photographs of experiment conducted at Demonstration farm

Field preparation with Organic manuring (FYM)

Transplanted Paddy Field (02-06-003)

Irrigating the paddy field

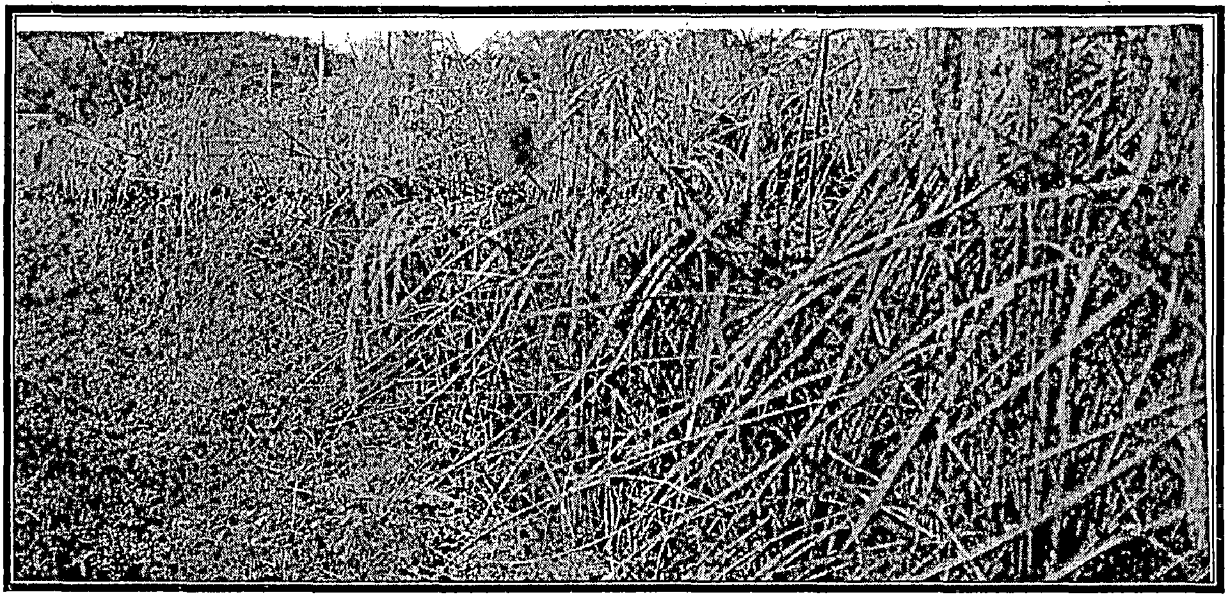


Rice crop at tillering stage

Rice crop at ear emergence stage

Bumper Rice crop at grain filling stage

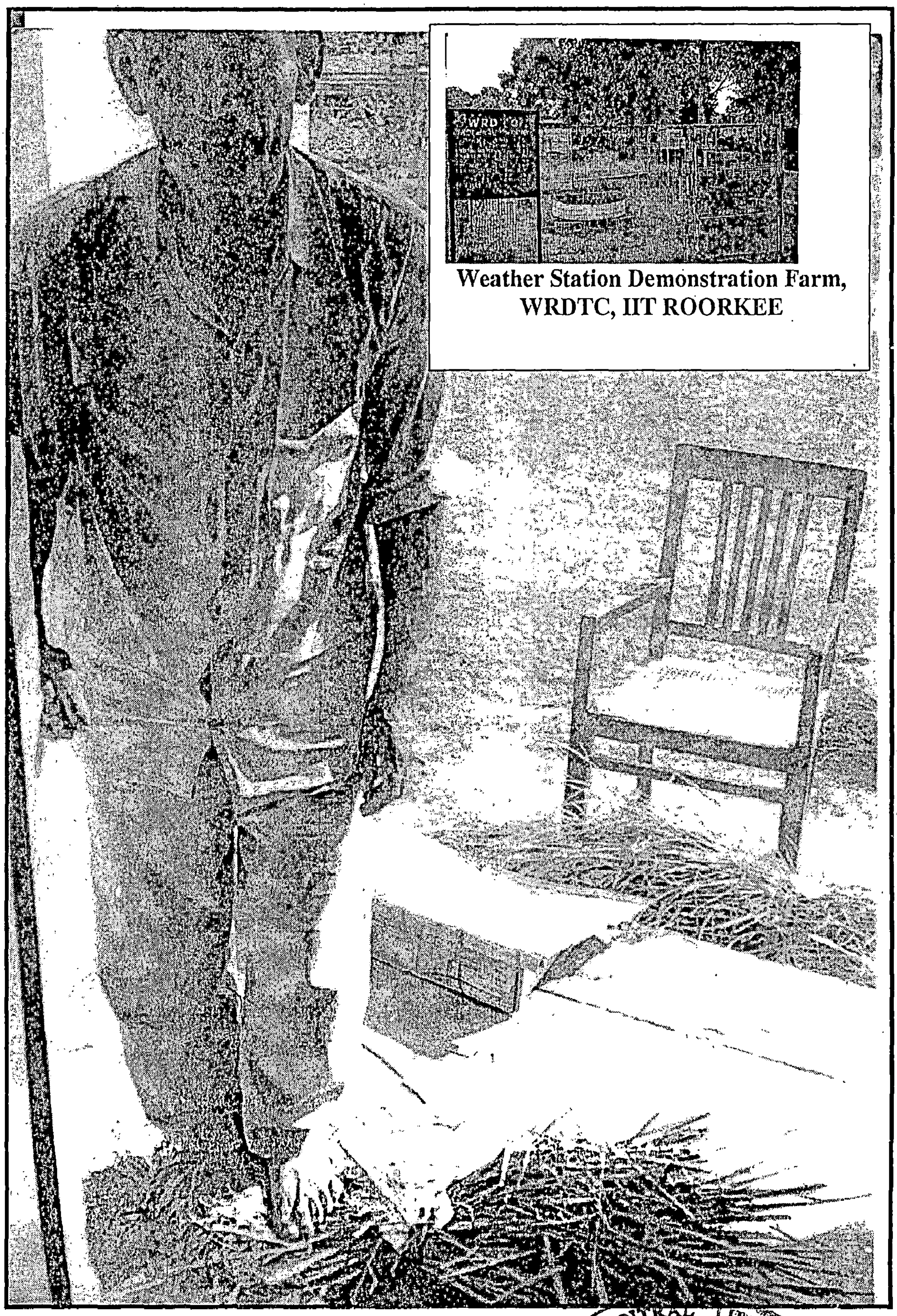
Measuring the ht.of rice crop at maturity



Bumper rice crop at maturity

Bundle of rice crop taken from one sq.meter

Harvesting of rice crop on 23-10-2003



Weather Station Demonstration Farm,
WRDTC, IIT ROORKEE

Manually threshing of paddy bundle taken from one sq. meter

CHAPTER-4

DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER (DSSAT)

(AN OVERVIEW)

4.1 INTRODUCTION:

IBSNAT assembled and distributed a Decision Support System entitled DSSAT (Tsuiji et, al 1994), which enables the users to match the biological requirements of crops to the physical characteristics of land so that objectives specified by the user may be obtained. DSSAT is designed to answer " ***what if*** " questions frequently asked by the policy makers and farmer concerned with sustaining an economically sound and environmentally safe agriculture. The Decision Support System for Agrotechnology Transfer (DSSAT) has been in use for more than 15 years by researchers in over 100 countries worldwide. DSSAT is a microcomputer software program combining crop soil and weather databases and programs to manage them, with crop models and application programs, to simulate multi-year outcomes of crop management strategies. As a software package integrating the effects of soil, crop phenotype, weather and management options, DSSAT allows users to ask "*what if*' questions and simulate results by conducting, in minutes on a desktop computer, experiments which would consume a significant part of an agronomist's career. So DSSAT is a collection of computer programs integrated in to a single software package in order to facilitate the application of crop simulation model in research and decision-making.

The decision support system consists of:

1. A Database Management System DBMS) to enter, store and retrieve the "***minimum data set*** "needed to validate list and use the crop models for solving problems.
2. A set of validated crop models for simulating process and outcomes of genotype by environment interactions.
3. An applications program for analyzing and displaying outcomes of long-term simulated agronomic experiments.

In order to develop a simulation model regarding the extent of influence of weather and plant development a series of sub-model are required. The first sub-model must offer a possibility for the determination of soil moisture from the corresponding weather conditions. The second sub-model gives the effect of weather on carbon dioxide assimilation. Finally, another sub-model is required for describing the transport of nutrients and assimilation products for the production of plant biomass. An overview of input and output files used by crop models (Tsuji et al.) in DSSAT is presented in **Fig.4.1.**

DSSAT was designed for users to easily create "experiments" to simulate, on computers, outcomes of the complex interactions between various agricultural practices, soil and weather conditions and to suggest appropriate solutions to site specific problems. DSSAT relies heavily on crop simulation models to predict the performance of crops for making a wide range of decisions.

4.2 DESCRIPTION

4.2.1 SHELL

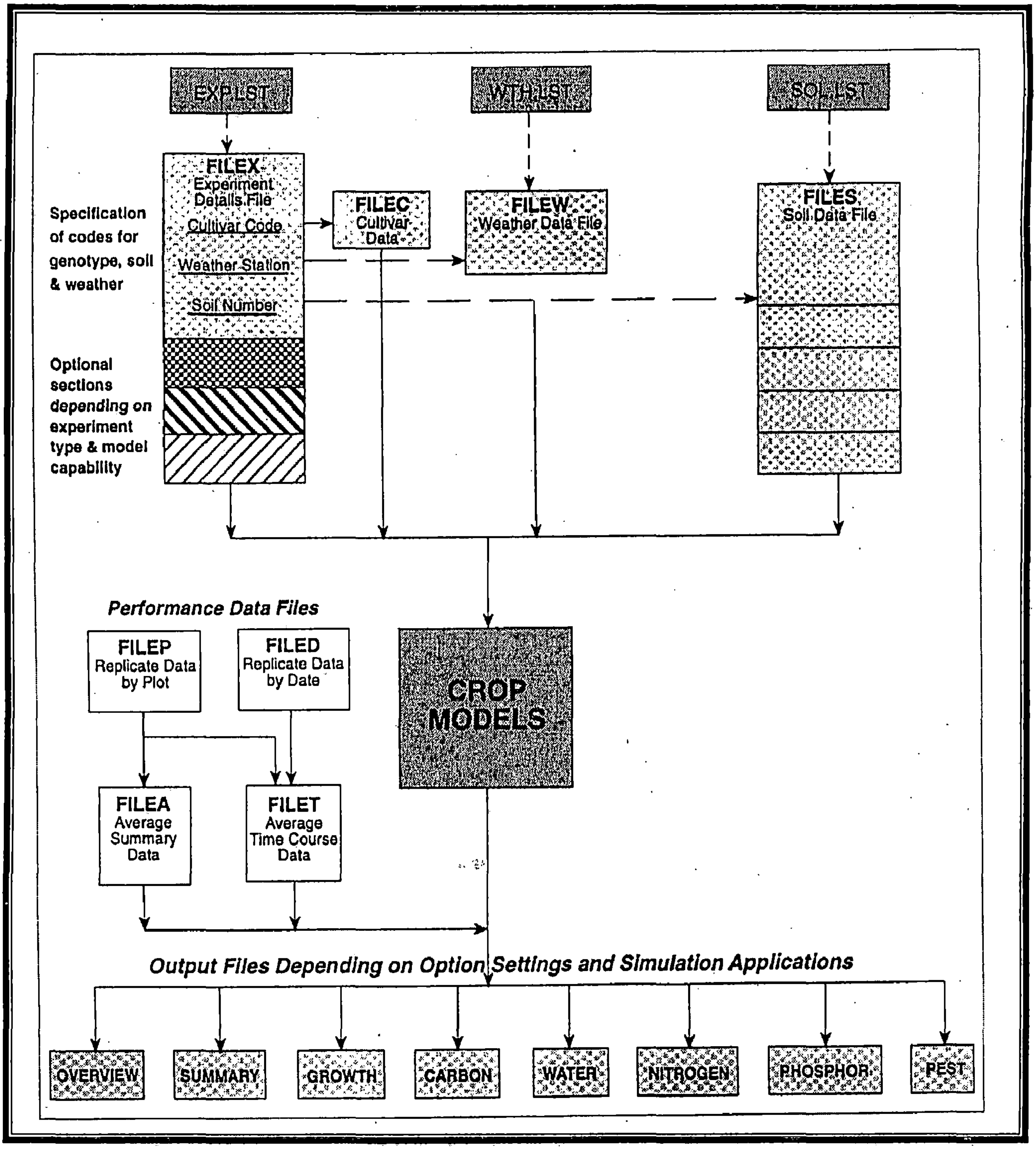
The DSSAT vs 3.5 Shell is a menu-driven program, which enables sers to easily select and use any of the DSSAT components. The Shell program provides access to the programs in DSSAT using pop-up menus. The shell also includes an install program that automatically creates directories on the hard disk as specified by the user. An information file, which specifies the path and name of each program and data component, is also maintained. The Shell ha five main menu items, each with various options: ***DATA, MODELS, ANALYSIS, TOOLS and SETUP/QUIT.***

The DATA main menu item provides users access to ***background, experiment, weather, soil, genotype pest and economic.***

Under the MODEL section, users can access models for **calibration, validation and sensitivity analysis** purpose. Models are available for various cereal crops (maize, wheat, sorghum, millet, rice and barley), grain legume crops (soybean, peanut and dry bean) and cassava, root crops and others.

Under the ANALYSIS section two choices appear: Season ***and Sequence***. The Season option allows users to setup simulation experiments, simulate them and analyze the results. The second option under ANALYSIS is to simulate sequences of crops, such as in crop rotation, for studying the long-term effects of practices on crop and soil performance, with emphasis on time trends and uncertainty. Under the TOOLS section, users can access their disk manager, their editor and spreadsheet, or go to DOS prompt temporarily without leaving

Figure 4.1: Showing Overview of Input and Output Files in DSSAT



DSSAT.The SETUP/QUIT section generally provides the users to exit safely from the DOS program.

4.2.2 CROP MODELS

The DSSAT crop models are mathematical representation of daily biological and physical processes and are used to predict harvestable yield, plant growth and development, nitrogen dynamics and water balance in response to controlled and uncontrolled variables. The IBSNAT crop models are daily incrementing, process oriented functional models. These are designed to use a minimum set of soil, weather, genetic and management information. These models simulate the effects of weather, soil, water, cultivar and nitrogen dynamics in the soil and the crop, on crop growth and yield. In order to predict a crop potential DSSAT crop models require the following information **(Sasseendran and Rathore, 1999).** Daily weather data consisting of max.and min. air temp, solar radiation and precipitation. The standard soil descriptions including data of soil properties as a function of depth, information on sowing date, plant population, amounts and dates of irrigation N- fertilizer, genetic information related to maturity type photo period sensitivity and yield components needed to evaluate optimum efficiencies with in the constraints of weather and soil.

The following table gives a list of various models that has been developed:

MODEL NAME	DEVELOPED BY
CERES-WHEAT	D.C. Godwin & J.T. Ritchie
CERES-MAIZE	J.T. Ritchie, C.A Jones & J.Kiniry
CERES-BARLEY	J.T. Ritchie, B.S.Johnson & S. Otter-Nacke
CERES- SORGHUM	J.T. Ritchie, U.Singh, G.Alagarswamy& G.Rao
CERES-MILLET	J.T. Ritchie &Y.Ramakrishna
CERES-RICE	U.Singh, J.T. Ritchie & D.C.Godwin
SOYGRO	J.W.Jones, G.Wilkerson & S.S.Jagtop
PNUTGRO	K.J.Boote, G.Hoogenboom &J.W.Jones
BEANGRO	G.Hoogenboom, J.W.Jones,& K.J.Boote
SUBSTOR-CASSAVA	R.B. Mathews
SUBSTOR-CASSAVA	R.B. Mathews
SUBSTOR-AROIDS	U.Singh, H.Prasad & R.Goenaga
SUBSTOR-POTATO	T.S. Griffin, B.S. Johnson & J.T. Ritchie

SUNFLOWER	F.Villalobes, A.J.Hall & J.T. Ritchie
SUGARCANE	G.Inman-Bamber, G.Kiker, J.W.Jones
PINEAPPLE	D.Bartholomew, J.Zhang, E.Malezeiux
COTTON	B.Kimball

4.2.3 CERES RICE MODEL

The **CERES** (***CROP ESTIMATION THROUGH RESOURCES AND ENVIRONMENT SYNTHESIS***) family of crop models is used in DSSAT to predict the performance of Rice crop. This model is designed to use a minimum set of soil, weather, genetic and management information. The CERES Rice model uses a minimum of readily available weather, soil and genetic inputs. To simulate growth, development and yield, the model take into account the following processes **(Singh, 2001).**

Phonological development, especially as it is affected by genotype and weather. The models simulate the effects of photoperiod and temperature on the timing of panicle initiation and duration of each major growth stage, extension growth of leaves, stem and roots. Biomass accumulation and partitioning, especially as phonological development affects the development and growth of vegetative and reproductive organs. Water balance that simulates the daily evapotranspiration, runoff, percolation and crop water uptake under fully irrigated conditions, and rainfed conditions. Soil nitrogen transformations associated with mineralization/immobilization, urea hydrolysis, nitrification, denitrification, ammonia volatilization, and losses of N associated with runoff and percolation and uptake and utilization of N by the crop.

4.2.4 Data Base Management System (DBMS)

DBMS is used to organized and store the minimum data sets, to provide users friendly data entry and retrieval and to integrate data from several sources. Retrieval programs extract data from the centralized database and create files for running the crop models. Output can be printed or graphically displayed and compared with experimental observations for validating the crop models and conducting sensitive analysis. The minimum data set for validation consists of 1) crop management and experiment data, 2) weather and 3) soil.

1. Crop management data include planting date, dates when soil condition were measured prior to planting, planting density, row spacing, planting depth, crop variety, irrigation and fertilizer practices.
2. The weather data includes latitudes, longitudes of the weather station and daily values of in coming solar radiation, maximum and minimum air temperatures and rainfall. Optional data include dry and wet bulb temperature and wind speed.
3. Soil data are pedon characterization data by horizon with soil profile descriptions. Some of the key informations are soil classification. Surface slope, colour, permeability and drainage class. Soil horizon data include layer depth, sand, silt, clay contents, 1/3 bar bulk density, organic carbon, pH etc. Users can manually enter their soil data set through an interactive program and add it to the database.

Genetic coefficients related to maturity type photoperiod sensitivity and yield components are required by each crop model to simulate the difference in crop performance among varieties. A procedure, GENCAL, has been developed to obtain these coefficients for new cultivars.

4.2.5 EVAPOTRANSPIRATION CALCULATIONS

In the CERES, CROPGRO and the other DSSAT vs 3.5 models, options exits for the Priestly-Taylor method for computing potential evapotranspiration, and for the Penman method using FAO definitions of the wind term. The Priestly-Taylor method is the same as used by ***Ritchie (1985)***, that needs the minimum data set while as Penman method requires daily humidity and wind speed data when they are available.

4.2.6 CARBON DIOXIDE EFFECT

The DSSAT vs 3.5 model has the capability to simulate the effect of CO2 on photosynthesis and water use. Daily potential transpiration is modified by CO2 concentration based on the effects of CO2 on stomata conductivity (***Peart et.al 1989***).

4.2.7 CLIMATE CHANGES STUDIES

The DSSAT vs 3.5 model has the capability to modify the daily weather data that are read from weather file, as well as day length. Each weather variable can be modified by multiplying constants times the input value and/or adding a constant to it.

4.2.8 WEATHER GENERATORS

The DSSAT v 3.5 has built-in capabilities for simulating weather using either one of two generators. One generator is SIMMETEO (Geng 1986) which requires only monthly averages of solar radiation, maximum and minimum temperatures, precipitation, and days with precipitation. This model computes coefficients and uses the WGEN to simulate daily data. The second generator is WGEN (Richardson 1985), which requires more statistics and are computed from daily data from number of years.

4.2.9 CROP ROTATION:

An option in the model allows users to select whether to reinitialize soil variables after each run or to use ending conditions from one run as inputs to the next run. This allows for crop rotations to be studied in the new models, with carry over effects in the soil currently limited to crop residue, soil nitrogen, carbon and water with depth.

4.2.10 STRATEGY EVALUATION

The real power of the DSSAT (Singh, 2001) for decision-making lies in its ability to analyze many different management strategies. When a user is convinced that the model can accurately simulate local results, a more comprehensive analysis of crop performance can be conducted for different soil types, cultivars, planting dates, planting densities, irrigation and fertilizer strategies to determine those practices that are most promising and least risky. The weather estimator and strategy evaluation program in DSSAT establish the desired combinations of management practice, link the models to historical weather data for the location, run the model, and analyze the present results to users. It assists users in evaluating the relative merits of the simulated strategies with respect to any of the experimental factors. These include crop cultivar, planting date, planting density, row spacing, soil type, irrigation and fertilizer strategies, initial condition and crop residue management. To make field scale DSSAT applicable at farm scale, more information would be required, such as the spatial variability of current land use, weather and soils, and the proposed alternative plans, or arrangements over space, of crops and their management practices.

4.2.11 INPUT AND OUTPUT

Input Files: Input files required for running the models are as follows.

a) **Experiment Details File (FILEX):** This file documents the inputs, either observed from field or hypothetical one to the models for each experiment to be simulated. The Crop management data required for inputting experiment detail file is as shown below.

FILE SECTION	MAJOR CONTENTS
Experiment Details	Experiment name and codes
General	Name of people, addresses, name and location of experiment site, plot information
Treatments	Treatment name, number and specification of level codes of the treatment factor
Cultivars	Cultivars level, crop code, cultivar ID, and name of genetic coefficient
Fields	Specification of field level, ID, weather station name, soil and field description details.
Soil analysis	Set of soil properties used for the simulation of nutrients dynamics based on horizon characteristics
Initial Conditions	Starting condition of water and soil in the profile along with the root residue from the previous crop.
Planting Details	Planting date, population, seeding depth and row spacing data
Irrigation	Irrigation dates, amounts, and rice flood water depth
Fertilizers	Fertilizer rate, date and type of application
Residues	Addition of organic manure, farmbarn manure straw with date, rate and type of application
Chemical Applications	Herbicides and pesticides application details
Environmental modifications	Adjustment factor for weather parameters as used in climate change and constant environment studies.
Tillage Information	Details of dates, types of tillage operation
Harvest Details	Information on harvest dates ,plants components harvested etc

b) Weather Data File (FILW): It contains daily weather data on maximum temperature, minimum temperature, total solar radiation and rainfall for the crop period. Solar radiation is computed from sunshine hours.

c) Soil Data File (FILES): The soil file contains soil information about all the sites encountered by CERES. To run the model one can either select a representative soil description from this file or simply add soil information to this file as needed. A soil number identifies soils. For each soil the values of soil albedo, the upper limit of drainage, cumulative evaporation, soil water conductivity factor, and runoff curve number are given. Layers including the depth of each layer describe soils. The lower and upper limits of plant extractable water, the saturated soil water content and the root distribution function are the most essential information needed for running the model out of numerous information provided in the file.

d) Cultivar Data File (FILEC): This file contains the cultivar specific coefficients. Specific number identifies the cultivars.

e) Experiment performance file (FILEA, FILET): The observed values of experimental performance of the crop, which can be used for comparison with the simulated outputs of the model, are provided in this file. FILEA, used to derive the genetic coefficients of the crop includes anthesis date, physiological maturity, grain yield, unit grain wt., grain number per spiklet, spiklet number, max LAI, total dry matter, nitrogen concentration in grain and stem. FILET (optional) contains time course data on different crop attributes, soil moisture and nitrogen for detailed comparison and verification.

OUTPUT FILES

The model run produces six out put files.

1. Overview output file ***(OVERVIEW.OUT):*** This file provides an overview of input conditions and crop performance and a comparison with the actual data if available.

2. Summary output file (*SUMMARY.OUT*): This file provides a summary of outputs for use in application program with one line of data for each crop season.

3. Growth output file *(.OUTG):* This file provides detailed simulation results, including simulated seasonal (at daily or less frequent intervals) growth and development.

4. Carbon Balance output file *(.OUTC):* This file provides detailed simulation results, including simulated seasonal (at daily or less frequent intervals) carbon balance.

5.Water balance output file *(.OUTW):* This file provides detailed simulation results, including simulated seasonal (at daily or less frequent intervals) water balance.

5.Nitrogen output file *(.OUTN):* This file provides detailed simulation results, including simulated seasonal (at daily or less frequent intervals) nitrogen balance.

All of the above output files are setup so that successive simulated results in one season are appended to the respective file. The output files are temporary files, created during simulation, and they are overwritten when a new simulation session is started.

4.3 ACESSING DATA, MODELS & APPLICATION PROGRAMS

The DSSAT vs 3.5 Shell **(as shown in screen 1)** interface between the user and the crop models, application programs and data files found in DSSAT *vs* 3.5 The Shell is menu driven and thus enables users to easily select and use any DSSAT components. DSSAT main menu has five main menu options. They are DATA, MODELS, ANALYSIS, TOOLS, and SETUP/QUIT

4.3.1 DATA MENU OPTION

Data menu option provides users with access to various types of data on experiment, crops, weather, soils, climate, economics and pest. These data are found under various options headings such as **BACKGROUND, EXPERIMENT, GENOTYPE, WEATHER, SOIL, PEST** and **ECONOMICS**. Each of these options has various submenus, which are accessed when one of option is selected.

a) **Background:** - This menu is to provide **general information, fields information and codes.**

General information: Regarding Institute, sites and people.

Fields: help users to review and edit description data on fields and soil analysis data from the field.

Codes: to give users access to information on codes used for specifying fertilizers, chemicals, growth stages and other management inputs.

b) Experiment: - The purpose of "Experiment" menu option is to provide access to experimental data management functions, including inputting, editing, graphing, listing, linking them to model and printing. Under this menu there are three options: "**L**-List, **C**-Create and **U**- Utilities"

List: Lists all experiments in a particular directory, giving for each experiment, the file name, the crop code, standard and local experiment names and a brief description of the experiment as well as allows users to search and locate the experiments in the current path.

Create: The purpose of this menu option is to enable the users to create an experiment file (FILEX), which is used as an input file to the crop models. This includes field information, initial conditions, irrigation fertilizer, residue management, cultivar and other data needed to specify experimental conditions.

Utilities: Purpose of this menu is to allow the user to review crop performance data, compute average from replicate data.

c) GENOTYPE: This menu is to provide access to information on crop cultivars and on cultivar coefficients for crop models. This menu contains "**L** List, **A** Append, and **C** Calculate".

d) WEATHER: The purpose of the "WEATHER" menu is to provide users access to a wide range of weather data management capabilities including searching and sorting for weather stations, editing, printing, re-formatting weather data files, generating daily data, monthly data, analyzing real and simulated weather data.

e) SOIL: The purpose of " soil" data menu is to provide users access to all soil profile data, which is stored in file named "*. SOIL" and* users can search on soils by name, description texture, depth as well as site country, and latitude and longitude of the of the soil sample.

4.3.2 MODELS MENU OPTIONS

Under the MODELS menu option items are listed "**C**- CEREAL, **L**-LEGUMES,**R**-ROOTCROPS, and **O**- OTHERS". These items provide users with access to crop simulation models for simulating the performance of real experiments and comparing model result with observed results **(screen-2).** When any option under this menu is opened then further sub-menu such as " *C*-Create, *I*-

Inputs, *S*-Simulate *O*-Output and *G*-Graph will again open for accessing the users to particular job.

4.3.3 ANALYSIS

This option gives users access to two programs, seasonal analysis and sequence analysis that provide analysis capabilities for uncertainty and risk as well as for long-term sustainability of agricultural practices at a field scale. Seasonal analysis allows running large experiments with many treatments replicated across many years simulated or historical weather data. The results can be analyzed by comparing the treatments with respect to a wide variety of model output such as yields. In sequence analysis mode crop rotation or sequence can be simulated along with the attendant carry over effects of soil water and nitrogen process from one crop to another **(screen-3).**

4.3.4 TOOLS MENU OPTIONS

This menu gives user access to DOS shell and to user supplied disk manager, text editor and spreadsheet program.

4.3.5 SET UP/QUITE MENU OPTIONS

This option enables users to modify program, paths, program names and data file paths used in different section of DSSAT and also to quit from DSSAT vs 3.5.

4.4 CREATING MANAGEMENT FILES TO RUN MODELS AND DOCUMENT EXPERIMENTS

Researchers in the IBSNAT network have developed a system of data files, formats, and conventions for storing information on crop production. The purposes of this system are to provide a uniform structure for documenting crop experiments conducted at any site provide uniform data structures for crop model inputs and applications. This system includes files for daily weather, soil, crop and management data for documenting the environment, crop and cultivar characteristics and field management. These data files are also used as input to crop model. The program which creates management files to run models and document experiment is called **XCreate** and was developed to help users to create a file that describes an experiment. This file, referred to as FILEX, can be used to store detail for an actual or hypothetical experiment in a standard ASCII file. XCreate can be used to enter data from actual experiments on from hypothetical ones that are to be simulated on a computer. A user can create a FILEX for running the DSSAT vs 3.5 crop models in three modes. These are

- Interactive or Experiment Mode
- Seasonal analysis mode
- Sequence analysis mode

The interactive or experiment mode for running the crop models will usually be used for calibration, validation and sensitivity analysis for single-season crop simulations, compare simulated with observed outputs.

4.4.1 Creating a FILEX

Xcreat is, in essence, an experiment data entry program for DSSAT and as such allows the users to enter management information for the various treatments and sections of an experiment. The information includes cultivar, field, soil analysis, and initial conditions, planting, irrigation fertilizer residue, chemical applications, tillage and rotation, environmental modifications, harvest and simulation control conditions as shown in **screen (4-8)**.

The basic procedure involved in creating a **FILEX** is as follows:

- Select an existing experiment as a "template".
- Add or remove treatments.
- Edit sections as required until complete.
- Save the new FILEX.

A user can also start with a blank "template" and enter all treatment data and information needed to describe the details of an experiment. The menu bar provided in DSSATvs3.5 for creating FILEX are FILE, EXPERIMENT, MANAGEMENT, CONTROLS AND OPTIONS. Each item in this menu bar has a related pull down menu.

FILE MENU: Under the file menu item (Screen-) are options, which enable users to create a new experiment using an existing experiments as a template or to enter a new experiment without a template, to change the working directory and to save a newly created FILEX. Under FILE menu sub menu are **1. Open using template, 2. Change working directory, 3. Save current work**

EXPERIMENT MENU: Under the EXPERIMENT menu item are several options that allow the users to enter or modify data that will be stored in the experiment section of a FILEX.The four menu options are 1.Identifiers, **2. General, 3. Plot information, 4. Notes**

MANAGEMENT MENU: Under the MANAGEMENT menu item (Screen-) are several management options to enable a user to define management- related information for the FILEX. The menu options provided under this item are 1. Treatments, 2. Cultivars, 3. Fields, 4.Soil analysis, 4. Initial conditions, 5. Planting, 6. Irrigation, 7. Fertilizer, 8.Residue, 9. Tillage/Rotation, 10.Chemicals, 11.Environment, 12. Harvest

CONTROLS MENU: The CONTROLS menu allows users to set various Simulation Control options, including starting dates and ON/OFF options for model components such as soil water or nitrogen balance for FILEX. The menu option under this item are 1. General, 2. Options, 3. Methods, 4. Management, 5. Output.

4.5 Input and Output Files

The IBSNAT has published document for a set of crop model input and outputs. This system of files and data format was used for the models integrated into the DSSAT. The work reported by IBSNAT provided a basis for many of the files and files structures presented here. In that original work, the inputs and outputs were limited in those that described weather, soil, and nutrients condition, row and planting geometries and crop management. In the current document, not only have those inputs and outputs been expanded but they are now more flexible, have more valiables and contain additional environmental conditions. The files and file structures described here are designed to accommodate a diversity of crop models and applications.

4.5.1 File Naming Conventions and codes

A set of file naming conventions has been adopted to facilitate recognition of different categories of data. This has two parts.

1. The file extension, which is used to specify the type of file.
2. The prefix, which is used to identify the contents of the file

EXTENSIONS:

.WTH	weather data file
.SOL	soil profile data file
.CUL	cultivar specific coefficient file
. OUT	output file generated by the crop model

.LST	list file
.CCX	experiment detail file (FILEX)
.CCP	observation data
.CCD	performance data
.CCA	average value of observation data

The 'CC' in the above extension indicates a crop code. The crop code for rice is **'RI'**. Other Experimental detail codes are presented in **Annexure I**. Simulated and field data codes are presented in **Annexure II.**Growth and development codes are presented in **Annexure III.** Codes for soil data are shown in **Annexure IV.**Genotype Coefficent Codes are presented in **Annexure V.**Weather data codes are presented in **Annexure VI.**

In DSSAT files are organized in to input, output and experiment data files. In the RICE Model, different files are presented as shown in **Table 4.1**

Table 4.1: Crop Model Input and Output Files

File Name	Files Name(s)	Description
	INPUT FILES	
FILEL	Exp.LST	LISTING of all available experiment detail files
FILEX	RNRA7301.RIX	Experiment detail file used for validation of DSSAT
	RNRI7301.RIX	Experiment detail file used for prediction from DSSAT
FILEW	WRDF73017301	Weather data file of Demonstration farm WRDTC,IIT Roorkee year 2003 (June-1 to 23 rd October)
FILES	SOIL.SOL (WR00730001.SOL)	Soil data file for Demonstration farm WRDTC,IIT Roorkee.(Retrieve from Soil Data File)
FILEC	RICER940	RICE MODEL & Cultivar

	(WR0002.CUL)	for a rice crop used
	OUTPUT FILES	
OUTO	OVERVIEW.OUT	Overview of inputs and soil variables
OUTS	SUMMARY.OUT	Summary information
OUTG	GROWTH.OUT	Growth
OUTC	CARBON.OUT	Carbon balance
OUTW	WATER.OUT	Water balance
OUTN	NITROGEN.OUT	Nitrogen balance

4.6 DATA FORMATE OF DIFFERENT INPUT FILES

a) **EXPERIMENT DETAILS FILE:** A main file refereed to as FILEX, documents the inputs to the models for each experiment to be simulated and the file structure is shown in **ANNEXURE VII.**

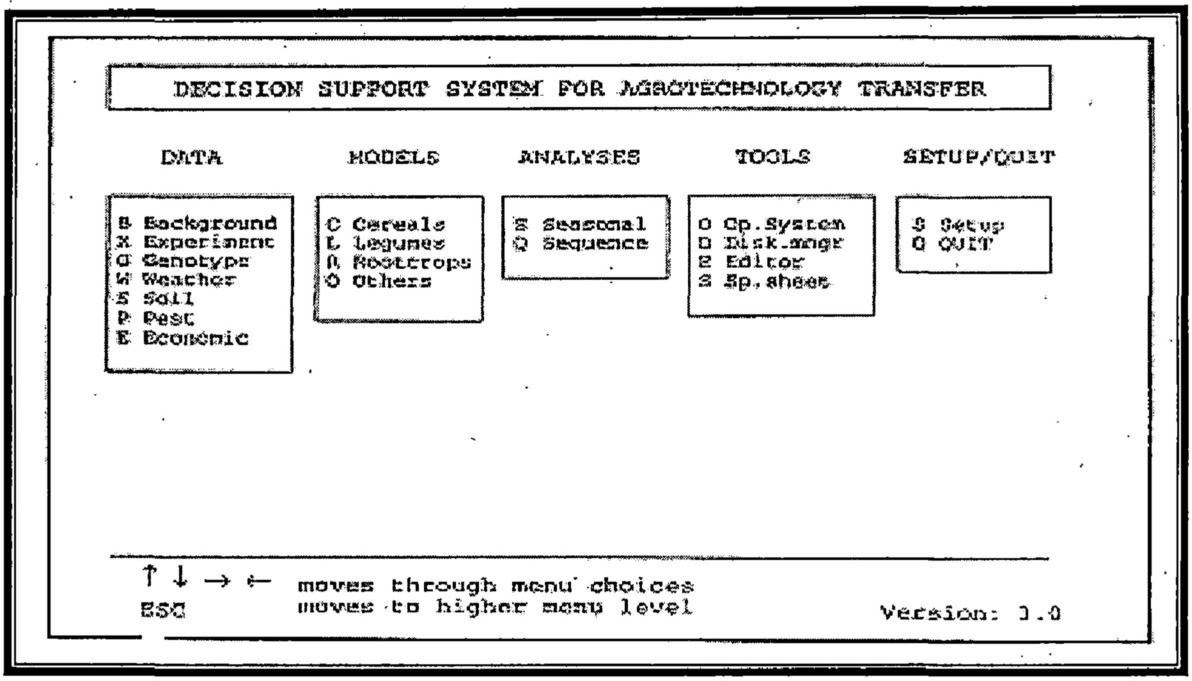
b) **WEATHER DATA FILE:** Daily weather data required were observed at DEMONSTRATIONFARM, WRDTC, IIT Roorkee from beginning with the day of Field preparation to end of crop maturity and contains at file WRDF7301. The data format shown **in ANNEXURE VIII.**

c) **DETAILED SIMULATION WATER BALANCE OUTPUT FILE:** The data format is shown in **ANNEXURE IX.**

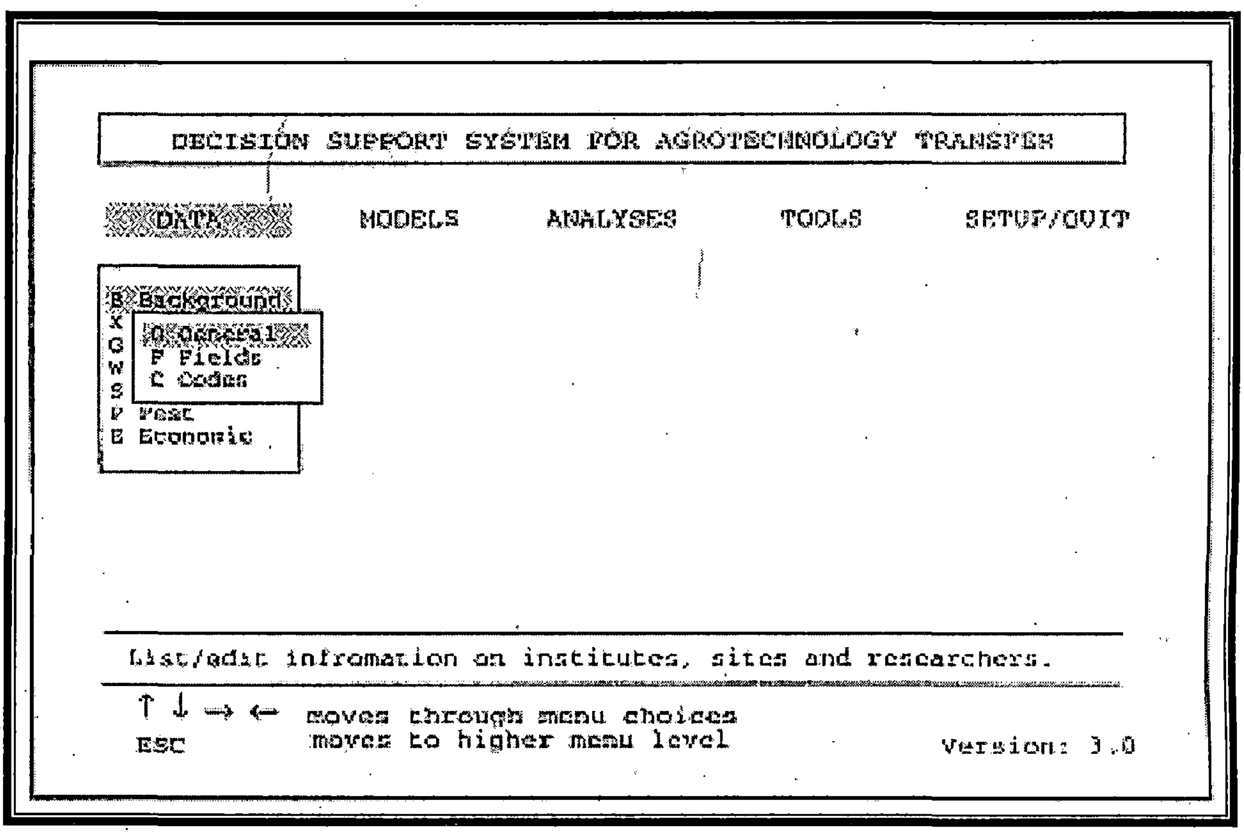
d) **DETAILED SIMULATION WATER BALANCE OUTPUT FILE:** The data format shown in **ANNEXURE X.**

e) **SIMULATION CONTROL:** The data format is shown in **ANNEXURE XI.**

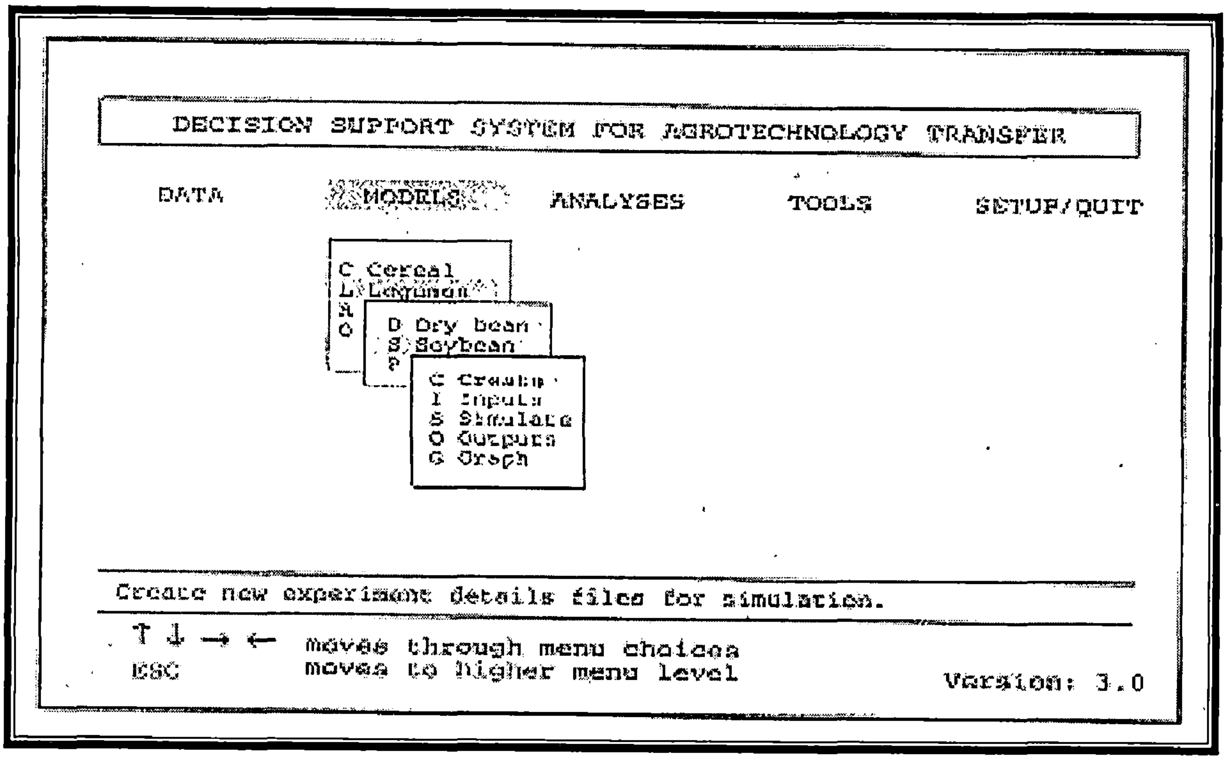
Different Shell of DSSAT



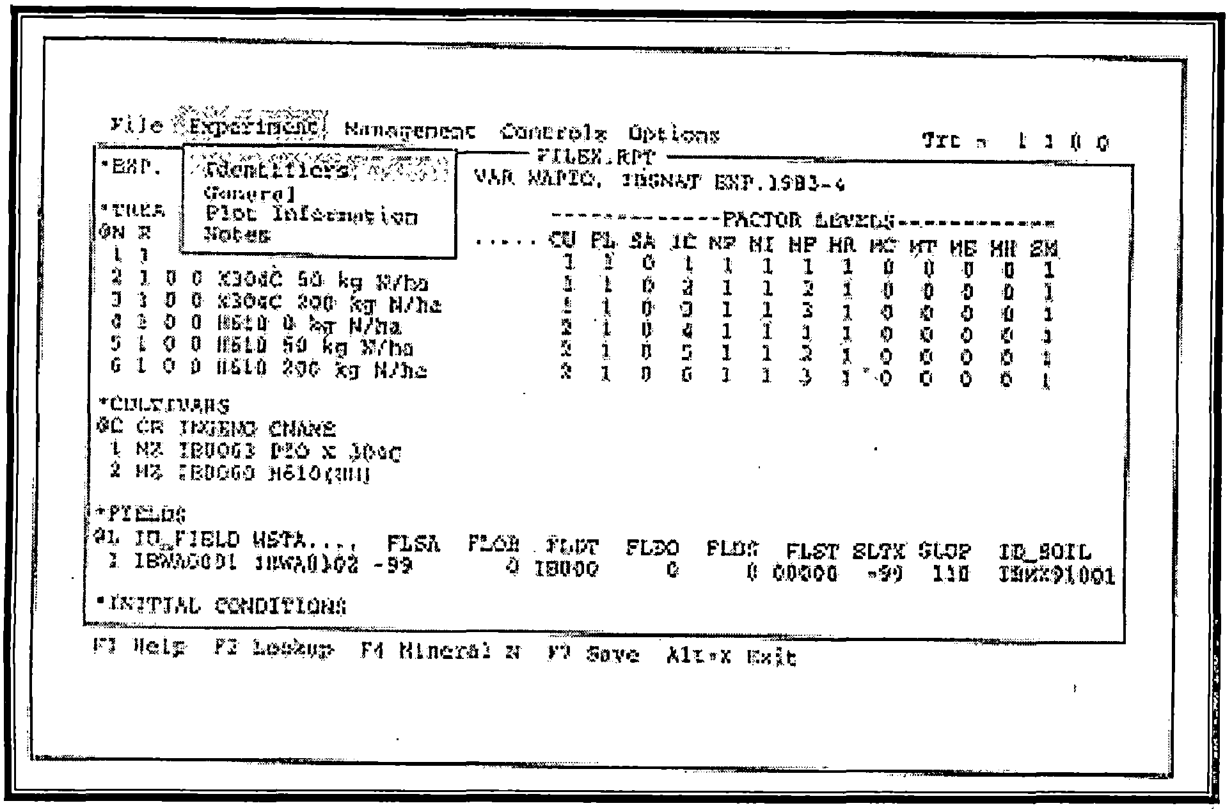
SCREEN-1



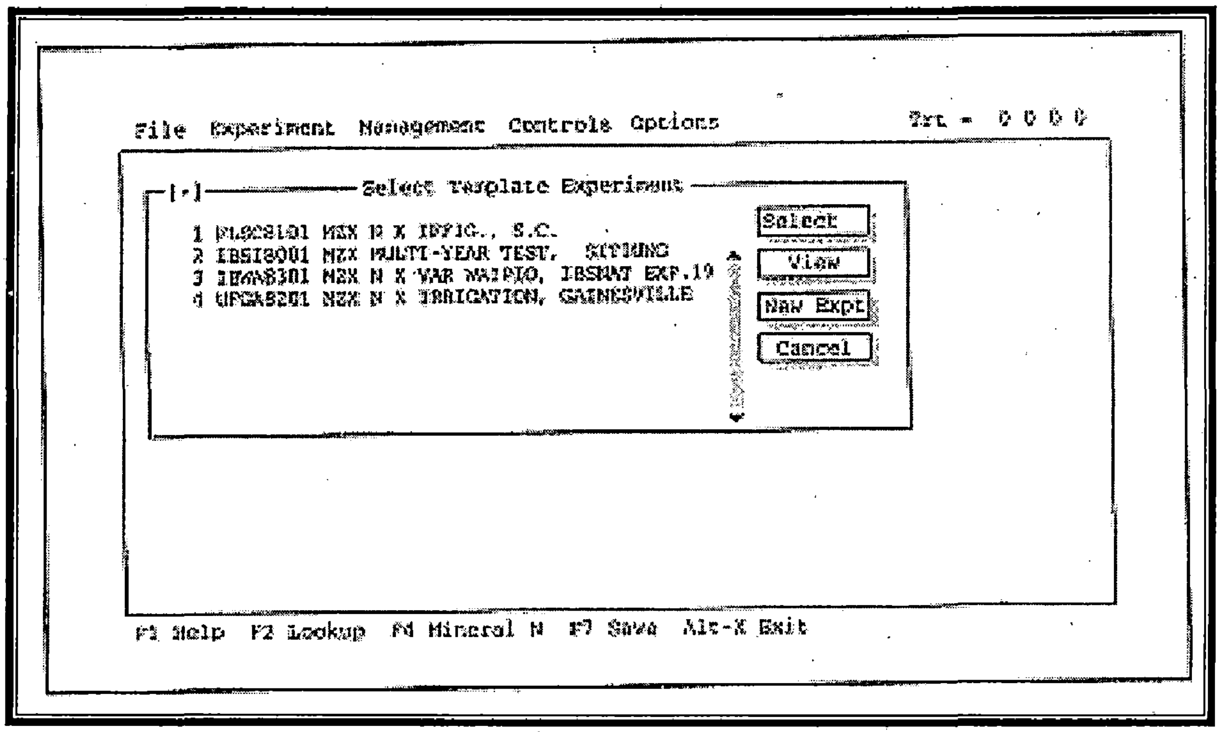
SCREEN-2



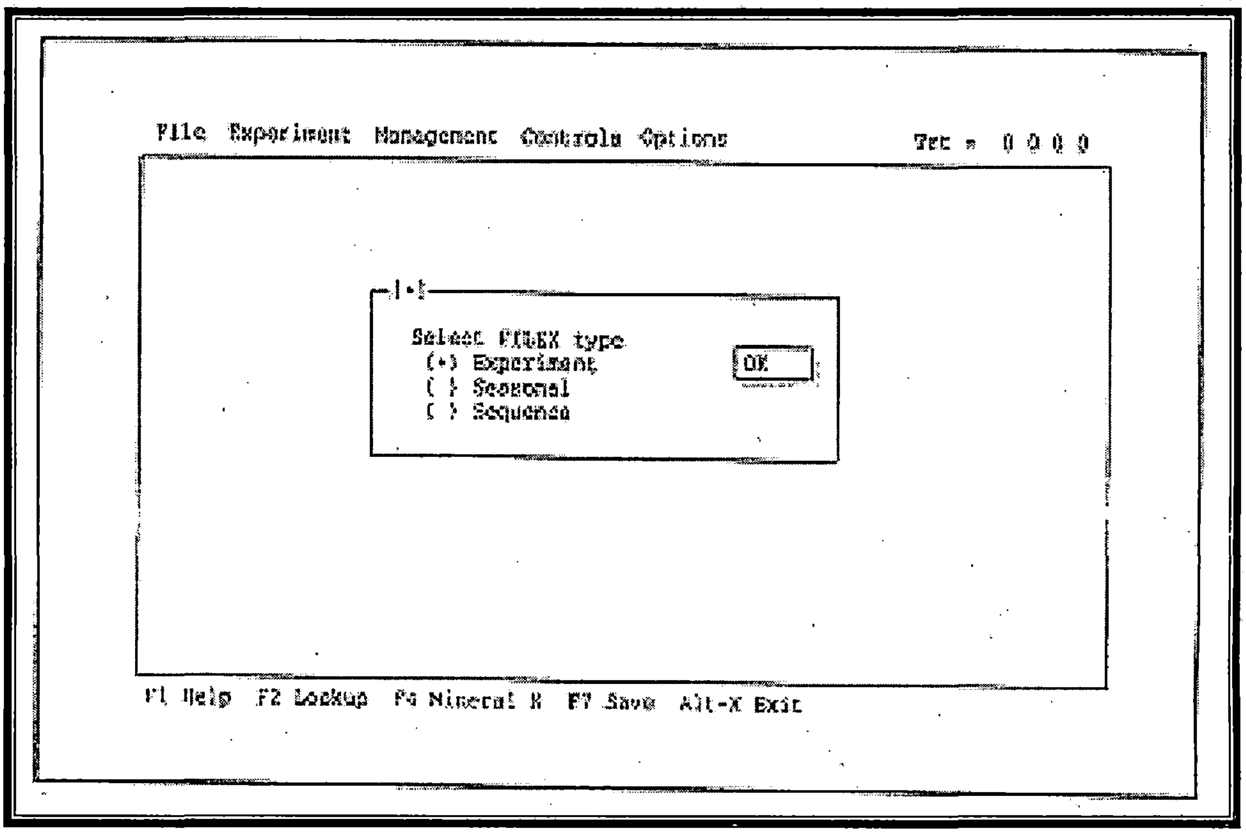
SCREEN-3



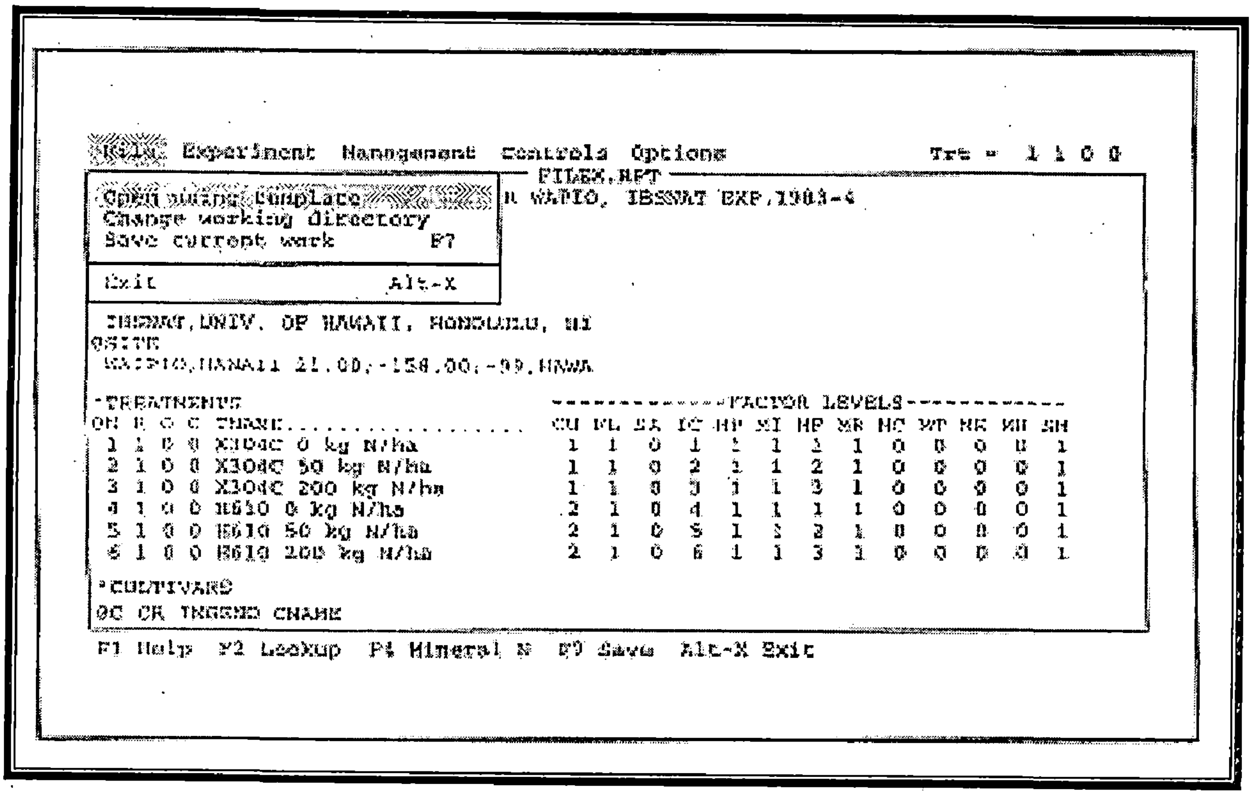
SCREEN-4



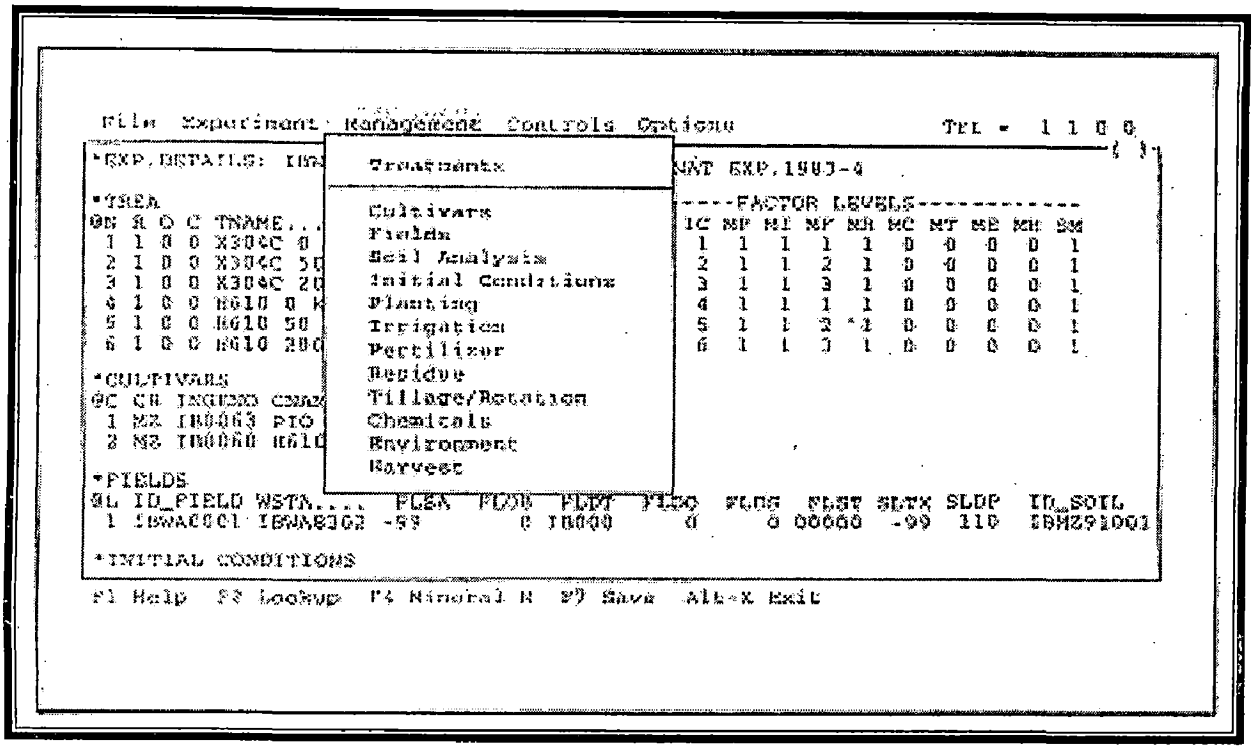
SCREEN-5



SCREEN-6



SCREEN-7



SCREEN-8

4.7 Rice Modeling- Growth and Development

4.7.1 Phenological events and stages

Phenological events and stages in the model are numbered through 1 to 9 as follows.

a) Above the Ground Stages

1. Juvenile stage (ISTAGE1)
2. Panicle Initiation stage (ISTAGE2)
3. Heading stage (1ST AGE3)
4. Pre-grain filling stage (ISTAGE4)
5. Grain filling stage (ISTAGE5)
6. Physiological maturity stage (ISTAGE6)

b) Below ground Stages

1.Sowing (ISTAGE7)

2. Germination stage (ISTAGE8)

3 Emergence Stage (1ST AGE9)

Duration of each Phenological stage makes use of thermal time or degree-day at time k, DTT(k).

DTT *(k)=f* {TEMPMN (k), TEMPMX (k), and TBASE}

Where,

DTT (k)= Thermal time or degree day time

TEMPMN (k)= Minimum Temperature

TEMPMX (k) = Max. Temperature

TBASE = Temperature threshold = taken 8 ^{0}C for rice

When TEMPMN (k) > TBASE & TEMPMX (k) < 33°C, then

$$DTT(k) = TEMPM(k) - TBASE$$

$$TEMPM(k) = \tfrac{1}{2}\{TEMPMX(k) + TEMPMN(k)\}$$

Other wise, $DTT(k) = \frac{1}{8}\sum_{i=1}^{8}(TTMP(k)i - TBASE), \text{if } TBASE < TTMP(k)$

$$DTT(k) = \frac{(33 - TBASE)}{8}\sum_{i=1}^{8}[1 - \frac{1}{9}(TTMP(k)i - 33)], \text{ if } 33^0C < TTMP(k)i < 42^0C$$

Otherwise, DTT (k)= 0

Temperature correction factor for (8*3) hr section (TMFAC(k)) and air temperature for 3h section TTMP(k) can be calculated as

$TTMP(k) = TEMPMN(k) + TMFAC(k)i\,(TEMPMX(k) - TEMPMN(k))$ ......i=1 8

$TMFAC(k)_I = 0.931+0.114\, i^1 - 0.07031 i^2 + 0.0053 i^3$ ... .,i=1 8

4.7.2 Modeling Phenologial Events and Stages

1 SOWING: Sowing occurs when seeds are sown in the ground. Discrete time k is set to 0, i.e.. k=0 will be incremented by 1 every simulation step hereafter.

2. GERMINATION STAGE: This stage covers the period from sowing until germination. In the model germination take place when the following 4 condition satisfied.

a) There is enough moisture in the soil seed layer,ie

$$SW(k)\ \lambda 0 > LL\lambda 0$$

Where, SW (k) = soil water content of the seed layer, λ0

LL = Lower limit of plant extractable soil water

or

$$SWSD(k)= 0.65[SW(k)\ \lambda 0 - LL\lambda 0] + 0.35[SW(k)\ \lambda 0{+}1 - L\lambda 0{+}1 \geq 0.02$$

b) Mean air temp. is at time k is between 15-42 ^{0}C.

$$15°C \leq TEMPM(k) \leq 42\ ^{0}C$$

c) Thermal time

Accumulated thermal time after sowing ≥45

d) Duration for seeds in the soil is no more than 40 days

if duration>40d, simulation ends

3 EMERGENCE STAGE: Period from germination to emergence and the duration in degree-days is P9 which is a linear function of sowing depth (SDEPTH) with a slope of 7 degree days per cm depth.

$$P9= 7\ \{SDEPTH\}$$

4.JUVENILE STAGE: Period from seedling emergence to the end of basic vegetative phase. The thermal time required for this stage is equal to P1.

$$P1= \text{Seedling age} \times TEMPM(k)$$

5. PANICLE INITIATION STAGE: The PI stage in the model covers the period from the end of the basic vegetative phase to PI. Rice is a short day crop, initiating panicle primordia in response to short photoperiods. The duration of the PI stage varies with cultivar photoperiod sensitivity and photoperiod. The day length at which the duration from from sowing to flowering is at a minimum is called optimum photo period. The critical photoperiod is the longest photoperiod at which the cultivar will flower.

Photoperiod at time k (HRLT (k)) in hours is a function of LAT and solar declination at time k (DEC (k), in radians. DEC (k) is a sine function of the day of year (JDATE).

$$DEC(k) = 0.4093 \sin[0.0172(JDATE-82.2)]$$

Day length variation (DLV (k))

$$DLV(k) = \frac{-\sin(LAT)\sin[DEC(k)] - 0.1047}{\cos(LAT)\cos[DEC(k)]}$$

$$\text{Photo period } HRLT(k) = 7.639 \arccos[DLV(k)]$$

Rate of floral induction per degree day at time (RA TI N (k)) is a constant 1 /136 if HRL T(k) ≤ optimum photo period P20 of the cultivar. If HRL T(k) is > P20,(RATIN(k)) is reduced and becomes function of HRL T(k}, P20, and rate of photo induction (P2R).

$$RATEIN(k) = \frac{1}{136 + [P2R(HRLT(k) - P20)]}$$

The PI stage is completed when sum of the product of RATEIN(k) and DTT(k) from the beginning of this stage (k_2) until time kp is 1.0, where kp is the day of PI. That is

$$\sum_{k=k2}^{k_p} RATEIN(k)[DTT(k)] = 1.0$$

6 HEADING STAGE: The heading stage is from the end of the PI stage to the time when 50% of the panicles have fully exerted. The duration of the heading stage is P3. It is equivalent to 450 degree days +0.15 of the accumulated degree days from the beginning of the juvenile stage (k1) until PI (kp).

$$P3 = 450 + 0.15 \sum_{k=k1}^{k_p} DTT(k)$$

7. PRE GRAIN FILLING STAGE: The pre grain filling stage is from the time when 50% of the panicle have exerted to the beginning of the grain filling. The duration is 170-degree days.

8. GRAIN FILLING STAGE: The grain filling stage covers the period of grain filling. The duration, in degree-days, is 0.95 of the genetic coefficient P5.

9. PHYSIOLOGICAL MATURITY: The duration of physiological maturity is the time required to complete P5 or when DTT (k) ≤ 0.

When DTT (k) =0, simulation stop

4.7.3 GROWTH AND ORGAN DEVELOPMENT: This routine has three fold purpose

1. To establish the leaf area of the plants at the sites of biomass production through photosynthesis.

2. To partition the photosynthates between leaves, roots, stems, and ears.

3. To calculate the product of the number of grains filled and their average weight.

Photosynthesis is the process where the plant converts intercepted light in to carbohydrates using following equation

$PG = PG_{MAX}.FL.FG.FN.FT.Kp$

Where,

PG = Photosynthetic rate

PGMAX= Max. Carbohydrate production rate for a full crop canopy and given amount of radiation (g/m2day)

FG= Reduction in PG due to sub optimal soil water content.

FN = Reduction in PG due to sub optimal leaf nitrogen.

FT = Reduction in PG due to sub optimal temperature

Kp = PG calibration constant

Major principles followed for partitioning assimilates in to different plants parts are as under:

1. During vegetative growth, shoots have higher priority than roots for assimilate as long as the supply of water and nutrients from the soil is adequate. When water or nutrients are limited during vegetative growth, roots have a higher priority for assimilates than shoots.

2. During the grain filling stage the grain are the dominant sink for assimilates. Material for filling the grain s can be derived from photosynthesis and stored assimilates. Water and nutrients deficiencies have little effect on the ability of material to be transported to the rain.

So, Potential biomass production (PCARB) *(glm2)* is

PCARB= 7.5x IPARo.6

$$= \frac{7.5xPAR^{0.6}x(1-Exp(-0.85xLAI))}{No\,of\,plants\,per\,m^2}$$

Where, PAR = Photosynthetically active radiation

IPAR = intercepted PAR= O.021x net radiation

The temperature reduction effect (PRFT) is dependent on a weighted daytime temperature (T) calculated from max. and min. temperature and expressed as

$$PRFT = 1.0.0025x(T-16)2 = (0-1)$$

$$T = 0.25x\ T\ n + 0.75xTx$$

The water stress reduction factor (SWDF1) is calculated whenever the crop extraction of soil water falls below the potential transpiration rate calculated for the crop. The actual biomass production (CARBO) is then a function of the smallest of the two-reduction factor and PCARB. Dry matter accumulation is represented by following equation.

$$\partial W_L / \partial t = X_L W^+ -- S_L - M_L$$

$$\partial W_L / \partial t = X_S W^+ - S_S - M_S$$

$$\partial W_R / \partial t = X_R W^+ - S_R$$

Where,

W_L = Dry wt. of leaf per unit ground area *(g/m2)*

Ws= Dry wt. of stem per unit ground area *(g/m2)*

W_R = Dry wt. of root per unit ground area *(g/m2)*

t= Time in day

X_L= Fraction of photosynthate to leaves

M_L = Rate of protein remoblism to seeds from leaves

Ss = Petiole dry weight senesced per unit time *(g/m2/day)*

Ms = Rate of protein remobilization to seeds from stem *(g/m2/day)*

Xs = Fraction of photosynthate to stem

XR = Fraction of photosynthate partitioned to roots *(g/m2/day)*

SR = Root dry wt. Senesced per unit time *(g/m2/day)*

SL = Leaf dry wt. Senesced per unit time *(g/m2/day)*

W+ = Growth rate of new plant tissues which is function of photosynthesis.

The proportion of CARBO partitioned to shoot growth (PTF) is a function of the soil water deficit factor (SWDF1) prior to grain filling or a function of the ratio of the stem weight at anthesis (SWMIN) during grain filling. In different growth stage, the proportion of CARBO portitioned to roots increases slightly under water deficits. Following partitioning schedule has been used in the model.

Stage	PTF
1	0.65
2	$0.70+0.1x\ SWDF_1$
3	$0.75+0.1\ x\ SWDF_1$
4	$0.80+0.1x\ SWDF_1$

5 $$0.65+0.35 \times \frac{SWMN}{STMWT}$$

Respiration rates are assumed to be proportional to gross photosynthesis and are not calculated independently in to calculation of PCARB and PRFT by following equation

$$Rm = Ro\ Wc + R_A P_G$$

Where,

Rm = Maintenance respiration

Ro = Gram of carbohydrate required to maintain cell membrane and ion gradient per gram dry wt. Per unit time.

We = Dry wt. Per unit ground area of canopy (g/m2)

RA = Gram carbohydrate required in maintenance respiration for the protein turn over per gram photosynthate per unit time

PG =Photosynthetic rate

4.7.4 Soil Water Balance

The soil water balance module of the DSSAT models computes, on a daily basis, all processes that directly affect water content in the soil profile throughout the seasonal simulation. Ritchie (1985) describes many of these algorithms in detail. The change in soil water content for the soil profile is calculated on a daily time step using the equation:

$$\Delta S = P + I - EP - ES - R - D$$

Where S = Change in soil water content

P = Precipitation

I = Irrigation

EP = Transpiration

ES = Soil Evaporation

R = Surface Runoff

D = Drainage from Soil Profile

Figure 1 illustrates the processes modeled. A maximum of 20 soil layers can be specified to represent the soil profile. Soil evaporation, root absorption, or flow to an adjacent layer can decrease the water content in any layer.

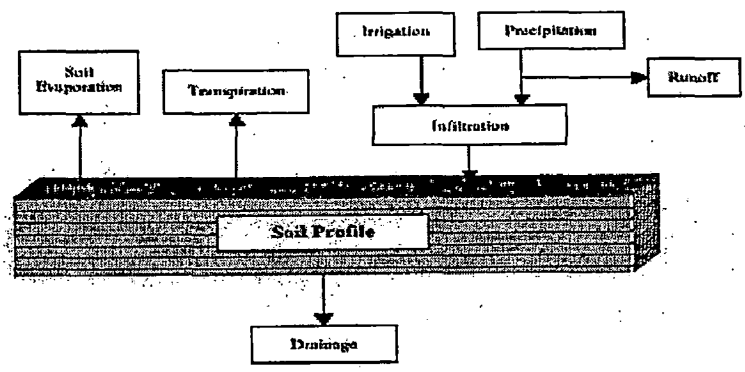


Figure 1 - Soil Water Processes Modeled in WATBAL

1.0 <u>INFILTRATION</u> :

It is the first process that has attempted in the model. Infiltration of water in to the soil is calculated as the difference between rainfall or irrigation and runoff,

Infiltration = (Irrigation/rainfall – Runoff)

2.0 **Runoff:** Runoff is calculated using USDA- soil Conservation Service (SCS) procedure termed the curve number technique (Soil Conservation Service, 1972). Soil Conservation Service (SCS) curve number equation is as follows:

$$R = \frac{(P - 0.2S)^2}{(P+0.8\,S)}, \quad \text{if } P > 0.2S$$

$$R = 0, \quad \text{if } P \leq 0.2S$$

Where, R = daily runoff

P = Daily rainfall

S =retention parameter which varies among soil type, land use,

Management slope and S

The retention parameter, S is related to curve number (CN) using SCS equation

$$S = 254\left(\frac{100}{CN} - 1\right)$$

CN can be obtained using SCS hydrology handbook in which CN is related to soil type, land use and management. In the model when irrigation water is applied, the runoff procedure is bypassed. Thus all the irrigation is assumed to infiltrate.

3.0 DRAINAGE: Because water can be taken up by plants while drainage is occurring, the drained upper limit soil water content is not always the appropriate upper limit of soil water availability. Many productive agricultural soils drain quite slowly, and may thus provide an appreciable quantity of water to plants before drainage practically stops. In the model drainage rate are calculated using an empirical relation that evaluates the field drainage reasonably well *(J. T. Ritchie and D. C. Godwin)*

The drainage formula assumes a fixed saturated volumetric water content (SAT), and fixed drained upper limit water content (DUL). Thus drainage take place when the water content (SW) is between those two limits. The equation is

DRAIN = SWCON x (SW -DUL)x DEPTH, if SW > DUL

Or

DRAIN = 0, if SW< DUL

Where, SWCON = Drainage coefficient

DEPTH = thickness of the layer being considered

SW = the current water content of the layer

In the model, constant drainage for one day is assumed and the value SWCON represents the fraction of water between DUL and SW that drain in one day.

4.0 EVAPOTRANSPIRATION: Evapotranspiration (ET) component of the model accounts for water losses from the soil surface and transpiration by plants. The determination of ET is a two step process. First, the daily potential (PET) is calculated in terms of atmospheric data and then checks are made to determine if ET is limited by the soil water conditions. If not, ET is set equal to PET; otherwise ET is set equal to smaller amount that can be supplied from the soil system.

In the Model ET is calculated using procedures described by *Ritchie* (1972). The procedure separates soil evaporation (ES) from transpiration (EP) for plants growing without a shortage of soil water, primarily on the basis of the energy reaching the-soil,the time since surface layer was wet, and LAI. The potential ET is calculated using an equilibrium evaporation concept as modified by *Priestly and Taylor* (1972). The developed equation calculates the approximate daytime net radiation and equilibrium evaporation. Potential evapotranspiration is calculated as equilibrium evaporation times 1.1 to account for the effects of unsaturated air. The multiplier is increased above 1.1 to allow for advection when the max. temp. is greater than 24 ° C, and reduced for the temperatures below 0° C to account for the influence of cold temperature on stomatal closure.

5.0 ROOT WATER ABSORPTION: The CERES model calculates root water absorption using an approach in which the larger of the soil or the root resistance determines the max. possible flow rate of water in the roots. The soil limited water absorption rate considers radial flow to single roots as a function of soil hydraulic conductivity, an assumed daily averaged constant water potential between roots surface and the bulk soil, an assumed constant root radius, and the root length density.

At each soil layer, root water uptake by a single root (RWU) depends on soil water availability and rooting density, according to the following relationship:

$$RWU = \frac{132K_e}{7.01 - L_n RLV}$$

In which, RWU =(0.03 cm3 of water/cm of root /day)

RL V = root length density, cm of *root*/ cm3 of soil

Ke = hydraulic conductivity, cm /day

Ke = 10-5 e[CON(SW -LL)]

Where, SW is actual soil moisture, LL is lower limit of soil available water,(cm3/cm3)

CON = 45 for LL > 0.3 cm3/cm3

Or

CON = 120- 250 LL,

Root water uptake from each soil layer in the rooting zone is integrated to calculate Total Root Water Uptake (TRWU).

Conditions:

1. If the max. uptake exceeds the max. calculated transpiration rate, the maximum absorption rates calculated for each depth are reduced so that the uptake becomes equal to the transpiration rate.
2. If the max. uptake is less than the max. transpiration, transpiration rate is set equal to the maximum absorption rate.

4.7.5 NITROGEN BALANCE: Typically the supply of N to plants at the beginning of the season is relatively high and becomes lower as the plants reaches maturity. During early growth, N concentrations are usually high due to the synthesis of large amounts of organic N compounds required by the growth process. As the plant ages less of this material is required and translocation from old tissues to new tissues occurs, lowering the whole plant N concentration. At any point, there exits a critical N concentration in the aerial plant tissue (TCNP) and in *roots* (RCNP), below which growth will be reduced.

$$\text{Nitrogen factor (NFAC)}= \frac{TCNP}{TMNC} = 0-1$$

Where TMNC is minimum N concentration,

NFAC is the primary mechanism used within the model to determine the effect of N on plant growth. It is an index of N deficiency relating the actual concentration in aerial plant parts (T ANC) to these critical concentrations. The CERES-model calculates the components of crop demand for N and soil supply of N separately and uses the lesser of these *two* to determine actual uptake rate. The crop demand has two components, First there is a deficiency demand which is the N required to restore actual N concentration to the critical N concentration for the above ground part. This deficiency demand (TNDEM) is quantified as product of biomass (TOPWI) and concentration difference as:

TNDEM= TOPWT (TCNP-TANC)

If TANC> TCNP, (-)ve N demand, due to luxury consumption

So N - uptake calculated = 0

Similarly, root N demand can be calculated as

$$RNDEM = RTWT\ (RCNP-RANC)$$

The Second component of N demand is the demand for N by the new growth. It is assumed that the plant would attempt to maintain a critical N concentration in the newly formed plant tissues. During the early stages of plant growth, the N demand for new growth will be the major part of the total demand. As the crop grows the deficiency demand (TNDEM) becomes large components. During the grain filling period after flowering stage, the N required by the grain is removed *from* vegetative and *root* pool to form a grain pool. The resultant of lowering of concentration in vegetative and root pool may lead to increased demand. The total plant N demand is the sum of all these demand components.

Mobilization of N does not start until the beginning of reproductive growth and can potentially be mobilized from the leaves, roots, stems, and shells to the seeds. N can be supplied through either N-uptake or N-fxation. The potential N supply to crop is calculated using a zero to one availability N factor (NFAC) as under:

$$NAFC = 1 - (\frac{(TCNP - TANC)}{TCNP - TMNC)}$$

The model accounts for the cost of reducing N from N03 - to NH4+ and incorporating in to proteins. The N- fixation is assumed to cost as much as N03 - reduction.

CHAPTER-5

DSSAT VALIDATION ON RICE cv HR 6444

The DSSAT was validated on data generated from the field experiment on Hybrid Rice cv HR 6444 during kharif 2003 on the Demonstration Farm of WRDTC, IIT Roorkee. The details of experiment, observations made and are presented in chapter-3. The treatment includes Organic manuring (FYM) @ 0 Kg/ha (F0, control), 4000 Kgs/ha (F1), 8000 Kgs/ha (F2), and 12000 Kgs/ha (F3). Rests of crop treatments were kept uniform.

Input files of experiment details, soil data, weather data, and genetic coefficient to run the DSSAT model were prepared. DSSAT model produced output files of simulation overview: summary of soil and genetics input parameter, simulated crop and soil status at main development stages, main growth and development variables, environmental stress factors, growth aspects are shown from Run No.1: 1- 1:4 under simulation over view file of this chapter. The programme is validated on the basis of the grain yield recorded through experimentation.

5.1-GRAIN YIELD

The Table 5.1 shows the yield actually observed and yield predicted by DSSAT under different treatments combinations. The overall average yield predicted by DSSAT is higher by 1.45 % over that of actually observed. This variation in yield is reasonably acceptable for a model prediction. Grain yield recorded under different treatments and predicted by DSSAT as given in Table 5.1 and depicted in Fig.5.1, was compared using paired ttest .The calculated value of 't' is 0.27 where as the tabulated $t_{0.05}$ is 2.45. Since the calculated value of 't ' is lesser than the tabulated value of 't', it can be attributed that there is no significant difference between the measured and DSSAT predicted grain yield. The DSSAT model in case of predicting grain yield of rice cv HR 6444 in the soil climatic conditions of Roorkee may be treated as validated.

Table 5.1: Showing Grain yield of Rice cv HR6444 validity by DSSAT predicted grain yield

Treatments	Grain Yield (Kgs/ha)		Deviation from measured %
	Measured	Predicted	
F0	5841	5993	+1.68
F1	6461	6606	+2.24
F2	6881	6911	+0.44
F3	6960	7067	+1.54
Average	**6535.8**	**6630.8**	**+1.45**

The above Table implies that the model has predicted the average grain yield with a difference of 95 kg in comparison to the field results. It is worth noting that the highest yield predicted was recorded in treatment F3 and the same was actually measured in the field.

Table 5.2: T-Test for Measured and Predicted Grain Yield

Treatment	Grain yield (Kgs/ha)		$(X-\bar{X})$	$(Y-\bar{Y})$	$(X-\bar{X})^2$	$(Y-\bar{Y})^2$
	Measured 'X'	Predicted 'Y'				
I2F0	5841	5939	-694.75	-691.75	482677.56	478518.06
I2F1	6461	6606	-74.75	-24.75	5587.56	612.56
I2F2	6881	6911	345.25	280.25	119197.56	7854.06
I2F3	6960	7067	424.25	436.25	179988.06	19314.06
Total	**26143**	**26523**	**0**	**0**	**787450.75**	**677298.74**
Average	**6535.75**	**6630.75**	-	-	-	-

$$S^2 = \frac{1}{(n_1 + n_2 - 2)}\left[\Sigma(X - \bar{X})^2 + \Sigma(Y - \bar{Y})^2\right]$$

$$= \frac{1}{(4 + 4 - 2)}(787450.75 + 677298.74)$$

=244124.92

$$\text{Now } t_{Cal} = \left|\frac{\bar{X} - \bar{Y}}{\sqrt{S^2(\frac{1}{n_1} + \frac{1}{n_2})}}\right| = \left|\frac{66535.75 - 6630.75}{\sqrt{244124.92(\frac{1}{4} + \frac{1}{4})}}\right| = 0.27$$

Tabulated $t_{0.05}$ for 6 d.f. =2.45

∴ Since the calculated value of 't ' is lesser than the tabulated value of 't', it can be attributed that there is no significant difference between the measured and DSSAT predicted grain yield.

5.3 SUMMARY OUTPUT OF VALIDATED DSSAT

The summary of all output from validated DSSAT is shown in Table5.3.

Table 5.3 : Showing DSSAT Summary output as predicted by DSSAT 3.5 of Hybrid rice cv HR 6444 under the cultural condition practised in the experiment at Demostration Farm

Experiment		Dates (Julian days)				Dry Wt.		Water Balance						Nitrogen Balance		
TN	TNAME	SDAT	PDAT	MDAT	HDAT	CWAM	HWAH	IRCM	PRCM	ETCM	ROCM	DRCM	SWXM	NICM	NUCM	NLCM
1	F0	73181	73183	73294	73296	8770	5993	880	602	489	103	947	57	117	82	76
2	F1	73181	73183	73295	73296	9958	6606	880	602	488	102	949	57	117	97	69
3	F2	73181	73183	73295	73296	10508	6911	880	602	488	102	950	58	117	105	63
4	F3	73181	73183	73296	73296	10812	7067	880	602	486	102	951	57	117	111	58

F0=0 kg/ha FYM F1=4000 kgs/ha FYM F2=8000 kgs/ha FYM F3=12000 kgs/ha FYM

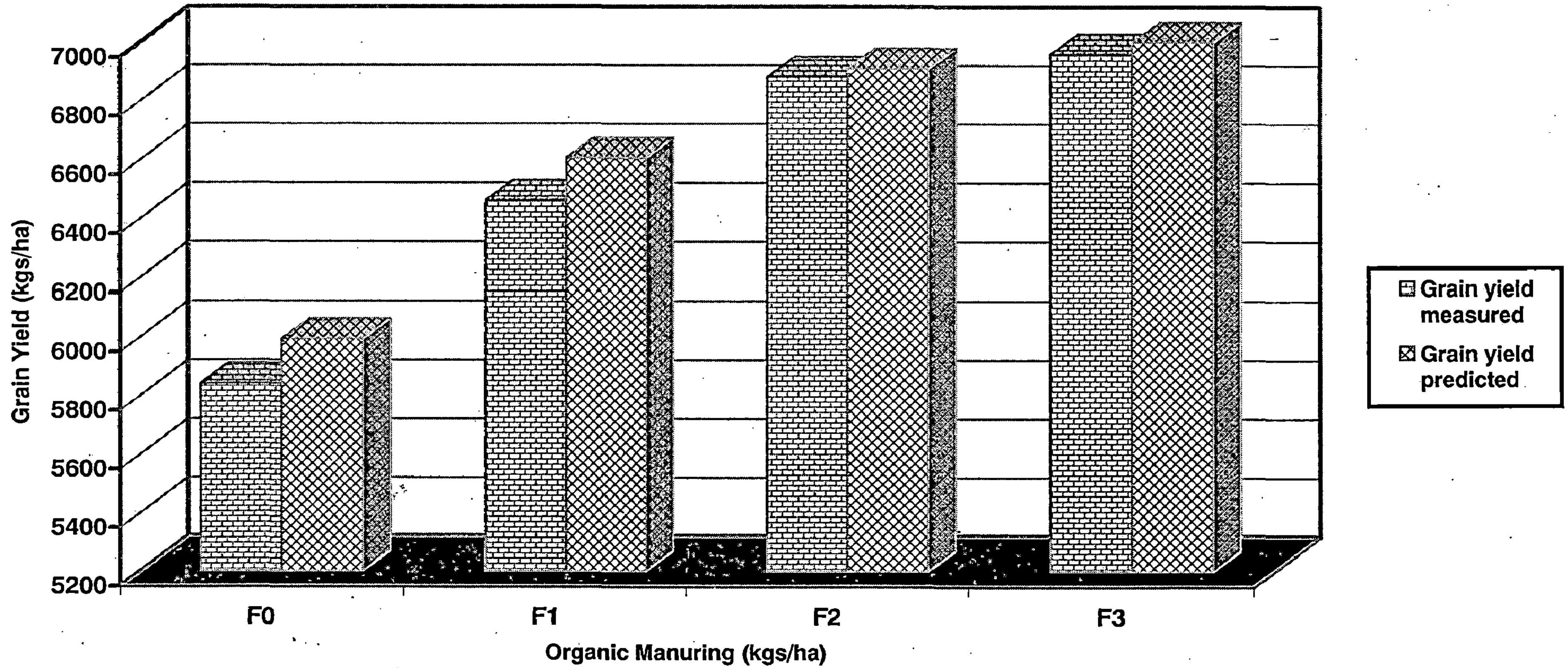


Fig.5.1: Showing grain yield of Hybrid rice cv HR6444 actually measured and predicted by DSSAT3.5 for the cultural condition practised in the experiment at Demostration Farm

*RUN 1:1 F0 (80*0)

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRA7301 RI    R.N.P.YADAV
TREATMENT  1     : F0 (80*0)
CROP             : RICE           CULTIVAR : HR 6444          - ...............
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001     TEXTURE : SALO   - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :      880 mm IN      11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;        0 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER   :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

```
TOT- 90   11.3   22.6   32.4   11.3   22.6  <--cm   -  kg/ha-->   43.9    5.9  11080
SOIL ALBEDO     :  .13         EVAPORATION LIMIT : 9.40        MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00          DRAINAGE RATE     :  .60        FERT. FACTOR : 1.00

RICE        CULTIVAR :WR0002-HR 6444             ECOTYPE :......-...............
P1      : 550.0  P2R     : 185.0  P5      : 250.0  P2O     :  11.7
G1      :  60.0  G2      : .0250  G3      :  1.00  G4      :  1.15
```

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO.1 F0 (80*0)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm.	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	4.0	.04	.00
21 AUG	50	Pan Init	1633	1.44	16	224	393	400	0	35	2.2	.00	.53
25 SEP	85	Heading	5661	2.88	23	372	602	720	0	81	1.4	.00	.42
5 OCT	95	Beg Gr Fil	7547	2.31	23	421	602	800	0	81	1.1	.00	.08
18 OCT	108	End Mn Fil	8770	.63	23	479	602	880	0	82	.9	.00	.33
20 OCT	110	End Ti Fil	8770	.41	23	483	602	880	0	82	.9	.00	.53
21 OCT	111	Maturity	8770	.41	23	485	602	880	0	82	.9	.00	.53
23 OCT	113	Harvest	8770	.41	23	489	602	880	0	82	.9	.00	.53

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	82
PHYSIOL. MATURITY (dap)	111	113
GRAIN YIELD (kg/ha) AT 14% H2O	5939	5841
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	20429	27136
PANICLE NUMBER (PANICLE/m2)	641.41	348
MAXIMUM LAI (m2/m2)	2.98	7.72
BIOMASS (kg/ha) AT ANTHESIS	5532	11157
BIOMASS N (kg N/ha) AT ANTHESIS	81	-99
BIOMASS (kg/ha) AT HARVEST MAT.	8770	14206
STALK (kg/ha) AT HARVEST MAT.	3663	8363
HARVEST INDEX (kg/kg)	.582	0.42
FINAL LEAF NUMBER	23	26
GRAIN N (kg N/ha)	48	-99
BIOMASS N (kg N/ha)	82	-99
STALK N (kg N/ha)	34	-99
SEED N (%)	.94	-99

*ENVIRONMENTAL AND STRESS FACTORS

	ENVIRONMENT					STRESS			
DEVELOPMENT PHASE	TIME	WEATHER				WATER		NITROGEN	
	DURATION days	TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.005
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.505	.659
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.431	.601
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.122	.198
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.000	.000	.317	.464

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 5939 kg/ha [DRY WEIGHT]

*RUN 1:2 F1 (80*4000)

MODEL : RICER980 - RICE
EXPERIMENT : RNRA7301 RI R.N.P.YADAV
TREATMENT 2 : F1 (80*4000)

CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 880 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 4000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

TOT- 90 11.3 22.6 32.4 11.3 22.6 <--cm - kg/ha--> 43.9 5.9 11080
SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-...............
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 2 F1 (80*4000)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	3.8	.04	.00
21 AUG	50	Pan Init	1817	1.64	16	223	393	400	0	43	2.3	.00	.49
25 SEP	85	Heading	6343	3.38	23	371	602	720	0	96	1.5	.00	.39
5 OCT	95	Beg Gr Fil	8437	2.70	23	420	602	800	0	96	1.1	.00	.05
18 OCT	108	End Mn Fil	9958	.76	23	479	602	880	0	97	1.0	.00	.23
21 OCT	111	End Ti Fil	9958	.26	23	485	602	880	0	97	1.0	.00	.50

22 OCT	112	Maturity	9958	.26	23	487	602	880	0	97	1.0	.00	.50
23 OCT	113	Harvest	9958	.26	23	488	602	880	0	97	1.0	.00	.50

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	82
PHYSIOL. MATURITY (dap)	112	113
GRAIN YIELD (kg/ha) AT 14% H2O	6606	6461
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	22723	29368
PANICLE NUMBER (PANICLE/m2)	717.11	374
MAXIMUM LAI (m2/m2)	3.47	8.32
BIOMASS (kg/ha) AT ANTHESIS	6188	11352
BIOMASS N (kg N/ha) AT ANTHESIS	96	-99
BIOMASS (kg/ha) AT HARVEST MAT.	9958	16105
STALK (kg/ha) AT HARVEST MAT.	4277	9644
HARVEST INDEX (kg/kg)	.570	0.40
FINAL LEAF NUMBER	23	26
GRAIN N (kg N/ha)	58	-99
BIOMASS N (kg N/ha)	97	-99
STALK N (kg N/ha)	39	-99
SEED N (%)	1.01	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.007
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.473	.642
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.400	.565
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.075	.147
Grain Filling Phase	16	32.53	17.22	18.39	11.35	.000	.000	.245	.378

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6606 kg/ha [DRY WEIGHT]

***RUN 1:3 F2 (80*8000)**

MODEL : RICER980 - RICE
EXPERIMENT : RNRA7301 RI R.N.P.YADAV
TREATMENT 3 : F2 (80*8000)
CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 880 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 8000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	- kg/ha-->		43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-...............
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 3 F2 (80*8000)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	3.7	.04	.00
21 AUG	50	Pan Init	1827	1.66	16	222	393	400	0	45	2.5	.00	.49
25 SEP	85	Heading	6660	3.65	23	370	602	720	0	104	1.6	.00	.36
5 OCT	95	Beg Gr Fil	8901	2.89	23	419	602	800	0	104	1.2	.00	.00
18 OCT	108	End Mn Fil	10508	.86	23	479	602	880	0	105	1.0	.00	.21
21 OCT	111	End Ti Fil	10508	.32	23	486	602	880	0	105	1.0	.00	.48
22 OCT	112	Maturity	10508	.32	23	487	602	880	0	105	1.0	.00	.48

```
23 OCT 113 Harvest   10508  .32  23  488  602  880   0 105 1.0 .00 .48
```

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	82
PHYSIOL. MATURITY (dap)	112	113
GRAIN YIELD (kg/ha) AT 14% H2O	6911	6881
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	23773	31273
PANICLE NUMBER (PANICLE/m2)	764.75	374
MAXIMUM LAI (m2/m2)	3.72	8.57
BIOMASS (kg/ha) AT ANTHESIS	6489	11119
BIOMASS N (kg N/ha) AT ANTHESIS	104	-99
BIOMASS (kg/ha) AT HARVEST MAT.	10508	16799
STALK (kg/ha) AT HARVEST MAT.	4565	9918
HARVEST INDEX (kg/kg)	.566	0.41
FINAL LEAF NUMBER	23	26
GRAIN N (kg N/ha)	63	-99
BIOMASS N (kg N/ha)	105	-99
STALK N (kg N/ha)	43	-99
SEED N (%)	1.06	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.009
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.466	.635
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.371	.532
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.025	.119
Grain Filling Phase	16	32.53	17.22	18.39	11.35	.000	.000	.228	.351

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6911 kg/ha [DRY WEIGHT]

*RUN 4: F3(80*12000)

```
MODEL              : RICER980 - RICE
EXPERIMENT         : RNRA7301 RI     R.N.P.YADAV
TREATMENT  4       :  F3 (80*12000)

CROP               : RICE             CULTIVAR : HR 6444              - ...............
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973      PLANTS/m2 : 33.0      ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001       TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :      880 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :      25 kg/ha ;    12000 kg/ha IN       1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=       .00  SRAD=       .00  TMAX=       .00  TMIN=       .00
                     RAIN=       .00  CO2 = R330.00  DEW =        .00  WIND=       .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO  :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	- kg/ha-->		43.9	5.9	11080

```
SOIL ALBEDO     :  .13          EVAPORATION LIMIT : 9.40          MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00           DRAINAGE RATE     :  .60          FERT. FACTOR : 1.00

RICE          CULTIVAR :WR0002-HR 6444              ECOTYPE :......-...............
P1      : 550.0  P2R     : 185.0  P5      : 250.0  P20     :   11.7
G1      :  60.0  G2      : .0250  G3      :  1.00  G4      :   1.15
```

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 4 F3 (80*12000)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.1	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	3.5	.04	.00
21 AUG	50	Pan Init	1751	1.59	16	221	393	400	0	46	2.6	.00	.49
25 SEP	85	Heading	6835	3.81	23	368	602	720	0	110	1.6	.00	.33
5 OCT	95	Beg Gr Fil	9102	2.98	23	417	602	800	0	108	1.2	.00	.00
18 OCT	108	End Mn Fil	10812	.92	23	478	602	880	0	110	1.0	.00	.17
22 OCT	112	End Ti Fil	10812	.10	23	486	602	880	0	111	1.0	.00	.46

23	OCT	113	Maturity	10812	.10	23	486	602	880	0	111	1.0	.00	.47
23	OCT	113	Harvest	10812	.10	23	486	602	880	0	111	1.0	.00	.47

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@	VARIABLE	PREDICTED	MEASURED
	PANICLE INITIATION DATE (dap)	50	-99
	FLOWERING DATE (dap)	85	82
	PHYSIOL. MATURITY (dap)	113	113
	GRAIN YIELD (kg/ha) AT 14% H2O	7067	6960
	WT. PER GRAIN (g)	.025	0.023
	GRAIN NUMBER (GRAIN/m2)	24311	31636
	PANICLE NUMBER (PANICLE/m2)	803.64	374
	MAXIMUM LAI (m2/m2)	3.89	8.59
	BIOMASS (kg/ha) AT ANTHESIS	6655	12751
	BIOMASS N (kg N/ha) AT ANTHESIS	110	-99
	BIOMASS (kg/ha) AT HARVEST MAT.	10812	16996
	STALK (kg/ha) AT HARVEST MAT.	4735	10036
	HARVEST INDEX (kg/kg)	.562	0.41
	FINAL LEAF NUMBER	23	26
	GRAIN N (kg N/ha)	66	-99
	BIOMASS N (kg N/ha)	111	-99
	STALK N (kg N/ha)	45	-99
	SEED N (%)	1.09	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.010
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.471	.640
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.342	.495
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.021	.090
Grain Filling Phase	17	32.50	17.06	18.35	11.33	.000	.000	.210	.323

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 7067 kg/ha [DRY WEIGHT]

CHAPTER-6

DSSAT PREDICTIONS ON RICE cv HR 6444 UNDER IRRIGATION AND ORGANIC MANURING

The validated program as discussed in Chapter-5 was extended further to predict yield etc. under different agronomical practices as listed in Table 6.1. Predictions on grain yield, straw yield, total biomass, water balance and nitrogen balance were made. The treatment combination consisted of 4 different depth of irrigation and 4 different dozes of organic manuring. Rests of crop treatments were kept uniform as used for DSSAT validation. The details of experiment input files used for prediction are shown in Table 6.2. DSSAT model produced output files of simulation overview: summary of soil and genetics input parameter; simulated crop and soil status at main development stages; main growth and development variables; environmental stress factors; growth, nitrogen balance and water balance for all sixteen combinations are shown from Run No.2: 1- 2:16. The summary of yield, water balance (initial soil water, total rainfall, irrigation applied, total runoff, total drainage and final soil water) and nitrogen balance (Initial soil nitrogen, nitrogen applied through organic and inorganic source, total nitrogen uptake and leached, final soil nitrogen) under the influence of irrigation and organic manuring in rice cv HR6444 as predicted by DSSAT 3.5 is shown in Table 6.3.

Table6.1: Treatment combinations used in DSSAT model prediction

S.N.	Treatment	Number	Sub Treatment
1	Irrigation	4	I0= "0" mm I1= "440"mm I2= "880" mm I3= "1320"mm
2	Organic manure	4	F0= "0"kg/ha F1= "4000"kg/ha F2= "8000"kg/ha F3= "12000" kg/ha
Total number of treatments used for prediction = 4*4=16 nos.			

6.1-GRAIN YIELD

The grain yield predicted by DSSAT as influenced by irrigation and organic manure dozes is presented in this chapter under simulation overview through Run no-2: 1 to Run no-2: 16. The summary of grain yields of all treatment combinations are shown in **Table 6.3.**

6.1.1 "NO" IRRIGATION (I0) WITH DIFFERENT DOZES OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The grain yield predicted is presented in Run no-2: 1 to Run no-2: 4 in simulation overview file of this chapter. The grain yield predicted was 6731 kgs/ha, 6758 kgs/ha, 6736 kgs/ha and 6670 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in the grain yield between organic manuring treatment at no irrigation.

6.1.2 "440" mm (I1) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The grain yield predicted is presented in Run no-2: 5 to Run no-2: 8 in simulation overview file of this chapter. The grain yield predicted was 7526 kgs/ha, 7891 kgs/ha, 7991kgs/ha and 7943 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure considerably increased grain yield at 440 mm of irrigation application.

6.1.3 "880"mm (I2) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The grain yield predicted is presented in Run no-2: 9 to Run no-2: 12 of simulation overview file of this chapter. The grain yield predicted was 5939 kgs/ha, 6606 kgs/ha, 6911 kgs/ha and 7067 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Although grain yield increased with increasing the organic manuring dose with 880 mm of irrigation. This was however lower than that recorded at 440 mm irrigation depth.

6.1.4"1320"mm (I3) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The grain yield predicted is presented in Run no-13 to Run no-16 of simulation overview file of this chapter. The grain yield predicted was 5048 kg/ha, 5834 kg/ha, 6301 kg/ha and 6546 kg/ha respectively under F0, F1, F2, & F3 organic manuring treatments. The grain yield was further reduced at irrigation depth of1320 mm.

6.2-STRAW

The straw yield predicted by DSSAT as influenced by irrigation and organic manure dozes is presented in this chapter under simulation overview through Run no-2: 1 to Run no-2: 16. The summary of straw yields of all treatment combinations are shown in **Table 6.3.**

6.2.1 "NO" IRRIGATION (I0) WITH DIFFERENT DOSE OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The straw yield predicted is presented in Run no-2: 1 to Run no-2: 4 in simulation overview file of this chapter. The straw yield predicted was 6444kgs/ha, 6516 kgs/ha, 6478 kgs/ha and 6421 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in the straw yield between organic manuring treatment at no irrigation.

6.2.2 "440" mm (I1) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The straw yield predicted is presented in Run no-2: 5 to Run no-2: 8 in simulation overview file of this chapter. The straw yield predicted was 4954 kgs/ha, 5300 kgs/ha, 5364 kgs/ha and 5414 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure decreased straw yield at 440 mm of irrigation application than at no irrigation but straw yield increases with increasing the organic manuring dose.

6.2.3 "880"mm (I2) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The straw yield predicted is presented in Run no-2: 9 to Run no-2: 12 of simulation overview file of this chapter. The straw yield predicted was3663 kgs/ha, 4277 kgs/ha, 4565 kgs/ha and 4735 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Although straw yield increased with increasing the organic manuring dose with 880 mm of irrigation. This was however lower than that recorded at 440 mm irrigation depth.

6. 2.4"1320"mm (I3) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The straw yield predicted is presented in Run no-2: 13 to Run no-2: 16 of simulation overview file of this chapter. The straw yield predicted was 3003 kg/ha, 3775 kg/ha, 4157 kg/ha and 4429 kg/ha respectively under F0, F1, F2, & F3 organic manuring treatments. The straw yield was further reduced at irrigation depth of 1320 mm.

6.3-TOTAL BIOMASS

The total biomass predicted by DSSAT and influenced by irrigation and organic manure dozes is presented in this chapter under simulation overview through Run no-2: 1 to Run no-2: 16. The summary of total biomass of all treatment combinations are shown in **Table 6.3.**

6.3.1 "NO" IRRIGATION (I0) WITH DIFFERENT DOSE OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The total biomass predicted is presented in Run no-2: 1 to Run no-2: 4 in simulation overview file of this chapter. The total biomass predicted was 12233 kgs/ha, 12329 kgs/ha, 12271 kgs/ha and 12157 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in the total biomass between organic manuring treatment at no irrigation.

6.3.2 "440" mm (I1) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The total biomass predicted is presented in Run no-2: 5 to Run no-2: 8 in simulation overview file of this chapter. The total biomass predicted was 11426 kgs/ha, 12086 kgs/ha, 12236 kgs/ha and 12245 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure decreased biomass at 440 mm of irrigation application than at no irrigation but biomass increases with increasing the organic manuring dose.

6.3.3 "880"mm (I2) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The total biomass predicted is presented in Run no-2: 9 to Run no-2: 12 of simulation overview file of this chapter. The total biomass predicted was 8770 kgs/ha, 9958 kgs/ha, 10508 kgs/ha and 10812 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Although biomass increased with increasing the organic manuring dose with 880 mm of irrigation. This was however lower than that recorded at 440 mm irrigation depth.

6.3.4"1320"mm (I3) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE (F0, F1, F2, F3)

The total biomass predicted is presented in Run no-2: 13 to Run no-2: 16 of simulation overview file of this chapter. The total biomass predicted was 7344 kg/ha, 8792 kg/ha, 9575 kg/ha and 10058 kg/ha respectively under F0, F1, F2, & F3 organic manuring treatments. The biomass was further reduced at irrigation depth of 1320 mm.

6.4 EVAPOTRANSPIRATION

The Evapotranspiration predicted by DSSAT as influenced by irrigation and organic manure dozes is presented in this chapter under water balance summary through Run no-2: 1 to Run no-2: 16.The summary of evapotranspiration of all treatment combinations are shown in **Table 6.3.**

6.4.1 "NO"(I0) IRRIGATION WITH DIFFERENT DOSE OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The Evapotranspiration predicted is presented in Run no-2: 1 to Run no-2: 4 of water balance summary file of this chapter. Evapotranspiration predicted was 428.0 mm, 426.0mm, 425.0 mm, and 421.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in evapotranspiration between organic manuring treatment at no irrigation.

6.4.2 "440 mm"(I1) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Evapotranspiration predicted is presented in Run no-2: 5 to Run no-2: 8 of water balance summary file of this chapter. The Evapotranspiration predicted were 489.0 mm, 490.0mm, 490.0 mm, and 489.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure considerably increased evapotranspiration at 440 mm of irrigation application

6.4.3 "880"mm (I2) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Evapotranspiration predicted is presented in Run no-2: 5 to Run no-2: 8 of water balance summary file of this chapter. The Evapotranspiration predicted were 489.0 mm, 488.0mm, 488.0 mm, and 486.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in evapotranspiration between organic manuring treatment at 880-mm irrigation. This was however lower than that recorded at 440 mm irrigation depth.

6.4.4"1320"mm (I3) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Evapotranspiration predicted is presented in Run no-9 to Run no-12 of water balance summary file of this chapter. The Evapotranspiration predicted were 483.0 mm, 486.0mm, 485.0 mm, and 485.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in ET_C between organic manuring treatment at 1320-mm irrigation. This was however not differ than that recorded at 880-mm irrigation depth.

6.5 RUNOFF

The Total Runoff predicted by DSSAT as influenced by irrigation and organic manure dozes is presented in this chapter under water balance summary file through Run no-2: 1 to Run no-2: 16. The summary of Total Runoff of all treatment combinations are shown in **Table 6.3.**

6.5.1 "NO" (I0) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The Total Runoff predicted is presented in Run no-2: 1 to Run no-2: 4 under water balance summary file of this chapter. The Total Runoff predicted were 97.0 mm, 96.0

mm, 96.0 mm, and 96.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in Total Runoff between organic manuring treatment at no irrigation.

6.5.2 "440"mm (I1) IRRIGATION WITH DIFFERENT AMOUNT OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Runoff predicted is presented in Run no-2: 5 to Run no-2: 8 under water balance summary file of this chapter. The Total Runoff (RO) predicted were 104.0 mm, 104.0 mm, 104.0 mm, and 103.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure considerably increased Total Runoff at 440 mm of irrigation application.

6.5.3 "880"mm (I2) IRRIGATION WITH DIFFERENT AMOUNT OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Runoff predicted is presented in Run no-2: 9 to Run no-2: 12 under water balance summary file of this chapter. The Total Runoff predicted were 103.0 mm, 102.0 mm, 102.0 mm, and 102.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. This was however lower than that recorded at 440-mm irrigation depth with no effect of organic manure doses.

6.5.4 "1320"(I3) mm IRRIGATION WITH DIFFERENT AMOUNT OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Runoff predicted is presented in Run no-2: 13 to Run no-2: 16 under water balance summary file of this chapter. The Total Runoff predicted were 100.0 mm, 101.0 mm, 101.0 mm, and 101.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. No considerable effect with increase of irrigation than 880-mm even at different doses of organic manuring.

6.6 DRAINAGE (S&P)

The Total Drainage predicted by DSSAT as influenced by irrigation and organic manure dozes is presented in this chapter under water balance summary file through Run no-2: 1 to Run no-2: 16. The summary of Total Drainage of all treatment combinations are shown in **Table 6.3.**

6.6.1 "NO"(I0) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The Total Drainage predicted is presented in Run no-2: 1 to Run no-2: 4 under water balance summary file of this chapter. Total Drainage predicted were 187.00 mm, 188.0 mm, 189.0 mm, and 193.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in the Total Drainage (DR) between organic manuring treatment at no irrigation.

6.6.2 "440" mm (I1) IRRIGATION WITH DIFFERENT AMOUNT OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Drainage predicted is presented in Run no-2: 5 to Run no-2: 8 under water balance summary file of this chapter. The Total Drainage predicted were 509 mm, 509 mm, 510.0 mm, and 511.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. Application of 440 mm of irrigation considerably increased Total Drainage (DR).

6.6.3 "880"mm (I2) IRRIGATION WITH DIFFERENT AMOUNT OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Drainage predicted is presented in Run no-9 to Run no-12 under water balance summary file of this chapter. The Total Drainage predicted were 947.0 mm, 949.0 mm, 950.0 mm, and 951.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. Total drainage increased with increased of irrigation doses from 440 to 880mm with no effect of organic manure.

6.6.4 "1320"mm (I3) IRRIGATION WITH DIFFERENT AMOUNT OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Drainage predicted is presented in Run no-13 to Run no-16 under water balance summary file of this chapter. The Total Drainage predicted were 1390.0 mm, 11391.0 mm, 1392.0 mm, and 1394.0 mm respectively under F0, F1, F2, & F3 organic manuring treatments. Total drainage increased with increased of irrigation doses from 880 to 1320 mm with no effect of organic manure.

6.7 NITROGEN UPTAKE

The Nitrogen Uptake predicted by DSSAT as influenced by irrigation and organic manure doses is presented in this chapter under nitrogen balance summary file through Run no-2: 1 to Run no-2: 16. The summary of Total Nitrogen Uptake of all treatment combinations are shown in **Table 6.3.**

6.7.1 "NO" (I0) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The Total Nitrogen Uptake predicted is presented in Run no-2: 1 to Run no-2: 4 under nitrogen balance summary file of this chapter. The Total Nitrogen Uptake predicted was 137 kgs/ha, 139 kgs/ha, 140 kgs/ha and 139 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in Total Nitrogen Uptake between organic manuring treatment at no irrigation.

6.7.2 "440 mm"(I1) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Nitrogen Uptake predicted is presented in Run no-2: 5 to Run no-2: 8 under nitrogen balance summary file of this chapter. The Total Nitrogen Uptake predicted was 114 kgs/ha, 125 kgs/ha, 128 kgs/ha and 130 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure decreased Total Nitrogen Uptake at 440 mm of irrigation application than at no irrigation but Total Nitrogen Uptake increases with increasing the organic manuring dose.

6.7.3"880" mm (I2) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Nitrogen Uptake predicted is presented in Run no-2: 9 to Run no-2: under nitrogen balance summary file of this chapter. The Total Nitrogen Uptake predicted was 82 kgs/ha, 97 kgs/ha, 105 kgs/ha and 111 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure decreased Total Nitrogen Uptake at 880 mm of irrigation application than at 440-mm depth irrigation but Total Nitrogen Uptake increases with increasing the organic manuring dose.

6.7.4"1320"mm (I3) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Nitrogen Uptake predicted is presented in Run no-13 to Run no-16 under nitrogen balance summary file of this chapter. The Total Nitrogen Uptake predicted was 67 kgs/ha, 84 kgs/ha, 94 kgs/ha and 101 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments.

6.8 NITROGEN LEACHED

The Total Nitrogen Leached predicted by DSSAT as influenced by irrigation and organic manure dozes is presented in this chapter under nitrogen balance summary file through Run no-2: 1 to Run no-2: 16. The summary of Total Nitrogen Leached of all treatment combinations are shown in **Table 6.3.**

6.8.1 "NO"(I0) IRRIGATION WITH DIFFERENT DOZES OF ORGANIC MANURE TREATMENTS (F0, F1, F2, F3)

The Total Nitrogen Leached predicted is presented in Run no-2: 1 to Run no-2: 4 under nitrogen balance summary file of this chapter. The Total Nitrogen Leached predicted were 18 kgs/ha, 17 kgs/ha, 16 kgs/ha and 16 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. There was practically no difference in Total Nitrogen Leached between organic manuring treatment at no irrigation.

6.8.2" 440"mm (I1) IRRIGATION" WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Nitrogen Leached predicted is presented in Run no-2: 5 to Run no-2: 8 under nitrogen balance summary file of this chapter. The Total Nitrogen Leached predicted was 44kgs/ha, 41 kgs/ha, 37kgs/ha and 37 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure considerably increased Total Nitrogen Uptake at 440 mm of irrigation application than at no irrigation but Total Nitrogen Uptake decreases with increasing the organic manuring dose.

6.8.3 "880"(I2) mm IRRIGATION" WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Nitrogen Leached predicted is presented in Run no-2:9 to Run no-2: under nitrogen balance summary file of this chapter. The Total Nitrogen Leached predicted was 76kgs/ha, 69 kgs/ha, 63 kgs/ha and 58 kgs/ha respectively under F0, F1, F2, & F3 organic manuring treatments. Application of organic manure considerably increased Total Nitrogen Uptake at 880 mm of irrigation application than at 440-mm irrigation but Total Nitrogen Leached decreases with increasing the organic manuring dose.

6.8.4 "1320"(I3) mm IRRIGATION" WITH DIFFERENT DOZES OF ORGANIC MANURE (F0, F1, F2, F3)

The Total Nitrogen Leached predicted is presented in run no-2: 13 to Run no-2: 16 under nitrogen balance summary file of this chapter. The Total Nitrogen Leached predicted was 91 kgs/ha, 84 kgs/ha, 76 kgs/ha and 70 kgs/ha respectively under F0, F1, F2, &F3 organic manuring treatments. Application of organic manure considerably increased Total Nitrogen Uptake at 1320 mm of irrigation application than at 880-mm irrigation but Total Nitrogen Uptake decreases with increasing the organic manuring dose.

Table 6.2: Input Data file

EXP.DETAILS: RNRY7301RI R.N.P.YADAV

(For DSSAT prediction under different agronomic condition)

```
*GENERAL
@PEOPLE
 R.N. YADAV
@ADDRESS
 WRDTC,IIT ROORKEE
@SITE
 DEMOFARM,WRDTC,IIT ROORKEE
@ PAREA  PRNO  PLEN  PLDR  PLSP  PLAY HAREA  HRNO  HLEN HARM.........
   75.0    15  25.0   -99   100 RBD     1.0    10  20.0  MANUAL
@NOTES
 A PART OF M.TECH. DESSERTATION
 TOPIC: APPLICATION OF DSSAT ON HYBRID RICE

*TREATMENTS                        -------------FACTOR LEVELS------------
@N R O C TNAME.................... CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 0 0 0 I0F0 (0*0)                 1  1  1  1  1  1  1  1  0  1  0  1  1
 2 0 0 0 I0F1 (0*4000)              1  1  1  1  1  1  1  2  0  1  0  1  1
 3 0 0 0 I0F2 (0*8000)              1  1  1  1  1  1  1  3  0  1  0  1  1
 4 0 0 0 I0F3 (0*12000)             1  1  1  1  1  1  1  4  0  1  0  1  1
 5 0 0 0 I1F0 (40*0)                1  1  1  1  1  2  1  1  0  1  0  1  1
 6 0 0 0 I1F1 (40*4000)             1  1  1  1  1  2  1  2  0  1  0  1  1
 7 0 0 0 I1F2 (40*8000)             1  1  1  1  1  2  1  3  0  1  0  1  1
 8 0 0 0 I1F3 (40*12000)            1  1  1  1  1  2  1  4  0  1  0  1  1
 9 0 0 0 I2F0 (80*0)                1  1  1  1  1  3  1  1  0  1  0  1  1
10 0 0 0 I2F1 (80*4000)             1  1  1  1  1  3  1  2  0  1  0  1  1
11 0 0 0 I2F2 (80*8000)             1  1  1  1  1  3  1  3  0  1  0  1  1
12 0 0 0 I2F3 (80*12000)            1  1  1  1  1  3  1  4  0  1  0  1  1
13 0 0 0 I3F0 (120*0)               1  1  1  1  1  4  1  1  0  1  0  1  1
14 0 0 0 I3F1 (120*4000)            1  1  1  1  1  4  1  2  0  1  0  1  1
15 0 0 0 I3F2 (120*8000)            1  1  1  1  1  4  1  3  0  1  0  1  1
16 0 0 0 I3F3 (120*12000)           1  1  1  1  1  4  1  4  0  1  0  1  1

*CULTIVARS
@C CR INGENO CNAME
 1 RI WR0002 HR6444

*FIELDS
@L ID_FIELD WSTA....  FLSA  FLOB  FLDT  FLDD  FLDS  FLST SLTX   SLDP  ID_SOIL
 1 DEMOFARM WRDF       0.0     0 DR000     0     0 00000 SALO     90  WR00730001
@L ...........XCRD ...........YCRD .....ELEV .............AREA .SLEN .FLWR .SLAS
 1         0.00000         0.00000    252.00             990.0    22   2.0   0.0

*SOIL ANALYSIS
@A SADAT  SMHB  SMPX  SMKE
 1 73151 SA001 SA001 SA001
@A  SABL  SADM  SAOC  SANI  SAHW  SAHB  SAEX  SAKE
 1    20  1.45  0.30  0.08   7.5 -99.0  15.0  30.0
 1    40  1.46  0.10  0.02   7.5 -99.0   5.0  15.0
 1    30  1.47  0.01  0.01   7.5 -99.0   1.0   1.5

*INITIAL CONDITIONS
@C   PCR ICDAT  ICRT  ICND  ICRN  ICRE  ICWD ICRES ICREN ICREP ICRIP ICRID
 1    WH 73181    20     0  0.00  0.00 490.0    25  0.08  0.05   100    15
@C  ICBL  SH2O  SNH4  SNO3
 1    20 0.242   0.2  12.2
```

```
 1     60 0.248    0.5    0.8
 1     90 0.261    0.5    0.8

*PLANTING DETAILS
P PDATE EDATE PPOP PPOE PLME   PLDS   PLRS   PLRD PLDP   PLWT   PAGE   PENV   PLPH   SPRL
 1 73183 -99  33.0 33.0   T      R     20      0  3.0     80     28   25.0    1.0   10.0

*IRRIGATION AND WATER MANAGEMENT
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 1  1.00    10   -99   -99 GS006 IR006     0
@I IDATE  IROP IRVAL  IIRV
 1 73198 IR006     0     0
 1 73207 IR006     0     0
 1 73212 IR006     0     0
 1 73216 IR006     0     0
 1 73232 IR006     0     0
 1 73237 IR006     0     0
 1 73254 IR006     0     0
 1 73256 IR006     0     0
 1 73262 IR006     0     0
 1 73272 IR006     0     0
 1 73279 IR006     0     0
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 2  1.00    10   -99   -99 GS006 IR006    40
@I IDATE  IROP IRVAL  IIRV
 2 73198 IR006    40     0
 2 73207 IR006    40     0
 2 73212 IR006    40     0
 2 73216 IR006    40     0
 2 73232 IR006    40     0
 2 73237 IR006    40     0
 2 73254 IR006    40     0
 2 73256 IR006    40     0
 2 73262 IR006    40     0
 2 73272 IR006    40     0
 2 73279 IR006    40     0
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 3  1.00    10   -99   -99 GS006 IR006   120
@I IDATE  IROP IRVAL  IIRV
 3 73198 IR006   120     0
 3 73207 IR006   120     0
 3 73212 IR006   120     0
 3 73216 IR006   120     0
 3 73232 IR006   120     0
 3 73237 IR006   120     0
 3 73254 IR006   120     0
 3 73256 IR006   120     0
 3 73262 IR006   120     0
 3 73272 IR006   120     0
 3 73279 IR006   120     0

*FERTILIZERS (INORGANIC)
@F FDATE  FMCD  FACD  FDEP  FAMN  FAMP  FAMK  FAMC  FAMO  FOCD
 1 73183 FE006 AP002     1    24    57     0     0    80 FE018
 1 73195 FE005 AP002     1    31     0     0     0     0 -99
 1 73232 FE005 AP002     1    62     0     0     0     0 -99

*RESIDUES AND OTHER ORGANIC MATERIALS
@R RDATE  RCOD  RAMT  RESN  RESP  RESK  RINP  RDEP  RMET
 1 73182 RE003     0  0.00  0.00  0.00     0     0 AP002
```

```
 2 73182 RE003  4000  0.43  0.15  0.30   100    15 AP002
 3 73182 RE003  8000  0.43  0.15  0.30   100    15 AP002
 4 73182 RE003 12000  0.43  0.15  0.30   100    15 AP002

*TILLAGE AND ROTATIONS
@T TDATE TIMPL  TDEP
 1 73166 TI010    15
 1 73176 TI010    15
 1 73182 TI022    15

*HARVEST DETAILS
@H HDATE  HSTG  HCOM HSIZE   HPC  HBPC
 1 73296 GS006 C     A     100.0  48.5

*SIMULATION CONTROLS
@N GENERAL     NYERS NREPS START SDATE RSEED SNAME....................
 1 GE              1     1     I 73181  2150 YIELD OF HYBRID RICE
@N OPTIONS     WATER NITRO SYMBI PHOSP POTAS DISES  CHEM  TILL
 1 OP              Y     Y     N     N     N     N     N     N
@N METHODS     WTHER INCON LIGHT EVAPO INFIL PHOTO HYDRO
 1 ME              M     M     E     P     S     R     R
@N MANAGEMENT  PLANT IRRIG FERTI RESID HARVS
 1 MA              R     R     R     R     R
NOUTPUTS FNAME OVVEW SUMRY FROPTGROUT CAOUT WAOUT NIOUT MIOUT DIOUT LONG CHOUT
OPOUT
     1 OU   Y  Y     Y     5     Y     N     Y     Y     N     N     N     N
N

@  AUTOMATIC MANAGEMENT
@N PLANTING    PFRST PLAST PH2OL PH2OU PH2OD PSTMX PSTMN
 1 PL          73176 73190    40   100    30    40    10
@N IRRIGATION  IMDEP ITHRL ITHRU IROFF IMETH IRAMT IREFF
 1 IR             30    50   100 GS000 IR001    10  1.00
@N NITROGEN    NMDEP NMTHR NAMNT NCODE NAOFF
 1 NI             30    50    25 FE001 GS000
@N RESIDUES    RIPCN RTIME RIDEP
 1 RE            100     1    20
@N HARVEST     HFRST HLAST HPCNP HPCNR
 1 HA              0 73296   100     0
```

Table 6.1 : Showing DSSAT Summary output as predicted by DSSAT 3.5 of Hybrid rice cv HR 6444 under the influnce of irrigation and organic manuring

Experiment		Dates (Julian days)			Dry Wt.		Water Balance					Nitrogen Balance		
TN	TNAME	SDAT	PDAT	HDAT	CWAM	HWAH	IRCM	PRCM	ETCM	ROCM	DRCM	NICM	NUCM	NLCM
1	I1F0	73181	73183	73296	12233	6731	0	602	428	97	187	117	137	18
2	I1F1	73181	73183	73296	12329	6758	0	602	426	96	188	117	139	17
3	I1F2	73181	73183	73296	12271	6736	0	602	425	96	189	117	140	16
4	I1F3	73181	73183	73296	12157	6670	0	602	421	96	193	117	139	16
5	I1F0	73181	73183	73296	11426	7526	440	602	489	104	509	117	114	44
6	I1F1	73181	73183	73296	12086	7891	440	602	490	104	509	117	125	41
7	I1F2	73181	73183	73296	12236	7991	440	602	490	104	510	117	128	37
8	I1F3	73181	73183	73296	12245	7343	440	602	489	103	511	117	130	37
9	I2F0	73181	73183	73296	8770	5993	880	602	489	103	947	117	82	76
10	I2F1	73181	73183	73296	9958	6606	880	602	488	102	949	117	97	69
11	I2F2	73181	73183	73296	10508	6911	880	602	488	102	950	117	105	63
12	I2F3	73181	73183	73296	10812	7067	880	602	486	102	951	117	111	58
13	I3F0	73181	73183	73296	7344	5048	1320	602	483	100	1390	117	67	91
14	I3F1	73181	73183	73296	8792	5834	1320	602	486	101	1391	117	84	84
15	I3F2	73181	73183	73296	9575	6301	1320	602	485	101	1392	117	94	76
16	I3F3	73181	73183	73296	10058	6546	1320	602	485	101	1394	117	101	70

*SIMULATION OVERVIEW FILE

*RUN 2:1: (IOFO)

MODEL	: RICER980 - RICE
EXPERIMENT	: RNRY7301 RI R.N.P.YADAV
TREATMENT 1	: IOFO (0*0)
CROP	: RICE CULTIVAR : HR 6444 - ....
STARTING DATE	: JUN 30 1973
PLANTING DATE	: JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER	: WRDF 1973
SOIL	: WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C	: DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE	: IRRIGATE ON REPORTED DATE(S)
IRRIGATION	: 0 mm IN 11 APPLICATIONS
NITROGEN BAL.	: SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER	: 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE	: INITIAL : 25 kg/ha ; 0 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT.	: DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
	RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT	: WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT	: PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	- kg/ha-->		43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-................
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 1

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	67	185	0	0	4	3.7	.04	.00
21 AUG	50	Pan Init	2380	2.65	16	193	393	0	0	74	3.1	.05	.39
25 SEP	85	Heading	8441	5.38	23	339	602	0	0	137	1.6	.00	.29
5 OCT	95	Beg Gr Fil	10833	3.83	23	387	602	0	0	137	1.3	.00	.00
18 OCT	108	End Mn Fil	12233	1.31	23	425	602	0	0	137	1.1	.51	.00
20 OCT	110	End Ti Fil	12233	.91	23	426	602	0	0	137	1.1	.85	.00

21 OCT	111	Maturity	12233	.91	23	427	602	0	0	137	1.1	.84	.00
23 OCT	113	Harvest	12233	.91	23	428	602	0	0	137	1.1	.87	.00

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	111	-99
GRAIN YIELD (kg/ha) AT 14% H2O	6731	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	23155	-99
PANICLE NUMBER (PANICLE/m2)	900.24	-99
MAXIMUM LAI (m2/m2)	5.55	-99
BIOMASS (kg/ha) AT ANTHESIS	8202	-99
BIOMASS N (kg N/ha) AT ANTHESIS	137	-99
BIOMASS (kg/ha) AT HARVEST MAT.	12233	-99
STALK (kg/ha) AT HARVEST MAT.	6444	-99
HARVEST INDEX (kg/kg)	.473	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	61	-99
BIOMASS N (kg N/ha)	137	-99
STALK N (kg N/ha)	76	-99
SEED N (%)	1.05	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	ENVIRONMENT: TIME DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS: WATER PHOTO SYNTH	STRESS: WATER GROWTH	STRESS: NITROGEN PHOTO SYNTH	STRESS: NITROGEN GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.005
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.010	.054	.381	.540
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.299	.449
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.000	.070
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.409	.495	.000	.014

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6731 kg/ha [DRY WEIGHT]

*RUN :2:2 (IOF1)

MODEL : RICER980 - RICE
EXPERIMENT : RNRY7301 RI R.N.P.YADAV
TREATMENT 2 : IOF1 (0*4000)

CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 0 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 4000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	-	kg/ha-->	43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-................
P1 : 550.0 P2R : 185.0 P5 : 250.0 P20 : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 2

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	67	185	0	0	4	3.5	.04	.00
21 AUG	50	Pan Init	2300	2.58	16	192	393	0	0	72	3.1	.04	.40
25 SEP	85	Heading	8561	5.46	23	337	602	0	0	140	1.6	.00	.26
5 OCT	95	Beg Gr Fil	10956	3.86	23	386	602	0	0	141	1.3	.00	.00
18 OCT	108	End Mn Fil	12329	1.32	23	423	602	0	0	139	1.1	.52	.00
20 OCT	110	End Ti Fil	12329	.92	23	424	602	0	0	139	1.1	.85	.00

21 OCT	111	Maturity	12329	.92	23	425	602	0	0	139	1.1	.83	.00
23 OCT	113	Harvest	12329	.92	23	426	602	0	0	139	1.1	.87	.00

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	111	-99
GRAIN YIELD (kg/ha) AT 14% H2O	6758	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	23249	-99
PANICLE NUMBER (PANICLE/m2)	903.78	-99
MAXIMUM LAI (m2/m2)	5.63	-99
BIOMASS (kg/ha) AT ANTHESIS	8322	-99
BIOMASS N (kg N/ha) AT ANTHESIS	140	-99
BIOMASS (kg/ha) AT HARVEST MAT.	12329	-99
STALK (kg/ha) AT HARVEST MAT.	6516	-99
HARVEST INDEX (kg/kg)	.471	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	61	-99
BIOMASS N (kg N/ha)	139	-99
STALK N (kg N/ha)	78	-99
SEED N (%)	1.05	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.007
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.009	.037	.388	.543
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.273	.429
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.000	.064
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.421	.505	.000	.005

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6758 kg/ha [DRY WEIGHT]

***RUN: 2:3 (IOF2)**

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRY7301 RI    R.N.P.YADAV
TREATMENT  3     : IOF2 (0*8000)

CROP             : RICE          CULTIVAR : HR 6444          - ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973   PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001    TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :        0 mm IN     11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :    25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	-	kg/ha-->	43.9	5.9	11080

```
SOIL ALBEDO     :  .13      EVAPORATION LIMIT : 9.40        MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00       DRAINAGE RATE     :  .60        FERT. FACTOR : 1.00

RICE        CULTIVAR :WR0002-HR 6444          ECOTYPE :......-...............
P1      : 550.0  P2R     : 185.0  P5      : 250.0  P2O     :  11.7
G1      :  60.0  G2      : .0250  G3      :  1.00  G4      :  1.15
```

***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 1 1

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	67	185	0	0	4	3.3	.04	.00
21 AUG	50	Pan Init	2137	2.41	16	191	393	0	0	67	3.1	.01	.42
25 SEP	85	Heading	8510	5.41	23	336	602	0	0	141	1.7	.00	.24
5 OCT	95	Beg Gr Fil	10903	3.84	23	385	602	0	0	141	1.3	.00	.00
18 OCT	108	End Mn Fil	12271	1.30	23	422	602	0	0	140	1.1	.52	.00
20 OCT	110	End Ti Fil	12271	.90	23	423	602	0	0	140	1.1	.85	.00
21 OCT	111	Maturity	12271	.90	23	424	602	0	0	140	1.1	.83	.00

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23 OCT  113 Harvest     12271    .90   23  425    602      0       0  140 1.1 .87 .00
```

***MAIN GROWTH AND DEVELOPMENT VARIABLES**

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	111	-99
GRAIN YIELD (kg/ha) AT 14% H2O	6736	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	23173	-99
PANICLE NUMBER (PANICLE/m2)	906.76	-99
MAXIMUM LAI (m2/m2)	5.58	-99
BIOMASS (kg/ha) AT ANTHESIS	8271	-99
BIOMASS N (kg N/ha) AT ANTHESIS	141	-99
BIOMASS (kg/ha) AT HARVEST MAT.	12271	-99
STALK (kg/ha) AT HARVEST MAT.	6478	-99
HARVEST INDEX (kg/kg)	.472	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	61	-99
BIOMASS N (kg N/ha)	140	-99
STALK N (kg N/ha)	79	-99
SEED N (%)	1.05	-99

***ENVIRONMENTAL AND STRESS FACTORS**

DEVELOPMENT PHASE	TIME: DURATION days	ENVIRONMENT WEATHER: TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	WATER: GROWTH	NITROGEN: PHOTO SYNTH	NITROGEN: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.009
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.003	.014	.404	.565
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.251	.412
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.000	.052
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.422	.506	.000	.000

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6736 kg/ha [DRY WEIGHT]

***RUN 2:4 (IOF3)**

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI    R.N.P.YADAV
TREATMENT  4      : IOF3 (0*12000)

CROP              : RICE           CULTIVAR : HR 6444          - ................
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :        0 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :    25 kg/ha ;    12000 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

```
TOT- 90   11.3   22.6   32.4   11.3   22.6  <--cm    -  kg/ha-->   43.9     5.9   11080
SOIL ALBEDO      :  .13         EVAPORATION LIMIT : 9.40         MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00           DRAINAGE RATE     :  .60         FERT. FACTOR : 1.00

RICE         CULTIVAR :WR0002-HR 6444              ECOTYPE :......-...............
P1      : 550.0  P2R     : 185.0  P5      : 250.0  P2O     :  11.7
G1      :  60.0  G2      : .0250  G3      :  1.00  G4      :  1.15
```

***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 1 1

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.1	.00	.00
21 JUL	19	End Juveni	102	.19	8	67	185	0	0	3	3.1	.04	.01
21 AUG	50	Pan Init	1959	2.21	16	188	393	0	0	62	3.1	.00	.42
25 SEP	85	Heading	8417	5.33	23	334	602	0	0	141	1.7	.00	.22
5 OCT	95	Beg Gr Fil	10807	3.80	23	382	602	0	0	141	1.3	.00	.00
18 OCT	108	End Mn Fil	12157	1.27	23	418	602	0	0	139	1.1	.53	.00
20 OCT	110	End Ti Fil	12157	.88	23	420	602	0	0	139	1.1	.85	.00
21 OCT	111	Maturity	12157	.88	23	420	602	0	0	139	1.1	.83	.00
23 OCT	113	Harvest	12157	.88	23	421	602	0	0	139	1.1	.86	.00

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	111	-99
GRAIN YIELD (kg/ha) AT 14% H2O	6670	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	22945	-99
PANICLE NUMBER (PANICLE/m2)	901.37	-99
MAXIMUM LAI (m2/m2)	5.49	-99
BIOMASS (kg/ha) AT ANTHESIS	8178	-99
BIOMASS N (kg N/ha) AT ANTHESIS	141	-99
BIOMASS (kg/ha) AT HARVEST MAT.	12157	-99
STALK (kg/ha) AT HARVEST MAT.	6421	-99
HARVEST INDEX (kg/kg)	.472	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	60	-99
BIOMASS N (kg N/ha)	139	-99
STALK N (kg N/ha)	79	-99
SEED N (%)	1.05	-99

*ENVIRONMENTAL AND STRESS FACTORS

ENVIRONMENT						STRESS			
DEVELOPMENT PHASE	TIME	WEATHER				WATER		NITROGEN	
	DURA TION days	TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.024
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.410	.572
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.231	.398
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.000	.045
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.425	.511	.000	.000

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6670 kg/ha [DRY WEIGHT]

***RUN 2:5 (I1F0)**

```
MODEL              : RICER980 - RICE
EXPERIMENT         : RNRY7301 RI      R.N.P.YADAV
TREATMENT  5       : I1F0 (40*0)

CROP               : RICE            CULTIVAR : HR 6444          - ................
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :      440 mm IN    11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :    25 kg/ha ;        0 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                     RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT     : WATER     :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
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***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

```
TOT- 90   11.3   22.6   32.4   11.3   22.6   <--cm    -  kg/ha-->   43.9     5.9   11080
SOIL ALBEDO     :  .13        EVAPORATION LIMIT :  9.40        MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00         DRAINAGE RATE     :   .60        FERT. FACTOR : 1.00

RICE        CULTIVAR :WR0002-HR 6444           ECOTYPE :......-................
P1      : 550.0  P2R     : 185.0  P5      : 250.0  P2O     :  11.7
G1      :  60.0  G2      : .0250  G3      :  1.00  G4      :  1.15
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***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 5

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	40	0	5	4.2	.04	.00
21 AUG	50	Pan Init	2557	2.57	16	224	393	200	0	62	2.4	.00	.41
25 SEP	85	Heading	7453	4.33	23	371	602	360	0	113	1.5	.00	.40
5 OCT	95	Beg Gr Fil	9670	3.27	23	419	602	400	0	113	1.2	.00	.05
18 OCT	108	End Mn Fil	11426	1.02	23	481	602	440	0	113	1.0	.00	.18
22 OCT	112	End Ti Fil	11426	.07	23	489	602	440	0	114	1.0	.00	.47
23 OCT	113	Maturity	11426	.07	23	489	602	440	0	114	1.0	.00	.48
23 OCT	113	Harvest	11426	.07	23	489	602	440	0	114	1.0	.00	.48

*MAIN GROWTH AND DEVELOPMENT VARIABIES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	113	-99
GRAIN YIELD (kg/ha) AT 14% H2O	7526	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	25888	-99
PANICLE NUMBER (PANICLE/m2)	742.93	-99
MAXIMUM LAI (m2/m2)	4.45	-99
BIOMASS (kg/ha) AT ANTHESIS	7292	-99
BIOMASS N (kg N/ha) AT ANTHESIS	113	-99
BIOMASS (kg/ha) AT HARVEST MAT.	11426	-99
STALK (kg/ha) AT HARVEST MAT.	4954	-99
HARVEST INDEX (kg/kg)	.566	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	68	-99
BIOMASS N (kg N/ha)	114	-99
STALK N (kg N/ha)	46	-99
SEED N (%)	1.04	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.005
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.390	.544
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.414	.584
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.076	.151
Grain Filling Phase	17	32.50	17.06	18.35	11.33	.000	.000	.218	.338

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD:7526 kg/ha [DRY WEIGHT]

***RUN 2:6(I1F1)**

MODEL : RICER980 - RICE
EXPERIMENT : RNRY7301 RI R.N.P.YADAV
TREATMENT 6 : I1F1 (40*4000)

CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 440 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 4000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	- kg/ha-->		43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-...............
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 6

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	40	0	5	4.1	.04	.00
21 AUG	50	Pan Init	2616	2.66	16	224	393	200	0	67	2.5	.00	.40
25 SEP	85	Heading	7858	4.67	23	370	602	360	0	124	1.6	.00	.37
5 OCT	95	Beg Gr Fil	10210	3.47	23	419	602	400	0	124	1.2	.00	.00
18 OCT	108	End Mn Fil	12086	1.14	23	481	602	440	0	124	1.0	.00	.14
22 OCT	112	End Ti Fil	12086	.12	23	490	602	440	0	125	1.0	.00	.44
23 OCT	113	Maturity	12086	.12	23	490	602	440	0	125	1.0	.00	.46

23 OCT	113	Harvest	12086	.12	23	490	602	440	0	125	1.0	.00	.46

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	113	-99
GRAIN YIELD (kg/ha) AT 14% H2O	7891	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	27145	-99
PANICLE NUMBER (PANICLE/m2)	784.42	-99
MAXIMUM LAI (m2/m2)	4.81	-99
BIOMASS (kg/ha) AT ANTHESIS	7679	-99
BIOMASS N (kg N/ha) AT ANTHESIS	124	-99
BIOMASS (kg/ha) AT HARVEST MAT.	12086	-99
STALK (kg/ha) AT HARVEST MAT.	5300	-99
HARVEST INDEX (kg/kg)	.561	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	74	-99
BIOMASS N (kg N/ha)	125	-99
STALK N (kg N/ha)	50	-99
SEED N (%)	1.09	-99

*ENVIRONMENTAL AND STRESS FACTORS

	ENVIRONMENT					STRESS			
DEVELOPMENT PHASE	TIME	WEATHER				WATER		NITROGEN	
	DURATION days	TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.007
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.381	.540
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.383	.546
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.024	.105
Grain Filling Phase	17	32.50	17.06	18.35	11.33	.000	.000	.184	.292

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 7891 kg/ha [DRY WEIGHT]

***RUN 2:7 (I1F2)**

```
MODEL              : RICER980 - RICE
EXPERIMENT         : RNRY7301 RI     R.N.P.YADAV
TREATMENT  7       : I1F2 (40*8000)

CROP               : RICE            CULTIVAR : HR 6444          - ................
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :      440 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :      25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=      .00  SRAD=       .00  TMAX=       .00  TMIN=       .00
                     RAIN=      .00  CO2 = R330.00  DEW =        .00  WIND=       .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
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***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

```
TOT- 90   11.3   22.6  32.4  11.3  22.6  <--cm    -  kg/ha-->   43.9     5.9  11080
SOIL ALBEDO      :   .13         EVAPORATION LIMIT : 9.40        MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00            DRAINAGE RATE     :   .60       FERT. FACTOR : 1.00

RICE         CULTIVAR :WR0002-HR 6444             ECOTYPE :......-................
P1       : 550.0  P2R      : 185.0  P5       : 250.0  P20      :    11.7
G1       :  60.0  G2       : .0250  G3       :   1.00 G4       :    1.15
```

***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 7

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	40	0	4	3.9	.04	.00
21 AUG	50	Pan Init	2496	2.51	16	224	393	200	0	65	2.6	.00	.41
25 SEP	85	Heading	7957	4.73	23	370	602	360	0	129	1.6	.00	.34
5 OCT	95	Beg Gr Fil	10314	3.50	23	418	602	400	0	129	1.3	.00	.00
18 OCT	108	End Mn Fil	12236	1.15	23	480	602	440	0	127	1.0	.00	.12
22 OCT	112	End Ti Fil	12236	.13	23	489	602	440	0	128	1.0	.00	.43
23 OCT	113	Maturity	12236	.13	23	490	602	440	0	128	1.0	.00	.44
23 OCT	113	Harvest	12236	.13	23	490	602	440	0	128	1.0	.00	.44

***MAIN GROWTH AND DEVELOPMENT VARIABLES**

@	VARIABLE	PREDICTED	MEASURED
	PANICLE INITIATION DATE (dap)	50	-99
	FLOWERING DATE (dap)	85	-99
	PHYSIOL. MATURITY (dap)	113	-99
	GRAIN YIELD (kg/ha) AT 14% H2O	7991	-99
	WT. PER GRAIN (g)	.025	-99
	GRAIN NUMBER (GRAIN/m2)	27488	-99
	PANICLE NUMBER (PANICLE/m2)	811.01	-99
	MAXIMUM LAI (m2/m2)	4.87	-99
	BIOMASS (kg/ha) AT ANTHESIS	7771	-99
	BIOMASS N (kg N/ha) AT ANTHESIS	128	-99
	BIOMASS (kg/ha) AT HARVEST MAT.	12236	-99
	STALK (kg/ha) AT HARVEST MAT.	5364	-99
	HARVEST INDEX (kg/kg)	.562	-99
	FINAL LEAF NUMBER	23	-99
	GRAIN N (kg N/ha)	76	-99
	BIOMASS N (kg N/ha)	128	-99
	STALK N (kg N/ha)	52	-99
	SEED N (%)	1.10	-99

***ENVIRONMENTAL AND STRESS FACTORS**

DEVELOPMENT PHASE	TIME: DURATION days	ENVIRONMENT – WEATHER: TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	STRESS – WATER: PHOTO SYNTH	GROWTH	NITROGEN: PHOTO SYNTH	GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.009
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.394	.551
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.354	.510
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.021	.077
Grain Filling Phase	17	32.50	17.06	18.35	11.33	.000	.000	.164	.274

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 7991 kg/ha [DRY WEIGHT]

***RUN 2:8(I1F3)**

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI      R.N.P.YADAV
TREATMENT  8      : I1F3 (40*12000)

CROP              : RICE            CULTIVAR : HR 6444          - ................
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0      ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :       440 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :       117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :      25 kg/ha ;    12000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=       .00  SRAD=       .00  TMAX=       .00  TMIN=       .00
                    RAIN=       .00  CO2 = R330.00  DEW =        .00  WIND=       .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO  :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
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*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

```
TOT- 90   11.3   22.6   32.4   11.3   22.6  <--cm    -  kg/ha-->   43.9     5.9  11080
SOIL ALBEDO      :  .13         EVAPORATION LIMIT : 9.40        MIN. FACTOR   : 1.00
RUNOFF CURVE # :76.00           DRAINAGE RATE     :  .60        FERT. FACTOR  : 1.00

RICE        CULTIVAR :WR0002-HR 6444            ECOTYPE :......-...............
P1     : 550.0  P2R     : 185.0  P5     : 250.0  P20     :  11.7
G1     :  60.0  G2      : .0250  G3     :   1.00  G4      :  1.15
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*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 8

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.1	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	40	0	4	3.7	.04	.00
21 AUG	50	Pan Init	2334	2.31	16	223	393	200	0	62	2.6	.00	.42
25 SEP	85	Heading	7926	4.69	23	369	602	360	0	130	1.6	.00	.32
5 OCT	95	Beg Gr Fil	10280	3.48	23	418	602	400	0	130	1.3	.00	.00
18 OCT	108	End Mn Fil	12245	1.14	23	480	602	440	0	130	1.1	.00	.09
22 OCT	112	End Ti Fil	12245	.13	23	489	602	440	0	130	1.1	.00	.40
23 OCT	113	Maturity	12245	.13	23	489	602	440	0	130	1.1	.00	.42
23 OCT	113	Harvest	12245	.13	23	489	602	440	0	130	1.1	.00	.42

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	113	-99
GRAIN YIELD (kg/ha) AT 14% H2O	7943	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	27323	-99
PANICLE NUMBER (PANICLE/m2)	829.09	-99
MAXIMUM LAI (m2/m2)	4.80	-99
BIOMASS (kg/ha) AT ANTHESIS	7689	-99
BIOMASS N (kg N/ha) AT ANTHESIS	129	-99
BIOMASS (kg/ha) AT HARVEST MAT.	12245	-99
STALK (kg/ha) AT HARVEST MAT.	5414	-99
HARVEST INDEX (kg/kg)	.558	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	77	-99
BIOMASS N (kg N/ha)	130	-99
STALK N (kg N/ha)	53	-99
SEED N (%)	1.12	-99

*ENVIRONMENTAL AND STRESS FACTORS

--DEVELOPMENT PHASE--	-TIME-	-------WEATHER-------- (ENVIRONMENT)				---WATER--- (STRESS)		-NITROGEN- (STRESS)	
	DURA TION days	TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.010
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.406	.576
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.338	.490
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.000	.065
Grain Filling Phase	17	32.50	17.06	18.35	11.33	.000	.000	.139	.243

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 7943 kg/ha [DRY WEIGHT]

*RUN 2:9 I2F0 (80*0)

MODEL : RICER980 - RICE
EXPERIMENT : RNRA7301 RI R.N.P.YADAV
TREATMENT 9 : I2F0 (80*0)

CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 880 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 0 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	- kg/ha-->		43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-................
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO.9 I2F0 (80*0)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	4.0	.04	.00
21 AUG	50	Pan Init	1633	1.44	16	224	393	400	0	35	2.2	.00	.53
25 SEP	85	Heading	5661	2.88	23	372	602	720	0	81	1.4	.00	.42
5 OCT	95	Beg Gr Fil	7547	2.31	23	421	602	800	0	81	1.1	.00	.08
18 OCT	108	End Mn Fil	8770	.63	23	479	602	880	0	82	.9	.00	.33
20 OCT	110	End Ti Fil	8770	.41	23	483	602	880	0	82	.9	.00	.53

21 OCT	111 Maturity	8770	.41	23	485	602	880	0	82	.9	.00	.53
23 OCT	113 Harvest	8770	.41	23	489	602	880	0	82	.9	.00	.53

***MAIN GROWTH AND DEVELOPMENT VARIABLES**

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	82
PHYSIOL. MATURITY (dap)	111	113
GRAIN YIELD (kg/ha) AT 14% H2O	5939	5841
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	20429	27136
PANICLE NUMBER (PANICLE/m2)	641.41	348
MAXIMUM LAI (m2/m2)	2.98	7.72
BIOMASS (kg/ha) AT ANTHESIS	5532	11157
BIOMASS N (kg N/ha) AT ANTHESIS	81	-99
BIOMASS (kg/ha) AT HARVEST MAT.	8770	14206
STALK (kg/ha) AT HARVEST MAT.	3663	8363
HARVEST INDEX (kg/kg)	.582	0.42
FINAL LEAF NUMBER	23	26
GRAIN N (kg N/ha)	48	-99
BIOMASS N (kg N/ha)	82	-99
STALK N (kg N/ha)	34	-99
SEED N (%)	.94	-99

***ENVIRONMENTAL AND STRESS FACTORS**

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.005
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.505	.659
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.431	.601
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.122	.198
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.000	.000	.317	.464

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 5939 kg/ha [DRY WEIGHT]

***RUN 2:10 I2F1 (80*4000)**

MODEL : RICER980 - RICE
EXPERIMENT : RNRA7301 RI R.N.P.YADAV
TREATMENT 10 : I2F1 (80*4000)

CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 880 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 4000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

TOT- 90 11.3 22.6 32.4 11.3 22.6 <--cm - kg/ha--> 43.9 5.9 11080
SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-...............
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 10 I2F1 (80*4000)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	3.8	.04	.00
21 AUG	50	Pan Init	1817	1.64	16	223	393	400	0	43	2.3	.00	.49
25 SEP	85	Heading	6343	3.38	23	371	602	720	0	96	1.5	.00	.39
5 OCT	95	Beg Gr Fil	8437	2.70	23	420	602	800	0	96	1.1	.00	.05
18 OCT	108	End Mn Fil	9958	.76	23	479	602	880	0	97	1.0	.00	.23
21 OCT	111	End Ti Fil	9958	.26	23	485	602	880	0	97	1.0	.00	.50
22 OCT	112	Maturity	9958	.26	23	487	602	880	0	97	1.0	.00	.50

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23 OCT  113 Harvest     9958   .26   23  488   602   880     0   97 1.0 .00 .50
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*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	82
PHYSIOL. MATURITY (dap)	112	113
GRAIN YIELD (kg/ha) AT 14% H2O	6606	6461
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	22723	29368
PANICLE NUMBER (PANICLE/m2)	717.11	374
MAXIMUM LAI (m2/m2)	3.47	8.32
BIOMASS (kg/ha) AT ANTHESIS	6188	11352
BIOMASS N (kg N/ha) AT ANTHESIS	96	-99
BIOMASS (kg/ha) AT HARVEST MAT.	9958	16105
STALK (kg/ha) AT HARVEST MAT.	4277	9644
HARVEST INDEX (kg/kg)	.570	0.40
FINAL LEAF NUMBER	23	26
GRAIN N (kg N/ha)	58	-99
BIOMASS N (kg N/ha)	97	-99
STALK N (kg N/ha)	39	-99
SEED N (%)	1.01	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.007
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.473	.642
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.400	.565
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.075	.147
Grain Filling Phase	16	32.53	17.22	18.39	11.35	.000	.000	.245	.378

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6606 kg/ha [DRY WEIGHT]

***RUN 2:11 I1F2 (80*8000)**

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MODEL             : RICER980 - RICE
EXPERIMENT        : RNRA7301 RI     R.N.P.YADAV
TREATMENT  11 : I2F2 (80*8000)
CROP              : RICE            CULTIVAR : HR 6444            - ................
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :      880 mm IN    11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :    25 kg/ha ;    8000 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=     .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=     .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT    : PLANTING:R   IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
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***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT cm3/cm3	SAT SW cm3/cm3	EXTR SW cm3/cm3	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

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TOT- 90  11.3   22.6  32.4   11.3  22.6  <--cm    -  kg/ha-->   43.9     5.9  11080
SOIL ALBEDO     :  .13        EVAPORATION LIMIT : 9.40        MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00        DRAINAGE RATE      :  .60        FERT. FACTOR : 1.00

RICE        CULTIVAR :WR0002-HR 6444               ECOTYPE :......-................
P1      : 550.0  P2R     : 185.0  P5     : 250.0  P2O     :  11.7
G1      :  60.0  G2      : .0250  G3     :  1.00  G4      :  1.15
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***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 11   I2F2 (80*8000)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	3.7	.04	.00
21 AUG	50	Pan Init	1827	1.66	16	222	393	400	0	45	2.5	.00	.49
25 SEP	85	Heading	6660	3.65	23	370	602	720	0	104	1.6	.00	.36
5 OCT	95	Beg Gr Fil	8901	2.89	23	419	602	800	0	104	1.2	.00	.00
18 OCT	108	End Mn Fil	10508	.86	23	479	602	880	0	105	1.0	.00	.21
21 OCT	111	End Ti Fil	10508	.32	23	486	602	880	0	105	1.0	.00	.48
22 OCT	112	Maturity	10508	.32	23	487	602	880	0	105	1.0	.00	.48
23 OCT	113	Harvest	10508	.32	23	488	602	880	0	105	1.0	.00	.48

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	82
PHYSIOL. MATURITY (dap)	112	113
GRAIN YIELD (kg/ha) AT 14% H2O	6911	6881
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	23773	31273
PANICLE NUMBER (PANICLE/m2)	764.75	374
MAXIMUM LAI (m2/m2)	3.72	8.57
BIOMASS (kg/ha) AT ANTHESIS	6489	11119
BIOMASS N (kg N/ha) AT ANTHESIS	104	-99
BIOMASS (kg/ha) AT HARVEST MAT.	10508	16799
STALK (kg/ha) AT HARVEST MAT.	4565	9918
HARVEST INDEX (kg/kg)	.566	0.41
FINAL LEAF NUMBER	23	26
GRAIN N (kg N/ha)	63	-99
BIOMASS N (kg N/ha)	105	-99
STALK N (kg N/ha)	43	-99
SEED N (%)	1.06	-99

*ENVIRONMENTAL AND STRESS FACTORS

	ENVIRONMENT						STRESS			
--DEVELOPMENT PHASE--	-TIME-	WEATHER					---WATER--		-NITROGEN-	
	DURA TION days	TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr		PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78		.008	.037	.000	.009
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31		.000	.000	.466	.635
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41		.000	.000	.371	.532
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73		.000	.000	.025	.119
Grain Filling Phase	16	32.53	17.22	18.39	11.35		.000	.000	.228	.351

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6911 kg/ha [DRY WEIGHT]

***RUN 2:12 I2F3(80*12000)**

MODEL : RICER980 - RICE
EXPERIMENT : RNRA7301 RI R.N.P.YADAV
TREATMENT 12 : I2F3 (80*12000)

CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 880 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 12000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	-	kg/ha-->	43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-................
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGE**

RUN NO. 12 I2F3 (80*12000)

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.1	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	80	0	4	3.5	.04	.00
21 AUG	50	Pan Init	1751	1.59	16	221	393	400	0	46	2.6	.00	.49
25 SEP	85	Heading	6835	3.81	23	368	602	720	0	110	1.6	.00	.33
5 OCT	95	Beg Gr Fil	9102	2.98	23	417	602	800	0	108	1.2	.00	.00
18 OCT	108	End Mn Fil	10812	.92	23	478	602	880	0	110	1.0	.00	.17
22 OCT	112	End Ti Fil	10812	.10	23	486	602	880	0	111	1.0	.00	.46
23 OCT	113	Maturity	10812	.10	23	486	602	880	0	111	1.0	.00	.47

23 OCT	113	Harvest	10812	.10	23	486	602	880	0	111	1.0	.00	.47

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	82
PHYSIOL. MATURITY (dap)	113	113
GRAIN YIELD (kg/ha) AT 14% H2O	7067	6960
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	24311	31636
PANICLE NUMBER (PANICLE/m2)	803.64	374
MAXIMUM LAI (m2/m2)	3.89	8.59
BIOMASS (kg/ha) AT ANTHESIS	6655	12751
BIOMASS N (kg N/ha) AT ANTHESIS	110	-99
BIOMASS (kg/ha) AT HARVEST MAT.	10812	16996
STALK (kg/ha) AT HARVEST MAT.	4735	10036
HARVEST INDEX (kg/kg)	.562	0.41
FINAL LEAF NUMBER	23	26
GRAIN N (kg N/ha)	66	-99
BIOMASS N (kg N/ha)	111	-99
STALK N (kg N/ha)	45	-99
SEED N (%)	1.09	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.010
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.471	.640
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.342	.495
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.021	.090
Grain Filling Phase	17	32.50	17.06	18.35	11.33	.000	.000	.210	.323

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 7067 kg/ha [DRY WEIGHT]

***RUN 2:13 (I3F0)**

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MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI     R.N.P.YADAV
TREATMENT   13    : I3F0 (120*0)

CROP              : RICE            CULTIVAR : HR 6444          - ................
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :      1320 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :       117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     25 kg/ha ;        0 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=      .00  TMAX=       .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01

```
TOT- 90  11.3   22.6   32.4   11.3   22.6  <--cm    -  kg/ha-->   43.9     5.9  11080
SOIL ALBEDO     :  .13        EVAPORATION LIMIT : 9.40         MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00         DRAINAGE RATE     :  .60         FERT. FACTOR : 1.00

RICE         CULTIVAR :WR0002-HR 6444           ECOTYPE :......-................
P1      : 550.0  P2R      : 185.0  P5       : 250.0  P20      :  11.7
G1      :  60.0  G2       : .0250  G3       :  1.00  G4       :  1.15
```

***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 13

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	120	0	4	3.8	.04	.00
21 AUG	50	Pan Init	1183	.99	16	222	393	600	0	25	2.1	.00	.60
25 SEP	85	Heading	4724	2.28	23	371	602	1080	0	66	1.4	.00	.41
5 OCT	95	Beg Gr Fil	6419	1.88	23	420	602	1200	0	66	1.0	.00	.09
18 OCT	108	End Mn Fil	7344	.47	23	475	602	1320	0	67	.9	.00	.41
20 OCT	110	End Ti Fil	7344	.30	23	479	602	1320	0	67	.9	.00	.55

21 OCT	111	Maturity	7344	.30	23	480	602	1320	0	67	.9	.00	.55
23 OCT	113	Harvest	7344	.30	23	483	602	1320	0	67	.9	.00	.55

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	111	-99
GRAIN YIELD (kg/ha) AT 14% H2O	5048	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	17364	-99
PANICLE NUMBER (PANICLE/m2)	579.62	-99
MAXIMUM LAI (m2/m2)	2.36	-99
BIOMASS (kg/ha) AT ANTHESIS	4608	-99
BIOMASS N (kg N/ha) AT ANTHESIS	66	-99
BIOMASS (kg/ha) AT HARVEST MAT.	7344	-99
STALK (kg/ha) AT HARVEST MAT.	3003	-99
HARVEST INDEX (kg/kg)	.591	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	39	-99
BIOMASS N (kg N/ha)	67	-99
STALK N (kg N/ha)	28	-99
SEED N (%)	.91	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.005
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.573	.725
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.423	.589
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.128	.206
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.000	.000	.388	.543

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 5048 kg/ha [DRY WEIGHT]

***RUN 2:14(I3F1)**

MODEL : RICER980 - RICE
EXPERIMENT : RNRY7301 RI R.N.P.YADAV
TREATMENT 14 : I3F1 (120*4000)

CROP : RICE CULTIVAR : HR 6444 - ....
STARTING DATE : JUN 30 1973
PLANTING DATE : JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER : WRDF 1973
SOIL : WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 1320 mm IN 11 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE : INITIAL : 25 kg/ha ; 4000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT. : DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT : WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT : PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

***SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS**

SOIL DEPTH cm	LOWER LIMIT	UPPER LIMIT cm3/cm3	SAT SW	EXTR SW cm3/cm3	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	-	kg/ha-->	43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-...............
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

***SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES**

RUN NO. 14

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	120	0	4	3.6	.04	.00
21 AUG	50	Pan Init	1424	1.22	16	221	393	600	0	33	2.3	.00	.55
25 SEP	85	Heading	5509	2.79	23	370	602	1080	0	82	1.5	.00	.39
5 OCT	95	Beg Gr Fil	7458	2.28	23	419	602	1200	0	82	1.1	.00	.05
18 OCT	108	End Mn Fil	8792	.63	23	477	602	1320	0	84	1.0	.00	.27
20 OCT	110	End Ti Fil	8792	.42	23	481	602	1320	0	84	1.0	.00	.51
21 OCT	111	Maturity	8792	.42	23	483	602	1320	0	84	1.0	.00	.51

23 OCT	113	Harvest	8792	.42	23	486	602	1320	0	84	1.0	.00	.51

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	111	-99
GRAIN YIELD (kg/ha) AT 14% H2O	5834	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	20070	-99
PANICLE NUMBER (PANICLE/m2)	678.49	-99
MAXIMUM LAI (m2/m2)	2.86	-99
BIOMASS (kg/ha) AT ANTHESIS	5369	-99
BIOMASS N (kg N/ha) AT ANTHESIS	82	-99
BIOMASS (kg/ha) AT HARVEST MAT.	8792	-99
STALK (kg/ha) AT HARVEST MAT.	3775	-99
HARVEST INDEX (kg/kg)	.571	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	49	-99
BIOMASS N (kg N/ha)	84	-99
STALK N (kg N/ha)	35	-99
SEED N (%)	.98	-99

*ENVIRONMENTAL AND STRESS FACTORS

	ENVIRONMENT					STRESS			
DEVELOPMENT PHASE	TIME	WEATHER				WATER		NITROGEN	
	DURATION days	TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.007
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.524	.686
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.401	.566
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.083	.164
Grain Filling Phase	15	32.53	17.37	18.44	11.36	.000	.000	.267	.422

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 5834 kg/ha [DRY WEIGHT]

*RUN 2:15(I3F2)

MODEL	: RICER980 - RICE
EXPERIMENT	: RNRY7301 RI R.N.P.YADAV
TREATMENT 15	: I3F2 (120*8000)
CROP	: RICE CULTIVAR : HR 6444 - ....
STARTING DATE	: JUN 30 1973
PLANTING DATE	: JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER	: WRDF 1973
SOIL	: WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C	: DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE	: IRRIGATE ON REPORTED DATE(S)
IRRIGATION	: 1320 mm IN 11 APPLICATIONS
NITROGEN BAL.	: SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER	: 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE	: INITIAL : 25 kg/ha ; 8000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT.	: DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
	RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT	: WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT	: PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	-	kg/ha-->	43.9	5.9	11080

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.40 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :WR0002-HR 6444 ECOTYPE :......-................
P1 : 550.0 P2R : 185.0 P5 : 250.0 P2O : 11.7
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT SAGES

RUN NO. 15

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP N kg/ha	N %	STRESS H2O	STRESS N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.2	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	120	0	4	3.4	.04	.00
21 AUG	50	Pan Init	1482	1.29	16	220	393	600	0	37	2.5	.00	.53
25 SEP	85	Heading	5983	3.15	23	369	602	1080	0	92	1.5	.00	.36
5 OCT	95	Beg Gr Fil	8086	2.55	23	418	602	1200	0	93	1.1	.00	.02
18 OCT	108	End Mn Fil	9575	.73	23	477	602	1320	0	94	1.0	.00	.22
21 OCT	111	End Ti Fil	9575	.27	23	483	602	1320	0	94	1.0	.00	.49
22 OCT	112	Maturity	9575	.27	23	484	602	1320	0	94	1.0	.00	.49
23 OCT	113	Harvest	9575	.27	23	485	602	1320	0	94	1.0	.00	.49

***MAIN GROWTH AND DEVELOPMENT VARIABLES**

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	112	-99
GRAIN YIELD (kg/ha) AT 14% H2O	6301	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	21675	-99
PANICLE NUMBER (PANICLE/m2)	728.55	-99
MAXIMUM LAI (m2/m2)	3.21	-99
BIOMASS (kg/ha) AT ANTHESIS	5825	-99
BIOMASS N (kg N/ha) AT ANTHESIS	92	-99
BIOMASS (kg/ha) AT HARVEST MAT.	9575	-99
STALK (kg/ha) AT HARVEST MAT.	4157	-99
HARVEST INDEX (kg/kg)	.566	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	56	-99
BIOMASS N (kg N/ha)	94	-99
STALK N (kg N/ha)	38	-99
SEED N (%)	1.04	-99

***ENVIRONMENTAL AND STRESS FACTORS**

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.009
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.508	.679
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.368	.528
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.050	.136
Grain Filling Phase	16	32.53	17.22	18.39	11.35	.000	.000	.242	.377

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD : 6301 kg/ha [DRY WEIGHT]

*RUN 2:16(I3F3)

MODEL	: RICER980 - RICE
EXPERIMENT	: RNRY7301 RI R.N.P.YADAV
TREATMENT 16	: I3F3 (120*12000)

CROP	: RICE CULTIVAR : HR 6444 - ....
STARTING DATE	: JUN 30 1973
PLANTING DATE	: JUL 2 1973 PLANTS/m2 : 33.0 ROW SPACING : 20.cm
WEATHER	: WRDF 1973
SOIL	: WR00730001 TEXTURE : SALO - SOLANI SERIES
SOIL INITIAL C	: DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.9kg/ha NH4: 5.9kg/ha
WATER BALANCE	: IRRIGATE ON REPORTED DATE(S)
IRRIGATION	: 1320 mm IN 11 APPLICATIONS
NITROGEN BAL.	: SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER	: 117 kg/ha IN 3 APPLICATIONS
RESIDUE/MANURE	: INITIAL : 25 kg/ha ; 12000 kg/ha IN 1 APPLICATIONS
ENVIRONM. OPT.	: DAYL= .00 SRAD= .00 TMAX= .00 TMIN= .00
	RAIN= .00 CO2 = R330.00 DEW = .00 WIND= .00
SIMULATION OPT	: WATER :Y NITROGEN:Y N-FIX:N PESTS :N PHOTO :R ET :P
MANAGEMENT OPT	: PLANTING:R IRRIG :R FERT :R RESIDUE:R HARVEST:R WTH:M

*SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

SOIL DEPTH cm	LOWER LIMIT cm3/cm3	UPPER LIMIT	SAT SW cm3/cm3	EXTR SW	INIT SW cm3/cm3	ROOT DIST	BULK DENS g/cm3	pH	NO3 ugN/g	NH4 ugN/g	ORG C %
0- 5	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
5- 15	.116	.242	.360	.126	.242	.50	1.45	7.50	12.20	.20	.30
15- 30	.122	.246	.355	.124	.246	.23	1.46	7.50	4.60	.40	.17
30- 45	.125	.248	.353	.123	.248	.10	1.47	7.50	.80	.50	.01
45- 60	.125	.248	.353	.123	.248	.10	1.50	7.60	.80	.50	.01
60- 90	.134	.261	.370	.127	.261	.10	1.56	7.60	.80	.50	.01
TOT- 90	11.3	22.6	32.4	11.3	22.6	<--cm	-	kg/ha-->	43.9	5.9	11080

SOIL ALBEDO : .13	EVAPORATION LIMIT : 9.40	MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00	DRAINAGE RATE : .60	FERT. FACTOR : 1.00

RICE	CULTIVAR :WR0002-HR 6444				ECOTYPE :......-................		
P1	: 550.0	P2R	: 185.0	P5	: 250.0	P2O	: 11.7
G1	: 60.0	G2	: .0250	G3	: 1.00	G4	: 1.15

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 16

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	FLOOD mm	CROP kg/ha	N %	STRESS H2O	N
30 JUN	0	Start Sim	0	.01	0	6	9	0	0	0	4.4	.00	.00
2 JUL	0	Transplant	21	.05	4	16	14	0	0	1	4.1	.00	.00
21 JUL	19	End Juveni	110	.22	8	77	185	120	0	4	3.3	.04	.00
21 AUG	50	Pan Init	1453	1.28	16	219	393	600	0	39	2.7	.00	.52
25 SEP	85	Heading	6273	3.42	23	367	602	1080	0	99	1.6	.00	.33
5 OCT	95	Beg Gr Fil	8481	2.75	23	416	602	1200	0	100	1.2	.00	.00
18 OCT	108	End Mn Fil	10058	.82	23	476	602	1320	0	101	1.0	.00	.21
21 OCT	111	End Ti Fil	10058	.33	23	482	602	1320	0	101	1.0	.00	.47
22 OCT	112	Maturity	10058	.33	23	484	602	1320	0	101	1.0	.00	.48

23 OCT	113	Harvest	10058	.33	23	485	602	1320	0	101	1.0	.00	.48

***MAIN GROWTH AND DEVELOPMENT VARIABLES**

@ VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	50	-99
FLOWERING DATE (dap)	85	-99
PHYSIOL. MATURITY (dap)	112	-99
GRAIN YIELD (kg/ha) AT 14% H2O	6546	-99
WT. PER GRAIN (g)	.025	-99
GRAIN NUMBER (GRAIN/m2)	22519	-99
PANICLE NUMBER (PANICLE/m2)	757.84	-99
MAXIMUM LAI (m2/m2)	3.48	-99
BIOMASS (kg/ha) AT ANTHESIS	6104	-99
BIOMASS N (kg N/ha) AT ANTHESIS	99	-99
BIOMASS (kg/ha) AT HARVEST MAT.	10058	-99
STALK (kg/ha) AT HARVEST MAT.	4429	-99
HARVEST INDEX (kg/kg)	.560	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	60	-99
BIOMASS N (kg N/ha)	101	-99
STALK N (kg N/ha)	41	-99
SEED N (%)	1.06	-99

***ENVIRONMENTAL AND STRESS FACTORS**

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	WATER STRESS: PHOTO SYNTH	WATER STRESS: GROWTH	NITROGEN STRESS: PHOTO SYNTH	NITROGEN STRESS: GROWTH
Emergence-End Juvenile	21	32.40	25.79	20.27	13.78	.008	.037	.000	.011
End Juvenil-Panicl Init	31	32.82	25.77	20.95	13.31	.000	.000	.503	.680
Panicl Init-End Lf Grow	35	31.16	24.89	18.27	12.41	.000	.000	.339	.493
End Lf Grth-Beg Grn Fil	10	31.20	20.70	19.39	11.73	.000	.000	.024	.114
Grain Filling Phase	16	32.53	17.22	18.39	11.35	.000	.000	.227	.349

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD: 6546 kg/ha [DRY WEIGHT]

*WATER BALANCE SUMMARY FILE

***RUN 2:1 : IOFO (0*0)**

```
MODEL               : RICER980 - RICE
EXPERIMENT          : RNRY7301 RI    R.N.P.YADAV
TREATMENT  1        : IOFO (0*0)

CROP                : RICE           CULTIVAR : HR 6444        - ................
STARTING DATE       : JUN 30 1973
PLANTING DATE       : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER             : WRDF   1973
SOIL                : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C      : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE       : IRRIGATE ON REPORTED DATE(S)
IRRIGATION          :       0 mm IN    11 APPLICATIONS
NITROGEN BAL.       : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER        :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE      : INITIAL :     25 kg/ha ;       0 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.      : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                      RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=      .00
SIMULATION OPT      : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT      : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

========================		--mm--
Soil H20 (start) on day	73181	225.9000
Soil H20 (final) on day	73296	116.8808
Irrigation		.0000
Effective Irrigation		.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		186.5215
Percolation		.0000
Final flood depth		.0000
Runoff		96.7719
Soil Evaporation		143.4787
Flood Water Evaporation		.0000
Transpiration		284.4472
Evapotranspiration		427.9259
Potential ET		576.4480

Final Balance **.0000**

```
*RUN  2:1          : IOF1 (0*4000)

MODEL              : RICER980 - RICE
EXPERIMENT         : RNRY7301 RI     R.N.P.YADAV
TREATMENT  2       : IOF1 (0*4000)

CROP               : RICE            CULTIVAR : HR 6444              - ...............
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :        0 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :     25 kg/ha ;     4000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                     RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

```
========================               --mm--

Soil H20 (start) on day  73181     225.9000
Soil H20 (final) on day  73296     117.8925
Irrigation                             .0000
Effective Irrigation                   .0000
Irrigation Lost                        .0000
Precipitation                      602.2001
Drainage                           188.1242
Percolation                            .0000
Final flood depth                      .0000
Runoff                              96.4935
Soil Evaporation                   144.2972
Flood Water Evaporation                .0000
Transpiration                      281.2925
Evapotranspiration                 425.5897
Potential ET                       576.8502
```

Final Balance **.0000**

```
*RUN   2:3          : IOF2 (0*8000)

 MODEL              : RICER980 - RICE
 EXPERIMENT         : RNRY7301 RI     R.N.P.YADAV
 TREATMENT  3       : IOF2 (0*8000)

 CROP               : RICE            CULTIVAR : HR 6444               - ................
 STARTING DATE      : JUN 30 1973
 PLANTING DATE      : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
 WEATHER            : WRDF   1973
 SOIL               : WR00730001      TEXTURE : SALO   - SOLANI SERIES
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :        0 mm IN     11 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :      117 kg/ha IN     3 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :     25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
 ENVIRONM. OPT.     : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                      RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
 SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
 MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

```
    ========================            --mm--

    Soil H20 (start) on day  73181     225.9000
    Soil H20 (final) on day  73296     117.9665
    Irrigation                            .0000
    Effective Irrigation                  .0000
    Irrigation Lost                       .0000
    Precipitation                      602.2001
    Drainage                           189.3237
    Percolation                           .0000
    Final flood depth                     .0000
    Runoff                              96.1895
    Soil Evaporation                   147.3134
    Flood Water Evaporation               .0000
    Transpiration                      277.3068
    Evapotranspiration                 424.6203
    Potential ET                       577.6575
```

Final Balance **.0000**

***RUN 2:4 : IOF3 (0*12000)**

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI     R.N.P.YADAV
TREATMENT  4      : IOF3 (0*12000)

CROP              : RICE            CULTIVAR : HR 6444              - ...............
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0      ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :         0 mm IN      11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     25 kg/ha ;    12000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

		--mm--
Soil H2O (start) on day	73181	225.9000
Soil H2O (final) on day	73296	118.3366
Irrigation		.0000
Effective Irrigation		.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		192.5219
Percolation		.0000
Final flood depth		.0000
Runoff		95.8849
Soil Evaporation		151.5591
Flood Water Evaporation		.0000
Transpiration		269.7974
Evapotranspiration		421.3566
Potential ET		578.7441
Final Balance		**.0000**

***RUN 2:5 : I1F0 (40*0)**

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRY7301 RI     R.N.P.YADAV
TREATMENT  5     : I1F0 (40*0)

CROP             : RICE          CULTIVAR : HR 6444          - ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973   PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H20:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :      440 mm IN     11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;       0 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

	--mm--
Soil H20 (start) on day 73181	225.9000
Soil H20 (final) on day 73296	165.9445
Irrigation	440.0000
Effective Irrigation	440.0000
Irrigation Lost	.0000
Precipitation	602.2001
Drainage	508.7046
Percolation	.0000
Final flood depth	.0000
Runoff	104.3197
Soil Evaporation	187.1539
Flood Water Evaporation	.0000
Transpiration	301.9774
Evapotranspiration	489.1312
Potential ET	575.4702
Final Balance	**.0000**

***RUN 2:6 : I1F1 (40*4000)**

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI     R.N.P.YADAV
TREATMENT  6      : I1F1 (40*4000)
CROP              : RICE            CULTIVAR : HR 6444          - ...............
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO   - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :      440 mm IN      11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :    25 kg/ha ;     4000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

		--mm--
Soil H20 (start) on day	73181	225.9000
Soil H20 (final) on day	73296	164.4053
Irrigation		440.0000
Effective Irrigation		440.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		509.0923
Percolation		.0000
Final flood depth		.0000
Runoff		104.3254
Soil Evaporation		183.0400
Flood Water Evaporation		.0000
Transpiration		307.2369
Evapotranspiration		490.2769
Potential ET		575.0289
Final Balance		**.0000**

***RUN 2:7 : I1F2 (40*8000)**

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRY7301 RI     R.N.P.YADAV
TREATMENT  7     : I1F2 (40*8000)

CROP             : RICE           CULTIVAR : HR 6444          - ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :      440 mm IN    11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :    25 kg/ha ;     8000 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=     .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=     .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

WATER BALANCE PARAMETERS		--mm--
Soil H2O (start) on day	73181	225.9000
Soil H2O (final) on day	73296	164.2349
Irrigation		440.0000
Effective Irrigation		440.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		510.0015
Percolation		.0000
Final flood depth		.0000
Runoff		103.8361
Soil Evaporation		186.3077
Flood Water Evaporation		.0000
Transpiration		303.7200
Evapotranspiration		490.0276
Potential ET		575.6545
Final Balance		**.0000**

***RUN 2:8 : I1F3 (40*12000)**

```
MODEL              : RICER980 - RICE
EXPERIMENT         : RNRY7301 RI     R.N.P.YADAV
TREATMENT  8       : I1F3 (40*12000)

CROP               : RICE          CULTIVAR : HR 6444             - ................
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973   PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001    TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :      440 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :     25 kg/ha ;    12000 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                     RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

========================		--mm--
Soil H20 (start) on day	73181	225.9000
Soil H20 (final) on day	73296	164.4315
Irrigation		440.0000
Effective Irrigation		440.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		510.8495
Percolation		.0000
Final flood depth		.0000
Runoff		103.4676
Soil Evaporation		191.6083
Flood Water Evaporation		.0000
Transpiration		297.7431
Evapotranspiration		489.3514
Potential ET		576.4958
Final Balance		**.0000**

```
*RUN  2: 9        : I2F0 (80*0) (validation)

MODEL              : RICER980 - RICE
EXPERIMENT         : RNRA7301 RI    R.N.P.YADAV
TREATMENT  9       : I2F0 (80*0)

CROP               : RICE           CULTIVAR : HR 6444          - ................
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :      880 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :    25 kg/ha ;       0 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                     RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

```
=======================              --mm--

Soil H20 (start) on day  73181      225.9000
Soil H20 (final) on day  73296      170.4114
Irrigation                          880.0000
Effective Irrigation                880.0000
Irrigation Lost                        .0000
Precipitation                       602.2001
Drainage                            947.3726
Percolation                            .0000
Final flood depth                      .0000
Runoff                              101.6784
Soil Evaporation                    229.3528
Flood Water Evaporation                .0000
Transpiration                       259.2851
Evapotranspiration                  488.6379
Potential ET                        581.7857
```

Final Balance **.0000**

```
*RUN   2:10       : I2F1 (80*4000)

 MODEL             : RICER980 - RICE
 EXPERIMENT        : RNRA7301 RI     R.N.P.YADAV
 TREATMENT  10     : I1F1 (80*4000)

 CROP              : RICE            CULTIVAR : HR 6444             - ...............
 STARTING DATE     : JUN 30 1973
 PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
 WEATHER           : WRDF   1973
 SOIL              : WR00730001      TEXTURE : SALO   - SOLANI SERIES
 SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
 WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION        :      880 mm IN     11 APPLICATIONS
 NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER      :      117 kg/ha IN     3 APPLICATIONS
 RESIDUE/MANURE    : INITIAL :     25 kg/ha ;     4000 kg/ha IN      1 APPLICATIONS
 ENVIRONM. OPT.    : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                     RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
 SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
 MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M


     WATER BALANCE PARAMETERS
     ========================                 --mm--

     Soil H20 (start) on day  73181      225.9000
     Soil H20 (final) on day  73296      169.5770
     Irrigation                          880.0000
     Effective Irrigation                880.0000
     Irrigation Lost                        .0000
     Precipitation                       602.2001
     Drainage                            948.5134
     Percolation                            .0000
     Final flood depth                      .0000
     Runoff                              102.0986
     Soil Evaporation                    218.5783
     Flood Water Evaporation                .0000
     Transpiration                       269.3328
     Evapotranspiration                  487.9111
     Potential ET                        580.1482


     Final Balance                          .0000
```

***RUN 2: 11 : I1F2 (80*8000)**

```
MODEL              : RICER980 - RICE
EXPERIMENT         : RNRA7301 RI     R.N.P.YADAV
TREATMENT  11      : I1F2 (80*8000)

CROP               : RICE           CULTIVAR : HR 6444           - ................
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :      880 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :     25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                     RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=      .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y   N-FIX:N   PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT     : PLANTING:R   IRRIG   :R   FERT :R   RESIDUE:R   HARVEST:R   WTH:M
```

WATER BALANCE PARAMETERS

========================		--mm--
Soil H20 (start) on day	73181	225.9000
Soil H20 (final) on day	73296	167.8220
Irrigation		880.0000
Effective Irrigation		880.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		949.7476
Percolation		.0000
Final flood depth		.0000
Runoff		102.0320
Soil Evaporation		215.9613
Flood Water Evaporation		.0000
Transpiration		272.5371
Evapotranspiration		488.4984
Potential ET		579.8377
Final Balance		**.0000**

***RUN 2: 12 : I1F3 (80*12000)**

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRA7301 RI    R.N.P.YADAV
TREATMENT  12    : I1F3 (80*12000)

CROP             : RICE           CULTIVAR : HR 6444           - ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :      880 mm IN     11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;    12000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=       .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=      .00
SIMULATION OPT   : WATER   :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

		--mm--
Soil H20 (start) on day	73181	225.9000
Soil H20 (final) on day	73296	169.3118
Irrigation		880.0000
Effective Irrigation		880.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		950.8906
Percolation		.0000
Final flood depth		.0000
Runoff		101.7934
Soil Evaporation		216.7257
Flood Water Evaporation		.0000
Transpiration		269.3786
Evapotranspiration		486.1042
Potential ET		580.3671
Final Balance		**.0000**

*RUN 2: 13 : I3F0 (120*0)

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI     R.N.P.YADAV
TREATMENT  13      : I3F0 (120*0)

CROP              : RICE             CULTIVAR : HR 6444          - ................
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973      PLANTS/m2 : 33.0      ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001       TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :     1320 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     25 kg/ha ;        0 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

		--mm--
Soil H20 (start) on day	73181	225.9000
Soil H20 (final) on day	73296	174.6477
Irrigation		1320.0000
Effective Irrigation		1320.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		1390.4480
Percolation		.0000
Final flood depth		.0000
Runoff		100.1731
Soil Evaporation		246.9263
Flood Water Evaporation		.0000
Transpiration		235.9051
Evapotranspiration		482.8314
Potential ET		586.5874

Final Balance .0000

```
*RUN  2:14      : I3F1 (120*4000)

MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI     R.N.P.YADAV
TREATMENT 14      : I3F1 (120*4000)

CROP              : RICE            CULTIVAR : HR 6444          - ................
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0      ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO   - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :     1320 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     25 kg/ha ;    4000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=       .00  TMAX=        .00  TMIN=       .00
                    RAIN=      .00  CO2 = R330.00  DEW =        .00  WIND=       .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

========================		--mm--
Soil H20 (start) on day	73181	225.9000
Soil H20 (final) on day	73296	170.4872
Irrigation		1320.0000
Effective Irrigation		1320.0000
Irrigation Lost		.0000
Precipitation		602.2001
Drainage		1390.6960
Percolation		.0000
Final flood depth		.0000
Runoff		100.7394
Soil Evaporation		237.2504
Flood Water Evaporation		.0000
Transpiration		248.9268
Evapotranspiration		486.1772
Potential ET		583.7824

Final Balance **.0000**

```
*RUN 2:15         : I3F2 (120*8000)

 MODEL            : RICER980 - RICE
 EXPERIMENT       : RNRY7301 RI     R.N.P.YADAV
 TREATMENT 15     : I3F2 (120*8000)

 CROP             : RICE            CULTIVAR : HR 6444          - ................
 STARTING DATE    : JUN 30 1973
 PLANTING DATE    : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
 WEATHER          : WRDF   1973
 SOIL             : WR00730001      TEXTURE : SALO   - SOLANI SERIES
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :     1320 mm IN     11 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :      117 kg/ha IN      3 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :     25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
 ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
 SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
 MANAGEMENT OPT   : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

```
    ========================          --mm--

    Soil H20 (start) on day  73181     225.9000
    Soil H20 (final) on day  73296     170.1584
    Irrigation                        1320.0000
    Effective Irrigation              1320.0000
    Irrigation Lost                       .0000
    Precipitation                      602.2001
    Drainage                          1391.9780
    Percolation                           .0000
    Final flood depth                     .0000
    Runoff                             100.9008
    Soil Evaporation                   231.7599
    Flood Water Evaporation               .0000
    Transpiration                      253.3036
    Evapotranspiration                 485.0635
    Potential ET                       582.9669


    Final Balance                         .0000
```

```
*RUN 2: 16        : I3F3 (120*12000)

 MODEL            : RICER980 - RICE
 EXPERIMENT       : RNRY7301 RI    R.N.P.YADAV
 TREATMENT 16     : I3F3 (120*12000)

 CROP             : RICE          CULTIVAR : HR 6444            - ................
 STARTING DATE    : JUN 30 1973
 PLANTING DATE    : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
 WEATHER          : WRDF   1973
 SOIL             : WR00730001     TEXTURE : SALO   - SOLANI SERIES
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :      1320 mm IN     11 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :       117 kg/ha IN      3 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :     25 kg/ha ;    12000 kg/ha IN      1 APPLICATIONS
 ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
 SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
 MANAGEMENT OPT   : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

WATER BALANCE PARAMETERS

```
=======================                   --mm--

Soil H20 (start) on day  73181        225.9000
Soil H20 (final) on day  73296        168.2591
Irrigation                           1320.0000
Effective Irrigation                 1320.0000
Irrigation Lost                          .0000
Precipitation                         602.2001
Drainage                             1393.5970
Percolation                              .0000
Final flood depth                        .0000
Runoff                                100.8905
Soil Evaporation                      229.1451
Flood Water Evaporation                  .0000
Transpiration                         256.2086
Evapotranspiration                    485.3537
Potential ET                          582.7477
```

Final Balance **.0000**

*NITROGEN BALANCE SUMMARY FILE

*RUN 2:1 : IOFO (0*0)

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRY7301 RI    R.N.P.YADAV
TREATMENT  1     : IOFO (0*0)
CROP             : RICE           CULTIVAR : HR 6444    -  ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :        0 mm IN     11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;         0 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER   :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	kg N/ha	
Soil Organic N	3529.50	3511.26
Initial Residue N	.22	.63
Soil NO3	43.92	18.73
Soil NH4	5.88	5.83
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	17.94
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	.00	.00
N Uptake From Soil	.00	143.00
Total N	3696.54	3696.54
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
		kg N/ha	
Leaf N	34.98	.00	34.98
Stem N	41.31	.00	41.31
Shell N	.00	.00	.00
Seed N	60.94	.00	60.94
Root N	5.77	.00	5.77
Nodule N	.00	.00	.00
Total N	143.00	.00	143.00
N leakage			.00
TOTAL N			143.00

N Uptake From Soil + Seed N At Planting + N2 Fixed 143.02

MODEL 2:2 : RICER980 - RICE

```
EXPERIMENT        : RNRY7301 RI      R.N.P.YADAV
TREATMENT  2      : IOF1 (0*4000)
CROP              : RICE             CULTIVAR : HR 6444        -
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973      PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001       TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :        0 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     25 kg/ha ;     4000 kg/ha IN       1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=       .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00   DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	--------kg N/ha--------	
Soil Organic N	3529.50	3515.11
Initial Residue N	.22	8.46
Soil NO3	43.92	21.70
Soil NH4	5.88	6.21
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	16.96
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	17.20	.00
N Uptake From Soil	.00	146.14
Total N	3713.74	3713.74
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	--------kg N/ha--------		
Leaf N	36.01	.00	36.01
Stem N	42.11	.00	42.11
Shell N	.00	.00	.00
Seed N	61.20	.00	61.20
Root N	6.82	.00	6.82
Nodule N	.00	.00	.00
Total N	146.14	.00	146.14
N leakage			.00
TOTAL N			146.14

N Uptake From Soil + Seed N At Planting + N2 Fixed 146.16

***RUN 2:3 : IOF2 (0*8000)**

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI     R.N.P.YADAV
TREATMENT  3      : IOF2 (0*8000)
CROP              : RICE            CULTIVAR : HR 6444 -
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :        0 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=       .00  SRAD=       .00  TMAX=       .00  TMIN=       .00
                    RAIN=       .00  CO2 = R330.00  DEW =       .00  WIND=       .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	--------------kg N/ha--------------	
Soil Organic N	3529.50	3522.23
Initial Residue N	.22	17.72
Soil NO3	43.92	22.39
Soil NH4	5.88	6.44
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	16.18
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	34.40	.00
N Uptake From Soil	.00	146.82
Total N	3730.94	3730.94
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	---------------kg N/ha---------------		
Leaf N	36.41	.00	36.41
Stem N	42.99	.00	42.99
Shell N	.00	.00	.00
Seed N	61.02	.00	61.02
Root N	6.40	.00	6.40
Nodule N	.00	.00	.00
Total N	146.82	.00	146.82
N leakage			.00
TOTAL N			146.82

N Uptake From Soil + Seed N At Planting + N2 Fixed 146.85

```
*RUN 2: 4          : IOF3 (0*12000)

MODEL              : RICER980 - RICE
EXPERIMENT         : RNRY7301 RI    R.N.P.YADAV
TREATMENT  4       : IOF3 (0*12000)

CROP               : RICE           CULTIVAR : HR 6444 -  ................
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :        0 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :     25 kg/ha ;    12000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                     RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=      .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO  :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	kg N/ha	
Soil Organic N	3529.50	3528.91
Initial Residue N	.22	27.68
Soil NO3	43.92	23.37
Soil NH4	5.88	6.60
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	16.02
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	51.60	.00
N Uptake From Soil	.00	146.41
Total N	3748.14	3748.14
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	kg N/ha		
Leaf N	35.94	.00	35.94
Stem N	43.00	.00	43.00
Shell N	.00	.00	.00
Seed N	60.49	.00	60.49
Root N	6.97	.00	6.97
Nodule N	.00	.00	.00
Total N	146.41	.00	146.41
N leakage			.00
TOTAL N			146.41

N Uptake From Soil + Seed N At Planting + N2 Fixed   146.43

*RUN 2: 5 : I2F0 (40*0)

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI     R.N.P.YADAV
TREATMENT  5      : I1F0 (40*0)

CROP              : RICE            CULTIVAR : HR 6444  -  ...............
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :      440 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :    25 kg/ha ;       0 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=     .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                    RAIN=     .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	--------------kg N/ha--------------	
Soil Organic N	3529.50	3510.97
Initial Residue N	.22	.38
Soil NO3	43.92	11.68
Soil NH4	5.88	11.79
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	44.44
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	.00	.00
N Uptake From Soil	.00	118.13
Total N	3696.54	3696.54
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	---------------kg N/ha---------------		
Leaf N	21.25	.00	21.25
Stem N	25.05	.00	25.05
Shell N	.00	.00	.00
Seed N	67.54	.00	67.54
Root N	4.29	.00	4.29
Nodule N	.00	.00	.00
Total N	118.13	.00	118.13
N leakage			.00
TOTAL N			118.13

N Uptake From Soil + Seed N At Planting + N2 Fixed   118.15

***RUN 2: 6 : I2F1 (40*4000)**

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRY7301 RI    R.N.P.YADAV
TREATMENT  6     : I1F1 (40*4000)

CROP             : RICE          CULTIVAR : HR 6444    ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973   PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF    1973
SOIL             : WR00730001    TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :      440 mm IN     11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;     4000 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	kg N/ha	
Soil Organic N	3529.50	3513.17
Initial Residue N	.22	5.20
Soil NO3	43.92	12.21
Soil NH4	5.88	11.76
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	40.58
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	17.20	.00
N Uptake From Soil	.00	131.66
Total N	3713.74	3713.74
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	kg N/ha		
Leaf N	23.46	.00	23.46
Stem N	27.02	.00	27.02
Shell N	.00	.00	.00
Seed N	74.13	.00	74.13
Root N	7.05	.00	7.05
Nodule N	.00	.00	.00
Total N	131.66	.00	131.66
N leakage			.00
TOTAL N			131.66

N Uptake From Soil + Seed N At Planting + N2 Fixed 131.68

***RUN 2:7 : I2F2 (40*8000)**

```
MODEL             : RICER980 - RICE
EXPERIMENT        : RNRY7301 RI    R.N.P.YADAV
TREATMENT  7      : I1F2 (40*8000)

CROP              : RICE          CULTIVAR : HR 6444   ................
STARTING DATE     : JUN 30 1973
PLANTING DATE     : JUL  2 1973   PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER           : WRDF   1973
SOIL              : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :      440 mm IN     11 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.    : DAYL=      .00  SRAD=       .00  TMAX=      .00  TMIN=      .00
                    RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT    : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT    : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	**Final, DOY 73296**
	kg N/ha	
Soil Organic N	3529.50	3519.94
Initial Residue N	.22	11.01
Soil NO3	43.92	13.34
Soil NH4	5.88	12.77
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	37.48
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	34.40	.00
N Uptake From Soil	.00	137.24
Total N	3730.94	3730.94
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
		kg N/ha	
Leaf N	24.25	.00	24.25
Stem N	27.84	.00	27.84
Shell N	.00	.00	.00
Seed N	75.57	.00	75.57
Root N	9.59	.00	9.59
Nodule N	.00	.00	.00
Total N	137.24	.00	137.24
N leakage			.00
TOTAL N			137.24

N Uptake From Soil + Seed N At Planting + N2 Fixed 137.26

```
*RUN   2:8        : I2F3 (40*12000)

 MODEL            : RICER980 - RICE
 EXPERIMENT       : RNRY7301 RI    R.N.P.YADAV
 TREATMENT  8     : I1F3 (40*12000)

 CROP             : RICE           CULTIVAR : HR 6444 -  ................
 STARTING DATE    : JUN 30 1973
 PLANTING DATE    : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
 WEATHER          : WRDF   1973
 SOIL             : WR00730001     TEXTURE : SALO   - SOLANI SERIES
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :      440 mm IN     11 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :    25 kg/ha ;   12000 kg/ha IN     1 APPLICATIONS
 ENVIRONM. OPT.   : DAYL=     .00  SRAD=     .00  TMAX=      .00  TMIN=      .00
                    RAIN=     .00  CO2 = R330.00  DEW =      .00  WIND=      .00
 SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO  :R  ET :P
 MANAGEMENT OPT   : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	--------------kg N/ha--------------	
Soil Organic N	3529.50	3527.17
Initial Residue N	.22	17.15
Soil NO3	43.92	14.88
Soil NH4	5.88	12.86
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	37.27
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	51.60	.00
N Uptake From Soil	.00	139.65
Total N	3748.14	3748.14
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	---------------kg N/ha---------------		
Leaf N	24.50	.00	24.50
Stem N	28.95	.00	28.95
Shell N	.00	.00	.00
Seed N	76.62	.00	76.62
Root N	9.58	.00	9.58
Nodule N	.00	.00	.00
Total N	139.65	.00	139.65
N leakage			.00
TOTAL N			139.65

N Uptake From Soil + Seed N At Planting + N2 Fixed   139.67

***RUN 2:9 : 12F0 (80*0)**

```
MODEL           : RICER980 - RICE
EXPERIMENT      : RNRA7301 RI    R.N.P.YADAV
TREATMENT  9  : I2F0(80*0)
CROP            : RICE           CULTIVAR : HR 6444-  ................
STARTING DATE   : JUN 30 1973
PLANTING DATE   : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER         : WRDF   1973
SOIL            : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C  : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE   : IRRIGATE ON REPORTED DATE(S)
IRRIGATION      :      880 mm IN     11 APPLICATIONS
NITROGEN BAL.   : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER    :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE  : INITIAL :     25 kg/ha ;        0 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.  : DAYL=      .00  SRAD=       .00  TMAX=      .00  TMIN=      .00
                  RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=      .00
SIMULATION OPT  : WATER   :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO  :R  ET :P
MANAGEMENT OPT  : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	kg N/ha	
Soil Organic N	3529.50	3511.52
Initial Residue N	.22	.32
Soil NO3	43.92	10.18
Soil NH4	5.88	14.21
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	76.31
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	.00	.00
N Uptake From Soil	.00	84.85
Total N	3696.54	3696.54
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	kg N/ha		
Leaf N	14.10	.00	14.10
Stem N	19.65	.00	19.65
Shell N	.00	.00	.00
Seed N	47.90	.00	47.90
Root N	3.20	.00	3.20
Nodule N	.00	.00	.00
Total N	84.85	.00	84.85
N leakage			.00
TOTAL N			84.85

N Uptake From Soil + Seed N At Planting + N2 Fixed 84.87

*RUN 2: 10: : I2F1 (80*4000)

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRA7301 RI     R.N.P.YADAV
TREATMENT  10    : I2F1 (80*4000)
CROP             : RICE            CULTIVAR : HR 6444     ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001      TEXTURE : SALO   - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :      880 mm IN     11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;    4000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER     :Y  NITROGEN:Y  N-FIX:N  PESTS    :N  PHOTO   :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG     :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	kg N/ha	
Soil Organic N	3529.50	3512.93
Initial Residue N	.22	5.43
Soil NO3	43.92	10.81
Soil NH4	5.88	14.54
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	69.20
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	17.20	.00
N Uptake From Soil	.00	101.66
Total N	3713.74	3713.74
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
		kg N/ha	
Leaf N	16.50	.00	16.50
Stem N	22.87	.00	22.87
Shell N	.00	.00	.00
Seed N	57.59	.00	57.59
Root N	4.70	.00	4.70
Nodule N	.00	.00	.00
Total N	101.66	.00	101.66
N leakage			.00
TOTAL N			101.66

N Uptake From Soil + Seed N At Planting + N2 Fixed 101.68

```
*RUN   2:11        : I2F2 (80*8000)

 MODEL             : RICER980 - RICE
 EXPERIMENT        : RNRA7301 RI       R.N.P.YADAV
 TREATMENT  11     : I2F2 (80*8000)
 CROP              : RICE              CULTIVAR : HR 6444
................
 STARTING DATE     : JUN 30 1973
 PLANTING DATE     : JUL  2 1973     PLANTS/m2 : 33.0      ROW SPACING :   20.cm
 WEATHER           : WRDF   1973
 SOIL              : WR00730001      TEXTURE : SALO   - SOLANI SERIES
 SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:   5.9kg/ha
 WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION        :      880 mm IN      11 APPLICATIONS
 NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER      :      117 kg/ha IN      3 APPLICATIONS
 RESIDUE/MANURE    : INITIAL :      25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
 ENVIRONM. OPT.    : DAYL=      .00  SRAD=       .00  TMAX=       .00  TMIN=       .00
                     RAIN=      .00  CO2 = R330.00  DEW =        .00  WIND=       .00
 SIMULATION OPT    : WATER   :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
 MANAGEMENT OPT    : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	kg N/ha	
Soil Organic N	3529.50	3519.78
Initial Residue N	.22	11.48
Soil NO3	43.92	11.67
Soil NH4	5.88	14.15
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	62.90
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	34.40	.00
N Uptake From Soil	.00	111.79
Total N	3730.94	3730.94
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	kg N/ha		
Leaf N	18.03	.00	18.03
Stem N	24.51	.00	24.51
Shell N	.00	.00	.00
Seed N	62.81	.00	62.81
Root N	6.43	.00	6.43
Nodule N	.00	.00	.00
Total N	111.79	.00	111.79
N leakage			.00
TOTAL N			111.79

N Uptake From Soil + Seed N At Planting + N2 Fixed   111.81

```
*RUN   2:12       : I2F3 (80*12000)

MODEL              : RICER980 - RICE
EXPERIMENT         : RNRA7301 RI     R.N.P.YADAV
TREATMENT  12       : I2F3 (80*12000)
CROP               : RICE            CULTIVAR : HR 6444 -  ................
STARTING DATE      : JUN 30 1973
PLANTING DATE      : JUL  2 1973     PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER            : WRDF   1973
SOIL               : WR00730001      TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :      880 mm IN     11 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :      117 kg/ha IN      3 APPLICATIONS
RESIDUE/MANURE     : INITIAL :      25 kg/ha ;   12000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.     : DAYL=       .00  SRAD=       .00  TMAX=       .00  TMIN=       .00
                     RAIN=       .00  CO2 = R330.00  DEW =       .00  WIND=       .00
SIMULATION OPT     : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT     : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	**Final, DOY 73296**
	--------------kg N/ha--------------	
Soil Organic N	3529.50	3526.83
Initial Residue N	.22	18.12
Soil NO3	43.92	12.15
Soil NH4	5.88	14.36
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	58.48
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	51.60	.00
N Uptake From Soil	.00	119.05
Total N	3748.14	3748.14
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	--------------kg N/ha--------------		
Leaf N	19.06	.00	19.06
Stem N	25.48	.00	25.48
Shell N	.00	.00	.00
Seed N	66.07	.00	66.07
Root N	8.44	.00	8.44
Nodule N	.00	.00	.00
Total N	119.05	.00	119.05
N leakage			.00
TOTAL N			119.05

N Uptake From Soil + Seed N At Planting + N2 Fixed   119.07

RUN 2:13 : I3F0 (120*0)

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRY7301 RI     R.N.P.YADAV
TREATMENT  13    : I3F0 (120*0)

CROP             : RICE          CULTIVAR : HR 6444     ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL  2 1973   PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001    TEXTURE : SALO   - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :     1320 mm IN     11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;       0 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	**Final, DOY 73296**
	kg N/ha	
Soil Organic N	3529.50	3512.14
Initial Residue N	.22	.30
Soil NO3	43.92	9.22
Soil NH4	5.88	14.60
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	91.42
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	.00	.00
N Uptake From Soil	.00	69.70
Total N	3696.54	3696.54
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	kg N/ha		
Leaf N	11.06	.00	11.06
Stem N	16.46	.00	16.46
Shell N	.00	.00	.00
Seed N	39.45	.00	39.45
Root N	2.72	.00	2.72
Nodule N	.00	.00	.00
Total N	69.70	.00	69.70
N leakage			.00
TOTAL N			69.70

N Uptake From Soil + Seed N At Planting + N2 Fixed   69.72

```
*RUN  2:14        : I3F1 (120*4000)

 MODEL            : RICER980 - RICE
 EXPERIMENT       : RNRY7301 RI     R.N.P.YADAV
 TREATMENT 14     : I3F1 (120*4000)

 CROP             : RICE           CULTIVAR : HR 6444  -  ................
 STARTING DATE    : JUN 30 1973
 PLANTING DATE    : JUL  2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
 WEATHER          : WRDF   1973
 SOIL             : WR00730001     TEXTURE : SALO  - SOLANI SERIES
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :     1320 mm IN     11 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :      117 kg/ha IN      3 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :     25 kg/ha ;     4000 kg/ha IN      1 APPLICATIONS
 ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=       .00  TMIN=       .00
                    RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=       .00
 SIMULATION OPT   : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
 MANAGEMENT OPT   : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M

                                  Initial, DOY 73181   Final, DOY 73296
                                  --------------kg N/ha--------------
     Soil Organic N                    3529.50              3513.05
     Initial Residue N                     .22                 5.69
     Soil NO3                            43.92                 9.75
     Soil NH4                             5.88                14.43
     Soil UREA                             .00                  .00
     Algal N                               .00                  .00
     Leached NO3                           .00                83.98
     N Denitrified                         .00                  .00
     Ammonia loss                          .00                  .00
     Runoff N                              .00                  .00
     Flood N                               .00                  .00
     Seedling N Gain                       .00                 -.84
     Fertilizer N                       117.00                  .00
     Organic Added N                     17.20                  .00
     N Uptake From Soil                    .00                87.69
     Total N                           3713.74              3713.74

     Seed N At Planting                    .02                  .00
     N2 Fixed                              .00                  .00


     Plant Component          At Harvest        Senesced          Total
                              ---------------kg N/ha---------------
     Leaf N                      13.69              .00            13.69
     Stem N                      20.96              .00            20.96
     Shell N                       .00              .00              .00
     Seed N                      49.22              .00            49.22
     Root N                       3.82              .00             3.82
     Nodule N                      .00              .00              .00
     Total N                     87.69              .00            87.69
     N leakage                                                       .00
     TOTAL N                                                       87.69

     N Uptake From Soil + Seed N At Planting + N2 Fixed            87.71
```

```
*RUN  2:15          : I3F2 (120*8000)

MODEL               : RICER980 - RICE
EXPERIMENT          : RNRY7301 RI     R.N.P.YADAV
TREATMENT 15        : I3F2 (120*8000)

CROP                : RICE             CULTIVAR : HR 6444 -  ................
STARTING DATE       : JUN 30 1973
PLANTING DATE       : JUL  2 1973      PLANTS/m2 : 33.0      ROW SPACING :  20.cm
WEATHER             : WRDF    1973
SOIL                : WR00730001       TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C      : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE       : IRRIGATE ON REPORTED DATE(S)
IRRIGATION          :     1320 mm IN     11 APPLICATIONS
NITROGEN BAL.       : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER        :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE      : INITIAL :     25 kg/ha ;     8000 kg/ha IN      1 APPLICATIONS
ENVIRONM. OPT.      : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                      RAIN=      .00  CO2 = R330.00  DEW =       .00  WIND=      .00
SIMULATION OPT      : WATER    :Y  NITROGEN:Y  N-FIX:N  PESTS   :N  PHOTO   :R  ET :P
MANAGEMENT OPT      : PLANTING:R  IRRIG    :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	Final, DOY 73296
	kg N/ha	
Soil Organic N	3529.50	3519.72
Initial Residue N	.22	11.95
Soil NO3	43.92	10.64
Soil NH4	5.88	14.08
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	75.80
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	34.40	.00
N Uptake From Soil	.00	99.59
Total N	3730.94	3730.94
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
	kg N/ha		
Leaf N	15.41	.00	15.41
Stem N	22.81	.00	22.81
Shell N	.00	.00	.00
Seed N	56.10	.00	56.10
Root N	5.27	.00	5.27
Nodule N	.00	.00	.00
Total N	99.59	.00	99.59
N leakage			.00
TOTAL N			99.59

N Uptake From Soil + Seed N At Planting + N2 Fixed   99.62

***RUN 2:16 : I3F3 (120*12000)**

```
MODEL            : RICER980 - RICE
EXPERIMENT       : RNRY7301 RI    R.N.P.YADAV
TREATMENT 16     : I3F3 (120*12000)

CROP             : RICE           CULTIVAR : HR 6444  -  ................
STARTING DATE    : JUN 30 1973
PLANTING DATE    : JUL '2 1973    PLANTS/m2 : 33.0     ROW SPACING :  20.cm
WEATHER          : WRDF   1973
SOIL             : WR00730001     TEXTURE : SALO  - SOLANI SERIES
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.9kg/ha  NH4:  5.9kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :     1320 mm IN    11 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      117 kg/ha IN     3 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     25 kg/ha ;   12000 kg/ha IN     1 APPLICATIONS
ENVIRONM. OPT.   : DAYL=      .00  SRAD=      .00  TMAX=      .00  TMIN=      .00
                   RAIN=      .00  CO2 = R330.00  DEW =      .00  WIND=      .00
SIMULATION OPT   : WATER   :Y  NITROGEN:Y  N-FIX:N  PESTS  :N  PHOTO  :R  ET :P
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:R  HARVEST:R  WTH:M
```

	Initial, DOY 73181	**Final, DOY 73296**
	kg N/ha	
Soil Organic N	3529.50	3526.74
Initial Residue N	.22	18.81
Soil NO3	43.92	11.65
Soil NH4	5.88	14.09
Soil UREA	.00	.00
Algal N	.00	.00
Leached NO3	.00	69.75
N Denitrified	.00	.00
Ammonia loss	.00	.00
Runoff N	.00	.00
Flood N	.00	.00
Seedling N Gain	.00	-.84
Fertilizer N	117.00	.00
Organic Added N	51.60	.00
N Uptake From Soil	.00	107.94
Total N	3748.14	3748.14
Seed N At Planting	.02	.00
N2 Fixed	.00	.00

Plant Component	At Harvest	Senesced	Total
		kg N/ha	
Leaf N	16.94	.00	16.94
Stem N	24.05	.00	24.05
Shell N	.00	.00	.00
Seed N	59.85	.00	59.85
Root N	7.11	.00	7.11
Nodule N	.00	.00	.00
Total N	107.94	.00	107.94
N leakage			.00
TOTAL N			107.94

N Uptake From Soil + Seed N At Planting + N2 Fixed 107.97

CHAPTER-7

RESULTS AND DISCUSSIONS

This chapter deals with the results obtained from running validated DSSAT model giving input variation of irrigation application and organic manuring. The Major points taken for discussion are yield (grain yield, straw yield, biomass and harvest index), water balance (initial soil water, rainfall, irrigation, evapotranspiration, runoff, drainage and residual moisture) as well as the nitrogen balance (initial soil nitrogen, nitrogen added through fertilizer and organic manure, nitrogen uptake by crop, nitrogen leached from the field and residual nitrogen). The data is presented in **Table7.1** and **Fig.7.1-7.9**. Results obtained are discussed below.

7.1 DSSAT RESPONSE TO IRRIGATION AND ORGANIC MANURING ON YIELD

The DSSAT response to the yield in the form of grain yield, straw yield, total biomass, and harvest index. This is discussed in the forthcoming paragraph.

7.1.1 Grain yield

The average grain yield recorded was 6743.75 kgs/ha. This was influenced by irrigation dose and farm yard manure (FYM) dose. The application of irrigation recorded increase in the grain yield only upto 440 mm. There after this showed a declining trend. Similarly FYM application beyond 8000 kgs/ha noticed a declining trend in yield marginally. Under the rainfed condition application of FYM did not yield any response on grain yield. However when the irrigation dose was increased to 440 mm and FYM applied was 8000 kgs/ha, the grain yield responded was highest (7991.0 kgs/ha). Further increase in application of FYM and irrigation resulted in to decreasing grain yield. The yield response at 1320-mm irrigation was lowest. However adding the FYM mitigated the yield loss to some extent **(Table7.1, Fig.7.1)**. The decrease in grain yield with increase in doses of irrigation could be ascribed to the fact that opportunity of leaching of nutrient is increased when irrigation is increased. The field study reported by Balasubraminan (2002), Bali & Uppal (1995) Beldar et al. (2004), Bisht et al. (1991), Bodruzzaman et al. (2002), Dawe et al. (2003), Gijsman et al. (2002), Hariom et al. (1997), Hariom et al.

(1998), Hundal and Kaur (1999), Jones et al. (2003), Monte et al. (2002), Manish et al. (2003), Meena et al. (2002), Nain et al. (1999), Pang et al. (1997), Saseendran et al. (1998), Sextone et al. (1996), Sharma et al (2002), Surek et al. (1998), Timisina et al. (1998), Zamen et al.(2002) and Zhang et al.(2004) also confirmed this results.

7.1.2 Straw Yield

The average straw yield recorded was 4968.5 kgs/ha. This was influenced by irrigation dose and farm yard manure (FYM) dose. The increase of irrigation recorded decrease in the straw yield progressively. Similarly FYM application recorded noticed an increasing trend in straw yield marginally. Under the rainfed condition application of FYM did not yield any response to straw yield. The straw yield response at 1320-mm irrigation was lowest (3003.0 kgs/ha)(**Table7.1, Fig.7.2**). The decrease in straw yield with increase in doses of irrigation could be ascribed to the fact that opportunity of leaching of nutrient is increased and nitrogen uptake is decreased when irrigation is increased. Use of organic amendments is generally seen as a key issue for soil health improvement and sustainability in the intensive rice based cropping system in terms of supplying important micronutrients. Similar trend was reported by Hariom et al. (1997), Hariom et al. (1998), Jones et al. (2003), Manish et al. (2003), and Surek et al. (1999).

7.1.3 Biomass

The average biomass yield recorded was 10,800.0 kgs/ha. This was influenced by irrigation and farmyard manure (FYM) application. Progressive increase in the applications of irrigation recorded progressive decrease in the biomass production. Similarly FYM addition recorded an increased biomass production. Under the rainfed condition application of FYM did not yield any significant response to biomass production. The biomass production at 1320-mm irrigation was lowest (8942.0 kgs/ha) (**Table7.1, Fig.7.3**). The decrease in biomass with increase in doses of irrigation could be ascribed to the fact that opportunity of leaching of nutrient is increased and nitrogen uptake is decreased. Increased biomass production with organic manuring and irrigation has also been reported by Hariom et al. (1997), Hariom et al. (1998), Jones et al. (2003), Manish et al. (2003), Surek et al. (1999).

7.1.4 Harvest Index (HI)

The DSSAT model calculated harvest index taking only 86% of the grain yield and 100 % straw yield. The average harvest index was 0.544. This was influenced by irrigation dose and farm yard manure (FYM) dose. Increasing the applications of irrigation recorded increased the harvest index **(Table7.1, Fig.7.4).** On the contrary progressive increase in FYM application recorded a decreased harvest index. Under the rainfed condition application of FYM did not affect the harvest index. This trend could be attributed to the opportunity of transforming biomass into grain yield being different in irrigation and FYM treatments.

7.2 DSSAT RESPONSE TO IRRIGATION AND ORGANIC MANURING ON WATER BALANCE

The DSSAT response to water balances in the form of evapotranspiration, runoff and drainage that took place during the whole crop period. This is discussed in the forthcoming paragraph.

7.2.1 Total Evapotranspiration

The average of total evapotranspiration recorded was 472.0mm **(Table 7.1, Fig. 7.5).** This was low in rainfed and high in irrigated treatments. There was no influence of FYM application. The expression of such a trend by the model is not natural. Under normal condition adding FYM increases biomass production, therefore crop evapotranspiration could also increase. The daily actual evapotranspiration predicted by DSSAT (water balance file) showed that maximum evapotranspiration took place from panicle initiation to end of leaf growth stage and then it started decline due to decrease in leaf area index (LAI). Evaporation and evapotranspiration are basic components of hydrologic cycle. There is a number of climatic parameter that affect the rate of evaporation and evapotranspiration. Such results are also confirmed by Bandyopadhya (1997), De Datta (1981), Doornbos et al (1997), Eitzingera et al. (2002), Eitzingera et al. (2003), and Zhang et al. (2004).

7.2.2 Total Runoff

The average of total runoff recorded was 101.0mm. This shows that shows under the soil and climatic condition of Roorkee there was no appreciable difference in total runoff with respect to irrigation depth. This is because of model limitation that when irrigation water is applied, it is assumed to infiltrate. Predicted runoff was due to the daily precipitation > 0.2 times retention capacity. The small variation in runoff at different depths of irrigation could be due to the change of soil properties due to increased depth of irrigation. Also, adding the FYM showed no significant effect on total runoff **(Table7.1, Fig.7.6)**. These results are also in conformity with Etizinger (2003), Faria et al. (2003), Singh et al. (1999), SCS (1972).

7.2.3 Total Drainage (S&P)

The average of total drainage recorded was 760.0mm. This was influenced by irrigation dose and farm yard manure (FYM) dose. Higher the application of irrigation increased in the total drainage. Similarly FYM application showed no significant effect on total drainage. Under the rainfed condition application of FYM did not yield any response on drainage. However when irrigation dose is increased to 1320 mm the total drainage was highest (1394.0 mm). **Table 7.1 and Fig.7.7** shows that under the soil and climatic condition of Roorkee there was appreciable effect of irrigation depths on total drainage. The increase in total drainage with increase in doses of irrigation could be ascribed to the fact that opportunity of seepage and percolation was more. Bandyopadhya (1997), Eitzingera et al. (2003), Faria et al. (2003) Singh et al (1999) Yoon et al. (2002) also reported increased drainage with increased in irrigation depth.

7.3 DSSAT RESPONSE TO IRRIGATION AND ORGANIC MANURING ON NITROGEN BALANCE

DSSAT response to the nitrogen balance in the form of nitrogen uptake and nitrogen leaching. This is discussed in the forth-coming paragraph.

7.3.1 NITROGEN UPTAKE

The average of total nitrogen uptake was 112.0 kgs/ha. This was influenced by irrigation dose and farm yard manure (FYM) dose. The application of irrigation recorded decrease in the total nitrogen uptake progressively. Under the rainfed condition application of FYM did not yield any response to nitrogen uptake. However when the irrigation doses is increased to 1320 mm the total nitrogen uptake goes lowest (67.0 kgs/ha) at no organic manuring treatment. However adding the FYM recorded progressive increase in total nitrogen uptake **(Table7.1, Fig. 7.7)**. These results were also inconfirmity with the reports of Manish et al. (2003), Saren et al. (1999), Sextone et al.

(1996), Sharma et al. (2002), Surekha et al. (1999), Suren et.al (1999), Zamen et al. (2002).

7.3.2 NITROGEN LEACHED

The average of total nitrogen leached was 51.0 kgs/ha. This was influenced by irrigation dose and farm yard manure (FYM) dose. The application of irrigation recorded increase in the total nitrogen leached progressively. Under the rainfed condition application of FYM did not yield any response. However when the irrigation doses is increased to 1320 mm the total nitrogen leached goes to the highest (91.0 kgs/ha. However adding the FYM recorded progressive decrease in total nitrogen uptake **(Table7.1, Fig.7.9)**. The increase in total nitrogen leached with increase in doses of irrigation could be ascribed to the fact that opportunity leaching beyond rootzone increases when irrigation is increased. Similar results are also reported by Lars et al. (2002), Pang et al. (2002), Saren et al. (1999), Sextone et al. (1996), Sharma et al. (2002), Surekha et al. (1999) Yoon et al (2003).

Table 7.1 : Showing yield,water balance,and nitrogen balance under the influence of irrigation and organic manuring in rice cv HR 6444 as predicted by DSSAT.

Treatment	DSSAT Predictions																
	Yield (Kgs/ha)				Water balance (mm)							Nitrogen balance (N-Kgs/ha)					
	Grain yield	Straw	Biomass	Harvest Index	Initial soil water	Total rainfall	Total Irrigation	Evapotranspiratio	Total runoff	Total drainage	Final soil water	Initial soil nitrogen	Nitrogen added		Nitrogen Uptake	Nitrogen Leached	Final soil nitrogen
													Fertilizer	Organic			
I0F0	6731	6444	12233	0.473	226	602	0	428	97	187	116	3579.52	117	0	137	18	3541.52
I0F1	6758	6516	12329	0.471	226	602	0	426	96	188	118	3579.52	117	17.2	139	17	3557.72
I0F2	6736	6478	12271	0.472	226	602	0	425	96	189	118	3579.52	117	34.4	140	16	3574.92
I0F3	6670	6421	12157	0.472	226	602	0	421	96	193	118	3579.52	117	51.6	139	16	3593.12
Average	6723.75	6465	12248	0.47	226	602	0	425	96	189	118	3580	117	26	139	17	3567
I1F0	7526	4954	11426	0.566	226	602	440	489	104	509	166	3579.52	117	0	114	44	3538.52
I1F1	7891	5300	12086	0.561	226	602	440	490	104	509	165	3579.52	117	17.2	125	41	3547.72
I1F2	7991	5364	12236	0.562	226	602	440	490	104	510	164	3579.52	117	34.4	128	37	3565.92
I1F3	7343	5414	12245	0.558	226	602	440	489	104	511	164	3579.52	117	51.6	130	37	3581.12
Average	7687.75	5258	11998	0.562	226	602	440	490	104	510	165	3580	117	26	124	40	3558
I2F0	5939	3663	8770	0.582	226	602	880	489	103	947	169	3579.52	117	0	82	76	3538.52
I2F1	6606	4277	9958	0.570	226	602	880	488	102	949	169	3579.52	117	17.2	97	69	3547.72
I2F2	6911	4565	10508	0.566	226	602	880	488	102	950	168	3579.52	117	34.4	105	63	3562.92
I2F3	7067	4735	10812	0.562	226	602	880	486	102	951	169	3579.52	117	51.6	111	58	3579.12
Average	6630.75	4310	10012	0.570	226	602	880	488	102	949	169	3580	117	26	99	67	3557
I3F0	5048	3003	7344	0.591	226	602	1320	483	100	1390	175	3579.52	117	0	67	91	3538.52
I3F1	5834	3775	8792	0.571	226	602	1320	486	101	1391	170	3579.52	117	17.2	84	84	3545.72
I3F2	6301	4157	9575	0.566	226	602	1320	485	101	1392	170	3579.52	117	34.4	94	76	3560.92
I3F3	6546	4429	10058	0.560	226	602	1320	485	101	1394	168	3579.52	117	51.6	101	70	3577.12
Average	5932	3841	8942	0.572	226	602	1320	485	101	1392	171	3580	117	26	87	80	3556
Overall Average	6743.75	4968.5	10800	0.544	226	602	660	472	101	760	155	3580	117	26	112	51	3563

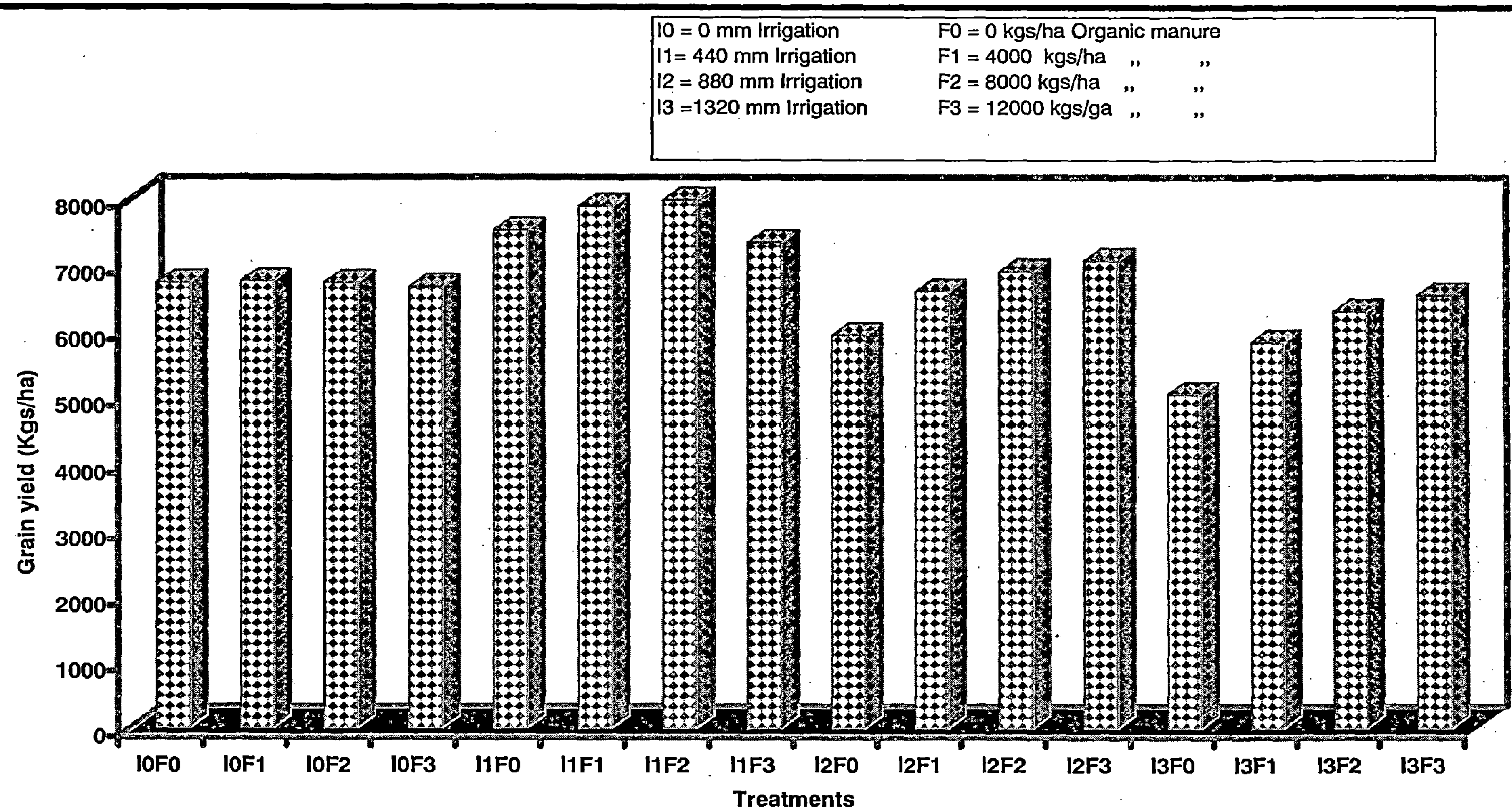

Fig.7.1:Showing grain yield as influeced by irrigation and Organic manuring in Hybrid rice cv HR 6444 as predicted by DSSAT3.5.

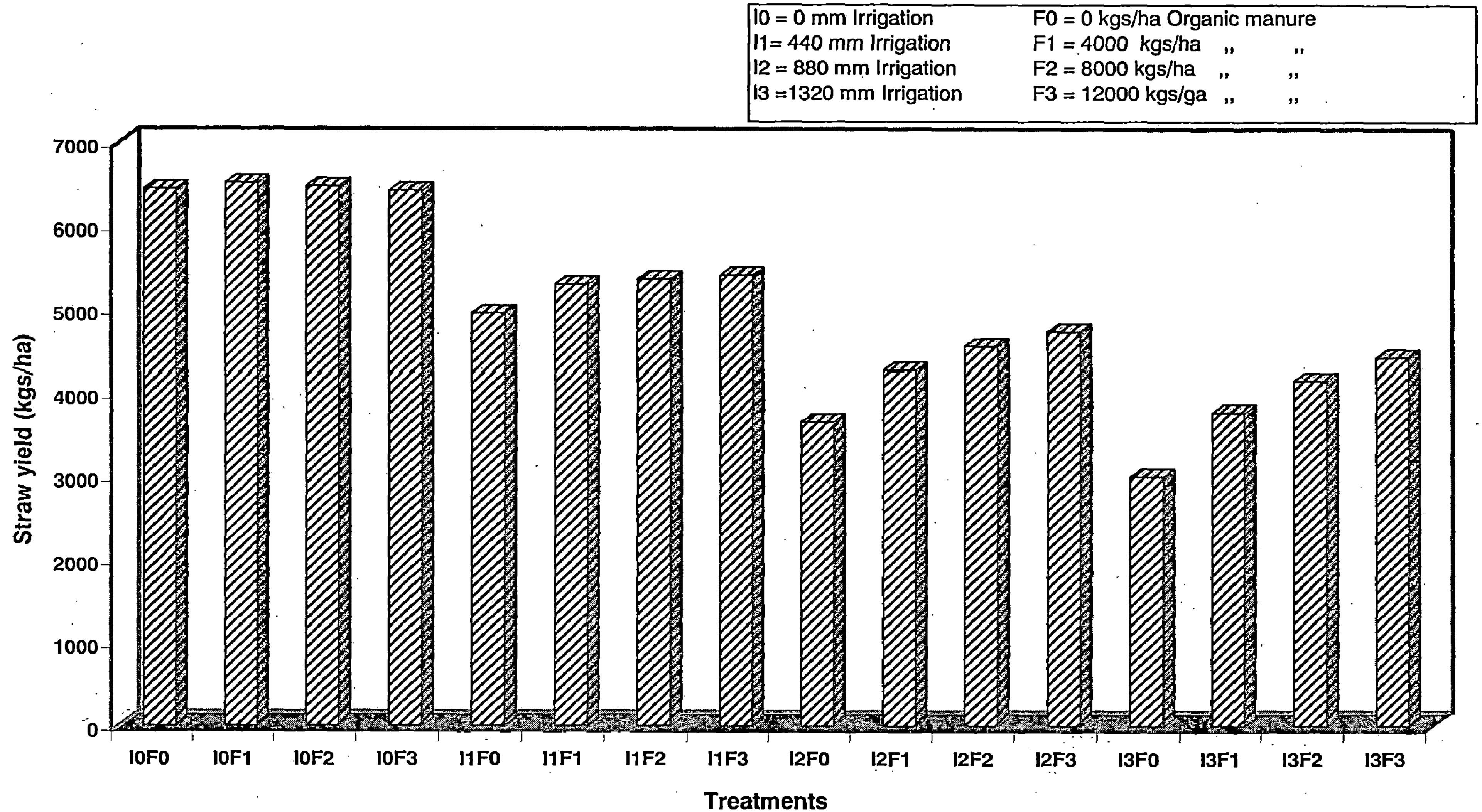

Fig.7.2: Showing Straw yield as influnced by irrigation and organic manuring in Hybrid rice cv HR6444 as predicted by DSSAT3.5

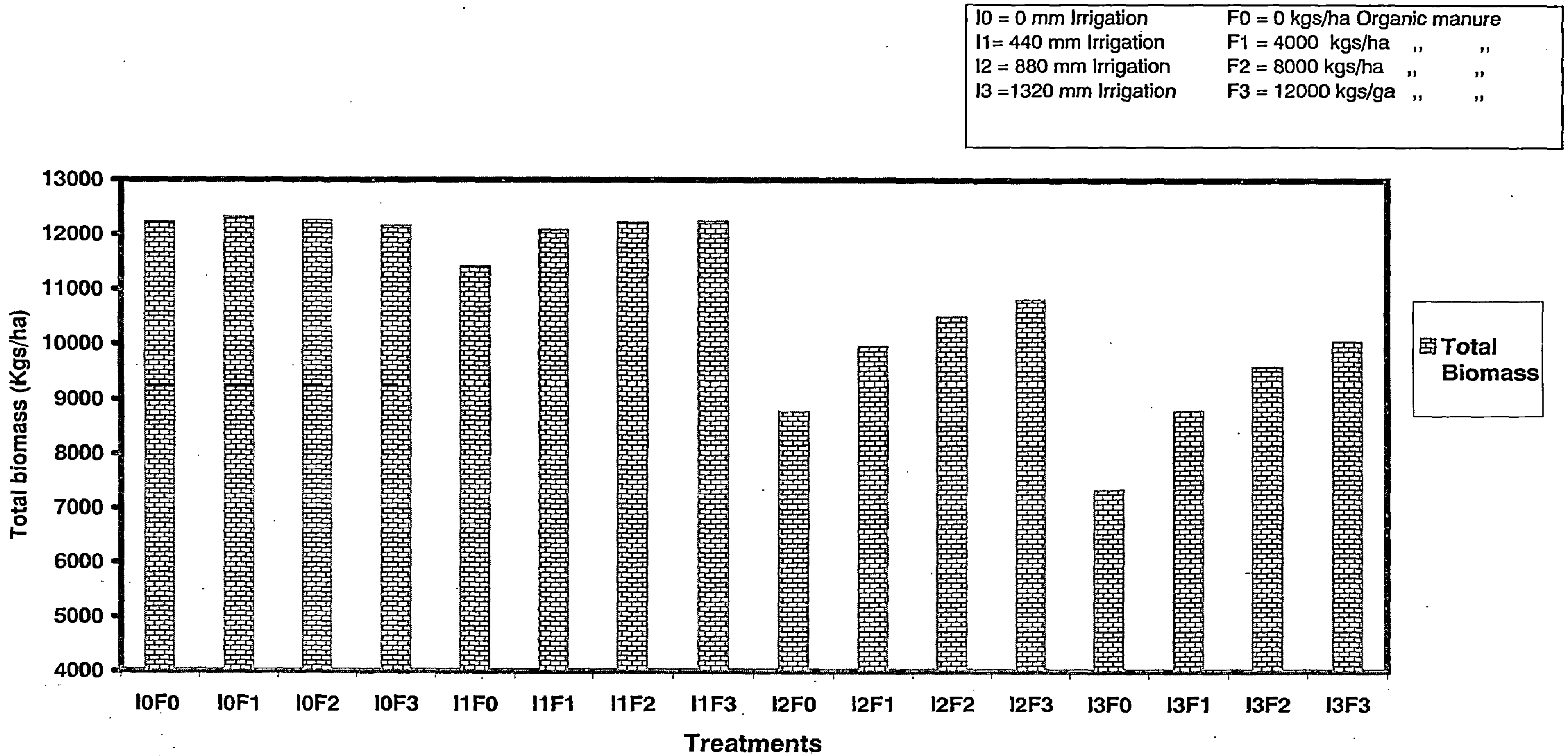

Fig.7.3: Showing total biomass as influenced by irrigation and organic manuring in hHybrid rice cv HR6444 as predicted by DSSAT3.5

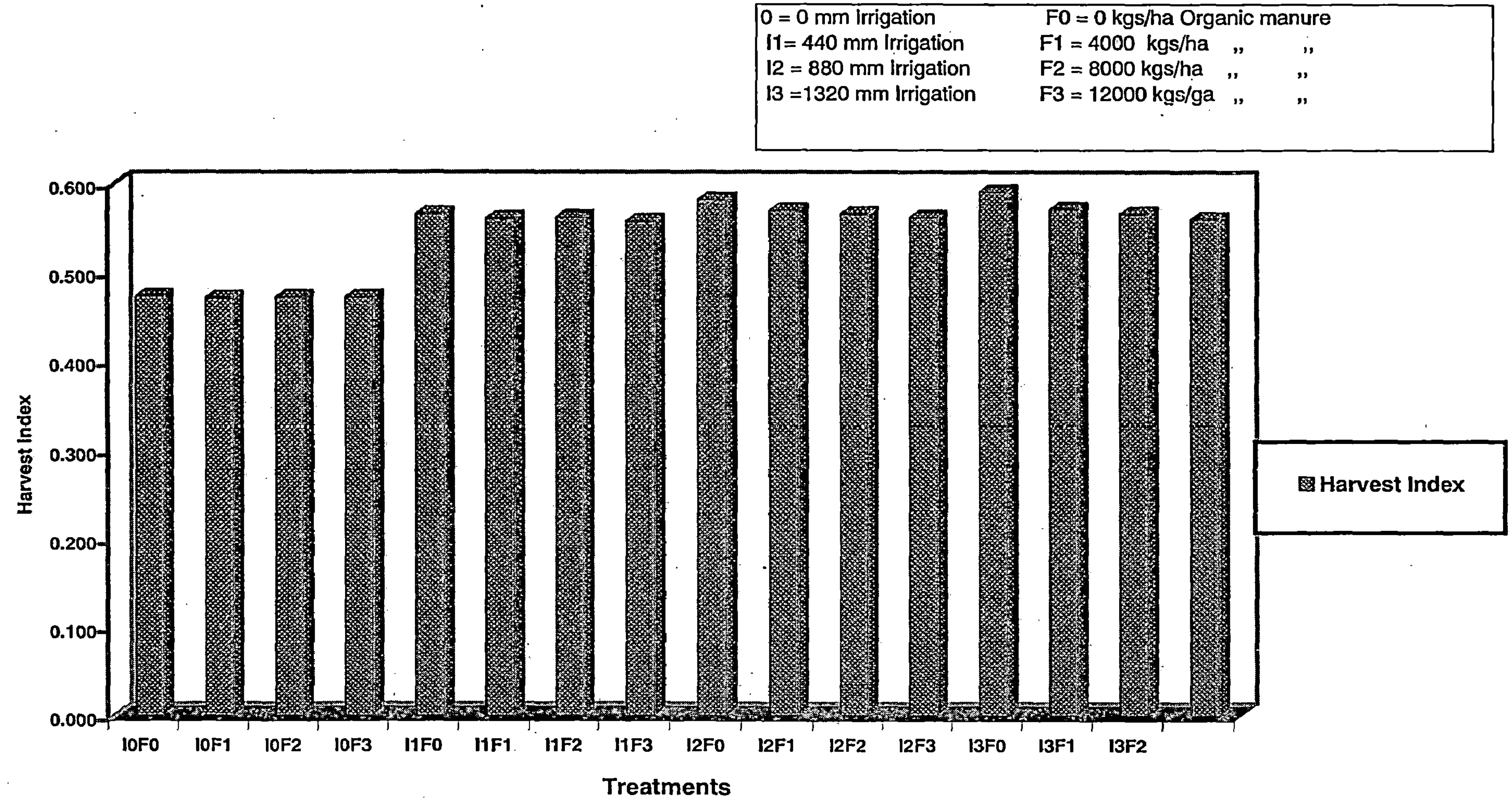

Fig.7.4: Showing Harvest Index as influnced by irrigation and organic manuring in Hybrid rice cv HR6444 as predicted by DSSAT3.5

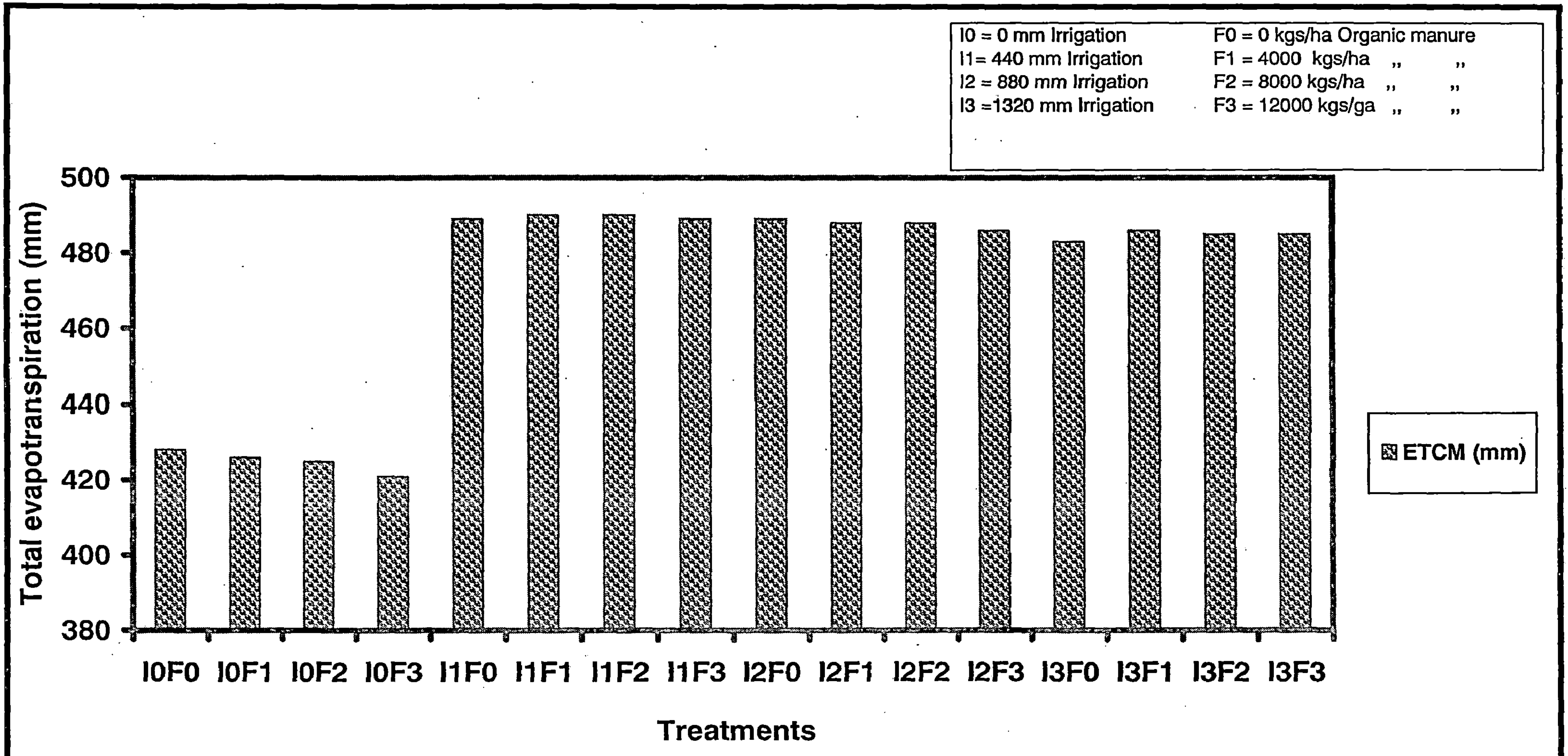

Fig.7.5 Showing total evapotranspiration as influenced by irrigation and organic manuring in Hybrid rice cv HR6444 as predicted by DSSAT 3.5.

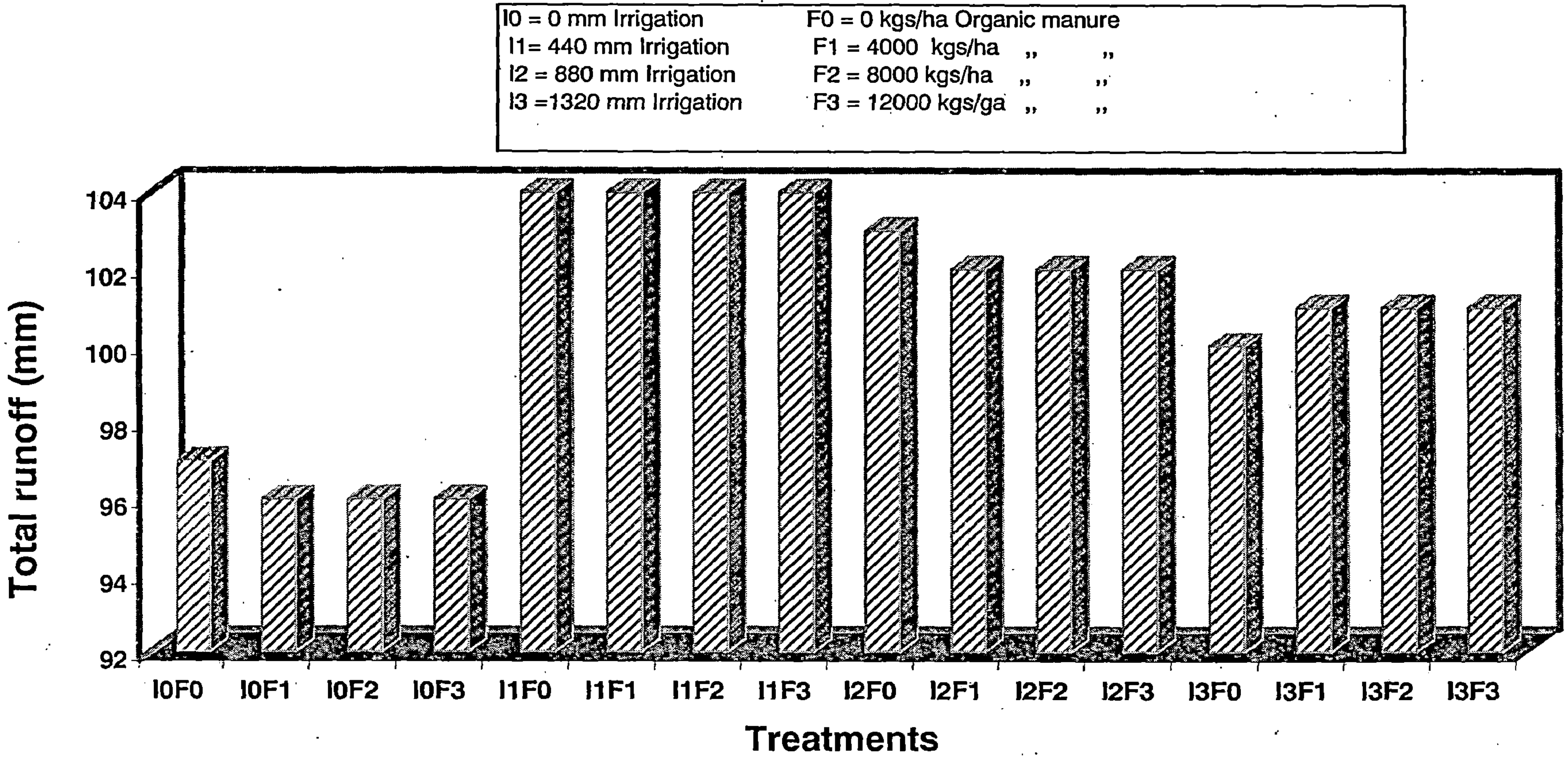

Fig.7.6: Showing total runoff as influeced by irrigation and organic manuring in hybrid rice cv HR6444 as predicted by DSSAT3.5

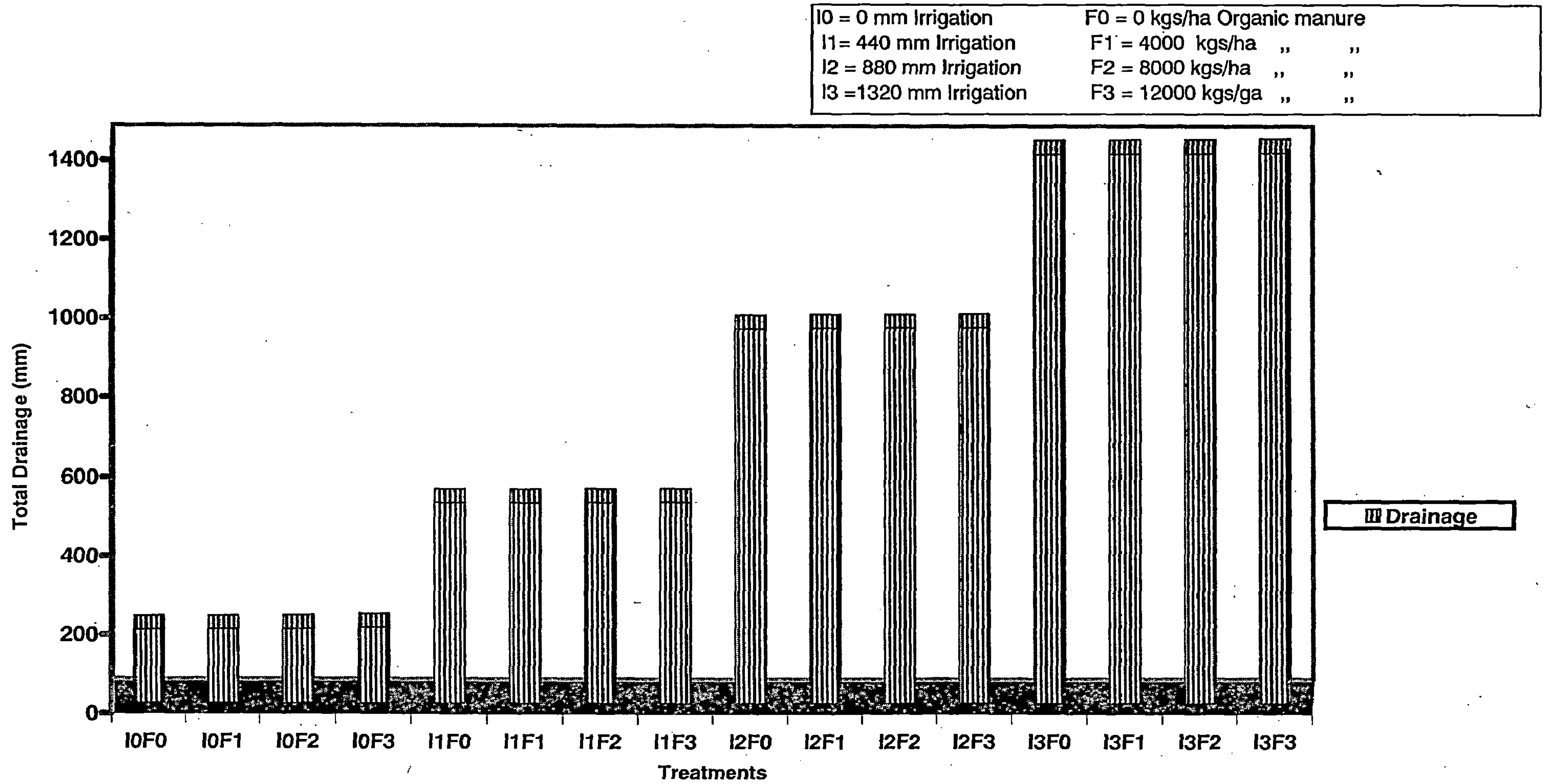

Fig.7.7: Showing total drainage as influenced by irrigation and organic manuring in Hybrid rice cv HR6444 as predicted by DSSAT3.5

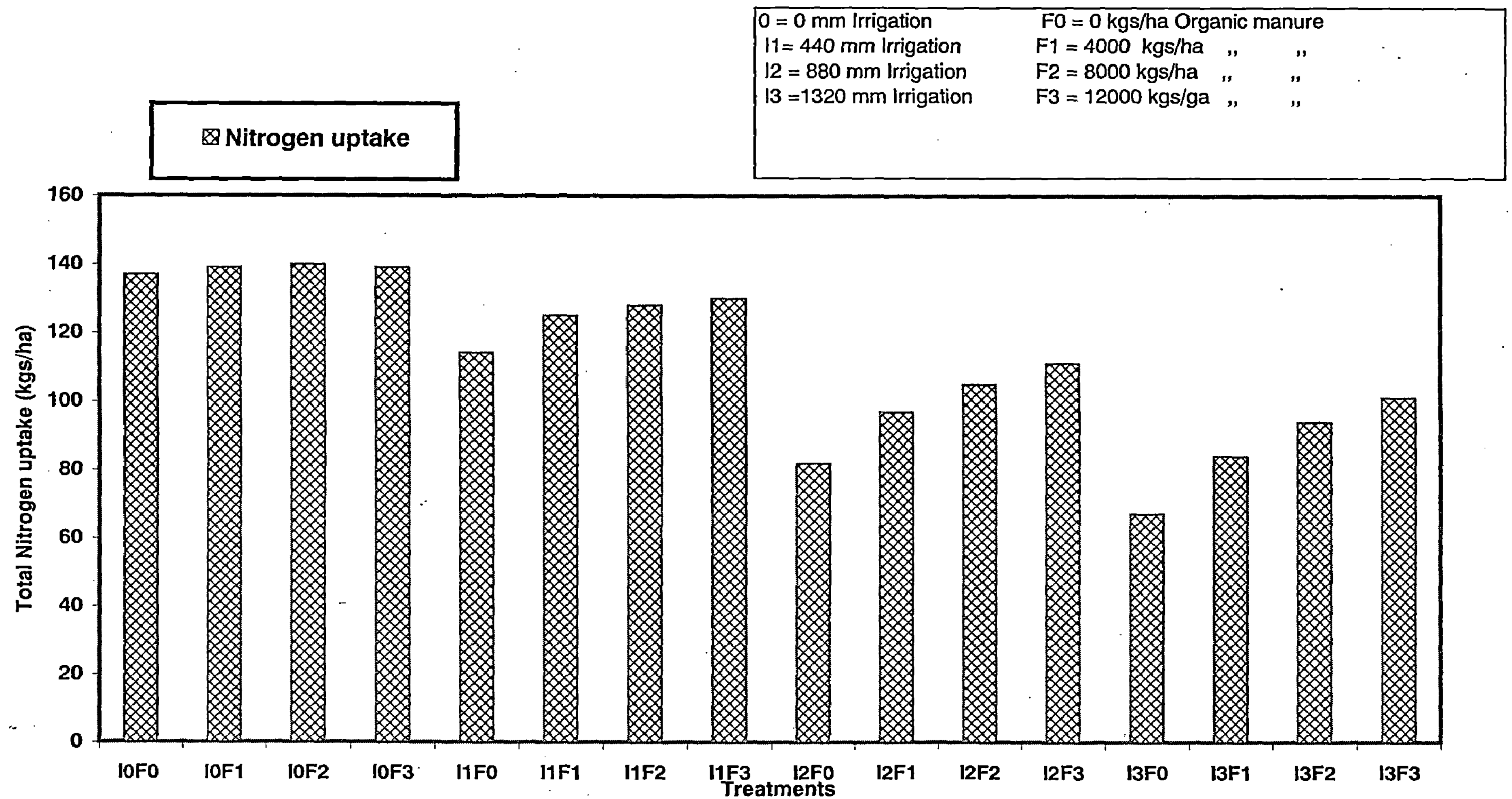

Fig.7.8: Showing total nitrogen uptake as influenced by irrigation and organic manuring in hybrid rice cv HR6444 as predicted by DSSAT3.5

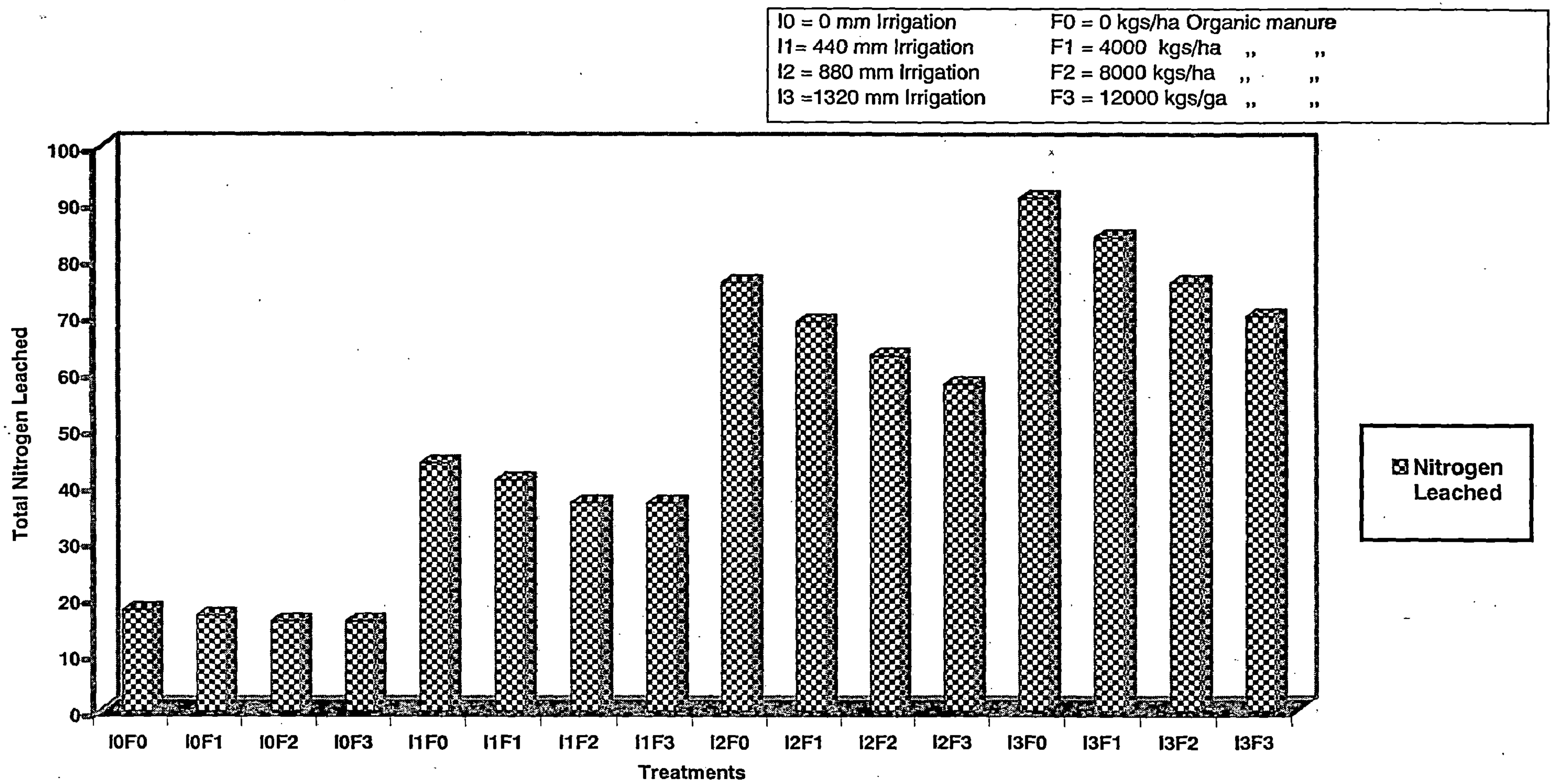

Fig.7.9: Showing total nitrogen leached as influeced by irrigation and organic manuring in Hybrid rice cv HR6444 as predicted by DSSAT3.5

CHAPTER-8

SUMMARY AND CONCLUSIONS

Rice *(Oryza sativa L.)* is the most important crop of India and second most important crop of the world. More than 90% of the world rice production is from Asia. It is also one of the important cereals both for human and animals consumption. It is estimated that 40% of the world population use rice as major source of calories. Now adays rice has become the symbol of cultural identity and global unity. The year 2004 is declared as ***"RICE YEAR"*** by FAO. Hybrid rice occupies a special status owing to its high yield, excellent cooking and eating qualities. Rice seedling from the nursery can be transplanted to the field when the mean daily temperature is about 13^0–15^0 C. Weather variable affects the crop growth differently in different phenophase during its growth. Temperature between 20^0– 30^0 C is required for good growth at all stages but during flowering and yield formation small difference between day and night temperatures are required for good yield. The total growing period normally varies between 90 – 150 days depending on variety, temperature and sensitivity to day length.

Crop modeling and systems analysis have become important tools in modern agricultural research. A crop model synthesizes our insights into the physiological and ecological processes that govern crop growth into mathematical equations. Modeling, especially crop simulation models for rice explains this process by quantifying each process of the system. The development of crop growth simulation model is a natural progression of scientific research.

The **Decision Support System for Agrotechnology Transfer (DSSAT)** has been in use for more than 15 years by researchers in over 100 countries worldwide. DSSAT is a collection of computer programs integrated in to a single software package in order to facilitate the application of crop simulation model in research and decision-making. This software package was developed by IBSNAT (International Benchmark Sites Network for Agrotechnology Transfer) project. Inputting the users minimum data set, running the model and comparing the outputs accomplish crop model validation. In view of above a study entitled **"Application of Decision Support System for Agrotechnology Transfer on Hybrid rice"** was undertaken with the following objectives:

1. To generate field base data for use in DSSAT CERES-RICE model developed by IBSNAT.
2. To validate the actual field results with DSSAT CERES-RICE model.
3. To predict grain yield and yield attributes, nitrogen uptake, nitrogen leaching, evapotranspiration, soil moisture condition using validated DSSAT-RICE model under different agronomical management conditions of rice cv. HR-6444.

Field experiment during kharif season 2003 was conducted in Randomized Block Design with four treatment of organic manure (F0=0kg/ha, F1=4000 kg/ha, F2=8000kg/ha, F3=12000kg/ha) and 3 replications. Irrigation was applied uniformly and total amount applied was 880mm at different phonological development stages, at **Demonstration Farm of WRDTC, IIT Roorkee,** to generate the base data required for the use in **DSSAT vs 3.5 CERES- RICE** model. The crop was transplanted on 2nd July. Seedlings were 28 days old. Crop was harvested on 23 rd October 2003. There were four organic manuring treatments viz. F1, F2, F3 & F4. Other practices were common at all the treatments. The minimum input data required from the field experiments are plot details, treatments, cultivars, fields, soil analysis, initial condition, planting detail, irrigation and water management, fertilizers detail residue and other organic materials, harvested details, weather data, grain yield and yield attributes were collected from the field. The DSSAT was run and the result validated.

The field result showed that the average grain yield was 6535.8 kg/ha where as the DSSAT crop model also predicted the grain yield of 6630.8 kg/ha. This implies that the model has predicted in an acceptable limit. The predicted yield attributes and other development variables such as wt. per grain, flowering date, physiological maturity date, grain no./m2, biomass at harvest maturity etc, predicted by the DSSAT model was also compared and found with in the acceptable limit although these were on higher side than the actual field results. The extent of variability in actually observed and DSSAT predicted result was well with in acceptable limit. Therefore the DSSAT model in case of predicting grain yield of rice cv HR 6444 in the soil climatic conditions of Roorkee be treated as validated.

The validated program was further extended under different agronomic practices:4 depths of irrigation i.e.I0= no irrigation but rainfed, I1=440mm irrigation, I2=880mm irrigation & I3=1320mm irrigation and 4 doses of organic manuring i.e. F0= no FYM, F1=4,000kgs/ha FYM, F2=8,000kgs/ha FYM and F3=12,000kgs/ha FYM.Grain yield, strawyield, total biomass, harvest index, total crop evapotranspiration, runoff, drainage of water, nitrogen uptake,and nitrogen leaching were predicted under different doses of irrigation and organic manuring.These results obtained are summarized as below:

- Application of irrigation up to 440mm over and above the residual moisture and rainfall predicted increased grain yield but further increase in irrigation predicted reduced grain yield. The total drainage increased with increasing irrigation depths, but the seasonal run-off however remained unaffected.
- Increasing the dozes of organic manure recorded increases in the grain yield, nitrogen uptake but nitrogen leaching, cumulative evapotranspiration, seasonal run-off, and total drainage remained unaffected.

Keeping in view the above findings, it is concluded that DSSAT can satisfactorily predict the yield of hybrid rice cv HR 6444 in the soil climate condition of Roorkee. Also the ideal agronomic practice to cultivate rice cv HR 6444 in the soil climate condition of Roorkee could be evolved using this Decision Support system.

However, further studies with different aspects of management can be carried out at different sites to validate the accuracy and reliability of the DSSAT crop model. For accuracy one has to give more attention during field observation. This is very useful to planner to forecast crop yield to enable the government to take policy decision on advance planning of internal food distribution, relief measures and grain storage etc.

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ANNEXURE-I

*EXPERIMENTAL DETAILS CODES

```
! Headers used in the @ line to identify variables are listed first, codes to
! identify methods, chemicals, etc. are listed next in sections that relate to
! specific aspects (Chemicals;Crop and weed species;Diseases and pests;Drainage;
! Environment modification factors;Fertilizers,inoculants and amendments;
! Harvest components;Harvest size categories;Methods-fertilizer and chemical
! applications;Methods-irrigation and water management;Methods-soil analysis;
! Planting materials;Plant distribution;Residues and organic fertilizers;
! Rotations;Soil texture;and Tillage implements).
!
! The fields in the file are as follows:
!  CDE   The 'universal' code used to facilitate data interchange.
!  DESCRIPTION  A description of the code, with units.
!  SO    The source of the codes (IB=IBSNAT). Codes added by a user should be
!        referenced in this field and the name and address of the person adding
!        the code should be entered as a comment (ie.with a '!' in column 1)
!        below this note. This is important to ensure that information from
!        different workers can be easily integrated. Users adding codes should
!        also ensure that those constructed by adding a number to a section
!        code (eg.FE001,CH001) are clearly identified with a letter in the third
!        position (eg.FEK01 for a fertilizer code added by someone with a family
!        name beginning with K).
```

***Headers**

@CDE	DESCRIPTION	SO
ADDRESS	Contact address of principal scientist	IB
C	Crop component number (default = 1)	IB
CDATE	Application date, year + day or days from planting	IB
CHAMT	Chemical application amount, kg ha-1	IB
CHCOD	Chemical material, code	IB
CHDEP	Chemical application depth, cm	IB
CHME	Chemical application method, code	IB
CHNOTES	Chemical notes (Targets, chemical name, etc.)	IB
CNAME	Cultivar name	IB
CNOTES	Cultivar details (Type, pedigree, etc.)	IB
CR	Crop code	IB
CU	Cultivar level	IB
ECO2	CO2 adjustment, A,S,M,R + vpm	IB
EDATE	Emergence date, earliest treatment	IB
EDAY	Daylength adjustment, A,S,M,R + h	IB
EDEW	Humidity adjustment, A,S,M,R + oC	IB
EMAX	Temperature (maximum) adjustment, A,S,M,R + oC	IB
EMIN	Temperature (minimum) adjustment, A,S,M,R + oC	IB
ERAD	Radiation adjustment, A,S,M,R + MJ m-2day-1	IB
ERAIN	Precipitation adjustment, A,S,M,R + mm	IB
EWIND	Wind adjustment, A,S,M,R + km day-1	IB
FACD	Fertilizer application/placement, code	IB
FAMC	Ca in applied fertilizer, kg ha-1	IB
FAMK	K in applied fertilizer, kg ha-1	IB
FAMN	N in applied fertilizer, kg ha-1	IB
FAMO	Other elements in applied fertilizer, kg ha-1	IB
FAMP	P in applied fertilizer, kg ha-1	IB
FDATE	Fertilization date, year + day or days from planting	IB
FDEP	Fertilizer incorporation/application depth, cm	IB
FL	Field level	IB
FLDD	Drain depth, cm	IB
FLDS	Drain spacing, m	IB

FLDT	Drainage type, code	IB
FLOB	Obstruction to sun, degrees	IB
FLSA	Slope and aspect, degrees from horizontal plus direction (W, NW, etc.	IB
FLST	Surface stones (Abundance, % + Size, S,M,L)	IB
FMCD	Fertilizer material, code	IB
FOCD	Other element code, e.g.,. MG	IB
HAREA	Harvest area, m-2	IB
HARM	Harvest method	IB
HCOM	Harvest component, code	IB
HDATE	Harvest date, year + day or days from planting	IB
HL	Harvest level	IB
HLEN	Harvest row length, m	IB
HPC	Harvest percentage, %	IB
HRNO	Harvest row number	IB
HSIZ	Harvest size group, code	IB
HSTG	Harvest stage	IB
IAME	Method for automatic applications, code	IB
IAMT	Amount per automatic irrigation if fixed, mm	IB
IC	Initial conditions level	IB
ICBL	Depth, base of layer, cm	IB
ICDAT	Initial conditions measurement date, year + days	IB
ICND	Nodule weight from previous crop, kg ha-1	IB
ICRE	Rhizobia effectiveness, 0 to 1 scale	IB
ICRN	Rhizobia number, 0 to 1 scale	IB
ICRT	Root weight from previous crop, kg ha-1	IB
IDATE	Irrigation date, year + day or days from planting	IB
IDEP	Management depth for automatic application, cm	IB
ID_FIELD	Field ID (Institute + Site + Field)	IB
ID_SOIL	Soil ID (Institute + Site + Year + Soil)	IB
IEFF	Irrigation application efficiency, fraction	IB
IEPT	End point for automatic appl., % of max. available	IB
INGENO	Cultivar identifier	IB
IOFF	End of automatic applications, growth stage	IB
IROP	Irrigation operation, code	IB
IRVAL	Irrigation amount, depth of water/watertable, etc., mm	IB
ITHR	Threshold for automatic appl., % of max. available	IB
MC	Chemical applications level	IB
ME	Environment modifications level	IB
MF	Fertilizer applications level	IB
MH	Harvest level	IB
MI	Irrigation level	IB
MP	Planting level	IB
MR	Residue level	IB
MT	Tillage level	IB
NOTES	Notes	IB
O	Rotation component - option (default = 1)	IB
ODATE	Environmental modification date, year + day or days from planting	IB
PAGE	Transplant age, days	IB
PAREA	Gross plot area per rep, m-2	IB
PCR	Previous crop code	IB
PDATE	Planting date, year + days from Jan. 1	IB
PENV	Transplant environment, ~C	IB
PEOPLE	Names of scientists	IB
PLAY	Plot layout	IB
PLDP	Planting depth, cm	IB
PLDR	Plots relative to drains, degrees	IB
PLDS	Planting distribution, row R, broadcast B, hill H	IB
PLEN	Plot length, m	IB
PLME	Planting method, code	IB
PLOR	Plot orientation, degrees from N	IB
PLPH	Plants per hill (if appropriate)	IB

PLRD	Row direction, degrees from N	IB
PLRS	Row spacing, cm	IB
PLSP	Plot spacing, cm	IB
PLWT	Planting material dry weight, kg ha-1	IB
PPOE	Plant population at emergence, m-2	IB
PPOP	Plant population at seeding, m-2	IB
PRNO	Rows per plot	IB
R	Rotation component - number (default = 1)	IB
RACD	Residue application/placement, code	IB
RAMT	Residue amount, kg ha-1	IB
RCOD	Residue material, code	IB
RDATE	Incorporation date, year + days	IB
RDEP	Residue incorporation depth, cm	IB
RDMC	Residue dry matter content, %	IB
RESK	Residue potassium concentration, %	IB
RESN	Residue nitrogen concentration, %	IB
RESP	Residue phosphorus concentration, %	IB
RINP	Residue incorporation percentage, %	IB
SA	Soil analysis level	IB
SABD	Bulk density, moist, g cm-3	IB
SABL	Depth, base of layer, cm	IB
SADAT	Analysis date, year + days from Jan. 1	IB
SAHB	pH in buffer	IB
SAHW	pH in water	IB
SAKE	Potassium, exchangeable, cmol kg-1	IB
SANI	Total nitrogen, g kg-1	IB
SAOC	Organic carbon, g kg-1	IB
SAPX	Phosphorus, extractable, mg kg-1	IB
SH20	Water, cm3 cm-3	IB
SITE(S)	Name and location of experimental site(s)	IB
SLDP	Soil depth, cm	IB
SLTX	Soil texture	IB
SM	Simulation control level	IB
SMHB	pH in buffer determination method, code	IB
SMKE	Potassium determination method, code	IB
SMPX	Phosphorus determination method, code	IB
SNH4	Ammonium, KCl, g elemental N Mg-1 soil	IB
SNO3	Nitrate, KCl, g elemental N Mg-1 soil	IB
TDATE	Tillage date, year + day	IB
TDEP	Tillage depth, cm	IB
TIMPL	Tillage implement, code	IB
TL	Tillage level	IB
TN	Treatment number	IB
TNAME	Treatment name	IB
WSTA	Weather station code (Institute + Site)	IB

***Chemicals (Herbicides, Insecticides, Fungicides, etc.)**

@CDE	DESCRIPTION	SO
CH001	Alachlor (Lasso), Metolachlor (Dual) [Herbicide]	IB
CH002	Propanil [Herbicide]	IB
CH003	Trifluralin [Herbicide]	IB
CH004	Dalapon [Herbicide]	IB
CH005	MCPA [Herbicide]	IB
CH006	2,4-D [Herbicide]	IB
CH007	2,4,5-T [Herbicide]	IB
CH008	Pendimethalin [Herbicide]	IB
CH009	Atrazine [Herbicide]	IB
CH010	Diquat [Herbicide]	IB
CH011	Paraquat [Herbicide]	IB
CH021	Carbaryl, Sevin, Septene [Insecticide]	IB
CH022	Malathion, Mercaptothion [Insecticide]	IB

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CH023  Naled [Insecticide]                                        IB
CH024  Dimethoate [Insecticide]                                   IB
CH025  Fention [Insecticide]                                      IB
CH026  Diazinon, Basudin [Insecticide]                            IB
CH027  Ethion, Diethion [Insecticide]                             IB
CH028  Oxydemeton-Methyl [Insecticide]                            IB
CH029  Azinphos-Methyl [Insecticide]                              IB
CH030  Phosphamidon [Insecticide]                                 IB
CH031  Mevinphosl [Insecticide]                                   IB
CH032  Methyl Parathion [Insecticide]                             IB
CH033  Parathion [Insecticide]                                    IB
CH034  DDT [Insecticide]                                          IB
CH035  BHC, HCH [Insecticide]                                     IB
CH036  Chlordane [Insecticide]                                    IB
CH037  Heptachlor [Insecticide]                                   IB
CH038  Toxaphene [Insecticide]                                    IB
CH039  Aldrin [Insecticide]                                       IB
CH040  Dieldrin [Insecticide]                                     IB
CH041  Endrin, Nendrin [Insecticide]                              IB
CH042  Methomyl, Lannat [Insecticide]                             IB
CH043  Thiotex [Insecticide]                                      IB
CH044  Furadan [Insecticide]                                      IB
CH045  Endosulfan [Insecticide]                                   IB
CH051  Captan [Fungicide]                                         IB
CH052  Benomyl [Fungicide]                                        IB
CH053  Zineb [Fungicide]                                          IB
CH054  Maneb [Fungicide]                                          IB
CH055  Mancozeb [Fungicide]                                       IB
CH056  Tilt [Fungicide]                                           IB
CH057  Rhizobium (for legume crops)                               IB

*Crop and Weed Species
@CDE   DESCRIPTION                                                SO
AR     Aroid                                                      IB
AL     Alfalfa/Lucerne                                            IB
BA     Barley                                                     IB
BN     Dry bean                                                   IB
BS     Beet sugar                                                 IB
BW     Broad leaf weeds                                           IB
CO     Cotton                                                     IB
CS     Cassava                                                    IB
FA     Fallow                                                     IB
GW     Grass weeds                                                IB
ML     Pearl Millet                                               IB
MZ     Maize                                                      IB
OA     Oats                                                       IB
PN     Peanut                                                     IB
PT     Potato                                                     IB
RI     Rice                                                       IB
SB     Soybean                                                    IB
SC     Sugar Cane                                                 IB
SG     Grain sorghum                                              IB
ST     Shrubs/trees                                               IB
WH     Wheat                                                      IB

*Disease and Pest Organisms
@CDE   DESCRIPTION                                                SO
!Examples of codes that have been used are given below.           IB
CEW    Corn earworm (Heliothis zea), no. m-2                      IB
VBC    Velvetbean caterpillar (Anticarsia gemmatalis), no. m-2    IB
SBL    Soybean looper (Pseudoplusia includens), no. m-2           IB
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SKB    Southern green stinkbug (Mezara viridula), no. m-2        IB
RKN    Root-knot nematode (Meloidogyne spp.), no. cm-3 soil      IB
CUT    Cutworm, no. m-2                                          IB

*Drainage
@CDE   DESCRIPTION                                               SO
DR000  No drainage                                               IB
DR001  Ditches                                                   IB
DR002  Sub-surface tiles                                         IB
DR003  Surface furrows                                           IB

*Environment Modification Factors
@CDE   DESCRIPTION                                               SO
A      Add                                                       IB
S      Subtract                                                  IB
M      Multiply                                                  IB
R      Replace                                                   IB

*Fertilizers, Inoculants and Amendments
@CDE   DESCRIPTION                                               SO
FE001  Ammonium nitrate                                          IB
FE002  Ammonium sulfate                                          IB
FE003  Ammonium-nitrate-sulfate                                  IB
FE004  Anhydrous ammonia                                         IB
FE005  Urea                                                      IB
FE006  Diammnoium phosphate                                      IB
FE007  Monoammonium phosphate                                    IB
FE008  Calcium nitrate                                           IB
FE009  Aqua ammonia                                              IB
FE010  Urea ammonium nitrate solution                            IB
FE011  Calcium ammonium nitrate solution                         IB
FE012  Ammonium polyphosphate                                    IB
FE013  Single superphosphate                                     IB
FE014  Triple superphosphate                                     IB
FE015  Liquid phosphoric acid                                    IB
FE016  Potassium chloride                                        IB
FE017  Potassium nitrate                                         IB
FE018  Potassium sulfate                                         IB
FE019  Urea super granules                                       IB
FE020  Dolomitic limestone                                       IB
FE021  Rock phosphate                                            IB
FE022  Calcitic limestone                                        IB
FE024  Rhizobium                                                 IB
FE026  Calcium hydroxide                                         IB

*Harvest components
@CDE   DESCRIPTION                                               SO
C      Canopy                                                    IB
L      Leaves                                                    IB
H      Harvest product                                           IB

*Harvest size categories
@CDE   DESCRIPTION                                               SO
A      All                                                       IB
S      Small - less than 1/3 full size                           IB
M      Medium - from 1/3 to 2/3 full size                        IB
L      Large - greater than 2/3 full size                        IB

*Methods - Fertilizer and Chemical Applications
@CDE   DESCRIPTION                                               SO
AP000  Applied when required - no shortage                       IB
```

```
*Harvest size categories
@CDE    DESCRIPTION                                                    SO
A       All                                                            IB
S       Small - less than 1/3 full size                                IB
M       Medium - from 1/3 to 2/3 full size                             IB
L       Large - greater than 2/3 full size                             IB

*Methods - Fertilizer and Chemical Applications
@CDE    DESCRIPTION                                                    SO
AP000   Applied when required - no shortage                            IB
AP001   Broadcast, not incorporated                                    IB
AP002   Broadcast, incorporated                                        IB
AP003   Banded on surface                                              IB
AP004   Banded beneath surface                                         IB
AP005   Applied in irrigation water                                    IB
AP006   Foliar spray                                                   IB
AP007   Bottom of hole                                                 IB
AP008   On the seed                                                    IB
AP009   Injected                                                       IB
AP011   Brodcast on flooded/saturated soil, none in soil               IB
AP012   Brodcast on flooded/saturated soil, 15% in soil                IB
AP013   Brodcast on flooded/saturated soil, 30% in soil                IB
AP014   Brodcast on flooded/saturated soil, 45% in soil                IB
AP015   Brodcast on flooded/saturated soil, 60% in soil                IB
AP016   Brodcast on flooded/saturated soil, 75% in soil                IB
AP017   Brodcast on flooded/saturated soil, 90% in soil                IB
AP018   Band on saturated soil,2cm flood, 92% in soil                  IB
AP019   Deeply placed urea super granules/pellets, 95% in soil         IB
AP020   Deeply placed urea super granules/pellets, 100% in soil        IB

*Methods - Irrigation and Water Management (Units for associated data)
@CDE    DESCRIPTION                                                    SO
IR001   Furrow, mm                                                     IB
IR002   Alternating furrows, mm                                        IB
IR003   Flood, mm                                                      IB
IR004   Sprinkler, mm                                                  IB
IR005   Drip or trickle, mm                                            IB
IR006   Flood depth, mm                                                IB
IR007   Water table depth, mm                                          IB
IR008   Percolation rate, mm day-1                                     IB
IR009   Bund height, mm                                                IB
IR010   Puddling (for Rice only)                                       IB

*Methods - Soil Analysis
@CDE    DESCRIPTION                                                    SO
SA001   Olsen                                                          IB
SA002   Bray No. 1                                                     IB
SA003   Bray No. 2                                                     IB
SA004   Mehlich                                                        IB
SA005   Anion exchange resin                                           IB
SA006   Truog                                                          IB
SA007   Double acid                                                    IB
SA008   Colwell                                                        IB
SA009   Water                                                          IB
SA010   IFDC Pi strip                                                  IB
```

```
*Planting Material/Method
@CDE   DESCRIPTION                                                SO
PM001  Dry seed                                                   IB
PM002  Transplants                                                IB
PM003  Vegetative cuttings                                        IB
PM004  Pregerminated seed                                         IB

*Plant Distribution
@CDE   DESCRIPTION                                                SO
R      Rows                                                       IB
H      Hills                                                      IB
U      Uniform                                                    IB

*Residues and Organic Fertilizer
@CDE   DESCRIPTION                                                SO
RE001  Crop residue                                               IB
RE002  Green Manure                                               IB
RE003  Barnyard Manure                                            IB
RE004  Liquid Manure                                              IB


*Rotation
@CDE   DESCRIPTION                                                SO
RO001  Continuous arable crops                                    IB
RO002  Rotation with forages                                      IB

*Soil Texture
@CDE   DESCRIPTION                                                SO
CLOSA  Coarse loamy sand                                          IB
CSA    Coarse sand                                                IB
CSI    Coarse silt                                                IB
CSALO  Coarse sandy loam                                          IB
CL     Clay                                                       IB
CLLO   Clay loam                                                  IB
FLO    Fine loam                                                  IB
FLOSA  Fine loamy sand                                            IB
FSA    Fine sand                                                  IB
FSALO  Fine sandy loam                                            IB
SICLL  Silty clay loam                                            IB
LO     Loam                                                       IB
LOSA   Loamy sand                                                 IB
SA     Sand                                                       IB
SACL   Sandy clay                                                 IB
SACLL  Sandy clay loam                                            IB
SI     Silt                                                       IB
SICL   Silty clay                                                 IB
SILO   Silty loam                                                 IB
SALO   Sandy loam                                                 IB
VFLOS  Very fine loamy sand                                       IB
VFSA   Very fine sand                                             IB
VFSAL  Very fine sandy loam                                       IB

*Tillage Implements
@CDE   DESCRIPTION                                                SO
TI002  Tandem disk                                                IB
TI003  Offset disk                                                IB
TI004  Oneway disk                                                IB
TI005  Moldboard plow                                             IB
TI006  Chisel plow                                                IB
TI007  Disk plow                                                  IB
TI008  Subsoiler                                                  IB
```

TI009	Beeder/lister	IB
TI010	Field cultivator	IB
TI011	Row crop cultivator	IB
TI012	Harrow-springtooth	IB
TI013	Harrow-spike	IB
TI014	Rotary hoe	IB
TI015	Roto-tiller	IB
TI016	Row crop planter	IB
TI017	Drill	IB
TI018	Shredder	IB
TI019	Hoe	IB
TI020	Planting stick	IB
TI021	Animal-drawn implement	IB
TI022	Hand	IB
TI023	Manual hoeing	IB

ANNEXURE-II

*CODES FOR SIMULATED AND FIELD DATA

```
! Codes currently used for both simulated and field data are listed in sections
! relating to specific model output files. Codes currently only used for field
! data are listed in a section headed Expdata.
! Codes are assigned as far as possible in accord with the following convention:
!  1st letter: Plant component (eg. C for canopy; H for harvest product)
!  2nd letter: Measurement aspect (eg. W for dry weight; N for nitrogen weight)
!  3rd letter: Basis of measurement (eg. A for unit area; P for plant)
!  4th letter: Time or stage of measurement (eg. D for specific day)
! For complex aspects (eg. ear plus grain) this convention has been modified by
! dropping the usual 4th letter and using the first 2 letter for component(s).
! Codes for dates have letters for the stage first and then a D or DAT.
!
! The fields in the file are as follows:
! CDE  The 'universal' code used to facilitate data interchange.
! LABEL  A short description used when labelling graphs.
! DESCRIPTION  A 35 character description of the aspect.
! OTHER CODE(S)  Additional codes that may be used locally (eg. YILD for HWAM)
! SO The source of the codes (IB=IBSNAT). Codes added by a user should be
!    referenced in this field and the name and address of the person adding
!    the code should be entered as a comment (ie.with a '!' in column 1)
!    below this note. This is important to ensure that information from
!    different workers can be easily integrated.
!    [ SE  The section to which the code belongs. Used for sorting.]
```

***SUMMARY**

@CDE	LABEL	DESCRIPTION	OTHER CODE(S)	SO	SE
ADAT	ANTHESIS day	Anthesis date (YrDoy)	ANTH	IB	SU
BWAH	BYPRODUCT kg/ha	By-product harvest (kg dm/ha)		IB	SU
CNAA	TOPS N,ANTHESIS	Tops N at anthesis (kg/ha)		IB	SU
CNAM	TOPS N kg/ha	Tops N at maturity (kg/ha)		IB	SU
CPAM	TOPS P kg/ha	Tops P at maturity (kg/ha)		IB	SU
CWAA	TOPS WT,ANTHSIS	Tops weight at anthesis (kg dm/ha		IB	SU
CWAM	TOPS WT kg/ha	Tops weight at maturity (kg dm/ha		IB	SU
DRCM	DRAINAGE mm	Season water drainage (mm)		IB	SU
DWAP	SOWING WT kg/ha	Planting material weight (kg dm/h		IB	SU
ETCM	ET TOTAL mm	Season evapotranspiration (mm)		IB	SU
FNAM	FIELD NAME	Field name		IB	SU
GN%M	GRAIN N%,MATURE	Grain N at maturity (%)		IB	SU
GNAM	GRAIN N kg/ha	Grain N at maturity (kg/ha)		IB	SU
H#AM	NUMBER #/m2	Number at maturity (no/m2)		IB	SU
H#UM	NUMBER #/unit	Number at maturity (no/unit)		IB	SU
HDAT	HARVEST day	Harvest date (YRDOY)		IB	SU
HIAM	HARVEST INDEX	Harvest index at maturity		IB	SU
HIPM	POD INDEX	Pod harvest index at maturity		IB	GR
HWAH	HAR YIELD kg/ha	Yield at harvest (kg dm/ha)		IB	SU
HWAM	MAT YIELD kg/ha	Yield at maturity (kg dm/ha)		IB	SU
HWUM	WEIGHT mg/unit	Unit wt at maturity (mg dm/unit)		IB	SU
HYAH	FIELD WT Mg/ha	Field weight at harvest (Mg fm/ha)		IB	SU
IR#M	IRRIG APPS #	Irrigation applications (no)		IB	SU
IRCM	IRRIG mm	Season irrigation (mm)		IB	SU
L#SM	LEAF NUMBER #	Leaf number per stem,maturity		IB	SU

L#SX	LEAF NUMBER #	Leaf number per stem,maximum	IB	SU
LAIX	LAI MAXIMUM	Leaf area index, maximum	IB	SU
MDAT	MATURITY day	Physiological maturity date (YrDoy)	IB	SU
NFXM	N FIXED kg/h	N fixed during season (kg/ha)	IB	SU
NI#M	N APPLICATION #	N applications (no)	IB	SU
NIAM	SOIL N kg/ha	Inorganic N at maturity (kg N/ha)	IB	SU
NICM	TOT N APP kg/ha	Inorganic N applied (kg N/ha)	IB	SU
NLCM	N LEACHED kg/ha	N leached during season (kg N/ha)	IB	SU
NUCM	N UPTAKE kg/ha	N uptake during season (kg N/ha)	IB	SU
OCAM	ORGANIC C t/ha	Organic soil C at maturity (t/ha)	IB	SU
ONAM	ORGANIC N kg/ha	Organic soil N at maturity (kg/ha)	IB	SU
PD1T	POD 1 DATE yd	Pod 1 date (YrDoy)	IB	SU
PDAT	PLANTING DATE	Planting date (YrDoy)	IB	SU
PDFT	FULL POD DATE	Full pod date (YrDoy)	IB	SU
PO#M	P APPLICATION #	Number of P applications (no)	IB	SU
POCM	P APPLIED kg/ha	P applied (kg/ha)	IB	SU
PRCM	PRECIP mm	Season precipitation (mm)	IB	SU
PWAM	POD WT kg/ha	Pod weight at maturity (kg dm/ha)	IB	SU
RECM	RESIDUE kg/ha	Residue applied (kg/ha)	IB	SU
ROCM	RUNOFF mm	Season surface runoff (mm)	IB	SU
R1AT	FIRST BLOOM	Beginning Bloom Stage	IB	SU
R2AT	FIRST PEG	Beginning Peg Stage	IB	SU
R3AT	FIRST POD	Beginning Pod Stage	IB	SU
R4AT	FULL POD	Full Pod Stage	IB	SU
R5AT	FIRST SEED	Beginning Seed Stage	IB	SU
R6AT	FULL SEED	Full Seed Stage	IB	SU
R7AT	FIRST MATURITY	Beginning Maturity Stage	IB	SU
R8AT	HARV MATURITY	Harvest Maturity Stage	IB	SU
R9AT	OVER-MATURE	Over-Mature Pod Stage	IB	SU
SDAT	SIMULATION DATE	Simulation start date (YrDoy)	IB	SU
SNAM	STEM N,MATURITY	Stem N at maturity (kg/ha)	IB	SU
SPAM	SOIL P kg/ha	Soil P at maturity (kg/ha)	IB	SU
SWXM	EXTR WATER mm	Extractable water at maturity (mm)	IB	SU
TDAT	TUBER INIT day	Tuber initiation date (YrDoy)	IB	SU
THAM	THRESHING %	Threshing % at maturity	IB	SU
TNAH	BIOMASS N kg/ha	Tuber+stem+leaf N at harvest (kg/ha)	IB	SU
TNAM	TREATMENT NAME	Treatment title	IB	SU
TN%H	TUBER N %	Tuber N at harvest (%)	IB	SU
TWAH	TOTAL WT kg/ha	Total wt, harvest (kg dm/ha)	IB	SU
UNAM	TUBER N kg/ha	Tuber N at harvest (kg/ha)	IB	SU
UN%H	TUBER N %	Tuber N at harvest (%)	IB	SU
UWAH	TUBER kg dm/ha	Tuber dry weight (kg dm/ha) harvest	IB	SU
UYAH	TUBER Mg fm/ha	Tuber fresh weight (Mg fm/ha) harvest	IB	SU

***GROWTH**

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO	SE
A#PD	APEX NUMBER	Apex number per plant (#)		IB	GR
CDAY	CROP AGE days	Crop age (days from planting)		IB	GR
CDVD	CROP AGE Vdays	Crop age (Vegetative days)		IB	GR
CHTD	CANOPY HEIGHT m	Canopy height (m)		IB	GR
CWAD	TOPS WT kg/ha	Tops weight (kg dm/ha)		IB	GR
CWPD	TOPS WT g/pl	Tops weight (g dm/pl)		IB	GR
CWID	CANOPY WIDTH m	Canopy width (m;for 1 row)		IB	GR
E#AD	EAR NO./m2	Ear number (no/m2)		IB	GR
EWAD	EAR WT. kg/ha	Ear (no grain) weight (kg dm/ha)		IB	GR
G#AD	GRAIN NO #/m2	Grain number (no/m2)		IB	GR
GSTD	GROWTH STAGE	Growth stage		IB	GR
GWAD	GRAIN WT kg/ha	Grain weight (kg dm/ha)		IB	GR

GWGD	GRAIN WT mg	Unit grain weight (mg dm/grain)	IB	GR
HIAD	HARVEST INDEX	Harvest index (grain/top)	IB	GR
HIPD	POD INDEX	Pod harvest index (pod/top)	IB	GR
HWAD	HARVEST WT	Harvest product wt (kg dm/ha)	IB	GR
HYAD	FIELD WT Mg/ha	Field weight (Mg fm/ha)	IB	GR
L#SD	LEAF NUMBER	Leaf number per stem	IB	GR
LAID	LAI	Leaf area index	IB	GR
LAWD	SLA cm2/g	Specific leaf area (cm2/g)	IB	GR
LN%D	LEAF N %	Leaf nitrogen concentration (%)	IB	GR
LRSD	LEAF APP RATE	Leaf appearance rate (#/bday)	IB	GR
LWAD	LEAF WT kg/ha	Leaf weight (kg dm/ha)	IB	GR
NSTD	N STRESS FACTOR	Nitrogen stress factor (0-1)	IB	GR
NWAD	NODULE WT kg/ha	Nodule weight (kg dm/ha)	IB	GR
P#AD	POD NO #/m2	Pod number (no/m2)	IB	GR
PMWD	PLANTING WT	Planting material wt (kg/ha)	IB	GR
PRSD	SHOOT FRACTION	Partitioning of wt to shoot (ratio)	IB	GR
PWAD	POD WT kg/ha	Pod weight (kg dm/ha)	IB	GR
PWDD	DETACHED POD WT	Detached pod weight (kg dm/ha)	IB	GR
PWTD	POD WT kg/ha	Total pod weight (kg dm/ha)	IB	GR
RGRD	RELATIVE GR (%)	Relative growth rate (g/100g.day)	IB	GR
RDPD	ROOT DEPTH m	Root depth (m)	IB	GR
RL10	RLD 180-210cm	Root density,180-210cm (cm/cm3)	IB	GR
RL1D	RLD 0-5 cm	Root density, 0-5 cm (cm/cm3)	IB	GR
RL2D	RLD 5-15 cm	Root density, 5-15 cm (cm/cm3)	IB	GR
RL3D	RLD 15-30 cm	Root density, 15-30 cm (cm/cm3)	IB	GR
RL4D	RLD 30-45 cm	Root density, 30-45 cm (cm/cm3)	IB	GR
RL5D	RLD 45-60 cm	Root density, 45-60 cm (cm/cm3)	IB	GR
RL6D	RLD 60-90 cm	Root density, 60-90 cm (cm/cm3)	IB	GR
RL7D	RLD 90-120cm	Root density, 90-120cm (cm/cm3)	IB	GR
RL8D	RLD 120-150cm	Root density,120-150cm (cm/cm3)	IB	GR
RL9D	RLD 150-180cm	Root density,150-180cm (cm/cm3)	IB	GR
RN%D	ROOT N %	Root N concentration (%)	IB	GR
RWAD	ROOT WT kg/ha	Root weight (kg dm/ha)	IB	GR
RSPD	RT SENESCE g/pl	Root senescence (g dm/pl)	IB	GR
SEAD	SENESCE kg/ha.d	Senescence,tops (kg dm/ha.day)	IB	GR
SH%D	SHELLING %	Shelling % (seed wt/pod wt*100)	IB	GR
SHAD	SHELL WT kg/ha	Shell weight (kg dm/ha)	IB	GR
SHND	SHELL N %	Shell N concentration (%)	IB	GR
SLAD	SLA cm2/g	Specific leaf area (cm2/g)	IB	GR
SN%D	STEM N %	Stem (stover) N concentration %)	IB	GR
SWAD	STEM WT kg/ha	Stem weight (kg dm/ha)	IB	GR
T#AD	TILLER NO #/m2	Tiller number (no/m2)	IB	GR
UYAD	TUBER Mg fm/ha	Tuber fresh weight (Mg fm/ha)	IB	GR
UWAD	TUBER kg dm/ha	Tuber dry weight (kg/ha)	IB	GR
WSGD	H20 STRESS,GR	Water stress - growth (0-1)	IB	GR
WSPD	H20 STRESS,PHS	Water stress - photosynthesis (0-1)	IB	GR

***NITROGEN**

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO	SU
AMLS	NH3VOL kgN/ha/d	Ammonia Vol. (kg N/ha/day)		IB	NI
CNAD	CROP N kg/ha	Tops N (kg/ha)		IB	NI
FALG	ALGAL ACTIVITY	Floodwater Phot.Act.Index (0 to 1)		IB	NI
FALI	FLOOD LT INDX	Floodwater Light Index (0 to 1)		IB	NI
FDEN	DNITRF kgN/ha/d	Floodwater Denitrif Rt (kg N/ha/d)		IB	NI
FL3C	FLD NH3 mg N/l	Floodwater Aqueous NH3 (mg N/l)		IB	NI
FL3N	FLD NO3 mg N/l	Floodwater NO3-N (mg N/l)		IB	NI
FL4C	FLD NH4 mg N/l	Floodwater NH4-N Conc. (mg N/l)		IB	NI
FL4N	FLD NH4 kgN/ha	Floodwater Ammoniacal N (kg N/ha)		IB	NI

FLBD	Puddle BD g/cc	Puddled Soil Surface L BD (g/cc)	IB	NI
FLEF	Flood Evap mm	Floodwater Evaporation Rate (mm/d)	IB	NI
FLNI	FLOOD NIT INDX	Floodwater Nitrogen Index (0 to 1)	IB	NI
FLPH	FLOOD pH	Maximum Daytime Floodwater pH	IB	NI
FLTI	FLOOD TMP INDX	Floodwater Temp. Index (0 to 1)	IB	NI
FLUR	FLD UREA kgN/ha	Floodwater Urea N (kg N/ha)	IB	NI
FUHY	UREA HYD kgN/ha	Urea Hydrol Floodwater (kg N/ha/d)	IB	NI
GN%D	GRAIN N %	Grain N concentration (%)	IB	NI
GNAD	GRAIN N kg/ha	Grain N (kg/ha)	IB	NI
LN%D	LEAF N %	Leaf N concentration (%)	IB	NI
LNAD	LEAF N kg/ha	Leaf N (kg/ha)	IB	NI
NAPC	N APPLIED kg/ha	Inorganic N applied (kg/ha)	IB	NI
NFXC	N FIXED kg/ha	N fixed (kg/ha)	IB	NI
NFXD	N FIXED kg/ha.d	N fixation rate (kg/ha.day)	IB	NI
NH10	NH4 ug/g180-210	NH4 in 180-210cm (ug N/g soil)	IB	NI
NH1D	NH4 ug/g 0-5cm	NH4 in 0-5 cm (ug N/g soil)	IB	NI
NH2D	NH4 ug/g 5-15cm	NH4 in 5-15 cm (ug N/g soil)	IB	NI
NH3D	NH4 ug/g15-30cm	NH4 in 15-30 cm (ug N/g soil)	IB	NI
NH4D	NH4 ug/g30-45cm	NH4 in 30-45 cm (ug N/g soil)	IB	NI
NH5D	NH4 ug/g45-60cm	NH4 in 45-60 cm (ug N/g soil)	IB	NI
NH6D	NH4 ug/g60-90cm	NH4 in 60-90 cm (ug N/g soil)	IB	NI
NH7D	NH4 ug/g 90-120	NH4 in 90-120cm (ug N/g soil)	IB	NI
NH8D	NH4 ug/g120-150	NH4 in 120-150cm (ug N/g soil)	IB	NI
NH9D	NH4 ug/g150-180	NH4 in 150-180cm (ug N/g soil)	IB	NI
NHTD	TOTAL NH4 kg/ha	Total soil NH4 (kg N/ha)	IB	NI
NI10	NO3 ug/g180-210	NO3 in 180-210cm (ug N/g soil)	IB	NI
NI1D	NO3 ug/g 0-5cm	NO3 in 0-5 cm (ug N/g soil)	IB	NI
NI2D	NO3 ug/g 5-15cm	NO3 in 5-15 cm (ug N/g soil)	IB	NI
NI3D	NO3 ug/g15-30cm	NO3 in 15-30 cm (ug N/g soil)	IB	NI
NI4D	NO3 ug/g30-45cm	NO3 in 30-45 cm (ug N/g soil)	IB	NI
NI5D	NO3 ug/g45-60cm	NO3 in 45-60 cm (ug N/g soil)	IB	NI
NI6D	NO3 ug/g60-90cm	NO3 in 60-90 cm (ug N/g soil)	IB	NI
NI7D	NO3 ug/g 90-120	NO3 in 90-120cm (ug N/g soil)	IB	NI
NI8D	NO3 ug/g120-150	NO3 in 120-150cm (ug N/g soil)	IB	NI
NI9D	NO3 ug/g150-180	NO3 in 150-180cm (ug N/g soil)	IB	NI
NIAD	TOTAL N kg/ha	Total soil NO3+NH4 (kg N/ha)	IB	NI
NITD	TOTAL NO3 kg/ha	Total soil NO3 (kg N/ha)	IB	NI
NLCC	N LEACHED kg/ha	N leached (kg N/ha)	IB	NI
NOAD	ORGANIC N kg/ha	Organic N in soil (kg N/ha)	IB	NI
NUPC	N UPTAKE kg/ha	N uptake (kg N/ha)	IB	NI
OXRN	OXNITR kgN/ha/d	Ox Layer Nitrif Rt (kg N/ha/d)	IB	NI
RN%D	ROOT N %	Root N concentration (%)	IB	NI
SHND	SHELL N %	Shell N concentration (%)	IB	NI
SN%D	STEM N %	Stem (stover) N concentration (%)	IB	NI
SNAD	STEM N kg/ha	Stem N (kg/ha)	IB	NI
TUNA	Total N kg/ha	Tuber+stem+leaf N (kg/ha)	IB	NI
UNAD	Tuber N kg/ha	Tuber N (kg/ha)	IB	NI
UN%D	Tuber N %	Tuber N concentration (%)	IB	NI
VN%D	VEG N %	Veg (stem+leaf) N concentration (%)	IB	NI
VNAD	VEGE N kg/ha	Veg (stem+leaf) N (kg/ha)	IB	NI

***WATER**

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO	SE
DA3D	DAYLENGTH h	Daylength (h;3 deg basis)		IB	WA
DAYD	DAYLENGTH h	Daylength (h;sunrise to sunset)		IB	WA
DRNC	DRAINAGE mm	Cumulative drainage (mm)		IB	WA
EOAA	POT EVAP mm/d	Av pot.evapotranspiration (mm/d)		IB	WA
EOAD	POT EVAP mm/d	Potential evapotranspiration (mm/d)		IB	WA
EPAA	PLANT EVAP mm/d	Av plant transpiration (mm/d)		IB	WA
EPAC	TRANSPIRATION	Cumulative transpiration (mm)		IB	WA
EPAD	PLANT EVAP mm/d	Plant transpiration (mm/d)		IB	WA

ESAA	SOIL EVAP mm/d	Av soil evaporation (mm/d)	IB	WA
ESAC	SOIL EVAP mm	Cumulative soil evaporation (mm)	IB	WA
ESAD	SOIL EVAP mm/d	Soil evaporation (mm/d)	IB	WA
ETAA	EVAPOTRANS mm/d	Av evapotranspiration (mm/d)	IB	WA
ETAC	EVAPOTRANS mm	Cumulative evapotranspiration (mm)	IB	WA
ETAD	EVAPOTRANS mm/d	Evapotranspiration (mm/d)	IB	WA
IR#C	IRRIGATION #	Irrigation applications (no)	IB	WA
IRRC	IRRIGATION mm	Cumulative irrigation (mm)	IB	WA
PREC	PRECIPITATION	Cumulative precipitation (mm)	IB	WA
ROFC	RUNOFF mm	Cumulative runoff (mm)	IB	WA
SRAA	SRAD MJ/m2.day	Av solar radiation (MJ/m2.day)	IB	WA
SW10	SWC 180-210cm	Soil water 180-210cm(cm3/cm3)	IB	WA
SW1D	SWC 0-5 cm	Soil water 0-5 cm(cm3/cm3)	IB	WA
SW2D	SWC 5-15 cm	Soil water 5-15 cm(cm3/cm3)	IB	WA
SW3D	SWC 15-30 cm	Soil water 15-30 cm(cm3/cm3)	IB	WA
SW4D	SWC 30-45 cm	Soil water 30-45 cm(cm3/cm3)	IB	WA
SW5D	SWC 45-60 cm	Soil water 45-60 cm(cm3/cm3)	IB	WA
SW6D	SWC 60-90 cm	Soil water 60-90 cm(cm3/cm3)	IB	WA
SW7D	SWC 90-120cm	Soil water 90-120cm(cm3/cm3)	IB	WA
SW8D	SWC 120-150cm	Soil water 120-150cm(cm3/cm3)	IB	WA
SW9D	SWC 150-180cm	Soil water 150-180cm(cm3/cm3)	IB	WA
SWXD	EXTR WATER mm	Extractable water (mm)	IB	WA
TMNA	MINIMUM TEMP C	Av minimum temperature (C)	IB	WA
TMXA	MAXIMUM TEMP C	Av maximum temperature (C)	IB	WA
TS10	S-TMP 80-210cm	Soil temperature 180-210cm (C)	IB	WA
TS1D	S-TMP 0-5 cm	Soil temperature 0-5 cm (C)	IB	WA
TS2D	S-TMP 5-15 cm	Soil temperature 5-15 cm (C)	IB	WA
TS3D	S-TMP 15-30 cm	Soil temperature 15-30 cm (C)	IB	WA
TS4D	S-TMP 30-45 cm	Soil temperature 30-45 cm (C)	IB	WA
TS5D	S-TMP 45-60 cm	Soil temperature 45-60 cm (C)	IB	WA
TS6D	S-TMP 60-90 cm	Soil temperature 60-90 cm (C)	IB	WA
TS7D	S-TMP 90-120cm	Soil temperature 90-120cm (C)	IB	WA
TS8D	S-TMP 20-150cm	Soil temperature 120-150cm (C)	IB	WA
TS9D	S-TMP 50-180cm	Soil temperature 150-180cm (C)	IB	WA

***CARBON**

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO	SE
CGRD	CGR g/m2.d	Crop growth rate (g top+store/m2.d)		IB	CA
CHAD	CH2O g/m2.d	CH2O accumulation (g CH2O/m2.d)		IB	CA
CL%D	LEAF C %	C in leaf (%)		IB	CA
CMAD	CH MOB g/m2.d	C mobilization (g CH2O/m2.d)		IB	CA
CS%D	STEM C %	C in stem (%)		IB	CA
GRAD	GR RESP g/m2.d	Growth respiration (g CH2O/m2.d)		IB	CA
LI%D	LIGHT INTER %	Light (PAR) interception (%)		IB	CA
LI%N	NOON LIGHT IN %	Noon light (PAR) interception (%)		IB	CA
LMHN	NOON PMAX,SHADE	Noon Pmax shaded leaves (mg/m2.s)		IB	CA
LMLN	NOON PMAX,LIGHT	Noon Pmax sunlit leaves (mg/m2.s)		IB	CA
MRAD	M RESP g/m2.d	Maintenance resp (g CH2O/m2.d)		IB	CA
N%HN	NOON N,SHADE %	Noon N shaded leaves (%)		IB	CA
N%LN	NOON N,LIGHT %	Noon N sunlit leaves (%)		IB	CA
OMAC	OM APPL kg/ha	Cumulative OM applied (kg dm/ha)		IB	CA
PHAD	P GROSS g/m2.d	Gross photosynthesis (g CH2O/m2.d)		IB	CA
PHAN	PG,NOON mg/m2.s	Gross photosyn.,noon (mg CO2/m2.s)		IB	CA
SLHN	NOON SLW,SHADE	SLW in shaded lves,noon (mg dm/cm2)		IB	CA
SLLN	NOON SLW,Light	SLW in sunlit lves,noon (mg dm/cm2)		IB	CA
SOCD	SOIL OC t/ha	Soil organic carbon (t/ha)		IB	CA
TGAV	AVG CAN TMP, C	Daily average canopy temp (C)		IB	CA
TGNN	NOON CAN TMP, C	Noon canopy temperature (C)		IB	CA
TWAD	TOTAL WT kg/ha	Tops+roots+storage wt (kg dm/ha)		IB	CA

***PESTS**

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO	SE
CASM	ASSIM g CH2O	Cumulative assimilate reduction		IB	PE
CEW	CEW #/row-m	Corn Earworm		IB	PE
CLAI	LAI m2/m2	Cumulative leaf area consumed		IB	PE
CLFM	LEAF g/m2	Cumulative leaf mass consumed		IB	PE
CPO%	PLTPOP %	Cumulative pl population reduction		IB	PE
CRLF	ROOT cm/cm2	Cumulative root length consumed		IB	PE
CRLV	ROOT cm/cm2	Cumulative root ln density consumed		IB	PE
CRTM	ROOT g/m2	Cumulative root mass consumed		IB	PE
CSD#	SEED #/m2	Cumulative seed number consumed		IB	PE
CSDM	SEED g/m2	Cumulative seed mass consumed		IB	PE
CSH#	SHELL #/m2	Cumulative shell number consumed		IB	PE
CSHM	SHELL g/m2	Cumulative shell mass consumed		IB	PE
CSTM	STEM g/m2	Cumulative stem mass consumed		IB	PE
DASM	ASSIM g CH2O/d	Daily carbohydrate pool reduction		IB	PE
DLA	DIS. LAI cm2/m2	Daily diseased leaf area increase		IB	PE
DLA%	DIS. LAI %/d	Daily % diseased leaf area increase		IB	PE
DLAI	LAI m2/m2.d	Daily leaf area consumed		IB	PE
DLFM	LEAF g/m2.d	Daily leaf mass consumed		IB	PE
DPO%	PLTPOP %/day	Daily plant population reduction		IB	PE
DRLF	ROOT cm/cm2.d	Daily total root length consumed		IB	PE
DRLV	ROOT cm/cm3.d	Daily root length density consumed		IB	PE
DRTM	ROOT g/m2.d	Daily root mass consumed		IB	PE
DSD#	SEED #/m2.d	Daily seed number consumed		IB	PE
DSDM	SEED g/m2.d	Daily seed mass consumed		IB	PE
DSH#	SHELL #/m2.d	Daily shell number consumed		IB	PE
DSHM	SHELL g/m2.d	Daily shell mass consumed		IB	PE
DSTM	STEM g/m2.d	Daily stem mass consumed		IB	PE
FAW	FAW #/m	Fall armyworm		IB	PE
RTWM	RTWM #/m	Root worm		IB	PE
SGSB	SGSB #/m	Southern green stinkbug		IB	PE
SL	SB LOOPER #/m	Soybean looper		IB	PE
VBC5	VBC5 #/m	5 instar velvetbean caterpillar		IB	PE
VBC6	VBC6 #/m	6 instar velvetbean caterpillar		IB	PE

***EXPERIMENTAL DATA**

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO	SE
AP1D	APEX 1cm day	Apex 1cm date (YrDoy)		IB	EX
BR1D	BRANCH 1 YrDoy	Branch 1 date (YrDoy)		IB	EX
BR2D	BRANCH 2 YrDoy	Branch 1 date (YrDoy)		IB	EX
BR3D	BRANCH 3 YrDoy	Branch 1 date (YrDoy)		IB	EX
BR4D	BRANCH 4 YrDoy	Branch 1 date (YrDoy)		IB	EX
CDWA	CANOPY+D kg/ha	Tops+dead wt (kg dm/ha)		IB	EX
CHN%	CHAFF N %	Chaff N (%)		IB	EX
CHWA	CHAFF WT kg/ha	Chaff weight (kg dm/ha)		IB	EX
DRID	DOUBLE RIDGES d	Double ridges date (YrDoy)		IB	EX
DWAD	DEAD WT kg/ha	Dead material weight (kg dm/ha)		IB	EX
EDAT	EMERGENCE day	Emergence date (YrDoy)		IB	EX
EEMD	EAR EMERGENCE d	Ear emergence date (YrDoy)		IB	EX
EGWA	EAR+GRAIN kg/ha	Ear plus grain weight (kg dm/ha)		IB	EX
EGWS	EAR+GRAIN g/s	Ear+grain weight (g dm/shoot)		IB	EX
G#PD	GRAIN NO #/pl	Grain number (no/plant)		IB	EX
G#SD	GRAIN NO #shoot	Grain number (no/shoot)		IB	EX
GW%M	GRAIN H20 %	Grain moisture at maturity (%)		IB	EX
GWAM	GRAIN WT kg/ha	Grain wt at maturity (kg dm/ha)		IB	EX
GWGM	GRAIN WT mg	Unit wt at maturity (mg dm/grain)		IB	EX
GWPM	GRAIN WT g/pl	Grain wt at maturity (g dm/plant)		IB	EX

```
GYAM GRAIN YLD kg/ha Grain yield at maturity (kg fm/ha)              IB EX
GYPM GRAIN YLD g/pl  Grain yld at maturity (g fm/plant)              IB EX
GYVM TEST WT kg/hl   Test weight at maturity (kg fm/hl)              IB EX
HWAC COR YIELD kg/ha Corrected yield (kg dm/ha)                      IB EX
HWAD YIELD  kg/ha    Yield on specified day (kg dm/ha)               IB EX
HYAM HARVEST kg/ha   Harvest yld at maturity (kg fm/ha)              IB EX
LAFD FLAG AREA cm2   Flag leaf area (cm2/leaf)                       IB EX
LALD LEAF AREA cm2   Leaf area (cm2/leaf)                            IB EX
LALN LEAF AREA,NEW   Leaf area,new leaves (cm2 lf-1)                 IB EX
LAPD LEAF AREA cm2/p Leaf area (cm2/plant)                           IB EX
LARD LEAF APPEARANCE Leaf appearance rate (#/day)                    IB EX
L#IR LEAF # INCREASE Leaf number increase rate (#/day)               IB EX
LDAD DEAD LEAF kg/ha Dead leaf weight (kg dm/ha)                     IB EX
LF3D LEAF 3 FULL day Full expansion, leaf 3 (Yrdoy)                  IB EX
LF5D LEAF 5 FULL day Full expansion, leaf 5 (Yrdoy)                  IB EX
LLFD LAST LEAF day   Last leaf date (YrDoy)                          IB EX
LWAM LEAF WT kg/ha   Leaf weight (kg/ha)                             IB EX
LWPD LEAF WT g/plant Leaf weight (g/plant)                           IB EX
PARI PAR INTERCEPT % PAR interception (%)                            IB EX
RLAD ROOT LN cm/cm2  Root length (cm/cm2)                            IB EX
RLWD ROOT L/W cm/g   Root length/weight (cm/g)                       IB EX
RWLD ROOT W/L g/cm   Root weight/length (g/cm)                       IB EX
S#PD SHOOT NO #/pl   Shoot (apex) number (no/plant)                  IB EX
S#AD SHOOT NO #/m2   Shoot (apex) number (no/m2)                     IB EX
SCWA STM+CHAFF kg/ha Stem plus chaff (kg/ha)                         IB EX
SDWT SEED WT g/pl    Seed weight (g pl-1)                            IB EX
SP#P SPIKELETS #/pl  Spikelet number (no/plant)                      IB EX
SWPD STEM WT g/plant Stem weight (g dm/plant)                        IB EX
T#PD TILLER NO.#/pl  Tiller number (no/plant)                        IB EX
T#AD TILLER NO.#/m2  Tiller number (no/m2)                           IB EX
TDWA TOTAL+D  kg/ha  Tops+roots+storage+dead (kg dm/ha)              IB EX
TNIM TOTAL N kg/ha   Total N at maturity (kg N/ha)                   IB EX
TSPD TERMINAL SPKL d Terminal spikelet date (YrDoy)                  IB EX
TWAM TOTAL WT kg/ha  Total wt, maturity (kg dm/ha)                   IB EX
VWAM VEG WT kg/ha    Veg (lf+st) wt,maturity (kg dm/ha)              IB EX
Z21D ZADOKS 21 day   Zadoks 21 date (YrDoy)                          IB EX
Z30D ZADOKS 30 day   Zadoks 30 date (YrDoy)                          IB EX
Z31D ZADOKS 31 day   Zadoks 31 date (YrDoy)                          IB EX
Z37D ZADOKS 37 day   Zadoks 37 date (YrDoy)                          IB EX
Z39D ZADOKS 39 day   Zadoks 39 date (YrDoy)                          IB EX
```

ANNEXURE-III

Growth and Development Codes - CERES-Rice

@CDE	NAME DESCRIPTION	SO
GS000	None	IB
GS001	End Juvenile phase	IB
GS002	Panicle initiation	IB
GS003	Heading	IB
GS004	Begin grain filling	IB
GS005	End of grain filling phase, main plant	IB
GS006	Maturity	IB
GS007	Sowing date	IB
GS008	Germination	IB
GS009	Emergence	IB
GS010	Pre-germination sowing	IB
GS011	Transplant	IB
GS012	End grain filling, tillers	IB
GS013	Start simulation	IB
GS014	Harvest	IB

ANNEXURE-IV

*CODES FOR SOIL DATA

```
! Codes currently used for both detailed profile analysis and occasional
! analysis of the surface layers are listed. The soil analysis codes are
! also listed in the DATA.CDE file.
! The fields in the file are as follows:
!  CDE    The 'universal' code used to facilitate data interchange.
!  DESCRIPTION  A description of the code, with units.
!  SO     The source of the codes (IB=IBSNAT). Codes added by a user should be
!         referenced in this field and the name and address of the person adding
!         the code should be entered as a comment (ie.with a '!' in column 1)
!         below this note. This is important to ensure that information from
!         different workers can be easily integrated.
```

@CDE	DESCRIPTION	SO
LAT	Latitude, degrees (decimals)	IB
LONG	Longitude, degrees (decimals)	IB
SABD	Bulk density, moist, g cm-3	IB
SABL	Depth, base of layer, cm	IB
SADAT	Analysis date, year + days from Jan. 1	IB
SAHB	pH in buffer	IB
SAHW	pH in water	IB
SAKE	Potassium, exchangeable, cmol kg-1	IB
SALB	Albedo, fraction	IB
SANI	Total nitrogen, g kg-1	IB
SAOC	Organic carbon, g kg-1	IB
SAPX	Phosphorus, extractable, mg kg-1	IB
SBDM	Bulk density, moist, g cm-3	IB
SCEC	Cation exchange capacity, cmol kg-1	IB
SCOM	Color, moist, Munsell hue	IB
SCSFAM	Family, SCS system	IB
SDUL	Upper limit, drained, cm3 cm-3	IB
SH20	Water, cm3 cm-3	IB
SITE	Site name	IB
SLAL	Aluminum	IB
SLB	Depth, base of layer, cm	IB
SLBS	Base saturation, cmol kg-1	IB
SLCA	CaCO3 content, g kg-1	IB
SLCF	Coarse fraction (>2 mm), %	IB
SLCY	Clay (<0.002 mm), %	IB

SLDP	Soil depth, cm	IB
SLDR	Drainage rate, fraction day-1	IB
SLEC	Electric conductivity, seimen	IB
SLFE	Iron	IB
SLHB	pH in buffer	IB
SLHW	pH in water	IB
SLKE	Potassium, exchangeable, cmol kg-1	IB
SLLL	Lower limit, cm3 cm-3	IB
SLMG	Magnesium, cmol kg-1	IB
SLMH	Master horizon	IB
SLMN	Manganese	IB
SLNA	Sodium, cmol kg-1	IB
SLNF	Mineralization factor, 0 to 1 scale	IB
SLNI	Total nitrogen g kg-1	IB
SLOC	Organic carbon, g kg-1	IB
SLPA	Phosphorus isotherm A, mmol kg-1	IB
SLPB	Phosphorus iostherm B, mmol 1-1	IB
SLPF	Photosynthesis factor, 0 to 1 scale	IB
SLPO	Phosphorus, organic, mg kg-1	IB
SLPT	Phosphorus, total, mg kg-1	IB
SLPX	Phosphorus, extractable, mg kg-1	IB
SLRF	Root growth factor, soil+plant, 0.0 to 1.0	IB
SLRO	Runoff curve no. (Soil Conservation Service)	IB
SLSI	Silt (0.05 to 0.002 mm), %	IB
SLSU	Sulphur	IB
SLTX	Soil texture	IB
SLU1	Evaporation limit, mm	IB
SMHB	pH in buffer determination method, code	IB
SMKE	Potassium determination method, code	IB
SMPX	Phosphorus determination code	IB
SNH4	Ammonium, KCl, g elemental N Mg-1 soil	IB
SNO3	Nitrate, KCl, g elemental N Mg-1 soil	IB
SRGF	Root growth factor, soil only, 0.0 to 1.0	IB
SSAT	Upper limit, saturated, cm3 cm-3	IB
SSKS	Sat. hydraulic conductivity, macropore, cm h-1	IB

ANNEXURE-V

*RICE GENOTYPE COEFFICIENTS - RICER980 MODEL

```
! COEFF        DEFINITIONS
! ========     ===========
! VAR#         Identification code or number for a specific cultivar.
! VAR-NAME     Name of cultivar.
! ECO#         Ecotype code for this cultivar points to the Ecotype in the ECO
!              file (currently not used).
! P1           Time period (expressed as growing degree days [GDD] in øC above
!              a base temperature of 9øC) from seedling emergence during which
!              the rice plant is not responsive to changes in photoperiod. This
!              period is also referred to as the basic vegetative phase of the
!              plant.
! P20          Critical photoperiod or the longest day length (in hours) at
!              which the development occurs at a maximum rate. At values higher
!              than P20 developmental rate is slowed, hence there is delay due
!              to longer day lengths.
! P2R          Extent to which phasic development leading to panicle initiation
!              is delayed (expressed as GDD in øC) for each hour increase in
!              photoperiod above P20.
! P5           Time period in GDD øC) from beginning of grain filling (3 to
!              4 days after flowering) to physiological maturity with a base
!              temperature of 9øC.
! G1           Potential spikelet number coefficient as estimated from the
!              number of spikelets per g of main culm dry weight (less lead
!              blades and sheaths plus spikes) at anthesis. A typical value
!              is 55.
! G2           Single grain weight (g) under ideal growing conditions, i.e.
!              nonlimiting light, water, nutrients, and absence of pests
!              and diseases.
! G3           Tillering coefficient (scaler value) relative to IR64 cultivar
!              under ideal conditions. A higher tillering cultivar would have
!              coefficient greater than 1.0.
! G4           Temperature tolerance coefficient. Usually 1.0 for varieties
!              grown in normal environments. G4 for japonica type rice growing
!              in a warmer environment would be 1.0 or greater. Likewise, the
!              G4 value for indica type rice in very cool environments or
!              season would be less than 1.0.
!
```

@VAR#	VAR-NAME........	ECO#	P1	P2R	P5	P20	G1	G2	G3	G4
!			1	2	3	4	5	6	7	8
990001	IRRI ORIGINALS	IB0001	880.0	52.0	550.0	12.0	65.0	.0280	1.00	1.00
990002	IRRI RECENT	IB0001	450.0	149.0	350.0	11.7	68.0	.0230	1.00	1.00
990003	JAPANESE	IB0001	220.0	35.0	510.0	12.0	55.0	.0250	1.00	1.00
990004	N.AMERICAN	IB0001	318.0	189.0	550.0	12.8	65.0	.0280	1.00	1.00!
IB0001	IR 8	IB0001	880.0	52.0	550.0	12.1	65.0	.0280	1.00	1.00
IB0002	IR 20	IB0001	500.0	166.0	500.0	11.2	65.0	.0280	1.00	1.00
IB0003	IR 36	IB0001	450.0	149.0	350.0	11.7	68.0	.0230	1.00	1.00
IB0004	IR 43	IB0001	720.0	120.0	580.0	10.5	65.0	.0280	1.00	1.00
IB0005	LABELLE	IB0001	318.0	189.0	550.0	12.8	65.0	.0280	1.00	1.00
IB0006	MARS	IB0001	698.0	134.0	550.0	13.0	65.0	.0280	1.00	1.00
IB0007	NOVA 66	IB0001	389.0	155.0	550.0	11.0	65.0	.0280	1.00	1.00
IB0008	PETA	IB0001	420.0	240.0	550.0	11.3	65.0	.0280	1.00	1.00
IB0009	STARBONNETT	IB0001	880.0	164.0	550.0	13.0	65.0	.0280	1.00	1.00
IB0010	UPLRI5	IB0001	620.0	160.0	380.0	11.5	50.0	.0220	0.60	1.00
IB0011	UPLRI7	IB0001	760.0	150.0	450.0	11.7	65.0	.0280	1.00	1.00
IB0012	IR 58	IB0001	460.0	5.0	420.0	13.5	60.0	.0250	1.00	1.00

IB0013	SenTaNi (???)	IB0001	320.0	50.0	550.0	10.0	70.0	.0300	1.00	1.00
IB0014	IR 54	IB0001	350.0	125.0	520.0	11.5	60.0	.0280	1.00	1.00
IB0015	IR 64	IB0001	500.0	160.0	450.0	12.0	60.0	.0250	1.00	1.00
IB0016	IR 60(Est)	IB0001	490.0	100.0	320.0	11.5	75.0	.0275	1.00	1.00
IB0017	IR 66	IB0001	500.0	50.0	490.0	12.5	62.0	.0265	1.00	1.00
IB0018	IR 72x	IB0001	400.0	100.0	580.0	12.0	76.0	.0230	1.00	1.00
IB0019	RD 7 (cal.)	IB0001	603.3	150.0	452.5	11.2	65.0	.0230	1.00	1.00
IB0020	RD 23 (cal.)	IB0001	310.3	140.0	370.0	11.2	53.0	.0230	1.00	1.00
IB0021	CICA8	IB0001	700.0	120.0	360.0	11.7	60.0	.0270	1.00	1.00
IB0022	LOW TEMP.SEN	IB0001	400.0	120.0	420.0	12.0	60.0	.0250	1.00	0.80
IB0023	LOW TEMP.TOL	IB0001	400.0	120.0	420.0	12.0	60.0	.0250	1.00	1.25
IB0024	17 BR11,T.AMAN	IB0001	740.0	180.0	400.0	10.5	55.0	.0250	1.00	0.90
IB0025	18 BR22,T.AMAN	IB0001	650.0	110.0	400.0	12.0	60.0	.0250	1.00	1.00
IB0026	19 BR 3,T.AMAN	IB0001	650.0	110.0	420.0	12.0	65.0	.0250	1.00	1.00
IB0027	20 BR 3,BORO	IB0001	650.0	90.0	400.0	13.0	65.0	.0250	1.00	1.00
IB0029	CPIC8	IB0001	380.0	150.0	300.0	12.8	38.0	.0210	1.00	1.00
IB0030	LEMONT	IB0001	500.0	50.0	300.0	12.8	60.0	.0207	1.00	1.00
IB0031	RN12	IB0001	380.0	50.0	300.0	12.8	40.0	.0199	1.00	1.15
IB0032	TW	IB0001	360.0	50.0	290.0	12.8	55.0	.0210	1.00	1.00
IB0115	IR 64	IB0001	540.0	160.0	490.0	12.0	50.0	.0250	1.10	1.00
IB0116	HEAT SENSITIVE	IB0001	460.0	5.0	390.0	13.5	62.0	.0250	1.00	1.15
IB0118	IR 72	IB0001	560.0	20.0	390.0	13.5	60.0	.0250	1.00	1.00
IB0117	BR14	IB0001	560.0	200.0	500.0	11.5	45.0	.0260	1.00	1.00
IB0119	BR11	IB0001	825.0	300.0	390.0	11.5	52.0	.0240	1.00	1.00
IB0120	PANT-4	IB0001	830.0	160.0	300.0	11.4	45.0	.0300	1.00	0.80
IB0121	JAYA	IB0001	830.0	100.0	200.0	11.4	40.0	.0300	1.00	0.80
IB0121	BPRI10	IB0001	740.0	200.0	225.0	13.5	40.0	.0230	1.00	1.00
IB0151	ZHENG DAO 9380	IB0001	400.0	120.0	420.0	13.0	60.0	.0270	1.00	1.15
IB0200	CL-448	IB0001	100.0	120.0	250.0	12.0	40.0	.0250	1.00	1.25
WR0001	PUSABASMATI	IB0001	620.0	160.0	380.0	11.5	50.0	.0220	0.60	1.00
WR0002	**HR 6444**	**WR0001**	**550.0**	**185.0**	**250.0**	**11.7**	**60.0**	**.0247**	**1.00**	**1.15**

ANNEXURE-VI

*WEATHER DATA CODES

```
! Headers used in the @ line to identify variables are listed first; codes
! ('flags') used to designate data types are listed next.
!
! The fields in the file are as follows:
!  CDE   The 'universal' code used to facilitate data interchange.
!  DESCRIPTION  A description of the code, with units.
!  SO    The source of the codes (IB=IBSNAT). Codes added by a user should be
!        referenced in this field and the name and address of the person adding
!        the code should be entered as a comment (ie.with a '!' in column 1)
!        below this note. This is important to ensure that information from
!        different workers can be easily integrated.
```

***Headers**

@CDE	DESCRIPTION	SO
ALPHA	Rainfall distribution scale parameter, monthly, mm-2	IB
AMTH	Angstrom 'a' coefficient, monthly, unitless	IB
ANGA	Angstrom 'a' coefficient, yearly, unitless	IB
ANGB	Angstrom 'b' coefficient, yearly, unitless	IB
BMTH	Angstrom 'b' coefficient, monthly, unitless	IB
DATE	Date, year + days from Jan. 1	IB
DEWP	Daily dewpoint temperature, C	IB
DURN	Duration of summarization period for climate files, Yr	IB
ELEV	Elevation, m	IB
EVAP	Daily pan evaporation (mm d-1)	IB
GSDU	Growing season duration, Day	IB
GSST	Growing season start day, Doy	IB
INSI	Institute and site code	IB
LAT	Latitude, degrees (decimals)	IB
LONG	Longitude, degrees (decimals)	IB
MTH	Month, #	IB
NAMN	Temperature minimum,all days,monthly average, C	IB
NASD	Temperature minimum,all days,monthly standard deviation, C	IB
PAR	Daily photosynthetic radiation, moles m-2 day-1	IB
PDW	Probability of a dry-wet sequence	IB
RAIN	Daily rainfall (incl.snow), mm day-1	IB
RAIY	Rainfall, yearly total, mm	IB
REFHT	Reference height for weather measurements, m	IB
RNUM	Rainy days, # month-1	IB
RTOT	Rainfall total, mm month-1	IB
SAMN	Solar radiation,all days,monthly average, MJ m-2 d-1	IB
SDMN	Solar radiation,dry days,monthly average, MJ m-2 d-1	IB
SDSD	Solar radiation,dry days,monthly standard deviation, MJ m-2 d-1	IB
SHMN	Daily sunshine duration, monthly average, percent	IB
SOURCE	Source of daily weather data, text	IB
SRAD	Daily solar radiation, MJ m-2 day-1	IB
SRAY	Solar radiation,yearly average, MJ m-2 day-1	IB
START	Start of summary period for climate (CLI) files, Year	IB
SUNH	Daily sunshine duration, percent	IB
SWMN	Solar radiation,wet days,monthly average, MJ m-2 d-1	IB
SWSD	Solar radiation,wet days,monthly standard deviation, MJ m-2 d-1	IB
TAMP	Temperature amplitude, monthly averages, C	IB
TAV	Temperature average for whole year, C	IB
TDRY	Daily dry-bulb temperature, C	IB
TMAX	Daily temperature maximum, C	IB

TMIN	Daily temperature minimum, C	IB
TMNY	Temperature minimum, yearly average, C	IB
TMXY	Temperature maximum, yearly average, C	IB
TWET	Daily wet-bulb temperature, C	IB
WIND	Daily wind speed (km d-1)	IB
WNDHT	Reference height for windspeed measurements, m	IB
XAMN	Temperature maximum,all days,monthly average, C	IB
XDMN	Temperature maximum,dry days,monthly average, C	IB
XDSD	Temperature maximum,dry days,standard deviation, C	IB
XWMN	Temperature maximum,wet days,monthly average, C	IB
XWSD	Temperature maximum,wet days,standard deviation, C	IB

*Flags
! Flags attached to data to indicate the nature of the original data. Upper
! case flags = original data replaced; lower-case flags = original data.

@CDE	**DESCRIPTION**	**SO**
A	Above maximum - data replaced	IB
a	Above maximum - but original data left	IB
B	Below minimum - data replaced	IB
b	Below minimum - - but original data left	IB
D	Decadal averages only in original file - data replaced	IB
d	Decadal averages only in original file - but original data left	IB
E	Format error in original file - data replaced	IB
e	Format error in original file - but original data left	IB
H	Solar radiation as sunshine hours - data replaced	IB
h	Solar radiation as sunshine hours - but original data left	IB
M	Monthly averages only in original file - data replaced	IB
m	Monthly averages only in original file - but original data left	IB
N	No data in original file - data replaced	IB
n	No data in original file - but original data left	IB
R	Rate of change exceeded - data replaced	IB
r	Rate of change exceeded - but original data left	IB

ANNEXURE-VII

EXPERIMENT DETAIL FILE. (FILEX)

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]
Line 1			
*EXP.DETAILS:			0 C 13
Experiment identifier, made up of:			
Institute code	INSTE		1 C 2
Site code	SITEE		0 C 2
Experiment number/abbreviation	EXPTNO		0 C 4
Crop group code	CG		0 C 2
Experiment name[4]	ENAME[4]		1 C 60
*GENERAL[5]			
Line 1 (People)			
Names of scientists	PEOPLE	PEOPLE	1 C 75
Line 2 (Address)			
Contact address of principal scientist	ADDRESS	ADDRESS	1 C 75
Line 3 (Sites)			
Name and location of experimental site(s)[6]	SITE(S)[6]	SITE(S)	1 C 75
Line 4 (Plot information)			
Gross plot area per rep, m^{-2}	PAREA	PAREA	3 R 6 1
Rows per plot	PRNO	PRNO	1 I 5
Plot length, m	PLEN	PLEN	1 R 5 1
Plots relative to drains, degrees	PLDR	PLDR	1 I 5
Plot spacing, cm	PLSP	PLSP	1 I 5
Plot layout	PLAY	PLAY	1 C 5
Harvest area, m^{-2}	HAREA	HAREA	1 R 5 1
Harvest row number	HRNO	HRNO	1 I 5
Harvest row length, m	HLEN	HLEN	1 R 5 1
Harvest method	HARM	HARM	1 C 15
All other lines (Incidents)			
Notes	NOTES	NOTES	1 C 75
*TREATMENTS			
Treatment number	TRTNO	TN	0 I 2
Rotation component: number (default=1)	ROTNO	R	1 I 1
option (default=1)	ROTOPT	O	1 I 1
Crop component number (default = 0)	CRPNO	C	1 I 1

Treatment name	TITLET	TNAME	1	C	25	
Cultivar level	LNCU	CU	1	I	2	
Field level	LNFLD	FL	1	I	2	
Soil analysis level	LNSA	SA	1	I	2	
Initial conditions level	LNIC	IC	1	I	2	
Planting level	LNPLT	MP	1	I	2	
Irrigation level	LNIR	MI	1	I	2	
Fertilizer level	LNFER	MF	1	I	2	
Residue level	LNRES	MR	1	I	2	
Chemical applications level	LNCHE	MC	1	I	2	
Tillage and rotations level	LNTIL	MT	1	I	2	
Environmental modifications level	LNENV	ME	1	I	2	
Harvest level	LNHAR	MH	1	I	2	
Simulation control level	LNSIM	SM	1	I	2	
*CULTIVARS						
Cultivar level	LNCU	CU	0	I	2	
Crop code	CG	CR	1	C	2	
Cultivar identifier (Institute code + Number)	VARNO	INGENO	1	C	6	
Cultivar name	CNAME	CNAME	1	C	16	
*FIELDS						
Field level	LNFLD	FL	0	I	2	
Field ID (Institute + Site + Field)	FLDNAM	ID_FIELD	1	C	8	
Weather station code (Institute+Site)	WSTA	WSTA	1	C	8	
Slope and aspect, degrees from horizontal plus direction (W, NW, etc.)	SLOPE	FLSA	1	C	5	
Obstruction to sun, degrees	FLOB	FLOB	1	R	5	0
Drainage type, code[7]	DFDRN	FLDT	1	C	5	
Drain depth, cm	FLDD	FLDD	1	R	5	0
Drain spacing, m	SFDRN	FLDS	1	R	5	0
Surface stones (Abundance, %+Size, S, M, L)	FLST	FLST	1	C	5	
Soil texture[7]	SLTX	SLTX	1	C	5	
Soil depth, cm	SLDP	SLDP	1	R	5	0
Soil ID (Institute+Site+Year+Soil)	SLNO	ID_SOIL	1	C	10	
*SOIL ANALYSIS						
Line 1						
Soil analysis level	LNSA	SA	0	I	2	
Analysis date, year + days from Jan. 1	SADAT	SADAT	1	I	5	
pH in buffer determination method, code[7]	SMHB	SMHB	1	C	5	
Phosphorus determination method, code[7]	SMPX	SMPX	1	C	5	
Potassium determination method, code[7]	SMKE	SMKE	1	C	5	

All other lines (L = Layer number)			
Soil analysis level	LNSA	SA	0 I 2
Depth, base of layer, cm	SABL(L)	SABL	1 R 5 0
Bulk density, moist, g cm^{-3}	SADM(L)	SADM	1 R 5 1
Organic carbon, g kg^{-1}	SAOC(L)	SAOC	1 R 5 2
Total nitrogen, g kg^{-1}	SANI(L)	SANI	1 R 5 2
pH in water	SAPHW(L)	SAHW	1 R 5 1
pH in buffer	SAPHB(L)	SAHB	1 R 5 1
Phosphorus, extractable, mg kg^{-1}	SAPX(L)	SAEX	1 R 5 1
Potassium, exchangeable, cmol kg^{-1}	SAKE(L)	SAKE	1 R 5 1
*INITIAL CONDITIONS			
Line 1			
Initial conditions level	LNIC	IC	0 I 2
Previous crop code	PRCROP	PCR	1 C 5
Initial conditions measurement date, year + days	IDAYIC	ICDAT	1 I 5
Root weight from previous crop, kg ha^{-1}	WRESR	ICRT	1 R 5 0
Nodule weight from previous crop, kg ha^{-1}	WRESND	ICND	1 R 5 0
Rhizobia number, 0 to 1 scale (default = 1)	EFINOC	ICRN	1 R 5 2
Rhizobia effectiveness, 0 to 1 scale (default = 1)	EFNFIX	ICRE	1 R 5 2
All other lines (L = Layer number)			
Initial conditions level	LNIC	IC	0 I 2
Depth, base of layer, cm	DLAYRI(L)	ICBL	1 R 5 0
Water, cm^3 cm^{-3} x 100 volume percent	SWINIT(L)	SH20	1 R 5 3
Ammonium, KCl, g elemental N Mg^{-1} soil	INH4(L)	SNH4	1 R 5
Nitrate, KCl, g elemental N Mg^{-1} soil	INO3(L)	SNO3	1 R 5 1
*PLANTING DETAILS			
Planting level number	LNPLT	MP	0 I 2
Planting date, year + days from Jan. 1	YRPLT	PDATE	1 I 5
Emergence date, earliest treatment	IEMRG	EDATE	1 I 5
Plant population at seeding, plants m^{-2}	PLANTS	PPOP	1 R 5 1
Plant population at emergence, plants m^{-2}	PLTPOP	PPOE	1 R 5 1
Planting method, transplant (T), seed (S), pregerminated seed (P) or nursery (N)	PLME	PLME	5 C 1
Planting distribution, row (R), broadcast (B) or hill (H)	PLDS	PLDS	5 C 1
Row spacing, cm	ROWSPC	PLRS	1 R 5 0
Row direction, degrees from N	AZIR	PLRD	1 R 5 0
Planting depth, cm	SDEPTH	PLDP	1 R 5 1

Planting material dry weight, kg ha^{-1}	SDWTPL	PLWT	1	R 5 0
Transplant age, days	SDAGE	PAGE	1	R 5 0
Temp. of transplant environment, °C	ATEMP	PENV	1	R 5 1
Plants per hill (if appropriate)	PLPH	PLPH	1	R 5 1
*IRRIGATION AND WATER MANAGEMENT				
Line 1				
Irrigation level	LNIR	MI	0	I 2
Irrigation application efficiency, fraction	EFFIRX	EFIR	1	R 5 2
Management depth for automatic application, cm	DSOILX	IDEP	1	R 5 0
Threshold for automatic appl., % of max. available	THETCX	ITHR	1	R 5 0
End point for automatic appl., % of max. available	IEPTX	IEPT	1	R 5 0
End of applications, growth stage	IOFFX	IOFF	1	C 5
Method for automatic applications, code[5]	IAMEX	IAME	1	C 5
Amount per irrigation if fixed, mm	AIRAMX	IAMT	1	R 5 0
All other lines (J = Irrigation application number)				
Irrigation level	LNIR	MI	0	I 2
Irrigation date, year + day or days from planting	IDLAPL(J)	IDATE	1	I 5
Irrigation operation, code[7]	IRRCOD(J)	IROP	1	C 5
Irrigation amount, depth of water/water table, bund height, or percolation rate, mm or mm day^{-1}	AMT(J)	IRVAL	1	R 5 0
*FERTILIZERS (INORGANIC) (J = Fertilizer application number)				
Fertilizer application level	LNFERT	MF	0	I 2
Fertilization date, year + day or days from planting	FDAY(J)	FDATE	1	I 5
Fertilizer material, code[7]	IFTYPE(J)	FMCD	1	C 5
Fertilizer application/placement, code[7]	FERCOD(J)	FACD	1	C 5
Fertilizer incorporation/application depth, cm	DFERT(J)	FDEP	1	R 5 0
N in applied fertilizer, kg ha^{-1}	ANFER(J)	FAMN	1	R 5 0
P in applied fertilizer, kg ha^{-1}	APFER(J)	FAMP	1	R 5 0
K in applied fertilizer, kg ha^{-1}	AKFER(J)	FAMK	1	R 5 0
Ca in applied fertilizer, kg ha^{-1}	ACFER(J)	FAMC	1	R 5 0
Other elements in applied fertilizer, kg ha^{-1}	AOFER(J)	FAMO	1	R 5 0
Other element code, e.g.,. MG	FOCOD(J)	FOCD	1	C 5

*RESIDUES AND OTHER ORGANIC MATERIALS (J = Residue application number)						
Residue management level	LNRES	MR	0	I	2	
Incorporation date, year + days	RESDAY(J)	RDATE	1	I	5	
Residue material, code[7]	RESCOD(J)	RCOD	1	C	5	
Residue amount, kg ha^{-1}	RESIDUE(J)	RAMT	1	R	5	0
Residue nitrogen concentration, %	RESN(J)	RESN	1	R	5	2
Residue phosphorus concentration, %	RESP(J)	RESP	1	R	5	2
Residue potassium concentration, %	RESK(J)	RESK	1	R	5	2
Residue incorporation percentage, %	RINP(J)	RINP	1	R	5	0
Residue incorporation depth, cm	DEPRES(J)	RDEP	1	R	5	0
*CHEMICAL APPLICATIONS (J = Chemical application number)						
Chemical applications level	LNCHE	MC	0	I	2	
Application date, year + day or days from planting	CDATE(J)	CDATE	1	I	5	
Chemical material, code[7]	CHCOD(J)	CHCOD	1	C	5	
Chemical application amount, kg ha^{-1}	CHAMT(J)	CHAMT	1	R	5	2
Chemical application method, code	CHMET(J)	CHME	1	C	5	
Chemical application depth, cm	CHDEP(J)	CHDEP	1	C	5	
Chemical targets	CHT	CHT	1	C	5	
*TILLAGE (J = Tillage application number)						
Tillage level	TL	TL	0	I	2	
Tillage date, year + day	TDATE(J)	TDATE	1	I	5	
Tillage implement, code[7]	TIMPL(J)	TIMPL	1	C	5	
Tillage depth, cm	TDEP(J)	TDEP	1	R	5	0
*ENVIRONMENT MODIFICATIONS (J = Environment modification number)						
Environment modifications level	LNENV	ME	0	I	2	
Modification date, year + day or days from planting	WMDATE(J)	ODATE	1	I	5	
Daylength adjustment factor (A,S,M,R)	DAYFAC(J)	E	1	C	1	
Daylength adjustment, h	DAYADJ(J)	DAY	0	R	4	1
Radiation adjustment factor (A,S,M,R)	RADFAC(J)	E	1	C	1	
Radiation adjustment, MJ m^{-2} d^{-1}	RADADJ(J)	RAD	0	R	4	1
Temperature (maximum) adjustment factor (A,S,M,R)	TXFAC(J)	E	1	C	1	
Temperature (maximum) adjustment, °C	TXADJ(J)	MAX	0	R	4	1
Temperature (minimum) adjustment factor (A,S,M,R)	TMFAC(J)	E	1	C	1	
Temperature (minimum) adjustment, °C	TMADJ(J)	MIN	0	R	4	1
Precipitation adjustment factor (A,S,M,R)	PRCFAC(J)	E	1	C	1	
Precipitation adjustment, mm	PRCADJ(J)	RAIN	0	R	4	1
CO_2 adjustment code (A,S,M,R)	CO2FAC(J)	E	1	C	1	
CO_2 adjustment, vpm	CO2ADJ(J)	CO2	0	R	4	0
Humidity adjustment factor (A,S,M,R)	DPTFAC(J)	E	1	C	1	
Humidity (dew pt) adjustment, °C	DPTADJ(J)	DEW	0	R	4	1

Wind adjustment factor (A,S,M,R)	WNDFAC(J)	E	1 C 1
Wind adjustment, km day^{-1}	WNDADJ(J)	WIND	0 R 4 1
N.B. A = add, S = subtract, M = multiply, R = replace			
*HARVEST DETAILS (J = Harvest number)			
Harvest level	LNHAR	HL	0 I 2
Harvest date, year + day or days from planting	HDATE(J)	HDATE	1 I 5
Harvest stage	HSTG(J)	HSTG	1 C 5
Harvest component, code[7]	HCOM(J)	HCOM	1 C 5
Harvest size group, code[7]	HSIZ(J)	HSIZ	1 C 5
Harvest percentage, %	HPC(J)	HPC	1 R 5 0

1 *Abbreviations used as variable names in the IBSNAT models.*

2 *Abbreviations suggested for use in header lines (those designated with '@') within the file.*

3 *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

4 *It is suggested that Experiment Name be composed of a short name, followed by a blank space, summary of treatment factors, followed by a blank space, and end with a local abbreviation for the experiment in parenthesis. This information will then be available for searching and organizing experiments, using the list managers described in Volume 1-3 (Hunt et al. 1994) of this book.*

5 *Each section in the actual file needs a heading of this type.*

6 *It is suggested that the SITE information on data line 3 be composed of a short site name, followed by a blank space, then latitude, longitude, elevation (in meters above sea level, and climate zone, each separated by a semi-colon. For example:*

GAINESVILLE,FL 29.63N;82.37W;40M;SEUSA

7 *For a complete listing of these codes, see Appendix B.*

ANNEXURE-VIII

WEATHER DATA FILE

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]
Line 1			
*WEATHER :		0	C 10
Site + country name		1	C 60
Line 2			
Institute code	INSTE	IN	2 C 2
Site code	SITEE	SI	0 C 2
Latitude, degrees (decimals)	XLAT	LAT	1 R 8 3
Longitude, degrees (decimals)	XLONG	LONG	1 R 8 3
Elevation, m	ELEV	ELEV	1 R 5 0
Air temperature average, °C	TAV	TAV	1 R 5 1
Air temperature amplitude, monthly averages, °C	TAMP	AMP	1 R 5 1
Height of temperature measurements, m	REFHT	TMHT	1 R 5 1
Height of wind measurements, m	WNDHT	WMHT	1 R 5 1
All other lines			
Year + days from Jan. 1	YRDOYW	DATE	0 I 5
Solar radiation, MJ m^{-2} day^{-1}	SRAD	SRAD	1 R 5 1
Air temperature maximum, °C	TMAX	TMAX	1 R 5 1
Air temperature minimum, °C	TMIN	TMIN	1 R 5 1
Precipitation, mm	RAIN	RAIN	1 R 5 1
Dewpoint temperature[5], °C	TDEW	DEWP	1 R 5 1
Wind run[5], km day^{-1}	WINDSP	WIND	1 R 5 1
Photosynthetic active radiation (PAR)[5], moles m^{-2} day^{-1}	PAR	PAR	1 R 5 1

1 *Abbreviations used as variable names in the IBSNAT models.*

2 *Abbreviations suggested for use in header lines (those designated with '@') within the file.*

3 *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

4 *The blank space following a weather variable can be used to place a "flag," which would indicate an estimated value had replaced missing or suspect data. (e.g., UFGAE 29.6 32.6...), where 'E' is the "flag" indicating the data item following it (i.e,'29.6') is an error value. In this example, since no "flag" preceeds the 32.6', this number is a reported value. (See Appendix D for a full listing of Weather Flags.)*

5 *Optional data, which are used by crop models for some options but are not necessary.*

DETAILED SIMULATION WATER BALANCE OUTPUTFILE (OUTW)

Structure

Variable	Variable Name[1]	Header[2]	Format[3]		
Line 1					
Run number[4]	NREP		5	I	3
Run identifier	TITLER		10	C	25
Line 2					
Model name	MODEL		19	C	8
Crop name	CROPD		3	C	10
Line 3					
Experiment identifier, made up of:					
Institute code	INSTE		18	C	2
Site code	SITEE		0	C	2
Experiment number/abbreviation	EXPTNO		0	C	4
Crop group code	CROP		1	C	2
Experiment name (Treatment set and experimental condition names, separated by a semi-colon)	ENAME		18	C	60
Line 4					
Treatment number	TRTNO		11	I	2
Treatment name	TITLET		5	C	25
Line 5[5]					
Variable abbreviations			1	C	77+
Line 6 on					
Date (Year + days from Jan. 1)	YRDOY	DATE	1	I	5
Days from planting	DAP	CDAY	1	I	5
Plant Transpiration, mm d^{-1}	AVEP	EPAA	1	R	5 2
Evapotranspiration, mm day^{-1}	AVET	ETAA	1	R	5 2
Potential evaporation, mm day^{-1}	AVEO	EOAA	1	R	5 2
Potentially extractable water, cm	PESW	SWXD	1	R	5 1
Cumulative runoff	TRUNOF	ROFC	1	R	5 1
Cumulative drainage	TDRAIN	DRNC	1	I	5
Cumulative precipitation, mm	CRAIN	PREC	1	I	5
Cummulative irrigation, mm	TOTIR	IRRC	1	I	5
Average solar radiation, MJ m^{-2}	AVSRAD	SRAA	1	R	5 1
Average maximum temperature, °C	AVTMX	TMXA	1	R	5 1
Average minimum temperature, °C	AVTMN	TMNA	1	R	5 1

1 Abbreviations used as variable names in the IBSNAT models.

2 Abbreviations suggested for use in header lines (those designated with '@') within the file. They correspond to the variable names used in the associated database.

3 Formats are presented as follo :: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.

4 Each new run should be demarcated with '*RUN' at the beginning of this line in each file.

5 Additional information can be placed between lines 4 and 5, as required by a user, as illustrated in the example, and as documented for the Overview file in the text.

ANNEXURE-X

DETAILED SIMULATION NITROGEN OUTPUT FILE (OUTN)

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]			
Line 1						
Run number[4]	NREP		5	I	3	
Run identifier	TITLER		10	C	25	
Line 2						
Model name	MODEL		18	C	8	
Crop name	CROPD		3	C	10	
Line 3						
Experiment identifier, made up of:						
Institute code	INSTE		18	C	2	
Site code	SITEE		0	C	2	
Experiment number/abbreviation	EXPTNO		0	C	4	
Crop group code	CROP		1	C	2	
Experiment name (Treatment set and experimental condition names, separated by a semi-colon)	ENAME		18	C	60	
Line 4						
Treatment number	TRTNO		11	I	2	
Treatment name	TITLET		5	C	25	
Line 5[5]						
Variable abbreviations			1	C	77+	
Line 6 on						
Date (Year + days from Jan. 1)	YRDOY	DATE	1	I	5	
Days from planting	DAP	CDAY	1	I	5	
Crop nitrogen	WTNCAN	CNAD	1	R	5	1
Grain nitrogen, kg ha^{-1}	WTNSD	GNAD	1	R	5	1
Veg. (stem + leaf) nitrogen, kg ha^{-1}	WTNVEG	VNAD	1	R	5	1
Percent nitrogen in grain, %	PCNGRN	HN%D	1	R	5	2
Percent veg(stem+leaf) nitrogen, %	PCNVEG	VN%D	1	R	5	2
Cumulative inorganic N applied, kg ha^{-1}	TANFGR	NAPC	1	R	5	I
Cumulative N fixation, kg ha^{-1}	WTNFX	NFXC	1	R	5	1
Cumulative N uptake, kg ha^{-1}	WTNUP	NUPC	1	R	5	1
Cumulative N leached, kg ha^{-1}	TLCH	NLCC	1	R	5	1
Inorganic N in soil, kg ha^{-1}	TSIN	NIAD	1	R	5	1
Organic N in soil, kg ha^{-1}	TSON	NOAD	1	I	5	

1 *Abbreviations used as variable names in the IBSNAT models.*

2 *Abbreviations suggested for use in header lines (those designated with '@') within the file. They correspond to the variable names used in the associated database.*

3 *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

4 *Each new run should be demarcated with '*RUN' at the beginning of this line in each file.*

5 *Additional information can be placed between lines 4 and 5, as required by a user, as illustrated in the example, and as documented for the Overview file in the text.*

ANNEXURE-XI

SIMULATION CONTROL

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]		
Line 1: General					
Level number	LNSIM	N	0	I	2
Identifier	TITCOM	GENERAL	1	C	11
Runs:					
Years	NYRS	NYERS	4	I	2
Replications	NREPSQ	NREPS	4	I	2
Start of Simulation, code:	ISIMI	START	5	C	1
Suggested codes:					
E = On reported emergence date					
I = When initial conditions measured					
P = On reported planting date					
S = On specified date					
Date, year + day (if needed)	YRSIM	SDATE	1	I	5
Random number seed	RSEED	RSEED	1	I	5
Title	TITSIM	SNAME	1	C	25
Line 2: Options					
Level number	LNSIM	N	0	I	2
Identifier	TITOPT	OPTIONS	1	C	11
Water (Y = yes; N = no)	ISWWAT	WATER	5	C	1
Nitrogen (Y = yes; N = no)	ISWNIT	NITRO	5	C	1
Symbiosis (Y= yes, N= no, U= unlimited N)	ISWSYM	SYMBI	5	C	1
Phosphorus (Y = yes; N = no)	ISWPHO	PHOSP	5	C	1
Potassium (Y = yes; N = no)	ISWPOT	POTAS	5	C	1
Diseases and other pests (Y = yes; N = no)	ISWDIS	DISES	5	C	1
(Y = simulate process; N = do not simulate process)					
Line 3: Methods					
Level number	LNSIM	N	0	I	2
Identifier	TITMET	METHODS	1	C	11
Weather	MEWTH	WTHER	5	C	1
M = Measured data, as recorded					
G = Simulated data, stored as *.WTG files					
S = Simulated data (Internal weather generator using monthly inputs)					
W = Simulated data (Internal WGEN weather generator)					
Initial Soil Conditions	MESIC	INCON	5	C	1
M = As reported					
S = Simulated outputs from previous model run					

```
Light interception                              MELI       LIGHT        5  C  1
    E  =  Exponential with LAI
    H  =  'Hedgerow' calculations
Evaporation                                     MEEVP      EVAPO        5  C  1
    P  =  FAO - Penman
    R  =  Ritchie modification of Priestley-Taylor
Infiltration                                    MEINF      INFIL        5  C  1
    R  =  Ritchie method
    S  =  Soil Conservation Service routines
Photosynthesis                                  MEPHO      PHOTO        5  C  1
    C  =  Canopy photosynthesis response curve
    R  =  Radiation use efficiency
    L  =  Leaf photosynthesis response curve

Line 4: Management
Level number                                    LNSIM      N            0  I  2
Identifier                                      TITMAT     MANAGEMENT   1  C  11
Planting/Transplanting                          IPLTI      PLANT        5  C  1
    A  =  Automatic when conditions satisfactory
    R  =  On reported date
Irrigation and Water Management                 IIRRI      IRRIG        5  C  1
    A  =  Automatic when required
    N  =  Not irrigated
    F  =  Automatic with fixed amounts at each irrigation date
    R  =  On reported dates
    D  =  As reported, in days after planting
Fertilization                                   IFERI      FERTI        5  C  1
    A  =  Automatic when required
    N  =  Not fertilized
    F  =  Automatic with fixed amounts at each fertilization date
    R  =  On reported dates
    D  =  As reported, in days after planting
Residue applications                            IRESI      RESID        5  C  1
    A  =  Automatic for multiple years/crop sequences
    N  =  No applications
    F  =  Automatic with fixed amounts at each residue application date
    R  =  On reported dates
    D  =  As reported, in days after planting
Harvest                                         IHARI      HARVS        5  C  1
    A  =  Automatic when conditions satisfactory
    G  =  At reported growth stage(s)
    M  =  At maturity
    R  =  On reported date(s)
    D  =  On reported days after planting
```

Line 5: Outputs						
Level number	LNSIM	N	0	I	2	
Identifier	TITOUT	OUTPUTS	1	C	11	
Experiment (Y = yes, files named with the experiment code; N = no)	IOX	FNAME	5	C	1	
General (Y = yes, new; A = append; N = no)						
Overview	IDETO	OVVEW	5	C	1	
Summary	IDETS	SUMRY	5	C	1	
Details - individual aspects						
Frequency of output (days)	FROP	FROPT	4	I	2	
Growth (Y = yes; N = no)	IDETG	GROUT	5	C	1	
Carbon (Y = yes; N = no)	IDETC	CAOUT	5	C	1	
Water (Y = yes; N = no)	IDETW	WAOUT	5	C	1	
Nitrogen (Y = yes; N = no)	IDETN	NIOUT	5	C	1	
Phosphorous (Y = yes; N = no)	IDETP	MIOUT	5	C	1	
Diseases and other pests (Y = yes; N = no)	IDETD	DIOUT	5	C	1	
Wide (Y) or 80-column (N) daily outputs	IDETL	LONG	5	C	1	

Other lines

These deal separately with different aspects of automatic management. They are only necessary if automatic management is called for.

Planting:						
Level number	LNSIM	N	0	I	2	
Identifier	TITPLA	PLANTING	1	C	11	
Earliest, year and day of year (YRDOY)	PWDINF	PFRST	1	I	5	
Latest, year and day of year (YRDOY)	PWDINL	PLAST	1	I	5	
Lowermost soil water, %	SWPLTL	PH2OL	1	R	5	0
Uppermost soil water, %	SWPLTH	PH2OU	1	R	5	0
Management depth for water, cm	SWPLTD	PH2OD	1	R	5	0
Max. soil temp. (10 cm av.), °C	PTX	PSTMX	1	R	5	0
Min. soil temp. (10 cm av.), °C	PTTN	PSTMN	1	R	5	0
Irrigation and Water Management:						
Level number	LNSIM	N	0	I	2	
Identifier	TITIRR	IRRIGATION	1	C	11	
Management depth, cm	DSOIL	IMDEP	1	R	5	0
Threshold, % of maximum available	THETAC	ITHRL	1	R	5	0
End point, % of maximum available	IEPT	ITHRU	1	R	5	0
End of applications, growth stage	IOFF	IROFF	1	C	5	
Method, code	IAME	IMETH	1	C	5	
Amount per irrigation, if fixed, mm	AIRAMT	IRAMT	1	R	5	0
Irrigation application efficiency, fraction	EFFIRR	IREFF	1	R	5	2

Nitrogen Fertilization:						
Level number	LNSIM	N	0	I	2	
Identifier	TITNIT	NITROGEN	1	C	11	
Application depth, cm	DSOILN	NMDEP	1	R	5	0
Threshold, N stress factor, %	SOILNC	NMTHR	1	R	5	0
Amount per application, kg N ha^{-1}	SOILNX	NAMNT	1	R	5	0
Material, code	NCODE	NCODE	1	C	5	
End of applications, growth stage	NEND	NAOFF	1	C	5	
Residues:						
Level number	LNSIM	N	0	I	2	
Identifier	TITRES	RESIDUES	1	C	11	
Incorporation percentage, % of remaining	RIP	RIPCN	1	R	5	0
Incorporation time, days after harvest	NRESDL	RTIME	1	I	5	
Incorporation depth, cm	DRESMG	RIDEP	1	R	5	0
Harvests:						
Level number	LNSIM	N	0	I	2	
Identifier	TITHAR	HARVESTS	1	C	11	
Earliest, days after maturity	HDLAY	HFRST	1	I	5	
Latest, year and day of year (YRDOY)	HLATE	HLAST	1	I	5	
Percentage of product harvested, %	HPP	HPCNP	1	R	5	0
Percentage of residue harvested, %	HRP	HRCNR	1	R	5	0

[1] *Abbreviations used as variable names in the IBSNAT models.*

[2] *Abbreviations suggested for use in header lines (those designated with '@') within the file.*

[3] *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*