USE OF DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER IN PREDICTING RICE YIELD

A DISSERTATION

submitted in partial fulfilment 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 **"USE OF DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER IN PREDICTING RICE YIELD"** which is being submitted in partial fulfillment of the requirements for the award of **Master's Degree of Technology** in **Irrigation Water Management** at Water Resources Development Training Centre (WRDTC), Indian Institute of Technology, Roorkee (formerly University of Roorkee) is an authentic record of my own work carried out during the period of 16.7.2001 to 31.1.2002 under the supervision and guidance of **Dr. S.K.Tripathi**, Professor, WRDTC, IIT, Roorkee.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree.

(Ram Salone Sharma)

Place : Roorkee
Dated : 31.01.2002

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 (Oriza sativa L.) is one of the most important cereals both for human and animal consumption. Rice is grown in climates ranging from temperate to tropics. Rice seedlings from the nursery bed can be transplanted to the field when the mean daily temperature is about 13 to 15°C. Weather variables affect the crop growth differently in different phenophases during its growth cycle.

Field experiment during the kharif season of 2001 conducted with cv IR 64 was laid out in split plot design with Three Irrigation (I_1, I_2, I_3) and Two Nitrogen (N_1, N_2) treatments at the Demonstration Farm of WRDTC, IIT, Roorkee. Lysimeteric experiment with these treatments was also conducted. The main objectives of the study was to generate base data for using in DSSAT Rice CERES model and use it for prediction of yield, nitrogen uptake and nitrogen leach under different agrotechnical conditions.

The validation of DSSAT revealed that the predicted and actual yield recorded was 38.31 Q/ha & 35.00 Q/ha; 48.31 Q/ha & 45.17 Q/ha; 36.18 Q/ha & 32.83 Q/ha;' 45.02 Q/ha & 46.00 Q/ha; 34.15 Q/ha & 37.33 Q/ha as well as 42.49 Q/ha & 41.67 Q/ha respectively in I_1N_1, I_1N_2, I_2N_1, I_2N_2, I_3N_1 and I_3N_2 treatments respectively. The overall variability shows that predicted values were high over actual recorded by 2.72% which is well within the acceptable limit.

The validated DSSAT was used to predict grain yield. Nitrogen uptake, nitrogen leached and cumulative evapotranspiration under different agrotechnical conditions viz.

seedlings Transplant age, (25, 30, & 35 days old), seedling health (very healthy, healthy, normal, and fair), seedlings transplanted per hill (2 seedlings/hill, 3 seedlings/hill), irrigation depth applied (510mm, 1020 mm & 1530 mm), nitrogen dose (50 kgs/ha, 75 kgs/ha, 100 kgs/ha, 125 kgs/ha), and split application of nitrogen 3 splits (Top dressing), 4 splits (top dressing). Thus the total number of treatments tested were 576. This is totally impossible to conduct such a massive agronomic experiment with such a large number of treatments. This could, however, be possible on computer through DSSAT.

DSSAT predicted result on yield revealed that advancing the age of seedling transplant reduced the yield, reducing the health of seedling at the time of transplanting also reduced the yield, increasing the seedlings transplanted per hill from 2 to 3 increased the yield, increasing the depth of irrigation reduced the yield, increasing the dose of nitrogen, proportionately increased the yield and increasing the number of splits from 3 to 4 reduced the grain yield. The Nitrogen uptake was noticed under all the treatments the pattern similar to that observed in grain yield.

Leaching of nitrogen increased by advancing the age of seedling transplant, reducing the health of seedlings at the time of transplant, transplanting only 2 seedlings/hill, increasing irrigation depth and nitrogen dose and applying total nitrogen in 3 splits only.

In view of the above DSSAT predicted findings for the soil climatic conditions of Roorkee to grow rice cv IR64; the transplanting of 25 or 30 days old seedlings of very healthy nature, with 3 seedlings/hill and 510 mm irrigation and 120 kgs N/ha application in 3 splits is suggested.

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CHAPTER – 1

INTRODUCTION

Rice (Oriza-sativa) is one of the most important cereals both for human and animal consumption and ranks as the second important crop after wheat in the world. Among cereals, Rice in India ranks first in total area (42.6 m.ha out of present net cropped area 142.0 m.ha). The present population of the country is about 1040 millions – the second largest in the world after China. This leaves a pressure of 7.3 persons/ha of net cropped area. It is grown as rainfed as well as irrigated crop in kharif and only irrigated crop in Rabi season wherever irrigation facilities are available. Average production of Rice in India is only 26.30 Q/ha whereas the countries like Korea (DPR), USA, Japan, China, Peru and Camroon record 75.00, 66.47, 61.85, 58.55, 56.63, 51.42 and 50.00 Q/ha respectively (Tripathi, S.K. 1994).

The average production of Rice ranks very low although the country is endowed with the good soil and climatic condition as well as the water resources potential. In order to feed the growing population of the country improving the productivity is urgently required to make the country rank in the world comparison.

1.1 CLIMATIC REQUIREMENT OF RICE

In general, Indica rice is grown in humid tropics and Japonica rice is best suited to temperate and subtropical climates. Rice seedlings from the nursery bed can be transplanted to the field when the mean daily temperature is about 13 to 15°C below 12°C germination does not occur (Doorenbos et.al 1979). Temperature between 22 and 30°C are 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 and 150 days depending on variety, temperature and sensitivity to day length. Optimum day and night temperatures for the growth of rice are in the range of 28 to 35°C.

A wide range of soils are suitable for Rice cultivation but heavier soils are preferred due to low seepage & percolation losses, generally very sandy soils are not very much suitable for Rice cultivation. The crop has a high tolerance to acidity with optimum pH between 5.5 and 6.0. Rice is moderately tolerant to salinity.

Since weather is a major variable affecting crop production in advanced agricultural system, knowledge of weather at a particular site which affects the crop performance is important in many ways (I) to select culivars which are suited to the climate in which they are grown, (ii) it allows agronomists and crop physiologists to take account of the effects of weather on the growth, development and yield of crops, and (iii) it also helps the planners with the government for early estimation of the crop yields.

Weather variables affect crop growth and development differently in different phenophases of the crop during its growth cycle. Dry matter production depends, initially on the amount of solar radiation intercepted which is dependent on the leaf area of the crop. In the early growing season, small LAI causes low radiation interception by the crop and this limits the crop growth rate. The effects of weather on yield are complex. In general, it appears that the influences of weather on the physiological and development processes which determines the number of seed of a crop and also their size are more important. Earlier studies based on source and sink development indicate that, the quantam of intercepted radiation during flowering stage of the crop is the dominant factor in determining the grain number.

The radiation from the Sun is the prime source of energy for plant growth and development, which regulates the carbon exchange rates of leaves. Photosynthesis is governed principally by the intensity of light received at the crop canopy of the plant. Plant characteristics such as canopy architecture, leaf area Index, Plant density, littering and height are the most important governing factors in light distribution within the crop canopy. IR 64 a HYV rice has been recommended for the soil climatic conditions of Roorkee.

1.2 WATER REQUIREMENT

Rice is a luxuriant user of soil water for dry matter production. Water requirement of rice for evapotranspiration is between 450 and 700 mm, depending on climate and length of the total growing period. Evapotranspiration increases with increasing vegetative growth and is highest just before flowering to early yield formation, after which it declines. For maximum production, a medium maturity crop requires between 500 and 600 mm of water depending on the climate. Rice is an aquatic plant and grows well under submerged conditions. The most susceptible stage for whole plant submergence are head development and flowering.

1.3 DSSAT (Decision Support System for Agrotechnology Transfer)

International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) (a collaborative program of USAID with University of Hawaii Honolulu, USA) was designed to help the acceleration of the process of knowledge dissemination to the decision makers. Crop models which share a common input and output data format have been developed and embedded in a software package called DSSAT (Decision Support System for Agrotechnology Transfer). The DSSAT itself is a shell that allows the user to organise and manipulate crop, soil and weather and to run crop models in various ways and analyse their outputs. IBSNAT incorporated process oriented dynamic crop simulation model into its international programme for agrotechnology transfer and developed DSSAT packages. The models available in the DSSAT are :

1. Cereals models (CERES) : Wheat, Rice, Maize, Barley, Sorghum and Millet.
2. Grain legume models (CROPGRO) : Soyabean, Peanut and Dry bean
3. Root crop models (SUBSTOR) : Cassava, Aroid and Potato
4. SUNFLOWER
5. SUGARCANE
6. COTTON

The decision support software consists of

(i) a data base management system (DBMS) to enter, store and retrieve the "minimum data set" needed to validate, list and use the crop models for solving problems,

(ii) a set of validated crop models for simulating processes and outcomes of genotype by environment interactions; and

(iii) an application program for analysing and displaying outcomes of long term simulated agronomic experiment.

A major milestone was achieved by IBSNAT with the integration of crop models. Databases for weather, soil and crops and agrotechnology transfer application programs and their incorporation into a single computer software package known as DSSAT. The CERES-Rice model (Tsuji et al 1994 & Godwin et al 1992) 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 into grain and straw through the use of land, energy (solar, chemical and biological) and management practices, subject to environmental factors such as solar radiation max./min. air temp. precipitation, day length variation, soil water properties and soil water condition.

1.4 POTENTIAL USE OF DSSAT

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.

In India, food production is marginal and solely dependent on monsoon rainfall. Failure of monsoon on a wide scale throws the economy of the country out of the gear. A pre-harvest forecast of crop yield could be of immense use to the planners. It will enable the government to take policy decisions on advance planning of internal food distribution, relief measure grain storage, and even providing alternative employment in drought affected areas. Crop simulation models are proposed as tools for agricultural risk analysis in order to explore the potential cropping locations and appropriate farming systems.

Boote et al (1996) proposed three primary uses of DSSAT as :

1. Model use as research tool – this includes (a) synthesize research understanding, (b) integrate knowledge across disciplines; (c) experiment documentation; (d) assist in genetic improvement; (e) yield gap analysis; weather vs non-weather effects.
2. Crop system amanagement – this includes; (a) assist in cultural management (b) assist in water and fertilizer N management; (c) in-season decisions aid for producers; and (d) site-specific on precision farming.
3. Policy analysis tool- this includes (a) assist in best management decisions to reduce fertilizer and pesticide leaching and soil erosion (b) yield forecasting; and (c) evaluate climate change effects.

1.5 OBJECTIVES OF STUDY

In view of the above a study entitled "Use of Decision Support System for Agrotechnology Transfer in Predicting Rice Yield" was undertaken with the following objectives :

1. to generate field 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, nitrogen uptake, nitrogen leach and evapotranspiration using validated DSSAT rice model under different agronomical management practices of rice cv IR 64.

CHAPTER – 2

REVIEW OF LITERATURE

Hundal and Kaur (1999) reported that Crop growth simulation models are quantitative tools based on scientific knowledge that can evaluate the effect of climatic, edaphic, 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, AFRCWHEAT, WTGROWS, MACROS and SWHEAT) have been developed outside India. Field studies at Ludhiana (Punjab) were conducted for the validation of wheat crop simulation model (CERES-Wheat). The results 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 satisfactorily 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.

Kurrey and Tripathi (1999) reported that Crop simulation modelling and production forecasting is the need of the hour to manage the situation of demand and supply. Simulation and forecasting also becomes essential to take the stock of agricultural production and manage the national economy. The present study was conducted during kharif 1998 at Demonstration Farm, WRDTC and aimed at developing the regression equation taking into account the climatic conditions (cumulative rainfall x_1 and cumulative reference evapotranspiration x_2) management technology (cumulative irrigation, x_3 & cumulative nitrogen application x_4 and plant growth condition (Leaf Area Index Days x_5) so as to predict the harvestable dry matter production. The end drymatter could be converted into grain production when multiplied by the harvest index.

The best fit regression model was developed as $y = -0.2164\ x_1 - 0.0020\ x_2 - 0.0021\ x_3 + 0.0118\ x_4 + 0.0450\ x_5$ ...... $R^2 = 0.9963$. Where y = cumulative dry matter production. The observed yield was 4.6 t/ha. Other yield attributing parameters were earhead density, 295.1 m^2, unfilled grains, 27.6%, filled grains/earhead, 87.4: and test weight of grain was 19.02g/1000 seeds. Harvest index was only 0.34 which is low because of the disease incidence in the standing crop. The model is sensitive to record changes in the dry matter production with changed input parameters. The climatic and plant growth data could be collected with the help of aerial photograph whereas the irrigation & fertiliser data could be obtained from the respective offices to use them for production forecasting.

Lal et.al. (1998) reported that Agricultural sector is one of the sensitive areas which would be influenced by the projected global warming and associated climate change. In spite of the uncertainties about the precise magnitude of climate change on regional scales an assessment of the possible impacts of changes in key climatic elements on our agricultural resources is important for formulating response strategies. In this study, vulnerability of wheat and rice crops in northwest India to the projected climate change is examined. CERES wheat and rice models adopted for the study were validated for their ability to reproduce yields at the selected NW Indian stations. The sensitivity experiments with these models showed higher yields for both wheat and rice (28% and 15% respectively for a doubling of CO_2) under elevated CO_2 levels. A 3°C (2°C) rise in air temperature nearly cancels out the positive effect of elevated CO_2 on the wheat (rice) yields. While the wheat crops are found to be sensitive to increase in maximum temperature, the rice crops are vulnerable to increase in minimum temperature. The combined effect of enhanced CO_2 and imposed thermal stress on the wheat (rice) crop is 21% (4%) increase in yield for the irrigation schedule presently practised in the region. While the adverse impacts of likely water shortage on wheat crops would be minimised to a certain extent under elevated CO_2 levels, they would largely be maintained for the rice crops would be minimised to a certain extent under elevated CO_2levels, they would largely be maintained for the rise crops shorting in about 20% net decline in rice yields. In general, acute water shortage conditions combined with the thermal stress should adversely affect both the wheat and more severely the rice productivity in NW India even under the positive effects of elevated CO_2 in the future.

Saseendran and Rathore (1999) reported that International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) (a collaborative program of USAID with University of Hawaii) was designed to help the acceleration of the process of knowledge dissemination to the decision-makers. IBSNAT incorporated process oriented dynamic crop simulation models into its international programme for agrotechnology transfer and developed DSSAT (Decision Support System for Agrotechnology Transfer) version 2.3 and 3.5 packages. In this context, a mathematical model is considered an effective tool for the capture, condensation and organization of knowledge. Models can become the means by which knowledge about systems and their performance is made portable and accessible to users of these systems. These crop models are mathematical representations 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 management and uncontrolled Weather variables. All the IBSNAT models simulate the effects of weather soil, water, cultivar and nitrogen dynamics in the soil and crop on the crop growth and yield. The models available in the DSSAT are 1 Cereal models (CERES) : wheat, Maize, Barley, Sorghum, Millet and Rice. 2. Grain legume models (CROPGRO) Soybean, Peanut and Dry bean; (3) Root crop models (SUBSTIR): Cassava Aroid and Potato. The Penman method or Priestly Taylor method can make evapotranspiration calculation in the models. The DSSAT v3.5 module have the capability to simulate the effects of CO_2 on Photosynthesis and Water use and such can be made use of in climate change impact studies. There are two strategy evaluation programs in DSSAT one for seasonal analysis and another for sequential analysis. Also, DSSAT models have built in capabilities for simulating weather using either one of two generators viz. WGEN or SIMMETEO physiological coupling points are provided in the three grain legume models for incorporating the effects of post damage on crop performance.

Saseendran et.al. (1998) reported that the CERES-Rice version 3.0 crop growth simulation model was calibrated and evaluated for the agroclimatic conditions of the state of Kerala in India. Genetic coefficients were developed for the rice crop variety Jaya and used for the model evaluation studies. In four experiments using different transplanting dates during the virippu season (June to September) under rainfed conditions (i.e. no irrigation), the flowering date was predicted within an error of four days and date of crop maturity within an error of two days. The model was found to predict the phenological events of the crop fairly well. The grain yield predicted by the model was within an error of 3% for all the transplanting dates, but the straw yield prediction was within 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 the agroclimatic conditions of Kerala. It can be concluded from this study that the model can be used for making various strategic and tactical decisions related to agricultural planning in the state.

Zhiquing et.al (1994) reported that the CERES-Rice model was calibrated and validated for nine sites in Southern China to examine its suitability to model rice production in the region, using agronomic data from three or more successive years. After determining the genetic coefficients for the cultivars, the CERES-Rice model lwas run a second time for the same locations for a time period of 20-30 years. The model used local climate data (1958-86) and doubled CO_2 climate change scenarios generated from the GISS, GFDL, and UKMO General Circulation Models (GCMs), with and without supplemental irrigation (to model paddy and upland rice, respectively). This study assessed the direct physiological effects of CO_2 on rice growth for each scenario. Finally, the study examined several strategies for adapting rice production to climate change.

The results of the study are listed below. They should not be regarded as predictions, but as plausible assessments of the potential effects of climate change on rice production in Southern China.

(1) Climate Change alone

Simulated rainfed rice yields decreased under climate change alone due to increases in temperature that shorten the growing season for rice. For some sites, however, sharp decreases in precipitation were also an important factor in the decreased yield of rainfed rice.

Rice yields simulated under "automatic" irrigation also decreased. Although irrigation did not fully compensate for the negative effects of climate change, it significantly improved simulated rice yields, especially in regions where precipitation decreased under climate change conditions.

(2) **Climate change with the direct effects of CO_2**

In rainfed rice, the direct effects of CO_2 compensated for the negative effects of climate change alone in most sites, except in sites, where rainfall sharply decreased in the climate change scenarios.

In irrigated rice, the three GCM scenarios produced increases in modeled rice yields in comparison with the beseline yields in the northern sites, but decreases in the central and southern sites. These findings suggest that there is less compensation by the physiological effects of CO_2 in areas with high temperature.

(3) **General results**

Simulated irrigated rice yields are higher and have less year to year variability than rainfed yields.

Under all climate change scenarios studied, the amount of water needed for automatic irrigation greatly increased in areas where precipitation sharply decreased.

Evapotranspiration (ET) for rainfed rice was usually less than that for automatic irrigated rice. Therefore, cultivation of upland rice may be extended into areas where irrigation water is not available.

An increase in temperature would increase China's rice-based cropping system. The northern limits for double-rice and triple-rice cropping systems could be moved northward about 5-10 degrees of latitude, depending on the climate scenario.

Introducing upland rice cultivars to areas where precipitation sharply decreased under the climate change scenarios significantly improved rainfed rice yields at some sites, but not at others.

For paddy rice, adjusting planting dates ameliorated the negative effects of climate change on modeled yields in the northern part of the study region, but not in the southern part.

CHAPTER – 3

BASE DATA GENERATION

The details of base data generated for use in DSSAT CERES-Rice model during kharif 2001 on Demonstration Farm (Photographs Plate No.1,2, & 3), WRDTC, IIT, Roorkee are described in forthcoming paragraphs.

3.1 EXPERIMENT DETAILS

Experiment Details : Rice crop cv IR 64 grown at DEMONSTRATION FARM, IIT, Roorkee was sown on 11.6.2001 in nursery, transplanted with 2 seedlings/hill at 35 days age and harvested on 19.10.2001, with three treatment of irrigation (I_1= 30 mm, I_2 = 60 mm and I_3 = 90 mm) and two nitrogen treatments (N_1 = 50 kgsN/ha & N_2 = 100 kgN/ha) combination. Treatment combinations were I_1N_1, I_1N_2, I_2N_1, I_2N_2, I_3N_1, and I_3N_2.

File name for storing experiment and model prediction informations are :

D:\DSSAT35\RICE\RSSE2001.RIX

D:\DSSAT35\RICE\RSSP2001.RIX

3.2 PLOT INFORMATION

	Header	Input Data
Gross plot area, m^2	PAREA	44.0 m^2
Rows per plot	PRNO	20
Plot length, m	PLEN	11.0 m
Plot spacing, cm	PLSP	100 cm
Harvest area, m^2	HAREA	30.0 m^2
Harvest Row no.	HRNO	15
Harvest Row length, m	HLEN	10 m
Harvest method	HARM	manual

3.3 TREATMENTS

Treatment	Given in Table 3.1		
Cultiver 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	30 mm (I_1)
		2	60 mm (I_2)
		3	90 mm (I_3)
Fertilizer level	MF	1	50 kg (N_1) applied in 3 split (S_1)
		2	100 kg (N_2) applied in 3 split (S_1)
		3	50 kg (N_1) applied in 4 split (S_2)
		4	100 kg (N_2) applied in 4 split (S_2)
		5	75 kg (N_3) applied in 3 split (S_1)
		6	125 kg (N_4) applied in 3 split (S_1)
		7	75 kg (N_3) applied in 4 split (S_2)
		8	125 kg (N_4) applied in 4 split (S_2)
Environmental modification Level	ME	1	
Harvest level	MH	1	
Simulation control level	SM	1	

3.4 CULTIVARS

Crop code	CR	RI
Cultivar identifier	INGENO	IB0015
Cultivar name	CNAME	IR 64

3.5 FIELDS

Field ID	IDFIELD	DEMOFARM
Weather station code	WSTA	WRDF

Drainage Type code	FLDT	DROOO (no drainage)
Soil Texture	SLTX	SALO (sandy loam)
Soil depth, cm	SLOP	90 cm
Soil ID	ID SOIL	WR00810001
Elevation, m	ELEV	252 m
Total area, m^2	AREA	1000 m^2
Field length width Ratio	FLWR	1.6

3.6 SOIL ANALYSIS

Analysis date (year + days from Jan. 1)	SADAT	81162 (11.06.2001)
(In view of Y2K problem with DSSAT the year 2001 is considered as 1981)		
pH in buffer determination method code	SMHB	SA 011
Phosphorus determination method code	SMPX	SA001
Potassium determination method code	SMKE	SA001
Depth, base of layer, cm	SABL	20 cm
		40 cm
		30 cm
Bulk density, most, g/cm^3	SADM	1.45
		1.46
		1.47
Organic carbon g/kg	SAOC	0.90
		0.10
		0.01
Total nitrogen g/kg	SANI	0.90
		0.10
		0.01
pH in water	SAHW	7.5
		7.5
		7.5

Phosphorous, extractable mg/kg	SAEX	15
		15
		10
Potassium, exchangeable mg/kg	SAKE	45
		45
		50

3.7 INITIAL CONDITIONS

Previous crop code	PCR	WH
Initial conditions measurement date (year + days)	ICDAT	81162 (11.06.2001)
Rout weight from previous crop kg/ha	ICRT	20
Nodule weight from previous crop, kg/ha	ICND	0
Rhizobia number (0 to 1 scale) (default=1)	ICRN	1
Rhizobia effectiveness, 0 to 1 scale (default = 1)	ICRE	1
Initial ground water depth, cm	ICWD	250 cm
Depth, base of layer, cm	ICBL	20
		60
		90
Water cm^3/cm^3x100 volume percent	SH_2O	0.228
		0.239
		0.249
Annonium, KCl, g elemental N/mg Soil	SNH_4	0.2
		0.2
		0.5
Nitrate, KCl, g elemental N/mg soil	SNO_3	12.0
		1.7
		1.2

3.8 PLANTING DETAILS

Planting date, year + day from Jan. 1	PDATE	81162 (11.6.2001)
Emergence date	EDATE	-99(not observed)
Plant population at seedling, plant/m^2	PPOP	70.7
Plant population at emergence, plant/m^2	PPOE	70.7
Planting method, transplant, T	PLME	T
Planting distribution, Hill H	PLPS	H
Row spacing, cm	PLRS	20
Planting depth, cm	PLDP	3.0
Planting material dry weight kg/ha	PLWT	very healthy (200 kgs/ha dry wt.) healthy (160 kgs/ha dry wt.) normal (120 kgs/ha dry wt.) fair (80 kgs/ha dry wt.)
Transplant age, days	PAGE	25 30 35
Temperature of transplant environment, °C	PENV	25.0
Plants per hill	PLPH	2 & 3

3.9 IRRIGATION AND WATER MANAGEMENT

Irrigation application efficiency, traction	EFIR	1.0
Threshhold for automatic appl., % of max. available	ITHR	50
End point for automatic appl. % of max. available	IEPT	100
End of application, growth stage code	IOFF	GS006

Method for automatic application, code	IAME	IR006
Amount per irrigation, mm	IAMT	30, 60 and 90
Irrigation date, year + day	IDATE	17 irrigation applied on date 1/8, 6/8, 8/8, 10/8, 20/8, 25/8, 8/8, 30/8, 1/9, 4/9, 7/9, 10/9, 13/9, 20/9, 5/9, 28/9 and 6.10.2001 Julian day's 81213, 218, 220, 222, 232, 237, 240, 242, 244, 247, 250, 81253, 81256, 263, 268, 271 and 81279

3.10 FERTILIZERS

Fertilizer application level	MF	8 levels	
Fertilization date, year + day	FDATE	Julian days 81197, 81211, 81227, 81229, 81242, 81248, 81258 date (16.7.01, 30.7.01, 15.8.01, 17.8.01, 30.8.01, 5.9.01 and 15.9.01)	
Fertilizer material, code	FMCD	FE018	Potassium Sulphate
		FE006	Diammonium Phosphate
		FE005	Urea
Fertilizer application, code	FACO	AP002	Broadcast
Fertilizer application depth, cm	FDEP	2	
N in applied fertilizer kg/ha	FAMN	FE006	5 (Total)
	FE005	50(Total)	
		@17 applied in 3 splits	
		75(Total)	
		@25 applied in 3 splits	

		100(Total)	
		@34 applied in 3 splits	
		125(Total)	
		@42 applied in 3 splits	
		50(Total)	
		@12 applied in 4 splits	
		75(Total)	
		@19 applied in 4 splits	
		100(Total)	
		@25 applied in 4 splits	
		125(Total)	
		@31 applied in 4 splits	
P in applied fertilizer kg/ha	FAMP	FE006	40
K in applied fertilizer, kg/ha	FAMK	FE018	40
Ca in applied fertilizer, kg/ha	FAMC	0	0
Other elements in applied fertilizer, kg/ha	FAMO	0	0

3.11 ENVIONRMENTAL MODIFICATIONS

Modification date, year + day	ODATE	81162 (11.6.01)
Day length adjustment factor	E	A

3.12 HARVEST DETAILS

Harvest level	HL	1
Harvest date, year + day	HDATE	81292
Harvest stage	HSTG	GS006
Harvest component, code	HCOM	H (Harvest product)
Harvest size group, code	HSIZE	A (all)
Harvest percentage, %	HPC	100.0

3.13 WEATHER DATA

Site + country name	WRDF	WRDF8101.WTH
Latitude, degrees	LAT	29°52'N

Longitude, degrees	LONG	77°54' E
Elevation, m	ELEV	252
Height of wind measurements, m	WMHT	2
Year + days from Jan. 1	DATE	81151-81288
Solar radiation	SRAO	*Sunshine hours (11.6.01-15.10.2001)
Air temperature max. °C	Tmax	*max. temp. recorded (11.6.01-15.10.01)
Air temp. min. °C	Tmin.	*Min. temp. recorded (11.6.01 –15.10.01)
Precipitation, mm	RAIN	*Rainfall recorded (11.6.01-15.10.01)

* These data are presented in annexure (i)- (v).

Experiment details of D:\DSSAT35\RICE\RSSP2001.RIX are presented in Table 3.1.

3.14 TOTAL WATER USE (IRRIGATION + RAINFALL)

Total water use during the crop period is shown in Table 3.2.

3.15 CROP EVAPOTRANSPIRATION (Etc)

Crop evapotranspiration were recorded through Lysimetric experiment for six treatments at Demonstration Farm, IIT, Roorkee is presented in table 3.3.

3.16 YIELD AND YIELD ATTRIBUTES

Yield and yield attributed was measured after maturity of crop and presented in Table 3.4.

3.17 OVERALL VIEW

An overall view of the field and crop is given in Plate 1 and Plate 2.

Table 3.1 : INPUT DATA FILE

```
*EXP.DETAILS: RSSP2001RI R.S. SHARMA

*GENERAL
@PEOPLE
 R.S.SHARMA T.O.,M.TECH(IWM)
@ADDRESS
 IIT ROORKEE
@SITE
 DEMOFARM ROORKEE
@ PAREA  PRNO  PLEN  PLDR  PLSP  PLAY HAREA  HRNO  HLEN HARM...........
  44.0     20  11.0   -99   100        30.0    15  10.0 MANNUAL
@NOTES
 a part of M.TECH Dessertation

*TREATMENTS                        -------------FACTOR LEVELS------------
@N R O C TNAME.................... CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 1 0 0 I1N1S1                     1  1  1  1  1  1  1  0  0  0  1  1  1
 2 1 0 0 I1N2S1                     1  1  1  1  1  1  2  0  0  0  1  1  1
 3 1 0 0 I2N1S1                     1  1  1  1  1  2  1  0  0  0  1  1  1
 4 1 0 0 I2N2S1                     1  1  1  1  1  2  2  0  0  0  1  1  1
 5 1 0 0 I3N1S1                     1  1  1  1  1  3  1  0  0  0  1  1  1
 6 1 0 0 I3N2S1                     1  1  1  1  1  3  2  0  0  0  1  1  1
 7 1 0 0 I1N1S2                     1  1  1  1  1  1  3  0  0  0  1  1  1
 8 1 0 0 I1N2S2                     1  1  1  1  1  1  4  0  0  0  1  1  1
 9 1 0 0 I2N1S2                     1  1  1  1  1  2  3  0  0  0  1  1  1
10 1 0 0 I2N2S2                     1  1  1  1  1  2  4  0  0  0  1  1  1
11 1 0 0 I3N1S2                     1  1  1  1  1  3  3  0  0  0  1  1  1
12 1 0 0 I3N2S2                     1  1  1  1  1  3  4  0  0  0  1  1  1
13 1 0 0 I1N3S1                     1  1  1  1  1  1  5  0  0  0  1  1  1
14 1 0 0 I1N4S1                     1  1  1  1  1  1  6  0  0  0  1  1  1
15 1 0 0 I2N3S1                     1  1  1  1  1  2  5  0  0  0  1  1  1
16 1 0 0 I2N4S1                     1  1  1  1  1  2  6  0  0  0  1  1  1
17 1 0 0 I3N3S1                     1  1  1  1  1  3  5  0  0  0  1  1  1
18 1 0 0 I3N4S1                     1  1  1  1  1  3  6  0  0  0  1  1  1
19 1 0 0 I1N3S2                     1  1  1  1  1  1  7  0  0  0  1  1  1
20 1 0 0 I1N4S2                     1  1  1  1  1  1  8  0  0  0  1  1  1
21 1 0 0 I2N3S2                     1  1  1  1  1  2  7  0  0  0  1  1  1
22 1 0 0 I2N4S2                     1  1  1  1  1  2  8  0  0  0  1  1  1
23 1 0 0 I3N3S2                     1  1  1  1  1  3  7  0  0  0  1  1  1
24 1 0 0 I3N4S2                     1  1  1  1  1  3  8  0  0  0  1  1  1

*CULTIVARS
@C CR INGENO CNAME
 1 RI IB0015 IR 64

*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
WR00810001
@L ...........XCRD ...........YCRD .....ELEV .............AREA .SLEN .FLWR
.SLAS
 1         0.00000         0.00000    252.00            1000.0     0   1.6
0.0
*SOIL ANALYSIS
@A SADAT  SMHB  SMPX  SMKE
 1 81162 SA011 SA001 SA001
@A  SABL  SADM  SAOC  SANI  SAHW  SAHB  SAEX  SAKE
 1    20  1.45  0.90  0.09   7.5 -99.0  15.0  45.0
 1    40  1.46  0.10  0.01   7.5 -99.0  15.0  45.0
 1    30  1.47  0.01  0.01   7.5 -99.0  10.0  50.0
```

```
*INITIAL CONDITIONS
@C   PCR ICDAT  ICRT  ICND  ICRN  ICRE  ICWD ICRES ICREN ICREP ICRIP ICRID
 1    WH 81162    20     0  1.00  1.00 250.0     0  0.03  0.00     0     0
@C  ICBL  SH2O  SNH4  SNO3
 1    20 0.228   0.2  12.0
 1    60 0.239   0.2   1.7
 1    90 0.248   0.5   0.2

*PLANTING DETAILS
@P PDATE EDATE  PPOP  PPOE  PLME  PLDS  PLRS  PLRD  PLDP  PLWT  PAGE  PENV
PLPH  SPRL
 1 81162   -99  70.7  70.7     T     H    20     0   3.0    80    25  25.0
2.0   0.0

*IRRIGATION AND WATER MANAGEMENT
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 1  1.00     3    50   100 GS006 IR006    30
@I IDATE  IROP IRVAL  IIRV
 1 81213 IR006    30     0
 1 81218 IR006    30     0
 1 81220 IR006    30     0
 1 81222 IR006    30     0
 1 81232 IR006    30     0
 1 81237 IR006    30     0
 1 81240 IR006    30     0
 1 81242 IR006    30     0
 1 81244 IR006    30     0
 1 81247 IR006    30     0
 1 81250 IR006    30     0
 1 81253 IR006    30     0
 1 81256 IR006    30     0
 1 81263 IR006    30     0
 1 81268 IR006    30     0
 1 81271 IR006    30     0
 1 81279 IR006    30     0
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 2  1.00     3    50   100 GS006 IR006    60
@I IDATE  IROP IRVAL  IIRV
 2 81213 IR006    60     0
 2 81218 IR006    60     0
 2 81220 IR006    60     0
 2 81222 IR006    60     0
 2 81232 IR006    60     0
 2 81237 IR006    60     0
 2 81240 IR006    60     0
 2 81242 IR006    60     0
 2 81244 IR006    60     0
 2 81247 IR006    60     0
 2 81250 IR006    60     0
 2 81253 IR006    60     0
 2 81256 IR006    60     0
 2 81263 IR006    60     0
 2 81268 IR006    60     0
 2 81271 IR006    60     0
 2 81279 IR006    60     0
```

```
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 3  1.00     3    50   100 GS006 IR006    90
@I IDATE  IROP IRVAL  IIRV
 3 81213 IR006    90     0
 3 81218 IR006    90     0
 3 81220 IR006    90     0
 3 81222 IR006    90     0
 3 81232 IR006    90     0
 3 81237 IR006    90     0
 3 81240 IR006    90     0
 3 81242 IR006    90     0
 3 81244 IR006    90     0
 3 81247 IR006    90     0
 3 81250 IR006    90     0
 3 81253 IR006    90     0
 3 81256 IR006    90     0
 3 81263 IR006    90     0
 3 81268 IR006    90     0
 3 81271 IR006    90     0
 3 81279 IR006    90     0

*FERTILIZERS (INORGANIC)
@F FDATE  FMCD  FACD  FDEP  FAMN  FAMP  FAMK  FAMC  FAMO  FOCD
 1 81197 FE018 AP002     2     0     0    40     0     0
 1 81197 FE006 AP002     2     5    40     0     0     0
 1 81211 FE005 AP002     2    17     0     0     0     0
 1 81229 FE005 AP002     2    17     0     0     0     0
 1 81248 FE005 AP002     2    17     0     0     0     0
 2 81197 FE018 AP002     2     0     0    40     0     0
 2 81197 FE006 AP002     2     5    40     0     0     0
 2 81211 FE005 AP002     2    34     0     0     0     0
 2 81229 FE005 AP002     2    34     0     0     0     0
 2 81248 FE005 AP002     2    34     0     0     0     0
 3 81197 FE006 AP002     2     5    40     0     0     0
 3 81197 FE018 AP002     2     0.    0    40     0     0
 3 81211 FE005 AP002     2    12     0     0     0     0
 3 81227 FE005 AP002     2    12     0     0     0     0
 3 81242 FE005 AP002     2    12     0     0     0     0
 3 81258 FE005 AP002     2    12     0     0     0     0
 4 81197 FE006 AP002     2     5    40     0     0     0
 4 81197 FE018 AP002     2     0     0    40     0     0
 4 81211 FE005 AP002     2    25     0     0     0     0
 4 81227 FE005 AP002     2    25     0     0     0     0
 4 81242 FE005 AP002     2    25     0     0     0     0
 4 81258 FE005 AP002     2    25     0     0     0     0
 5 81197 FE018 AP002     2     0     0    40     0     0
 5 81197 FE006 AP002     2     5    40     0     0     0
 5 81211 FE005 AP002     2    25     0     0     0     0
 5 81229 FE005 AP002     2    25     0     0     0     0
 5 81248 FE005 AP002     2    25     0     0     0     0
 6 81197 FE018 AP002     2     0     0    40     0     0
 6 81197 FE006 AP002     2     5    40     0     0     0
 6 81211 FE005 AP002     2    42     0     0     0     0
 6 81229 FE005 AP002     2    42     0     0     0     0
 6 81248 FE005 AP002     2    42     0     0     0     0
 7 81197 FE006 AP002     2     5    40     0     0     0
 7 81197 FE018 AP002     2     0     0    40     0     0
 7 81211 FE005 AP002     2    19     0     0     0     0
 7 81227 FE005 AP002     2    19     0     0     0     0
 7 81242 FE005 AP002     2    19     0     0     0     0
 7 81258 FE005 AP002     2    19     0     0     0     0
```

```
 8 81197 FE006 AP002      2     5    40     0     0     0
 8 81197 FE018 AP002      2     0     0    40     0     0
 8 81211 FE005 AP002      2    31     0     0     0     0
 8 81227 FE005 AP002      2    31     0     0     0     0
 8 81242 FE005 AP002      2    31     0     0     0     0
 8 81258 FE005 AP002      2    31     0     0     0     0

*ENVIRONMENTAL MODIFICATIONS
@E ODATE EDAY  ERAD  EMAX  EMIN  ERAIN  ECO2  EDEW EWIND
 1 81162 A 0.0 A 0.0 A 0.0 A 0.0 A 0.0 A    0 A 0.0 A 0.0

*HARVEST DETAILS
@H HDATE  HSTG  HCOM HSIZE   HPC  HBPC
 1 81292 GS006 H     A     100.0  43.0

*SIMULATION CONTROLS
@N GENERAL     NYERS NREPS START SDATE RSEED SNAME..................
 1 GE              1     1     P 81162  2150 IRRIGATION AND NITROGEN
@N OPTIONS     WATER NITRO SYMBI PHOSP POTAS DISES  CHEM  TILL
 1 OP              Y     Y     N     Y     Y     N     N     N
@N METHODS     WTHER INCON LIGHT EVAPO INFIL PHOTO HYDRO
 1 ME              M     M     E     R     S     C     R
@N MANAGEMENT  PLANT IRRIG FERTI RESID HARVS
 1 MA              R     R     R     N     R
@N OUTPUTS     FNAME OVVEW SUMRY FROPT GROUT CAOUT WAOUT NIOUT MIOUT DIOUT
LONG CHOUT OPOUT
 1 OU              Y     Y     Y     1     Y     Y     Y     Y     Y     N
Y    N    N

@  AUTOMATIC MANAGEMENT
@N PLANTING    PFRST PLAST PH2OL PH2OU PH2OD PSTMX PSTMN
 1 PL          81190 81204    40   100    30    40    10
@N IRRIGATION  IMDEP ITHRL ITHRU IROFF IMETH IRAMT IREFF
 1 IR             30    50   106 GS000 IR006    10  1.00
@N NITROGEN    NMDEP NMTHR NAMNT NCODE NAOFF
 1 NI             30    50    25 FE005 GS000
@N RESIDUES    RIPCN RTIME RIDEP
 1 RE            100     1    20
@N HARVEST     HFRST HLAST HPCNP HPCNR
 1 HA              0 82197   100     0
```

```
*EXP.DETAILS: RSSE2001RI R.S. SHARMA

*GENERAL
@PEOPLE
 R.S.SHARMA
@ADDRESS
 WRDTC
@SITE
 DF
@ PAREA  PRNO  PLEN  PLDR  PLSP  PLAY HAREA  HRNO  HLEN HARM.........
   44.0    20  11.0   -99   100        30.0    15  10.0 MANNUAL
@NOTES
 ME DESSERTATION

*TREATMENTS                        -------------FACTOR LEVELS------------
@N R O C TNAME.................... CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 1 0 0 I1N1                       1  1  1  1  1  1  1  0  0  0  0  1  1
 2 1 0 0 I1N2                       1  1  1  1  1  1  2  0  0  0  0  1  1
 3 1 0 0 I2N1                       1  1  1  1  1  2  1  0  0  0  0  1  1
 4 1 0 0 I2N2                       1  1  1  1  1  2  2  0  0  0  0  1  1
 5 1 0 0 I3N1                       1  1  1  1  1  3  1  0  0  0  0  1  1
 6 1 0 0 I3N2                       1  1  1  1  1  3  2  0  0  0  0  1  1

*CULTIVARS
@C CR INGENO CNAME
 1 RI IB0015 IR 64

*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
WR00810001
@L ...........XCRD ...........YCRD .....ELEV .............AREA .SLEN .FLWR
.SLAS
 1         0.00000         0.00000    252.00           1000.0     0   1.6
0.0

*SOIL ANALYSIS
@A SADAT  SMHB  SMPX  SMKE
 1 81162 SA011 SA001 SA001
@A  SABL  SADM  SAOC  SANI  SAHW  SAHB  SAEX  SAKE
 1    20  1.45  0.90  0.09   7.5 -99.0  15.0  45.0
 1    40  1.46  0.10  0.01   7.5 -99.0  15.0  45.0
 1    30  1.47  0.01  0.01   7.5 -99.0  10.0  50.0

*INITIAL CONDITIONS
@C   PCR ICDAT  ICRT  ICND  ICRN  ICRE  ICWD ICRES ICREN ICREP ICRIP ICRID
 1    WH 81162    20     0  1.00  1.00   250     0  0.03  0.00     0     0
@C  ICBL  SH2O  SNH4  SNO3
 1    20 0.228   0.2  12.0
 1    60 0.239   0.2   1.7
 1    90 0.248   0.5   0.2

*PLANTING DETAILS
@P PDATE EDATE  PPOP  PPOE  PLME  PLDS  PLRS  PLRD  PLDP  PLWT  PAGE  PENV
PLPH  SPRL
 1 81162   -99  70.7  70.7     T     H    20     0   3.0   120    35  25.0
2.0   0.0
```

```
*IRRIGATION AND WATER MANAGEMENT
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 1  1.00     3    50   100 GS006 IR006    30
@I IDATE  IROP IRVAL  IIRV
 1 81213 IR006    30     0
 1 81218 IR001    30     0
 1 81220 IR001    30     0
 1 81222 IR001    30     0
 1 81232 IR001    30     0
 1 81237 IR001    30     0
 1 81240 IR001    30     0
 1 81242 IR001    30     0
 1 81244 IR001    30     0
 1 81247 IR001    30     0
 1 81250 IR001    30     0
 1 81253 IR001    30     0
 1 81256 IR001    30     0
 1 81263 IR001    30     0
 1 81268 IR001    30     0
 1 81271 IR001    30     0
 1 81279 IR001    30     0
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 2  1.00     3    50   100 GS006 IR006    60
@I IDATE  IROP IRVAL  IIRV
 2 81213 IR001    60     0
 2 81218 IR001    60     0
 2 81220 IR001    60     0
 2 81222 IR001    60     0
 2 81232 IR001    60     0
 2 81237 IR001    60     0
 2 81240 IR001    60     0
 2 81242 IR001    60     0
 2 81244 IR001    60     0
 2 81247 IR001    60     0
 2 81250 IR001    60     0
 2 81253 IR001    60     0
 2 81256 IR001    60     0
 2 81263 IR001    60     0
 2 81268 IR001    60     0
 2 81271 IR001    60     0
 2 81279 IR001    60     0
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 3  1.00     3    50   100 GS006 IR006    90
@I IDATE  IROP IRVAL  IIRV
 3 81213 IR001    90     0
 3 81218 IR001    90     0
 3 81220 IR001    90     0
 3 81222 IR001    90     0
 3 81232 IR001    90     0
 3 81237 IR001    90     0
 3 81240 IR001    90     0
 3 81242 IR001    90     0
 3 81244 IR001    90     0
 3 81247 IR001    90     0
 3 81250 IR001    90     0
 3 81253 IR001    90     0
 3 81256 IR001    90     0
 3 81263 IR001    90     0
 3 81268 IR001    90     0
 3 81271 IR001    90     0
 3 81279 IR001    90     0
```

```
*FERTILIZERS (INORGANIC)
@F FDATE  FMCD  FACD  FDEP  FAMN  FAMP  FAMK  FAMC  FAMO  FOCD
 1 81197 FE018 AP002     2     0    00    40     0     0
 1 81197 FE006 AP002     2     5    40    00     0     0
 1 81211 FE005 AP002     2    17     0     0     0     0
 1 81229 FE005 AP002     2    17     0     0     0     0
 1 81248 FE005 AP002     2    17     0     0     0     0
 2 81197 FE018 AP002     2     0     0    40     0     0
 2 81197 FE006 AP002     2     5    40     0     0     0
 2 81211 FE005 AP002     2    34     0     0     0     0
 2 81229 FE005 AP002     2    34     0     0     0     0
 2 81248 FE005 AP002     2    34     0     0     0     0

*HARVEST DETAILS
@H HDATE  HSTG  HCOM HSIZE   HPC  HBPC
 1 81292 GS006  H     A     100.0  43.0

*SIMULATION CONTROLS
@N GENERAL     NYERS NREPS START SDATE RSEED SNAME....................
 1 GE              1     1     P 81162  2150 IRRIGATION AND NITROGEN
@N OPTIONS     WATER NITRO SYMBI PHOSP POTAS DISES  CHEM  TILL
 1 OP              Y     Y     N     Y     Y     N     N     N
@N METHODS     WTHER INCON LIGHT EVAPO INFIL PHOTO HYDRO
 1 ME              M     M     E     R     S     C     R
@N MANAGEMENT  PLANT IRRIG FERTI RESID HARVS
 1 MA              R     R     R     N     R
@N OUTPUTS     FNAME OVVEW SUMRY FROPT GROUT CAOUT WAOUT NIOUT MIOUT DIOUT
LONG CHOUT OPOUT
 1 OU              Y     Y     Y     1     Y     Y     Y     Y     Y     N
Y     N     N

@  AUTOMATIC MANAGEMENT
@N PLANTING    PFRST PLAST PH2OL PH2OU PH2OD PSTMX PSTMN
 1 PL          81190 81204    40   100    30    40    10
@N IRRIGATION  IMDEP ITHRL ITHRU IROFF IMETH IRAMT IREFF
 1 IR             30    50   106 GS000 IR006    10  1.00
@N NITROGEN    NMDEP NMTHR NAMNT NCODE NAOFF
 1 NI             30    50    25 FE005 GS000
@N RESIDUES    RIPCN RTIME RIDEP
 1 RE            100     1    20
@N HARVEST     HFRST HLAST HPCNP HPCNR
 1 HA              0 82197   100     0
```

Table 3.2 : Total Water Use (irrigation + Rainfall) in Rice cv IR64

Treatment → / Period (date) ↓	Total water use in (mm)					
	I_1N_1	I_1N_2	I_2N_1	I_2N_2	I_3N_1	I_3N_2
11/6-20/6	116.6	116.6	116.6	116.6	116.6	116.6
21/6-30/6	85.6	85.6	85.6	85.6	85.6	85.6
1/7-15/7	26.6	26.6	26.6	26.6	26.6	26.6
16/7-20/7	140.4	140.4	140.4	140.4	140.4	140.4
21/7-31/7	106.8	106.8	106.8	106.8	106.8	106.8
1/8-10/8	120.0	120.0	240.0	240.0	360.0	360.0
11/8-20/8	182.2	182.2	212.2	212.2	242.2	242.2
21/8-31/8	94.6	94.6	184.60	184.60	276.6	276.6
1/9-10/9	120	120	240	240	360	360
11/9-20/9	60	60	120	120	180	180
21/9-30/9	60	60	120	120	180	180
1/10-10/10	32.6	32.6	62.6	62.6	92.6	92.6
Total	1148	1148	1658	1658	2168	2168

Total irrigation for I_1 @ 30 mm per irrigation = 17x30 = 510 mm

I_2 @ 60 mm per irrigation = 17x60 = 1020 mm

I_3 @ 90 mm per irrigation = 17x90 = 1530 mm

Total Rainfall = 638 mm

Table 3.3 : Evapotranspiration in Rice cv IR64 grown under different irrigation and Nitrogen Treatments in Lysimeters

Treatment → / Period (date) ↓	Crop Evapotranspiration (ET_c) in mm							
	I_1N_1 Lys-1	I_1N_2 Lys-2	I_2N_1 Lys-3	I_2N_2 Lys-4	I_3N_1 Lys-5	I_3N_2 Lys-6	Daily Av. ET_c	Total av. ET_c
18/7-20/7	17.95	15.00	14.90	19.8	15.2	17.6	5.58	16.74
21/7-31/7	20.69	17.92	21.91	22.65	19.93	25.48	1.95	21.43
1/8-10/8	52.02	53.07	59.44	55.43	53.71	56.36	5.50	55.00
11/8-20/8	52.61	57.07	63.56	55.77	55.89	61.45	5.77	57.72
21/8-31/8	98.60	111.39	122.44	104.39	107.59	103.87	9.84	108.21
1/9-10/9	110.58	125.08	136.07	110.05	120.23	120.54	12.04	120.42
11/9-20/9	125.96	140.36	144.74	125.12	133.15	127.66	13.28	132.83
21/9-30/9	124.01	137.22	148.48	119.37	131.19	117.27	12.96	129.59
1/10-10/10	71.19	87.84	97.12	85.89	88.79	83.80	8.57	85.77
11/10-15/10	34.49	44.58	46.20	41.82	46.21	39.35	8.42	42.10
Total	708.1	789.53	855.86	743.84	772.02	753.38	-	769.81
Av.ET_c	7.86	8.77	9.50	8.26	8.578	8.37	-	8.55

Table 3.4 : Yield and Yield Attributes, observed Kharif Rice-2001 cv IR64 Demofarm IIT, Roorkee

Sl. No.	Treat ment	Grain yield (Q/ha)	Straw Q/ha	No. of ear head per sq. metre	Filled grain per ear head	Un filled grain per ear head	Grain weight per 1000 No.	Kernel wt (gm) per 1000 No.	Grain length (mm)	Grain width (mm)	Kernel length (mm)	Kernel width (mm)	G:S	% filled grain	Shell-ing %
No.	**Tr**	**GY**	**SY**	**ED**	**FG**	**UFG**	**Gtw**	**Ktw**	**GL**	**GW**	**KL**	**KW**	**Ratio**	**%**	**%**
1.	I_1N_1	35.00	46.67	234.33	71.67	7.00	23.33	21.87	9.44	2.55	6.94	1.86	0.74	91.10	93.74
2.	I_1N_2	45.17	53.33	279.33	88.33	22.33	23.50	21.10	9.42	2.58	7.00	1.70	0.84	79.82	89.78
3.	I_2N_1	32.83	44.67	237.67	86.67	8.67	23.20	21.00	9.50	2.70	6.76	1.82	0.73	90.90	90.51
4.	I_2N_2	46.00	62.17	260.00	93.00	22.00	24.14	21.46	9.44	2.54	6.93	1.83	0.74	80.86	88.89
5.	I_3N_1	37.33	49.33	246.00	66.33	15.33	22.68	20.43	9.40	2.66	6.86	1.81	0.75	81.22	90.07
6.	I_3N_2	41.67	55.17	262.67	101.0	19.00	23.83	19.63	9.60	2.70	6.94	1.83	0.75	84.16	82.37

Plate –1 : Experimental field having Lysimeters in treatment plots

Plate – 2 : Installing the water level instrument in Lysimeter

Plate – 3 : Bumper crop of experimental field

CHAPTER – 4

DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER (DSSAT) (AN OVERVIEW)

4.1 INTRODUCTION

IBSNAT assembled and distributed a Decision Support System entitled DSSAT (Tsuji et. al 1994) which enables its users to match the biological requirements of crops to the physical characteristics of land so that objectives specified may be obtained. These crop models are mathematical representations of daily biological and physical processes and are used to predict harvestable yield, plant growth and development. DSSAT contains crop-soil-weather simulation models, data bases for weather, soil and crops. The decision support software consists of :

(i) a database management system to enter, store and retrieve the "minimum data set" needed to validate, list and use the crop models for solving problems.

(ii) A set of validated crop models for simulating process and outcomes of genotype by environment interactions; and

(iii) An application program for analysing 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-models 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 bio mass.

A schematic diagram (Saseendran and Rathore 1999) of DSSAT components are presented in Fig. 4.1.

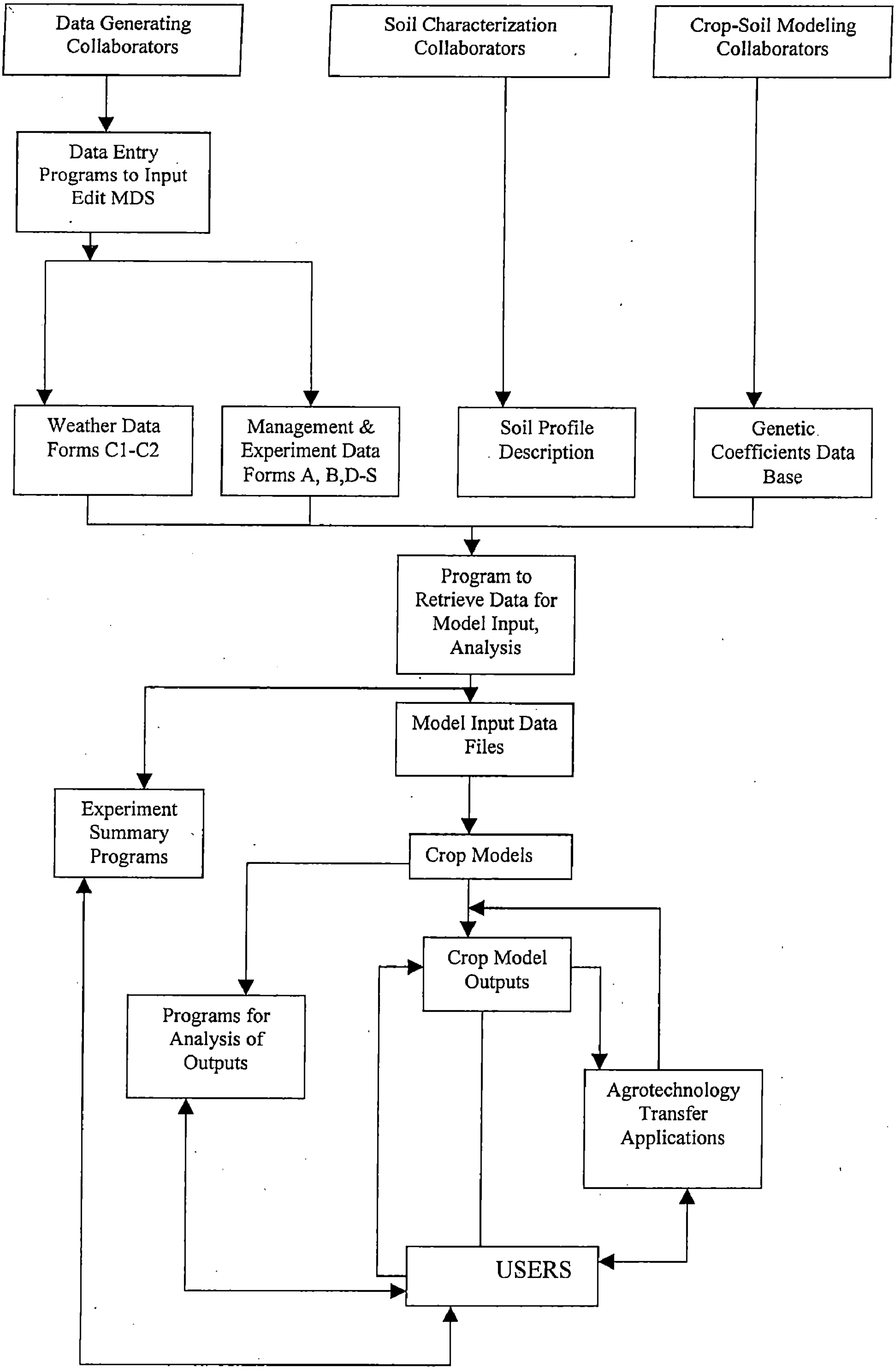


Fig. 4.1 : Schematic diagram of DSSAT components

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 realise heavily on crop simulation models to predict the performance of crops for making a wide range of decisions.

4.2 DSSAT OVERVIEW : DESCRIPTION

4.2.1 Shell

The DSSAT shell programme provides access to the programmes. DSSAT shell is a menu-driven program which enables user to easily select and use any of the DSSAT components. The shell has five main menu items each with various options : DATA, MODELS, ANALYSIS, TOOLS and SETUP /QUIT.

The DATA main menu item provides users access to weather, soil and experiment data. There is also climate and Genotype section. There is a background section which allows users to obtain general information on the data contained in their system, and sections on PEST and ECONOMICS to store and handle pest and economic data.

Under the MODELS section, user can access models for calibration, validation and sensitivity analysis purposes. Models are available for various cereal crops, legume crops and root crops.

Under the ANALYSIS section, two choices appears :

Seasonal and sequencial, the seasonal option allows users to setup simulation experiments, simulate them and analyze the results. The second option is to simulate sequences of crops such as in crop rotation, for studying the long term effects of practices on crop and soil performances.

Under TOOLS section, user can access their disk manager, their editor and spreadsheet.

4.2.2 Crop Models

The DSSAT crop models are mathematical representations 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 (management) and uncontrolled (weather) variables. These models simulates the effect of weather, soil, water, cultivar and nitrogen dynamics in the soil and crop on crop growth and yield. In order to predict a crop potential DSSAT crop models require the following informations (Saseendran and Rathore, 1999) :

i. The daily weather data consisting of maximum and minimum air temperatures, solar radiation and precipitation.

ii. The standard soil descriptions including data of soil properties as a function of depth.

iii. Information on sowing date, plant population amounts and dates of irrigation and amount and dates of N-fertilizer.

iv. Genetic information related to maturity type photoperiod sensitivity and yield components needed to evaluate optimum efficiencies within the constraints of weather and soil.

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

Model name	Developed By
CERES – Rice	Upendra Singh, Joc.T. Ritchie & D.C.Godwin
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.Ramkrishna
Soy GRO	J.W.Jones, G.Wilkerson & S.S.Jagtap
PNUT GRO	K.J. Boote, G.Hoogenboom & J.W.Jones
BENNGRO	G.Hoogenboom, J.w. Jones & K.J. Boote
SUBSTOR-Potato	T.S..Griffin. B.S. Johnson & J.T.Ritchie

SUNFLOWER	F.Villalobon, A.J. Hall & J.T. Ritchie
SUGARCANE	G.Inman – Bamber. G.Kiker, J.W. Jones
COTTON	B.Kimbal

4.2.3 Cereal Model : Rice

The cereal or 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 model is daily incrementing and require daily weather data consisting of maximum & minimum air temperature, solar radiation and rainfall. They calculate crop phasic and morphological development using temperature, day length, genetic characteristics and vernalization where appropriate leaf expansion growth and plant population provide information for determining the amount of light intercepted which is assumed to be proportional to biomass production.

The CERES-Rice model use a minimum of readily available weather, soil and specific genetic inputs. To simulate growth, development and yield the model take into account the following processes (Singh 2001) :

- Phenological development, especially as it is affected by genotype and weather. The model simulate the effect of photoperiod and temperature on the timing of panicle initiation and the duration of each major growth stage.
- Extensive growth of leaves, stem and roots
- Biomass accumulation and partitioning especially as phenological development affects the development and growth of vegetative and reproductive organs.
- Water balance that simulates daily evaporation 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 losses & N associated with runoff and percolation and uptake and utilisation of N by the crop.

4.2.4 Data Base Management System (DBMS)

DBMS is used to organize and store the minimum data sets, to provide user friendly data entry and retrieval and to integrate data from several sources. Retrieval programs extracts data from the centralized database and create files for running the crop models. Output can be printed and compared with experimental observations for validating the crop models and conducting sensitivity analysis application or agrotechnology transfer, programme facilitate running crop models for different management practices over several seasons to determine the most promising and least risky combination of management for various locations and soil types.

Crop management data include following :

File Section	Typical Contents
Experiment details	Experiment Name and Codes
General	Name of People, addresses, name and location of experiment site(s); plot information
Treatments	Treatment number, name and specification of level codes of the treatment factors
Cultivar	Cultival level, crop code, cultivar ID and name genetic coefficients
Fields	Specifications 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 field nutrients sampling, if any. Soil data are pedon characterization data by horizon with soil profile description
Initial conditions	Starting conditions for water and nitrogen in the profile. Also used for caryover of root residue from 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 information
Residues	Addition of straw, green manure, animal manure
Chemical applications	Herbicide and pesticide application data
Environment Modifications	Adjustment factor for weather parameters as used in climate change and constant environment studies (e.g., constant daylength, shading, constant temperature, etc.)
Tillage information	Details of dates, types of tillage operations
Harvest details	Information on harvest dates, plant components harvested etc.

Programme link weather and experimental data with the crop models by creating crop model input files. The minimum required weather data include latitude and longitude of the weather station and daily values of incoming solar radiation maximum & minimum air temperatures and rainfall.

4.2.5 Strategy Evaluation

The real power of the DSSAT (Singh 2001) for decision making lies in its ability to analyse many different management strategies. When a user in 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, and irrigation and fertilizer strategies to determine those practices that are most promising and least risky. The weather estimator and strategy evaluation programs in DSSAT establish the desired combinations of management practices, link the models to historical weather data for the location, run the model and analyse and present results to the user. performance variables include net return per hectare, duration of growth stages, Nitrogen and irrigation water stress and usage rates and Biomass and yield data.

4.2.6 Weather Generators

Weather estimators or generators (Saseendran and Rathore, 1999) software WGEN and WMAKER developed by Richerdson and Wreight (1985) and Keller (1982) respectively are included in DSSAT each estimator has two programmes : One program to compute weather coefficients from historical weather data and the second programme to generate weather data using these coefficients. The WGEN requires daily maximum and minimum temperatures. Solar radiation and precipitation from a number of years. While the other WMAKER relies on monthly means and standard deviations of potential evapotranspiration average air temperature, precipitation and number of wet days in a month.

4.2.7 Evapotranspiration Calculations

In the CERES, CROPGRO and the other DSSAT models, options exist for the Priestly-Taylor method for computing potential evapotranspiration, and for the Penman method using the FAO definitions of the wind term. The use of Penman method requires daily humidity solar radiation and wind speed data. The new weather file format includes columns for these data when they are available. When they are not available users should select the Priestly-Taylor method.

4.2.8 Carbon Dioxide Effects

The DSSAT models have the capability to simulate the effects of CO_2 on photosynthesis and water use (Lal et. al. 1998).

4.2.9 Climate Change Studies

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

4.2.10 Crop Rotations

An option in the models 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.

4.2.11 Input and Output Requirements

Input files : The input data files required for running the model are as follows :

(a) Weather data file (FILEW) : It contains daily weather data on maximum temperature, minimum temperature, total solar radiation and rainfall for the crop period. Solar radiation are computed from sunshine hours.

(b) Soil data file (FILES) : The soil file contains soil information about all the site 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. Soils are identified by a soil number. For each soil the values of soil albino, cumulative evaporation, the soil water conductivity factor and the runoff curve number are given. Soils are described by layer including the depth of each layer. 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 the numerous information provided in the file.

(c) Cultivar data file (FILEC) : This file contains the cultivar specific coefficients. A specific number identifies the cultivars.

(d) Experiment details file (FILEX) : This file documents the inputs (observed field data or hypothetical one) to the models for each experiment to be simulated as described in para 4.2.4. (DBMS).

(e) Experiment performance file (FILEP) : The observed values of experimental performance of the crop which can be used for comparison with the simulated outputs of the model run are provided in this file. The information provided includes anthesis date, physical maturity, yield, grain weight grain number, ear number, maximum LAI, total dry matter nitrogen concentration in rain and stem.

Output files : The model run produces six output files. The output file, OVERVIEW provides an overview of input conditions and crop performance, and a comparison with actual data if available. The second output file, SUMMERY provides a summery of output for use in application programs with one line of data for each crop season. The remaining four files namely GROWTH, CARBON, WATER and NITROGEN contain detailed simulation results including growth and development, carbon balance, water balance and nitrogen balance.

4.3 ACCESSING DATA, MODELS & APPLICATION PROGRAMMES

The DSSAT shell (as shown in screen 1) is the interface between the user and the crop models, application programmes and data files found in DSSAT. The shell is menu driven and thus enables users to easily select and use any of the DSSAT components.

DSSAT Main Menu: DSSAT has 5 main menu options. DATA, MODELS, ANALYSES, TOOLS, SETUPT/QUIT.

4.3.1 Data Menu Options

Data menu option provide users with access to various type of data on experiments, crops, weather, soils, climate, economics and pest. These data are found under the option headings BACKGROUND, EXPERIMENT, GENOTYPE, WEATHER SOIL, PEST and ECONOMICS.

(a) Background :

This menu is to provide general information, fields information and codes.

General information	Regarding Institutes, sites and people
Fields	helps users to review and edit description data on field and soil analysis data from field
Codes	The purpose of this menu option is to give users access to information on codes used for specifying fertilizers chemicals, growth stages and other management inputs.

(b) Experiment :

The purpose of the experiment menu option is to provide access to experiment 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 and brief description of experiment.

Create : Purpose of this menu option is to enable the users to create an experiment file (FILE X) which is used as an input file to the crop models. This includes field information, initial conditions, irrigation, fertilizer management, 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-formating weather data files; generating daily data; monthly data, analysing real and simulated weather data.

(e) Soil :

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

4.3.2 Models Menu Options

Under the models main menu item are listed "C Cereals", "L Legumes", "R Root crops" and "O others". These items provide users with access to crop simulation models for simulating the performance of real experiments and comparing model results with observed results (screen 2).

4.3.3 Analysis

This option gives users access to two programmes, 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 allow to run large experiments with many treatments replicated across many years of simulated or historical weather data. The results can be analyzed by comparing the treatments with respect to a wide variety of model outputs such as yields. In sequence analysis mode, crop rotation or sequence can be simulated alongwith 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 option give user access to the DOS shell and to user supplied disk manager, text editor and spread sheet programme.

4.3.5 Set Up/Quit Menu Options

This option enable users to modify programme paths, programme names and data file paths used in different sections of DSSAT.

4.4 CREATING MANAGEMENT FILES TO RUN MODELS AND DOCUMENT EXPERIMENTS

IBSNAT network have developed a system of data files, formats and conventions for storing information on crop production. The purpose of this system are to

(i) provide a uniform structure for documenting crop experiments conducted at any site, and

(ii) provide uniform data structures for crop model inputs and applications.

This system includes file 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 models. The programme which creates management files to run models and documents experiments is called X create. X create can be used to enter data from actual experiments or from hypothetical ones that are to be simulated on a computer. A user can create a FILEX for running the DSSAT crop models in three modes. These are :

1. Interactive or Experiment mode
2. Seasonal analysis mode
3. Sequence analysis mode

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

4.4.1 Creating a FILEX

X create is, in essence, an experiment data entry program for DSSAT and as such allows the user to enter management information for the various treatments and sections of an experiment. The information includes cultivar, field, soil analysis, initial conditions, planting, irrigation fertilizer, residues, chemical application, tillage and rotation, environmental modifications, harvest as shown in screen 4-8.

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

1. Select an existing experiment as a "template"
2. Add or remove treatments
3. Edit sections as required until complete
4. 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.

4.5 INPUT AND OUTPUT FILES

The IBSNAT has published documentation for a set of crop model input and outputs. This system of files and data formats 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 to those that described weather, soil, water and nutrient conditions, row and planting geometrics and crop management. In the current document, not only have those inputs and outputs been expanded but they are now more flexible, have more variables 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

A set of file naming conventions have 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/variety specific coefficient file
.OUT	Output file generated by the crop model
.LST	List file – Provides a list of either experiment weather data sets or soil data sets.
.CCX	Experiment details file (FILEX)
.CCP	Observation data (replicate values)
.CCD	Performance data (replicate values)
.CCA	Average values of observation data

The 'cc' in the above extension indicates a crop code. The crop code for Rice is as below :

Code	Crop
RI	Rice

The files are organized into input, output and experiment data file. In this RICE MODEL, different files are presented in Table 4.1.

Table 4.1 : Crop Model Input & Output Files

File Name	**Files Name (s)**	**Description**
Input files :		
Experiment :		
FILEL	Exp. LST	LISTING of all available experiment details files (FILEXs)
FILEX	RSSP 2001.RIX	Experiment details file for Rice : Treatments, field condition, crop management and simulation controls
WEATHER & SOIL :		
FILEW	WRDF 8101.WTH	Weather data, daily, for WRDTC Meteorological station, Roorkee for one year i.e. 2001
FILES	SOIL.SOL	Soil profile data for sandy soil for DEMOFARM, IIT, Roorkee
CROP & CULTIVAR :		
FILEC	RICER980-CUL	Cultivar for a Rice crop and model
OUTPUT FILES :		
OUTO	OVERVIEW.OUT	Overview of input & soil variables
OUTS	SUMMERY.OUT	Summery information
OUTG	GROWTH.OUT	Growth
OUTC	CARBON.OUT	Carbon balance
OUTW	WATER.OUT	Water balance
OUTN	NITROGEN.OUT	Nitrogen balance
OUTP	PHOSPHOROUS.OUT	Phosphorus balance

4.6 EXPERIMENT DETAILS FILE

One main file, referred to as FILEX documents the inputs to the models for each experiment to be simulated (Table 4.2 & Table 4.3).

EXPERIMENT :

A Rice Crop (IR 64) was grown at DEMOFARM-IIT Roorkee (11.6.2001 to 19.10.2001) with three treatments of Irrigation (30 mm, 60 mm and 90 mm) and two Nitrogen treatments (50 kgN/ha, 100 Kg N/ha) combination. Total combination were six. (e.g. I_1N_1, I_1N_2, I_2N_1, I_2N_2, I_3N_1, I_3N_2, where I_1 = 30 mm, I_2 = 60 mm, I_3 = 90 mm and N_1 = 50 kg N/ha and N_2 = 100 kg N/ha). In the simulation control section, the water and Nitrogen were both turned on as indicated by the 'Y' under water and NITRO options. Other details are shown in Table 3.1.

4.7 WEATHER DATA FILE

Daily weather data required were observed at DEMOFARM IIT Roorkee beginning with the day of planting and ending at crop maturity and contains at file WRDF 8101.WTH. The data format shown in Table 4.4.

4.8 SOIL DATA FILE

The soil file (FILES) contains data on the soil profile properties. Soil Identifier of DEMOFARM is WR000810001 and contained in the file SOIL.SOL. The data format shown in Table 4.5.

4.9 GENETIC COEFFICIENTS FILE FOR CERES-RICE (RICER 940.CUL)

Information on differences among crop genotypes are input to the model through genetic coefficient files. The coefficients stored in the file allow a single crop growth model to predict differences in development growth and yield.

Table 4.6 shows the current cultivars and genetic coefficients defined for Rice.

Experiment details codes are presented in Annexure XXX.

Simulated and field data codes are presented in Annexure XXXI.

Weather data codes are presented in Annexure XXXII.

Table 4.2 : Experiment Details 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)	SH2O	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.*

Table 4.3 : Simulation Controls

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	PH20L	1	R	5	0
Uppermost soil water, %	SWPLTH	PH2OU	1	R	5	0
Management depth for water, cm	SWPLTD	PH20D	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.*

Table 4.4 : Weather Data File. (FILEW)

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.*

TABLE 4.5. SOIL DATA FILE. (FILES)

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]
Line 1			
*SOILS:			0 C 10
Institute + country name			1 C 70
Subsequent lines relate to sections, as follows:			
Line 1			
Identifier (Institute + Site + Year + Soil)	PEDON	ID_SOIL	1 C 10
Source	SLSOUR	SLSOURCE	2 C 11
Texture, code[4]	SLTX	SLTX	1 C 5
Depth, cm	SLDP	SLDP	1 R 5 0
Description or local classification	SLDESC	SLDESCRIP	1 C 50
Line 2			
Site name	SSITE	SITE	1 C 11
Country name	SCOUNT	COUNTRY	1 C 11
Latitude	SLAT	LAT	1 R 8 3
Longitude	SLONG	LONG	1 R 8 3
Family, SCS system	TACON	SCSFAMILY	1 C 50
Line 3			
Color, moist, Munsell hue	SCOM	SCOM	1 C 5
Albedo, fraction	SALB	SALB	1 R 5 2
Evaporation limit, cm	U	SLUI	1 R 5 0
Drainage rate, fraction day^{-1}	SWCON	SLDR	1 R 5 2
Runoff curve number (Soil Conservation Service)	CN2	SLRO	1 R 5 0
Mineralization factor, 0 to 1 scale	SLNF	SLNF	1 R 5 2
Photosynthesis factor, 0 to 1 scale	SLPF	SLPF	1 R 5 2
pH in buffer determination method, code[4]	SMHB	SMHB	1 C 5
Phosphorus, extractable, determination code[4]	SMPX	SMPX	1 C 5
Potassium determination method, code[4]	SMKE	SMKE	1 C 5
Line 4 + (NL-1), where NL = number of layers.			
(L = Layer number)			
Depth, base of layer, cm	ZLYR(L)	SLB	1 R 5 0
Master horizon	MH(L)	SLMH	1 C 5
Lower limit, cm^3 cm^{-3}	LL(L)	SLLL	1 R 5 3
Upper limit, drained, cm^3 cm^{-3}	DUL(L)	SDUL	1 R 5 3

Upper limit, saturated, $cm^3\ cm^{-3}$	SAT(L)	SSAT	1 R 5 3
Root growth factor, 0.0 to 1.0	SHF(L)	SRGF	1 R 5 2
Sat. hydraulic conductivity, macropore, $cm\ h^{-1}$	SWCN(L)	SSKS	1 R 5 1
Bulk density, moist, $g\ cm^{-3}$	BD(L)	SBDM	1 R 5 2
Organic carbon, %	OC(L)	SLOC	1 R 5 2
Clay (<0.002 mm), %	CLAY(L)	SLCL	1 R 5 1
Silt (0.05 to 0.002 mm), %	SILT(L)	SLSI	1 R 5 1
Coarse fraction (>2 mm), %	STONES(L)	SLCF	1 R 5 1
Total nitrogen, %	TOTN(L)	SLNI	1 R 5 2
pH in water	PH(L)	SLHW	1 R 5 1
pH in buffer	PHKCL(L)	SLHB	1 R 5 1
Cation exchange capacity, $cmol\ kg^{-1}$	CEC(L)	SCEC	1 R 5 1

Line 4 + NL to (4 + NL + (NL - 1)), where NL = number of layers.
(L = Layer number)

Depth, base of layer, cm	ZZLYR(L)	SLB	1 R 5 0
Phosphorus, extractable, $mg\ kg^{-1}$	EXTP(L)	SLPX	1 R 5 1
Phosphorus, total, $mg\ kg^{-1}$	TOTP(L)	SLPT	1 R 5 1
Phosphorus, organic, $mg\ kg^{-1}$	ORGP(L)	SLPO	1 R 5 1
$CaCO_3$ content, $g\ kg^{-1}$	CACO(L)	SLCA	1 R 5 1
Aluminum	EXTAL(L)	SLAL	1 R 5 1
Iron	EXTFE(L)	SLFE	1 R 5 1
Manganese	EXTMN(L)	SLMN	1 R 5 1
Base saturation, $cmol\ kg^{-1}$	TOTBAS(L)	SLBS	1 R 5 1
Phosphorus isotherm A, $mmol\ kg^{-1}$	PTERMA(L)	SLPA	1 R 5 1
Phosphorus iostherm B, $mmol\ kg^{-1}$	PTERMB(L)	SLPB	1 R 5 1
Potassium, exchangeable, $cmol\ kg^{-1}$	EXK(L)	SLKE	1 R 5 1
Magnesium, $cmol\ kg^{-1}$	EXMG(L)	SLMG	1 R 5 1
Sodium, $cmol\ kg^{-1}$	EXNA(L)	SLNA	1 R 5 1
Sulfur	EXTS(L)	SLSU	1 R 5 1
Electric conductivity, seimen	SLEC(L)	SLEC	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 (Char acter = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

4 *For a complete listing of these codes, see Appendix B.*

Table 4.6 : Genetic Coefficients File for CERES-Rice (RICER940.CUL)

*RICE GENOTYPE COEFFICIENTS - RICER940 MODEL

!

@VAR#	VAR-NAME........	ECO#	P1	P2R	P5	P2O	G1	G2	G3	G4
!			1	2	3	4	5	6	7	8
!										
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

CERES-RICE

Table 4.6 shows an example of the current cultivars defined for rice. Required genetic coefficients include :

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 °C above a base temperature of 9°C) 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.

P2O Critical photoperiod or the longest day length (in hours) at which the development occurs at a maximum rate. At values higher than P2O 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 °C) for each hour increase in photoperiod above P2O

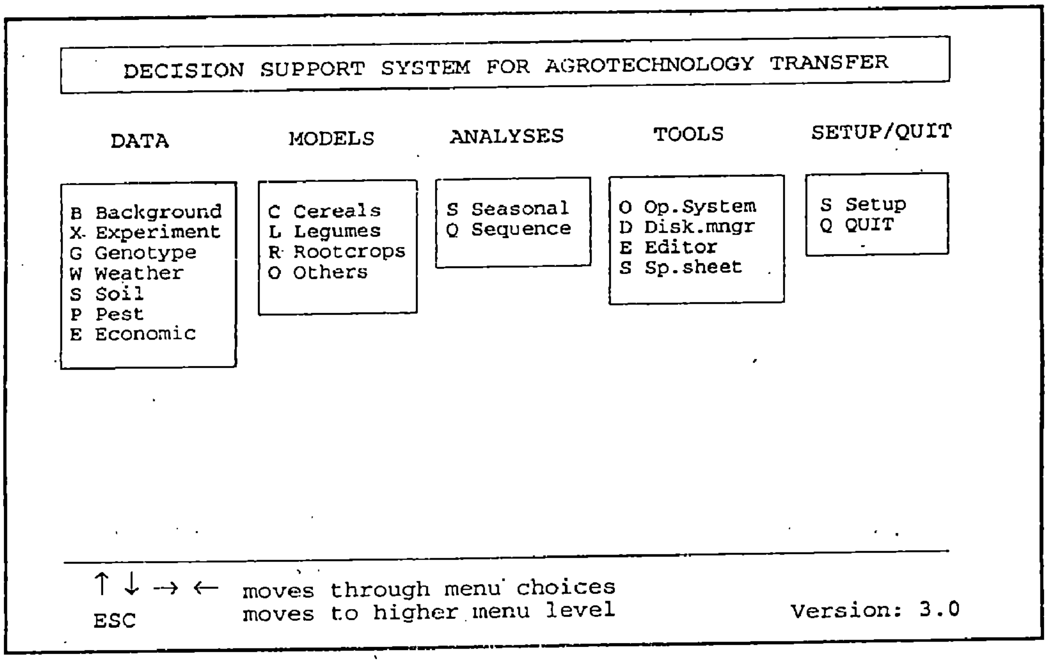
P5 Time period in GDD (°C) from beginning of grain filling (3 to 4 days after flowering) to physiological maturity with a base temperature of 9°C.

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.

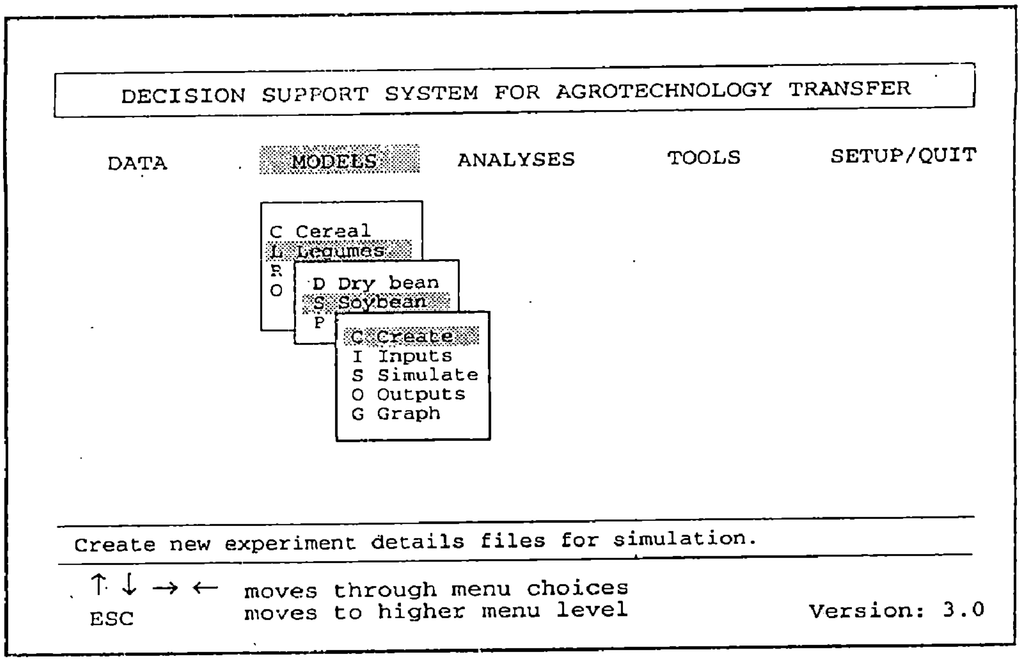
G2 Single grain weight (g) under ideal growing conditions, i.e. nonlimiting light, water, nutrients, and absence of pests and diseases.

G3 Tillering coefficient (scaler value) relative to IR64 cultivar under ideal conditions. A higher tillering cultivar would have coefficient greater than 1.0.

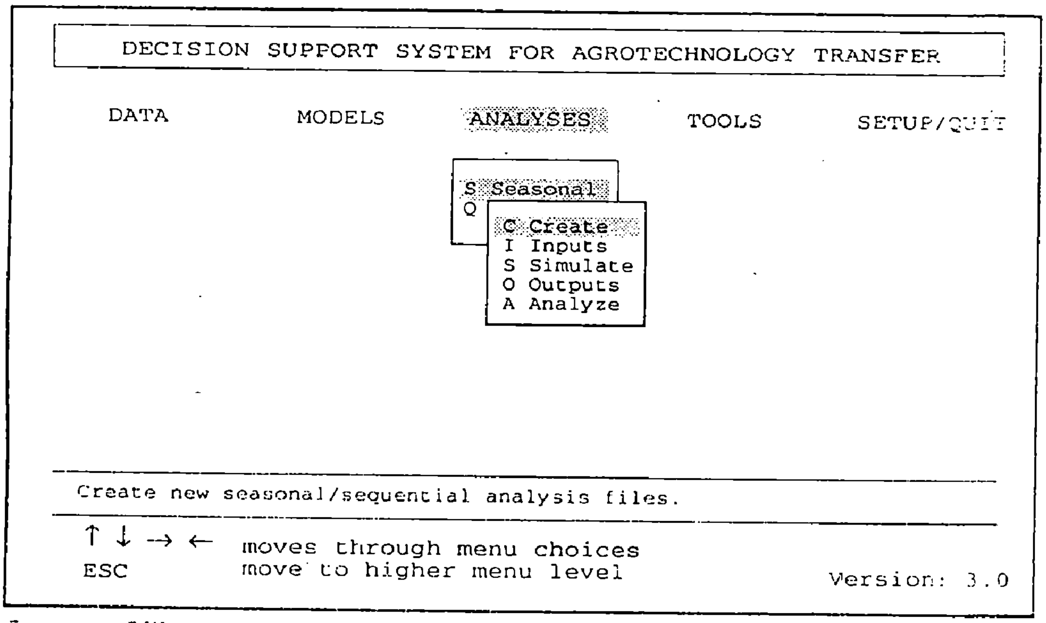
G4 Temperature tolerance coefficient. Usually 1.0 for varieties grown in normal environments. G4 for japonica type rice growing in a warmer environment would be 1.0 or greater. Likewise, the G4 value for indica type rice in very cool environments or season would be less than 1.0.



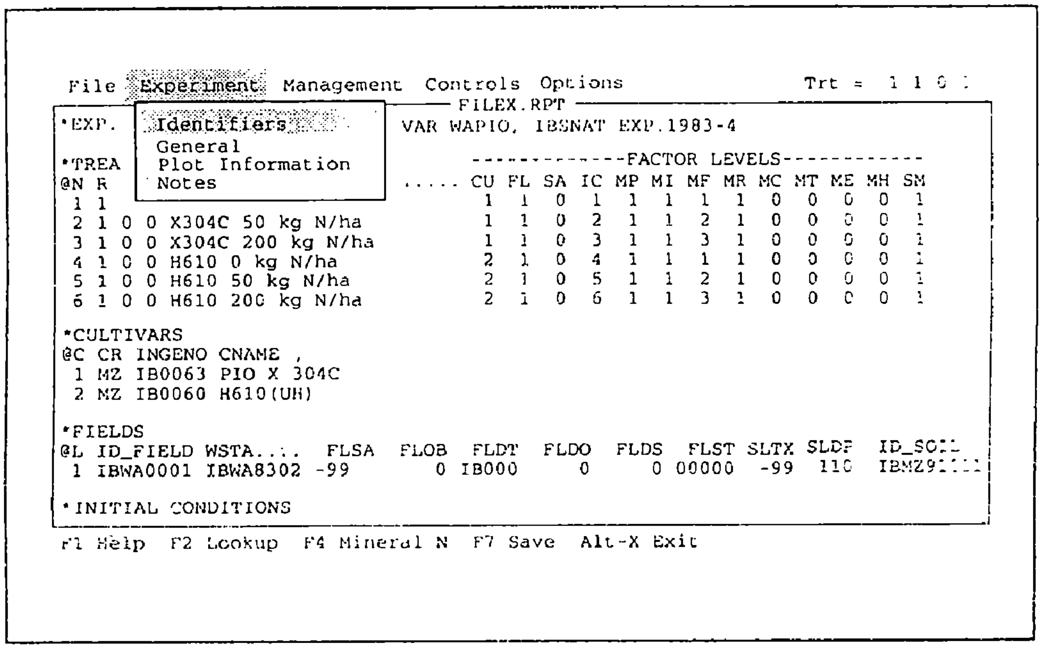
SCREEN 1



SCREEN 2



SCREEN 3



SCREEN 4

```
File  Experiment  Management  Controls  Options              Trt =  0 0 0 0

        [•]
          Select FILEX type                            OK
           (•) Experiment
           ( ) Seasonal
           ( ) Sequence

F1 Help  F2 Lookup  F4 Mineral N  F7 Save  Alt-X Exit
```

SCREEN 5

```
File  Experiment  Management  Controls  Options              Trt =  0 0 0 0

 [•]──────────── Select Template Experiment ──────────────
    1 FLSC8101 MZX N X IFFIG., S.C.                    Select
    2 IBSI8001 MZX MULTI-YEAR TEST,  SITIUNG         ▲
    3 IBWA8301 MZX N X VAR WAIPIO, IBSNAT EXP.19       View
    4 UFGA8201 MZX N X IRRIGATION, GAINESVILLE
                                                      New Expt

                                                       Cancel
                                                 ▼

F1 Help  F2 Lookup  F4 Mineral N  F7 Save  Alt-X Exit
```

SCREEN 6

```
 File  Experiment  Management  Controls  Options              Trt =  1 1 0 0
┌────────────────────────────┐── FILEX.RPT ──────────────────────────────
│Open using template         │R WAPIO, IBSNAT EXP.1983-4
│Change working directory    │
│Save current work       F7  │
├────────────────────────────┤
│Exit                  Alt-X │
└────────────────────────────┘
 IBSNAT,UNIV. OF HAWAII, HONOLULU, HI
@SITE
 WAIPIO,HAWAII 21.00;-158.00;-99;HAWA

*TREATMENTS                          -------------FACTOR LEVELS------------
@N R O C TNAME....................  CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 1 0 0 X304C 0 kg N/ha             1  1  0  1  1  1  1  1  0  0  0  0  1
 2 1 0 0 X304C 50 kg N/ha            1  1  0  2  1  1  2  1  0  0  0  0  1
 3 1 0 0 X304C 200 kg N/ha           1  1  0  3  1  1  3  1  0  0  0  0  1
 4 1 0 0 H610 0 kg N/ha              2  1  0  4  1  1  1  1  0  0  0  0  1
 5 1 0 0 H610 50 kg N/ha             2  1  0  5  1  1  2  1  0  0  0  0  1
 6 1 0 0 H610 200 kg N/ha            2  1  0  6  1  1  3  1  0  0  0  0  1

*CULTIVARS
@C CR INGENO CNAME
 F1 Help  F2 Lookup  F4 Mineral N  F7 Save  Alt-X Exit
```

SCREEN 7

```
 File  Experiment  Management  Controls  Options              Trt =  1 1 0 0
┌──────────────┌─────────────────────────┐─────────────────────────────[ ]┐
│*EXP.DETAILS: IBW│ Treatments            │NAT EXP.1983-4                  │
│                 ├───────────────────────┤                                │
│*TREA            │                       │----FACTOR LEVELS------------   │
│@N R O C TNAME...│ Cultivars             │IC MP MI MF MR MC MT ME MH SM   │
│ 1 1 0 0 X304C 0 │ Fields                │ 1  1  1  1  1  0  0  0  0  1   │
│ 2 1 0 0 X304C 50│ Soil Analysis         │ 2  1  1  2  1  0  0  0  0  1   │
│ 3 1 0 0 X304C 20│ Initial Conditions    │ 3  1  1  3  1  0  0  0  0  1   │
│ 4 1 0 0 H610 0 k│ Planting              │ 4  1  1  1  1  0  0  0  0  1   │
│ 5 1 0 0 H610 50 │ Irrigation            │ 5  1  1  2  1  0  0  0  0  1   │
│ 6 1 0 0 H610 200│ Fertilizer            │ 6  1  1  3  1  0  0  0  0  1   │
│                 │ Residue               │                                │
│*CULTIVARS       │ Tillage/Rotation      │                                │
│@C CR INGENO CNAM│ Chemicals             │                                │
│ 1 MZ IB0063 PIO │ Environment           │                                │
│ 2 MZ IB0060 H610│ Harvest               │                                │
│*FIELDS          └───────────────────────┘                                │
│@L ID_FIELD WSTA....  FLSA  FLOB  FLDT  FLDD  FLDS  FLST SLTX SLDP  ID_SOIL │
│ 1 IBWA0001 IBWA8302 -99       0 IB000    0     0 00000  -99  110  IBMZ91001│
│                                                                            │
│*INITIAL CONDITIONS                                                         │
└────────────────────────────────────────────────────────────────────────────┘
 F1 Help  F2 Lookup  F4 Mineral N  F7 Save  Alt-X Exit
```

SCREEN 8

CHAPTER – 5

DSSAT VALIDATION ON RICE cv IR 64

Data generated from the field experimentation on Rice cv IR 64 during Kharif 2001 on the Demonstration Farm of Indian Institute of Technology, Roorkee were used for validation. The treatments included 3 irrigation levels (I_1 = 510 mm, I_2 = 1020 mm, I_3 = 1530 mm) and 2 nitrogen level (N_1 = 50 kgs N/ha and N_2 100 kgs N/ha). Treatment combinations based for model validation are shown in Table 5.1. Besides, field experiments, the treatments were tried in the Lysimeter also. Observations used for validating the DSSAT model was grain yield and evapotranspiration of rice cv IR 64.

Simulation overview, summery of soil and genetic input parameter, simulated crop and soil status at main development stages, main growth and development variables, environmental and stress factors and abstract of various run for all six treatments are shown in Run 1:1 – 1:6.

Table 5.1 : Treatment Combinations used in DSSAT Model Validation

For Rice cv IR 64 under soil conditions of
Demonstration Farm of IIT Roorkee

Sl. No.	Main treatments	Numbers	Sub treatments
1	Dept of Irrigation	3	510 mm (I_1) 1020 mm (I_2) 1530 mm (I_3)
2	Nitrogen dose	2	50 kgs N/ha (N_1) 100 kgs N/ha (N_2)
Total Treatment = 3 x 2 = 6 nos.			

5.1 GRAIN YIELD

The Table 5.2 shows the yield actually observed and yield predicted by DSSAT under different treatments combinations. The overall average yield predicted by DSSAT is higher by 2.72% only over that of actually observed. This variation in yield is reasonably acceptable from a model prediction.

The yield observed and yield predicted by DSSAT for Rice cv IR 64 has also been presented in Fig. 5.1. This is worth noting that the highest yield predicted was recorded in treatment I_1N_2 and the same was actually observed.

Table 5.2 : Showing Grain Yield of Rice cv IR 64 validity by DSSAT
(seedling transplanted at the age of 35 days)

Treatments	Grain yield (kgs/ha)		Deviation for actuals (%)
	Actual	Predicted by DSSAT	
I_1N_1	3500	3831	+9.46
I_1N_2	4517	4831	+6.95
I_2N_1	3283	3618	+10.20
I_2N_2	4600	4502	-2.13
I_3N_1	3733	3415	- 8.52
I_3N_2	4167	4249	+1.97
Average	3967	4074	+2.72

5.2 EVAPOTRANSPIRATION

The cumulative evapotranspiration (CET) during the crop period from Rice cv IR 64 as predicted by DSSAT alongwith recorded values by Lysimeters during kharif 2001 grown under different treatment combinations are presented in Table 5.3.

The cumulative evapotranspiration actually predicted and recorded are shown in Fig. 5.2. Looking at the results, the average CET recorded from the Lysimeter was 770.3 mm whereas predicted by the DSSAT model was only 618.33 mm. In general the predicted values were lower by (19.45%) than the actuals, probably because of the limitation of the formulae used in the programme.

Table 5.3 : Showing Evapotranspiration of Rice cv IR 64 Validated by DSSAT

Treatments	Total Evapotranspiration (mm)		Deviation for actuals (%)
	Actual	Predicted by DSSAT	
I_1N_1	708	620	- 12.43
I_1N_2	789	623	- 21.04
I_2N_1	856	618	- 27.80
I_2N_2	744	619	- 16.8
I_3N_1	772	614	- 20.46
I_3N_2	753	616	- 18.19
Average	770.3	618.33	- 19.45

A validation study for CERES-wheat model (V2-1) was conducted at Ludhiana (Punjab) using the field data of eight consecutive crop seasons from 1985 to 1993 by Hundal & Prabhjyot Kaur (1997). The simulated anthesis and physiological maturity dates, grain and total biomass yield of wheat were compared with actual observations for one commonly grown cultivar HD 2329. The simulated and actual dates of phenologic events showed deviations from only –9 to –6 days for anthesis and –6 to +3 days for physiological maturity of the crop. The model predicted the grain yields from 80 to 115% (mean 97.5%) of the observed grain yield.

Saseendran et al (1998), selected the rice crop variety Jaya for calibration of the model as it is one of the popularly cultivated cultivar in Kerala. The model validation results showed that, in eight experiments with different planting dates under rainfed conditions, the flowering date was predicted within an error of four days and the date of crop maturity within an error of two days. The grain yield predicted by the model was within an error of 3% for both transplanting dates.

Jhiquing et.al (1994) examine DSSAT suitability in China and found fit for yield prediction.

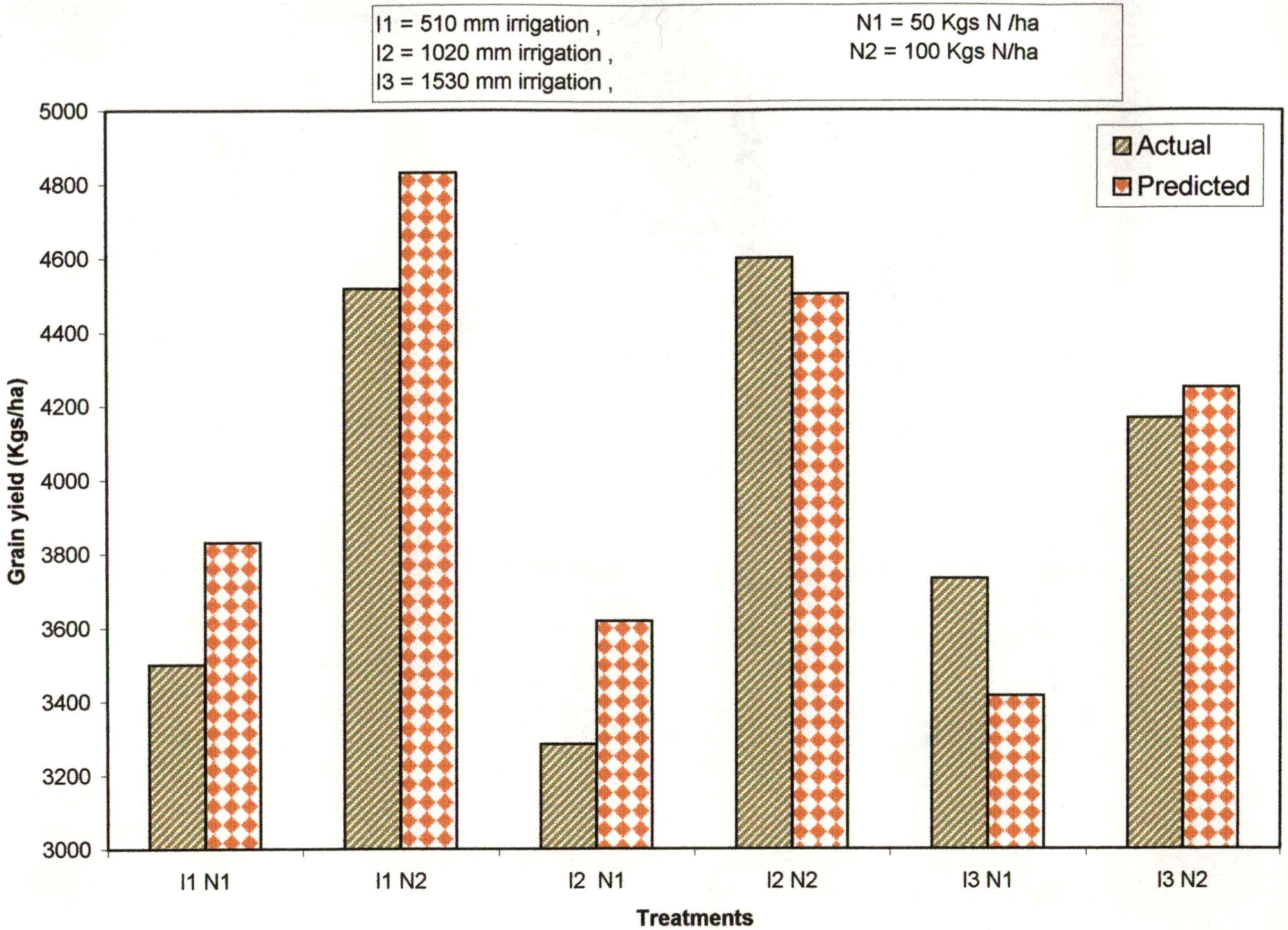


Fig. 5.1 : Grain yield (Kgs/ha) of rice cv IR 64 actually recorded and predicted by DSSAT for the cultural conditions practiced in the experiment.

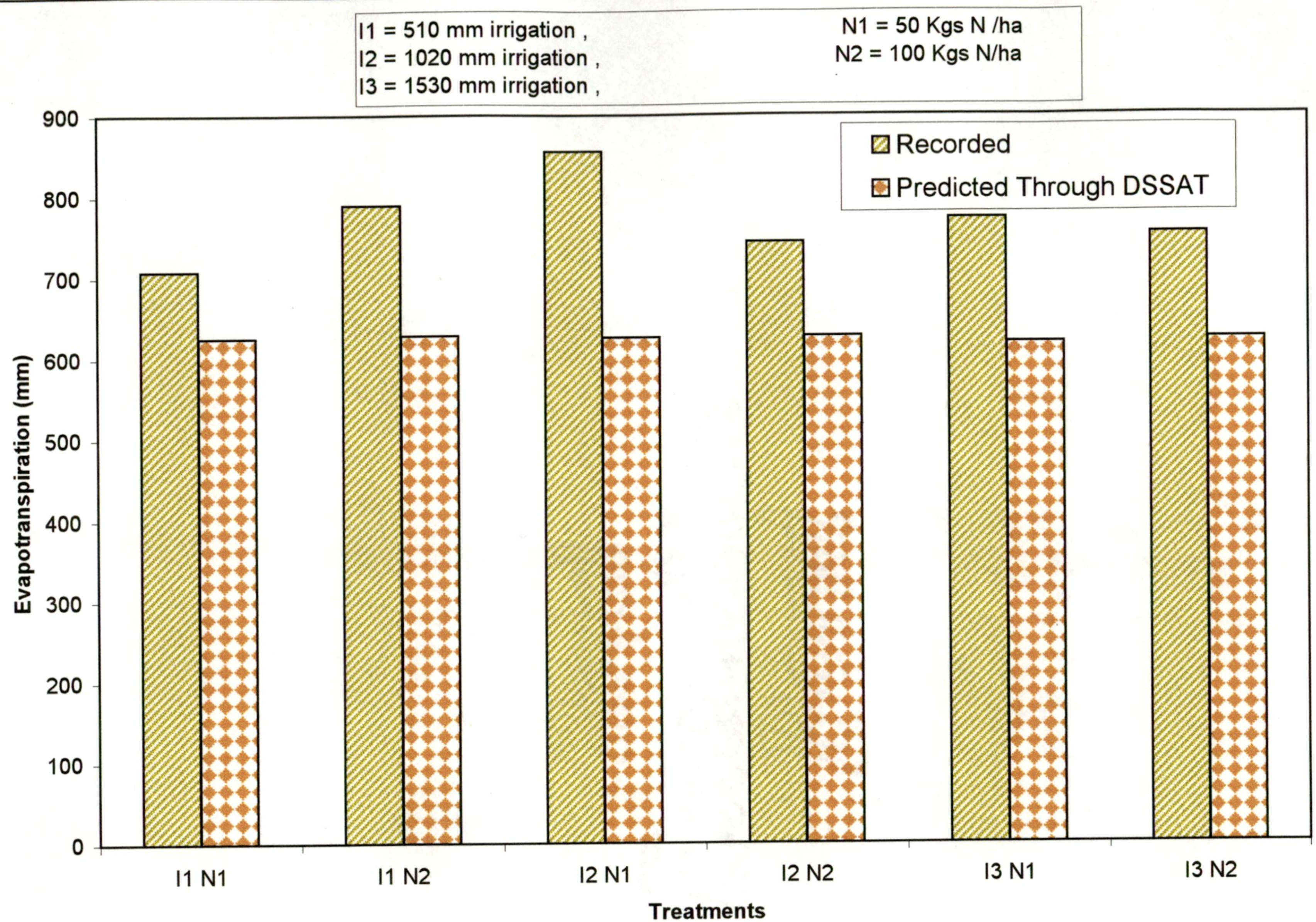


Fig. 5.2 : Evapotranspiration of rice cv IR 64 actually recorded in Lysimeter and predicted by DSSAT at Roorkee during Khrif 2001.

```
SIMULATION OVERVIEW

RUN   1          : 1
MODEL            : RICER980 - RICE
EXPERIMENT       : RSSE2001 RI    R.S. SHARMA
TREATMENT  1     : I1N1

CROP             : RICE             CULTIVAR : IR 64           -
STARTING DATE    : JUN 11 1981
PLANTING DATE    : JUN 11 1981      PLANTS/m2 : 70.7     ROW SPACING :  20.cm
WEATHER          : WRDF   1981
SOIL             : WR00810001       TEXTURE : SALO   - SANDY LOAM
SOIL INITIAL C   : DEPTH: 90cm EXTR. H20:111.1mm  NO3: 45.6kg/ha  NH4:  4.0kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :      510 mm IN     17 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :        56 kg/ha IN     5 APPLICATIONS
RESIDUE/MANURE   : INITIAL :      0 kg/ha ;        0 kg/ha IN     0 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  :C  ET :R
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:N  HARVEST:R  WTH:M

Please press < ENTER > key to continue
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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	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
5- 15	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
15- 30	.112	.235	.352	.124	.235	.30	1.46	7.50	5.13	.20	.37
30- 45	.116	.239	.351	.123	.239	.20	1.47	7.50	1.70	.20	.01
45- 60	.116	.239	.351	.123	.239	.20	1.45	7.50	1.70	.20	.10
60- 90	.125	.248	.353	.123	.248	.10	1.47	7.50	.20	.50	.01
TOT- 90	10.5	21.6	31.7	11.1	21.6	<--cm	-	kg/ha-->	45.6	4.0	30423

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.20 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :IB0015-IR 64 ECOTYPE : -
P1 : 500.0 P2R : 160.0 P5 : 450.0 P20 : 12.0
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.00
Please press < ENTER > key to continue

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	STRESS N
11 JUN	0	Transplant	126	.28	5	8	0	0	0	5	3.9	.00	.00
11 JUN	0	Start Sim	126	.28	5	8	0	0	0	5	3.9	.00	.00
24 JUN	13	End Juveni	173	.35	8	63	179	0	0	7	4.2	.14	.00
23 JUL	42	Pan Init	1437	1.23	15	205	402	0	0	27	1.9	.09	.63
22 AUG	72	Heading	3455	1.44	23	370	634	150	0	54	1.6	.00	.60
31 AUG	81	Beg Gr Fil	4853	1.31	23	426	635	240	0	58	1.2	.00	.08
19 SEP	100	End Mn Fil	6384	.45	23	524	635	390	0	72	1.1	.00	.31
21 SEP	102	End Ti Fil	6384	.36	23	536	635	420	0	73	1.1	.00	.48
22 SEP	103	Maturity	6384	.36	23	540	635	420	0	73	1.1	.00	.48
19 OCT	130	Harvest	6384	.36	23	620	638	510	0	73	1.1	.00	.48

Press < ENTER > key to continue

MAIN GROWTH AND DEVELOPMENT VARIABLES

VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	42	-99
FLOWERING DATE (dap)	72	96
PHYSIOL. MATURITY (dap)	103	118
GRAIN YIELD (kg/ha) AT 14% H2O	3831	3500
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	13180	16790
PANICLE NUMBER (PANICLE/m2)	671.42	234
MAXIMUM LAI (m2/m2)	1.46	-99
BIOMASS (kg/ha) AT ANTHESIS	3335	-99
BIOMASS N (kg N/ha) AT ANTHESIS	53	-99
BIOMASS (kg/ha) AT HARVEST MAT.	6384	8167
STALK (kg/ha) AT HARVEST MAT.	3089	4667
HARVEST INDEX (kg/kg)	.516	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	46	-99
BIOMASS N (kg N/ha)	73	-99
STALK N (kg N/ha)	27	-99
SEED N (%)	1.39	-99

RUN 1 : 1 ... Press < ENTER > key to continue

ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX xC	WEATHER: TEMP MIN xC	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	13	33.58	24.58	20.78	13.88	.128	.137	.000	.069
End Juvenil-Panicl Init	29	33.45	25.60	22.09	13.79	.038	.086	.604	.732
Panicl Init-End Lf Grow	30	32.95	25.98	21.18	13.27	.000	.000	.614	.779
End Lf Grth-Beg Grn Fil	9	33.72	26.00	22.86	12.77	.000	.000	.106	.250
Grain Filling Phase	21	33.83	23.69	21.69	12.33	.000	.000	.301	.468

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD : 3831 kg/ha [DRY WEIGHT]

Do you want to run more simulations ?
Y or N ? [Default = "N"] ===>

```
SIMULATION OVERVIEW

RUN    1          : 2
MODEL             : RICER980 - RICE
EXPERIMENT        : RSSE2001 RI    R.S. SHARMA
TREATMENT  2      : I1N2

CROP              : RICE           CULTIVAR : IR 64          -
STARTING DATE     : JUN 11 1981
PLANTING DATE     : JUN 11 1981    PLANTS/m2 : 70.7     ROW SPACING :  20.cm
WEATHER           : WRDF    1981
SOIL              : WR00810001     TEXTURE : SALO   - SANDY LOAM
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:111.1mm  NO3: 45.6kg/ha  NH4:  4.0kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :      510 mm IN    17 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :      107 kg/ha IN     5 APPLICATIONS
RESIDUE/MANURE    : INITIAL :     0 kg/ha ;        0 kg/ha IN     0 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  :C  ET :R
MANAGEMENT OPT    : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:N  HARVEST:R  WTH:M

Please press < ENTER > key to continue
```

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	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
5- 15	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
15- 30	.112	.235	.352	.124	.235	.30	1.46	7.50	5.13	.20	.37
30- 45	.116	.239	.351	.123	.239	.20	1.47	7.50	1.70	.20	.01
45- 60	.116	.239	.351	.123	.239	.20	1.45	7.50	1.70	.20	.10
60- 90	.125	.248	.353	.123	.248	.10	1.47	7.50	.20	.50	.01
TOT- 90	10.5	21.6	31.7	11.1	21.6	<--cm	-	kg/ha-->	45.6	4.0	30423

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.20 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :IB0015-IR 64 ECOTYPE : -
P1 : 500.0 P2R : 160.0 P5 : 450.0 P20 : 12.0
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.00
Please press < ENTER > key to continue

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	N
11 JUN	0	Transplant	126	.28	5	8	0	0	0	5	3.9	.00	.00
11 JUN	0	Start Sim	126	.28	5	8	0	0	0	5	3.9	.00	.00
24 JUN	13	End Juveni	173	.35	8	63	179	0	0	7	4.2	.14	.00
23 JUL	42	Pan Init	1437	1.23	15	205	402	0	0	27	1.9	.09	.63
23 AUG	73	Heading	4430	1.88	23	376	635	150	0	84	1.9	.00	.46
31 AUG	81	Beg Gr Fil	5961	1.68	23	426	635	240	0	88	1.5	.00	.00
20 SEP	101	End Mn Fil	8442	.50	23	531	635	420	0	120	1.4	.00	.00
22 SEP	103	End Ti Fil	8477	.39	23	541	635	420	0	120	1.4	.00	.00
23 SEP	104	Maturity	8477	.39	23	544	635	420	0	120	1.4	.00	.00
19 OCT	130	Harvest	8477	.39	23	623	638	510	0	120	1.4	.00	.00

Press < ENTER > key to continue

MAIN GROWTH AND DEVELOPMENT VARIABLES

VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	42	-99
FLOWERING DATE (dap)	73	103
PHYSIOL. MATURITY (dap)	104	128
GRAIN YIELD (kg/ha) AT 14% H2O	4831	4517
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	16617	24673
PANICLE NUMBER (PANICLE/m2)	774.34	279
MAXIMUM LAI (m2/m2)	1.90	-99
BIOMASS (kg/ha) AT ANTHESIS	4221	-99
BIOMASS N (kg N/ha) AT ANTHESIS	83	-99
BIOMASS (kg/ha) AT HARVEST MAT.	8477	9850
STALK (kg/ha) AT HARVEST MAT.	4323	5333
HARVEST INDEX (kg/kg)	.490	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	72	-99
BIOMASS N (kg N/ha)	120	-99
STALK N (kg N/ha)	48	-99
SEED N (%)	1.74	-99

RUN 1 : 2 ... Press < ENTER > key to continue

ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX xC	WEATHER: TEMP MIN xC	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	13	33.58	24.58	20.78	13.88	.128	.137	.000	.069
End Juvenil-Panicl Init	29	33.45	25.60	22.09	13.79	.038	.086	.604	.732
Panicl Init-End Lf Grow	31	32.84	26.02	21.08	13.26	.000	.000	.488	.632
End Lf Grth-Beg Grn Fil	8	34.25	25.88	23.46	12.75	.000	.000	.000	.000
Grain Filling Phase	22	33.84	23.59	21.72	12.31	.000	.000	.000	.072

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD : 4831 kg/ha [DRY WEIGHT]

Do you want to run more simulations ?
Y or N ? [Default = "N"] ===>

```
SIMULATION OVERVIEW

RUN    1          : 3
MODEL             : RICER980 - RICE
EXPERIMENT        : RSSE2001 RI    R.S. SHARMA
TREATMENT  3      : I2N1

CROP              : RICE              CULTIVAR : IR 64
STARTING DATE     : JUN 11 1981
PLANTING DATE     : JUN 11 1981       PLANTS/m2 : 70.7      ROW SPACING :  20.cm
WEATHER           : WRDF    1981
SOIL              : WR00810001        TEXTURE : SALO  - SANDY LOAM
SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:111.1mm  NO3: 45.6kg/ha  NH4:  4.0kg/ha
WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
IRRIGATION        :     1020 mm IN    17 APPLICATIONS
NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER      :        56 kg/ha IN     5 APPLICATIONS
RESIDUE/MANURE    : INITIAL :      0 kg/ha ;        0 kg/ha IN     0 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  :C  ET :R
MANAGEMENT OPT    : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:N  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	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
5- 15	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
15- 30	.112	.235	.352	.124	.235	.30	1.46	7.50	5.13	.20	.37
30- 45	.116	.239	.351	.123	.239	.20	1.47	7.50	1.70	.20	.01
45- 60	.116	.239	.351	.123	.239	.20	1.45	7.50	1.70	.20	.10
60- 90	.125	.248	.353	.123	.248	.10	1.47	7.50	.20	.50	.01
TOT- 90	10.5	21.6	31.7	11.1	21.6	<--cm	-	kg/ha-->	45.6	4.0	30423

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.20 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :IB0015-IR 64 ECOTYPE : -
P1 : 500.0 P2R : 160.0 P5 : 450.0 P20 : 12.0
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.00
Please press < ENTER > key to continue

SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 3

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
11 JUN	0	Transplant	126	.28	5	8	0	0	0	5	3.9	.00	.00
11 JUN	0	Start Sim	126	.28	5	8	0	0	0	5	3.9	.00	.00
24 JUN	13	End Juveni	173	.35	8	63	179	0	0	7	4.2	.14	.00
23 JUL	42	Pan Init	1437	1.23	15	205	402	0	0	27	1.9	.09	.63
22 AUG	72	Heading	3299	1.38	23	371	634	300	0	48	1.5	.00	.63
31 AUG	81	Beg Gr Fil	4521	1.27	23	427	635	480	0	52	1.1	.00	.20
19 SEP	100	End Mn Fil	5836	.42	23	524	635	780	0	61	1.0	.00	.40
21 SEP	102	End Ti Fil	5836	.34	23	536	635	840	0	61	1.0	.00	.57
22 SEP	103	Maturity	5836	.34	23	540	635	840	0	61	1.0	.00	.57
19 OCT	130	Harvest	5836	.34	23	618	638	1020	0	61	1.0	.00	.57

Press < ENTER > key to continue

MAIN GROWTH AND DEVELOPMENT VARIABLES

VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	42	-99
FLOWERING DATE (dap)	72	96
PHYSIOL. MATURITY (dap)	103	118
GRAIN YIELD (kg/ha) AT 14% H2O	3618	3283
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	12445	20598
PANICLE NUMBER (PANICLE/m2)	632.35	238
MAXIMUM LAI (m2/m2)	1.40	-99
BIOMASS (kg/ha) AT ANTHESIS	3194	-99
BIOMASS N (kg N/ha) AT ANTHESIS	48	-99
BIOMASS (kg/ha) AT HARVEST MAT.	5836	7750
STALK (kg/ha) AT HARVEST MAT.	2724	4467
HARVEST INDEX (kg/kg)	.533	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	39	-99
BIOMASS N (kg N/ha)	61	-99
STALK N (kg N/ha)	22	-99
SEED N (%)	1.25	-99

RUN 1 : 3 ... Press < ENTER > key to continue

ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME	ENVIRONMENT – WEATHER				STRESS – WATER		STRESS – NITROGEN	
	DURATION days	TEMP MAX xC	TEMP MIN xC	SOLAR RAD MJ/m2	PHOTOP [day] hr	PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	13	33.58	24.58	20.78	13.88	.128	.137	.000	.069
End Juvenil-Panicl Init	29	33.45	25.60	22.09	13.79	.038	.086	.604	.732
Panicl Init-End Lf Grow	30	32.95	25.98	21.18	13.27	.000	.000	.639	.805
End Lf Grth-Beg Grn Fil	9	33.72	26.00	22.86	12.77	.000	.000	.239	.379
Grain Filling Phase	21	33.83	23.69	21.69	12.33	.000	.000	.391	.558

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD : 3618 kg/ha [DRY WEIGHT]

Do you want to run more simulations ?
Y or N ? [Default = "N"] ===>

```
SIMULATION OVERVIEW

RUN    1         : 4
MODEL            : RICER980 - RICE
EXPERIMENT       : RSSE2001 RI    R.S. SHARMA
TREATMENT  4     : I2N2

CROP             : RICE           CULTIVAR : IR 64          -
STARTING DATE    : JUN 11 1981
PLANTING DATE    : JUN 11 1981    PLANTS/m2 : 70.7     ROW SPACING :  20.cm
WEATHER          : WRDF   1981
SOIL             : WR00810001     TEXTURE : SALO  - SANDY LOAM
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:111.1mm  NO3: 45.6kg/ha  NH4:  4.0kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :     1020 mm IN    17 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      107 kg/ha IN     5 APPLICATIONS
RESIDUE/MANURE   : INITIAL :      0 kg/ha ;       0 kg/ha IN     0 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  :C  ET :R
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:N  HARVEST:R  WTH:M

                        ey to continue
```

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	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
5- 15	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
15- 30	.112	.235	.352	.124	.235	.30	1.46	7.50	5.13	.20	.37
30- 45	.116	.239	.351	.123	.239	.20	1.47	7.50	1.70	.20	.01
45- 60	.116	.239	.351	.123	.239	.20	1.45	7.50	1.70	.20	.10
60- 90	.125	.248	.353	.123	.248	.10	1.47	7.50	.20	.50	.01
TOT- 90	10.5	21.6	31.7	11.1	21.6	<--cm	-	kg/ha-->	45.6	4.0	30423

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.20 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :IB0015-IR 64 ECOTYPE : -
P1 : 500.0 P2R : 160.0 P5 : 450.0 P20 : 12.0
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.00
Please press < ENTER > key to continue

SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 4

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
11 JUN	0	Transplant	126	.28	5	8	0	0	0	5	3.9	.00	.00
11 JUN	0	Start Sim	126	.28	5	8	0	0	0	5	3.9	.00	.00
24 JUN	13	End Juveni	173	.35	8	63	179	0	0	7	4.2	.14	.00
23 JUL	42	Pan Init	1437	1.23	15	205	402	0	0	27	1.9	.09	.63
22 AUG	72	Heading	3991	1.67	23	370	634	300	0	74	1.8	.00	.51
31 AUG	81	Beg Gr Fil	5614	1.50	23	426	635	480	0	78	1.4	.00	.00
20 SEP	101	End Mn Fil	7778	.43	23	531	635	840	0	103	1.3	.00	.08
22 SEP	103	End Ti Fil	7782	.33	23	541	635	840	0	103	1.3	.00	.32
23 SEP	104	Maturity	7782	.33	23	543	635	840	0	103	1.3	.00	.32
19 OCT	130	Harvest	7782	.33	23	619	638	1020	0	103	1.3	.00	.32

Press < ENTER > key to continue

MAIN GROWTH AND DEVELOPMENT VARIABLES

VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	42	-99
FLOWERING DATE (dap)	72	103
PHYSIOL. MATURITY (dap)	104	128
GRAIN YIELD (kg/ha) AT 14% H2O	4502	4600
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	15488	24180
PANICLE NUMBER (PANICLE/m2)	747.26	260
MAXIMUM LAI (m2/m2)	1.69	-99
BIOMASS (kg/ha) AT ANTHESIS	3817	-99
BIOMASS N (kg N/ha) AT ANTHESIS	71	-99
BIOMASS (kg/ha) AT HARVEST MAT.	7782	10817
STALK (kg/ha) AT HARVEST MAT.	3910	6217
HARVEST INDEX (kg/kg)	.498	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	65	-99
BIOMASS N (kg N/ha)	103	-99
STALK N (kg N/ha)	38	-99
SEED N (%)	1.69	-99

RUN 1 : I2N2 ... Press < ENTER > key to continue

ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX xC	WEATHER: TEMP MIN xC	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	13	33.58	24.58	20.78	13.88	.128	.137	.000	.069
End Juvenil-Panicl Init	29	33.45	25.60	22.09	13.79	.038	.086	.604	.732
Panicl Init-End Lf Grow	30	32.95	25.98	21.18	13.27	.000	.000	.535	.697
End Lf Grth-Beg Grn Fil	9	33.72	26.00	22.86	12.77	.000	.000	.000	.002
Grain Filling Phase	22	33.84	23.59	21.72	12.31	.000	.000	.088	.191

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD : 4502 kg/ha [DRY WEIGHT]

Do you want to run more simulations ?
Y or N ? [Default = "N"] ===>

```
SIMULATION OVERVIEW

RUN    1         : 5
MODEL            : RICER980 - RICE
EXPERIMENT       : RSSE2001 RI    R.S. SHARMA
TREATMENT  5     : I3N1

CROP             : RICE            CULTIVAR : IR 64
STARTING DATE    : JUN 11 1981
PLANTING DATE    : JUN 11 1981     PLANTS/m2 : 70.7     ROW SPACING :  20.cm
WEATHER          : WRDF   1981
SOIL             : WR00810001      TEXTURE : SALO   - SANDY LOAM
SOIL INITIAL C   : DEPTH: 90cm EXTR. H20:111.1mm  NO3: 45.6kg/ha  NH4:  4.0kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :     1530 mm IN    17 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :       56 kg/ha IN     5 APPLICATIONS
RESIDUE/MANURE   : INITIAL :     0 kg/ha ;       0 kg/ha IN     0 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  :C  ET :R
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:N  HARVEST:R  WTH:M

Please press < ENTER > key to continue
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SUMMARY OF SOIL AND GENETIC INPUT PARAMETERS

  SOIL LOWER UPPER   SAT  EXTR  INIT   ROOT   BULK     pH    NO3     NH4    ORG
 DEPTH LIMIT LIMIT   SW    SW    SW    DIST   DENS                           C
  cm   cm3/cm3     cm3/cm3   cm3/cm3          g/cm3         ugN/g  ugN/g     %
-------------------------------------------------------------------------------
  0-  5  .103  .228  .355  .125  .228    .50   1.45   7.50  12.00    .20    .90
  5- 15  .103  .228  .355  .125  .228    .50   1.45   7.50  12.00    .20    .90
 15- 30  .112  .235  .352  .124  .235    .30   1.46   7.50   5.13    .20    .37
 30- 45  .116  .239  .351  .123  .239    .20   1.47   7.50   1.70    .20    .01
 45- 60  .116  .239  .351  .123  .239    .20   1.45   7.50   1.70    .20    .10
 60- 90  .125  .248  .353  .123  .248    .10   1.47   7.50    .20    .50    .01

TOT- 90  10.5  21.6  31.7  11.1  21.6  <--cm   -  kg/ha-->  45.6    4.0  30423
SOIL ALBEDO    :  .13       EVAPORATION LIMIT : 9.20       MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00       DRAINAGE RATE     :  .60       FERT. FACTOR : 1.00

RICE      CULTIVAR :IB0015-IR 64              ECOTYPE :        -
P1     : 500.0  P2R     : 160.0  P5     : 450.0  P20     :   12.0
G1     :  60.0  G2      : .0250  G3     :  1.00  G4      :   1.00
Please press < ENTER > key to continue
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SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 I3N1

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
11 JUN	0	Transplant	126	.28	5	8	0	0	0	5	3.9	.00	.00
11 JUN	0	Start Sim	126	.28	5	8	0	0	0	5	3.9	.00	.00
24 JUN	13	End Juveni	173	.35	8	63	179	0	0	7	4.2	.14	.00
23 JUL	42	Pan Init	1437	1.23	15	205	402	0	0	27	1.9	.09	.63
22 AUG	72	Heading	3153	1.34	23	370	634	450	0	44	1.4	.00	.65
30 AUG	80	Beg Gr Fil	4012	1.24	23	420	635	720	0	44	1.1	.00	.38
19 SEP	100	End Mn Fil	5320	.38	23	524	635	1170	0	51	1.0	.00	.43
21 SEP	102	End Ti Fil	5320	.29	23	536	635	1260	0	51	1.0	.00	.61
22 SEP	103	Maturity	5320	.29	23	539	635	1260	0	51	1.0	.00	.61
19 OCT	130	Harvest	5320	.29	23	614	638	1530	0	51	1.0	.00	.61

Press < ENTER > key to continue

MAIN GROWTH AND DEVELOPMENT VARIABLES

VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	42	-99
FLOWERING DATE (dap)	72	96
PHYSIOL. MATURITY (dap)	103	118
GRAIN YIELD (kg/ha) AT 14% H2O	3415	3733
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	11748	16317
PANICLE NUMBER (PANICLE/m2)	589.79	246
MAXIMUM LAI (m2/m2)	1.35	-99
BIOMASS (kg/ha) AT ANTHESIS	3065	-99
BIOMASS N (kg N/ha) AT ANTHESIS	43	-99
BIOMASS (kg/ha) AT HARVEST MAT.	5320	8666
STALK (kg/ha) AT HARVEST MAT.	2383	4933
HARVEST INDEX (kg/kg)	.552	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	33	-99
BIOMASS N (kg N/ha)	51	-99
STALK N (kg N/ha)	19	-99
SEED N (%)	1.11	-99

RUN 1 : I3N1 ... Press < ENTER > key to continue

ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	ENVIRONMENT					STRESS			
	TIME	WEATHER				WATER		NITROGEN	
	DURATION days	TEMP MAX xC	TEMP MIN xC	SOLAR RAD MJ/m2	PHOTOP [day] hr	PHOTO SYNTH	GROWTH	PHOTO SYNTH	GROWTH
Emergence-End Juvenile	13	33.58	24.58	20.78	13.88	.128	.137	.000	.069
End Juvenil-Panicl Init	29	33.45	25.60	22.09	13.79	.038	.086	.604	.732
Panicl Init-End Lf Grow	30	32.95	25.98	21.18	13.27	.000	.000	.662	.827
End Lf Grth-Beg Grn Fil	8	33.63	26.06	22.80	12.78	.000	.000	.388	.554
Grain Filling Phase	22	33.86	23.77	21.76	12.34	.000	.000	.442	.611

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD : 3415 kg/ha [DRY WEIGHT]

Do you want to run more simulations ?
Y or N ? [Default = "N"] ===>

```
SIMULATION OVERVIEW

RUN   1          : 6
MODEL            : RICER980 - RICE
EXPERIMENT       : RSSE2001 RI    R.S. SHARMA
TREATMENT  6     : I3N2

CROP             : RICE            CULTIVAR : IR 64          -
STARTING DATE    : JUN 11 1981
PLANTING DATE    : JUN 11 1981     PLANTS/m2 : 70.7     ROW SPACING :  20.cm
WEATHER          : WRDF   1981
SOIL             : WR00810001      TEXTURE : SALO  - SANDY LOAM
SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:111.1mm  NO3: 45.6kg/ha  NH4:  4.0kg/ha
WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
IRRIGATION       :     1530 mm IN    17 APPLICATIONS
NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER     :      107 kg/ha IN     5 APPLICATIONS
RESIDUE/MANURE   : INITIAL :      0 kg/ha ;        0 kg/ha IN     0 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  :C  ET :R
MANAGEMENT OPT   : PLANTING:R  IRRIG   :R  FERT :R  RESIDUE:N  HARVEST:R  WTH:M

Please press < ENTER > key to continue
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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	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
5- 15	.103	.228	.355	.125	.228	.50	1.45	7.50	12.00	.20	.90
15- 30	.112	.235	.352	.124	.235	.30	1.46	7.50	5.13	.20	.37
30- 45	.116	.239	.351	.123	.239	.20	1.47	7.50	1.70	.20	.01
45- 60	.116	.239	.351	.123	.239	.20	1.45	7.50	1.70	.20	.10
60- 90	.125	.248	.353	.123	.248	.10	1.47	7.50	.20	.50	.01
TOT- 90	10.5	21.6	31.7	11.1	21.6	<--cm	- kg/ha-->		45.6	4.0	30423

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.20 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .60 FERT. FACTOR : 1.00

RICE CULTIVAR :IB0015-IR 64 ECOTYPE : -
P1 : 500.0 P2R : 160.0 P5 : 450.0 P20 : 12.0
G1 : 60.0 G2 : .0250 G3 : 1.00 G4 : 1.00
Please press < ENTER > key to continue

SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 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
11 JUN	0	Transplant	126	.28	5	8	0	0	0	5	3.9	.00	.00
11 JUN	0	Start Sim	126	.28	5	8	0	0	0	5	3.9	.00	.00
24 JUN	13	End Juveni	173	.35	8	63	179	0	0	7	4.2	.14	.00
23 JUL	42	Pan Init	1437	1.23	15	205	402	0	0	27	1.9	.09	.63
22 AUG	72	Heading	3764	1.56	23	370	634	450	0	65	1.7	.00	.55
31 AUG	81	Beg Gr Fil	5322	1.41	23	426	635	720	0	69	1.3	.00	.00
20 SEP	101	End Mn Fil	7095	.39	23	531	635	1260	0	88	1.2	.00	.23
22 SEP	103	End Ti Fil	7095	.30	23	540	635	1260	0	88	1.2	.00	.44
23 SEP	104	Maturity	7095	.30	23	543	635	1260	0	88	1.2	.00	.44
19 OCT	130	Harvest	7095	.30	23	616	638	1530	0	88	1.2	.00	.44

Press < ENTER > key to continue

MAIN GROWTH AND DEVELOPMENT VARIABLES

VARIABLE	PREDICTED	MEASURED
PANICLE INITIATION DATE (dap)	42	-99
FLOWERING DATE (dap)	72	103
PHYSIOL. MATURITY (dap)	104	128
GRAIN YIELD (kg/ha) AT 14% H2O	4249	4167
WT. PER GRAIN (g)	.025	0.023
GRAIN NUMBER (GRAIN/m2)	14615	26529
PANICLE NUMBER (PANICLE/m2)	716.52	262
MAXIMUM LAI (m2/m2)	1.58	-99
BIOMASS (kg/ha) AT ANTHESIS	3596	-99
BIOMASS N (kg N/ha) AT ANTHESIS	62	-99
BIOMASS (kg/ha) AT HARVEST MAT.	7095	9684
STALK (kg/ha) AT HARVEST MAT.	3441	5517
HARVEST INDEX (kg/kg)	.515	-99
FINAL LEAF NUMBER	23	-99
GRAIN N (kg N/ha)	58	-99
BIOMASS N (kg N/ha)	88	-99
STALK N (kg N/ha)	30	-99
SEED N (%)	1.58	-99

RUN 1 : 6 ... Press < ENTER > key to continue

ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX xC	WEATHER: TEMP MIN xC	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	13	33.58	24.58	20.78	13.88	.128	.137	.000	.069
End Juvenil-Panicl Init	29	33.45	25.60	22.09	13.79	.038	.086	.604	.732
Panicl Init-End Lf Grow	30	32.95	25.98	21.18	13.27	.000	.000	.573	.736
End Lf Grth-Beg Grn Fil	9	33.72	26.00	22.86	12.77	.000	.000	.000	.067
Grain Filling Phase	22	33.84	23.59	21.72	12.31	.000	.000	.226	.366

(0.0 = Minimum Stress
1.0 = Maximum Stress)

RICE YIELD : 4249 kg/ha [DRY WEIGHT]

Do you want to run more simulations ?
Y or N ? [Default = "N"] ===>

Do not interrupt this SIMULATION.

Please do not TOUCH the keyboard !!

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	6384	3831	638	510	620	84	73	21	20	3300	30
2	RI	2	73	104	8477	4831	638	510	623	83	120	21	23	3299	30
3	RI	3	72	103	5836	3618	638	1020	618	85	61	33	20	3301	30
4	RI	4	72	104	7782	4502	638	1020	619	86	103	38	23	3300	30
5	RI	5	72	103	5320	3415	638	1530	614	87	51	43	21	3301	30
6	RI	6	72	104	7095	4249	638	1530	616	87	88	54	23	3300	30

Do you want to run more simulations ?
Y or N ? [Default = "N"] ===>

DSSAT PREDICTIONS ON RICE cv IR 64

The validated programme as discussed in Chapter 5 was extended further to predict yield etc. under diverse agronomical practices as listed in Table 6.1. Predictions were made on account of grain yield, nitrogen uptake, nitrogen leached and evapotranspiration. Details are given in Annexure VI to XXIX.

6.1 GRAIN YIELD

The Rice yield predicted by DSSAT and influenced by age of seedlings, seedlings per hill, irrigation depth and nitrogen dose as well as the split application of nitrogen is given in Tables 6.2-6.5.

6.1.1 Very Healthy Seedlings Transplanted

The grain yield predicted are presented in Table 6.2. The overall average grain yield predicted was 4721.25 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 4510.53 & 4931.97 kgs/ha yield respectively. Crop transplanted with 25, 30 and 35 days old seedlings predicted 4994.75 kgs/ha, 4811.46 kgs/ha and 4357.54 kgs/ha yield respectively. Grain yield in irrigation dose I_1, I_2, and I_3 was predicted as 4862.29 kgs/ha, 4727.6 kgs/ha and 4573.85 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted yield 4119.58 kgs/ha, 4554.75 kgs/ha, 4942.42 kgs/ha & 5268.25 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 5286.74 kgs/ha and 4155.76 kgs/ha yield respectively.

6.1.2 Healthy Seedlings Transplanted

The grain yield predicted are presented in Table 6.3. The overall average grain yield predicted was 4522.55 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 4336.04 & 4709.06 kgs/ha yield respectively. Crop transplanted with 25, 30 and 35 days old seedlings predicted 4795.54 kgs/ha, 4621.54 kgs/ha and 4150.56 kgs/ha yield respectively. Grain yield in irrigation dose I_1, I_2, and I_3 was predicted as

4682.83 kgs/ha, 4531.17 kgs/ha and 4353.04 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted yield 3955.56 kgs/ha, 4361.08 kgs/ha, 4744.78 kgs/ha & 5028.78 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 5065.24 kgs/ha and 3979.86 kgs/ha yield respectively.

6.1.3 Normal Seedlings Transplanted

The grain yield predicted are presented in Table 6.4. The overall average grain yield predicted was 4355.72 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 4155.99 & 4555.35 kgs/ha yield respectively. Crop transplanted with 25, 30 and 35 days old seedlings predicted 4625.29 kgs/ha, 4409.35 kgs/ha and 4032.50 kgs/ha yield respectively. Grain yield in irrigation dose I_1, I_2, and I_3 was predicted as 4541.25 kgs/ha, 4333.867 kgs/ha and 4192.02 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted yield 3843.56 kgs/ha, 4226.19 kgs/ha, 4538.69 kgs/ha & 4814.42 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 4898.75 kgs/ha and 3812.68 kgs/ha yield respectively.

6.1.4 Fair Seedlings Transplanted

The grain yield predicted are presented in Table 6.5. The overall average grain yield predicted was 4093.47 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 3927.24 & 4259.69 kgs/ha yield respectively. Crop transplanted with 25, 30 and 35 days old seedlings predicted 4326.96 kgs/ha, 4149.73 kgs/ha and 3803.71 kgs/ha yield respectively. Grain yield in irrigation dose I_1, I_2, and I_3 was predicted as 4283.27 kgs/ha, 4094.67 kgs/ha and 3902.46 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted yield 3597.06 kgs/ha, 3956.72 kgs/ha, 4281.08 kgs/ha & 4539.00 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 4598.39 kgs/ha and 3588.54 kgs/ha yield respectively.

6.2 NITROGEN UPTAKE

The total nitrogen uptake (TNUP) predicted by DSSAT and influenced by age of seedlings, seedlings/hill irrigation depth and nitrogen dose as well as the split application of nitrogen is given in Tables 6.6 - 6.9.

6.2.1 Very Healthy Seedlings Transplanted

The TNUP predicted are presented in Table 6.6. The overall average TNUP predicted was 93.54 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 89.56 kgs/ha and 97.53 kgs/ha TNUP respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 97.08 kgs/ha, 95.96 kgs/ha and 87.58 kgs/ha TNUP respectively. TNUP in irrigation dose I_1, I_2 and I_3 was predicted as 102.21 kgs/ha, 100.65 kgs/ha and 86.00 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNUP 66.94 kgs/ha, 81.61 kgs/ha, 102.81 kgs/ha and 118.97 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 105.32 kgs/ha and 81.76 kgs/ha TNUP respectively.

6.2.2 Healthy Seedlings Transplanted

The TNUP predicted are presented in Table 6.7. The overall average TNUP predicted was 89.35 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 85.61 kgs/ha and 93.08 kgs/ha TNUP respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 92.50 kgs/ha, 91.87 kgs/ha and 83.66 kgs/ha TNUP respectively. TNUP in irrigation dose I_1, I_2 and I_3 was predicted as 99.10 kgs/ha, 97.25 kgs/ha and 80.60 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNUP 63.50 kgs/ha, 76.81 kgs/ha, 98.33 kgs/ha and 114.92 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 101.13 kgs/ha and 77.57 kgs/ha TNUP respectively.

6.2.3 Normal Seedlings Transplanted

The TNUP predicted are presented in Table 6.8. The overall average TNUP predicted was 84.71 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 82.53 kgs/ha and 86.89 kgs/ha TNUP respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 88.31 kgs/ha, 87.37 kgs/ha and 78.43 kgs/ha TNUP respectively. TNUP in irrigation dose I_1, I_2 and I_3 was predicted as 75.79 kgs/ha, 93.63 kgs/ha and 73.92 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNUP 59.97 kgs/ha, 70.94 kgs/ha, 94.17 kgs/ha and 109.92 kgs/ha respectively.

Nitrogen application in 3 and 4 splits recorded 96.15 kgs/ha and 73.26 kgs/ha TNUP respectively.

6.2.4 Fair Seedlings Transplanted

The TNUP predicted are presented in Table 6.9. The overall average TNUP predicted was 80.56 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 78.47 kgs/ha and 82.64 kgs/ha TNUP respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 83.71 kgs/ha, 82.33 kgs/ha and 75.63 kgs/ha TNUP respectively. TNUP in irrigation dose I_1, I_2 and I_3 was predicted as 92.06 kgs/ha, 89.77 kgs/ha and 69.90 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNUP 55.97 kgs/ha, 68.48 kgs/ha, 89.39 kgs/ha and 104.56 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 92.07 kgs/ha and 69.04 kgs/ha TNUP respectively.

6.3 NITROGEN LEACHING

The total nitrogen leached (TNLC) predicted by DSSAT and influenced by age of seedlings, seedlings per hill, irrigation depth and nitrogen dose as well as the split application of nitrogen is given in Table 6.6-6.9.

6.3.1 Very Healthy Seedlings Transplanted

The TNLC predicted are presented in Table 6.6. The overall average TNLC predicted was 26.89 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 29.43 kgs/ha and 24.35 kgs/ha TNLC respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 25.27 kgs/ha, 26.27 kgs/ha and 29.12 kgs/ha TNLC respectively. TNLC in irrigation dose I_1, I_2 and I_3 was predicted as 16.79 kgs/ha, 27.52 kgs/ha and 36.35 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNLC 24.22 kgs/ha, 26.08 kgs/ha, 27.25 kgs/ha and 30.00 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 27.88 kgs/ha and 25.90 kgs/ha TNLC respectively.

6.3.2 Healthy Seedlings Transplanted

The TNLC predicted are presented in Table 6.7. The overall average TNLC predicted was 29.28 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 31.56 kgs/ha and 27.01 kgs/ha TNLC respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 28.25 kgs/ha, 28.58 kgs/ha and 31.02 kgs/ha TNLC respectively. TNLC in irrigation dose I_1, I_2 and I_3 was predicted as 17.90 kgs/ha, 30.33 kgs/ha and 39.63 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNLC 26.08 kgs/ha, 28.36 kgs/ha, 30.42 kgs/ha and 32.28 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 30.85 kgs/ha and 27.72 kgs/ha TNLC respectively.

6.3.3 Normal Seedlings Transplanted

The TNLC predicted are presented in Table 6.8. The overall average TNLC predicted was 31.63 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 33.21 kgs/ha and 30.04 kgs/ha TNLC respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 30.50 kgs/ha, 31.04 kgs/ha and 33.33 kgs/ha TNLC respectively. TNLC in irrigation dose I_1, I_2 and I_3 was predicted as 19.08 kgs/ha, 32.52 kgs/ha and 43.27 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNLC 27.94 kgs/ha, 30.44 kgs/ha, 32.92 kgs/ha and 35.19 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 32.24 kgs/ha and 30.01 kgs/ha TNLC respectively.

6.3.4 Fair Seedlings Transplanted

The TNLC predicted are presented in Table 6.9. The overall average TNLC predicted was 34.49 kgs/ha. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 36.03 kgs/ha and 32.94 kgs/ha TNLC respectively. Crop transplanted with 25, 30, and 35 days old seedlings predicted 33.42 kgs/ha, 33.83 kgs/ha and 36.21 kgs/ha TNLC respectively. TNLC in irrigation dose I_1, I_2 and I_3 was predicted as 20.50 kgs/ha, 35.60 kgs/ha and 47.35 kgs/ha respectively. Nitrogen doses N_1, N_3, N_2 and N_4 predicted TNLC 30.44 kgs/ha, 33.14 kgs/ha, 36.00 kgs/ha and 38.36 kgs/ha respectively. Nitrogen application in 3 and 4 splits recorded 36.56 kgs/ha and 32.42 kgs/ha TNLC respectively.

6.4 CUMULATIVE EVAPOTRANSPIRATION

The cumulative evapotranspiration (CET) predicted by DSSAT and influenced by age of seedlings, seedlings/hill, irrigation depth and nitrogen dose as well as the split application of nitrogen etc. is given in Table 6.10-6.13.

6.4.1 Very Healthy Seedlings Transplanted

The evapotranspiration values predicted are presented in Table 6.10. The overall average evapotranspiration predicted was 640.03 mm. Crop transplanted with 2 seedlings per hill recorded 635.50 mm and 644.56 mm evapotranspiration respectively. Crop transplanted with 25, 30 and 35 days old seedlings predicted 646.28 mm, 641.48 mm and 632.33 mm evapotranspiration respectively. Evapotranspiration in irrigation dose I_1, I_2 and I_3 was predicted as 640.66 mm, 640.35 mm and 639.06 mm respectively. Evapotranspiration with Nitrogen doses N_1, N_3, N_2 & N_4 was predicted as 636.03 mm, 639.47 mm, 641.32 mm and 643.25 mm respectively. Nitrogen application in 3 & 4 splits recorded 641.47 mm and 637.58 mm respectively.

6.4.2 Healthy Seedling Transplanted

The evapotranspiration values predicted are presented in Table 6.11. The overall average evapotranspiration predicted was 635.58 mm. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 630.54 mm & 640.61 mm respectively. Crop transplanted with 25, 30 & 35 days old seedlings predicted 641.52 mm, 636.87 mm and 628.33 mm evapotranspiration respectively. Evapotranspiration in irrigation dose I_1, I_2, & I_3 was predicted as 636.10 mm, 635.99 mm & 634.63 mm respectively. Evapotranspiration predicted with Nitrogen doses N_1, N_3, N_2 and N_4 was 631.05 mm, 635.75 mm, 636.67 mm and 638.83 mm respectively. Nitrogen application in 3 and 4 splits recorded 638.64 mm and 632.51 mm respectively.

6.4.3 Normal Seedling Transplanted

The evapotranspiration values predicted are presented in Table 6.12. the overall average evapotranspiration predicted was 629.91 mm. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 625.00 mm & 634.82 mm respectively. Crop transplanted with 25, 30 & 35 days old seedlings predicted 636.29 mm, 631.40 mm and 622.04 mm evapotranspiration respectively. Evapotranspiration in irrigation dose I_1, I_2, & I_3 was predicted as 630.58 mm, 630.10 mm & 629.04 mm respectively. Nitrogen doses N_1, N_3, N_2 & N_4 predicted 625.61 mm, 630.36 mm, 630.92 mm and 632.75 mm respectively. Nitrogen application in 3 and 4 splits recorded 633.39 mm and 626.43 mm respectively.

6.4.4 Fair Seedling Transplanted

The evapotranspiration values predicted are presented in Table 6.13. the overall average evapotranspiration predicted was 621.54 mm. Crop transplanted with 2 seedlings & 3 seedlings per hill recorded 616.26 mm and 626.82 mm respectively. Crop transplanted with 25, 30 and 35 days old seedlings predicted 628.21 mm, 623.41 mm and 613.00 mm evapotranspiration respectively. Evapotranspiration in irrigation dose I_1, I_2, & I_3 was predicted as 622.42 mm, 621.90 mm & 620.31 mm respectively. Nitrogen doses N_1, N_3, N_2 & N_4 predicted 617.28 mm, 621.58 mm, 623.11 mm and 629.19 mm respectively. Nitrogen application in 3 and 4 splits recorded 625.25 mm and 617.83 respectively.

Table 6.1: Treatment Combinations used in DSSAT Model prediction

For Rice cv IR 64 under soil conditions of Demonstration Farm of IIT Roorkee

Sl No.	Main Treatments	Numbers	Sub treatments
1.	Seedling age	3	25 days old 30 days old 35 days old
2.	Seedling Health	4	Very healthy (200 Kgs/ha) Healthy (160 Kgs/ha) Normal (120 Kgs/ha) Fair (80 Kgs/ha)
3	Seedlings transplanted	2	2 Seedlings / hill 3 Seedlings / hill
4	Depth of Irrigation	3	510 mm (I_1) 1020 mm (I_2) 1530 mm (I_3)
5	Nitrogen dose	4	50 Kgs N / ha (N_1) 75 Kgs N / ha (N_3) 100 Kgs N / ha (N_2) 125 Kgs N / ha (N_4)
6	Nitrogen split application	2	3 splits (S_1) 4 splits (S_2)
Total Treatments = 3 x 4 x 2 x 3 x 4 x 2 = 576 nos.			

Table 6.2: DSSAT predicted Yield in Rice cv IR 64 planted with *very healthy seedlings (200 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

Sl. No.	Treatment Combin-atons	DSSAT predicted Yield (Kgs/ha)						Average (Kgs/ha)		Overall average
		25 days old seedling		30 days old seedling		35 days old seedling				
		2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	(Kgs/ha)
1	$I_1 N_1 S_1$	4618.00	4959.00	4472.00	4841.00	4155.00	4482.00	**4415.00**	**4760.67**	4587.83
2	$I_1 N_3 S_1$	5375.00	5710.00	5263.00	5682.00	4676.00	5032.00	**5104.67**	**5474.67**	5289.67
3	$I_1 N_2 S_1$	6130.00	6446.00	5831.00	6151.00	5154.00	5555.00	**5705.00**	**6050.67**	5877.83
4	$I_1 N_4 S_1$	6396.00	7018.00	6132.00	6730.00	5486.00	6056.00	**6004.67**	**6601.33**	6303.00
5	$I_2 N_1 S_1$	4273.00	4760.00	4255.00	4672.00	3905.00	4390.00	**4144.33**	**4607.33**	4375.83
6	$I_2 N_3 S_1$	4889.00	5505.00	4877.00	5372.00	4439.00	4849.00	**4735.00**	**5242.00**	4988.50
7	$I_2 N_2 S_1$	5921.00	6325.00	5655.00	6049.00	4995.00	5388.00	**5523.67**	**5920.67**	5722.17
8	$I_2 N_4 S_1$	6258.00	6869.00	5918.00	6533.00	5285.00	5904.00	**5820.33**	**6435.33**	6127.83
9	$I_3 N_1 S_1$	3982.00	4634.00	3951.00	4441.00	3754.00	4165.00	**3895.67**	**4413.33**	4154.50
10	$I_3 N_3 S_1$	4775.00	5285.00	4672.00	5107.00	4179.00	4717.00	**4542.00**	**5036.33**	4789.17
11	$I_3 N_2 S_1$	5467.00	6048.00	5353.00	4871.00	4775.00	5246.00	**5198.33**	**5388.33**	5293.33
12	$I_3 N_4 S_1$	6075.00	6699.00	5748.00	6389.00	5021.00	5655.00	**5614.67**	**6247.67**	5931.17
13	$I_1 N_1 S_2$	3910.00	4186.00	3827.00	4191.00	3526.00	3862.00	**3754.33**	**4079.67**	3917.00
14	$I_1 N_3 S_2$	4175.00	4584.00	4013.00	4419.00	3635.00	4000.00	**3941.00**	**4334.33**	4137.67
15	$I_1 N_2 S_2$	4397.00	4800.00	4187.00	4598.00	3746.00	4136.00	**4110.00**	**4511.33**	4310.67
16	$I_1 N_4 S_2$	4578.00	4999.00	4414.00	4836.00	3811.00	4210.00	**4267.67**	**4681.67**	4474.67
17	$I_2 N_1 S_2$	3825.00	4122.00	3803.00	4111.00	3485.00	3818.00	**3704.33**	**4017.00**	3860.67
18	$I_2 N_3 S_2$	4107.00	4489.00	3965.00	4351.00	3589.00	3973.00	**3887.00**	**4271.00**	4079.00
19	$I_2 N_2 S_2$	4316.00	4739.00	4125.00	4567.00	3684.00	4092.00	**4041.67**	**4466.00**	4253.83
20	$I_2 N_4 S_2$	4515.00	4957.00	4310.00	4737.00	3770.00	4189.00	**4198.33**	**4627.67**	4413.00
21	$I_3 N_1 S_2$	3806.00	4078.00	3727.00	4069.00	3457.00	3793.00	**3663.33**	**3980.00**	3821.67
22	$I_3 N_3 S_2$	4062.00	4449.00	3924.00	4325.00	3570.00	3937.00	**3852.00**	**4237.00**	4044.50
23	$I_3 N_2 S_2$	4257.00	4659.00	4075.00	4492.00	3655.00	4042.00	**3995.67**	**4397.67**	4196.67
24	$I_3 N_4 S_2$	4425.00	4896.00	4222.00	4697.00	3755.00	4164.00	**4134.00**	**4585.67**	4359.83
Average		**4772.17**	**5217.33**	**4613.29**	**5009.63**	**4146.13**	**4568.96**	**4510.53**	**4931.97**	4721.25

Table 6.3: DSSAT predicted Yield in Rice cv IR 64 planted with *healthy seedlings (160 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

Sl. No.	Treatment Combin-atons	DSSAT predicted Yield (Kgs/ha)						Average (Kgs/ha)		Overall average
		25 days old seedling		30 days old seedling		35 days old seedling				
		2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	(Kgs/ha)
1	$I_1 N_1 S_1$	4498.00	4740.00	4390.00	4621.00	3976.00	4396.00	**4288.00**	**4585.67**	4436.83
2	$I_1 N_3 S_1$	5225.00	5536.00	5041.00	5492.00	4446.00	4835.00	**4904.00**	**5287.67**	5095.83
3	$I_1 N_2 S_1$	5988.00	6342.00	5538.00	6040.00	5011.00	5368.00	**5512.33**	**5916.67**	5714.50
4	$I_1 N_4 S_1$	6330.00	6630.00	6047.00	6353.00	5308.00	5712.00	**5895.00**	**6231.67**	6063.33
5	$I_2 N_1 S_1$	4132.00	4476.00	4004.00	4461.00	3745.00	4216.00	**3960.33**	**4384.33**	4172.33
6	$I_2 N_3 S_1$	4883.00	5174.00	4724.00	5141.00	4275.00	4622.00	**4627.33**	**4979.00**	4803.17
7	$I_2 N_2 S_1$	5782.00	6132.00	5363.00	5839.00	4795.00	5216.00	**5313.33**	**5729.00**	5521.17
8	$I_2 N_4 S_1$	6131.00	6488.00	5780.00	6175.00	5083.00	5555.00	**5664.67**	**6072.67**	5868.67
9	$I_3 N_1 S_1$	3927.00	4217.00	3761.00	4225.00	3571.00	3971.00	**3753.00**	**4137.67**	3945.33
10	$I_3 N_3 S_1$	4508.00	4956.00	4412.00	4811.00	3980.00	4466.00	**4300.00**	**4744.33**	4522.17
11	$I_3 N_2 S_1$	5213.00	5888.00	5025.00	5703.00	4384.00	4033.00	**4874.00**	**5208.00**	5041.00
12	$I_3 N_4 S_1$	5840.00	6213.00	5514.00	5945.00	4801.00	5278.00	**5385.00**	**5812.00**	5598.50
13	$I_1 N_1 S_2$	3750.00	4079.00	3647.00	4027.00	3458.00	3677.00	**3618.33**	**3927.67**	3773.00
14	$I_1 N_3 S_2$	4011.00	4360.00	3836.00	4226.00	3565.00	3811.00	**3804.00**	**4132.33**	3968.17
15	$I_1 N_2 S_2$	4221.00	4581.00	4002.00	4402.00	3659.00	3920.00	**3960.67**	**4301.00**	4130.83
16	$I_1 N_4 S_2$	4406.00	4754.00	4221.00	4552.00	3734.00	4014.00	**4120.33**	**4440.00**	4280.17
17	$I_2 N_1 S_2$	3669.00	4048.00	3641.00	3988.00	3363.00	3658.00	**3557.67**	**3898.00**	3727.83
18	$I_2 N_3 S_2$	3941.00	4300.00	3781.00	4176.00	3456.00	3780.00	**3726.00**	**4085.33**	3905.67
19	$I_2 N_2 S_2$	4103.00	4525.00	3911.00	4353.00	3534.00	3885.00	**3849.33**	**4254.33**	4051.83
20	$I_2 N_4 S_2$	4296.00	4724.00	4066.00	4517.00	3622.00	3996.00	**3994.67**	**4412.33**	4203.50
21	$I_3 N_1 S_2$	3615.00	3987.00	3590.00	3927.00	3332.00	3617.00	**3512.33**	**3843.67**	3678.00
22	$I_3 N_3 S_2$	3882.00	4269.00	3738.00	4159.00	3428.00	3753.00	**3682.67**	**4060.33**	3871.50
23	$I_3 N_2 S_2$	4058.00	4465.00	3874.00	4312.00	3502.00	3845.00	**3811.33**	**4207.33**	4009.33
24	$I_3 N_4 S_2$	4237.00	4656.00	4011.00	4472.00	3604.00	3971.00	**3950.67**	**4366.33**	4158.50
Average		**4610.25**	**4980.83**	**4413.21**	**4829.88**	3984.67	**4316.46**	4336.04	**4709.06**	4522.55

Table 6.4: DSSAT predicted Yield in Rice cv IR 64 planted with *normal seedlings (120 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

SL. No.	Treatment Combin-atons	DSSAT predicted Yield (Kgs/ha)						Average (Kgs/ha)		Overall average
		25 days old seedling		30 days old seedling		35 days old seedling				
		2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	2 seedling/hill	3 seedling/hill	(Kgs/ha)
1	$I_1 N_1 S_1$	4339.00	4606.00	4228.00	4510.00	3831.00	4256.00	**4132.67**	**4457.33**	4295.00
2	$I_1 N_3 S_1$	5031.00	5342.00	4892.00	5220.00	4290.00	4580.00	**4737.67**	**5047.33**	4892.50
3	$I_1 N_2 S_1$	5763.00	6092.00	5360.00	5792.00	4831.00	5167.00	**5318.00**	**5683.67**	5500.83
4	$I_1 N_4 S_1$	6110.00	6475.00	5788.00	6189.00	5141.00	5507.00	**5679.67**	**6057.00**	5868.33
5	$I_2 N_1 S_1$	3905.00	4277.00	3907.00	4327.00	3618.00	4065.00	**3810.00**	**4223.00**	4016.50
6	$I_2 N_3 S_1$	4725.00	5057.00	4581.00	4887.00	4088.00	4459.00	**4464.67**	**4801.00**	4632.83
7	$I_2 N_2 S_1$	5547.00	5902.00	5137.00	5580.00	4502.00	4974.00	**5062.00**	**5485.33**	5273.67
8	$I_2 N_4 S_1$	5915.00	6293.00	5536.00	5964.00	4880.00	5267.00	**5443.67**	**5841.33**	5642.50
9	$I_3 N_1 S_1$	3736.00	3985.00	3599.00	4097.00	3415.00	3930.00	**3583.33**	**4004.00**	3793.67
10	$I_3 N_3 S_1$	4310.00	4770.00	4174.00	4653.00	3781.00	6280.00	**4088.33**	**5234.33**	4661.33
11	$I_3 N_2 S_1$	4934.00	5380.00	4815.00	5240.00	4249.00	4618.00	**4666.00**	**5079.33**	4872.67
12	$I_3 N_4 S_1$	5580.00	6038.00	5137.00	5696.00	4576.00	4984.00	**5097.67**	**5572.67**	5335.17
13	$I_1 N_1 S_2$	3620.00	5826.00	3523.00	3756.00	3319.00	3571.00	**3487.33**	**4384.33**	3935.83
14	$I_1 N_3 S_2$	3865.00	4114.00	3691.00	3953.00	3402.00	3667.00	**3652.67**	**3911.33**	3782.00
15	$I_1 N_2 S_2$	4072.00	4340.00	3838.00	4136.00	3488.00	3767.00	**3799.33**	**4081.00**	3940.17
16	$I_1 N_4 S_2$	4239.00	4523.00	4029.00	4523.00	3554.00	3824.00	**3940.67**	**4290.00**	4115.33
17	$I_2 N_1 S_2$	3503.00	3748.00	3472.00	3743.00	3216.00	3526.00	**3397.00**	**3672.33**	3534.67
18	$I_2 N_3 S_2$	3774.00	4072.00	3619.00	3927.00	3295.00	3609.00	**3562.67**	**3869.33**	3716.00
19	$I_2 N_2 S_2$	3948.00	4250.00	3751.00	4063.00	3424.00	3686.00	**3707.67**	**3999.67**	3853.67
20	$I_2 N_4 S_2$	4138.00	4443.00	3939.00	4220.00	3496.00	3771.00	**3857.67**	**4144.67**	4001.17
21	$I_3 N_1 S_2$	3480.00	3732.00	3360.00	3674.00	3171.00	3497.00	**3337.00**	**3634.33**	3485.67
22	$I_3 N_3 S_2$	3753.00	3987.00	3591.00	3862.00	3254.00	3588.00	**3532.67**	**3812.33**	3672.50
23	$I_3 N_2 S_2$	3878.00	4186.00	3690.00	4014.00	3318.00	3661.00	**3628.67**	**3953.67**	3791.17
24	$I_3 N_4 S_2$	4046.00	4365.00	3812.00	4154.00	3412.00	3755.00	**3756.67**	**4091.33**	3924.00
Average		**4425.46**	**4825.13**	**4227.88**	**4590.83**	**3814.63**	**4250.38**	4155.99	4555.44	4355.72

Table 6.5: DSSAT predicted Yield in Rice cv IR 64 planted with *fair seedlings (80 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

Sl. No.	Treatment Combinations	DSSAT predicted Yield (Kgs/ha) 25 days old seedling 2 seedling/hill	25 days old seedling 3 seedling/hill	30 days old seedling 2 seedling/hill	30 days old seedling 3 seedling/hill	35 days old seedling 2 seedling/hill	35 days old seedling 3 seedling/hill	Average (Kgs/ha) 2 seedling/hill	Average (Kgs/ha) 3 seedling/hill	Overall average (Kgs/ha)
1	$I_1 N_1 S_1$	4054.00	4483.00	4052.00	4316.00	3621.00	4123.00	3909.00	4307.33	4108.17
2	$I_1 N_3 S_1$	4836.00	5096.00	4652.00	4957.00	4034.00	4435.00	4507.33	4829.33	4668.33
3	$I_1 N_2 S_1$	5441.00	5845.00	5075.00	5457.00	4545.00	4902.00	5020.33	5401.33	5210.83
4	$I_1 N_4 S_1$	5827.00	6190.00	5499.00	5883.00	4896.00	5217.00	5407.33	5763.33	5585.33
5	$I_2 N_1 S_1$	3768.00	4148.00	3646.00	4076.00	3412.00	3930.00	3608.67	4051.33	3830.00
6	$I_2 N_3 S_1$	4433.00	4807.00	4274.00	4669.00	3775.00	4308.00	4160.67	4594.67	4377.67
7	$I_2 N_2 S_1$	5099.00	5545.00	4806.00	5209.00	4276.00	4625.00	4727.00	5126.33	4926.67
8	$I_2 N_4 S_1$	5513.00	5959.00	5222.00	5637.00	4531.00	4968.00	5088.67	5521.33	5305.00
9	$I_3 N_1 S_1$	3471.00	3722.00	3407.00	3872.00	3177.00	3747.00	3351.67	3780.33	3566.00
10	$I_3 N_3 S_1$	3953.00	4518.00	3919.00	4412.00	3490.00	4067.00	3787.33	4332.33	4059.83
11	$I_3 N_2 S_1$	4640.00	5000.00	4528.00	4872.00	3917.00	4462.00	4361.67	4778.00	4569.83
12	$I_3 N_4 S_1$	5193.00	5676.00	4792.00	5237.00	4232.00	4708.00	4739.00	5207.00	4973.00
13	$I_1 N_1 S_2$	3431.00	3633.00	3343.00	3616.00	3217.00	3425.00	3330.33	3558.00	3444.17
14	$I_1 N_3 S_2$	3661.00	3903.00	3497.00	3789.00	3295.00	3525.00	3484.33	3739.00	3611.67
15	$I_1 N_2 S_2$	3846.00	4101.00	3646.00	3900.00	3373.00	3664.00	3621.67	3888.33	3755.00
16	$I_1 N_4 S_2$	4028.00	4288.00	3774.00	4072.00	3418.00	3716.00	3740.00	4025.33	3882.67
17	$I_2 N_1 S_2$	3325.00	3576.00	3220.00	3434.00	3201.00	3369.00	3248.67	3459.67	3354.17
18	$I_2 N_3 S_2$	3566.00	3803.00	3423.00	3701.00	3247.00	3441.00	3412.00	3648.33	3530.17
19	$I_2 N_2 S_2$	3746.00	3969.00	3554.00	3788.00	3310.00	3511.00	3536.67	3756.00	3646.33
20	$I_2 N_4 S_2$	3902.00	4183.00	3710.00	3979.00	3357.00	3593.00	3656.33	3918.33	3787.33
21	$I_3 N_1 S_2$	3269.00	3488.00	3178.00	3338.00	3086.00	3320.00	3177.67	3382.00	3279.83
22	$I_3 N_3 S_2$	3528.00	3781.00	3373.00	3693.00	3185.00	3396.00	3362.00	3623.33	3492.67
23	$I_3 N_2 S_2$	3647.00	3910.00	3470.00	3761.00	3228.00	3451.00	3448.33	3707.33	3577.83
24	$I_3 N_4 S_2$	3811.00	4082.00	3589.00	3870.00	3301.00	3551.00	3567.00	3834.33	3700.67
Average		4166.17	4487.75	3985.38	4314.08	3630.17	3977.25	3927.24	4259.69	4093.47

Table6.6 : DSSAT predicted total nitrogen uptake (TNUP Kgs/ha) and total nitrogen leached (TNLC Kgs/ha) in Rice cv IR 64 planted with *very healthy seedlings (200 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

Sl. No.	Treatment Combination	TNUP and TNLC (Kgs/ha)												Average (Kgs/ha)				Overall Average (Kgs/ha)	
		25 days old seedlings				30 days old seedlings				35 days old seedlings									
		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill			
		TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC
1	$I_1N_1S_1$	78.00	17.00	85.00	15.00	79.00	18.00	84.00	16.00	78.00	18.00	81.00	18.00	**78.33**	**17.67**	**83.33**	**16.33**	80.83	17.00
2	$I_1N_3S_1$	101.00	18.00	108.00	16.00	101.00	18.00	106.00	16.00	101.00	19.00	106.00	17.00	**101.00**	**18.33**	**106.67**	**16.33**	103.83	17.33
3	$I_1N_2S_1$	129.00	18.00	133.00	16.00	128.00	18.00	132.00	16.00	126.00	19.00	130.00	17.00	**127.67**	**18.33**	**131.67**	**16.33**	129.67	17.33
4	$I_1N_4S_1$	150.00	18.00	158.00	16.00	149.00	17.00	156.00	16.00	147.00	20.00	152.00	18.00	**148.67**	**18.33**	**155.33**	**16.67**	152.00	17.50
5	$I_2N_1S_1$	69.00	28.00	79.00	21.00	69.00	28.00	78.00	23.00	65.00	32.00	73.00	26.00	**67.67**	**29.33**	**76.67**	**23.33**	72.17	26.33
6	$I_2N_3S_1$	87.00	32.00	96.00	26.00	87.00	32.00	96.00	26.00	87.00	31.00	94.00	28.00	**87.00**	**31.67**	**95.33**	**26.67**	91.17	29.17
7	$I_2N_2S_1$	116.00	30.00	122.00	22.00	111.00	34.00	122.00	26.00	112.00	32.00	119.00	28.00	**113.00**	**32.00**	**121.00**	**18.67**	117.00	25.33
8	$I_2N_4S_1$	135.00	32.00	143.00	27.00	134.00	32.00	143.00	28.00	129.00	37.00	135.00	32.00	**132.67**	**33.67**	**140.33**	**29.00**	136.50	31.33
9	$I_3N_1S_1$	62.00	35.00	74.00	26.00	62.00	35.00	70.00	30.00	58.00	38.00	68.00	32.00	**60.67**	**36.00**	**70.67**	**29.33**	65.67	32.67
10	$I_3N_3S_1$	81.00	39.00	92.00	30.00	80.00	39.00	93.00	29.00	76.00	43.00	85.00	37.00	**79.00**	**40.33**	**90.00**	**32.00**	84.50	36.17
11	$I_3N_2S_1$	99.00	46.00	112.00	35.00	99.00	47.00	113.00	34.00	97.00	47.00	113.00	34.00	**98.33**	**46.67**	**112.67**	**34.33**	105.50	40.50
12	$I_3N_4S_1$	123.00	45.00	135.00	36.00	119.00	49.00	133.00	37.00	114.00	52.00	126.00	44.00	**118.67**	**48.67**	**131.33**	**39.00**	125.00	43.83
13	$I_1N_1S_2$	64.00	17.00	72.00	14.00	63.00	17.00	71.00	15.00	57.00	18.00	62.00	15.00	**61.33**	**17.33**	**68.33**	**14.67**	64.83	16.00
14	$I_1N_3S_2$	83.00	17.00	92.00	14.00	83.00	17.00	91.00	15.00	68.00	18.00	74.00	16.00	**78.00**	**17.33**	**85.67**	**15.00**	81.83	16.17
15	$I_1N_2S_2$	98.00	17.00	107.00	15.00	96.00	17.00	106.00	15.00	81.00	18.00	87.00	16.00	**91.67**	**17.33**	**100.00**	**15.33**	95.83	16.33
16	$I_1N_4S_2$	114.00	17.00	119.00	15.00	112.00	17.00	121.00	15.00	91.00	19.00	96.00	17.00	**105.67**	**17.67**	**112.00**	**15.67**	108.83	16.67
17	$I_2N_1S_2$	61.00	24.00	68.00	22.00	60.00	25.00	67.00	22.00	52.00	27.00	58.00	24.00	**57.67**	**25.33**	**64.33**	**22.67**	61.00	24.00
18	$I_2N_3S_2$	76.00	27.00	85.00	22.00	74.00	27.00	83.00	23.00	62.00	30.00	70.00	26.00	**70.67**	**28.00**	**79.33**	**23.67**	75.00	25.83
19	$I_2N_2S_2$	89.00	29.00	100.00	23.00	87.00	29.00	97.00	24.00	72.00	33.00	79.00	28.00	**82.67**	**30.33**	**92.00**	**25.00**	87.33	27.67
20	$I_2N_4S_2$	102.00	32.00	113.00	26.00	100.00	32.00	113.00	25.00	80.00	36.00	87.00	32.00	**94.00**	**33.33**	**104.33**	**27.67**	99.17	30.50
21	$I_3N_1S_2$	57.00	30.00	64.00	27.00	55.00	30.00	62.00	27.00	50.00	32.00	55.00	30.00	**54.00**	**30.67**	**60.33**	**28.00**	57.17	29.33
22	$I_3N_3S_2$	71.00	33.00	81.00	27.00	70.00	34.00	80.00	27.00	89.00	38.00	67.00	32.00	**76.67**	**35.00**	**76.00**	**28.67**	76.33	31.83
23	$I_3N_2S_2$	84.00	37.00	92.00	31.00	82.00	37.00	91.00	31.00	66.00	44.00	74.00	38.00	**77.33**	**39.33**	**85.67**	**33.33**	81.50	36.33
24	$I_3N_4S_2$	94.00	41.00	107.00	32.00	93.00	42.00	105.00	34.00	74.00	48.00	81.00	44.00	**87.00**	**43.67**	**97.67**	**36.67**	92.33	40.17
Average		**92.63**	**28.29**	**101.54**	**23.08**	**91.38**	**28.79**	**100.54**	**23.75**	**84.67**	**31.21**	**90.50**	**27.04**	89.56	29.43	97.53	24.35	93.54	26.89

Table 6.7: DSSAT predicted total nitrogen uptake (TNUP Kgs/ha) and total nitrogen leached (TNLC Kgs/ha) in Rice cv IR 64 planted with *healthy seedlings (160 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

Sl. No.	Treatment Combination	TNUP and TNLC (Kgs/ha)												Average (Kgs/ha)				Overall Average (Kgs/ha)	
		25 days old seedlings				30 days old seedlings				35 days old seedlings									
		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill			
		TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC
1	$I_1 N_1 S_1$	76.00	19.00	80.00	17.00	77.00	19.00	79.00	18.00	75.00	20.00	80.00	17.00	76.00	19.33	79.67	17.33	77.83	18.33
2	$I_1 N_3 S_1$	100.00	19.00	103.00	16.00	99.00	19.00	103.00	17.00	98.00	20.00	102.00	18.00	99.00	19.33	102.67	17.00	100.83	18.17
3	$I_1 N_2 S_1$	126.00	19.00	129.00	17.00	124.00	19.00	129.00	18.00	124.00	20.00	127.00	19.00	124.67	19.33	128.33	18.00	126.50	18.67
4	$I_1 N_4 S_1$	147.00	19.00	154.00	17.00	149.00	18.00	153.00	17.00	143.00	21.00	150.00	18.00	146.33	19.33	152.33	17.33	149.33	18.33
5	$I_2 N_1 S_1$	65.00	31.00	72.00	27.00	65.00	31.00	72.00	27.00	61.00	34.00	70.00	28.00	63.67	32.00	71.33	27.33	67.50	29.67
6	$I_2 N_3 S_1$	87.00	31.00	92.00	29.00	86.00	31.00	92.00	29.00	84.00	34.00	88.00	31.00	85.67	32.00	90.67	29.67	88.17	30.83
7	$I_2 N_2 S_1$	110.00	33.00	118.00	28.00	107.00	37.00	116.00	30.00	110.00	34.00	113.00	32.00	109.00	34.67	115.67	30.00	112.33	32.33
8	$I_2 N_4 S_1$	131.00	34.00	138.00	29.00	130.00	36.00	138.00	29.00	125.00	40.00	134.00	33.00	128.67	36.67	136.67	30.33	132.67	33.50
9	$I_3 N_1 S_1$	59.00	37.00	67.00	32.00	57.00	39.00	67.00	32.00	55.00	41.00	63.00	35.00	57.00	39.00	65.67	33.00	61.33	36.00
10	$I_3 N_3 S_1$	75.00	43.00	83.00	38.00	74.00	44.00	85.00	36.00	70.00	48.00	81.00	39.00	73.00	45.00	83.00	37.67	78.00	41.33
11	$I_3 N_2 S_1$	92.00	51.00	108.00	37.00	95.00	49.00	106.00	40.00	94.00	48.00	102.00	44.00	93.67	49.33	105.33	40.33	99.50	44.83
12	$I_3 N_4 S_1$	113.00	53.00	126.00	43.00	115.00	53.00	130.00	40.00	110.00	55.00	123.00	45.00	112.67	53.67	126.33	42.67	119.50	48.17
13	$I_1 N_1 S_2$	62.00	18.00	68.00	16.00	61.00	18.00	68.00	16.00	55.00	19.00	58.00	17.00	59.33	18.33	64.67	16.33	62.00	17.33
14	$I_1 N_3 S_2$	80.00	18.00	87.00	16.00	79.00	18.00	87.00	16.00	67.00	19.00	73.00	17.00	75.33	18.33	82.33	16.33	78.83	17.33
15	$I_1 N_2 S_2$	95.00	18.00	102.00	16.00	92.00	19.00	101.00	16.00	79.00	19.00	82.00	17.00	88.67	18.67	95.00	16.33	91.83	17.50
16	$I_1 N_4 S_2$	110.00	18.00	116.00	16.00	108.00	19.00	115.00	16.00	91.00	19.00	94.00	17.00	103.00	18.67	108.33	16.33	105.67	17.50
17	$I_2 N_1 S_2$	56.00	26.00	64.00	22.00	56.00	27.00	64.00	22.00	50.00	28.00	55.00	25.00	54.00	27.00	61.00	23.00	57.50	25.00
18	$I_2 N_3 S_2$	72.00	29.00	80.00	24.00	71.00	30.00	79.00	25.00	59.00	32.00	65.00	28.00	67.33	30.33	74.67	25.67	71.00	28.00
19	$I_2 N_2 S_2$	83.00	32.00	95.00	26.00	82.00	33.00	94.00	26.00	68.00	35.00	76.00	30.00	77.67	33.33	88.33	27.33	83.00	30.33
20	$I_2 N_4 S_2$	98.00	34.00	106.00	30.00	95.00	34.00	106.00	29.00	78.00	37.00	84.00	34.00	90.33	35.00	98.67	31.00	94.50	33.00
21	$I_3 N_1 S_2$	54.00	31.00	61.00	27.00	53.00	32.00	61.00	27.00	47.00	34.00	53.00	30.00	51.33	32.33	58.33	28.00	54.83	30.17
22	$I_3 N_3 S_2$	67.00	36.00	76.00	30.00	66.00	36.00	74.00	30.00	56.00	40.00	63.00	35.00	63.00	37.33	71.00	31.67	67.00	34.50
23	$I_3 N_2 S_2$	78.00	40.00	88.00	33.00	77.00	40.00	86.00	33.00	62.00	46.00	70.00	41.00	72.33	42.00	81.33	35.67	76.83	38.83
24	$I_3 N_4 S_2$	90.00	44.00	101.00	37.00	88.00	45.00	99.00	37.00	71.00	50.00	78.00	46.00	83.00	46.33	92.67	40.00	87.83	43.17
Average		88.58	30.54	96.42	25.96	87.75	31.08	96.00	26.08	80.50	33.04	86.83	29.00	85.61	31.56	93.08	27.01	89.35	29.28

Table 6.8: DSSAT predicted total nitrogen uptake (TNUP Kgs/ha) and total nitrogen leached (TNLC Kgs/ha) in Rice cv IR 64 planted with *normal seedlings (120 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

SL. No.	Treatment Combination	TNUP and TNLC (Kgs/ha)												Average (Kgs/ha)				Overall Average (Kgs/ha)	
		25 days old seedlings				30 days old seedlings				35 days old seedlings									
		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill			
		TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC
1	$I_1 N_1 S_1$	73.00	20.00	78.00	18.00	73.00	20.00	79.00	18.00	73.00	21.00	76.00	19.00	**73.00**	**20.33**	**77.67**	**18.33**	75.33	19.33
2	$I_1 N_3 S_1$	98.00	20.00	99.00	18.00	97.00	20.00	101.00	18.00	95.00	21.00	100.00	20.00	**96.67**	**20.33**	**100.00**	**18.67**	98.33	19.50
3	$I_1 N_2 S_1$	124.00	20.00	125.00	19.00	123.00	20.00	127.00	19.00	120.00	21.00	126.00	19.00	**122.33**	**20.33**	**126.00**	**19.00**	124.17	19.67
4	$I_1 N_4 S_1$	146.00	20.00	149.00	18.00	144.00	21.00	149.00	18.00	137.00	22.00	146.00	20.00	**142.33**	**21.00**	**148.00**	**18.67**	145.17	19.83
5	$I_2 N_1 S_1$	63.00	31.00	67.00	29.00	61.00	33.00	67.00	29.00	61.00	33.00	64.00	32.00	**61.67**	**32.33**	**66.00**	**30.00**	63.83	31.17
6	$I_2 N_3 S_1$	83.00	33.00	88.00	30.00	85.00	33.00	87.00	31.00	81.00	35.00	85.00	32.00	**83.00**	**33.67**	**86.67**	**31.00**	84.83	32.33
7	$I_2 N_2 S_1$	108.00	35.00	114.00	31.00	109.00	35.00	113.00	31.00	103.00	38.00	109.00	35.00	**106.67**	**36.00**	**112.00**	**32.33**	109.33	34.17
8	$I_2 N_4 S_1$	127.00	37.00	135.00	33.00	126.00	38.00	133.00	33.00	121.00	43.00	128.00	37.00	**124.67**	**39.33**	**132.00**	**34.33**	128.33	36.83
9	$I_3 N_1 S_1$	55.00	40.00	61.00	35.00	55.00	41.00	61.00	35.00	51.00	43.00	57.00	39.00	**53.67**	**41.33**	**59.67**	**36.33**	56.67	38.83
10	$I_3 N_3 S_1$	71.00	46.00	78.00	40.00	70.00	47.00	78.00	41.00	67.00	49.00	7.00	44.00	**69.33**	**47.33**	**54.33**	**41.67**	61.83	44.50
11	$I_3 N_2 S_1$	93.00	49.00	97.00	47.00	92.00	50.00	98.00	47.00	88.00	54.00	95.00	48.00	**91.00**	**51.00**	**96.67**	**47.33**	93.83	49.17
12	$I_3 N_4 S_1$	112.00	54.00	115.00	50.00	109.00	56.00	115.00	52.00	107.00	57.00	115.00	52.00	**109.33**	**55.67**	**115.00**	**51.33**	112.17	53.50
13	$I_1 N_1 S_2$	60.00	18.00	64.00	17.00	60.00	19.00	64.00	17.00	53.00	20.00	57.00	18.00	**57.67**	**19.00**	**61.67**	**17.33**	59.67	18.17
14	$I_1 N_3 S_2$	76.00	19.00	82.00	17.00	75.00	19.00	81.00	18.00	66.00	20.00	68.00	18.00	**72.33**	**19.33**	**77.00**	**17.67**	74.67	18.50
15	$I_1 N_2 S_2$	92.00	19.00	96.00	17.00	90.00	19.00	95.00	18.00	76.00	20.00	78.00	19.00	**86.00**	**19.33**	**89.67**	**18.00**	87.83	18.67
16	$I_1 N_4 S_2$	107.00	19.00	112.00	18.00	105.00	19.00	105.00	18.00	87.00	21.00	91.00	19.00	**99.67**	**19.67**	**102.67**	**18.33**	101.17	19.00
17	$I_2 N_1 S_2$	54.00	28.00	59.00	25.00	54.00	28.00	58.00	25.00	47.00	30.00	51.00	27.00	**51.67**	**28.67**	**56.00**	**25.67**	53.83	27.17
18	$I_2 N_3 S_2$	67.00	31.00	75.00	27.00	67.00	32.00	74.00	28.00	58.00	33.00	61.00	30.00	**64.00**	**32.00**	**70.00**	**28.33**	67.00	30.17
19	$I_2 N_2 S_2$	80.00	33.00	87.00	30.00	78.00	34.00	86.00	31.00	66.00	37.00	71.00	34.00	**74.67**	**34.67**	**81.33**	**31.67**	78.00	33.17
20	$I_2 N_4 S_2$	94.00	36.00	101.00	32.00	93.00	35.00	98.00	33.00	76.00	39.00	79.00	36.00	**87.67**	**36.67**	**92.67**	**33.67**	90.17	35.17
21	$I_3 N_1 S_2$	50.00	33.00	56.00	30.00	49.00	34.00	55.00	30.00	44.00	36.00	49.00	35.00	**47.67**	**34.33**	**53.33**	**31.67**	50.50	33.00
22	$I_3 N_3 S_2$	63.00	38.00	70.00	34.00	61.00	39.00	68.00	35.00	52.00	42.00	58.00	38.00	**58.67**	**39.67**	**65.33**	**35.67**	62.00	37.67
23	$I_3 N_2 S_2$	74.00	43.00	82.00	38.00	71.00	44.00	80.00	38.00	59.00	49.00	65.00	44.00	**68.00**	**45.33**	**75.67**	**40.00**	71.83	42.67
24	$I_3 N_4 S_2$	86.00	47.00	93.00	42.00	83.00	49.00	92.00	42.00	68.00	53.00	73.00	48.00	**79.00**	**49.67**	**86.00**	**44.00**	82.50	46.83
Average		85.67	**32.04**	90.96	28.96	84.58	32.71	90.17	29.38	77.33	34.88	79.54	31.79	82.53	33.21	86.89	30.04	84.71	31.63

Table 6.9: DSSAT predicted total nitrogen uptake (TNUP Kgs/ha) and total nitrogen leached (TNLC Kgs/ha) in Rice cv IR 64 planted with *fair seedlings (80 kg/ha)* grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

SL. No.	Treatment Combination	TNUP and TNLC (Kgs/ha)												Average (Kgs/ha)				Overall Average (Kgs/ha)	
		25 days old seedlings				30 days old seedlings				35 days old seedlings									
		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill		2 seedling /hill		3 seedling /hill			
		TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC	TNUP	TNLC
1	$I_1 N_1 S_1$	71.00	21.00	74.00	20.00	71.00	21.00	74.00	20.00	70.00	22.00	73.00	20.00	**70.67**	**21.33**	**73.67**	**20.00**	72.17	20.67
2	$I_1 N_3 S_1$	94.00	21.00	98.00	19.00	95.00	21.00	98.00	20.00	93.00	23.00	95.00	20.00	**94.00**	**21.67**	**97.00**	**19.67**	95.50	20.67
3	$I_1 N_2 S_1$	121.00	22.00	123.00	19.00	120.00	21.00	124.00	20.00	117.00	24.00	121.00	21.00	**119.33**	**22.33**	**122.67**	**20.00**	121.00	21.17
4	$I_1 N_4 S_1$	142.00	22.00	147.00	20.00	140.00	23.00	125.00	21.00	131.00	24.00	139.00	22.00	**137.67**	**23.00**	**137.00**	**21.00**	137.33	22.00
5	$I_2 N_1 S_1$	58.00	35.00	63.00	31.00	58.00	35.00	63.00	32.00	58.00	36.00	61.00	34.00	**58.00**	**35.33**	**62.33**	**32.33**	60.17	33.83
6	$I_2 N_3 S_1$	79.00	36.00	84.00	32.00	79.00	36.00	84.00	33.00	75.00	40.00	81.00	35.00	**77.67**	**37.33**	**83.00**	**33.33**	80.33	35.33
7	$I_2 N_2 S_1$	100.00	41.00	108.00	34.00	102.00	39.00	104.00	37.00	97.00	44.00	105.00	38.00	**99.67**	**41.33**	**105.67**	**36.33**	102.67	38.83
8	$I_2 N_4 S_1$	123.00	41.00	127.00	37.00	122.00	42.00	127.00	37.00	117.00	47.00	122.00	42.00	**120.67**	**43.33**	**125.33**	**38.67**	123.00	41.00
9	$I_3 N_1 S_1$	50.00	44.00	56.00	40.00	49.00	45.00	55.00	41.00	47.00	47.00	53.00	42.00	**48.67**	**45.33**	**54.67**	**41.00**	51.67	43.17
10	$I_3 N_3 S_1$	65.00	51.00	71.00	45.00	65.00	51.00	70.00	46.00	63.00	53.00	67.00	49.00	**64.33**	**51.67**	**69.33**	**46.67**	66.83	49.17
11	$I_3 N_2 S_1$	89.00	53.00	90.00	53.00	89.00	53.00	91.00	51.00	82.00	59.00	88.00	54.00	**86.67**	**55.00**	**89.67**	**52.67**	88.17	53.83
12	$I_3 N_4 S_1$	103.00	62.00	112.00	54.00	105.00	60.00	109.00	57.00	98.00	65.00	109.00	56.00	**102.00**	**62.33**	**110.00**	**55.67**	106.00	59.00
13	$I_1 N_1 S_2$	57.00	20.00	60.00	18.00	56.00	20.00	60.00	19.00	50.00	21.00	53.00	19.00	**54.33**	**20.33**	**57.67**	**18.67**	56.00	19.50
14	$I_1 N_3 S_2$	74.00	20.00	77.00	18.00	72.00	20.00	76.00	19.00	63.00	21.00	66.00	20.00	**69.67**	**20.33**	**73.00**	**19.00**	71.33	19.67
15	$I_1 N_2 S_2$	89.00	20.00	92.00	19.00	88.00	21.00	91.00	19.00	74.00	22.00	76.00	20.00	**83.67**	**21.00**	**86.33**	**19.33**	85.00	20.17
16	$I_1 N_4 S_2$	104.00	20.00	107.00	19.00	101.00	21.00	105.00	19.00	85.00	22.00	87.00	20.00	**96.67**	**21.00**	**99.67**	**19.33**	98.17	20.17
17	$I_2 N_1 S_2$	50.00	30.00	55.00	28.00	49.00	31.00	53.00	28.00	44.00	33.00	47.00	30.00	**47.67**	**31.33**	**51.67**	**28.67**	49.67	30.00
18	$I_2 N_3 S_2$	64.00	33.00	68.00	31.00	64.00	33.00	67.00	31.00	54.00	36.00	58.00	33.00	**60.67**	**34.00**	**64.33**	**31.67**	62.50	32.83
19	$I_2 N_2 S_2$	77.00	35.00	81.00	33.00	75.00	36.00	79.00	34.00	63.00	39.00	66.00	36.00	**71.67**	**36.67**	**75.33**	**34.33**	73.50	35.50
20	$I_2 N_4 S_2$	90.00	37.00	95.00	35.00	88.00	38.00	93.00	35.00	72.00	42.00	77.00	38.00	**83.33**	**39.00**	**88.33**	**36.00**	85.83	37.50
21	$I_3 N_1 S_2$	46.00	36.00	51.00	33.00	45.00	36.00	50.00	33.00	40.00	39.00	45.00	36.00	**43.67**	**37.00**	**48.67**	**34.00**	46.17	35.50
22	$I_3 N_3 S_2$	59.00	42.00	64.00	37.00	57.00	43.00	63.00	37.00	48.00	46.00	53.00	42.00	**54.67**	**43.67**	**60.00**	**38.67**	57.33	41.17
23	$I_3 N_2 S_2$	68.00	47.00	74.00	43.00	67.00	47.00	72.00	43.00	56.00	51.00	59.00	48.00	**63.67**	**48.33**	**68.33**	**44.67**	66.00	46.50
24	$I_3 N_4 S_2$	81.00	50.00	87.00	47.00	78.00	51.00	84.00	48.00	64.00	55.00	68.00	52.00	**74.33**	**52.00**	**79.67**	**49.00**	77.00	50.50
Average		**81.42**	**34.96**	**86.00**	**31.88**	**80.63**	**35.17**	**84.04**	**32.50**	**73.38**	**37.96**	**77.88**	**34.46**	**78.47**	**36.03**	**82.64**	**32.94**	80.56	34.49

Table 6.10: DSSAT predicted cumulative evapotranspiration (mm) in Rice cv IR 64 planted with very healthy seedlings (200 kg/ha) grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

Sl. No.	Treatment Combi-nation	Cumulative Evapotranpiration (mm)						Average CET (mm)		Overall Average CET (mm)
		25 days old seedlings		30 days old seedlings		35 days old seedlings				
		2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	
1	$I_1 N_1 S_1$	642.00	644.00	636.00	646.00	630.00	639.00	**636.00**	**643.00**	**639.50**
2	$I_1 N_3 S_1$	648.00	654.00	643.00	644.00	624.00	635.00	**638.33**	**644.33**	**641.33**
3	$I_1 N_2 S_1$	646.00	655.00	640.00	652.00	634.00	645.00	**640.00**	**650.67**	**645.33**
4	$I_1 N_4 S_1$	650.00	658.00	645.00	656.00	639.00	640.00	**644.67**	**651.33**	**648.00**
5	$I_2 N_1 S_1$	640.00	649.00	635.00	641.00	629.00	633.00	**634.67**	**641.00**	**637.83**
6	$I_2 N_3 S_1$	645.00	650.00	641.00	650.00	632.00	635.00	**639.33**	**645.00**	**642.17**
7	$I_2 N_2 S_1$	646.00	654.00	639.00	651.00	633.00	643.00	**639.33**	**649.33**	**644.33**
8	$I_2 N_4 S_1$	650.00	658.00	645.00	655.00	638.00	640.00	**644.33**	**651.00**	**647.67**
9	$I_3 N_1 S_i$	636.00	647.00	634.00	643.00	625.00	630.00	**631.67**	**640.00**	**635.83**
10	$I_3 N_3 S_1$	639.00	652.00	640.00	646.00	630.00	632.00	**636.33**	**643.33**	**639.83**
11	$I_3 N_2 S_1$	644.00	653.00	638.00	649.00	628.00	641.00	**636.67**	**647.67**	**642.17**
12	$I_3 N_4 S_1$	648.00	657.00	642.00	655.00	634.00	638.00	**641.33**	**650.00**	**645.67**
13	$I_1 N_1 S_2$	635.00	645.00	631.00	641.00	625.00	635.00	**630.33**	**640.33**	**635.33**
14	$I_1 N_3 S_2$	639.00	649.00	634.00	644.00	625.00	636.00	**632.67**	**643.00**	**637.83**
15	$I_1 N_2 S_2$	641.00	650.00	635.00	645.00	625.00	636.00	**633.67**	**643.67**	**638.67**
16	$I_1 N_4 S_2$	642.00	651.00	636.00	646.00	625.00	636.00	**634.33**	**644.33**	**639.33**
17	$I_2 N_1 S_2$	639.00	644.00	627.00	640.00	623.00	635.00	**629.67**	**639.67**	**634.67**
18	$I_2 N_3 S_2$	639.00	649.00	634.00	644.00	625.00	636.00	**632.67**	**643.00**	**637.83**
19	$I_2 N_2 S_2$	641.00	651.00	635.00	645.00	625.00	636.00	**633.67**	**644.00**	**638.83**
20	$I_2 N_4 S_2$	642.00	651.00	636.00	646.00	626.00	636.00	**634.67**	**644.33**	**639.50**
21	$I_3 N_1 S_2$	632.00	643.00	627.00	640.00	622.00	634.00	**627.00**	**639.00**	**633.00**
22	$I_3 N_3 S_2$	639.00	649.00	634.00	644.00	625.00	636.00	**632.67**	**643.00**	**637.83**
23	$I_3 N_2 S_2$	641.00	651.00	635.00	645.00	625.00	636.00	**633.67**	**644.00**	**638.83**
24	$I_3 N_4 S_2$	642.00	651.00	635.00	646.00	626.00	636.00	**634.33**	**644.33**	**639.33**
Average		**641.92**	**650.63**	**636.54**	**646.42**	**628.04**	**636.63**	**635.50**	**644.56**	**640.03**

Table 6.11: DSSAT predicted cumulative evapotranspiration (mm) in Rice cv IR 64 planted with healthy seedlings (160 kg/ha) grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

SL. No.	Treatment Combi-nation	Cumulative Evapotranpiration (mm)						Average CET (mm)		Overall Average CET (mm)
		25 days old seedlings		30 days old seedlings		35 days old seedlings				
		2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	
1	$I_1N_1S_1$	633.00	640.00	632.00	641.00	625.00	635.00	630.00	638.67	634.33
2	$I_1N_3S_1$	644.00	651.00	638.00	647.00	628.00	637.00	636.67	645.00	640.83
3	$I_1N_2S_1$	642.00	650.00	643.00	645.00	628.00	639.00	637.67	644.67	641.17
4	$I_1N_4S_1$	646.00	654.00	640.00	650.00	635.00	644.00	640.33	649.33	644.83
5	$I_2N_1S_1$	629.00	644.00	631.00	636.00	625.00	632.00	628.33	637.33	632.83
6	$I_2N_3S_1$	642.00	647.00	637.00	646.00	628.00	637.00	635.67	643.33	639.50
7	$I_2N_2S_1$	641.00	649.00	642.00	644.00	627.00	637.00	636.67	643.33	640.00
8	$I_2N_4S_1$	645.00	653.00	638.00	650.00	633.00	643.00	638.67	648.67	643.67
9	$I_3N_1S_1$	631.00	642.00	629.00	637.00	618.00	633.00	626.00	637.33	631.67
10	$I_3N_3S_1$	634.00	648.00	634.00	641.00	625.00	635.00	631.00	641.33	636.17
11	$I_3N_2S_1$	638.00	648.00	639.00	643.00	623.00	633.00	633.33	641.33	637.33
12	$I_3N_4S_1$	643.00	652.00	636.00	648.00	629.00	640.00	636.00	646.67	641.33
13	$I_1N_1S_2$	630.00	639.00	627.00	635.00	613.00	631.00	623.33	635.00	629.17
14	$I_1N_3S_2$	634.00	645.00	629.00	640.00	613.00	631.00	625.33	638.67	632.00
15	$I_1N_2S_2$	636.00	646.00	630.00	641.00	613.00	631.00	626.33	639.33	632.83
16	$I_1N_4S_2$	637.00	647.00	631.00	641.00	614.00	632.00	627.33	640.00	633.67
17	$I_2N_1S_2$	633.00	638.00	621.00	634.00	620.00	630.00	624.67	634.00	629.33
18	$I_2N_3S_2$	634.00	645.00	629.00	640.00	621.00	631.00	628.00	638.67	633.33
19	$I_2N_2S_2$	636.00	647.00	630.00	641.00	621.00	632.00	629.00	640.00	634.50
20	$I_2N_4S_2$	637.00	648.00	630.00	641.00	621.00	632.00	629.33	640.33	634.83
21	$I_3N_1S_2$	633.00	639.00	621.00	634.00	617.00	630.00	623.67	634.33	629.00
22	$I_3N_3S_2$	634.00	644.00	628.00	638.00	621.00	631.00	627.67	637.67	632.67
23	$I_3N_2S_2$	635.00	646.00	630.00	641.00	621.00	632.00	628.67	639.67	634.17
24	$I_3N_4S_2$	637.00	647.00	630.00	641.00	621.00	632.00	629.33	640.00	634.67
Average		636.83	646.21	632.29	641.46	622.50	634.17	630.54	640.61	635.58

Table 6.12: DSSAT predicted cumulative evapotranspiration (mm) in Rice cv IR 64 planted with normal seedlings (120 kg/ha) grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

SL No.	Treatment Combi-nation	Cumulative Evapotranpiration (mm)						Average CET (mm)		Overall Average CET (mm)
		25 days old seedlings		30 days old seedlings		35 days old seedlings				
		2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	
1	$I_1 N_1 S_1$	629.00	640.00	627.00	635.00	620.00	629.00	625.33	634.67	630.00
2	$I_1 N_3 S_1$	639.00	647.00	633.00	642.00	623.00	631.00	631.67	640.00	635.83
3	$I_1 N_2 S_1$	637.00	645.00	638.00	638.00	623.00	632.00	632.67	638.33	635.50
4	$I_1 N_4 S_1$	641.00	648.00	634.00	643.00	628.00	639.00	634.33	643.33	638.83
5	$I_2 N_1 S_1$	627.00	638.00	621.00	634.00	618.00	628.00	622.00	633.33	627.67
6	$I_2 N_3 S_1$	637.00	646.00	632.00	641.00	621.00	630.00	630.00	639.00	634.50
7	$I_2 N_2 S_1$	635.00	644.00	636.00	645.00	619.00	630.00	630.00	639.67	634.83
8	$I_2 N_4 S_1$	641.00	647.00	633.00	642.00	627.00	637.00	633.67	642.00	637.83
9	$I_3 N_1 S_1$	628.00	635.00	622.00	628.00	614.00	621.00	621.33	628.00	624.67
10	$I_3 N_3 S_1$	631.00	637.00	628.00	638.00	619.00	639.00	626.00	638.00	632.00
11	$I_3 N_2 S_1$	639.00	641.00	634.00	644.00	616.00	626.00	629.67	637.00	633.33
12	$I_3 N_4 S_1$	637.00	646.00	637.00	640.00	621.00	633.00	631.67	639.67	635.67
13	$I_1 N_1 S_2$	624.00	634.00	619.00	631.00	608.00	625.00	617.00	630.00	623.50
14	$I_1 N_3 S_2$	629.00	638.00	623.00	634.00	609.00	625.00	620.33	632.33	626.33
15	$I_1 N_2 S_2$	630.00	640.00	624.00	634.00	609.00	625.00	621.00	633.00	627.00
16	$I_1 N_4 S_2$	631.00	641.00	625.00	635.00	609.00	625.00	621.67	633.67	627.67
17	$I_2 N_1 S_2$	628.00	638.00	617.00	627.00	614.00	622.00	619.67	629.00	624.33
18	$I_2 N_3 S_2$	628.00	639.00	623.00	633.00	615.00	625.00	622.00	632.33	627.17
19	$I_2 N_2 S_2$	630.00	640.00	624.00	634.00	608.00	625.00	620.67	633.00	626.83
20	$I_2 N_4 S_2$	631.00	641.00	625.00	635.00	609.00	625.00	621.67	633.67	627.67
21	$I_3 N_1 S_2$	626.00	632.00	621.00	627.00	613.00	622.00	620.00	627.00	623.50
22	$I_3 N_3 S_2$	627.00	638.00	621.00	632.00	615.00	625.00	621.00	631.67	626.33
23	$I_3 N_2 S_2$	630.00	640.00	624.00	634.00	615.00	625.00	623.00	633.00	628.00
24	$I_3 N_4 S_2$	631.00	641.00	625.00	635.00	615.00	626.00	623.67	634.00	628.83
Average		631.92	640.67	626.92	635.88	616.17	627.92	625.00	634.82	629.91

Table 6.13: DSSAT predicted cumulative evapotranspiration (mm) in Rice cv IR 64 planted with fair seedlings (80 kg/ha) grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, seedling transplant age and number of seedlings transplanted per hill.

Sl. No.	Treatment Combination	Cumulative Evapotranpiration (mm)						Average CET (mm)		Overall Average CET (mm)
		25 days old seedlings		30 days old seedlings		35 days old seedlings				
		2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	2 seedling /hill	3 seedling /hill	
1	$I_1 N_1 S_1$	623.00	629.00	618.00	628.00	610.00	620.00	617.00	625.67	621.33
2	$I_1 N_3 S_1$	630.00	640.00	625.00	635.00	614.00	624.00	623.00	633.00	628.00
3	$I_1 N_2 S_1$	628.00	638.00	628.00	639.00	613.00	624.00	623.00	633.67	628.33
4	$I_1 N_4 S_1$	632.00	642.00	625.00	635.00	619.00	629.00	625.33	635.33	630.33
5	$I_2 N_1 S_1$	622.00	627.00	616.00	629.00	609.00	619.00	615.67	625.00	620.33
6	$I_2 N_3 S_1$	627.00	638.00	622.00	633.00	612.00	623.00	620.33	631.33	625.83
7	$I_2 N_2 S_1$	633.00	643.00	627.00	637.00	612.00	619.00	624.00	633.00	628.50
8	$I_2 N_4 S_1$	631.00	641.00	624.00	633.00	617.00	628.00	624.00	634.00	629.00
9	$I_3 N_1 S_1$	616.00	627.00	612.00	620.00	606.00	614.00	611.33	620.33	615.83
10	$I_3 N_3 S_1$	622.00	631.00	619.00	630.00	611.00	621.00	617.33	627.33	622.33
11	$I_3 N_2 S_1$	630.00	640.00	624.00	635.00	607.00	617.00	620.33	630.67	625.50
12	$I_3 N_4 S_1$	628.00	638.00	627.00	638.00	613.00	622.00	622.67	632.67	627.67
13	$I_1 N_1 S_2$	615.00	626.00	611.00	620.00	604.00	617.00	610.00	621.00	615.50
14	$I_1 N_3 S_2$	620.00	631.00	614.00	626.00	605.00	617.00	613.00	624.67	618.83
15	$I_1 N_2 S_2$	621.00	632.00	615.00	627.00	605.00	610.00	613.67	623.00	618.33
16	$I_1 N_4 S_2$	622.00	633.00	615.00	627.00	605.00	610.00	614.00	623.33	618.67
17	$I_2 N_1 S_2$	617.00	624.00	613.00	620.00	598.00	613.00	609.33	619.00	614.17
18	$I_2 N_3 S_2$	619.00	630.00	614.00	625.00	604.00	617.00	612.33	624.00	618.17
19	$I_2 N_2 S_2$	621.00	632.00	615.00	627.00	604.00	617.00	613.33	625.33	619.33
20	$I_2 N_4 S_2$	622.00	633.00	616.00	627.00	604.00	617.00	614.00	625.67	619.83
21	$I_3 N_1 S_2$	617.00	629.00	612.00	624.00	603.00	614.00	610.67	622.33	616.50
22	$I_3 N_3 S_2$	617.00	630.00	611.00	623.00	601.00	616.00	609.67	623.00	616.33
23	$I_3 N_2 S_2$	620.00	632.00	614.00	626.00	603.00	617.00	612.33	625.00	618.67
24	$I_3 N_4 S_2$	622.00	633.00	616.00	627.00	604.00	616.00	614.00	625.33	619.67
Average		623.13	633.29	618.04	628.79	607.63	618.38	616.26	626.82	621.54

CHAPTER – 7

DISCUSSION

DSSAT predicted grain yield (Q/ha), total nitrogen uptake (kgs/ha), total nitrogen leached (kgs/ha) and cumulative evapotranspiration (mm) of rice cv IR 64 as influenced by the age of seedling transplant, seedlings transplanted/hill, health of the seedlings transplanted, irrigation depth applied, nitrogen dose given and split application of nitrogen as presented in Table 7.1 & Fig. 7.1 is discussed in this chapter in forthcoming paragraphs.

7.1 AGE OF SEEDLING TRANSPLANT

7.1.1 Grain Yield

Seedlings transplanted at the age of 25, 30 and 35 days recorded the grain yield of 46.86 Q/ha, 44.98 Q/ha & 40.86 Q/ha respectively. Grain yield predicted by DSSAT for different treatment combinations are shown in Table 6.2 – 6.5 and are depicted in Fig. 7.2 & 7.3. This shows that by advancing the age of seedling transplant grain yield is proportionately reduced. There is no appreciable reduction in 25 & 30 days age of seedling transplant but 35 days old seedling transplant recorded appreciable reduction in grain yield. This result shows that advancing the transplant age of seedlings reduces the grain yield @ 60 kgs/ha/day.

7.1.2 Total Nitrogen Uptake (TNUP kgs/ha)

Seedling transplanted at the age of 25, 30 and 35 days recorded the Total Nitrogen Uptake (TNUP) as 90.40 kgs/ha, 89.39 kgs/ha and 81.33 kgs/ha respectively. TNUP predicted by DSSAT for different treatments are shown in Table 6.6 – 6.9 and are depicted in Fig. 7.4 & 7.5. This shows that by advancing the age of seedlings transplant nitrogen uptake is proportionately reduced. There is no appreciable reduction in 25 to 30 days age of seedling transplant but 35 days old seedlings transplant recorded appreciable reduction in nitrogen uptake. Reduced nitrogen uptake with delayed transplanting might have been caused due to reduced biomass productivity.

7.1.3 Total Nitrogen Leached (TNLC kgs/ha)

Seedling transplanted at the age of 25, 30 and 35 days recorded the Total Nitrogen Leached (TNLC) as 23.04 kgs/ha, 29.93 kgs/ha and 32.42 kgs/ha respectively. TNLC predicted by DSSAT for different treatments are shown in Table 6.6 – 6.9 and are depicted in Fig. 7.6 & 7.7. This shows that by advancing the age of seedlings transplant nitrogen leaching is proportionately reduced. Increased nitrogen leaching on delaying transplant and age could be attributed to reduced biomass production.

7.1.4 Evapotranspiration

Seedling transplant at the age of 25, 30 and 35 days recorded the cumulative evapotranspiration as 638.07 mm, 633.29 mm and 623.93 mm respectively. Evapotranspiration predicted by DSSAT for different treatment combinations are shown in table 6.10 – 6.13 and are depicted in Fig. 7.8 – 7.9. Although there is reduction in evapotranspiration by advancing the transplant age but is not appreciable. For practical purpose it may be treated as unchanged.

7.2 SEEDLING HEALTH

7.2.1 Grain Yield

Seedlings transplanted with very healthy, healthy, normal and fair health recorded the grain yield of 47.21 Q/ha, 45.23 Q/ha, 43.56 Q/ha and 40.93 Q/ha respectively. Grain yield predicted by DSSAT for different treatment combinations are shown in Table 6.2 – 6.5 and are depicted in Fig. 7.2-7.3. This shows that by transplanting seedlings having poor health the grain yield is proportionately reduced. There is marginal reduction in yield in case of healthy seedlings in comparison to very healthy seedlings but seedlings having fair health recorded appreciably reduced grain yield. This result shows that by transplanting fair seedlings the grain yield is reduced to the extent of 6.28 Q/ha in comparison to very healthy seedlings. Transplanting of very healthy seedlings may establish early and subsequently favour growth & development and finally good biomass production.

7.2.2 Total Nitrogen Uptake

Total nitrogen uptake (TNUP) recorded was 93.54 kgs/ha 89.35 kgs/ha, 84.75 kgs/ha and 80.56 kgs/ha by transplanting very healthy, healthy, normal and fair seedlings respectively. TNUP predicted by DSSAT for different treatment combinations are shown in Table 6.6 – 6.9 and are depicted in Fig. 7.4 – 7.5. This shows that the seedlings transplanted with very healthy or healthy seedlings uptakes higher dose of nitrogen. The results also shows that the transplant of weak seedlings recorded appreciable reduction in nitrogen uptake. Reduced nitrogen uptake with unhealthy seedlings could be ascribed to the reduced biomass productivity in unhealthy seedlings.

7.2.3 Total Nitrogen Leached

Total nitrogen leached (TNLC) recorded 26.89 kgs/ha, 29.28 kgs/ha, 31.63 kgs/ha and 34.49 kgs/ha by transplanting very healthy, healthy, normal and fair seedlings respectively. TNLC predicted by DSSAT for different treatment combinations are shown in Table 6.6 – 6.9 and are depicted in Fig. 7.6 – 7.7. This shows that by transplanting healthy seedlings nitrogen leaching is reduced appreciably this is because of higher nitrogen uptake by the healthy plants. Fig. 7.7-7.8 revealed that TNLC is highest in the treatment receive fair health of seedlings. Increased nitrogen leaching in fields transplanted with unhealthy seedlings could be attributed to poor growth & development of crop.

7.2.4 Evapotranspiration

Cumulative evapotranspiration (CET) recorded 640.03 mm, 635.58 mm, 629.91 mm and 621.54 mm by transplanting very healthy, healthy, normal and fair seedlings respectively. CET predicted by DSSAT for different treatment combinations are presented in Table 6.10 – 6.13 and are depicted in Fig. 7.8-7.9. This shows that evapotranspiration decreased proportionately with decreasing healthy of seedling transplant. This means that by transplanting fair seedlings, biomass productivity is reduced, which might have resulted into reduced evapotranspiration. Results shows that by transplanting healthy or fair seedlings does not affect CET appreciably as it is mainly governed by weather condition.

7.3 SEEDLINGS TRANSPLANTED PER HILL

7.3.1 Grain Yield

The grain yield recorded 42.32 Q/ha and 46.14 Q/ha by transplanting 2 seedlings per hill and 3 seedlings per hill respectively. Grain yield predicted by DSSAT for different treatment combinations are shown in Table 6.2-6.5 and are depicted in Fig. 7.2-7.3. This shows that by transplanting 3 seedlings per hill the grain yield is increased by 3.82 Q/ha in comparison to 2 seedling transplanted per hill. The reason for this could be attributed to the increased tillers production in 3 seedlings per hill.

7.3.2 Total Nitrogen Uptake

The total nitrogen uptake (TNUP) recorded was 83.90 kgs/ha and 90.04 kgs/ha by transplanting 2 seedlings/hill and 3 seedlings/hill respectively. TNUP predicted by DSSAT for different treatments are shown in Table 6.6 – 6.9 and are depicted in Fig. 7.4 – 7.5. This shows that by transplanting 3 seedlings/hill, TNUP is increased. Increased nitrogen uptake with 3 seedlings /hill might have been caused due to increased biomass productivity of the crop.

7.3.3 Total Nitrogen Leached

The total nitrogen leached was recorded as 32.55 kgs/ha and 28.53 kgs/ha by transplanting 2 seedlings per hill and 3 seedlings/hill respectively. TNLC predicted by DSSAT for different treatment combinations are shown in Table 6.6-6.9 and are depicted in Fig. 7.6-7.7. This shows by transplanting 3 seedling/hill nitrogen leaching reduced. The reason for this could be ascribed to more number of tillers produced in transplanting 3 seedlings/hill in comparison to 23 seedling per hill and more nitrogen uptake by plants might have reduced nitrogen leaching.

7.3.4 Evapotranspiration

The cumulative evapotranspiration (CET) by transplanting 2 seedlings/hill and 3 seedlings/hill recorded was 626.83 mm and 636.70 mm respectively. CET predicted by DSSAT for different treatments are shown in Table 6.10 – 6.13 and are depicted in Fig. 7.8 – 7.9. This shows that CET increased by transplanting 3 seedling/hill. The reason for this could be increased biomass production might have resulted into increased evapotranspiration.

7.4 IRRIGATION

7.4.1 Grain Yield

The grain yield was recorded as 45.92 Q/ha, 44.22 Q/ha & 42.55 Q/ha by irrigation depth applied as 510 mm (I_1), 1020 mm (I_2) and 1530 mm (I_3) respectively. Grain yield predicted by DSSAT for different treatment are shown in Table 6.2-6.5 and are depicted in Fig. 7.2 – 7.3. This shows that by increasing the depth of irrigation, grain yield is proportionately decreased. By every mm increase in irrigation depth above 510 mm caused a grain yield loss of 0.33 kg/ha/mm. Increasing the depth of irrigation has recorded increase in nitrogen leaching.

7.4.2 Total Nitrogen Uptake

The total nitrogen uptake (TNUP) was recorded as 97.29 kgs/ha, 95.32 kgs/ha & 77.60 kgs/ha by irrigation depth applied as 510 mm, 1020 mm and 1530 mm respectively. TNUP predicted for different treatments are shown in Table 6.6-6.9 and are depicted in Fig. 7.4 – 7.5. This shows that by increasing irrigation depth TNUP proportionately reduced. There is no appreciable reduction in 510 mm & 1020 mm irrigation depth but by applying irrigation depth 1530 mm recorded appreciable reduction in nitrogen uptake. Results shows that by applying 1530 mm irrigation depth TNUP reduced by 19.69 kgs/ha in comparison to 510 mm irrigation depth. Reduced nitrogen uptake with increase in irrigation depth may be because of higher rate of percolation in sandy-loam soil. Leaching losses are increased as the percolating water increases and hence TNUP reduced.

7.4.3 Total Nitrogen Leached

The total nitrogen leached (TNLC) was recorded as 18.57 kgs/ha, 31.49 kgs/ha and 41.65 kgs/ha by applying irrigation depth of 510 mm, 1020 mm and 1530 mm respectively. TNLC predicted for different treatment are shown in Table 6.6-6.9 and are depicted in Fig. 7.6-7.7. This shows that by increasing irrigation depth the nitrogen leaching is increased proportionately. This variation in TNLC may be because of higher rate of percolation in sandy loam soil. Leaching losses are increased as the percolating water increases by increasing irrigation depth.

7.4.4 Evapotranspiration

The cumulative evapotranspiration (CET) was recorded as 632.44 mm, 632.09 mm and 630.76 mm by application of irrigation depth as 510 mm, 1020 mm and 1530 mm respectively. CET predicted by DSSAT for different treatments are shown in Table 6.10-6.13 and are depicted in Fig. 7.8-7.9. There is no appreciable difference in CET with respect to irrigation depth. This means that equal amount of water is available for ET in all case of irrigation depth applied.

7.5 NITROGEN DOSE

7.5.1 Grain Yield

The grain yield was recorded as 38.79 Q/ha, 42.75 Q/ha, 46.27 Q/ha and 49.12 Q/ha by nitrogen dose applied 50 kgN/ha (N_1), 75 kgN/ha (N_3), 100 kgN/ha (N_2) and 125 kgN/ha respectively. Grain yield predicted by DSSAT for different treatment are presented in Table 6.2-6.5 and are depicted in Fig. 7.2-7.3. This shows that by increasing the nitrogen dose grain yield is proportionately increased. Similar results have also been reported by Kurrey et.al 1999 & Rajput 2000.

7.5.2 Total Nitrogen Uptake

The Total nitrogen uptake (TNUP) was recorded as 61.59 kgs/ha, 74.44 kgs/ha, 95.97 kgs/ha and 112.09 kgs/ha by applying nitrogen dose of 50 kgN/ha, 75 kgN/ha, 100 kgN/ha and 125 kgN/ha respectively. TNUP predicted by DSSAT for different treatments are presented in Table 6.6-6.9 and are depicted in Fig. 7.4-7.5. This shows that by increasing the nitrogen dose TNUP is increased proportionately.

7.5.3 Total Nitrogen Leached

The total nitrogen leached was recorded as 27.17 kgs/ha, 29.50 kgs/ha, 31.64 kgs/ha and 33.94 kgs/ha by applying nitrogen dose of 50 kgN/ha, 75 kgN/ha, 100 kgN/ha and 125 kgN/ha respectively. TNLC predicted by DSSAT for different treatments are shown in Table 6.6-6.9 and are depicted in Fig. 7.6-7.7. This shows that by increasing nitrogen dose TNLC is also increased proportionately.

7.5.4 Evapotranspiration

The cumulative evapotranspiration (CET) was recorded as 627.49 mm, 631.79 mm, 633.01 mm and 634.76 mm by applying nitrogen dose of 50 kgN/ha, 75 kgN/ha, 100 kgN/ha and 125 kgN/ha respectively. CET predicted by DSSAT for different treatment combinations are shown in Table 6.10-6.13 and are depicted in Fig. 7.8-7.9. This shows that CET increases marginally with increasing nitrogen dose which may not be of much use.

7.6 NITROGEN SPLIT

7.6.1 Grain Yield

Nitrogen dose application in 3 split and 4 split was recorded the grain yield 49.62 Q/ha and 38.84 Q/ha respectively. Grain yield predicted by DSSAT for different treatments are shown in Table 6.2-6.5 and are depicted in Fig. 7.2-7.3. This shows that there is appreciable reduction in grain yield in 4 split application than that of 3 split application. The reduction in yield by applying nitrogen dose in 4 split may be because of less nitrogen uptake by plants than required and hence less biomass production which reduces grain yield.

7.6.2 Total Nitrogen Uptake

The total nitrogen uptake (TNUP) recorded 98.67 kgs/ha and 75.46 kgs/ha by nitrogen dose application in 3 splits and 4 splits respectively. TNUP predicted by DSSAT for different treatments are shown in Table 6.6-6.9 and are depicted in Fig. 7.4-7.5. This shows appreciable reduction in TNUP when nitrogen dose applied in 4 splits. Reduced nitrogen uptake with 4 split application may be because of deficiency in nitrogen amount available against required by plant.

7.6.3 Total Nitrogen Leached

The total nitrogen leached (TNLC) was recorded 32.13 kgs/ha and 29.01 kgs/ha by nitrogen dose application in 3 splits and 4 splits respectively. TNLC predicted by DSSAT for different treatments are shown in Table 6.6-6.9 and are predicted in Fig. 7.6-7.7. This shows marginal reduction in TNLC when nitrogen is applied in 4 splits.

7.6.4 Evapotranspiration

The cumulative evapotranspiration (CET) recorded 634.94 mm and 628.59 mm by nitrogen dose application in 3 splits & 4 splits respectively. CET predicted by DSSAT for different treatments are shown in Table 6.10-6.13 and are depicted in Fig.7.8-7.9. This shows that CET decreased marginally by application of nitrogen dose in 4 splits.

Table 7.1 : Showing DSSAT predicted grain yield (Q/ha), Total Nitrogen Uptake (TNUP kgs/ha), Total Nitrogen Leached (TNLC Kgs/ha) and Evapotranspiration (CET mm) in Rice cv IR 64 under different agronomic practices

Agronomic Practices	Grain yield Q/ha	TNUP kgs/ha	TNLC kgs/ha	CET (mm)
A. Seedlings Age				
25 days old	46.86	90.40	23.04	638.07
30 days old	44.98	89.39	29.93	633.29
35 days old	40.86	81.33	32.42	623.93
B. Seedling Health				
Very Healthy (200 kgs/ha)	47.21	93.54	26.89	640.03
Healthy (160 kgs/ha)	45.23	89.35	29.28	635.58
Normal (120 kgs/ha)	43.56	84.71	31.63	629.91
Fair (80 kgs/ha)	40.93	80.56	34.49	621.54
C. Seedlings transplanted/hill				
2 seedlings/hill	42.32	83.90	32.55	626.83
3 seedlings/hill	46.14	90.04	28.53	636.70
D. Irrigation				
510 mm I_1	45.92	97.29	18.57	632.44
1020 mm I_2	44.22	95.32	31.49	632.09
1530 mm I_3	42.55	77.60	41.65	630.76
E. Nitrogen dose				
50 kgs N/ha N_1	38.79	61.59	27.17	627.49
75 kgs N/ha N_3	42.75	74.44	29.50	631.79
100 kgs N/ha N_2	46.27	95.97	31.64	633.01
125 kgs N/ha N_4	49.12	112.09	33.94	634.76
F. Nitrogen Split				
3 splits (S_1)	49.62	98.67	32.13	634.94
4 splits (S_2)	38.84	75.46	29.01	628.59

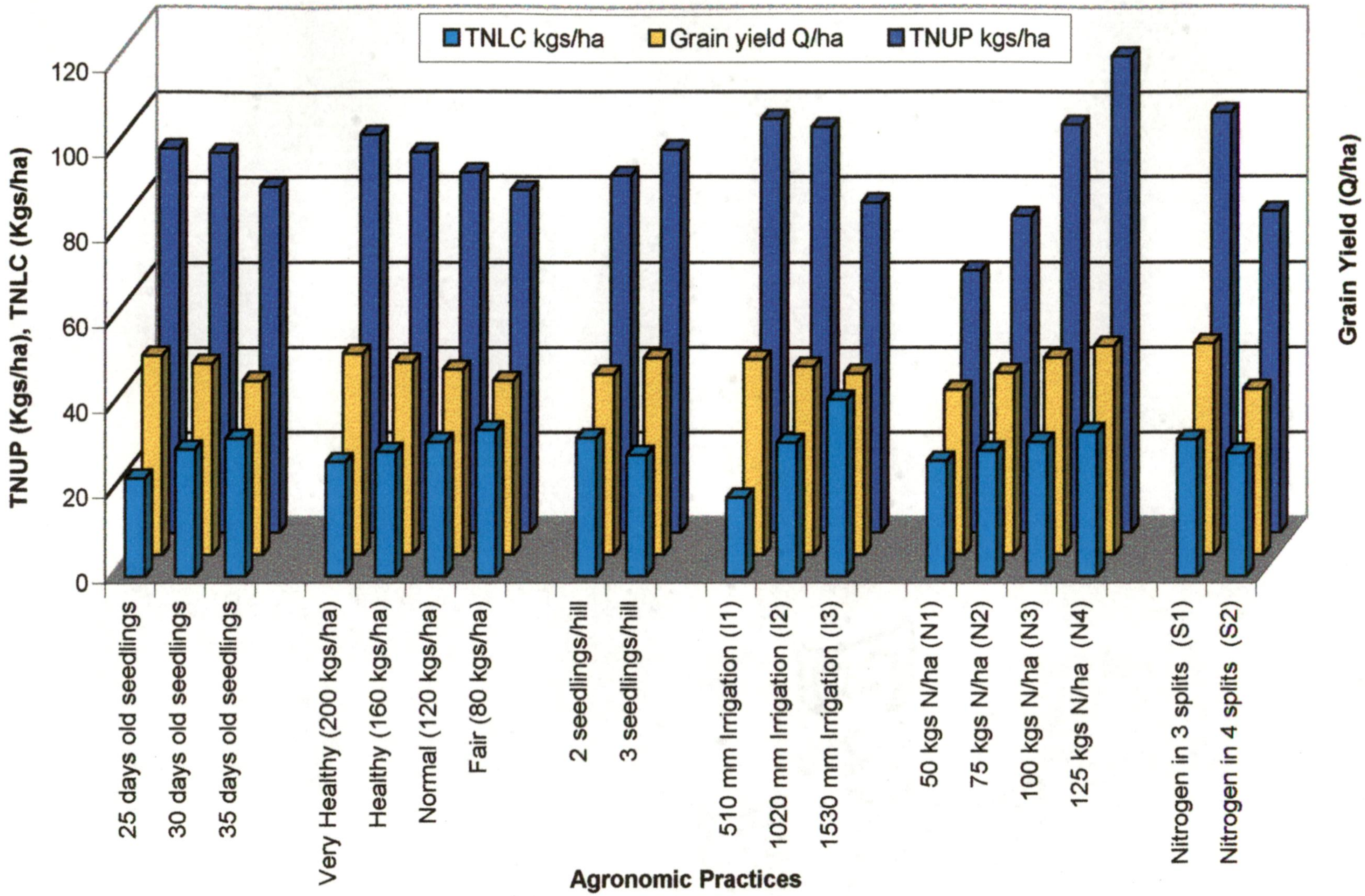

Fig. 7.1: Showing DSSAT predicted Total Nitrogen Leached (TNLC, Kgs/ha), grain yield (Q/ha) and Total Nitrogen Uptake (TNUP, kgs/ha), in Rice cv IR 64 under different agronomic practices

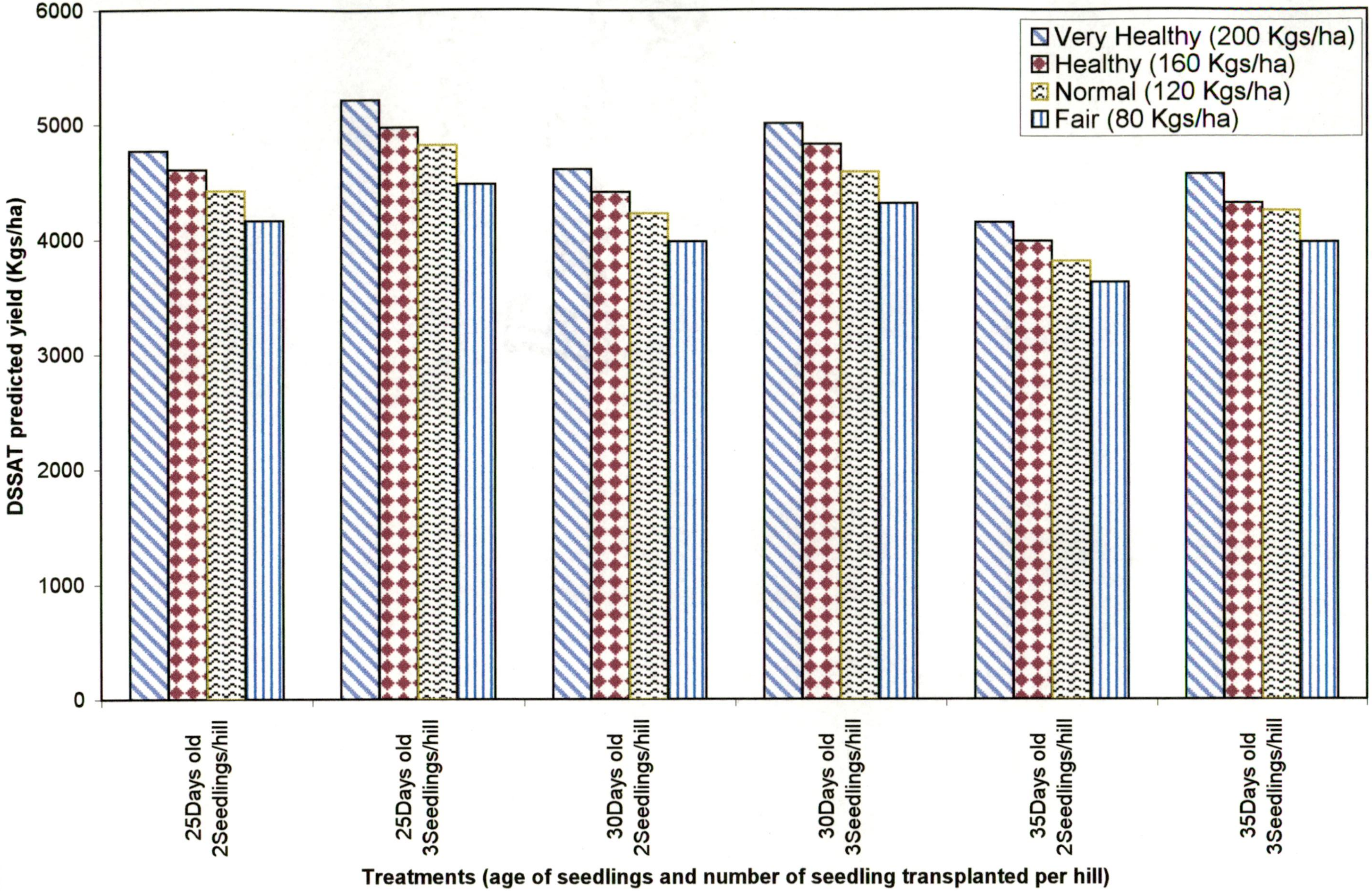

Fig. 7.2: DSSAT Predicted average yield (Kgs/ha) in rice cv IR 64 as influenced by seedling health, age of seedlings and number of seedlings transplanted per hill.

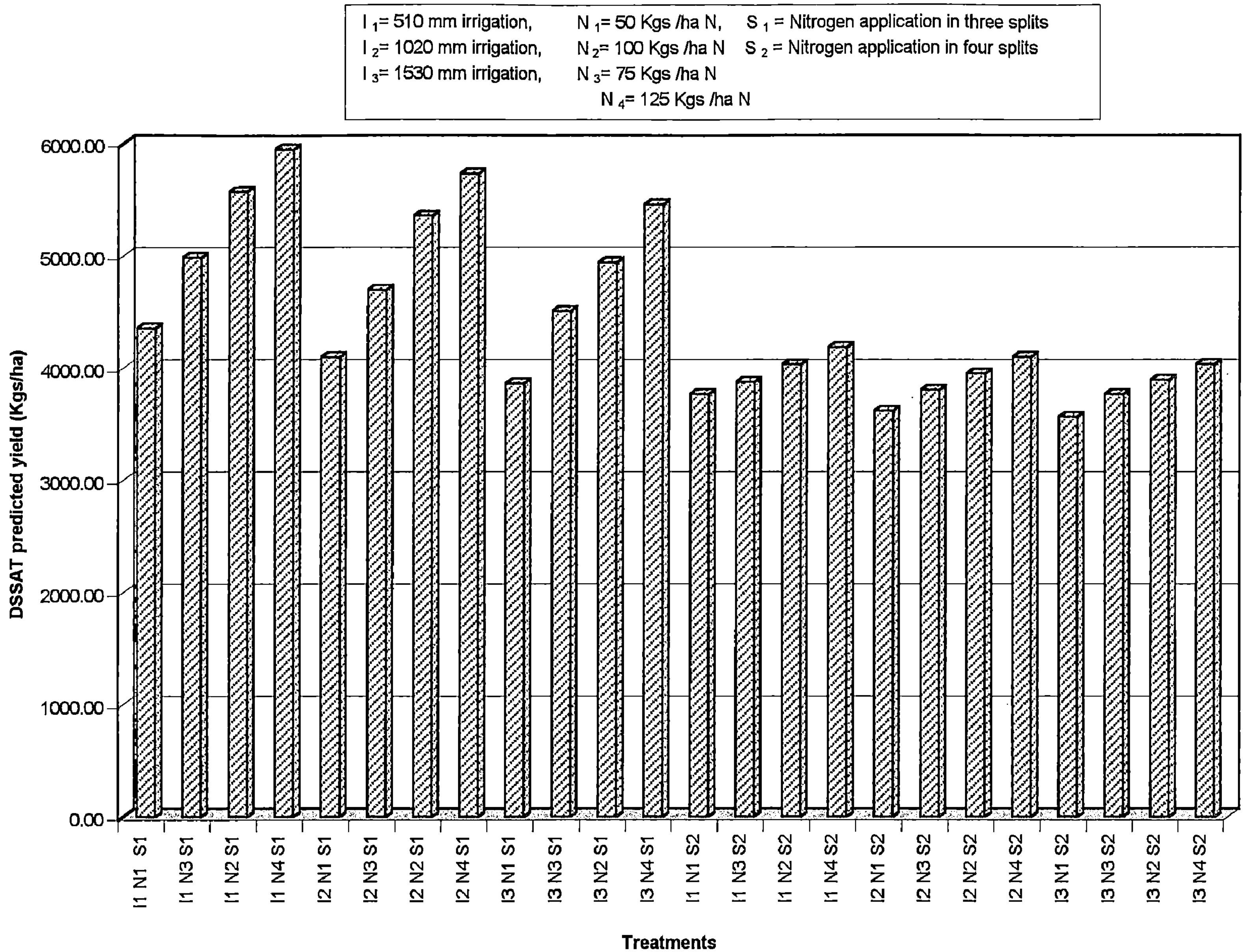

Fig. 7.3 : DSSAT Predicted average yield (Kgs/ha) in rice cv IR 64 as influenced by irrigation depth, nitrogen dose and spilt application of nitrogen dose

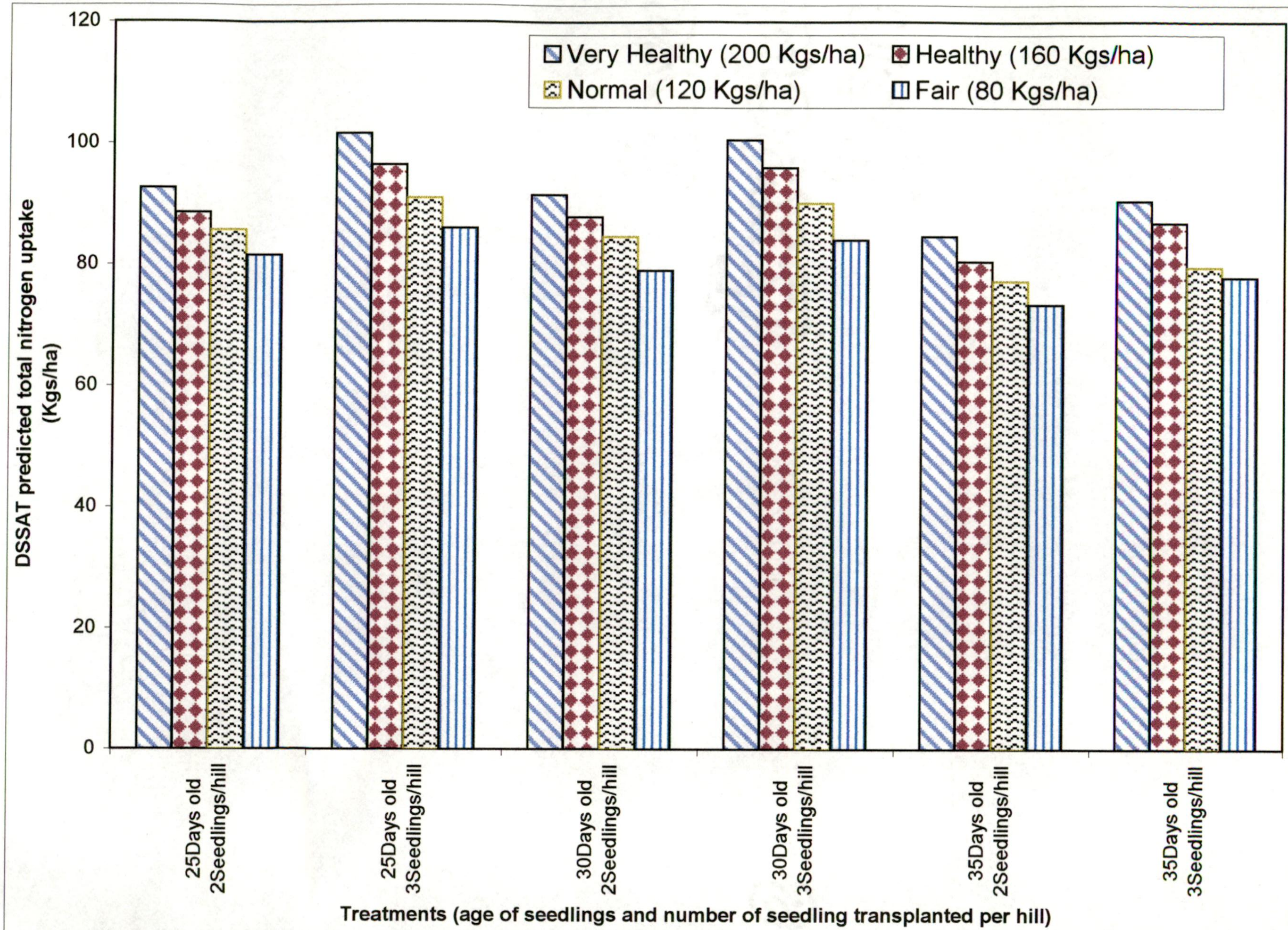

Fig. 7.4 : DSSAT Predicted average nitrogen uptake (Kgs/ha) in rice cv IR 64 as influenced by seedling health, age of seedlings and number of seedlings transplanted per hill.

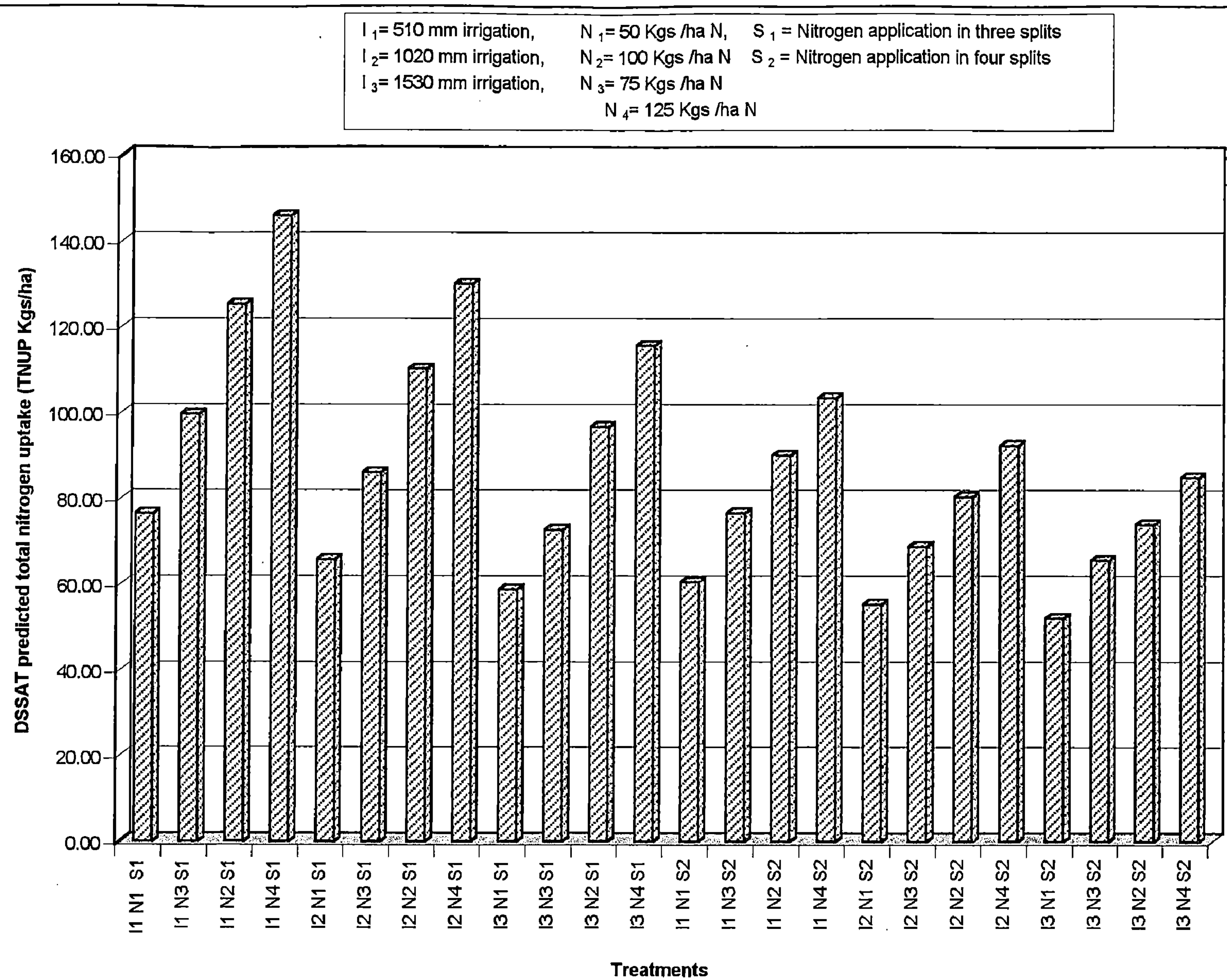

Fig. 7.5: DSSAT Predicted total nitrogen uptake (TNUP Kgs/ha) in rice cv IR 64 as influenced by irrigation depth, nitrogen dose and spilt application of nitrogen dose

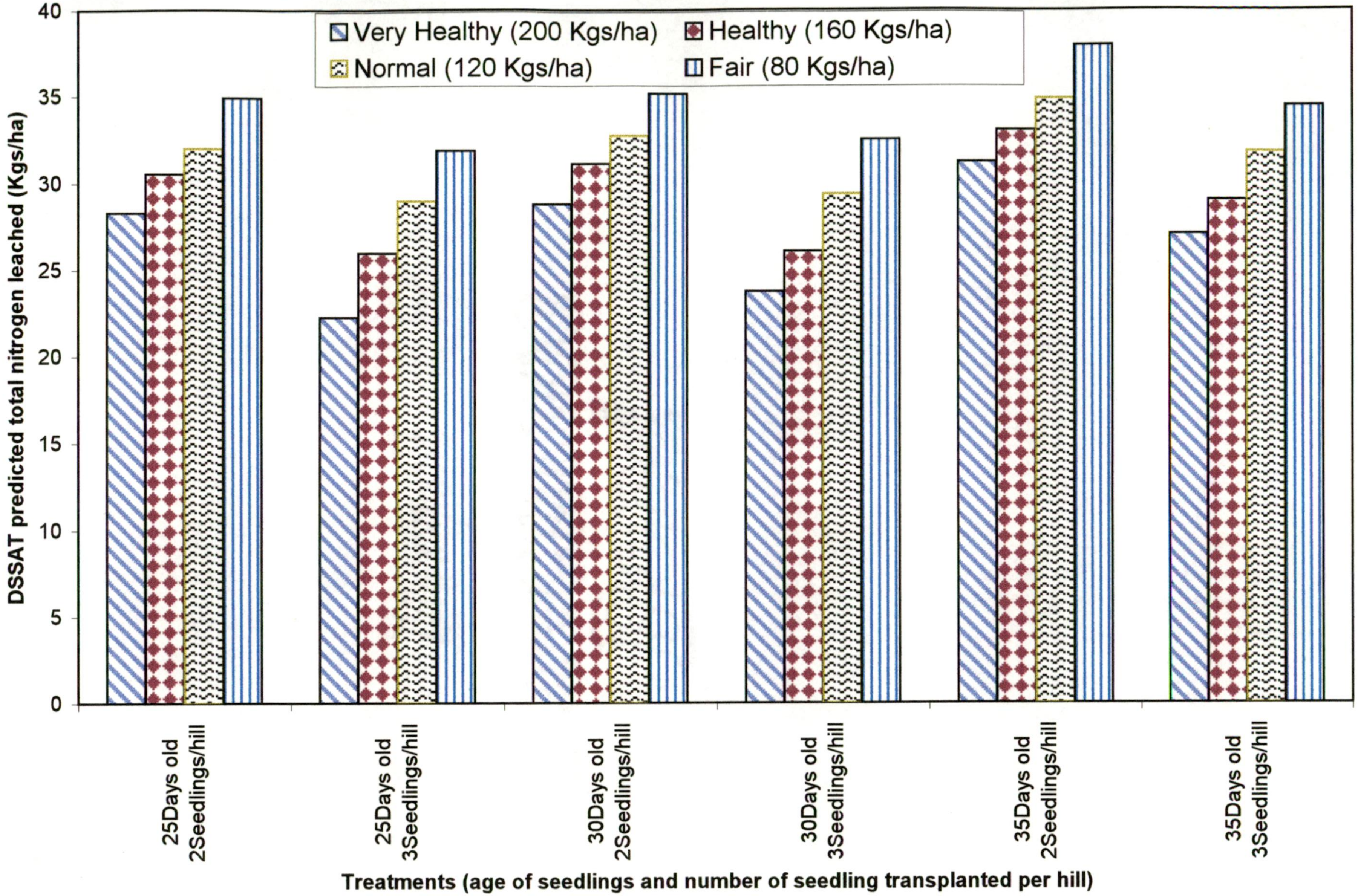

Fig. 7.6 : DSSAT Predicted average nitrogen leached (Kgs/ha) in rice cv IR 64 as influenced by seedling health, age of seedlings and number of seedlings transplanted per hill.

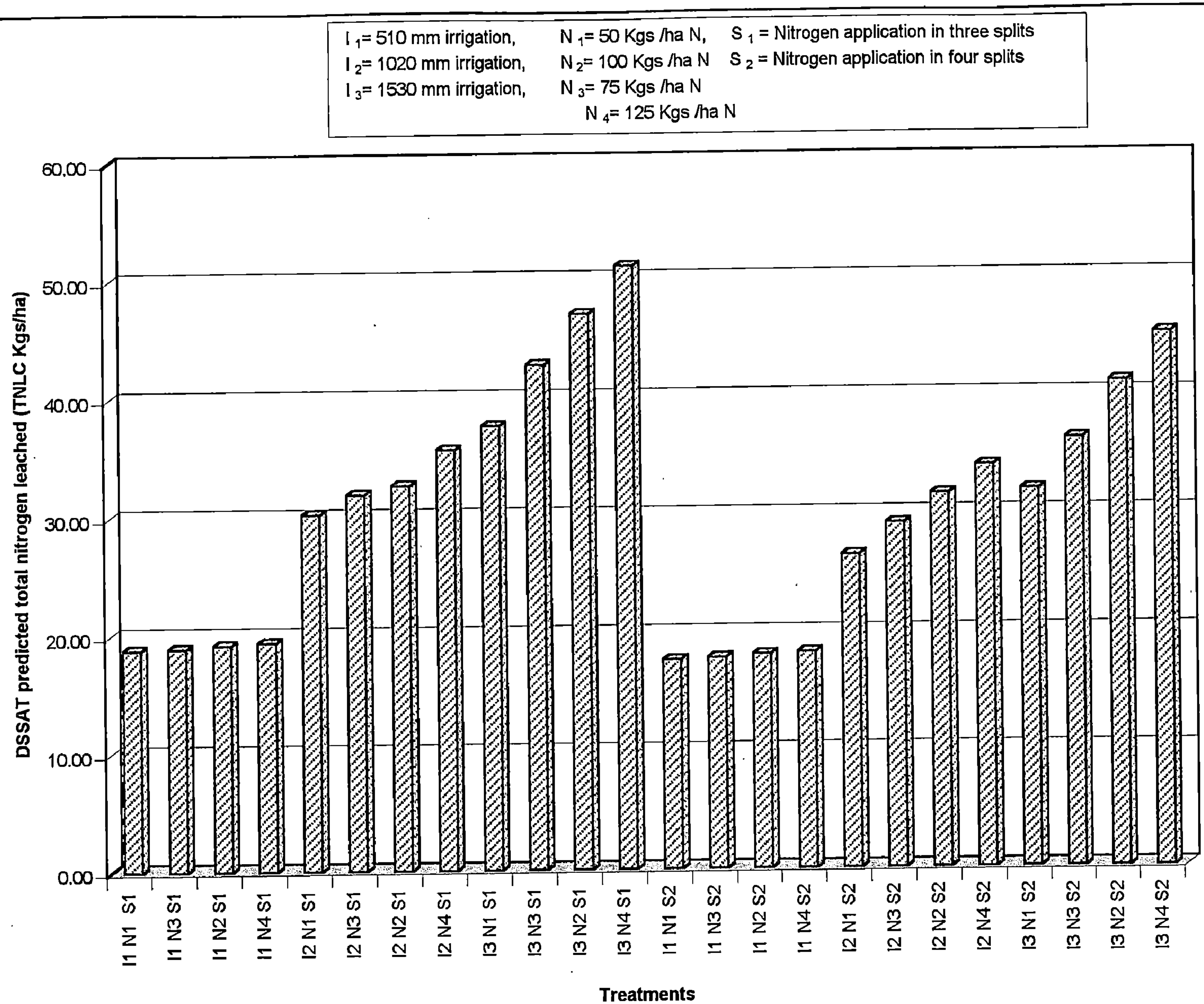

Fig.7.7: DSSAT Predicted total nitrogen leached (TNLC Kgs/ha) in rice cv IR 64 as influenced by irrigation depth, nitrogen dose and spilt application of nitrogen dose

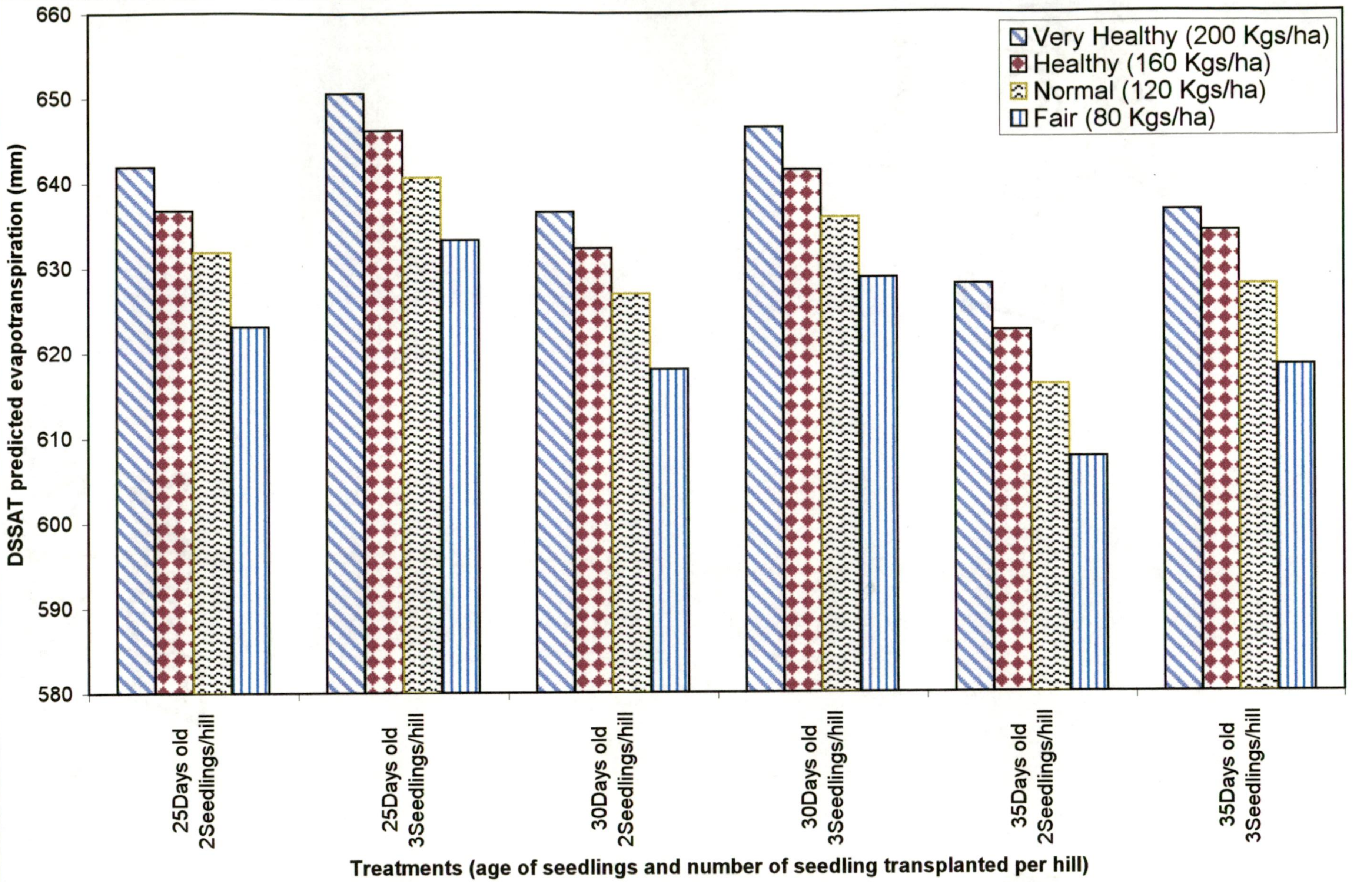

Fig.7.8 : DSSAT Predicted average evapotranspiration (mm) in rice cv IR 64 as influenced by seedling health, age of seedlings and number of seedlings transplanted per hill.

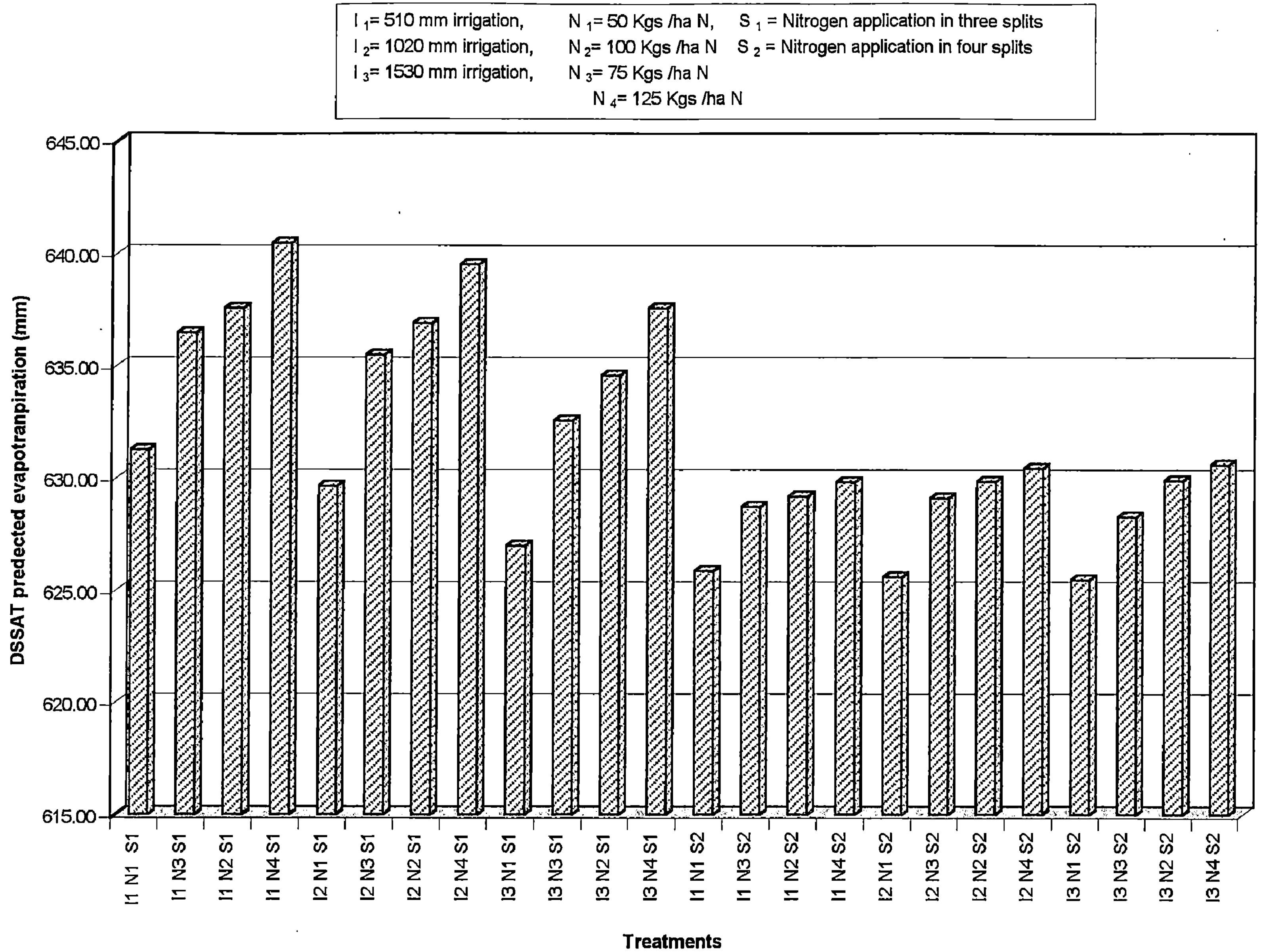

Fig. 7.9 : DSSAT Predicted average evapotranpiration (mm) in rice cv IR 64 as influenced by irrigation depth, nitrogen dose and spilt application of nitrogen dose

CHAPTER – 8

SUMMERY AND CONCLUSIONS

Rice (Oriza sativa) is one of the most important cereal crop for both human and animal consumption. Rice is grown in climates ranging from temperate to tropics. Rice seedlings from the nursery bed can be transplanted to the field when the mean daily temperature is about 13 to 15°C. Weather variables affect crop growth differently in different phenophases during its growth cycle. Water and nitrogen are equally important for survival, growth and development.

Crop models are developed to predict the effect of various cultural practices and crop treatment as well as the climatic changes on production of crops.

The Decision Support System for Agrotechnology Transfer (DSSAT) software is a product of the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT).

Base data to feed into the DSSAT model was collected from the field experiment conducted at the Demonstration Farm of Indian Institute of Technology, Roorkee during Kharif 2001 with three levels of irrigation (510 mm, 1020 mm & 1530 mm) and two levels of nitrogen (50 kgs N/ha & 100 kgs N/ha) and the rice crop variety IR 64 was grown.

The study on "Use of Decision Support System for Agrotechnology Transfer in Predicting Rice Yield" was undertaken with the following objectives :

(i) to generate data for running of DSSAT from field experimentation.
(ii) to validate the actual field results with DSSAT CERES-Rice model

The results obtained in the study are summarised below :

1. DSSAT model validated the grain yield with over estimation by about 2.7%.
2. Advancing the age of seedling transplant recorded reduction in grain yield, nitrogen uptake & cumulative evapotranspiration but increased nitrogen leaching.
3. Transplanting healthy seedlings recorded increased grain yield, nitrogen uptake & cumulative evapotranspiration but reduced nitrogen leaching.
4. Transplanting three seedlings/hill recorded increased grain yield, nitrogen uptake and cumulative evapotranspiration but reduced nitrogen leaching.
5. Increasing the depth of irrigation recorded reduced grain yield and nitrogen uptake but increased nitrogen leaching. The cumulative evapotranspiration however remained unaffected.
6. Increasing the dose of nitrogen recorded increased grain yield, nitrogen uptake, nitrogen leached and cumulative evapotranspiration.
7. Application of nitrogen in four splits over conventional 3 splits recorded reduced grain yield, nitrogen uptake, nitrogen leached and cumulative evapotranspiration.

Based on the above results, the ideal agronomic practice to cultivate Rice cv IR 64 in the soil climatic condition of Roorkee is suggested as below :

(a) Transplanting 30 day old seedling
(b) Using very healthy seedlings only
(c) Transplanting 3 seedlings/hill
(d) Applying irrigation between 500-1000 mm only
(e) Applying only 120 kgs N/ha
(f) Applying nitrogen in 3 splits only

Keeping in view the potential of DSSAT further studies may be undertaken to validate and test it on other varieties of rice and crops.

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ANNEXURES

Annexure – I

WEATHER DATA AND DAILY REFERENCE EVAPOTRANSP -Jun-01

Date	Jub-Day	Rain fall	Evap.	T min	Tmax	Tmean	Rh max	Rh min	Rh mean	Wind-spead	U	Sun-shine	N	n/N
		mm	mm	°c	°c	°c	%	%	%	km/day(U)	m/sec	hrs (n)	hrs	
1.6.01	136	0	5.7	26	36.5	31.25	58	52.48	55.24	26.00	0.30	11.00	13.59	0.81
2.6.01	137	0	3.6	25.5	35.5	30.5	70.21	60	65.11	24.00	0.28	10.50	13.60	0.77
3.6.01	138	9	5.5	25.5	35.5	30.5	71	60	65.50	20	0.23	10	13.61	0.73
4.6.01	139	4	1.6	22	26	24	84.34	77.36	80.85	34	0.39	4.5	13.62	0.33
5.6.01	140	0	2.3	22	32	27	64.94	54.2	59.57	13	0.15	8	13.63	0.59
6.6.01	141	0	3.1	23.5	33	28.25	64.94	48.1	56.52	19	0.22	8	13.63	0.59
7.6.01	142	0	2.7	23	33	28	65	49	57.00	20	0.23	9	13.64	0.66
8.6.01	143	0	2.6	23	32	27.5	65	50	57.50	20	0.23	10	13.65	0.73
9.6.01	144	0	3.4	23	32	27.5	66	51	58.50	20	0.23	11	13.65	0.81
10.6.01	145	0	3.5	23	33	28	66	51	58.50	15	0.17	11	13.66	0.81
11.6.01	146	0	5.3	22.5	37	29.75	58.06	49.67	53.87	67	0.78	11.5	13.66	0.84
12.6.01	147	0	4.8	28	38	33	63	46.1	54.55	60	0.69	11	13.67	0.80
13.6.01	148	0	4.1	28.5	38	33.25	55.41	50	52.71	58	0.67	10	13.67	0.73
14.6.01	149	0	3	24.5	27.2	25.85	88	78.29	83.15	28	0.32	7	13.68	0.51
15.6.01	150	6	1.8	22.5	31	26.75	85	78.29	81.65	19	0.22	6	13.68	0.44
16.6.01	151	1	2.5	24.5	29	26.75	84.82	75	79.91	19	0.22	6	13.69	0.44
17.6.01	152	0	2.5	24.5	29	26.75	85	74	79.50	18	0.21	7	13.69	0.51
18.6.01	153	44.6	2.5	23	35	29	67.96	55	61.48	30	0.35	2.5	13.69	0.18
19.6.01	154	21	2.9	22	34	28	76.18	68.73	72.46	12	0.14	7	13.70	0.51
20.6.01	155	0	3.6	25.5	35.5	30.5	60.94	50	55.47	24	0.28	8	13.70	0.58
21.6.01	156	0	3.8	26.5	36	31.25	63.89	50	56.95	43	0.50	7	13.70	0.51
22.6.01	157	14.6	4.8	22.5	35.5	29	72.87	59.16	66.02	35	0.41	7.5	13.70	0.55
23.6.01	158	3.6	2.4	25.5	27.5	26.5	78.7	65	71.85	30	0.35	7.25	13.71	0.53
24.6.01	159	0	2	24	30	27	75	60	67.50	20	0.23	7	13.71	0.51
25.6.01	160	8	2.3	23	31	27	74	63	68.50	19	0.22	8	13.71	0.58
26.6.01	161	1.8	1.1	22.5	31.5	27	75.77	73.2	74.49	7	0.08	8.25	13.71	0.60
27.6.01	162	8	3	25	35.5	30.25	62.16	52.77	57.47	22	0.25	12.5	13.71	0.91
28.6.01	163	0	4.6	25.5	35	30.25	68.36	63.89	66.13	20	0.23	12.5	13.71	0.91
29.6.01	164	0	2.2	28	35	31.5	76.17	73	74.59	53	0.61	5	13.71	0.36
30.6.01	165	0	1.7	28	35	31.5	76.9	73	74.95	41	0.47	4	13.71	0.29

ea	ed	ea-ed	Ra	Rs	f(T)	f(ed)	f(n/N)	Rnl	Rn	f(U)	w	(1-w)	c	Eto
mbar	mbar	mbar	mm/day	mm/day										
45.72	25.26	20.46	16.10	10.54	17.25	0.12	0.83	1.70	6.20	0.34	0.79	0.21	1.04	6.64
43.63	28.41	15.22	16.11	10.25	17.10	0.11	0.79	1.43	6.25	0.33	0.78	0.22	1.07	6.43
43.63	28.58	15.05	16.13	9.96	17.10	0.10	0.76	1.36	6.10	0.32	0.78	0.22	1.07	6.25
29.08	23.51	5.57	16.14	6.70	15.80	0.13	0.40	0.80	4.23	0.36	0.71	0.29	1.04	3.72
35.07	20.89	14.18	16.16	8.78	16.40	0.14	0.63	1.43	5.15	0.31	0.74	0.26	1.04	5.12
37.91	21.43	16.49	16.17	8.79	16.65	0.14	0.63	1.43	5.16	0.32	0.76	0.24	1.03	5.36
37.33	21.28	16.05	16.18	9.38	16.60	0.14	0.69	1.58	5.46	0.32	0.75	0.25	1.04	5.63
36.18	20.80	15.38	16.19	9.98	16.50	0.14	0.76	1.75	5.74	0.32	0.75	0.25	1.05	5.85
36.18	21.17	15.02	16.20	10.58	16.50	0.14	0.83	1.87	6.06	0.32	0.75	0.25	1.07	6.15
37.33	21.84	15.49	16.21	10.58	16.60	0.13	0.82	1.84	6.10	0.31	0.75	0.25	1.07	6.19
41.63	22.43	19.21	16.22	10.88	16.95	0.13	0.86	1.91	6.25	0.45	0.77	0.23	1.03	6.99
51.00	27.82	23.18	16.23	10.59	17.60	0.11	0.82	1.57	6.37	0.43	0.81	0.19	1.04	7.35
51.80	27.30	24.50	16.23	9.99	17.65	0.11	0.76	1.47	6.02	0.43	0.81	0.19	1.01	6.92
32.64	27.14	5.50	16.24	8.22	16.17	0.11	0.56	1.00	5.16	0.35	0.73	0.27	1.08	4.61
34.53	28.19	6.34	16.25	7.62	16.35	0.11	0.49	0.86	4.86	0.32	0.74	0.26	1.06	4.39
34.53	27.59	6.94	16.25	7.63	16.35	0.11	0.49	0.88	4.84	0.32	0.74	0.26	1.06	4.42
34.53	27.45	7.08	16.26	8.22	16.35	0.11	0.56	1.00	5.16	0.32	0.74	0.26	1.08	4.74
39.73	24.43	15.30	16.26	5.55	16.80	0.12	0.26	0.54	3.62	0.35	0.76	0.24	0.97	3.92
37.33	27.05	10.28	16.26	8.22	16.60	0.11	0.56	1.03	5.13	0.30	0.75	0.25	1.06	4.89
43.63	24.20	19.43	16.26	8.82	17.10	0.12	0.63	1.32	5.29	0.33	0.78	0.22	1.02	5.66
45.72	26.04	19.68	16.27	8.22	17.25	0.12	0.56	1.12	5.05	0.39	0.79	0.21	1.01	5.62
39.73	26.23	13.50	16.27	8.52	16.80	0.11	0.59	1.14	5.25	0.36	0.76	0.24	1.04	5.38
33.99	24.42	9.57	16.27	8.37	16.30	0.12	0.58	1.15	5.13	0.35	0.74	0.26	1.06	4.92
35.07	23.67	11.40	16.27	8.22	16.40	0.13	0.56	1.16	5.01	0.32	0.74	0.26	1.05	4.89
35.07	24.02	11.05	16.27	8.81	16.40	0.12	0.63	1.27	5.33	0.32	0.74	0.26	1.06	5.15
35.07	26.12	8.95	16.26	8.96	16.40	0.12	0.64	1.21	5.51	0.29	0.74	0.26	1.07	5.09
42.95	24.68	18.27	16.26	11.48	17.05	0.12	0.92	1.91	6.70	0.33	0.78	0.22	1.07	7.04
42.95	28.40	14.55	16.26	11.47	17.05	0.11	0.92	1.66	6.95	0.32	0.78	0.22	1.09	7.05
46.44	34.64	11.80	16.25	7.03	17.30	0.08	0.43	0.60	4.67	0.41	0.79	0.21	1.01	4.77
46.44	34.81	11.63	16.25	6.43	17.30	0.08	0.36	0.50	4.32	0.38	0.79	0.21	1.01	4.38

WEATHER DATA AND DAILY REFERENCE EVAPOTRANSPIRATION FOR THE MONTH-Jul-01

Date	Jub-Day	Rain fall	Evaporation	T min	Tmax	Tmean	Rh max	Rh min	Rh mean	Wind-spead	U	Sun-shine	N	n/N
		mm	mm	°c	°c	°c	%	%	%	km/day(U)	m/sec	hrs (n)	hrs	
1.7.01	166	0	2	27.5	33	30.25	70.8	60.4	65.60	25.00	0.29	9.00	13.71	0.66
2.7.01	167	0	3	25.5	33	29.25	73.73	73.73	73.73	42.00	0.49	9.00	13.71	0.66
3.7.01	168	0	2.5	27.5	34	30.75	68	63.53	65.77	30.00	0.35	10.00	13.71	0.73
4.7.01	169	0	4.1	27.5	35	31.25	69	63	66.00	30.00	0.35	10.00	13.71	0.73
5.7.01	170	0	4.1	27.5	35	31.25	70	64	67.00	20.00	0.23	11.00	13.70	0.80
6.7.01	171	0	2.8	25.5	32	28.75	79.72	68	73.86	25.00	0.29	12.00	13.70	0.88
7.7.01	172	0	2.4	26.5	28	27.25	85.43	71	78.22	20.00	0.23	11.00	13.70	0.80
8.7.01	173	0	2.8	26.5	28	27.25	85	71	78.00	20.00	0.23	11.00	13.70	0.80
9.7.01	174	0	3.1	26.5	30	28.25	84	70	77.00	20.00	0.23	11.00	13.69	0.80
10.7.01	175	0	2.2	34	24	29	66.1	64	65.05	134.00	1.55	4.00	13.69	0.29
11.7.01	176	3	2.1	32	26	29	71	60	65.50	59.00	0.68	10.00	13.69	0.73
12.7.01	177	0	3.5	27.5	34	30.75	57.25	50	53.63	49.00	0.57	10.00	13.68	0.73
13.7.01	178	0	3.7	35	27	31	68	60	64.00	41.00	0.47	12.25	13.68	0.90
14.7.01	179	0	2.9	26	30	28	79.5	70	74.75	39.00	0.45	9.00	13.68	0.66
15.7.01	180	0	1	26	30	28	80	70	75.00	25.00	0.29	10.00	13.67	0.73
16.7.01	181	130.4	0.4	24	28	26	88.83	88.4	88.62	17.00	0.20	0.00	13.67	0.00
17.7.01	182	4	3.8	24	31	27.5	92.41	79.48	85.95	23.00	0.27	7.50	13.66	0.55
18.7.01	183	0	3	24.5	31	27.75	67.59	66.95	67.27	23.00	0.27	7.50	13.65	0.55
19.7.01	184	0	1.5	26.5	29	27.75	85.44	68.73	77.09	56.00	0.65	8.00	13.65	0.59
20.7.01	185	2	2.9	26	29	27.5	82	77.9	79.95	75.00	0.87	3.00	13.64	0.22
21.7.01	186	28.2	0.7	24	27	25.5	92.5	85.6	89.05	26.00	0.30	2.00	13.64	0.15
22.7.01	187	0	1.7	25	28	26.5	85.6	85.4	85.50	8.00	0.09	0.00	13.63	0.00
23.7.01	188	8	0.5	26	30	28	79.5	63	71.25	17.00	0.20	11.00	13.62	0.81
24.7.01	189	0	1.5	27.5	33	30.25	70.8	60.4	65.60	29.00	0.34	9.00	13.61	0.66
25.7.01	190	26	2	25	33	29	89.2	68.35	78.78	10.00	0.12	3.00	13.61	0.22
26.7.01	191	1	2.9	25.5	32	28.75	85.6	79.95	82.78	19.00	0.22	4.00	13.60	0.29
27.7.01	192	21.4	1.6	26.5	31	28.75	85.6	73.5	79.55	8.00	0.09	4.00	13.59	0.29
28.7.01	193	22.2	2.5	25	29	27	92.4	85.1	88.75	17.00	0.20	2.00	13.58	0.15
29.7.01	194	0	2.2	25	34	29.5	79.5	63	71.25	9.00	0.10	7.50	13.57	0.55
30.7.01	195	0	3.8	27	34.5	30.75	66.8	66.27	66.54	15.00	0.17	7.00	13.56	0.52
31.7.01	196	0	3.4	27.5	34	30.75	68.48	43.83	56.16	14.00	0.16	7.00	13.56	0.52

ea	ed	ea-ed	Ra	Rs	f(T)	f(ed)	f(n/N)	Rnl	Rn	f(U)	w	(1-w)	c	Eto
mbar	mbar	mbar	mm/day	mm/day										
42.95	28.18	14.78	16.24	9.39	17.05	0.11	0.69	1.25	5.79	0.34	0.78	0.22	1.06	5.93
40.36	29.75	10.60	16.24	9.39	16.85	0.10	0.69	1.16	5.88	0.38	0.77	0.23	1.06	5.76
44.32	29.14	15.17	16.23	9.98	17.15	0.10	0.76	1.33	6.15	0.35	0.78	0.22	1.06	6.32
45.72	30.18	15.54	16.22	9.97	17.25	0.10	0.76	1.28	6.20	0.35	0.79	0.21	1.06	6.40
45.72	30.63	15.09	16.21	10.56	17.25	0.10	0.82	1.37	6.55	0.32	0.79	0.21	1.08	6.69
39.12	28.89	10.23	16.20	11.15	16.75	0.10	0.89	1.54	6.82	0.34	0.76	0.24	1.11	6.70
35.62	27.86	7.76	16.19	10.55	16.45	0.11	0.82	1.46	6.45	0.32	0.74	0.26	1.12	6.11
35.62	27.78	7.84	16.18	10.54	16.45	0.11	0.82	1.46	6.44	0.32	0.74	0.26	1.12	6.10
37.91	29.19	8.72	16.17	10.54	16.65	0.10	0.82	1.40	6.50	0.32	0.76	0.24	1.12	6.26
39.73	25.85	13.89	16.16	6.40	16.80	0.12	0.36	0.71	4.09	0.63	0.76	0.24	0.93	4.83
39.73	26.02	13.71	16.15	9.94	16.80	0.12	0.76	1.47	5.98	0.43	0.76	0.24	1.05	6.25
44.32	23.76	20.55	16.13	9.93	17.15	0.13	0.76	1.63	5.82	0.40	0.78	0.22	1.02	6.46
45.01	28.81	16.20	16.12	11.25	17.20	0.10	0.91	1.62	6.82	0.38	0.79	0.21	1.08	7.19
37.33	27.90	9.43	16.11	9.33	16.60	0.11	0.69	1.24	5.76	0.38	0.75	0.25	1.07	5.58
37.33	28.00	9.33	16.09	9.91	16.60	0.11	0.76	1.35	6.08	0.34	0.75	0.25	1.09	5.85
32.95	29.20	3.75	16.07	4.02	16.20	0.10	0.10	0.17	2.85	0.32	0.73	0.27	1.01	2.42
36.18	31.10	5.09	16.06	8.42	16.50	0.09	0.59	0.93	5.39	0.33	0.75	0.25	1.10	4.89
36.75	24.72	12.03	16.04	8.42	16.55	0.12	0.59	1.19	5.12	0.33	0.75	0.25	1.03	4.99
36.75	28.33	8.42	16.02	8.70	16.55	0.11	0.63	1.10	5.43	0.42	0.75	0.25	1.07	5.29
36.18	28.93	7.25	16.00	5.76	16.50	0.10	0.30	0.51	3.81	0.47	0.75	0.25	0.99	3.68
31.94	28.44	3.50	15.98	5.17	16.10	0.11	0.23	0.39	3.48	0.34	0.73	0.27	1.03	2.95
33.99	29.06	4.93	15.96	3.99	16.30	0.10	0.10	0.17	2.83	0.29	0.74	0.26	1.00	2.47
37.33	26.60	10.73	15.94	10.42	16.60	0.11	0.83	1.55	6.27	0.32	0.75	0.25	1.10	6.13
42.95	28.18	14.78	15.92	9.24	17.05	0.11	0.69	1.26	5.67	0.35	0.78	0.22	1.05	5.84
39.73	31.30	8.43	15.90	5.73	16.80	0.09	0.30	0.47	3.83	0.30	0.76	0.24	1.04	3.67
39.12	32.38	6.74	15.88	6.30	16.75	0.09	0.36	0.55	4.18	0.32	0.76	0.24	1.04	3.85
39.12	31.12	8.00	15.85	6.30	16.75	0.09	0.36	0.58	4.14	0.29	0.76	0.24	1.05	3.89
35.07	31.12	3.95	15.83	5.12	16.40	0.09	0.23	0.36	3.48	0.32	0.74	0.26	1.04	3.02
40.99	29.21	11.78	15.81	8.32	16.90	0.10	0.60	1.03	5.21	0.29	0.77	0.23	1.07	5.13
44.32	29.49	14.83	15.78	8.02	17.15	0.10	0.56	0.98	5.03	0.31	0.78	0.22	1.02	5.06
44.32	24.89	19.43	15.75	8.01	17.15	0.12	0.56	1.17	4.84	0.31	0.78	0.22	1.03	5.24

WEATHER DATA AND DAILY REFERENCE EVAPOTRANSPIRATION FOR THE MONTH–Aug.2001

Date	Jub-Day	Rain fall	Evap	T min	Tmax	Tmean	Rh max	Rh min	Rh mean	Wind-spead	U	Sun-shine	N	n/N
		mm	mm	°c	oc	oc	%	%	%	km/day(U)	m/sec	hrs (n)	hrs	
1.8.01	197.00	-	2.20	26.00	34.00	30.00	79.10	68.73	73.92	25.00	0.29	10.00	13.55	0.74
2.8.01	198.00	-	4.10	25.50	35.00	30.25	73.62	63.53	68.58	32.00	0.37	11.50	13.54	0.85
3.8.01	199.00	-	2.00	26.50	34.00	30.25	67.23	66.10	66.67	45.00	0.52	9.00	13.53	0.67
4.8.01	200.00	-	2.90	26.50	30.00	28.25	81.70	75.80	78.75	15.00	0.17	9.50	13.52	0.70
5.8.01	201.00	-	3.80	26.00	34.50	30.25	79.72	58.36	69.04	20.00	0.23	11.00	13.50	0.81
6.8.01	202.00	-	4.00	26.50	35.00	30.75	60.00	58.80	59.40	37.00	0.43	11.50	13.49	0.85
7.8.01	203.00	-	3.00	27.50	31.00	29.25	79.48	65.07	72.28	33.00	0.38	11.50	13.48	0.85
8.8.01	204.00	-	2.90	27.00	34.00	30.50	70.21	60.34	65.28	59.00	0.68	11.75	13.47	0.87
9.8.01	205.00	-	5.00	25.50	34.50	30.00	67.60	58.36	62.98	48.00	0.56	12.00	13.46	0.89
10.8.01	206.00	-	3.30	27.00	35.00	31.00	70.21	58.36	64.29	36.00	0.42	11.75	13.45	0.87
11.8.01	207.00	38.60	5.60	27.00	35.00	31.00	69.17	58.36	63.77	36.00	0.42	11.50	13.43	0.86
12.8.01	208.00	52.00	0.90	24.00	27.00	25.50	92.41	85.43	88.92	12.00	0.14	1.50	13.42	0.11
13.8.01	209.00	29.40	0.50	24.00	27.00	25.50	92.30	80.94	86.62	32.00	0.37	-	13.41	-
14.8.01	210.00	16.20	0.90	23.50	27.00	25.25	92.41	92.27	92.34	15.00	0.17	-	13.40	-
15.8.01	211.00	-	1.70	25.00	34.00	29.50	79.10	63.53	71.32	10.00	0.12	11.50	13.38	0.86
16.8.01	212.00	16.00	4.50	24.00	34.00	29.00	73.73	66.80	70.27	18.00	0.21	11.00	13.37	0.82
17.8.01	213.00	-	3.00	25.50	34.00	29.75	76.46	68.73	72.60	12.00	0.14	7.00	13.35	0.52
18.8.01	214.00	-	2.80	27.00	34.00	30.50	85.78	57.75	71.77	27.00	0.31	9.00	13.34	0.67
19.8.01	215.00	-	2.00	26.50	34.50	30.50	70.00	60.94	65.47	11.00	0.13	9.50	13.33	0.71
20.8.01	216.00	-	4.10	26.50	35.00	30.75	70.54	53.20	61.87	19.00	0.22	11.00	13.31	0.83
21.8.01	217.00	-	2.50	27.00	33.00	30.00	73.73	68.00	70.87	14.00	0.16	6.00	13.30	0.45
22.8.01	218.00	3.80	1.00	27.00	29.50	28.25	85.78	85.45	85.62	29.00	0.34	3.00	13.28	0.23
23.8.01	219.00	0.80	2.20	25.00	33.50	29.25	73.41	71.21	72.31	14.00	0.16	6.00	13.26	0.45
24.8.01	220.00	-	2.70	25.50	33.50	29.50	85.44	68.86	77.15	12.00	0.14	10.00	13.25	0.75
25.8.01	221.00	-	2.40	24.50	34.00	29.25	72.67	71.23	71.95	17.00	0.20	10.00	13.23	0.76
26.8.01	222.00	-	4.00	26.50	34.00	30.25	86.34	68.73	77.54	32.00	0.37	11.50	13.22	0.87
27.8.01	223.00	-	3.60	26.50	35.00	30.75	65.70	60.94	63.32	25.00	0.29	9.50	13.20	0.72
28.8.01	224.00	-	2.90	27.00	35.00	31.00	72.67	63.20	67.94	23.00	0.27	9.00	13.18	0.68
29.8.01	225.00	-	3.40	26.50	34.50	30.50	64.26	63.20	63.73	26.00	0.30	10.00	13.16	0.76
30.8.01	226.00	-	2.90	25.50	34.50	30.00	69.26	63.53	66.40	17.00	0.20	9.50	13.15	0.72
31.8.01	227.00	-	3.20	26.00	35.00	30.50	79.10	69.20	74.15	14.00	0.16	10.00	13.13	0.76

ea	ed	ea-ed	Ra	Rs	f(T)	f(ed)	f(n/N)	Rnl	Rn	f(U)	w	(1-w)	c	Eto
mbar	mbar	mbar	mm/day	mm/day										
42.29	31.26	11.03	15.73	9.74	17.00	0.09	0.76	1.22	6.08	0.34	0.78	0.22	1.09	6.03
42.95	29.46	13.50	15.70	10.59	17.05	0.10	0.86	1.49	6.45	0.36	0.78	0.22	1.08	6.60
42.95	28.64	14.32	15.67	9.13	17.05	0.10	0.70	1.25	5.60	0.39	0.78	0.22	1.03	5.78
37.91	29.86	8.06	15.64	9.41	16.65	0.10	0.73	1.21	5.84	0.31	0.76	0.24	1.09	5.49
42.95	29.66	13.30	15.62	10.26	17.05	0.10	0.83	1.43	6.27	0.32	0.78	0.22	1.10	6.42
44.32	26.32	17.99	15.59	10.54	17.15	0.11	0.87	1.70	6.20	0.37	0.78	0.22	1.04	6.57
40.36	29.17	11.19	15.55	10.52	16.85	0.10	0.87	1.50	6.40	0.36	0.77	0.23	1.10	6.41
43.63	28.48	15.15	15.52	10.65	17.10	0.11	0.89	1.59	6.40	0.43	0.78	0.22	1.06	6.81
42.29	26.63	15.66	15.49	10.78	17.00	0.11	0.90	1.73	6.35	0.40	0.78	0.22	1.06	6.73
45.01	28.94	16.08	15.46	10.62	17.20	0.10	0.89	1.58	6.39	0.37	0.79	0.21	1.07	6.74
45.01	28.70	16.31	15.43	10.46	17.20	0.10	0.87	1.56	6.28	0.37	0.79	0.21	1.07	6.64
31.94	28.40	3.54	15.39	4.71	16.10	0.11	0.20	0.34	3.19	0.30	0.73	0.27	1.03	2.69
31.94	27.66	4.27	15.36	3.84	16.10	0.11	0.10	0.17	2.71	0.36	0.73	0.27	1.01	2.39
31.44	29.03	2.41	15.32	3.83	16.05	0.10	0.10	0.17	2.71	0.31	0.72	0.28	1.01	2.20
40.99	29.23	11.76	15.29	10.39	16.90	0.10	0.87	1.51	6.29	0.30	0.77	0.23	1.11	6.24
39.73	27.92	11.81	15.25	10.09	16.80	0.11	0.84	1.52	6.05	0.32	0.76	0.24	1.08	5.96
41.63	30.22	11.41	15.22	7.79	16.95	0.10	0.57	0.95	4.89	0.30	0.77	0.23	1.05	4.79
43.63	31.31	12.32	15.18	8.92	17.10	0.09	0.71	1.13	5.55	0.34	0.78	0.22	1.09	5.72
43.63	28.56	15.07	15.14	9.18	17.10	0.10	0.74	1.33	5.56	0.30	0.78	0.22	1.06	5.64
44.32	27.42	16.90	15.10	10.02	17.15	0.11	0.84	1.59	5.93	0.32	0.78	0.22	1.07	6.23
42.29	29.97	12.32	15.06	7.16	17.00	0.10	0.51	0.85	4.52	0.31	0.78	0.22	1.03	4.48
37.91	32.46	5.45	15.02	5.45	16.65	0.09	0.30	0.45	3.64	0.35	0.76	0.24	1.02	3.28
40.36	29.18	11.17	14.98	7.13	16.85	0.10	0.51	0.87	4.48	0.31	0.77	0.23	1.03	4.35
40.99	31.62	9.37	14.94	9.38	16.90	0.09	0.78	1.22	5.81	0.30	0.77	0.23	1.10	5.65
40.36	29.04	11.32	14.90	9.36	16.85	0.10	0.78	1.35	5.66	0.32	0.77	0.23	1.07	5.52
42.95	33.30	9.65	14.86	10.18	17.05	0.09	0.88	1.30	6.34	0.36	0.78	0.22	1.11	6.32
44.32	28.06	16.26	14.82	9.04	17.15	0.11	0.75	1.37	5.41	0.34	0.78	0.22	1.04	5.62
45.01	30.58	14.43	14.77	8.74	17.20	0.10	0.71	1.19	5.36	0.33	0.79	0.21	1.05	5.51
43.63	27.81	15.82	14.73	9.28	17.10	0.11	0.78	1.45	5.51	0.34	0.78	0.22	1.04	5.68
42.29	28.08	14.21	14.68	8.98	17.00	0.11	0.75	1.36	5.37	0.32	0.78	0.22	1.05	5.42
43.63	32.35	11.28	14.64	9.23	17.10	0.09	0.79	1.21	5.72	0.31	0.78	0.22	1.08	5.66

WEATHER DATA AND DAILY REFERENCE EVAPOTRANSPIRATION – SEP-01

Date	Jub-Day	Rain fall	Evap	T min	Tmax	Tmean	Rh max	Rh min	Rh mean	Wind-spead	U	Sun-shine	N	n/N
		mm	mm	° c	°c	°c	%	%	%	km/day(U)	m/sec	hrs (n)	hrs	
1.9.01	228	0	2.9	25	34	29.5	63.53	62.18	62.86	18.00	0.21	11.00	13.11	0.84
2.9.01	229	0	3.1	24.5	34.5	29.5	73.62	63.53	68.58	29.00	0.34	10.00	13.09	0.76
3.9.01	230	0	2.8	25	34.5	29.75	82	60.94	71.47	21.00	0.24	9.00	13.07	0.69
4.9.01	231	0	2	25	31.5	28.25	72.87	66.86	69.87	15.00	0.17	4.00	13.06	0.31
5.9.01	232	0	3.1	26	35	30.5	79.95	63.53	71.74	23.00	0.27	8.00	13.04	0.61
6.9.01	233	0	3.2	22.5	34	28.25	66.86	52.48	59.67	18.00	0.21	8.50	13.02	0.65
7.9.01	234	0	3.3	24	34.5	29.25	69.7	52.48	61.09	16.00	0.19	11.00	13.00	0.85
8.9.01	235	0	3.6	25	35	30	72.87	55.12	64.00	18.00	0.21	11.00	12.98	0.85
9.9.01	236	0	3.2	25	34	29.5	70.54	52.48	61.51	29.00	0.34	11.00	12.96	0.85
10.9.01	237	0	3	24	35	29.5	67.23	53.2	60.22	26.00	0.30	11.00	12.94	0.85
11.9.01	238	0	3.3	24	34.5	29.25	64.26	55.12	59.69	20.00	0.23	10.00	12.92	0.77
12.9.01	239	0	2.6	24	33.5	28.75	72.87	68	70.44	28.00	0.32	9.00	12.89	0.70
13.9.01	240	0	2.5	23.5	34	28.75	66.27	60.34	63.31	33.00	0.38	8.00	12.87	0.62
14.9.01	241	0	2.7	24.5	32.5	28.5	72.87	62.18	67.53	26.00	0.30	5.00	12.85	0.39
15.9.01	242	0	3.8	20.5	32	26.25	71.42	61.7	66.56	22.00	0.25	10.00	12.83	0.78
16.9.01	243	0	2.9	21.5	32.5	27	71.95	61.95	66.95	23.00	0.27	10.00	12.81	0.78
17.9.01	244	0	3.7	20.5	33	26.75	65.6	56.82	61.21	25.00	0.29	9.45	12.79	0.74
18.9.01	245	0	2.9	23	34	28.5	66.86	52.85	59.86	17.00	0.20	10.00	12.76	0.78
19.9.01	246	0	3.3	22.5	34.5	28.5	66.27	52.48	59.38	16.00	0.19	10.00	12.74	0.78
20.9.01	247	0	3	21.5	34.5	28	68.78	52.85	60.82	17.00	0.20	10.25	12.72	0.81
21.9.01	248	0	3.1	21.5	34	27.75	60.85	52.48	56.67	15.00	0.17	10.00	12.69	0.79
22.9.01	249	0	3.2	21.5	34	27.75	66.27	52.48	59.38	15.00	0.17	10.50	12.67	0.83
23.9.01	250	0	3	22	34	28	66.27	52.48	59.38	30.00	0.35	10.50	12.65	0.83
24.9.01	251	0	3.3	22.5	34.5	28.5	66.27	51.3	58.79	23.00	0.27	10.25	12.62	0.81
25.9.01	252	0	3.2	23	34.5	28.75	63.18	50.79	56.99	30.00	0.35	10.50	12.60	0.83
26.9.01	253	0	3	21.5	34	27.75	63.18	51.3	57.24	26.00	0.30	10.50	12.58	0.83
27.9.01	254	0	2.7	21.5	34	27.75	63.18	53.2	58.19	23.00	0.27	10.50	12.55	0.84
28.9.01	255	0	3.4	21.5	34.5	28	66.27	50.79	58.53	27.00	0.31	10.50	12.53	0.84
29.9.01	256	0	2.9	23.5	34	28.75	66.86	52.85	59.86	40.00	0.46	10.00	12.50	0.80
30.9.01	257	0	3	23.5	34	28.75	61.7	53.2	57.45	12.00	0.14	10.00	12.47	0.80

ea	ed	ea-ed	Ra	Rs	f(T)	f(ed)	f(n/N)	Rnl	Rn	f(U)	w	(1-w)	c	Eto
mbar	mbar	mbar	mm/day	mm/day										
40.99	25.76	15.23	14.59	9.77	16.90	0.12	0.86	1.69	5.64	0.32	0.77	0.23	1.05	5.72
40.99	28.11	12.88	14.55	9.19	16.90	0.11	0.79	1.42	5.47	0.35	0.77	0.23	1.06	5.55
41.63	29.76	11.88	14.50	8.62	16.95	0.10	0.72	1.22	5.24	0.33	0.77	0.23	1.07	5.30
37.91	26.49	11.43	14.45	5.83	16.65	0.11	0.38	0.71	3.66	0.31	0.76	0.24	1.00	3.63
43.63	31.30	12.33	14.40	8.02	17.10	0.09	0.65	1.05	4.97	0.33	0.78	0.22	1.06	5.05
37.91	22.62	15.29	14.36	8.28	16.65	0.13	0.69	1.50	4.71	0.32	0.76	0.24	1.03	4.88
40.36	24.65	15.70	14.31	9.63	16.85	0.12	0.86	1.76	5.46	0.31	0.77	0.23	1.06	5.67
42.29	27.06	15.23	14.26	9.61	17.00	0.11	0.86	1.63	5.58	0.32	0.78	0.22	1.07	5.79
40.99	25.21	15.78	14.21	9.58	16.90	0.12	0.86	1.74	5.45	0.35	0.77	0.23	1.06	5.77
40.99	24.68	16.31	14.16	9.56	16.90	0.12	0.87	1.78	5.39	0.34	0.77	0.23	1.05	5.70
40.36	24.09	16.27	14.10	8.99	16.85	0.12	0.80	1.67	5.07	0.32	0.77	0.23	1.03	5.29
39.12	27.55	11.56	14.05	8.42	16.75	0.11	0.73	1.33	4.98	0.35	0.76	0.24	1.04	4.95
39.12	24.76	14.35	14.00	7.85	16.75	0.12	0.66	1.34	4.55	0.36	0.76	0.24	1.01	4.75
38.51	26.00	12.51	13.95	6.20	16.70	0.12	0.45	0.87	3.78	0.34	0.76	0.24	1.00	3.90
33.47	22.28	11.19	13.89	8.89	16.25	0.13	0.80	1.72	4.94	0.33	0.73	0.27	1.05	4.84
35.07	23.48	11.59	13.84	8.86	16.40	0.13	0.80	1.67	4.98	0.33	0.74	0.26	1.05	4.92
34.53	21.13	13.39	13.78	8.54	16.35	0.14	0.77	1.72	4.68	0.34	0.74	0.26	1.03	4.76
38.51	23.05	15.46	13.73	8.81	16.70	0.13	0.81	1.73	4.88	0.32	0.76	0.24	1.04	5.07
38.51	22.87	15.65	13.67	8.78	16.70	0.13	0.81	1.75	4.84	0.31	0.76	0.24	1.04	5.04
37.33	22.70	14.63	13.61	8.89	16.60	0.13	0.83	1.79	4.88	0.32	0.75	0.25	1.05	5.04
36.75	20.82	15.93	13.56	8.73	16.55	0.14	0.81	1.86	4.68	0.31	0.75	0.25	1.02	4.85
36.75	21.82	14.93	13.50	8.97	16.55	0.13	0.85	1.88	4.84	0.31	0.75	0.25	1.04	4.99
37.33	22.16	15.16	13.44	8.94	16.60	0.13	0.85	1.87	4.84	0.35	0.75	0.25	1.03	5.12
38.51	22.64	15.87	13.38	8.78	16.70	0.13	0.83	1.81	4.77	0.33	0.76	0.24	1.03	5.06
39.12	22.29	16.83	13.32	8.88	16.75	0.13	0.85	1.88	4.78	0.35	0.76	0.24	1.02	5.17
36.75	21.04	15.71	13.26	8.85	16.55	0.14	0.85	1.95	4.69	0.34	0.75	0.25	1.03	4.98
36.75	21.38	15.37	13.20	8.82	16.55	0.14	0.85	1.93	4.69	0.33	0.75	0.25	1.03	4.92
37.33	21.85	15.48	13.14	8.79	16.60	0.13	0.85	1.91	4.69	0.34	0.75	0.25	1.03	5.00
39.12	23.41	15.70	13.08	8.50	16.75	0.13	0.82	1.75	4.63	0.38	0.76	0.24	1.02	5.05
39.12	22.47	16.64	13.02	8.47	16.75	0.13	0.82	1.81	4.55	0.30	0.76	0.24	1.02	4.76

WEATHER DATA AND DAILY REFERENCE EVAPOTRANSPIRATION FOR — Oct-01

Date	Jub-Day	Rain fall	Evap	T min	Tmax	Tmean	Rh max	Rh min	Rh mean	Wind-spead	U	Sun-shine	N	n/N
		mm	mm	°c	°c	°c	%	%	%	km/day(U)	m/sec	hrs (n)	hrs	
1.10.01	258	2.6	0.8	23.5	32	27.75	65.7	60.85	63.28	18.00	0.21	5.00	12.45	0.40
2.10.01	259	0	0.9	23	31	27	72.2	66.86	69.53	39.00	0.45	4.00	12.42	0.32
3.10.01	260	0	2.4	23	32	27.5	78.29	64.26	71.28	19	0.22	5	12.40	0.40
4.10.01	261	0	2.2	23.5	33	28.25	73.73	66.27	70.00	22	0.25	5.5	12.37	0.44
5.10.01	262	0	2	23.5	32.5	28	85.01	80.04	82.53	14	0.16	5	12.34	0.41
6.10.01	263	0	2.1	21	32.5	26.75	80.05	78.29	79.17	16	0.19	9.5	12.32	0.77
7.10.01	264	0	2.4	21	33	27	73.74	71.95	72.85	10	0.12	10	12.29	0.81
8.10.01	265	0	2.5	21.5	34	27.75	69.07	52.48	60.78	11	0.13	9.5	12.26	0.77
9.10.01	266	0	2.6	22	33.5	27.75	69.07	52.48	60.78	13	0.15	9.25	12.23	0.76
10.10.01	267	0	2.6	22	33.5	27.75	71.43	57.75	64.59	14	0.16	9.25	12.21	0.76
11.10.01	268	0	2.6	20	33.5	26.75	74.33	62.18	68.26	18	0.21	9.25	12.18	0.76
12.10.01	269	0	2.6	18	34	26	61.76	52.48	57.12	13	0.15	9.5	12.15	0.78
13.10.01	270	0	3	20.5	33.5	27	65.07	59.26	62.17	7	0.08	9.5	12.12	0.78
14.10.01	271	0	3	18	33	25.5	66.83	62.18	64.51	10	0.12	9	12.09	0.74
15.10.01	272	0	1.8	16.5	30	23.25	56.78	46.66	51.72	10	0.12	9	12.06	0.75

ea	ed	ea-ed	Ra	Rs	f(T)	f(ed)	f(n/N)	Rnl	Rn	f(U)	w	(1-w)	c	Eto
mbar	mbar	mbar	mm/day	mm/day										
36.75	23.25	13.50	12.96	5.84	16.55	0.13	0.46	0.98	3.40	0.32	0.75	0.25	0.98	3.55
35.07	24.38	10.69	12.89	5.30	16.40	0.12	0.39	0.78	3.19	0.38	0.74	0.26	0.98	3.32
36.18	25.79	10.39	12.83	5.79	16.50	0.12	0.46	0.89	3.46	0.32	0.75	0.25	1.01	3.47
37.91	26.54	11.37	12.76	6.03	16.65	0.11	0.50	0.94	3.58	0.33	0.76	0.24	1.00	3.63
37.33	30.80	6.52	12.70	5.75	16.60	0.10	0.46	0.74	3.57	0.31	0.75	0.25	1.03	3.29
34.53	27.33	7.19	12.63	8.03	16.35	0.11	0.79	1.43	4.60	0.31	0.74	0.26	1.06	4.23
35.07	25.55	9.52	12.57	8.26	16.40	0.12	0.83	1.61	4.59	0.30	0.74	0.26	1.05	4.34
36.75	22.33	14.42	12.50	7.97	16.55	0.13	0.80	1.74	4.23	0.30	0.75	0.25	1.03	4.39
36.75	22.33	14.42	12.44	7.81	16.55	0.13	0.78	1.71	4.15	0.31	0.75	0.25	1.03	4.33
36.75	23.74	13.01	12.37	7.78	16.55	0.13	0.78	1.63	4.21	0.31	0.75	0.25	1.03	4.30
34.53	23.57	10.96	12.30	7.75	16.35	0.13	0.78	1.62	4.19	0.32	0.74	0.26	1.04	4.16
32.95	18.82	14.13	12.23	7.84	16.20	0.15	0.80	1.94	3.94	0.31	0.73	0.27	1.01	4.07
35.07	21.80	13.27	12.16	7.81	16.40	0.13	0.81	1.78	4.08	0.29	0.74	0.26	1.02	4.10
31.94	20.60	11.34	12.09	7.52	16.10	0.14	0.77	1.74	3.90	0.30	0.73	0.27	1.02	3.82
27.75	14.35	13.40	12.02	7.49	15.65	0.17	0.77	2.09	3.53	0.30	0.70	0.30	0.99	3.63

Annexure – VI

DSSAT predicted yield and other observations in Rice cv IR 64 planted with very healthy seedlings (200 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 25 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	77	108	7567	4618	638	510	642	80	78	17	20	3300	30
2	RI	2	78	110	10222	6130	638	510	646	78	129	18	19	3299	30
3	RI	3	76	107	6932	4273	638	1020	640	82	69	28	19	3300	30
4	RI	4	78	110	9802	5921	638	1020	646	81	116	30	21	3299	30
5	RI	5	75	107	6634	3982	638	1530	636	83	62	35	19	3300	30
6	RI	6	78	110	8888	5467	638	1530	644	82	99	46	22	3300	30
7	RI	7	75	107	6446	3910	638	510	635	83	64	17	25	3301	30
8	RI	8	76	107	7598	4397	638	510	641	79	98	17	31	3299	30
9	RI	9	75	106	6244	3825	638	1020	639	82	61	24	21	3301	30
10	RI	10	76	107	7305	4316	638	1020	641	81	89	29	27	3300	30
11	RI	11	75	107	6105	3806	638	1530	632	85	57	30	20	3301	30
12	RI	12	76	107	7107	4257	638	1530	641	81	84	37	25	3300	30
13	RI	13	78	109	8951	5375	638	510	648	77	101	18	20	3300	30
14	RI	14	78	110	11039	6396	638	510	650	75	150	18	22	3299	30
15	RI	15	77	109	8159	4889	638	1020	645	81	87	32	21	3300	30
16	RI	16	78	110	10706	6258	638	1020	650	78	135	32	23	3299	30
17	RI	17	77	109	7713	4775	638	1530	639	84	81	39	20	3300	30
18	RI	18	78	110	10146	6075	638	1530	648	80	123	45	22	3299	30
19	RI	19	76	107	7102	4175	638	510	639	80	83	17	27	3300	30
20	RI	20	76	107	8141	4578	638	510	642	79	114	17	33	3298	30
21	RI	21	76	107	6842	4107	638	1020	639	82	76	27	24	3300	30
22	RI	22	76	107	7717	4515	638	1020	642	81	102	32	29	3300	30
23	RI	23	76	107	6638	4062	638	1530	639	82	71	33	23	3301	30
24	RI	24	76	107	7502	4425	638	1530	642	81	94	41	27	3300	30

Annexure – VII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with very healthy seedlings (200 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 25 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha		-----	kg/ha	t/ha
1	RI	1	76	108	8052	4959	638	510	644	80	85	15	18	3300	30
2	RI	2	78	110	10892	6446	638	510	655	74	133	16	19	3299	30
3	RI	3	76	107	7790	4760	638	1020	649	79	79	21	18	3300	30
4	RI	4	78	110	10591	6325	638	1020	654	77	122	25	21	3300	30
5	RI	5	76	107	7607	4634	638	1530	647	80	74	26	19	3300	30
6	RI	6	78	110	9977	6048	638	1530	653	78	112	35	22	3300	30
7	RI	7	75	107	7114	4186	638	510	645	79	72	14	22	3301	30
8	RI	8	76	107	8322	4800	638	510	650	76	107	15	25	3300	30
9	RI	9	75	107	6926	4122	638	1020	644	81	68	22	19	3301	30
10	RI	10	76	107	8066	4739	638	1020	651	78	100	23	24	3300	30
11	RI	11	75	107	6709	4078	638	1530	643	82	64	27	18	3301	30
12	RI	12	76	107	7841	4659	638	1530	651	78	92	31	24	3300	30
13	RI	13	78	109	9491	5710	638	510	654	75	108	16	18	3300	30
14	RI	14	79	110	11725	7018	638	510	658	71	158	16	18	3299	30
15	RI	15	77	109	8955	5505	638	1020	650	80	96	26	20	3300	30
16	RI	16	79	110	11305	6869	638	1020	658	74	143	27	21	3299	30
17	RI	17	77	108	8573	5285	638	1530	652	78	92	30	20	3300	30
18	RI	18	79	110	11011	6699	638	1530	657	75	135	36	21	3299	30
19	RI	19	76	107	7783	4584	638	510	649	77	92	14	23	3300	30
20	RI	20	76	107	8746	4999	638	510	651	76	119	15	32	3298	30
21	RI	21	76	107	7537	4489	638	1020	649	79	85	22	22	3300	30
22	RI	22	76	107	8443	4957	638	1020	651	78	113	26	26	3300	30
23	RI	23	76	107	7444	4449	638	1530	649	79	81	27	22	3300	30
24	RI	24	76	107	8341	4896	638	1530	651	78	107	32	25	3300	30

Annexure – VIII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with very healthy seedlings (200 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	75	107	7481	4472	638	510	636	82	79	18	19	3300	30
2	RI	2	76	108	9643	5831	638	510	640	80	128	18	20	3299	30
3	RI	3	75	106	6864	4255	638	1020	635	83	69	28	19	3300	30
4	RI	4	76	108	9277	5655	638	1020	639	83	111	34	21	3300	30
5	RI	5	74	105	6392	3951	638	1530	634	83	62	35	19	3300	30
6	RI	6	76	108	8671	5353	638	1530	638	83	99	47	20	3300	30
7	RI	7	74	105	6249	3827	638	510	631	83	63	17	26	3301	30
8	RI	8	74	105	7384	4187	638	510	635	81	96	17	33	3298	30
9	RI	9	74	105	6145	3803	638	1020	627	86	60	25	22	3301	30
10	RI	10	74	105	7122	4125	638	1020	635	83	87	29	28	3300	30
11	RI	11	74	105	5997	3727	638	1530	627	86	55	30	21	3301	30
12	RI	12	74	105	6918	4075	638	1530	635	83	82	37	26	3300	30
13	RI	13	76	107	8741	5263	638	510	643	78	101	18	21	3300	30
14	RI	14	76	108	10641	6132	638	510	645	77	149	17	23	3299	30
15	RI	15	76	107	7965	4877	638	1020	641	81	87	32	21	3300	30
16	RI	16	76	108	10279	5918	638	1020	645	80	134	32	24	3299	30
17	RI	17	76	107	7571	4672	638	1530	640	82	80	39	20	3300	30
18	RI	18	76	108	9670	5748	638	1530	642	81	119	49	22	3300	30
19	RI	19	74	105	6898	4013	638	510	634	81	83	17	27	3300	30
20	RI	20	74	105	7854	4414	638	510	636	80	112	17	35	3298	30
21	RI	21	74	105	6682	3965	638	1020	634	83	74	27	26	3301	30
22	RI	22	74	105	7571	4310	638	1020	636	82	100	32	31	3299	30
23	RI	23	74	105	6495	3924	638	1530	634	83	70	34	24	3301	30
24	RI	24	74	105	7286	4222	638	1530	635	82	93	42	28	3300	30

Annexure – IX

DSSAT predicted yield and other observations in Rice cv IR 64 planted with very healthy seedlings (200 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha		-----	kg/ha	t/ha
1	RI	1	75	106	7925	4841	638	510	646	78	84	16	19	3300	30
2	RI	2	76	108	10436	6151	638	510	652	75	132	16	20	3300	30
3	RI	3	74	106	7717	4672	638	1020	641	82	78	23	18	3300	30
4	RI	4	76	108	10136	6049	638	1020	651	78	122	26	21	3300	30
5	RI	5	74	105	7229	4441	638	1530	643	80	70	30	19	3300	30
6	RI	6	76	108	9905	5871	638	1530	649	79	113	34	22	3300	30
7	RI	7	74	105	6932	4191	638	510	641	79	71	15	22	3301	30
8	RI	8	74	105	8133	4598	638	510	645	77	106	15	26	3300	30
9	RI	9	74	105	6804	4111	638	1020	640	82	67	22	19	3301	30
10	RI	10	74	105	7948	4567	638	1020	645	79	97	24	27	3300	30
11	RI	11	74	105	6602	4069	638	1530	640	82	62	27	20	3301	30
12	RI	12	74	105	7738	4492	638	1530	645	79	91	31	24	3300	30
13	RI	13	76	108	9282	5682	638	510	644	80	106	16	20	3300	30
14	RI	14	77	108	11421	6730	638	510	656	73	156	16	20	3299	30
15	RI	15	76	107	8691	5372	638	1020	650	78	96	26	20	3300	30
16	RI	16	77	108	11012	6533	638	1020	655	76	143	28	22	3299	30
17	RI	17	75	107	8528	5107	638	1530	646	80	93	29	20	3300	30
18	RI	18	77	108	10553	6389	638	1530	655	76	133	37	23	3300	30
19	RI	19	74	105	7640	4419	638	510	644	78	91	15	24	3300	30
20	RI	20	74	105	8606	4836	638	510	646	77	121	15	29	3299	30
21	RI	21	74	105	7392	4351	638	1020	644	80	83	23	24	3300	30
22	RI	22	74	105	8348	4737	638	1020	646	79	113	25	27	3300	30
23	RI	23	74	105	7366	4325	638	1530	644	80	80	27	22	3300	30
24	RI	24	74	105	8146	4697	638	1530	646	79	105	34	26	3300	30

Annexure – X

DSSAT predicted yield and other observations in Rice cv IR 64 planted with very healthy seedlings (200 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	6983	4155	638	510	630	81	78	18	20	3300	30
2	RI	2	73	104	9096	5154	638	510	634	80	126	19	20	3300	30
3	RI	3	72	103	6413	3905	638	1020	629	84	65	32	19	3301	30
4	RI	4	73	104	8505	4995	638	1020	633	82	112	32	22	3300	30
5	RI	5	72	103	6013	3754	638	1530	625	85	58	38	20	3301	30
6	RI	6	73	104	7934	4775	638	1530	628	84	97	47	22	3300	30
7	RI	7	70	101	5961	3526	638	510	625	82	57	18	33	3299	30
8	RI	8	70	101	6953	3746	638	510	625	82	81	18	49	3298	30
9	RI	9	70	101	5752	3485	638	1020	623	85	52	27	28	3301	30
10	RI	10	70	101	6658	3684	638	1020	625	84	72	33	42	3298	30
11	RI	11	70	101	5635	3457	638	1530	622	85	50	32	24	3301	30
12	RI	12	70	101	6447	3655	638	1530	625	83	66	44	37	3299	30
13	RI	13	72	104	7902	4676	638	510	624	84	101	19	19	3300	30
14	RI	14	73	104	9664	5486	638	510	639	77	147	20	23	3298	30
15	RI	15	72	103	7496	4439	638	1020	632	82	87	31	21	3300	30
16	RI	16	73	104	9329	5285	638	1020	638	80	129	37	23	3300	30
17	RI	17	72	103	6930	4179	638	1530	630	83	76	43	21	3300	30
18	RI	18	73	104	8490	5021	638	1530	634	81	114	52	23	3300	30
19	RI	19	70	101	6503	3635	638	510	625	82	68	18	43	3298	30
20	RI	20	70	101	7135	3811	638	510	625	82	91	19	56	3297	30
21	RI	21	70	101	6253	3589	638	1020	625	84	62	30	36	3299	30
22	RI	22	70	101	6971	3770	638	1020	626	84	80	36	49	3298	30
23	RI	23	70	101	6113	3570	638	1530	625	84	59	38	31	3300	30
24	RI	24	70	101	6870	3755	638	1530	626	83	74	48	42	3299	30

Annexure – XI

DSSAT predicted yield and other observations in Rice cv IR 64 planted with very healthy seedlings (200 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	7472	4482	638	510	639	78	81	18	19	3300	30
2	RI	2	73	104	9553	5555	638	510	645	76	130	17	21	3300	30
3	RI	3	72	103	7056	4390	638	1020	633	83	73	26	19	3300	30
4	RI	4	73	104	9058	5388	638	1020	643	79	119	28	21	3300	30
5	RI	5	71	103	6813	4165	638	1530	630	84	68	32	19	3300	30
6	RI	6	73	104	8790	5246	638	1530	641	80	113	34	22	3300	30
7	RI	7	70	101	6690	3862	638	510	635	79	62	15	32	3299	30
8	RI	8	70	101	7781	4136	638	510	636	78	87	16	46	3298	30
9	RI	9	70	101	6484	3818	638	1020	635	81	58	24	26	3301	30
10	RI	10	70	101	7545	4092	638	1020	636	81	79	28	42	3298	30
11	RI	11	70	101	6318	3793	638	1530	634	81	55	30	23	3301	30
12	RI	12	70	101	7326	4042	638	1530	636	81	74	38	36	3299	30
13	RI	13	72	104	8657	5032	638	510	635	80	106	17	19	3300	30
14	RI	14	73	105	10429	6056	638	510	640	79	152	18	22	3299	30
15	RI	15	72	104	8262	4849	638	1020	635	83	94	28	20	3300	30
16	RI	16	73	105	10206	5904	638	1020	640	81	135	32	23	3300	30
17	RI	17	72	104	7842	4717	638	1530	632	83	85	37	20	3300	30
18	RI	18	73	105	9806	5655	638	1530	638	82	126	44	22	3300	30
19	RI	19	70	101	7317	4000	638	510	636	79	74	16	41	3299	30
20	RI	20	70	101	7974	4210	638	510	636	78	96	17	54	3297	30
21	RI	21	70	101	7061	3973	638	1020	636	81	70	26	35	3299	30
22	RI	22	70	101	7795	4189	638	1020	636	80	87	32	49	3298	30
23	RI	23	70	101	6967	3937	638	1530	636	81	67	32	31	3300	30
24	RI	24	70	101	7698	4164	638	1530	636	80	81	44	41	3299	30

Annexure – XII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with healthy seedlings (160 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 25 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha		-----	kg/ha	t/ha
1	RI	1	77	109	7269	4498	638	510	633	84	76	19	21	3300	30
2	RI	2	78	110	9993	5988	638	510	642	80	126	19	20	3299	30
3	RI	3	76	108	6612	4132	638	1020	629	86	65	31	20	3300	30
4	RI	4	78	110	9524	5782	638	1020	641	82	110	33	22	3300	30
5	RI	5	76	107	6251	3927	638	1530	631	85	59	37	19	3300	30
6	RI	6	78	110	8398	5213	638	1530	638	84	92	51	22	3300	30
7	RI	7	75	107	6212	3750	638	510	630	84	62	18	25	3301	30
8	RI	8	76	107	7299	4221	638	510	636	81	95	18	32	3299	30
9	RI	9	75	106	5908	3669	638	1020	633	83	56	26	23	3301	30
10	RI	10	76	107	6913	4103	638	1020	636	83	83	32	29	3300	30
11	RI	11	75	106	5789	3615	638	1530	633	83	54	31	20	3301	30
12	RI	12	76	107	6781	4052	638	1530	635	83	78	40	26	3300	30
13	RI	13	78	109	8763	5225	638	510	644	78	100	19	19	3300	30
14	RI	14	78	110	10746	6330	638	510	646	77	147	19	23	3298	30
15	RI	15	78	109	8020	4883	638	1020	642	81	87	31	21	3300	30
16	RI	16	78	110	10317	6131	638	1020	645	80	131	34	24	3299	30
17	RI	17	77	109	7232	4508	638	1530	634	85	75	43	21	3300	30
18	RI	18	78	110	9659	5840	638	1530	643	81	113	53	23	3299	30
19	RI	19	76	107	6864	4011	638	510	634	81	80	18	28	3300	30
20	RI	20	76	107	7798	4406	638	510	637	80	110	18	35	3298	30
21	RI	21	76	107	6541	3941	638	1020	634	83	72	29	25	3301	30
22	RI	22	76	107	7417	4296	638	1020	637	82	98	34	30	3300	30
23	RI	23	76	107	6331	3882	638	1530	634	83	67	36	23	3301	30
24	RI	24	76	107	7128	4237	638	1530	637	82	90	44	27	3300	30

Annexure – XIII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with healthy seedlings (160 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 25 days seedling transplant age

RUN		TRT	FLO dap	MAT dap	TOPWT kg/ha	SEEDW kg/ha	TRAIN mm	TIRR mm	CET mm	PESW mm	TNUP ----kg/ha	TNLC kg/ha	TNLF kg/ha-----	TSON kg/ha	TSOC t/ha
1	RI	1	76	108	7768	4740	638	510	640	82	80	17	20	3300	30
2	RI	2	78	110	10576	6342	638	510	650	77	129	17	20	3299	30
3	RI	3	76	107	7346	4476	638	1020	644	81	72	27	19	3300	30
4	RI	4	78	110	10108	6132	638	1020	649	80	118	28	21	3300	30
5	RI	5	75	107	7082	4217	638	1530	642	82	67	32	18	3300	30
6	RI	6	78	110	9531	5888	638	1530	648	80	108	37	22	3300	30
7	RI	7	75	107	6880	4079	638	510	639	81	68	16	23	3301	30
8	RI	8	76	107	8017	4581	638	510	646	78	102	16	28	3300	30
9	RI	9	75	107	6714	4048	638	1020	638	84	64	22	20	3301	30
10	RI	10	76	107	7756	4525	638	1020	647	79	95	26	25	3300	30
11	RI	11	75	107	6538	3987	638	1530	639	83	61	27	19	3301	30
12	RI	12	76	107	7568	4465	638	1530	646	80	88	33	24	3300	30
13	RI	13	78	109	9164	5536	638	510	651	76	103	16	21	3300	30
14	RI	14	78	110	11382	6630	638	510	654	74	154	17	20	3299	30
15	RI	15	77	109	8617	5174	638	1020	647	81	92	29	19	3300	30
16	RI	16	78	110	10923	6488	638	1020	653	77	138	29	24	3299	30
17	RI	17	77	108	8073	4956	638	1530	648	80	83	38	19	3300	30
18	RI	18	78	110	10488	6213	638	1530	652	78	126	43	22	3299	30
19	RI	19	76	107	7545	4360	638	510	645	78	87	16	26	3300	30
20	RI	20	76	107	8455	4754	638	510	647	77	116	16	32	3298	30
21	RI	21	76	107	7251	4300	638	1020	645	80	80	24	24	3300	30
22	RI	22	76	107	8102	4724	638	1020	648	79	106	30	28	3300	30
23	RI	23	76	107	7103	4269	638	1530	644	81	76	30	22	3300	30
24	RI	24	76	107	7982	4656	638	1530	647	79	101	37	26	3300	30

Annexure – XIV

DSSAT predicted yield and other observations in Rice cv IR 64 planted with healthy seedlings (160 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	76	107	7088	4390	638	510	632	83	77	19	20	3300	30
2	RI	2	76	107	9418	5538	638	510	643	77	124	19	22	3299	30
3	RI	3	75	106	6481	4004	638	1020	631	84	65	31	20	3300	30
4	RI	4	76	107	8907	5363	638	1020	642	80	107	37	21	3300	30
5	RI	5	74	105	5978	3761	638	1530	629	84	57	39	20	3301	30
6	RI	6	76	107	8275	5025	638	1530	639	81	95	49	22	3300	30
7	RI	7	74	105	6108	3647	638	510	627	83	61	18	26	3301	30
8	RI	8	74	105	7086	4002	638	510	630	82	92	19	35	3298	30
9	RI	9	74	105	5779	3641	638	1020	621	87	56	27	23	3301	30
10	RI	10	74	105	6756	3911	638	1020	630	84	82	33	30	3300	30
11	RI	11	74	105	5663	3590	638	1530	621	87	53	32	21	3301	30
12	RI	12	74	105	6562	3874	638	1530	630	84	77	40	27	3300	30
13	RI	13	76	107	8411	5041	638	510	638	79	99	19	21	3300	30
14	RI	14	76	108	10327	6047	638	510	640	79	149	18	22	3298	30
15	RI	15	76	107	7786	4724	638	1020	637	82	86	31	22	3300	30
16	RI	16	76	108	9745	5780	638	1020	638	82	130	36	23	3299	30
17	RI	17	76	107	7102	4412	638	1530	634	83	74	44	21	3300	30
18	RI	18	76	108	9132	5514	638	1530	636	83	115	53	22	3300	30
19	RI	19	74	105	6654	3836	638	510	629	83	79	18	30	3299	30
20	RI	20	74	105	7636	4221	638	510	631	82	108	19	37	3298	30
21	RI	21	74	105	6358	3781	638	1020	629	84	71	30	26	3300	30
22	RI	22	74	105	7173	4066	638	1020	630	83	95	34	34	3299	30
23	RI	23	74	105	6181	3738	638	1530	628	84	66	36	24	3301	30
24	RI	24	74	105	6956	4011	638	1530	630	83	88	45	30	3300	30

Annexure – XV

DSSAT predicted yield and other observations in Rice cv IR 64 planted with healthy seedlings (160 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	75	106	7572	4621	638	510	641	79	79	18	20	3300	30
2	RI	2	76	108	10162	6040	638	510	645	78	129	18	21	3299	30
3	RI	3	74	106	7334	4461	638	1020	636	84	72	27	19	3300	30
4	RI	4	76	108	9591	5839	638	1020	644	81	116	30	21	3300	30
5	RI	5	74	105	6871	4225	638	1530	637	82	67	32	18	3300	30
6	RI	6	76	108	9223	5703	638	1530	643	82	106	40	21	3300	30
7	RI	7	74	105	6671	4027	638	510	635	81	68	16	24	3301	30
8	RI	8	74	105	7826	4402	638	510	641	78	101	16	30	3299	30
9	RI	9	74	105	6585	3988	638	1020	634	84	64	22	20	3301	30
10	RI	10	74	105	7574	4353	638	1020	641	81	94	26	26	3300	30
11	RI	11	74	105	6425	3927	638	1530	634	83	61	27	19	3301	30
12	RI	12	74	105	7474	4312	638	1530	641	81	86	33	27	3300	30
13	RI	13	76	107	9035	5492	638	510	647	77	103	17	21	3300	30
14	RI	14	76	108	10995	6353	638	510	650	75	153	17	20	3299	30
15	RI	15	76	107	8385	5141	638	1020	646	80	92	29	20	3300	30
16	RI	16	76	108	10653	6175	638	1020	650	78	138	29	24	3299	30
17	RI	17	75	107	8116	4811	638	1530	641	82	85	36	20	3300	30
18	RI	18	76	108	10188	5945	638	1530	648	79	130	40	21	3299	30
19	RI	19	74	105	7337	4226	638	510	640	79	87	16	26	3300	30
20	RI	20	74	105	8226	4552	638	510	641	78	115	16	33	3298	30
21	RI	21	74	105	7108	4176	638	1020	640	81	79	25	24	3301	30
22	RI	22	74	105	8027	4517	638	1020	641	80	106	29	29	3300	30
23	RI	23	74	105	6943	4159	638	1530	638	82	74	30	24	3301	30
24	RI	24	74	105	7837	4472	638	1530	641	80	99	37	28	3300	30

Annexure – XVI

DSSAT predicted yield and other observations in Rice cv IR 64 planted with healthy seedlings (160 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	6609	3976	638	510	625	83	75	20	21	3300	30
2	RI	2	73	104	8782	5011	638	510	628	81	124	20	21	3299	30
3	RI	3	72	103	6131	3745	638	1020	625	84	61	34	20	3301	30
4	RI	4	73	104	8237	4795	638	1020	627	84	110	34	22	3300	30
5	RI	5	72	103	5610	3571	638	1530	618	87	55	41	20	3301	30
6	RI	6	72	104	7537	4384	638	1530	623	85	94	48	23	3300	30
7	RI	7	70	102	5794	3458	638	510	613	87	55	19	33	3299	30
8	RI	8	70	102	6620	3659	638	510	613	87	79	19	49	3297	30
9	RI	9	70	101	5490	3363	638	1020	620	85	50	28	27	3301	30
10	RI	10	70	101	6358	3534	638	1020	621	85	68	35	43	3298	30
11	RI	11	70	101	5352	3332	638	1530	617	86	47	34	25	3301	30
12	RI	12	70	101	6134	3502	638	1530	621	85	62	46	37	3299	30
13	RI	13	72	103	7634	4446	638	510	628	81	98	20	21	3300	30
14	RI	14	73	104	9363	5308	638	510	635	78	143	21	26	3298	30
15	RI	15	72	103	7259	4275	638	1020	628	83	84	34	21	3300	30
16	RI	16	73	104	8965	5083	638	1020	633	81	125	40	24	3299	30
17	RI	17	72	103	6575	3980	638	1530	625	84	70	48	21	3300	30
18	RI	18	73	104	8244	4801	638	1530	629	83	110	55	24	3300	30
19	RI	19	70	102	6251	3565	638	510	613	87	67	19	42	3298	30
20	RI	20	70	102	6871	3734	638	510	614	87	91	19	55	3297	30
21	RI	21	70	101	5978	3456	638	1020	621	85	59	32	37	3299	30
22	RI	22	70	101	6683	3622	638	1020	621	85	78	37	50	3298	30
23	RI	23	70	101	5833	3428	638	1530	621	85	56	40	31	3300	30
24	RI	24	70	101	6542	3604	638	1530	621	85	71	50	42	3299	30

Annexure – XVII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with healthy seedlings (160 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	7311	4396	638	510	635	80	80	17	19	3300	30
2	RI	2	73	104	9240	5368	638	510	639	78	127	19	21	3300	30
3	RI	3	72	103	6728	4216	638	1020	632	83	70	28	19	3300	30
4	RI	4	73	104	8752	5216	638	1020	637	81	113	32	22	3300	30
5	RI	5	71	102	6374	3971	638	1530	633	82	63	35	19	3300	30
6	RI	6	73	104	8392	5033	638	1530	633	82	102	44	21	3300	30
7	RI	7	70	101	6320	3677	638	510	631	80	58	17	34	3299	30
8	RI	8	70	101	7379	3920	638	510	631	80	82	17	49	3297	30
9	RI	9	70	101	6172	3658	638	1020	630	83	55	25	27	3301	30
10	RI	10	70	101	7177	3885	638	1020	632	82	76	30	42	3298	30
11	RI	11	70	101	6061	3617	638	1530	630	83	53	30	23	3301	30
12	RI	12	70	101	6953	3845	638	1530	632	82	70	41	37	3299	30
13	RI	13	72	103	8250	4835	638	510	637	78	102	18	20	3300	30
14	RI	14	73	104	10035	5712	638	510	644	75	150	18	22	3299	30
15	RI	15	72	103	7848	4622	638	1020	637	81	88	31	21	3300	30
16	RI	16	73	104	9722	5555	638	1020	643	78	134	33	24	3299	30
17	RI	17	72	103	7375	4466	638	1530	635	81	81	39	21	3300	30
18	RI	18	73	104	9123	5278	638	1530	640	80	123	45	23	3300	30
19	RI	19	70	101	6963	3811	638	510	631	80	73	17	40	3299	30
20	RI	20	70	101	7631	4014	638	510	632	80	94	17	55	3297	30
21	RI	21	70	101	6713	3780	638	1020	631	82	65	28	35	3299	30
22	RI	22	70	101	7488	3996	638	1020	632	82	84	34	48	3298	30
23	RI	23	70	101	6584	3753	638	1530	631	82	63	35	30	3300	30
24	RI	24	70	101	7354	3971	638	1530	632	82	78	46	41	3299	30

Annexure – XVIII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with Normal seedlings (120 kg/ha) grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, two seedlings **transplanted per hill and** 25 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	77	109	7160	4339	638	510	629	85	73	20	21	3300	30
2	RI	2	78	110	9675	5763	638	510	637	81	124	20	21	3299	30
3	RI	3	76	108	6410	3905	638	1020	627	85	63	31	20	3300	30
4	RI	4	78	110	9217	5547	638	1020	635	84	108	35	22	3300	30
5	RI	5	76	107	5886	3736	638	1530	628	85	55	40	19	3301	30
6	RI	6	78	109	8247	4934	638	1530	639	81	93	49	22	3300	30
7	RI	7	75	107	5929	3620	638	510	624	85	60	18	26	3301	30
8	RI	8	76	107	7139	4072	638	510	630	82	92	19	33	3298	30
9	RI	9	75	106	5650	3503	638	1020	628	84	54	28	22	3301	30
10	RI	10	76	107	6667	3948	638	1020	630	84	80	33	30	3300	30
11	RI	11	75	106	5504	3480	638	1530	626	85	50	33	21	3301	30
12	RI	12	76	107	6435	3878	638	1530	630	84	74	43	26	3300	30
13	RI	13	78	109	8486	5031	638	510	639	80	98	20	20	3300	30
14	RI	14	78	110	10464	6110	638	510	641	79	146	20	21	3299	30
15	RI	15	78	109	7696	4725	638	1020	637	82	83	33	21	3300	30
16	RI	16	78	110	9992	5915	638	1020	641	81	127	37	24	3299	30
17	RI	17	77	109	6961	4310	638	1530	631	85	71	46	21	3300	30
18	RI	18	78	110	9349	5580	638	1530	637	83	112	54	22	3300	30
19	RI	19	76	107	6615	3865	638	510	629	83	76	19	31	3299	30
20	RI	20	76	107	7586	4239	638	510	631	81	107	19	37	3298	30
21	RI	21	76	107	6211	3774	638	1020	628	85	67	31	27	3300	30
22	RI	22	76	107	7124	4138	638	1020	631	83	94	36	32	3299	30
23	RI	23	76	107	6067	3753	638	1530	627	85	63	38	24	3301	30
24	RI	24	76	107	6842	4046	638	1530	631	83	86	47	28	3300	30

Annexure – XIX

DSSAT predicted yield and other observations in Rice cv IR 64 planted with Normal seedlings (120 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 25 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	77	108	7544	4606	638	510	640	80	78	18	19	3300	30
2	RI	2	78	110	10123	6092	638	510	645	79	125	19	21	3299	30
3	RI	3	76	107	6916	4277	638	1020	638	82	67	29	19	3300	30
4	RI	4	78	110	9732	5902	638	1020	644	82	114	31	20	3300	30
5	RI	5	75	107	6585	3985	638	1530	635	83	61	35	19	3300	30
6	RI	6	78	110	8690	5380	638	1530	641	83	97	47	22	3300	30
7	RI	7	75	107	6483	3826	638	510	634	82	64	17	24	3301	30
8	RI	8	76	107	7624	4340	638	510	640	79	96	17	32	3299	30
9	RI	9	75	106	6226	3748	638	1020	638	82	59	25	22	3301	30
10	RI	10	76	107	7273	4250	638	1020	640	81	87	30	28	3300	30
11	RI	11	75	107	6073	3732	638	1530	632	85	56	30	20	3301	30
12	RI	12	76	107	7121	4186	638	1530	640	81	82	38	25	3300	30
13	RI	13	78	109	8862	5342	638	510	647	77	99	18	22	3300	30
14	RI	14	78	110	10960	6475	638	510	648	76	149	18	22	3299	30
15	RI	15	78	109	8264	5057	638	1020	646	80	88	30	20	3300	30
16	RI	16	78	110	10532	6293	638	1020	647	79	135	33	21	3299	30
17	RI	17	77	109	7611	4770	638	1530	637	84	78	40	21	3300	30
18	RI	18	78	110	10016	6038	638	1530	646	80	115	50	23	3300	30
19	RI	19	76	107	7089	4114	638	510	638	80	82	17	27	3300	30
20	RI	20	76	107	8131	4523	638	510	641	79	112	18	34	3298	30
21	RI	21	76	107	6880	4072	638	1020	639	82	75	27	25	3300	30
22	RI	22	76	107	7740	4443	638	1020	641	81	101	32	29	3300	30
23	RI	23	76	107	6640	3987	638	1530	638	82	70	34	23	3301	30
24	RI	24	76	107	7519	4367	638	1530	641	81	93	42	27	3300	30

Annexure – XX

DSSAT predicted yield and other observations in Rice cv IR 64 planted with Normal seedlings (120 kg/ha) grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, two seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	76	107	6873	4228	638	510	627	84	73	20	21	3300	30
2	RI	2	76	107	9135	5360	638	510	638	79	123	20	22	3299	30
3	RI	3	75	107	6123	3907	638	1020	621	88	61	33	20	3301	30
4	RI	4	76	107	8669	5137	638	1020	636	81	109	35	21	3300	30
5	RI	5	74	106	5824	3599	638	1530	622	87	55	41	19	3301	30
6	RI	6	76	107	8002	4815	638	1530	634	82	92	50	22	3300	30
7	RI	7	74	105	5806	3523	638	510	619	86	60	19	25	3301	30
8	RI	8	74	105	6829	3838	638	510	624	84	90	19	36	3298	30
9	RI	9	74	105	5527	3472	638	1020	617	87	54	28	22	3301	30
10	RI	10	74	105	6502	3751	638	1020	624	85	78	34	31	3300	30
11	RI	11	74	104	5366	3360	638	1530	621	85	49	34	22	3301	30
12	RI	12	74	105	6200	3690	638	1530	624	85	71	44	28	3300	30
13	RI	13	76	107	8193	4892	638	510	633	80	97	20	20	3300	30
14	RI	14	76	108	9955	5788	638	510	634	80	144	21	23	3299	30
15	RI	15	76	107	7546	4581	638	1020	632	83	85	33	20	3300	30
16	RI	16	76	108	9446	5536	638	1020	633	83	126	38	24	3299	30
17	RI	17	76	107	6678	4174	638	1530	628	85	70	47	22	3300	30
18	RI	18	76	107	8622	5137	638	1530	637	81	109	56	23	3300	30
19	RI	19	74	105	6363	3691	638	510	623	83	75	19	32	3299	30
20	RI	20	74	105	7286	4029	638	510	625	83	105	19	38	3298	30
21	RI	21	74	105	6041	3619	638	1020	623	85	67	32	27	3300	30
22	RI	22	74	105	6923	3939	638	1020	625	84	93	35	34	3299	30
23	RI	23	74	105	5868	3591	638	1530	621	86	61	39	26	3301	30
24	RI	24	74	105	6595	3812	638	1530	625	84	83	49	30	3300	30

Annexure – XXI

DSSAT predicted yield and other observations in Rice cv IR 64 planted with Normal seedlings (120 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	75	107	7455	4510	638	510	635	82	79	18	19	3300	30
2	RI	2	76	108	9552	5792	638	510	638	81	127	19	20	3299	30
3	RI	3	75	106	6760	4327	638	1020	634	84	67	29	19	3300	30
4	RI	4	76	107	9273	5580	638	1020	645	79	113	31	21	3300	30
5	RI	5	74	106	6391	4097	638	1530	628	86	61	35	20	3300	30
6	RI	6	76	107	8569	5240	638	1530	644	80	98	47	21	3300	30
7	RI	7	74	105	6337	3756	638	510	631	82	64	17	25	3301	30
8	RI	8	74	105	7399	4136	638	510	634	80	95	18	33	3298	30
9	RI	9	74	105	6121	3743	638	1020	627	86	58	25	22	3301	30
10	RI	10	74	105	7077	4063	638	1020	634	82	86	31	28	3300	30
11	RI	11	74	105	5959	3674	638	1530	627	86	55	30	20	3301	30
12	RI	12	74	105	6899	4014	638	1530	634	82	80	38	26	3300	30
13	RI	13	76	107	8650	5220	638	510	642	79	101	18	20	3300	30
14	RI	14	76	108	10520	6189	638	510	643	79	149	18	22	3298	30
15	RI	15	76	107	7934	4887	638	1020	641	81	87	31	21	3300	30
16	RI	16	76	108	10146	5964	638	1020	642	81	133	33	23	3299	30
17	RI	17	76	107	7475	4653	638	1530	638	83	78	41	21	3300	30
18	RI	18	76	108	9368	5696	638	1530	640	82	115	52	23	3300	30
19	RI	19	74	105	6968	3953	638	510	634	81	81	18	29	3300	30
20	RI	20	74	105	7774	4323	638	510	635	80	109	18	37	3298	30
21	RI	21	74	105	6685	3927	638	1020	633	83	74	28	26	3301	30
22	RI	22	74	105	7517	4220	638	1020	635	82	98	33	32	3299	30
23	RI	23	74	105	6468	3862	638	1530	632	83	68	35	24	3301	30
24	RI	24	74	105	7320	4154	638	1530	635	82	92	42	28	3300	30

Annexure – XXII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with Normal seedlings (120 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	6384	3831	638	510	620	84	73	21	20	3300	30
2	RI	2	73	104	8477	4831	638	510	623	83	120	21	23	3299	30
3	RI	3	72	103	5836	3618	638	1020	618	85	61	33	20	3301	30
4	RI	4	72	104	7782	4502	638	1020	619	86	103	38	23	3300	30
5	RI	5	72	103	5320	3415	638	1530	614	87	51	43	21	3301	30
6	RI	6	72	104	7095	4249	638	1530	616	87	88	54	23	3300	30
7	RI	7	70	102	5467	3319	638	510	608	88	53	20	34	3299	30
8	RI	8	70	102	6317	3488	638	510	609	88	76	20	49	3298	30
9	RI	9	70	101	5205	3216	638	1020	614	86	47	30	28	3301	30
10	RI	10	70	102	6013	3424	638	1020	608	89	66	37	43	3298	30
11	RI	11	70	101	5044	3171	638	1530	613	87	44	36	24	3301	30
12	RI	12	70	101	5827	3318	638	1530	615	86	59	49	37	3299	30
13	RI	13	72	103	7396	4290	638	510	623	82	95	21	22	3300	30
14	RI	14	73	104	9068	5141	638	510	628	80	137	22	30	3297	30
15	RI	15	72	103	6862	4088	638	1020	621	85	81	35	21	3300	30
16	RI	16	73	104	8556	4880	638	1020	627	82	121	43	24	3299	30
17	RI	17	72	103	6205	3781	638	1530	619	85	67	49	22	3300	30
18	RI	18	73	104	7901	4576	638	1530	621	85	107	57	24	3300	30
19	RI	19	70	102	6030	3402	638	510	609	88	66	20	41	3298	30
20	RI	20	70	102	6529	3554	638	510	609	88	87	21	57	3297	30
21	RI	21	70	101	5718	3295	638	1020	615	85	58	33	35	3299	30
22	RI	22	70	102	6368	3496	638	1020	609	89	76	39	49	3297	30
23	RI	23	70	101	5490	3254	638	1530	615	86	52	42	31	3300	30
24	RI	24	70	101	6150	3412	638	1530	615	86	68	53	42	3299	30

Annexure – XXIII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with Normal seedlings (120 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha	-----		kg/ha	t/ha
1	RI	1	72	103	6935	4256	638	510	629	81	76	19	20	3300	30
2	RI	2	73	104	9052	5167	638	510	632	80	126	19	20	3300	30
3	RI	3	72	103	6328	4065	638	1020	628	84	64	32	19	3301	30
4	RI	4	73	104	8342	4974	638	1020	630	83	109	35	22	3300	30
5	RI	5	72	103	5877	3930	638	1530	621	87	57	39	20	3301	30
6	RI	6	72	104	7835	4618	638	1530	626	84	95	48	22	3300	30
7	RI	7	70	101	6006	3571	638	510	625	82	57	18	33	3299	30
8	RI	8	70	101	6931	3767	638	510	625	82	78	19	50	3298	30
9	RI	9	70	101	5743	3526	638	1020	622	85	51	27	28	3301	30
10	RI	10	70	101	6635	3686	638	1020	625	83	71	34	42	3298	30
11	RI	11	70	101	5622	3497	638	1530	622	85	49	33	24	3301	30
12	RI	12	70	101	6453	3661	638	1530	625	83	65	44	37	3299	30
13	RI	13	72	103	7825	4580	638	510	631	80	100	20	19	3300	30
14	RI	14	73	104	9672	5507	638	510	639	77	146	20	24	3298	30
15	RI	15	72	103	7377	4459	638	1020	630	83	85	32	22	3300	30
16	RI	16	73	104	9226	5269	638	1020	637	80	128	37	24	3300	30
17	RI	17	72	103	6849	4280	638	1530	629	83	75	44	21	3300	30
18	RI	18	73	104	8527	4984	638	1530	633	82	115	52	23	3300	30
19	RI	19	70	101	6520	3667	638	510	625	82	68	18	43	3298	30
20	RI	20	70	101	7191	3824	638	510	625	82	91	19	56	3297	30
21	RI	21	70	101	6279	3609	638	1020	625	84	61	30	36	3299	30
22	RI	22	70	101	6991	3771	638	1020	625	83	79	36	49	3298	30
23	RI	23	70	101	6107	3588	638	1530	625	83	58	38	31	3300	30
24	RI	24	70	101	6896	3755	638	1530	626	83	73	48	42	3299	30

Annexure – XXIV

DSSAT predicted yield and other observations in Rice cv IR 64 planted with fair seedlings (80 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and**
25 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha	-----		kg/ha	t/ha
1	RI	1	77	109	6744	4054	638	510	623	85	71	21	21	3300	30
2	RI	2	78	110	9207	5441	638	510	628	83	121	22	21	3299	30
3	RI	3	77	108	5935	3768	638	1020	622	86	58	35	21	3300	30
4	RI	4	78	109	8568	5099	638	1020	633	82	100	41	23	3299	30
5	RI	5	76	107	5376	3471	638	1530	616	87	50	44	20	3301	30
6	RI	6	78	109	7768	4640	638	1530	630	83	89	53	22	3300	30
7	RI	7	75	107	5591	3431	638	510	615	87	57	20	27	3301	30
8	RI	8	76	107	6760	3846	638	510	621	84	89	20	35	3298	30
9	RI	9	75	106	5274	3325	638	1020	617	86	50	30	23	3301	30
10	RI	10	76	107	6336	3746	638	1020	621	85	77	35	31	3299	30
11	RI	11	75	106	5134	3269	638	1530	617	86	46	36	22	3301	30
12	RI	12	76	107	6018	3647	638	1530	620	85	68	47	28	3300	30
13	RI	13	78	109	8136	4836	638	510	630	81	94	21	21	3299	30
14	RI	14	78	110	10013	5827	638	510	632	81	142	22	23	3298	30
15	RI	15	78	109	7277	4433	638	1020	627	84	79	36	22	3300	30
16	RI	16	78	110	9352	5513	638	1020	631	83	123	41	23	3299	30
17	RI	17	77	109	6412	3953	638	1530	622	86	65	51	21	3300	30
18	RI	18	78	110	8652	5193	638	1530	628	85	103	62	23	3299	30
19	RI	19	76	107	6239	3661	638	510	620	85	74	20	32	3299	30
20	RI	20	76	107	7242	4028	638	510	622	83	104	20	38	3297	30
21	RI	21	76	107	5876	3566	638	1020	619	86	64	33	27	3300	30
22	RI	22	76	107	6776	3902	638	1020	622	85	90	37	33	3299	30
23	RI	23	76	107	5614	3528	638	1530	617	87	59	42	25	3301	30
24	RI	24	76	107	6455	3811	638	1530	622	85	81	50	29	3300	30

Annexure – XXV

DSSAT predicted yield and other observations in Rice cv IR 64 planted with fair seedlings (80 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 25 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	77	109	7071	4483	638	510	629	84	74	20	21	3300	30
2	RI	2	78	110	9745	5845	638	510	638	81	123	19	21	3299	30
3	RI	3	76	108	6447	4148	638	1020	627	86	63	31	20	3300	30
4	RI	4	78	109	9299	5545	638	1020	643	79	108	34	22	3300	30
5	RI	5	75	107	6045	3722	638	1530	627	86	56	40	19	3300	30
6	RI	6	78	109	8206	5000	638	1530	640	81	90	53	21	3300	30
7	RI	7	75	107	6068	3633	638	510	626	85	60	18	26	3301	30
8	RI	8	76	107	7240	4101	638	510	632	81	92	19	34	3298	30
9	RI	9	75	107	5807	3576	638	1020	624	86	55	28	22	3301	30
10	RI	10	76	107	6803	3969	638	1020	632	83	81	33	29	3300	30
11	RI	11	75	106	5629	3488	638	1530	629	84	51	33	21	3301	30
12	RI	12	76	107	6580	3910	638	1530	632	83	74	43	27	3300	30
13	RI	13	78	109	8544	5096	638	510	640	79	98	19	20	3300	30
14	RI	14	78	110	10537	6190	638	510	642	79	147	20	21	3299	30
15	RI	15	78	109	7804	4807	638	1020	638	82	84	32	21	3300	30
16	RI	16	78	110	9956	5959	638	1020	641	81	127	37	24	3299	30
17	RI	17	77	109	7160	4518	638	1530	631	85	71	45	21	3300	30
18	RI	18	78	110	9405	5676	638	1530	638	83	112	54	22	3300	30
19	RI	19	76	107	6722	3903	638	510	631	82	77	18	30	3299	30
20	RI	20	76	107	7776	4288	638	510	633	81	107	19	37	3298	30
21	RI	21	76	107	6359	3803	638	1020	630	84	68	31	26	3300	30
22	RI	22	76	107	7299	4183	638	1020	633	82	95	35	31	3300	30
23	RI	23	76	107	6220	3781	638	1530	630	84	64	37	24	3301	30
24	RI	24	76	107	7000	4082	638	1530	633	83	87	47	28	3300	30

Annexure – XXVI

DSSAT predicted yield and other observations in Rice cv IR 64 planted with fair seedlings (80 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** two seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha		-----	kg/ha	t/ha
1	RI	1	76	107	6530	4052	638	510	618	85	71	21	21	3300	30
2	RI	2	76	107	8805	5075	638	510	628	80	120	21	22	3299	30
3	RI	3	75	107	5894	3645	638	1020	616	87	58	35	21	3300	30
4	RI	4	76	107	8120	4806	638	1020	627	83	102	39	23	3299	30
5	RI	5	75	106	5257	3407	638	1530	612	88	49	45	20	3301	30
6	RI	6	76	107	7565	4528	638	1530	624	84	89	53	22	3299	30
7	RI	7	74	105	5463	3343	638	510	611	87	56	20	27	3301	30
8	RI	8	74	105	6471	3646	638	510	615	85	88	21	36	3298	30
9	RI	9	74	104	5141	3220	638	1020	613	86	49	31	24	3301	30
10	RI	10	74	105	6117	3554	638	1020	615	86	75	36	32	3299	30
11	RI	11	74	104	4991	3178	638	1530	612	87	45	36	22	3301	30
12	RI	12	74	105	5793	3470	638	1530	614	86	67	47	28	3300	30
13	RI	13	76	107	7736	4652	638	510	625	82	95	21	21	3299	30
14	RI	14	76	108	9471	5499	638	510	625	83	140	23	25	3298	30
15	RI	15	76	107	7053	4274	638	1020	622	85	79	36	22	3300	30
16	RI	16	76	108	8939	5222	638	1020	624	85	122	42	24	3299	30
17	RI	17	76	107	6234	3919	638	1530	619	86	65	51	22	3300	30
18	RI	18	76	107	8066	4792	638	1530	627	83	105	60	24	3299	30
19	RI	19	74	105	6048	3497	638	510	614	85	72	20	34	3298	30
20	RI	20	74	105	6836	3774	638	510	615	84	101	21	41	3297	30
21	RI	21	74	105	5705	3423	638	1020	614	86	64	33	28	3300	30
22	RI	22	74	105	6501	3710	638	1020	616	85	88	38	35	3299	30
23	RI	23	74	105	5444	3373	638	1530	611	88	57	43	26	3300	30
24	RI	24	74	105	6182	3589	638	1530	616	86	78	51	32	3299	30

Annexure – XXVII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with fair seedlings (80 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 30 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	75	107	6924	4316	638	510	628	84	74	20	21	3300	30
2	RI	2	76	107	9247	5457	638	510	639	78	124	20	21	3299	30
3	RI	3	75	106	6231	4076	638	1020	629	84	63	32	20	3300	30
4	RI	4	76	107	8658	5209	638	1020	637	81	104	37	23	3300	30
5	RI	5	74	106	5923	3872	638	1530	620	88	55	41	19	3301	30
6	RI	6	76	107	8036	4872	638	1530	635	82	91	51	23	3300	30
7	RI	7	74	105	5937	3618	638	510	620	85	60	19	26	3301	30
8	RI	8	74	105	7039	3900	638	510	627	83	91	19	35	3298	30
9	RI	9	73	105	5648	3434	638	1020	620	86	53	28	23	3301	30
10	RI	10	74	105	6629	3788	638	1020	627	84	79	34	31	3300	30
11	RI	11	73	104	5503	3338	638	1530	624	84	50	33	22	3301	30
12	RI	12	74	105	6355	3761	638	1530	626	84	72	43	28	3300	30
13	RI	13	76	107	8292	4957	638	510	635	80	98	20	20	3300	30
14	RI	14	76	108	10055	5883	638	510	635	80	145	21	22	3299	30
15	RI	15	76	107	7549	4669	638	1020	633	83	84	33	21	3300	30
16	RI	16	76	108	9531	5637	638	1020	633	83	127	37	23	3299	30
17	RI	17	76	107	6816	4412	638	1530	630	84	70	46	22	3300	30
18	RI	18	76	107	8777	5237	638	1530	638	81	109	57	22	3300	30
19	RI	19	74	105	6470	3789	638	510	626	83	76	19	32	3299	30
20	RI	20	74	105	7418	4072	638	510	627	82	105	19	39	3298	30
21	RI	21	74	105	6137	3701	638	1020	625	85	67	31	27	3300	30
22	RI	22	74	105	7078	3979	638	1020	627	84	93	35	33	3299	30
23	RI	23	74	105	6017	3693	638	1530	623	86	63	37	25	3301	30
24	RI	24	74	105	6767	3870	638	1530	627	84	84	48	29	3300	30

Annexure – XXVIII

DSSAT predicted yield and other observations in Rice cv IR 64 planted with fair seedlings (80 kg/ha) grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use, two seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	5965	3621	638	510	610	85	70	22	21	3300	30
2	RI	2	73	104	7915	4545	638	510	613	84	117	24	23	3299	30
3	RI	3	72	103	5496	3412	638	1020	609	87	58	36	21	3301	30
4	RI	4	73	104	7290	4276	638	1020	612	86	97	44	24	3299	30
5	RI	5	72	103	4842	3177	638	1530	606	88	47	47	21	3301	30
6	RI	6	72	104	6545	3917	638	1530	607	89	82	59	23	3300	30
7	RI	7	71	102	5020	3217	638	510	604	88	50	21	35	3299	30
8	RI	8	71	102	5938	3373	638	510	605	87	74	22	50	3297	30
9	RI	9	71	102	4776	3201	638	1020	598	91	44	33	28	3301	30
10	RI	10	71	102	5655	3310	638	1020	604	88	63	39	44	3298	30
11	RI	11	71	101	4598	3086	638	1530	603	89	40	39	25	3301	30
12	RI	12	71	102	5378	3228	638	1530	603	89	56	51	37	3299	30
13	RI	13	72	103	7026	4034	638	510	614	84	93	23	22	3300	30
14	RI	14	73	104	8657	4896	638	510	619	82	131	24	35	3296	30
15	RI	15	72	103	6377	3775	638	1020	612	85	75	40	22	3300	30
16	RI	16	73	104	7969	4531	638	1020	617	85	117	47	24	3299	30
17	RI	17	72	103	5754	3490	638	1530	611	87	63	53	22	3300	30
18	RI	18	73	104	7292	4232	638	1530	613	86	98	65	24	3300	30
19	RI	19	71	102	5598	3295	638	510	605	87	63	21	43	3298	30
20	RI	20	71	102	6119	3418	638	510	605	87	85	22	57	3297	30
21	RI	21	71	102	5290	3247	638	1020	604	88	54	36	36	3299	30
22	RI	22	71	102	5886	3357	638	1020	604	88	72	42	50	3297	30
23	RI	23	71	102	5001	3185	638	1530	601	90	48	46	31	3300	30
24	RI	24	71	102	5734	3301	638	1530	604	89	64	55	43	3299	30

Annexure – XXIX

DSSAT predicted yield and other observations in Rice cv IR 64 planted with fair seedlings (80 kg/ha) **grown under the treatments of irrigation, nitrogen dose, spliting of nitrogen use,** three seedlings **transplanted per hill and** 35 days seedling transplant age

RUN		TRT	FLO	MAT	TOPWT	SEEDW	TRAIN	TIRR	CET	PESW	TNUP	TNLC	TNLF	TSON	TSOC
			dap	dap	kg/ha	kg/ha	mm	mm	mm	mm	----kg/ha-----			kg/ha	t/ha
1	RI	1	72	103	6464	4123	638	510	620	84	73	20	21	3300	30
2	RI	2	73	104	8557	4902	638	510	624	83	121	21	22	3299	30
3	RI	3	72	103	5783	3930	638	1020	619	85	61	34	20	3301	30
4	RI	4	72	104	7905	4625	638	1020	619	85	105	38	22	3300	30
5	RI	5	72	103	5401	3747	638	1530	614	88	53	42	20	3301	30
6	RI	6	72	104	7154	4462	638	1530	617	87	88	54	23	3300	30
7	RI	7	70	101	5511	3425	638	510	617	84	53	19	34	3299	30
8	RI	8	70	102	6439	3664	638	510	610	88	76	20	50	3297	30
9	RI	9	70	101	5271	3369	638	1020	613	86	47	30	28	3301	30
10	RI	10	70	101	6077	3511	638	1020	617	85	66	36	43	3298	30
11	RI	11	70	101	5104	3320	638	1530	614	87	45	36	24	3301	30
12	RI	12	70	101	5906	3451	638	1530	617	85	59	48	37	3299	30
13	RI	13	72	103	7483	4435	638	510	624	82	95	20	22	3300	30
14	RI	14	73	104	9151	5217	638	510	629	80	139	22	29	3297	30
15	RI	15	72	103	6946	4308	638	1020	623	84	81	35	22	3300	30
16	RI	16	73	104	8669	4968	638	1020	628	82	122	42	24	3299	30
17	RI	17	72	103	6216	4067	638	1530	621	85	67	49	22	3300	30
18	RI	18	73	104	7977	4708	638	1530	622	85	109	56	24	3300	30
19	RI	19	70	101	6047	3525	638	510	617	84	66	20	41	3298	30
20	RI	20	70	102	6694	3716	638	510	610	88	87	20	56	3297	30
21	RI	21	70	101	5820	3441	638	1020	617	85	58	33	36	3299	30
22	RI	22	70	101	6436	3593	638	1020	617	85	77	38	49	3298	30
23	RI	23	70	101	5567	3396	638	1530	616	86	53	42	32	3300	30
24	RI	24	70	101	6285	3551	638	1530	617	85	68	52	42	3299	30

Annexure – XXX

Experiment 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 section code (eg.FE001,CH001) are clearly identified with a letter in the this 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
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
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
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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
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

*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 – XXXI

Simulated and Field Data Codes

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/ha)		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
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
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 cm	Extractable water at maturity (cm)	IB SU
THAM	THRESHING %	Threshing % at maturity	IB SU
TNAM	TREATMENT NAME	Treatment title	IB SU

*GROWTH

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO	SE
CDAY	CROP AGE days	Crop age (days from planting)		IB	GR
CHTD	CANOPY HEIGHT m	Canopy height (m)		IB	GR
CWAD	TOPS WT kg/ha	Tops weight (kg dm/ha)		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
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
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
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
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
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
WSGD	H2O STRESS,GR	Water stress - growth (0-1)		IB	GR
WSPD	H2O 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
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 DRAINGE 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
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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 cm	Extractable water (cm)	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
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
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
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
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
TNAM	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
TDWA	TOTAL+D kg/ha	Tops+roots+storage+dead (kg dm/ha)	IB EX
CDWA	CANOPY+D kg/ha	Tops+dead wt (kg dm/ha)	IB EX
LALN	LEAF AREA,NEW	Leaf area,new leaves (cm2.lf-1)	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
SDWT	SEED WT g/pl	Seed weight (g pl-1)	IB EX
HWAD	YIELD kg/ha	Yield on specified day (kg dm/ha)	IB EX

Annexure – XXXII

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	WGEN parameter	IB
ANGA	Angstrom 'a' coefficient	IB
ANGB	Angstrom 'b' coefficient	IB
DATE	Date, year + days from Jan. 1	IB
DEWP	Dewpoint temperature, ~C	IB
DURN	Duration of summarization period for climate files, Yr	IB
ELEV	Elevation, m	IB
GSDU	Growing season duration, Day	IB
GSST	Growing season start day, Doy	IB
IN	Institute code	IB
LAT	Latitude, degrees (decimals)	IB
LONG	Longitude, degrees (decimals)	IB
MONTH	Month, #	IB
NAMN	Temperature minimum,monthly average, C	IB
NASD	WGEN parameter	IB
PAR	Photosynthetic radiation, moles m-2 day-1	IB
PDW	WGEN parameter	IB
RAIN	Rainfall (incl.snow), mm day-1	IB
RAIY	Rainfall,yearly total, mm	IB
REFHT	Reference height for weather measurements, m	IB
RHUMM	Relative humidity average over whole day for month, %	IB
RNUM	Rainy days, # month-1	IB
RTOT	Rainfall total, mm month-1	IB
SAMN	Solar radiation,monthly average, MJ m-2 d-1	IB
SDMN	WGEN parameter	IB
SDSD	WGEN parameter	IB
SI	Site code	IB
SRAD	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
SWMN	WGEN parameter	IB
SWSD	WGEN parameter	IB
TAMP	Temperature amplitude, monthly averages, ~C	IB
TAV	Temperature average for whole year, ~C	IB
TMAX	Temperature maximum, ~C	IB
TMIN	Temperature minimum, ~C	IB
WIND	Wind speed average, m sec-1	IB
WINDM	Windspeed average over whole day for month, m s-1	IB
WNDHT	Reference height for windspeed measurements, m	IB
WRUN	Wind run, km day-1	IB
XAMN	Temperature maximum,monthly average, C	IB
XDMN	WGEN parameter	IB
XDSD	WGEN parameter	IB
XWMN	WGEN parameter	IB
XWSD	WGEN parameter	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

ABBREVIATIONS NOT INCLUDED IN CODES

TRT	Treatment
FLO	Flowering Date
dap	days after planting
MAT	Physiological Maturity
TOPWAT	Total Plant Weight at Harvest Maturity
SEEDW	Grain Yield (kg/ha) (seed weight)
TRAIN	Total Rainfall
TIRR	Total Irrigation
CET	Cumulative evapotranspiration
PESW	Plant extractable soil water
TNUP	Total Nitrogen Uptake
TNLC	Total Nitrogen Leached
TNLF	Total Leaf Nitrogen
TSON	Total Soil Organic Nitrogen
TSOC	Total Soil Organic Carbon