APPLICATION OF DECISION SUPPORT SYSTEM FOR AGRO-TECHNOLOGY TRANSFER FOR PREDICTION OF YIELD OF MAIZE

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree

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in

IRRIGATION WATER MANAGEMENT

By

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CANDIDATES DECLARATION

I hereby declare that the dissertation titled **"APPLICATION OF DECISION SUPPORT SYSTEM FOR AGRO-TECHNOLOGY TRANSFER FOR PREDICTION OF YIELD OF MAIZE"** Which is being submitted in partial fulfillment of the requirements for the award of **Degree of Master of technology** in **Irrigation water management** at Water Resources Development Training center (WRDTC), Indian Institute of Technology, Roorkee is an authentic record of my own work carried out during the period of 16.07.2002 to 30.11.2002 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.

Place Roorkee

Dated: 30.11.2002

(M.Arul Selvam)

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

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SYNOPSIS

Maize is one of the most important cereals of the world both for human and animal consumption. It occupies 6.30 million hectares with a production of 10.80 million tones. Over 85 percent of its production in the country is consumed directly as food in various forms, such as chapattis, roasted ears, popcorn etc. The maize is also used as feed for poultry and in the starch industry.

Maize can be grown on any type of soil ranging from deep clays to light sandy soils. It is however, necessary that the pH of the soil does not deviate from the range 7.5-8.5. The maize crop needs temperature ranging from 21°C-27°C for its proper growth. It is widely cultivated from the sea level up to altitude of 2500m.It needs a precipitation of about 500mm for rain fed cultivation. Maize is sown in rows 50-75cm apart and the plants in the row are spaced at 20-50cm.The maize crop sown for grain is harvested when the grains are dry and do not contain more than 20 percent moisture.

Crop models are developed to predict the grain yield under the effects of various cultural practices and the crop treatment as well as the climatic changes. DSSAT is one of them.

DSSAT is a collection of computer program integrated into a single software package in order to facilitate the application of crop simulation model in research and decision making. This software package was developed by IBSNAT (International bench mark site network for Agrotechnology transfer).

The study on "Application of decision support system for agrotechnology transfer in predicting the yield of maize crop" has been carried out with following objectives;

(1) To generate field data for use in DSSAT Cereals-Maize model developed byIBSNAT.

(2) To validate the DSSAT Cereals-Maize model with field results.

(3) To make sensitivity analyses of validated results to Nitrogen and plant spacing.

The base data required for use in DSSAT Cereals- Maize model has been generated from the field Experiments at the Demonstration Farm of WRDTC, IIT Roorkee during Kharif 2002. The crop was planted on 05.07.2002 and harvested on 08.10.2002. The minimum input data required from the field Experiments are Plot details, Treatment details, Type of Variety, Field details, Soil analyses detail, Initial condition, Planting details, Irrigation and Water management details, Fertilizer details, Harvest details and Weather data.

The DSSAT is a shell and is driven by menu option. The DSSAT shell has 5 main menu options. The menu options are DATA, MODEL, ANALYSES, TOOL, and SETUP/ QUIT. Management input files are required to Run and validate the DSSAT Cereals- maize model. The management input files are created using the above said menu option. The inputs files of the crop model are Experiment details file (FILEX), Weather data file (FILEW), Soil profile data file (FILES), and Cultivar's file (FILEC). The crop model using the above said input files give the output depending upon the option setting under the simulation control section. The outputs obtained are soil and genetic input parameters, crop and soil status at main development stage, main growth and development variables, and environmental stress factors.

The field result showed that the average Grain yield was 5197 kg/ha where as the DSSAT crop model has predicted the Grain yield of 5255 kg/ ha. This implies that the model has predicted 58 kg higher grain yield, which is acceptable. The predicted yield attributes and other development variables such as per grain weight, grains per cob, grain number per m^2, max LAI, biomass at harvest stage, byproduct etc, of the crop model were also compared with the field results. It has been observed that the crop model has predicted the value of the said attributes on a slightly higher side than the field results, except the number of Grains per m^2 and per cob. The extent of the variability was well with in the acceptable limit. The water and Nitrogen stress of the crop during the main development stage was also noticed. The crop was subjected to water and nitrogen stress of 9%, 6% when the crop was at the age of 12 days and 42 days respectively.

Further studies on the crop model was carried out to know the sensitivity under different management inputs. The result obtained are given summarized below:

(1) Increasing the plant population recorded increased grain yield, but decreased unit weight grain and the number of grains per cob.

(2) Increasing the nitrogen application increased the grain yield as well as the unit weight of grain and the number of grain per cob.

Keeping in view the above DSSAT findings, the variability of the attributes predicted and field observed results are within the acceptable limits. It is concluded that DSSAT can satisfactorily predict the yield of maize in soil climatic conditions of Roorkee, therefore may be accepted as validated at Roorkee for growing maize. However, further studies with different aspects of management can be carried out at different sites to validate the accuracy and reliability of the DSSAT crop model. This is useful to the planners to forecast maize crop yield to enable the government to take policy decision on advance planning of internal food distribution, relief measures, and grain storage etc.

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CHAPTER NO-1

INTRODUCTION

Maize is one of the most important cereals of the world both for human and animal consumption. With its world average yield of 27.8q/ha Maize ranks first among cereals and is followed by Rice, Wheat, and Millets with average grain yields of 22.5,16.3,6.60q/ha respectively. In India with regard to area and population it ranks only next to Rice, wheat, Jowar, and Bajara. It occupies about 6.30mllion hectares with an average production of 10.80million tones. Over 85 percent of its production in the country is consumed directly as food in various forms, such as chapathies, roasted ears, popcorn etc. The maize is also used as feed for poultry and in the starch industry.

1.1 Soil

Maize can be grown on any type of soil ranging from deep clays to light sandy stones. It is however necessary that the pH of the soil does not deviate from the range 7.5-8.5.The soil ideally suited for maize cultivation should have adequate water holding capacity and should also provide good drainage.

1.2 Climate and water requirement

The maize crop needs temperature ranging from 21°C-27°C for its proper growth. But the temperature ranging from 20°-21°C is most favorable for maximum yields. It is widely cultivated from the sea level up to altitude of 2500m.It needs a precipitation of about 500mm for rainfed cultivation.

Most of the varieties of the maize grown in India are relatively early in maturity (80-90 days). Hence to sustain the rapid rate of growth an adequate supply of soil moisture is essential. It has been estimated that the maize crop requires about 50 percent of its total water requirement (200-300mm) in a short period of 30-35 days after tasselling. A lack of adequate moisture during the grain filling stage adversely affects the yield. Even though maize can be grown with out additional irrigation in regions receiving about 600mm of well distributed rainfall, yet for obtaining the optimum yield additional irrigation become necessary when the rainfall fails.

1.3 Cultivation and harvesting

A good seedbed for maize should be fine but compact and free from weeds. It is desirable that the previous crop refuse is buried under. There are three distinct seasons for the cultivation of maize crops i.e. kharif, Rabi, and spring. Higher yields have been recorded in the Rabi and spring crops. The higher yields are primarily due to better management and a lower incidence of diseases and pests. Sowing made a week 10 days before the usual date of break of monsoon for better establishment of plants and increase the yield (10-20 %). Maize is sown in rows 50-75cm apart and the plants in the row are spaced at 20-50cm.

The maize crop sown for grain is harvested when the grains are nearly dry and do not contain more than 20 percent moisture. Harvested ears are removed from the standing crop and dried in the sun before shelling.

Maize grown for fodder should be harvested at the milk stage to early dough stage. The earlier harvested crop is likely to yield less and have a lower protein content.

1.4 DSSAT(Decision Support System for Agrotechnology Transfer.)

DSSAT is a collection of computer program integrated into a single software package in order to facilitate the application of crop simulation model in research and decision making. This software package was developed by IBSNAT (International bench mark site network for Agrotechnology transfer). The ISBNAT is a network consisting of contractors, its subcontractors and many global collaborators. It was designed to help the acceleration of the process of knowledge dissemination to the decision makers. The DSSAT itself is a shell that allows to organize and manipulate crop, Soil and weather data and to run crop model in various ways and analyze their outputs. ISBNAT incorporated process oriented dynamic crop simulation model in to its international Programme for Agrotechnology transfer and developed DSSAT packages. The models available in DSSAT are:

- Cereals model (CERES): Wheat, Rice, Maize, Barley, Sorghum, and Millet.
- Grain legume model (CROPGRO): Soybean, Peanut, and Dry bean.

- Root crop models SUBSTOR): Cassava, Aroid and Potato.
- Sunflower.
- Sugarcane.
- Cotton.

The decision support software consists of the following:

(i) Data base management system (DBMS) to enter, store, and retrive the minimum data set needed to validate, list, and use the crop model for solving problems.

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

(iii) An application Programme for analyzing and displaying of outcomes 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 in to a single software package known as DSSAT. The cereal – maize model 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 fertilizer in to grain and stack through the use of land, energy (solar, chemical and biological) and management practices subject to environmental factors such as solar radiation, maximum / minimum air temperature, precipitation, day length variation, soil water properties and soil water conditions.

1.5 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 decision on advance planing of internal food distribution, relief measures, grain storage, and even providing alternative employment in drought affected areas. The crop simulation models are proposed as tool 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 given below;

(1) Model use as research tool: This includes
- (a) Synthesize research understanding.
- (b) Integrate knowledge across disciplines.
- (c) Assist in genetic improvement.
- (d) Yield analysis gap.

(2) Crop system management: This includes
- (a) Assist in cultural management.
- (b) Assist in water and fertilizer N management.
- (c) In-season decision aid for producers.
- (d) Site-specific on precision farming.

(3) Policy analysis tool: This includes
- (a) Assist in best management decision to reduce fertilizer and pesticide leaching.
- (b) Yield forecasting.
- (c) Evaluate climatic change effects.

1.6 Objective of study:

Inview of the above a study entitled "Application of decision support system for agrotechnology transfer for prediction of the yield of maize crop" was undertaken with following objectives;

(1) To generate field data for use in DSSAT Cereals-Maize model developed by IBSNAT.

(2) To validate the field results with DSSAT Cereals-Maize model.

(3) To make sensitivity analyses of validated results to Nitrogen and plant spacing.

CHAPTER-2

REVIEW OF LITERATURE

Agarwal et. al.(2001) reported about yield forecast model based on weather variables and agricultural inputs on agro-climatic zone basis. This model was developed for wheat and rice grown in Madhya Pradesh, India. Data on weather parameter were collected from various districts from 1971 to 1990. Additional data were collected from percent area under irrigation, percent area under high yielding varieties and quantities of N, P, and K used. The result indicated that reliable yield forecast could be obtained using 15 years data when crops were 12 weeks old i.e. two months before harvest.

Ameta and Dhakar (2000) conducted a field survey and reported about the response of winter maize to nitrogen levels in relation to varying population density and row spacing. The experiment comprise two row spacing (60 and 75), four population levels (65, 75, 85, 95, thousand plants per hectare) and five nitrogen levels (60, 90, 120,150, and 180 N/ha.) were carried out during 1988-89 in Rajasthan. The result showed that closer row (60cm) gave 4.12% higher yields than wider rows (75 cm). The grain and stover yields increased linearly with each successive increase in population density and nitrogen levels up to 85 thousand plants per hectare and 150kg N/ha respectively. The population and nitrogen levels interacted significantly during both years of study. A population of 85 thousands plants per ha fertilized with 150 kg N/ha produced 58.37 and 60.68 q/ha of grain yield and generated Rs 11231/- and 11859/- per hectare net monetary returns during 1988-89 and 1989-90 respectively.

Kanwar et al (2001) studied and reported about the simulating effects of variable nitrogen application rates on corn yields and no_3 - N losses in subsurface drainage water. This study was conducted to test Root zone water quality model (RZWQM-98) using four years i.e. 1996-1999 of field measured data to simulate the effects of different N-application rates on maize yields and nitrate- nitrogen losses via subsurface drain water. The three N-application rates (Low, Medium, High), each replicated three times were applied to maize in 1996 and 1998 under a maize-soybean rotation field in USA. No nitrogen fertilizer was applied to soybean in 1997 and 1999. Model calibration and evaluation were based on the field experiments of tile flows, nitrate-nitrogen losses in tile water and yield by showing a percent differences of –8%, 15%, and 4% respectively, between simulated and measured values. The simulated yield response function showed that maize grain yields reached a plateau level when the N-application rate exceed 200kg N/ha in 1996 and 170kg N/ha in 1998. These results suggest that RZWQM have the potential to simulate the effects of N- application rates on maize yields and nitrate- nitrogen losses with tile water. However the model over estimated nitrate- nitrogen losses in subsurface drainage Water during soybean growth period which may require refinements in the N-cycling algorithm in relation to N_2-fixation N-up take processes.

Antonopoulos (2001) studied and reported about the simulation of soilwater and nitrogen balances of irrigated and fertilized corn-crop soil. This simulation study was conducted in a field in Northern Greece during 1996 growing period and subsequent non-cropped period using a one-dimensional model based on Galerkin finite element method. The simulation described dynamic environmental conditions, irrigation schedule, and inorganic N applications. They were carried out on two plots of the field that differed in the amount and the timing of nitrogen applications. Inadequate irrigation water was applied, resulting in low availability of water in the Root Zone. The qualitative and quantitative procedures for Model evaluation showed that there was good agreement between the simulated and measured values of water content and inorganic species of N at different soil depths and the cumulative N up take by the plants. The average error was $0.006 cm^3/cm^3$ for water content and ranged from -1.06 to 0.52 eg/g of soil for NH_4-N and from -0.107 to 2.753 eg/g soil for NO_3 -N. Different procedures for getting the characteristics curves resulted in differing water contents and Nitrogen concentrations in the soil.

Ferreira et al (2000) studied and reported about the productivity of maize genotypes under different irrigation management and fertilization system. The productivity of two maize cultivars (BR 2121 and BR 205) under different irrigation and fertilization (N and K) treatments was evaluated during june-october 1994 in Brazil. The data for stover height, ear and kernel weight, ear index, and harvest index were recorded at harvest. Both BR 2121 and BR 205 were affected when irrigation was suppressed for 10 days before flowering, but the effect was greater in BR 205. Fertilizer splitting had no significant effect on the variables tested.

Binder et al(2000) reported that fine tuning current best nitrogen management practices such as delayed N application to maize is needed to improve fertilizer recommendations. This study was conducted to determine the relationship between relative maize N deficiency and time of N-application. Levels of N deficiency were established by applying different rates of N fertilizer. Additional N was applied to each level of N deficiency at eight growth stages ranging from early vegetative growth to late reproductive growth. Chlorophyll meter reading was taken before each N application as a measure of maize N deficiency. A N sufficiency Index (SI) was calculated based on relationship between N-deficient and Non N- deficient maize. Delaying nitrogen application to the six leave stage resulted in nearly a 12% decrease from maximum grain yield when the SI was below 0.9 indicating N deficiency can be severe enough to prevent full recovery when N is side dressed. The greater the N deficiency the earlier N had to applied to obtain maximum grain production. Grain yield was increased from N application as late as R_3 stage for extremely N deficient maize, but maximum yield was not obtained. Grain yield was depressed when N was applied at R_3 stage for slightly N deficient maize. The potential benefit of late season N application depends on degree of N deficiency. A predictive function was developed in order to determine, if nitrogen fertilizer application would be warranted given the SI and time of N application.

Chandrashekara et al (2000) studied and reported about the response of maize to organic manure with inorganic fertilizer. A field experiment was conducted in Arabhavi, Karnataka, India during kharif season of 1996. Four treatment comprising of organic manure (10 Ton poultry manure/ha, 2.5 ton vermi compost per ha and 10 ton FYM per ha) with recommended rates of fertilizer (RRF, 150kg N/ ha) in three doses, 75 kg P/ha and 37.5 kg K/ha and control (RRF) were applied to maize hybrid DMH-1.The application of poultry manure with RRF gave higher (50.8 q/ha) and fodder (74.4 q/ha) yields than vermicompost with RRF, FYM with RRF and control treatments. The percent increase in grain yield with application of poultry manure, vermicompost and FYM were 33,16 and 14 % respectively, compared with control. Application of poultry manure with RRF produced taller plant (187.5), longer cobs (14.35 cm) with bigger diameter (15.6 cm) and heavier cob weight (170.5 gm/cob) than application with control. The percent increase in cob length, cob girth, and grain weight per plant with the application of poultry manure was 13.1, 23.8, and 53.2 % receptively compared with control. Application of poultry manure with RRF resulted in higher net returns (RS 6675) and benefit cost ratio (11.5). The net returns and benefits obtained were lowest in vermicompost due to the high cost of vermicompost (RS 2000/ton).

Mahal et al (2001) conducted a field experiment and reported about how to assess the damaged caused by flooding and ways to mitigate the loss through maize crop management practices. The experiment was conducted at Ludhiana during kharif, 1998. The experiment comprised three levels of flood (no flooding, continuos flood for 10 days at knee- high stage and at tasselling stage), two methods of planting (Flat and ridge) and two levels of nitrogen (120 and 150 kg N/ ha). The result showed that continuous flooding at knee- high stage reduced final plant height, dry matter accumulation, and grain yield by 9.2, 41.7, and 44.0 % compared with no flooding respectively. The corresponding decrease with flooding at tasselling stage was 2.7, 15.3, and 15.3 respectively. Sowing on ridges reduced the adverse effect of flooding and gave 9.9% more yields than flat sowing. Application of150 kg nitrogen per ha enhanced the grain yield by 9.1% as compared to the recommended level of 120kg N per ha.

Rusu et al (1999) studied and reported about long term fertilizer treatments on maize to determine the influence on maize yield of yearly application of same nitrogen, phosphorus, and Potassium rates on mineral organic mineral soil. The experiments were initiated in 1962 on typic chernozem and brown- luvic soil in Romania. The two types of soil belong to different fertilization classes according to the main agrochemical characteristics with greater production potential on the chernozem. The yield and soil chemical properties were determined in 1963-97. Soil reaction increased with higher N rates, while mobile P and K in soil were increased by the respective fertilizer elements. Several nutritional disturbances required the application of 11 kg Zn/ ha on chernozem. In 1985 five ton per ha calcium carbonate was applied on brown- luvi soil. In the autumn of 1993, 10 kg Zn /ha, 2 kg Mo/ha and 2 kg B/ ha were applied on both soil types. On chernozem, 15 kg Mn was also applied. Maize yield varied with fertilizer treatment, weather, and soil type. Yield was higher on unfertilized chernozem than on brown- luvic soil with difference greater in unfertilized control than where fertilizers were applied.

Megyes et al (2000) conducted experiment and reported about the effect of mineral fertilization on the yield of maize hybrid under irrigated and Non-irrigated conditions. A long-term field experiment was conducted in Hungary during 1995-1999 to determine the crop production factors with the greatest influence on maize production and the correlation and interaction between irrigation and nitrogen fertilizer applications. In the extremely dry year of 1995 fertilizer applications caused substantial yield depression in the absence of irrigation. Fertilizer applications reduced maize yield by 40-90% under irrigated conditions, there was an increase in maize yield, the yield surplus being 4.4-9.4 ton per ha depending on nutrient supply level. The greatest irrigation effect was recorded on plots supplied with 120 kg N/ ha. However, at 240 kg N /ha, the efficiency of irrigation was extremely low and the yield was almost 3 t / ha lower than that achieved with 120 kg N/ ha. During 1996-1999 mineral fertilizer application increased maize yield even without irrigation. The maximum yield surplus was obtained on plots supplied with 120 kg N/ ha. During the study period, the yield was significantly higher at all the nutrient supply level as a result of irrigation. The significant year x irrigation interaction was confirmed by the fact that the yield surplus (1.3-2.3 t/ha) differed greatly from the irrigation effects recorded in 1995.

Grazia et al (1999) studied and reported about the plant population and fertilization influence on sweet corn crop yield. In a field study at Hernandez, Argentina in 1996-97, sweet corn CV.Freshy was grown at 4,6,or 8 per m, giving plant populations of 56,800, 85,200, and 1,13,600 plants per hectare respectively. The crops were given no fertilizers, 100 kg monoammonium phosphate at sowing plus 100 kg urea spread when plant had eight leaves expanded. Yield was highest with 6 plants per m plus monoammonium phosphate and urea .The highest plant density gave lowest yield and at this density the higher fertilizer application also decreased yield.

Badran (2000) studied and reported about the response of some maize cultivars to Bio-fertilizer. In the study four mineral N fertilizer levels (0,40,80, and 120 kg/feddan) were compared in the presence and absence of bio-fertilizer (HALEX a mixture of 2 Azotobactor strains) on three local maize cultivars during 1996 and 1997 summer seasons in Behira, Egypt .The cultivars were Giza 2 synthetic three way cross 310 and single cross 10. Maize cultivars differed significantly in all studied characters except the no of surviving plants and the shelling percentage. Single cross 10 gave the highest yield in both season. Increasing the N fertilizer rate from 0-120 kg / feddan in the absence of biofertilizer (HALEX) increased all the characters except the no of surviving plants and shelling percentage. Application of 80 kg N/ feddan in the absence of biofertilizer gave the highest means in all the studied characters except the no of surviving plants and shelling percentage where there were no significant differences among the eight treatments.

Bavec (2001) studied and reported about the effect of maize plant double row spacing on nutrient uptake, leaf area index and yield. The field experiment was conducted in 4 years (1989-1991 and 1998) in Slovenia. The effect of plant spacing variation (zigzag arrangement of seeds in a double row 0.15+0.55m and single row spacing, 0.70 m) at 7 population densities (4.5, 6.0, 7.5, 9.0, 10.5, 12.0 and 13.5 plants per meter) on leaf area index (LAI), net assimilation rate (NAR), nutrient uptake (nitrogen, phosphorus, and potassium) and the yield of maize cultivars BCTWC 175, NS SC 201, BC SC 312, and ZP TWC 404 were determined. There were no significant differences between the effect of double and single row spacing on LAI and NAR. Double row spacing resulted in low grain yield and the yield of above-ground silage mass than single row spacing; however the influence of climatic conditions in individual year was important as the yield differences were only significant in the second of the 4 years studied. The double row spacing sowing method showed no advantages in comparison with conventional single row spacing.

Carvalho et al (1999) studied and reported about the green manures effects on maize yield and maize nitrogen under no till and conventional tillage system. The use of green manure contribute to more rational and sustainable soil management, increasing soil organic matter, soil biological activity, soil fertility, and soil protection erosion and increase solar radiation. Cover crops can be used during the fallow and beginning of the rainy season in cerrado region in Brazil. The present study aimed to evaluate the effects of green manure species and spontaneous weeds on the maize yields, under no till and conventional tillage systems in Brazil during 1997-98. The species that increased the maize production were Canavalia brasiliensis, Mucuna pruriens, and Crotalaria ochroleuca. Maize plants succeeding these species showed higher N accumulation in the grain. Maize yield and nitrogen accumulation was higher under no tillage system. No interaction between crop system and species of green manure were observed. Canavalia brasiliensis, Mucuna pruriens, and Crotalaria ochroleuca showed the best potential as green in succession with maize.

Dairy producers in northeastern USA who grow maize forage in narrow rows plant at 1,25,500 plants per ha and apply N fertilizer at 225 kg/ha because they believe narrow row maize yields are best at high plant densities and nitrogen rates. **Cox et al** evaluated maize in 1996and 1997 in NewYork, USA at two row spacing (0 .38 & 0.76m), two harvest densities (80,000 & 1,16,000 plants/ha) and six N rates (0,50,100,150,200 and 250 kg/ha) to determine if row spacing x N rate interactions existed for dry matter (DM) and calculated milk yields. No interaction existed for DM yield, forage quality characteristics and milk yields. Maize had greater DM and milk yield at 0.38m (20.3 and 16.1 Mg/ha respectively) V_s 0.76m spacing (18.9 and 15.2 Mg/ha respectively). Drymatter and milk yields had quadratic- plus- plateau responses to N rates with maximum yields ((20.6 and 17.1 Mg/ha respectively) at an N rate of150 kg/ha. Nitrogen accumulation at harvest, which had row spacing x N rate interaction, had a linear response to N rates at 0.38m spacing and a quadratic response at 0.76m spacing. Dairy farmers in the northeastern , USA can produce corn silage at similar plant densities and N fertility , regardless of row spacing. Dairy producers who have excess animal waste could apply slightly more N to narrow row maize silage because it accumulates more N at harvest.

Griesh et al (2001) studied and reported about the effect of plant population density and nitrogen fertilization on yield and yield components of some yellow and white maize hybrids under drip irrigation system in sandy soil. Two field experiments were conducted in Egypt to study the effects of 3 plant population densities (1,75,000 21,000 and 28000 plants per feddan) and three N levels (60, 90, and 210 kg/ fed.) on the yield and components of maize hybrid (single cross 124 and 155 and three way cross 320 and 352). Increasing N levels from 60-120 kg/ fed significantly increased plant height, ear height, length and diameter, number of rows , grain per row, no of ear per plant, 100 kernal weight , yield per plant and per feddan in both seasons of study. Increased plant densities significantly decreased all traits of yield and yield component except ear position. A significant interaction effect between densities and hybrid was detected for yield per plant and yield per feddan in both seasons and ear diameter, grain per row and 100 kernal weight in the first season only. Mean while, a significant interaction effect between hybrid and nitrogen levels was detected plant height, ear height, length and diameter, and ear position, grain per row, no of ear per plant, 100 kernal weight , yield per plant and per feddan in both seasons.

Mehrabadi et al (2000) studied and reported about the effects of urea foliar application time on growth indices, yield components and quality parameters of two grain corn cultivars. The experiment was carried out at the experimental station of Ferdowsi University of Mashad. To evaluate the effects of urea foliar application time on growth indices , yield components and quality parameters of two grain corn cultivars urea was applied at 20 kg/ha (2.5 % concentration) at two weeks before anthesis , two weeks after anthesis and two + four weeks after anthesis or plants were unsprayed. Urea increased protein content, DM yield and grain yield. Application two weeks before anthesis gave the highest grain yield.

Mihaila et al studied and reported (1996) about the result of long-term experiments with fertilizer in maize. Long term N and P experiments with fertilizer on Maize was conducted cambic chernozem soil at Fundulea in Romania during1967-95. The probability of obtaining certain yield level on yield increase in maize was established depending on the fertilizer rates. Correlation between yield increase obtained by applying fertilizers and rainfall at different times of the year was determined.

Nitrogen is one of the limiting nutrients for cereal production in many areas of west Africa such as Niger. One of the strategies to improve yield is to choose crops with high nitrogen use efficiency (NUE) that can produce economic yield under limited water supply. Little information is available on comparative performance of pearl millet, sorghum, and maize for their NUE. A field experiment was conducted by **Pandey et al** to evaluate several components of NUE for the three crop species on a sandy soil at two locations in 1997 and three locations in 1998 rainy seasons in Niger. NUE components were calculated as incremental increase in yield per applied N or per plant N. Leaf area index and leaf chlorophyll were determined as concomitant data. Among three cereals sorghum and millet had greater response to N (kg grain per kg N) than maize. Nitrogen use efficiency differed widely among Species. Partial factor productivity (kg grain per kg N) was higher in sorghum and pearl millet than maize over three sites in two years and declined with increasing N levels. Agronomic NUE (DELTA grain weight per kg N applied) was also higher in sorghum compared to pearl millet and maize over all N rates. Nitrogen recovery efficiency (DELTA grain weight per kg N applied) was higher in sorghum followed by millet and lowest in maize. Marginally lower NUE for biomass production in pearl millet was associated with higher biomass yield in non fertilized treatments. The ability of pearl millet to extract N from nutrient graded sandy soils and its better drought tolerance is the primary reason for its adaptation to sahel where it produces a moderate although reliable grain yield. Although pearl millet tended to have better performance where frequent drought was prevalent, sorghum had higher yields than pearl millet under improved N management and thus can significantly contribute to enhancing food production in areas where good management is practiced. This study also indicates that N efficiency could be detected using a SPAD chlorophyll meter early enough to apply additional N for achieving the target yield levels.

In maize N deficiency reduces grain yield by decreasing kernal weight and kernal number. In plot experiments **Paponov et al** (2001) investigated and reported (2001), the effects of different rates of N supply on sugar concentrations and on the incorporation of recently assimilated 14C into sucrose, hexoses and ethanol-insoluble compounds of pedicels and kernals during different stages of kernal development. Low individual kernal weight in N deficient plants at maturity was related to decreased production of total biomass rather than to low biomass partitioning to the ear. In the first 5-10 days after pollination i.e during early lag phase of kernal development the ratio of sucrose to total sugars as wells as 14C label ratios of sucrose to total sugars in the pedicels of nitrogen deficit plants were higher than in plants with optimum N supply, suggesting lower sucrose cleavage capacity in the pedicels of N deficient plants the concentration of soluble sugars were generally higher in the pedicels than in the kernals indicating some barrier for sugar transport into the kernals. In contrast, in N deficient plants sugar concentration were higher in the kernals in the pedicels suggesting the involvement of an active mechanism for sugar import to the kernal. During later stage of kernal development (grain filling period) the rate of N supply had no effect on partitioning between pedicels and kernals and 14C incorporation in to various chemical fraction.

CHAPTER NO-3

BASE DATA GENRATION

3.1 General discussion:

Before to start of the experiment, soil profile analysis was carried out on the experimental plot. The textural analysis was done. Bulk density (BD), Field capacity (FC), Permanent wilting (PWP), pH, Organic carbon content (OC), Nitrogen (N), Phosphorus (P), and Potassium (K) content were calculated in the soil analysis laboratory of WRDTC, I.I.T. Roorkee. The details of analysis were shown in table no 3.1. The details of weekly soil moisture status were shown in table no 3.2. The crop growth and development parameters such as height, dry weight, leaf number, width and length, leaf area index and rooting depth were observed at 20 days interval. The details of the observation were shown in table no3.3

Table no-3.1 Soil profile analysis data.

Depth Cm	Soil type			B.D %	F.C %	PWP %	O.C gm/kg	pH	N Gm/kg	P mg/kg	K mg/kg
	Sand %	Sil %	Clay %								
0-30	50.00	29.50	20.50	1.48	31.20	10.80	0.90	7.5	0.90	15.00	45.00
30-60	38.00	36.00	26.00	1.54	30.80	11.20	0.10	7.5	0.10	15.00	45.00
60-90	40.10	35.70	24.20	1.59	32.40	11.60	0.01	7.5	0.01	10.00	50.00

Table no-3.2 Weekly moisture status of the soil profile

Sl.no.	Date	Moisture content		
		0-30 Cm	30-60 Cm	60-90 Cm
1	05.07.02	14.9	12.8	11.8
2	11.07.02	12.4	11.5	11.0
3	18.07.02	10.1	10.7	11.5
4	25.07.02	13.9	12.8	11.3
5	01.08.02	13.3	11.9	11.1
6	08.08.02	16.3	17.1	14.9
7	15.08.02	19.4	19.9	19.0
8	22.08.02	18.5	16.9	17.2
9	29.08.02	15.5	15.7	16.3
10	05.09.02	17.4	15.7	15.4
11	12.09.02	20.4	20.0	21.5
12	19.09.02	17.9	18.1	20.0
13	26.09.02	15.5	15.3	15.6
14	03.10.02	14.6	14.9	16.9

Table no-3.3 Crop growth and development parameters at 20 days Interval.

Date	Height cm	Root depth cm	Leaf no	Leaf width cm	leaf length cm	LAI	Drywt kg/ha
25.07.02	23.80	13.70	6.00	2.90	31.10	0.17	300
14.07.02	91.10	27.80	8.10	7.50	76.10	1.65	3506
03.09.02	217.30	65.40	10.90	7.50	75.60	2.13	5200
23.09.02	217.50	68.30	7.70	6.40	71.60	1.40	8800

3.2 Experiment details:

Hybrid corn 4212 was sown in the experimental plot (16.0x11.5m) size of Demonstration farm, WRDTC, I.I.T. Roorkee on 05.07.2002. Before sowing, the plot was ploughed with the help of tiller. The plot was divided in to 9 numbers of subplots each of which is 4.0x2.5. The maize was sown in rows spacing of 50 cm and plant to plant spacing of 50 cm maintained. The seeding depth was 2-3 cm with 2 seeds per hill. A uniform dose of Diamonium phosphate (DAP) was applied on the plot at the rate of 50 kg per ha. The maize crop was irrigated thrice during the initial crop growth stage and there after due to rain at regular interval no irrigation was needed till harvesting. Urea was applied on 09.08.2002 @ 220 kg/ha when the crop was at knee high stage. The crop was harvested on 08.10.02 and the Yield and Yield Attributes was recorded.

The details of base data generated for use in DSSAT CERES- Maize model during kharif 2002 on demonstration farm, I.I.T.Roorkee were given below. The file name for storing experiment and model prediction information are:

C:\ DSSAT35\MAIZE\MASV2002.MZX

3.2.1 Plot information:

Various details.	Header.	Input data.
Gross plot area , m^2	PAREA	10.00
Rows per plot	PRNO	8.00
Plot length, m	PLEN	4.00
Plot spacing, cm	PLSP	100.00
Harvest area , m^2	HAREA	4.00
Harvest row No	HRNO	2.00
Harvest row length	HLEN	4.00
Harvest method	HARM	manual.

3.2.2 Treatments

Treatments are shown in Table No-3.4

Treatment

Cultivar level	CU	1
Field level	FL	1
Soil analysis level	SA	1
Initial condition level	IC	1
Planting level	MP	1
Irrigation level	MI	1
Fertilizer level	MF	1
Environmental level	ME	1
Harvest level	MH	1

3.2.3 Cultivars:

Crop code	CR	MZ
Cultivar identifier	INGENO	IB0071
Cultivar name	CNAME	Hybridcorn4212

3.2.4 Fields:

Field ID	IDFIELD	Demo farm
Weather station code	WSTA	WRDF
Drainage type code	FLDT	DR000
Soil Texture	SLTX	SALO
Soil depth, cm	SLOP	90.00
Soil ID	IDSOIL	WR00820001
Elevation, m	ELEV	252
Total area , m^2	AREA	90.00
Field length- width ratio	FLWR	1.6

3.2.5 Soil analysis

Analysis date (year + days from jan-1)	SADAT	82186(5.7.02)
pH in buffer determination method code	SMHB	SA011
Phosphorus determination method code	SMPX	SA011
Potassium determination method code	SMKE	SA011
Depth of base layer, cm	SABL	30.00
		30.00
		30.00
Bulk density ,gm/ cm	SADM	1.48
		1.54
		1.59
Organic carbon gm /kg	SAOC	0.90
		0.10
		0.01
Total nitrogen gm / kg	SANI	0.90
		0.10
		0.01
pH in water	SAHW	7.50
		7.50
		7.50
Phosphorus extractable, mg / kg	SAEX	15.00
		15.00
		10.00

Potassium exchangeable mg /kg	SAKE	45.00
		45.00
		50.00

3.2.6 Initial conditions:

Previous crop code	PCR	WH
Initial condition measurement date	ICDAT	82186(5.7.02)
Root weight from previous crop kg/ha	ICRT	20.00
Noduleweight from previous crop kg/ha	ICND	0
Rhizobia number(0-1 scale, default =1)	ICRN	1
Rhizobia effectiveness(0-1 scale,default-1)	ICRE	1
Depth of base layer ,cm	ICBL	20.00
		60.00
		90.00
Water cm^3/ cm^3 x100 volume present	SH_20	0.228
		0.239
		0.249
Ammonium, Kcl,gm elemental N/mg of soil	SNH_4	0.20
		0.20
		0.50
Nitrate, KC, gm elemental N/mg of soil	$SN0_3$	12.0
		1.70
		1.20

3.2.7 Planting details:

Planting date, year + day from jan-1	PDATE	82186(5.7.02)
Emergence date	EDATE	82190(9.7.02)
Plant population at seeding, seed/m^2	PPOP	4.00
Plant population at emergence, plant/m^2	PPOE	4.00
Planting method, seeding, S	PLME	S
Planting distribution, Hill	PLPS	R
Row spacing, cm	PLRS	50.00
Planting depth, cm	PLDP	2-3
Planting material dry weight, kg/ ha	PLWT	30.00
Plants per hill	PLPH	2.00

3.2.8 Irrigation and water management:

Irrigation application efficiency	EFIR	1.00
Threshold for automatic application, % of maximum available	ITHR	50.00
End point for automatic application, % of maximum available	IEPT	100.00
End of application, growth stage code	IOFF	GS009
Method for automatic application code	IAME	IR003
Amount per irrigation	IAMT	33, 25, 40mm
Irrigation date, year + day	IDATE	19.07.02
		23.07.02
		29.07.02

3.2.9 Fertilizers

Fertilizer application level	MF	1
Fertilization date, year + day	FDATE	8222(9.8.02)
Fertilizer material, code	FMCD	FE005
Fertilizer application, code	FACO	AP001
Fertilizer application depth, cm	FDEP	2.00
N in applied fertilizer, kg/ha	FAMN	FE005
P in applied fertilizer, kg/ha	FAMP	0
K in applied fertilizer, kg/ha	FAMK	0
Ca in applied fertilizer, kg/ha	FAMC	0
Other elements in applied fertilizer, kg/ha	FAMO	0

3.2.10 Environmental modification:

Modification date, year + date	ODATE	82186(5.7.02)
Day length adjustment factor	E	A

3.2.11 Harvest details:

Harvest levels	HL	1
Harvest date, year + date	HDATE	08.10.02
Harvest stage, code	HSTG	GS006
Harvest component, code	HCOM	H
Harvest size group, code	HSIZE	A
Harvest percentage, %	HPC	100.00

3.2.12 Weather data:

Site + country name	WRDF	WRDF8201.WTH
Latitude, degree	LAT	29.52
Longitude, degree	LONG	77.54
Elevation, m	ELEV	252.00
Height wind measurements, m	WMHT	2.00
Year + days from jan-1	DATE	82151-82281
Solar radiation	SRAO	sunshine hours (1.6.02-8.10.02)
Air temperate maximum, °C	T_{max}	Max.temp.Record (1.6.02-8.10.02)
Air temperature minimum, °C	T_{min}	Min.temp.Reçord.. (1.6.02-8.10.02)
Precipitation, mm	RAIN	Rain fall recorded (1.6.02-8.10.02)

3.3 Total water use(Irrigation + Rainfall)

The total water used during the crop period i.e. 05.07.02-08.10.02 including the Rainfall has been given below:

Date	Irrigation applied/Rainfall
19.07.02 (Irrigation)	33mm
23.07.02 (Irrigation)	23mm
29.07.02 (Irrigation)	40mm
05.07.02-08.10.02 (Rainfall)	670mm

3.4 Yield and Yield Attributes

The crop was harvested on 08.10.02 and the Yield and Yield Attributes of Maize CV Hybrid corn 4212 of each plots were recorded and summarized below in table-3.4.

Table-3.4 Yield and Yield Attributes

Plot no	Plant Population	Cob yield Kg\ha	Grain No Per cob	Grain No Per sq-m	Grain test weight gm/100	Grain yield kg/ha
1	40,000	5104	311	1244	32	3980.8
2	40,000	6120	409	1636	32	5235.2
3	40,000	6396	409	1636	32	5235.2
4	40,000	5760	365	1460	32	4672.2
5	40,000	7760	461	1844	32	5900.8
6	40,000	7600	425	1700	32	5440.0
7	40,000	7344	459	1836	32	5875.2
8	40,000	6200	390	1560	32	4992.0
9	40,000	7200	425	1700	32	5440.0
	Average	6609.3	406	1624	32	5196.5

3.5 Maize crop Model Validation input File

The Experiment details of C:\ DSSAT35\MAIZE\MASV2002.MZX are presented in next page.

```
*EXP.DETAILS: MASV2002MZ VALIDATION OF DSSAT ON MAIZE CROP

*GENERAL
@PEOPLE
 M.ARUL SELVAM T.O,M.TECH(IWM)
@ADDRESS
 WRDTC,IIT ROORKEE.
@SITE
 DEMOFARM.
@ PAREA  PRNO  PLEN  PLDR  PLSP  PLAY HAREA  HRNO  HLEN HARM...........
   10.0     8   4.0   -99   100 RBD    4.0     2   2.0 MANUAL
@NOTES
 IT IS A DISSERTATION WORK FOR THE AWARD OF THE DEGREE OF M.TECH
 IN IRRIGATION AND WATER MANAGEMENT.

*TREATMENTS                        -------------FACTOR LEVELS------------
@N R O C TNAME.................... CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 0 0 0 RESPONSE OF MAIZE ON N     1  1  1  1  1  1  1  0  0  1  1  1  1

*CULTIVARS
@C CR INGENO CNAME
 1 MZ IB0071 hybrid corn 4212

*FIELDS
@L ID_FIELD WSTA....  FLSA  FLOB  FLDT  FLDD  FLDS  FLST SLTX   SLDP ID_SOIL
 1 DEMOFARM WRDF       0.0     0 DR000     0     0 0    SALO     90 WR00820001
@L ...........XCRD ...........YCRD .....ELEV .............AREA .SLEN .FLWR .SLAS
 1         0.00000         0.00000    252.00              10.0     0   1.6   0.0

*SOIL ANALYSIS
@A SADAT  SMHB  SMPX  SMKE
 1 82186 SA011 SA009 SA009
@A  SABL  SADM  SAOC  SANI  SAHW  SAHB  SAEX  SAKE
 1    30  1.48  0.09  0.09   7.5 -99.0  15.0  45.0
 1    30  1.54  0.01  0.01   7.5 -99.0  15.0  45.0
 1    30  1.59  0.00  0.00   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 82186    20   -99  1.00  1.00   -99   -99   -99   -99   -99   -99
@C  ICBL  SH2O  SNH4  SNO3
 1    30 0.250   0.5   4.4
 1    60 0.278   0.5   0.5
 1    90 0.270   0.5   4.5
```

```
*PLANTING DETAILS
@P PDATE EDATE  PPOP  PPOE  PLME  PLDS  PLRS  PLRD  PLDP  PLWT  PAGE  PENV  PLPH
 1 82186 82190   4.0   4.0     S     R    50    90   3.0    30     0   -99   2.0

*IRRIGATION AND WATER MANAGEMENT
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 1  1.00     2    50   100 GS009 IR003   -99
@I IDATE  IROP IRVAL
 1 82200 IR003    33
 1 82204 IR003    25
 1 82210 IR003    40

*FERTILIZERS (INORGANIC)
@F FDATE  FMCD  FACD  FDEP  FAMN  FAMP  FAMK  FAMC  FAMO  FOCD
 1 82221 FE005 AP001     2   100     0     0     0     0

AND ROTATIONS
@T TDATE TIMPL  TDEP
 1 82178 TI002    30
 1 82181 TI013    30

*ENVIRONMENTAL MODIFICATIONS
@E ODATE EDAY  ERAD  EMAX  EMIN  ERAIN  ECO2  EDEW EWIND
 1 82186 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 82281 GS006     H     A   100.0  45.0

*SIMULATION CONTROLS
@N GENERAL     NYERS NREPS START SDATE RSEED SNAME....................
 1 GE              1     1     P 82186  2150 YIELD OF MAIZE CROP
@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
 1 OU              Y     Y     Y     7     Y     Y     Y     Y     N     N     N

@  AUTOMATIC MANAGEMENT
@N PLANTING    PFRST PLAST PH2OL PH2OU PH2OD PSTMX PSTMN
 1 PL          81179 81193    40   100    30    40    10
@N IRRIGATION  IMDEP ITHRL ITHRU IROFF IMETH IRAMT IREFF
 1 IR             30    50   100 GS000 IR001    10  1.00
@N NITROGEN    NMDEP NMTHR NAMNT NCODE NAOFF
 1 NI             30    50    25 FE001 GS000
@N RESIDUES    RIPCN RTIME RIDEP
 1 RE            100     1    20
@N HARVEST     HFRST HLAST HPCNP HPCNR
 1 HA              0 82186   100     0
```

CHAPTER NO-4

DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER (DSSAT) AN OVERVIEW

4.1 Introduction

DSSAT is a collection of computer programs integrated in to a single software package developed by IBSNAT, inorder to facilitate the application of crop simulation models in research and decision making. IBSNAT have assembled and distributed decision support system to enable its user 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, databases for weather, and soil and crops.

The decision support software consists of:

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

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

(iii) An application Programme for analyzing and displaying outcomes of long term simulated agronomic experiment.

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 determinations of soil moisture from the corresponding weather conditions. The second sub model gives the effect of weather on carbon dioxide assimilation. Finally, another sub model is required for describing the transport of nutrients and assimilation products for the production of plant biomass.

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

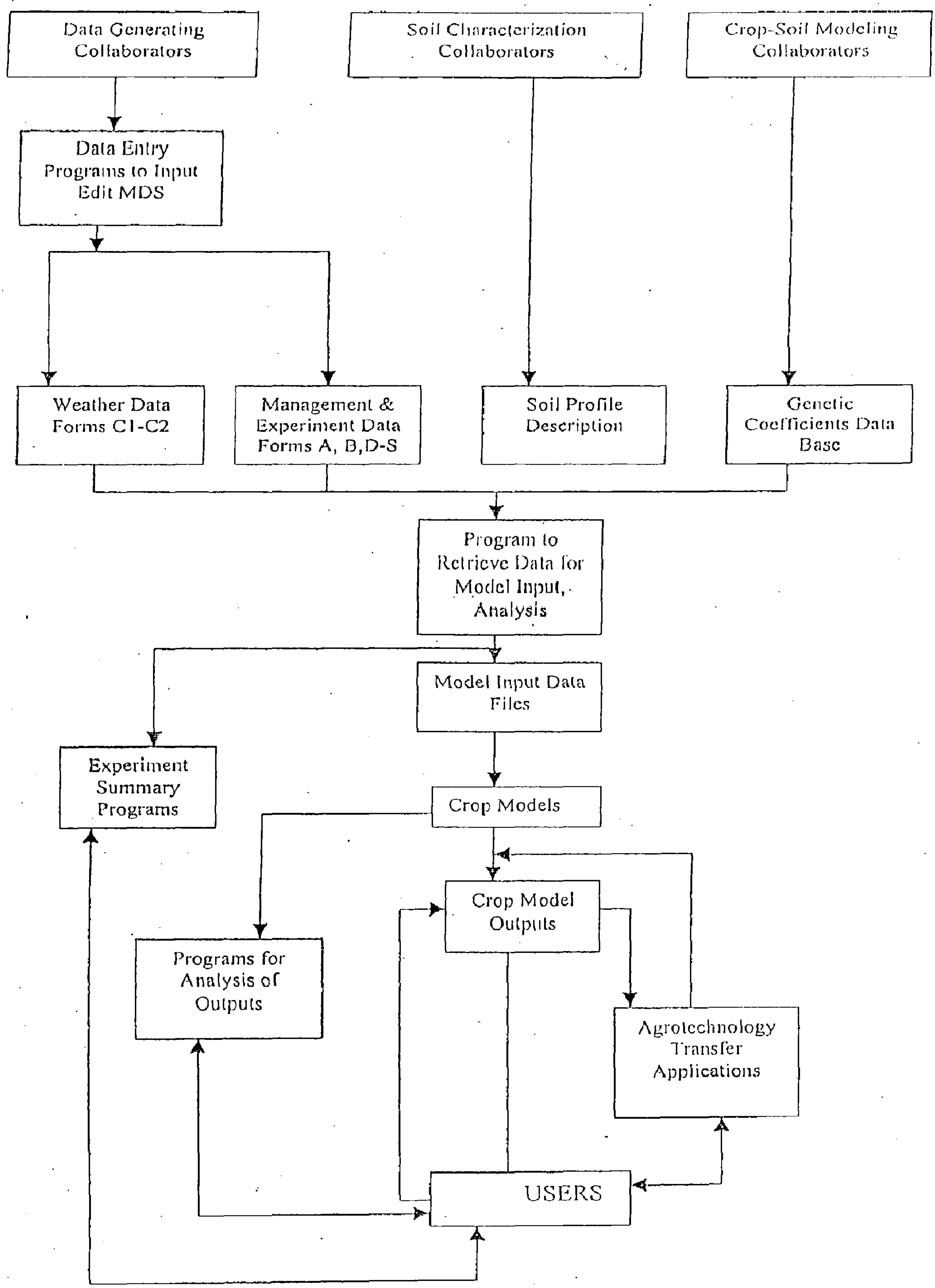


Fig. 4.1 : Schematic diagram of DSSAT components

DSSAT was designed for users to easily create "Experiments" to simulate, on computer outcomes of the complex interactions between various agricultural practices, soil and weather conditions and to suggest appropriate solutions to site specific problems. DSSAT realize 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, MODEL, ANALYSIS, TOOLS, and SETUP/QUIT.

The DATA main menu item provides users access to various types of data on Weather, soil, climate, crops, economics, pests and experiments. These data are found under the option headings: BACKGROUND, EXPERIMENT, WEATHER, SOIL, PEST, and ECONOMIC. Each of these options has various sub menus, which are accessed when one of the options is selected.

Under the model main menu item, the user can access the crop model for calibration, validation and sensitivity analysis purposes. The crop models available under the model menu are cereals, legume and Root crops.

The ANALYSIS main menu has two options. Seasonal, and Sequential. The seasonal option allows to set up simulation experiments, simulate them and analyze the results. The Sequential option is to simulate sequence of crops such as in crop rotation, for studying the long-term effects of practices on crop and soil performances.

Under the TOOLS main menu item, the 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 process and are used to predict harvestable yield, plant growth and development, Nitrogen dynamics and water balance in response to the controlled (management) and uncontrolled (weather) variables. These models simulate the effects of weather, soil, water, and 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 information's (Saeendran and Rathore, 1999):

(i) The daily weather data consisting of maximum and minimum air temperature, 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, amount and date of irrigation and amount and date of N fertilizer.

(iv) Genetic information related to maturity type, photoperiod, sensitivity analyses and yield components needed to evaluate optimum efficiencies with in the constraints of weather and soil.

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

Model name	Developed by
CEREALS-Rice	Upendra singh, Joc.T.Ritchie & D.C.Godwin
CEREALS-Wheat	D.C.Godwin& J.T.Ritchie.
CEREALS-Maize	J.T.Ritchie, C.a. Jones & S.Otter-Nacke.
CEREALS-Barley	J.T.Ritchie, B.S. Johnson & S.Otter-Nackle.
CEREALS-Sorghum	J.T.Ritchie, U.Singh, G.Alagarswamy& G.Rao.
CEREALS-Millet	J.T.Ritchie & Y.Ramakrishna.
SOY GRO	J.W.Jones, G. Wilkerson, & S.S.Jagtap.
PNUT GRO	K.J.Boote, G.Hoogenboon & J.W.Jones.
BENN GRO	G.Hoogenboon, J.W.Jones & K.J.Boote.
SUBSTOR-Potato	T.S.Grifin, 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 Cereals Model: Maize

The cereals or CERES (crop estimation through Resources and Environment synthesis) family of crop models is used in DSSAT to predict the performance of maize 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 and 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 interceptions which is assumed to be proportional to biomass production.

The cereals-Maize model uses a minimum of readily available weather, soil and specific genetic inputs. To simulate growth, developments and yield the model takes into account the following processes (Singh):

- Phenological development, especially as it is affected by genotype and weather. The model simulates the effect of photoperiod and temperature on the timing of flowering initiation and duration of each major growth stage.
- Extensive growth of leaves stems and roots.
- Biomass accumulation and partitioning especially as phenological development affects the developments and growth of reproductive organs.
- Water balance that simulates daily evaporation, runoff, percolation and crop uptake under fully irrigated conditions and rainfall conditions.
- Soil nitrogen transformations associated with mineralization, immobilization, urea hydrolysis, nitrification, and denitrification, ammonia volatilization losses and nitrogen associated with runoff and percolation and uptake and utilization of N by the crop.

4.2.4 Data Based 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 extract data from the centralized database and create files for running the crop models. Output can be printed and compared with experimental observations validating the crop models and conducting sensivity analysis application or agrotechnology transfer program 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 include the following:

File section	**Typical contents**
Experimental details	Experiment name and codes.
General	Name of people, addresses, name and location.
Treatments	Treatment number, name and specifications of level Codes of treatment factors.
Cultivar	Cultivar level, crop code, cultivar ID, and name of Genetic coefficients.
Fields	Specifications of field level, ID, weather station name, soil and field description details.
Soil analysis	Set of soil properties used for simulation of nutrient dynamics based on field nutrients.
Initial conditions	Starting conditions for water and nitrogen in the Profile. Also used for carryover of root residue from Previous crop.
Planting details	Planting date, population, seeding depth and spacing Data.
Irrigation	Irrigation date, amount and water depth.
Fertilizer	Fertilizer date, fertilizer rate and type information.
Residue	Addition of straw, green manure, animal manures.
Chemical applications	Herbicide and pesticide application data.
Environmental modifications	Adjustment factor for weather parameters as used in Climate change and constant environment studies, i.e. Constant day length, shading, constant temperature.
Tillage information	Details of dates, types of tillage operations.
Harvest details	Information on harvest dates, plant components Harvested etc.

Program link weather and experimental data with the crop models by creating crop model input files. The minimum required weather data include latitude and longitudes of the weather station and daily values of incoming solar radiation, maximum and minimum air temperature and rainfall.

4.2.5 Strategy Evaluation

The real power of the DSSAT (Singh 2001) for decision making lies in its ability to analyze many different management strategies. When a user is convinced that the model can accurately simulate local results, a more comprehensive analysis of crop performance can be conducted for different soil types, cultivars, planting dates, planting densities 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 model to historical weather data for the location, run the model and analyze and present the results to the user. Performance variable includes net return per hectare, duration of growth stages, Nitrogen and Water stress and usage rates and biomass and yield data.

4.2.6 Weather Generators

Weather estimator or generator (Saseendran and Rathore, 1999) software WGEN and WMAKER were developed (Richardson and Wreight, 1985 and Keller, 1982) are included in DSSAT. Each estimator has two programs: one program to compute weather coefficient from historical weather data and the program to generate weather data using these coefficients. The WGEN requires daily maximum and minimum air temperature, solar radiation, and precipitation from a number of years. While the other WMAKER relies on monthly means and standard deviations of the potential evapotranspirations, average air temperature, precipitation and number of wet days in a month. This ability to simulate weather using only monthly averages of variables will greatly expand the application of the models to areas where the monthly data are all that are available.

4.2.7 Evapotranspiration Calculation

In the CERES, CROPGRO and other DSSAT models option exists for the Priestly-Tayor method for computing potential evapotranspiration and for the Penman method using FAO definition of 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 user should select the Priestly-Tayor 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. Daily potential transpiration is modified by CO_2 concentration based on the effects of CO_2 on stomata conductivity (Peart et al., 1989).

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 user 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 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 the models are as follows:

(a) Weather data files (FILEW): It contains daily weather data on maximum temperature, minimum temperature, total solar radiation and rainfall for the crop period.

(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 soils the values of soil albido, cumulative evapotranspiration, 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 extractable water, the saturated soil water content and the root distribution function are the most essential information need for running the model out of the numerous information provided in the file.

(c) Cultivar 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 comparison with actual data if available. The second output file; SUMMARY provides a summary of output for use in application program with one line of data for each crop season. The remaining four files namely GROWTH, WATER, and NITROGEN contain detailed simulation results including growth and development, water balance and nitrogen balance.

CHAPTER-5

ACCESSING DATA, MODELS, AND APPLICATION PROGRAM

5.1 Introduction

The DSSAT shell (as shown in screen-1) is the interface between the user and the crop models, application programs and data files found in DSSAT. The shell is menu driven and thus enables user to easily select and use of any of the DSSAT components. These components are displayed as menu items under the DSSAT title. The DSSAT shell has 5 main menu options: DATA, MODEL, ANALYSIS, TOOL, and SETUP/QUIT.

5.2 Data Main Menu Options:

The data menu option provides user with access to various types of data on experiments, crops, weather, soil, economics, climate, and pests. These data are found under the option headings: BACKGROUND, EXPERIMENT, WEATHER, SOIL, PEST, and ECONOMIC. Each of these options have various submenus which are accessed one of the option is selected.

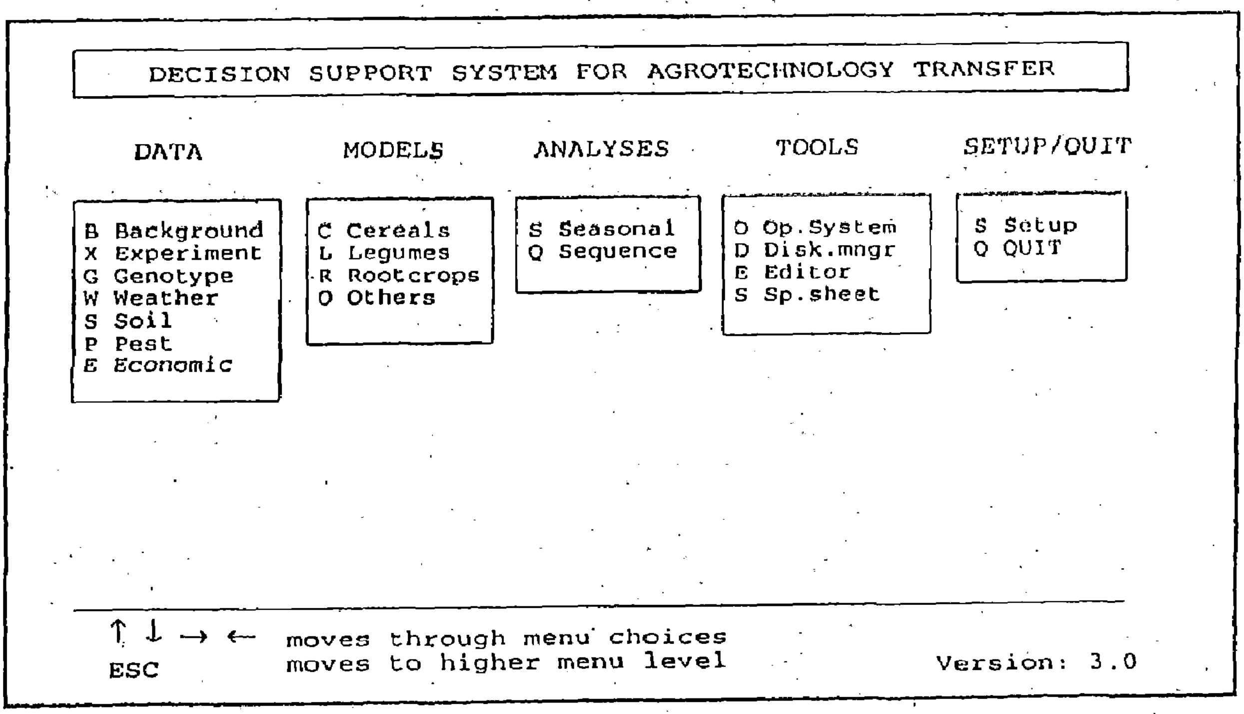
5.2.1 Background Menu Option

The background menu option under the data main menu has 3 menu options: GENERAL, FIELDS, and CODES.

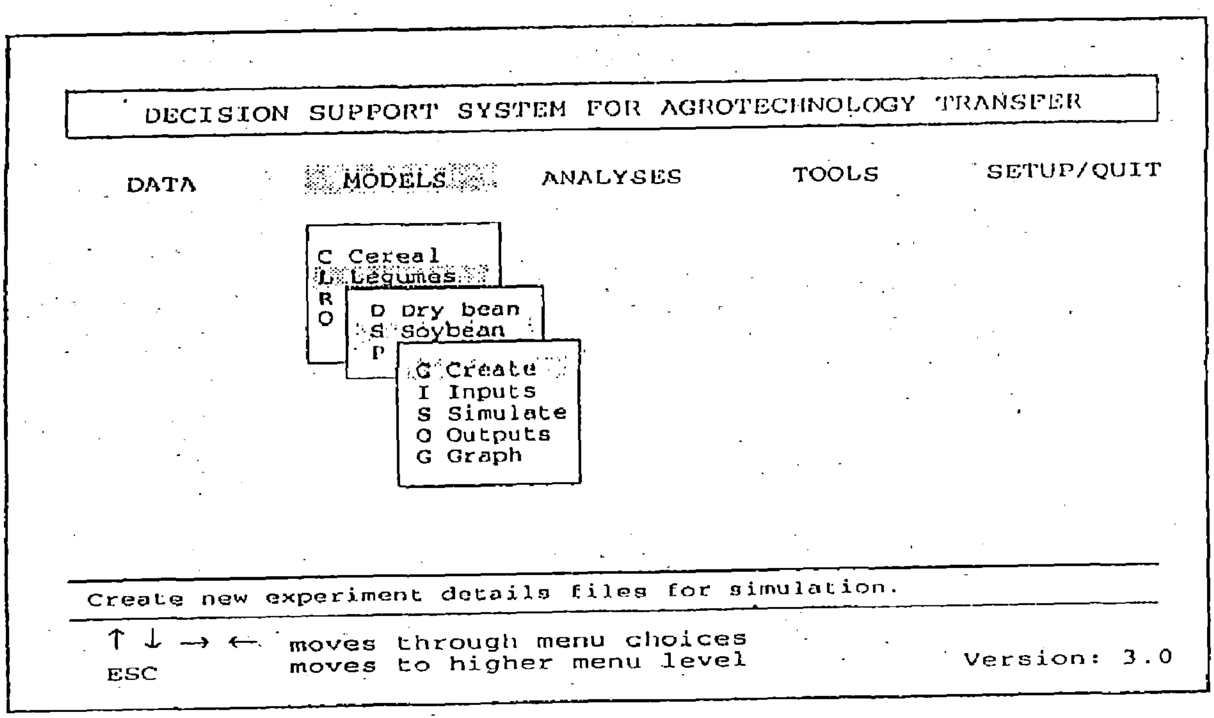
General: The purpose of the general menu option is to provide access to information on Institute, site, and people, such as address and experiments performed. It also allows to view and print out the informations and to make additions, deletions or changes in data.

Fields: The purpose of the field menu options to help users review and edit description data on fields and soil analysis data from the fields.

Screen-1



Screen-2



Codes: The purpose of this menu options is to give users access information on codes used for specifying fertilizer, chemicals, growth stage, and management inputs as well as abbreviations for data that are observed or simulated. Access to these files is with a user installed text editor. The path to a user editor and the name of the executable file must be installed from the SETUP main menu of the DSSAT shell.

5.2.2 Experiment menu option

The purpose of the experiment menu option is to provide access to experiment data management functions, including inputting, editing, graphing, listing, and linking them to models and printing. When it is accessed, a menu of three options will be presented: List/Edit, Create, and Utilities.

List/Edit: The purpose of the list/ edit menu option is follows:

(i) List all experiments in a particular directory, giving, each for experiment, the file names, the crop code, standard and local experimental name, and a brief description of the experiment. It also lists soil texture and depth, latitude, longitude, and elevation of the experiment site and the climate or agroecological zone to which the site belong.

(ii) Provide access to any of the experimental file ($FILEX_8$), using a file editor. User can choose experiment data file ($FILEX_8$) and crop performance averages(in FILETs and $FILEA_8$). Access is with either a user installed text editor or the editor supplied with DSSAT.

(iii) Allows for sorting of files to locate the experiment for specified crops, standard or universal name or local name.

(iv) Update the experiment list (EXP.LST) read by the crop models to include new experiments or to reduce the no of experiments that are listed for model simulations.

(v) Allows user to search and locate experiments in the current path based on the type of treatments included in the experiment, on type of soil, on people who conducted the experiment and on experiments performed at specific institutes.

(vi) Allows user access to a global list (EXPLSTG.DBF) of experiments for all crops in all DSSAT Directories.

Create: The purpose of this menu option is to create an experiment description file (FILEX), which is used as input files to the crop model, using the program entitled Xcreate. User can define treatment for new experiments as well as the crop management inputs used to manage the experiment. This includes field information, initial condition, irrigation, fertilizer management, residue management, cultivar and other data needed to specify experiment conditions. User can select an existing experiment from those in the current path (listed in EXP.LST) and modify it to create a new experiment, or they may start with an empty file and enter all data for a particular experiment. Xcreate can be used to enter real experiment as well as hypothetical one for sensitivity analysis, risk analysis etc. It also allows user to specify simulation control options.

Utility: The purpose of the utility menu option is to allow the user to retrieve crop performance data, compute averages from replicate data, and display graph of measurements made within the growing season (times series graph) and summary responses.

5.2.3 Genotype menu option

The purpose of the genotype menu option is to provide access to information on crop cultivars and on cultivar coefficient for crop models. It also allows user to calculate cultivar coefficients for crop models using their own experimental data, and allows user to access ecotype and species coefficients for crop models, if they are available. When genotype is accessed, a menu of three options will be presented: List/Edit, Append, and Calculate.

List/Edit: The purpose of this menu option is to enable user access to data files in order to search for information on genotypes, based on crop and cultivar names as well as those based on experiments, institutes, sites, and people providing information.

Append: The purpose of this menu option is to enable user to add a new cultivar entry into a cultivar coefficient file so that the genetic coefficient calculator program will have starting value when it estimates coefficients from experimental data.

Calculate: This menu option is to enable user to calculate cultivar coefficients for different crops.

5.2.4 Weather menu option

The purpose of this menu option is to user access to a wide range of weather data management capabilities including searching and sorting for weather station, editing, printing, reformatting weather data files; generating daily data; inputting monthly data; analyzing real and simulated weather data; cleaning and filling in missing observation; and graphing daily weather data and summary statistics. When weather is accessed, a menu of two options will be presented: List/Edit, and Utilities.

List/Edit: The purpose of List/Edit menu option is as follows:

(i) List all daily weather files in a path with the file name, site name, zone, years (station in place) latitude, longitude, elevation and annual temperature average and amplitude and sequences for each data file. Keep this list of file named WTHLST.DBF, which is updated, after new weather files are added.

(ii) Provides access to any of the daily weather data files (*.WTH files) using a file editor.

(iii) Allows sorting of files in order to locate weather for specified file name, site name, zone, years, latitude, longitude, elevation and annual temperature average and amplitude and sequences.

(iv) Update the experiment list (WTH.LST) read by the crop models to include new weather data or to reduce the no of weather files that are listed for model simulation.

(v) Allows user to search in order to locate weather data in the current path based on the file name, site name, zone, years, latitude, longitude, elevation and annual temperature average and amplitude.

(vi) Allows user access to a global list (WTHLSTG.DBF) of weather data in various paths. Allows user to select weather files in the path selected in order to maintain the WTH.LST for each path where weather data contained.

(vii) Provide capabilities for user to determine what daily-generated weather data are available. Climates files (. CLI files) contain general information as well as long term monthly means of daily weather variables. These data are used to generate daily weather data when actual daily data are not available for use.

Utilities: This menu option is to enable users to reformat weather data files, fill missing data, generate weather data, compute statistics on daily weather data, and graph data. The weather manager program is called weather man (WM.EXE) and is designed to Simplify or automate many of the tasks associated with handling, analyzing, and preparing weather data for use with crop models or other simulation software. The weather man main menu has the following options: FILE, STATION, IMPORT/ EXPORT, GENERATE, ANALYZE, OPTION.

5.2.5 Soil menu option

The soil menu option is to provide user access to all soil profile data in DSSAT. The soil data for models can be stored in a file named SOIL.SOL or they may be stored in other files, which designate the institute code for organizing a set of soils. User can search on soils by name, description, texture, and depth as wells site, country, and latitude, and longitude of the soil sample. Function to sort, print, and select files for editing are made available. Graphs of selected soils attributes V_s depth can be viewed.

Another major function of this menu option is to allow user to create new soil profiles for running the crop models in three ways:

(i) By entering soil data interactively with a program which will compute the soil parameters for the *. SOL files;

(ii) By accessing a large data base of soil characteristic data and selecting a soil similar to the one at a site;

(iii) By using a text editor to enter the soil parameter directly, based on the file formats.

List/Edit: The purpose of List/Edit menu option is as follows:

(i) List all soils from all *.SOL files in a path. The column on the screen display the soil, code, texture, depth, description, site, country, latitude, longitude, data source, and taxonomy.

(ii) Provide access to any of the soils in any of the soil files using file editor.

(iii) Allows sorting in order to locate soils based on any of the information in the column.

(iv) Create a list of selected soils (SOL.LST) for use by the crop models by allowing the user to include new soil or to reduce the no of soils that are listed for model simulation.

(v) Allows user to search and to locate the soils in the current path based on the soil code, depth, texture, description, site, country, latitude, longitude, data source and classification.

(vi) Allows user to a global list (SOLSTG.DBF) of soils for various paths on the computer. Allows user to select soil files in other paths and presents files in the paths selected in order to maintain the SOL.LST.

Create: The create menu option is to enable the user to create new soil profile data for the models, with a soil retrieval program. With this program, user can either manually input soil data to create new soil profile data or retrieve data from soil data files distributed with DSSAT.

Utilities: The purpose of the utility menu option is enable user to graph selected soil properties V_s depth. This program called GUM GRAF was written by R. Matthew for crop models. The graph program works with the standard DSSAT data files, which have data in columns with variables defined by abbreviations.

5.3 Model main menu options

The model menu option provide user with access to crop simulation models for simulating the performance of real experiments and for comparing model results with the observed results. Capabilities for interactive sensitivity analysis on model parameters and for simulating hypothetical management practices are also accessed under the MODEL main menu item. Graphs of simulated and observed data can be viewed and printed, numerical results of simulation can be viewed and new $FILEX_s$ or hypothetical experiments can be input. Under this model main menu item are listed Cereals, Legumes, Root crops, and other.

When any of these specific crop models listed under the model main menu is opened there will be 5 menu option: CREATE, INPUT, SIMULATE, OUTPUT, GRAPH.

Create: This menu option is to allow user to create a new set of inputs for a real or hypothetical experiment. Opening this option calls the program, create, which enables a user to load an existing experiment and modify crop management and other inputs. Xcreate is also used to input experimental practices for an actual experiment and is the same program used to enter multiple seasons or sequence input condition under the analysis main menu option.

Inputs: The purpose of input menu option is as follows:

(i) List all experiments in a path, giving its file name, the crop code, the standard and local experiment names, and a brief description of the experiment. Keeps this list of files in a file named EXPLST.DBF, which is updated after new experiments are added.

(ii) Provides access to any of the experiment files ($FILEX_B$) using a file editor. User can choose experimental data file ($FILEX_N$), crop performance averages (in FILET and FILEA).

(iii) Allows for sorting of files to locate experiments for specified crops, standard or universal name, or local names.

(iv) Updates the experiment list (EXP.LST) read by the crop models to include new experiments or to reduce the no of experiments that are listed for model simulation.

(v) Allows user to search to locate experiments in the current path based on the type of treatments included in the experiment, on type of soils, on people who conducted the experiments, and on experiments performed at specific institutes.

(vi) Establish a global list (EXPLSTG.DBF) of experiments for all crops on the computer in various paths. Allows user to select experiments in other paths and go to that path for maintaining EXP.LST for each crop.

Simulate: The purpose of this menu option is to enable users to run a simulation model for a specific crop. When this option is selected, the directory path is changed to the path for the specific crop, the appropriate model is called, and a list of available experiments for the selected crop is presented. After an experiment from this list is selected by entering the no of experiment, a screen is presented from which the user selects a treatment from a list of treatments. Following a treatment selection, a screen is presented which allows the user to choose between continuing with simulation defined by the experiment file selected, or modifying a range of management variables, soil characteristics, weather data, and cultivar coefficients for a sensitivity analysis. Then the model is run, displaying summary results on the screen. Additional runs may be made if desired, before running to DSSAT shell.

Output: The purpose of the output menu option is to give user to easy access to crop model output files so that they can be listed, printed, and viewed from within the DSSAT shell. This option allows user to access model output files for the selected crop with the standard naming conventions.

Graph: The purpose of the Graph menu option is to provide user with graphical analysis of simulated and observed results. A program called Graphing simulated and experiment data is initiated from DSSAT when this option is selected, and the data used for plotting is for the crop, which was selected before "graph" was opened. User will have typically simulated one or more experiments and treatments before opening this menu option.

5.4 Analyses main menu option

Under the ANALYSES main menu item are option that give user access to two program, Seasonal analyses and sequential analyses, that provides analyses capability for uncertainty and risk as well as for long term sustainability of agricultural practices at a field scale. Seasonal analyses 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 or strategies with respect to wide variety of model outputs, such as yield. Economic comparison of the treatments can also be made, allowing the user to draw tentative conclusion concerning the economic risk associated with each treatment. In sequence analyses mode, crop rotations or sequences can be simulated, along with the attendant carry over effects of soil water and nitrogen process from one crop to another, including some fallow period. These rotations can also be replicated with respect to different weather sequences.

5.5 Tools main menu option

Under tools menu item are options that give user access to the DOS shell and to user supplied disk manager, text editor, and spreadsheet programs. Path to this program is specified under the SETUP/QUIT main menu item of the shell.

Operating system: The purpose of this menu option is to allow user to go to the DOS operating system prompt while DSSAT remains in memory. User must type "EXIT" and then press the < ENTER> when they wish to return to DSSAT.

Disk Manager: The purpose of this menu option is to enable access to user's disk manager program. If one is not installed, an error message will be displayed.

Editor: The purpose of this menu option is to allow user text editor program. If not installed an editor under the SETUP/QUIT shell menu option, "tool" the editor supplied with DSSAT will be accessed.

Spreadsheet: The purpose of this menu option is to allow user's access spread sheet Program. If this one is not installed, an error message will be displayed.

5.6 SETUP/QUIT Menu main options

Under the SETUP/QUIT main menu item are options that enable users to modify program paths, program name, and data file path used in different section of the DSSAT. These menu option allow user to tailor the DSSAT package to their own disk configurations and to have more than one path on the computer with data or models that may be linked to DSSAT at any desired time. For example, user may have weather data in two paths in two different regions. Then, the path definition under the SETUP/QUIT section can be set to the path required for a specific set of runs. It is also possible for users to have more than one model of the same crop and select the model they want run by specifying its path and the name under the SETUP/QUIT main menu item.

CHAPTER-6

CREATING MANAGEMENT FILES TO RUN MODEL AND DOCUMENT EXPERIMENTS.

6.1 Introduction

IBSNAT network have developed a system of data files, formats, and conventions for storing information on crop production. The purpose of the system are: (i) Provide a uniform structure for documenting crop experiments conducted at any site.

(ii) Provide uniform data structure for crop model inputs and applications.

This system includes files for daily weather, soil, crop, and management data for documenting the environment, crop and cultivar characteristics and field management. These data files are also used as input to crop models. Other files are used to store measurement of crops, weather and soil responses during a season and at harvest, which are useful for evaluating the ability of the crop models to simulate real world responses.

The program which creates management files to run models and document experiment is called Xcreate and was developed to help user create a file that describes an experiment. Xcreate can be used to enter data from actual experiments or 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.

(i) Interactive or Experiment mode.

(ii) Seasonal analyses mode.

(iii) Sequence analyses mode.

6.1.1 Interactive or Experiment mode

The Interactive or Experiment mode for running the crop models will usually be used for calibration, validation, and sensitivity analyses; in other words to run single season crop simulations, and compare simulated with observed outputs. These model runs are made under the MODEL menu item of DSSAT shell, and the experiment FILEX may involve many treatments that are replicated or not replicated across different weather seasons. Though, however many treatments there are, they would usually relate one crop and hence to one crop model. Interactive changes to the model input data may be made, and many different options may be changed for each model run in this mode.

6.1.2 Seasonal analyses mode

Running the crop models in seasonal analyses mode is done under the ANALYSES menu item of the DSSAT shell. In contrast to the interactive mode, there is no provision for performing sensitivity analyses. Seasonal analyses, however, allows to run larger experiments with many treatments replicated across many years of simulated or historical data. Furthermore, the results can be analyzed by comparing the treatments or strategies with respect to wide variety of model outputs, such as yield. Economic comparison of the treatments can also be made, allowing the user to draw tentative conclusions concerning the economic risk associated with each treatment.

6.1.3 Sequence analyses mode

Sequence analyses mode also involves running the crop models under ANALYSES menu of the DSSAT shell. In this mode, crop rotations or crop sequences can be simulated, along with the attendant carry over effects of soil water and nitrogen processes from one crop to another, including some fallow period. These rotations can be replicated with respect to different weather sequences. The method of setting up a FILEX for a sequence Experiment is little different. Instead of defining a complete set of treatments the rotation "germ" or repeating unit is specified in FILEX, and the appropriate crop model will be run such that the germ is repeated over and over again until a specified no of years of simulated time has elapsed. The results of the sequence simulation can be analyzed with respect to model outputs and economics of particular rotations or sequence "strategies".

6.2 Creating a FILEX

Xcreate 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 analyses, initial conditions, planting, irrigation, fertilizer, residues, chemical application, tillage and rotation, environmental modification, harvest as shown in screen 3-8.

The basic procedure involved in creating a FILEX is follows:

(i) Select an existing experiment as a "Template".

(ii) Add or remove treatments.

(iii) Edit sections as required until complete

(iv) 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.

6.3 Codes

Abbreviation or codes are used in various places in experiment file (FILEX). For example, codes are used for fertilizer types, pesticide types, crops, residue types, and methods for applying fertilizer, irrigation methods, soil texture, tillage implements, and environment modification flags. These codes are contained in a file named CODES.FLE. Xcreate open this file and presents the code and their description to user at appropriate places, to facilitate the ease with which correct data can be entered for an experiment.

6.4 Key board commands

Following is a list of keyboard command.

<ESC>	Cancel/exit the current dialogue box or menu.
<F1>	Context sensitive help.
<F2>	Code selection list.
<F4>	Set initial soil, water, and mineral N conditions.
<F7>	Save edited file.
<TAB>	Move to the next data entry field or dialog item.
<SHIFT>-<TAB>	Move to the previous data entry field dialog item.

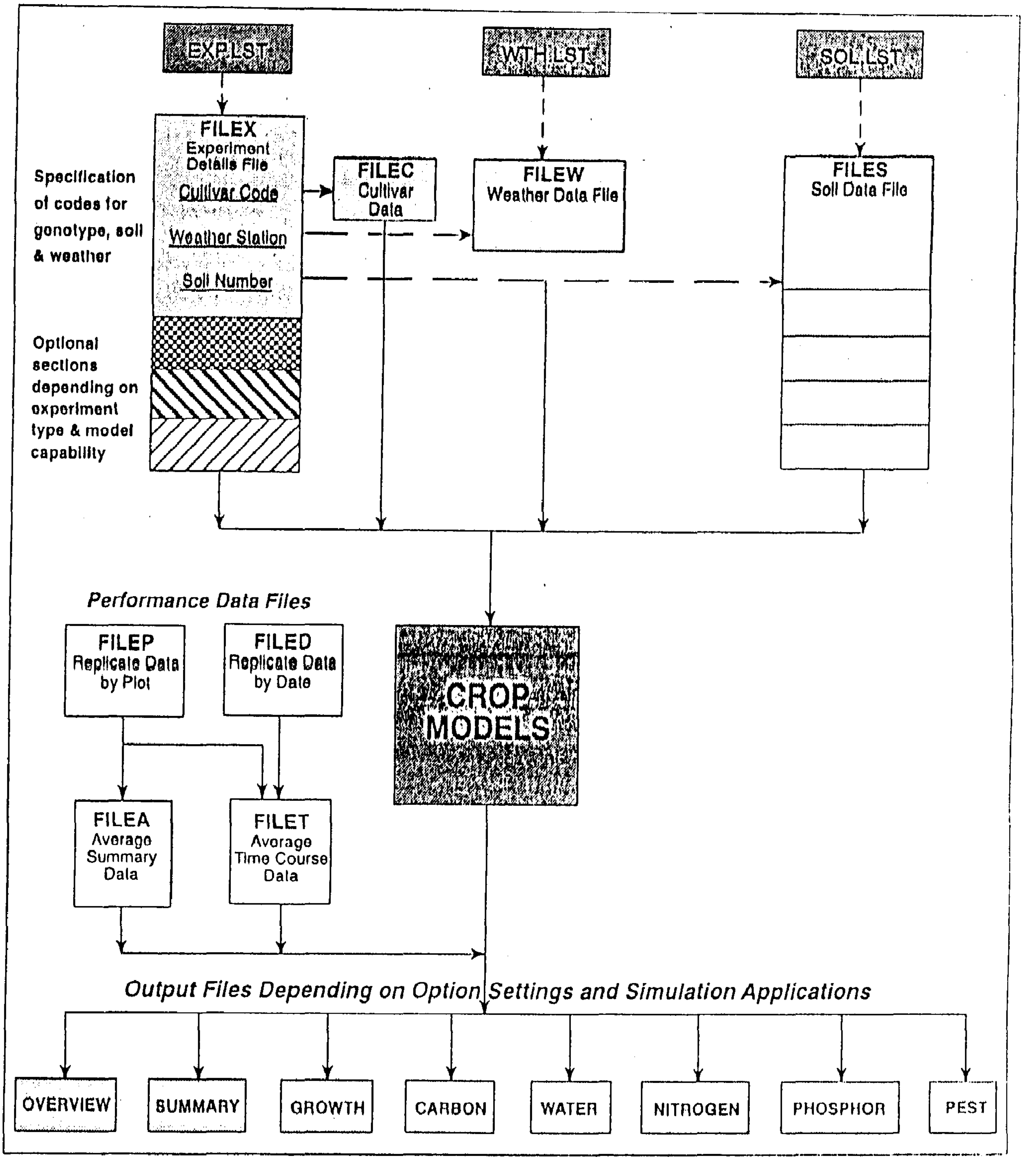


FIGURE 6·1 OVERVIEW OF INPUT AND OUTPUT FILES USED BY CROP MODELS.

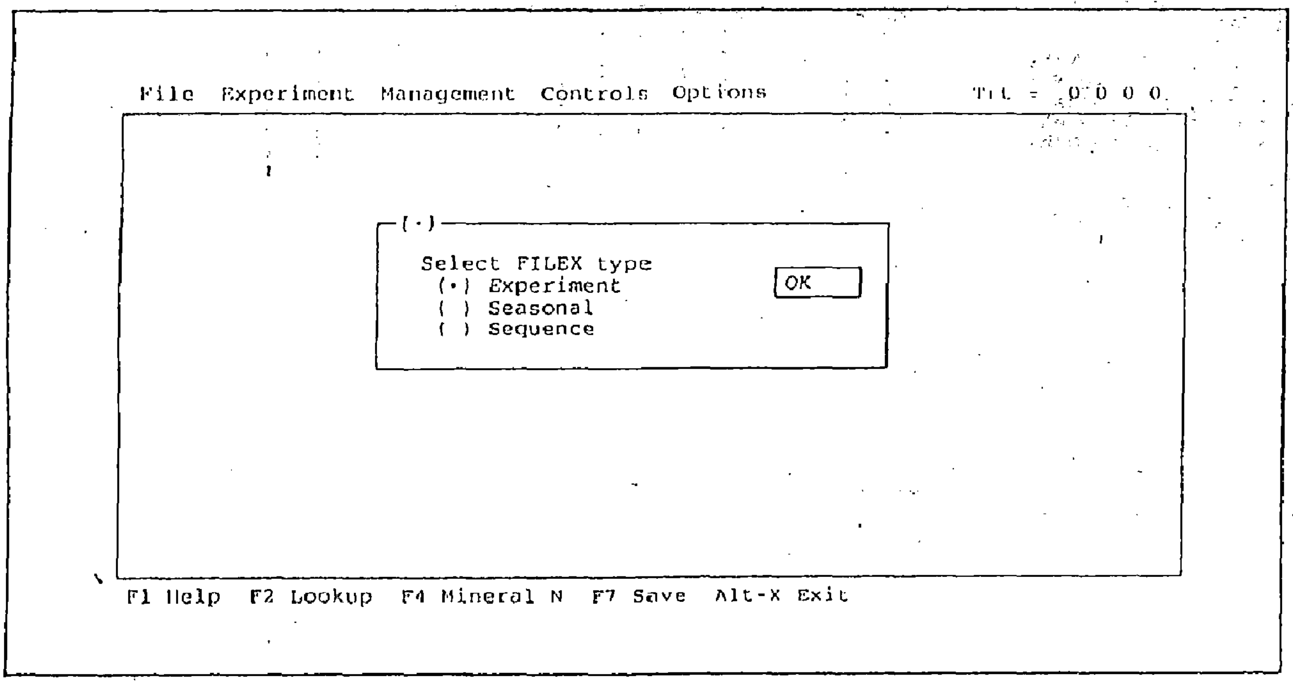
Screen-3

```
DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER

  DATA        MODELS        ANALYSES        TOOLS        SETUP/QUIT

                          S Seasonal
                          Q  C Create
                             I Inputs
                             S Simulate
                             O Outputs
                             A Analyze

Create new seasonal/sequential analysis files.

↑ ↓ → ←    moves through menu choices
ESC        move to higher menu level                    Version: 3.0
```

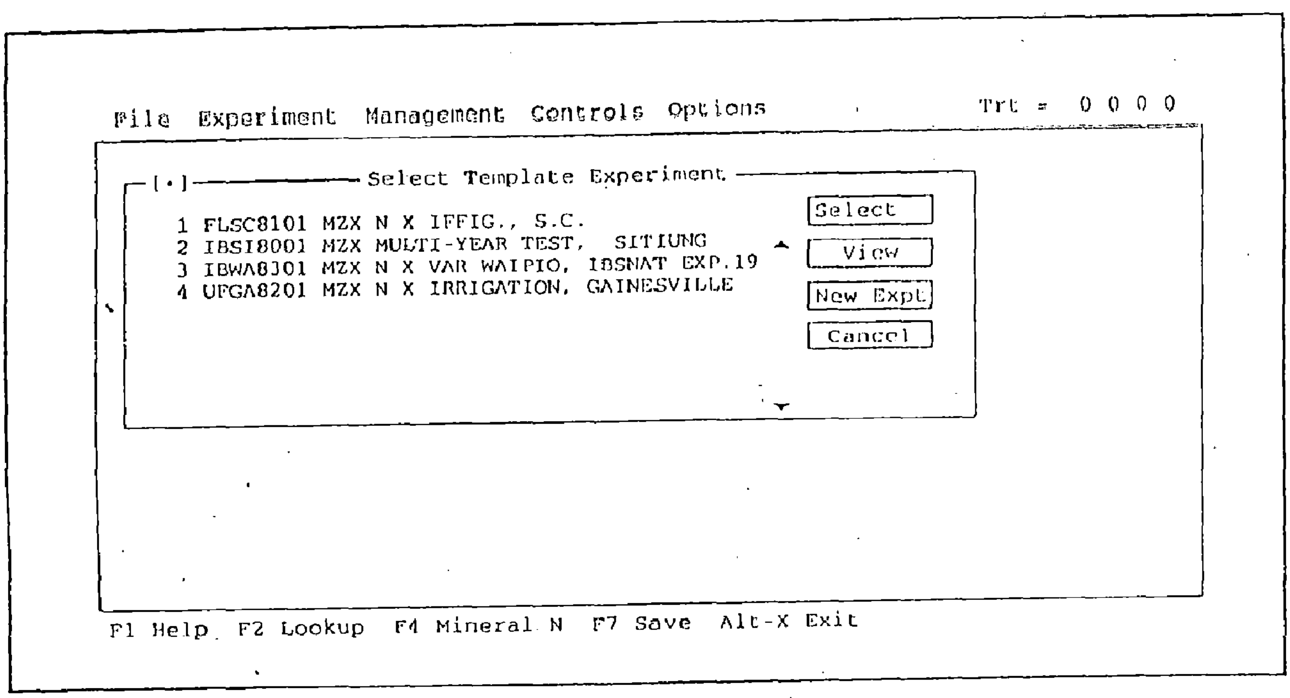
Screen-4

```
File  Experiment  Management  Controls  Options              Trt =  1 1 0 0
                                  FILEX.RPT
*EXP.    Identifiers          VAR WAPIO, IBSNAT EXP.1983-4
         General
*TREA    Plot Information         ------------FACTOR LEVELS-----------
@N R     Notes               ..... CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 1                               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
 1 MZ IB0063 PIO X 304C
 2 MZ IB0060 H610(UH)

*FIELDS
@L ID_FIELD WSTA....  FLSA  FLOB  FLDT  FLDO  FLDS  FLST SLTX SLOP  ID_SOIL
 1 IBWA0001 IBWA8302 -99     0 IB000     0     0 00000  -99  110  IBMZ910001

*INITIAL CONDITIONS

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

Screen-5



Screen-6



Screen-7

```
File  Experiment  Management  Controls  Options                  Trt =  1 1 0 0
 Open using template              ─ FILEX.RPT ─
 Change working directory         R WAPIO, IBSNAT EXP.1983-4
 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-8

```
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  IBMZ910001
*INITIAL CONDITIONS
F1 Help  F2 Lookup  F4 Mineral N  F7 Save  Alt-X Exit
```

Up arrow	Move up a list of items.
Down arrow	Move down a list of items.

6.5 File structure

The files are organized in to input, output and experiment performance data files (shown in table 6.1). A typical organization of these is depicted in Figure-6.1. The experiment performance files are needed only when simulated results are to compare with data recorded in particular experiment. In some cases they could be used as in put files to reset some variables during the course of a simulation run. The model output files are organized to allow user to select information needed for a particular application. Similarly, model inputs are organized to allow some flexibility in their use with specific model.

6.6 File Annotation

Each file should contain file heading, and if the file is partitioned into section, section headings. In addition, it is often desirable to add remarks to data contain with in file. These remarks may be header lines indicating the nature of the following data items or may be comments on some aspects of the quality or source of the data. Headers may be used by the input components of a model to under particular operations, while comment lines would be generally ignored. The following symbols, indicate the nature of the annotation:

- * File or section heading.
- @ header lines specifying variables occurring below.
- ! Comment line.

6.7 File naming conventions

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

(i) The file extension, which is used to specify the type of file.

(ii) 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 coefficient file.
.OUT	Output file generated by crop model.
.LST	A list file-provides a list of experiments, weather data sets or soil data sets.
.ccX	Experiments details file.
.ccP	Observation data file(replicate values)
.ccD	Performance data(replicate values).
.ccA	Averages values of observed data.
.ccT	Time course data(averages).

The "cc" in the above extension indicates a crop code. The crop code for Maize is given below

Code	Crop
MZ	Maize

The files are organized in to input, output, and experiment data file. In this Maize mode, different files are presented in Table-6.1.

Table 6.1: Crop model input and output files

Internal file name	File name	External description.
Input files		
Experiment		
FILEL	EXP.LST	Listing of all available experiment details file.
FILEX	MASV2002.MZX	Experiments details files for Maize: Treatments, field conditions, crop Management and simulation Controls.
Weather and soil		
FILEW	WRDF8201.WTH	Weather data daily for WRDTC Meteorological station, Roorkee for the year i.e. 2002.
FILES	SOIL.SOL	Soil profile data for sandy loam for DEMOFARM, I I T, Roorkee.

Crop and cultivar

FILEC	MZCER940.CUL	Cultivar for Maize model.
Output files		
OUTO	OVERVIEW.OUT	Over view of input and soil variables.
OUTG	GROWTH.OUT	Detail time sequence information on Growth.
OUTW	WATER.OUT	Water balance.
OUTN	NITROGEN.OUT	Nitrogen balance.

6.8 Experiment details file

One main file, referred to as FILEX, documents the inputs to the model for each experiment to simulated (Table-6.2 and Table-6.3)

The details of the experiment are given below:

Hybrid corn 4212 was sown in the experimental plot (16.0x11.5m) size of Demonstration farm, WRDTC, I.I.T. Roorkee on 05.07.2002. Before sowing, the plot was ploughed with the help of Tiller. The plot was divided in to 9 numbers of subplots each of which is 4.0x2.5. The maize was sown in rows spacing of 50 cm and plant to plant spacing of 50 cm maintained. The seeding depth was 2-3 cm with 2 seeds per hill. A uniform dose of Diamonium phosphate (DAP) was applied on the plot at the rate of 50 kg per ha. The maize crop was irrigated thrice during the initial crop growth stage and there after due to rain at regular interval no irrigation was needed till harvesting. Urea was applied on 09.08.2002 @ 220 kg/ha when the crop was at knee high stage. The crop was harvested on 08.10.02 and the Yield and Yield Attributes was recorded.

6.9 Weather data file

Daily weather data required were observed and recorded at DEMOFARM I I T Roorkee starting from the day of planting to the day at crop maturity. The recorded data are kept in the file WRDF8201.WTH. The format of the weather data file is shown in Table-6.4

6.10 Soil data file

The soil file contains the data on the soil profile properties of the DEMOFARM. The soil identifier of the DEMOFARM is WR000820001 and contains in the file SOIL.SOL. The format of the soil data file is shown in Table-6.5

6.11 Genetic coefficient file for CERES-MAIZE (MZCER940.CUL)

Information on differences among crop genotypes is input to the model through genetic coefficient files. The coefficient stored in the file allows a single crop growth model to predict differences in development, growth, and yield.
Table-6.6 shows the current cultivars and genetic coefficients defined for Maize.

Experiment details codes are presented in Annexure -VI
Simulated and field data codes are presented in Annexure-VII
Weather data codes are presented in Annexure-VII

6.12 Output files

Simulation Overview is the first output file, which provides an overview of input conditions and crop performance, and a comparison with actual data if available. This file consists of two sections. The first section presents information that uniquely describes the simulated data set, as described below:

Line1	Run number and description; default to the experiment code and name plus Treatment number and name.
Line2	Model name and version.
Line3	Experiment name, Institute code, site code, experiment no, crop code.
Line4	Treatment number and specification.
Line5	crop, cultivar, ecotype.
Line6	simulation starting date.
Line7	Planting date, population and row spacing.
Line8	Weather location, site and year.
Line9	Soil number, texture and family.
Line10	Soil initial condition.
Line11	Water balance.

Line12 Irrigation.
Line13 Nitrogen balance.
Line14 Fertilizer N application.
Line15 Residue application.
Line16 Environmental option.
Line17 Simulation option.
Line18 Management option.

The second contains a summary of soil characteristics and cultivar coefficients. The next section deals with the crop and soil status at the main developmental stages, followed by a comparison of simulated and measured data for major variables. This in turn is followed by information on simulated stress factors and weather data summary during the different development phase.

The other file contains detailed simulation results, including simulated **seasonal growth and development (as shown inTable-6.7), water balance (as shownTable-6.8), Nitrogen balance (as shown Table-6,9).** These files are included for detailed graphic and numerical comparison of simulated results with data collected periodically during a growing season. They can be saved in a files named according to the code of the first experiment in the simulation session, but with a final letter to indicate the aspect dealt with in the file.

Table-6.2 *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-6.3 ***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	PH2OL	1	R	5	0
Uppermost soil water, %	SWPLTH	PH2OU	1	R	5	0
Management depth for water, cm	SWPLTD	PH2OD	1	R	5	0
Max. soil temp. (10 cm av.), °C	PTX	PSTMX	1	R	5	0
Min. soil temp. (10 cm av.), °C	PTTN	PSTMN	1	R	5	0
Irrigation and Water Management:						
Level number	LNSIM	N	0	I	2	
Identifier	TITIRR	IRRIGATION	1	C	11	
Management depth, cm	DSOIL	IMDEP	1	R	5	0
Threshold, % of maximum available	THETAC	ITHRL	1	R	5	0
End point, % of maximum available	IEPT	ITHRU	1	R	5	0
End of applications, growth stage	IOFF	IROFF	1	C	5	
Method, code	IAME	IMETH	1	C	5	
Amount per irrigation, if fixed, mm	AIRAMT	IRAMT	1	R	5	0
Irrigation application efficiency, fraction	EFFIRR	IREFF	1	R	5	2

Nitrogen Fertilization:						
Level number	LNSIM	N	0	I	2	
Identifier	TITNIT	NITROGEN	1	C	11	
Application depth, cm	DSOILN	NMDEP	1	R	5	0
Threshold, N stress factor, %	SOILNC	NMTHR	1	R	5	0
Amount per application, kg N ha^{-1}	SOILNX	NAMNT	1	R	5	0
Material, code	NCODE	NCODE	1	C	5	
End of applications, growth stage	NEND	NAOFF	1	C	5	
Residues:						
Level number	LNSIM	N	0	I	2	
Identifier	TITRES	RESIDUES	1	C	11	
Incorporation percentage, % of remaining	RIP	RIPCN	1	R	5	0
Incorporation time, days after harvest	NRESDL	RTIME	1	I	5	
Incorporation depth, cm	DRESMG	RIDEP	1	R	5	0
Harvests:						
Level number	LNSIM	N	0	I	2	
Identifier	TITHAR	HARVESTS	1	C	11	
Earliest, days after maturity	HDLAY	HFRST	1	I	5	
Latest, year and day of year (YRDOY)	HLATE	HLAST	1	I	5	
Percentage of product harvested, %	HPP	HPCNP	1	R	5	0
Percentage of residue harvested, %	HRP	HRCNR	1	R	5	0

1 *Abbreviations used as variable names in the IBSNAT models.*

2 *Abbreviations suggested for use in header lines (those designated with '@') within the file.*

3 *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

Table-6.4 *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" precedes 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-6.5 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	SLU1	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 (Character = 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-6.6 *GENETIC COEFFICIENTS FILE FOR CERES-MAIZE. (MZCER940.CUL)*

```
*MAIZE GENOTYPE COEFFICIENTS - GECER940 MODEL
!
@VAR#  VRNAME          ECO#    P1    P2    P5    G2    G3 PHINT
!                                1     2     3     4     5     6
IB0001 CORNL281        IB0001 110.0 0.300 685.0 825.4  6.60 75.00
IB0002 CP170           IB0001 120.0 0.000 685.0 825.4 10.00 75.00
IB0003 LG11            IB0001 125.0 0.000 685.0 825.4 10.00 75.00
IB0004 F7 X F2         IB0001 125.0 0.000 685.0 825.4 10.00 75.00
IB0005 PIO 3995        IB0001 130.0 0.300 685.0 825.4  8.60 75.00
IB0006 INRA            IB0001 135.0 0.000 685.0 825.4 10.00 75.00
IB0007 EDO             IB0001 135.0 0.300 685.0 825.4 10.40 75.00
IB0008 A654 X F2       IB0001 135.0 0.000 685.0 825.4 10.00 75.00
IB0009 DEKALB XL71     IB0001 140.0 0.300 685.0 825.4 10.50 75.00
IB0010 F478 X W705A    IB0001 140.0 0.000 685.0 825.4 10.00 75.00
IB0011 DEKALBXL45      IB0001 150.0 0.400 685.0 825.4 10.15 75.00
IB0012 PIO 3382        IB0001 160.0 0.700 890.0 750.0  8.50 75.00
IB0013 B59*OH43        IB0001 162.0 0.800 685.0 784.0  6.90 75.00
IB0014 F16 X F19       IB0001 165.0 0.000 685.0 825.4 10.00 75.00
IB0015 WASHINGTON      IB0001 165.0 0.400 715.0 750.0 11.00 75.00
IB0016 B14XOH43        IB0001 172.0 0.300 685.0 825.4  8.50 75.00
IB0017 R1*(N32*B14)    IB0001 172.0 0.800 685.0 825.4 10.15 75.00
IB0018 B60*R71         IB0001 172.0 0.800 685.0 710.4  7.70 75.00
IB0019 WF9*B37         IB0001 172.0 0.800 685.0 825.4 10.15 75.00
IB0020 B59*C103        IB0001 172.0 0.800 685.0 825.4 10.15 75.00
IB0021 Garst 8702      IB0001 175.0 0.200 960.0 778.0  6.00 75.00
IB0022 B14*C103        IB0001 180.0 0.500 685.0 825.4 10.15 75.00
IB0023 B14*C131A       IB0001 180.0 0.500 685.0 825.4 10.15 75.00
IB0024 PIO 3720        IB0001 180.0 0.800 685.0 825.4 10.00 75.00
IB0025 WASH/GRAIN-1    IB0001 185.0 0.400 775.0 760.0 12.00 75.00
IB0026 A632 X W117     IB0001 187.0 0.000 685.0 825.4 10.00 75.00
IB0027 Garst 8750      IB0001 190.0 0.200 930.0 810.0  6.30 75.00
IB0028 TAINAN-11       IB0001 200.0 0.800 670.0 730.0  6.80 75.00
IB0029 PIO 3541        IB0001 200.0 0.300 800.0 700.0  8.50 75.00
IB0030 PIO 3707        IB0001 200.0 0.700 800.0 590.0  6.30 75.00
IB0031 PIO 3475        IB0001 200.0 0.700 800.0 725.0  8.60 75.00
IB0032 PIO 3382        IB0001 200.0 0.700 800.0 650.0  8.50 75.00
IB0033 PIO 3780        IB0001 200.0 0.760 685.0 600.0  9.60 75.00
IB0034 PIO 3780*       IB0001 200.0 0.760 685.0 725.0  9.60 75.00
IB0035 McCurdy 84aa    IB0001 200.0 0.300 940.0 700.0  8.00 75.00
IB0036 C281            IB0001 202.0 0.300 685.0 825.4  5.80 75.00
IB0037 SWEET CORN      IB0001 210.0 0.520 625.0 825.0 10.00 75.00
IB0038 Garst 8555      IB0001 215.0 0.400 890.0 800.0  9.00 75.00
IB0039 PIO 3901        IB0001 215.0 0.760 600.0 560.0  9.00 75.00
IB0040 B8*153R         IB0001 218.0 0.300 760.0 575.0  8.80 75.00
```

CERES-MAIZE

Table 6.6 shows an example of the current cultivars defined for corn. 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	Thermal time from seedling emergence to the end of the juvenile phase (expressed in degree days above a base temperature of 8°C) during which the plant is not responsive to changes in photoperiod.
P2	Extent to which development (expressed as days) is delayed for each hour increase in photoperiod above the longest photoperiod at which development proceeds at a maximum rate (which is considered to be 12.5 hours).
P5	Thermal time from silking to physiological maturity (expressed in degree days above a base temperature of 8°C).
G2	Maximum possible number of kernels per plant.
G3	Kernel filling rate during the linear grain filling stage and under optimum conditions (mg/day).
PHINT	Phylochron interval; the interval in thermal time (degree days) between successive leaf tip appearances.

Table-6.7 DETAILED SIMULATION GROWTH OUTPUT FILE. (OUTG)

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]			
Line 1						
Run number[4]	NREP		5	I	3	
Run identifier	TITLER		10	C	25	
Line 2						
Model name	MODEL		18	C	8	
Crop name	CROPD		3	C	10	
Line 3						
Experiment identifier, made up of:						
Institute code	INSTE		18	C	2	
Site code	SITEE		0	C	2	
Experiment number/abbreviation	EXPTNO		0	C	4	
Crop group code	CROP		1	C	2	
Experiment name (Treatment set and experimental condition names, separated by a semi-colon)	ENAME		18	C	60	
Line 4						
Treatment number	TRTNO		11	I	2	
Treatment name	TITLET		5	C	25	
Line 5[5]						
Variable abbreviations			1	C	77+	
Line 6 on						
Date (Year + days from Jan. 1)	YRDOY	DATE	1	I	5	
Crop age (days from planting)	DAP	CDAY	1	I	5	
Leaf number	VSTAGE	L#SD	1	R	5	1
Growth stage	RSTAGE	GSTD	1	I	5	
Leaf area index	XLAI	LAID	1	R	5	2
Leaf dry weight, kg ha^{-1}	WTLF	LWAD	1	I	5	
Stem dry weight, kg ha^{-1}	STMWT	SWAD	1	I	5	
Grain dry weight, kg ha^{-1}	SDWT	GWAD	1	I	5	
Root dry weight in layer L, kg ha^{-1}	RTWT	RWAD	1	I	5	
Crop dry weight, kg ha^{-1}	TOPWT	CWAD	1	I	5	
Grain number, $\#/m^2$	SEEDNO	G#AD	1	I	5	
Grain dry weight, mg/grain	SDSIZE	GWGD	1	R	5	1
Harvest index	HI	HIAD	1	R	5	3

1 *Abbreviations used as variable names in the IBSNAT models.*

2 *Abbreviations suggested for use in header lines (those designated with '@') within the file. They correspond to the variable names used in the associated database.*

3 *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

4 *Each new run should be demarcated with '*RUN' at the beginning of this line in each file.*

5 *Additional information can be placed between lines 4 and 5, as required by a user, as illustrated in the example, and as documented for the Overview file in the text.*

Table-6.8 DETAILED SIMULATION WATER BALANCE OUTPUTFILE. (OUTW)

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]			
Line 1						
Run number[4]	NREP		5	I	3	
Run identifier	TITLER		10	C	25	
Line 2						
Model name	MODEL		18	C	8	
Crop name	CROPD		3	C	10	
Line 3						
Experiment identifier, made up of:						
Institute code	INSTE		18	C	2	
Site code	SITEE		0	C	2	
Experiment number/abbreviation	EXPTNO		0	C	4	
Crop group code	CROP		1	C	2	
Experiment name (Treatment set and experimental condition names, separated by a semi-colon)	ENAME		18	C	60	
Line 4						
Treatment number	TRTNO		11	I	2	
Treatment name	TITLET		5	C	25	
Line 5[5]						
Variable abbreviations			1	C	77+	
Line 6 on						
Date (Year + days from Jan. 1)	YRDOY	DATE	1	I	5	
Days from planting	DAP	CDAY	1	I	5	
Plant Transpiration, mm d^{-1}	AVEP	EPAA	1	R	5	2
Evapotranspiration, mm day^{-1}	AVET	ETAA	1	R	5	2
Potential evaporation, mm day^{-1}	AVEO	EOAA	1	R	5	2
Potentially extractable water, cm	PESW	SWXD	1	R	5	1
Cumulative runoff	TRUNOF	ROFC	1	R	5	1
Cumulative drainage	TDRAIN	DRNC	1	I	5	
Cumulative precipitation, mm	CRAIN	PREC	1	I	5	
Cummulative irrigation, mm	TOTIR	IRRC	1	I	5	
Average solar radiation, MJ m^{-2}	AVSRAD	SRAA	1	R	5	1
Average maximum temperature, °C	AVTMX	TMXA	1	R	5	1
Average minimum temperature, °C	AVTMN	TMNA	1	R	5	1

1 *Abbreviations used as variable names in the IBSNAT models.*

2 *Abbreviations suggested for use in header lines (thoses designated with '@') within the file. They correspond to the variable names used in the associated database.*

3 *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

4 *Each new run should be demarcated with '*RUN' at the beginning of this line in each file.*

5 *Additional information can be placed between lines 4 and 5, as required by a user, as illustrated in the example, and as documented for the Overview file in the text.*

Table-6.9 DETAILED SIMULATION NITROGEN OUTPUT FILE. (OUTN)

STRUCTURE

Variable	Variable Name[1]	Header[2]	Format[3]			
Line 1						
Run number[4]	NREP		5	I	3	
Run identifier	TITLER		10	C	25	
Line 2						
Model name	MODEL		18	C	8	
Crop name	CROPD		3	C	10	
Line 3						
Experiment identifier, made up of:						
Institute code	INSTE		18	C	2	
Site code	SITEE		0	C	2	
Experiment number/abbreviation	EXPTNO		0	C	4	
Crop group code	CROP		1	C	2	
Experiment name (Treatment set and experimental condition names, separated by a semi-colon)	ENAME		18	C	60	
Line 4						
Treatment number	TRTNO		11	I	2	
Treatment name	TITLET		5	C	25	
Line 5[5]						
Variable abbreviations			1	C	77+	
Line 6 on						
Date (Year + days from Jan. 1)	YRDOY	DATE	1	I	5	
Days from planting	DAP	CDAY	1	I	5	
Crop nitrogen	WTNCAN	CNAD	1	R	5	1
Grain nitrogen, kg ha^{-1}	WTNSD	GNAD	1	R	5	1
Veg. (stem + leaf) nitrogen, kg ha^{-1}	WTNVEG	VNAD	1	R	5	1
Percent nitrogen in grain, %	PCNGRN	HN%D	1	R	5	2
Percent veg(stem+leaf) nitrogen, %	PCNVEG	VN%D	1	R	5	2
Cumulative inorganic N applied, kg ha^{-1}	TANFGR	NAPC	1	R	5	I
Cumulative N fixation, kg ha^{-1}	WTNFX	NFXC	1	R	5	1
Cumulative N uptake, kg ha^{-1}	WTNUP	NUPC	1	R	5	1
Cumulative N leached, kg ha^{-1}	TLCH	NLCC	1	R	5	1
Inorganic N in soil, kg ha^{-1}	TSIN	NIAD	1	R	5	1
Organic N in soil, kg ha^{-1}	TSON	NOAD	1	I	5	

1 *Abbreviations used as variable names in the IBSNAT models.*

2 *Abbreviations suggested for use in header lines (those designated with '@') within the file. They correspond to the variable names used in the associated database.*

3 *Formats are presented as follows: number of leading spaces, variable type (Character = C, Real = R, Integer = I), variable width, and (if real) number of decimals.*

4 *Each new run should be demarcated with '*RUN' at the beginning of this line in each file.*

5 *Additional information can be placed between lines 4 and 5, as required by a user, as illustrated in the example, and as documented for the Overview file in the text.*

CHAPTER-7

DSSAT VALIDATION AND SENSITIVITY ANALYSES ON MAIZE CV HYBRID CORN 4212

The data generated from the field experiments on Maize cv Hybrid corn 4212 during kharif 2002 on the Demonstration Farm of Indian Institute of Technology, Roorkee were used for validation. The details of the data generated and the specific details of the experiment are presented in chapter-3. The Yield and Yield Attributes recorded from different plots are also presented in chapter-3.

Similarly the output of the CERES-Maize crop model such as simulation overview, summary of soil and genetic input parameters, simulated crop and soil status at main development stages, main growth and development variables, and environmental and stress factors are shown in Run No-1 under the head "Response of Maize on Nitrogen." The growth aspects, Nitrogen balance and Water balance are also shown in this chapter.

7.1 The Yield and Yield Attributes of the Field and DSSAT prediction

The Yield and Yield Attributes observed in the Field and predicted by the DSSAT for Maize cv Hybrid corn 4212 is given in Table-7.1.

Table-7.1 Yield and Yield Attributes observed and predicted by DSSAT and its deviation

Parameters	Grain Yield kg/ha		Deviation from Actual
	Actual	Predicted	
Flowering date (dap)	44.00	42.00	-2Days
Physiological maturity(dap)	87.00	83.00	-3Days
Grain yield kg/ha	5197.00	5255.00	+58.00
Weight per Grain(gm)	0.32	0.3354	+0.154
Grain number/m^2	1624.00	1567.00	-57.00
Grains per Cob(nos)	406.00	391.70	-14.30
Maximum LAI	2.13	2.26	+0.13
Biomass at Harvest (kg/ha)	8957.00	9188.00	+231.00
Stack at the Harvest (kg/ha)	3760.00	3933.00	+173.00
Harvest Index (kg/kg)	0.58	0.572	-0.008

The above table implies that the model has predicted the grain yield with a difference of 58 kg in comparison to the field results. It has also been noticed that the crop model has predicted the value of the yield attributes on a slightly higher side than the field results except the number of Grain per sq m area, number of Grains per cob, and Harvest index. The extent of variability are well with in the acceptable limits. The Deviation of the Phenologic events such as the flowering date and physiological maturity date, i.e. –2 Days and –3 Days from the crop model prediction has also been found with in the acceptable limits.

7.20 Sensitivity analyses-DSSAT Prediction on Maize CV Hybrid Corn 4212

Since the variability of the DSSAT crop model predicted was with in the acceptable limits, the validated programme was further extended under different Agronomical practices and predictions were made on account of Grain Yield. The Experiment Treatment combination consists of three levels of Nitrogen with three levels of Plant populations. The all other input parameters were assumed the same as that used for validation. The details of the Experiment input file that was made are shown in this chapter. The Treatment combinations used for Grain Yield predictions are given below;

Treatments No	Name of the Treatments	Plant Population	Specification
T1	No Nitrogen With 50x50cm plant spacing	4	N_1S_1
T2	No Nitrogen With 50x40cm plant spacing	5	N_1S_2
T3	No Nitrogen With 50x33cm plant spacing	6	N_1S_3
T4	50kg Nitrogen With 50x50cm plant spacing	4	N_2S_1
T5	50kg Nitrogen With 50x40cm plant spacing	5	N_2S_2
T6	50kg Nitrogen With 50x33cm plant spacing	6	N_2S_3
T7	100kg Nitrogen With 50x50cm plant spacing	4	N_3S_1
T8	100kg Nitrogen With 50x40cm plant spacing	5	N_3S_2
T9	100kg Nitrogen With 50x33cm plant spacing	6	N_3S_3

Where N1, N2, N3 Represents No, 50kg, 100kg Nitrogen Application.

S1, S2, S3 Represents Row to Row and Plant to Plant Spacing.

Similarly the output of the crop model such as simulation overview, summary of soil and genetic input parameters, simulated crop and soil status at main development stages, main growth and development variables, and environmental and stress factors are annexed in this chapter. The other outputs such as Growth aspects, Nitrogen balance, and Water balance are also annexed. The summary of Yield and Yield Attributes predicted by DSSAT under different Treatment combinations are given below in Table-7.3

Table-7.3 The summary of Yield and Yield Attributes predicted by DSSAT under different combinations.

Sl No	Name of the Treatment	Grain yield (kg/ha)	Weight/ grain (gm)	Grain number Per m^2	Grains per cob
1	No Nitrogen With 50x50cm plant spacing	3531	0.2981	1185	296.1
2	No Nitrogen With 50x40cm plant spacing	3597	0.3053	1178	235.7
3	No Nitrogen With 50x33cm plant spacing	3606	0.3020	1194	199.0
4	50k Nitrogen With 50x50cm plant spacing	4952	0.3161	1567	391.6
5	50k Nitrogen With 50x40cm plant spacing	5028	0.3062	1642	328.4
6	50k Nitrogen With 50x33cm plant spacing	5070	0.2968	1708	284.7
7	100kg NitrogenWith50x50cm plant spacing	5255	0.3354	1567	391.7
8	100kg Nitrogen With 50x40cm plant spacing	5414	0.3297	1642	328.4
9	100kg Nitrogen With 50x33cm plant spacing	5525	0.3234	1708	284.7

7.2.1 No Nitrogen with 4 Plant population per Sq m Area

The Grain yield predicted are presented in Run No-1, N_1S_1. The average grain yield predicted was 3531 kg/ha. The unit weight of the grain was 0.2981 gm, where as the number of Grain per sq m and per cob were 1185 and 296.10 respectively.

7.2.2 No Nitrogen with 5 Plant population per Sq m Area

The Grain yield predicted are presented in Run No-2, N_1S_2. The average grain yield predicted was 3597 kg/ha which is about 1.87% more than the previous case. The number of Grain per sq m and per cob was 1178 and 235.7 respectively. The unit weight of the grain increased to 2.40% where as the number of Grain per sq m and per cob was reduced to 0.60%, and 20.40% respectively in comparison to 4 plant population per sq m area.

7.2.3 No Nitrogen with 6 Plant population per Sq m Area

The Grain yield predicted are presented in Run No-3, N_1S_3. The average grain yield predicted was 3606 kg/ha, which is about 2.12% more than 4 plant population per sq area. In comparison to 5 populations per sq area the difference in grain yield and the unit weight of the grain was not significant. The unit weight of the grain, the number of Grain per sq m and per cobs was 0.3020, 1194 and 199.0 respectively. The number of grain per Cob was reduced drastically to 32.80 %, 15.60 % in comparison to 4, 5 plant population per sq. m area respectively.

7.2.4 50 kg Nitrogen with 4 Plant populations per Sq m Area

The Grain yield predicted is presented in Run No-4, N_2S_1. The average grain yield predicted was 4952 kg/ha. The unit weight of grain was 0.3161 gm where as the number of grains per sq m and per Cob was 1567 and 391.6 respectively. The grain yield to 40.20 % where as the number of grains per sq m and per Cob increased to 32.20 %, 32.30 % respectively in comparison to no Nitrogen with 4 plant population per sq m area.

7.2.5 50 kg Nitrogen with 5 Plant populations per Sq m Area

The Grain yield predicted is presented in Run No-5, N_2S_2. The average grain yield predicted was 5028 kg/ha which is about 39.80 % and 1.53 % more in comparison to no Nitrogen with 5 plant population and 50 kg Nitrogen within 4 plant population respectively. However the unit weight of the grain (0.3062 gm) and the number of grains per Cob (328.4) decreased to 3.10 %, 16.10 % where as the number of grains per sq m area (1642) increased to 4.80 % respectively in comparison to 50 kg Nitrogen with 4 plant population.

7.2.6 50 kg Nitrogen with 6 Plant population per Sq m Area

The Grain yield predicted is presented in Run No-6, N_2S_3. The average grain yield predicted was 5070 kg/ha, which is about 40.60 % more in comparison to no Nitrogen with 6 plant population. Similarly the yield increased to 2.40 %, 0.84 % in comparison to 50 kg Nitrogen with 4 and 5 plant population respectively. However the unit weight of the grain (0.2968) and the number of grains per Cob (284.7) was reduced to 6.10 %, 27.30 % and the number of grains per sq m (1708) increased to 8.90 % respectively in comparison to 50 kg Nitrogen with 4 plant population per sq m area.

7.2.7 100 kg Nitrogen with 4Plant population per Sq m Area

The Grain yield predicted are presented in Run No-7, N_3S_1. The average grain yield predicted was 5255kg/ha. The unit weight of the grain was 0.3354 gm where as the number of grains per sq m area and per Cob was 1567 and 391.7 respectively. The grain yield has been increased to 48.80 %, 6.10 % respectively in comparison to no Nitrogen, 50 kg Nitrogen with 4 plant population per sq m area. There was no difference in the number of grains per sq m area and per Cob was found, where as the unit weight of the grain increased to 6.10 % in comparison to 50 kg Nitrogen with 4 plant population per sq m area. However at the same time the unit weight of the grain , the number of grains per sq m area and per Cob has been increased significantly in comparison to no Nitrogen with 4 plant population (12.50 %, 32.20 %. 32.30 % respectively.)

7.2.8 100 kg Nitrogen with 5 Plant populations per Sq m Area

The Grain yield predicted is presented in Run No-8, N_3S_2. The average grain yield predicted was 5414 kg/ha which is about 50.50 %, 7.70 % more in comparison to no Nitrogen and 50 kg Nitrogen with 5 plant population. Similarly the grain yield increased to 3.03 % more in comparison to 100 kg Nitrogen with 4 plant population. The predicted unit weight of the grain, grain number per sq m area and Cob were 0.3297 gm, 1642, and 328.40 respectively. There was no difference in the number of grains per sq m area and per Cob was found where as the unit weight of grain increased to 7.70 % in comparison to 50 kg Nitrogen with 5 plant population. However the unit weight of the grain, the number of grains per sq m and per Cob has increased significantly in comparison to no Nitrogen with 5 plant population (8.00 %, 39.40 %, 39.30 % respectively.). In comparison to 100 kg Nitrogen with 4 plant population the unit weight of the grain and the number of grains per Cob has reduced to 1.70 %, 16.20 % and the number of grains per sq m increased to 4.80 % respectively.

7.2.9 100 kg Nitrogen with 6 Plant population per Sq m Area

The Grain yield predicted are presented in Run No-9, N_3S_3. The average grain yield predicted was 5525 kg/ha which is about 53.20 %, 8.90 % more in comparison to no Nitrogen and 50 kg Nitrogen with 6 plant population respectively. Similarly the grain yield increased to 5.10 %, 2.10 % respectively more in comparison to 100 kg Nitrogen with 4, 5 plant population. The predicted unit weight of the grain, number of grains per sq m area and per Cob were 0.3234, 1708, 284.7 respectively. There was no difference in the number of grains per sq m area and per Cob was found where as the unit weight of the grain was increased to 8.90 % in comparison to 50 kg Nitrogen with 6 plant population. However the unit weight of the grain, number of grains per sq m area and per Cob has increased significantly in comparison to no Nitrogen with 6 plant population (7.10 %, 43.10 %, 43.10 respectively). In comparison to 100 kg Nitrogen with 4,5 plant population the unit weight of the grain and the number of grains per Cob has been reduced to 3.60 % 27.30 % and 1.90 %, 13.30 % and the number of grains per sq m area increased to 9.00 % and 4.00 % respectively

*SIMULATION OVERVIEW FILE

*RUN 1 : RESPONSE OF MAIZE ON N
MODEL : GECER980 - MAIZE
EXPERIMENT : MASV2002 MZ VALIDATION OF DSSAT ON MAIZE CROP
TREATMENT 1 : RESPONSE OF MAIZE ON N

CROP : MAIZE CULTIVAR : hybrid corn 4212
STARTING DATE : JUL 5 1982
PLANTING DATE : JUL 5 1982 PLANTS/m2 : 4.0 ROW SPACING : 50.cm
WEATHER : WRDF 1982
SOIL : WR00820001 TEXTURE : SALO - SANDY LOAM
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.3kg/ha NH4: 6.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 98 mm IN 3 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 100 kg/ha IN 1 APPLICATIONS
RESIDUE/MANURE : INITIAL : 0 kg/ha ; 0 kg/ha IN 0 APPLICATIONS
ENVIRONM. OPT. : DAYL= A .00 SRAD= A .00 TMAX= A .00 TMIN= A .00
RAIN= A .00 CO2 = R330.00 DEW = A .00 WIND= A .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

*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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	-	kg/ha-->	43.3	6.9	4458

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.60 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .40 FERT. FACTOR : 1.00

MAIZE CULTIVAR :IB0071-hybrid corn 4212 ECOTYPE :
P1 : 185.00 P2 : .4000 P5 : 775.00
G2 : 836.00 G3 : 12.000 PHINT : 38.900

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 RESPONSE OF MAIZE ON N

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	16	.00	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	89	.19	8.0	16	1	0	98	3	3.8	.09	.00
22 JUL	17	Floral Ini	295	.50	11.0	28	1	33	109	13	4.5	.02	.01
16 AUG	42	75% Silkin	3643	2.15	24.2	93	209	98	127	82	2.2	.00	.06
24 AUG	50	Beg Gr Fil	4716	2.03	24.2	112	256	98	120	82	1.7	.00	.02
26 SEP	83	Maturity	9188	.89	24.2	183	669	98	119	117	1.3	.00	.00
8 OCT	95	Harvest	9188	.89	24.2	205	670	98	93	117	1.3	.00	.00

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
FLOWERING DATE (dap)	42	44
PHYSIOL. MATURITY (dap)	83	87
GRAIN YIELD (kg/ha;dry)	5255	5197
WT. PER GRAIN (g;dry)	.3354	.320
GRAIN NUMBER (GRAIN/m2)	1567	1624
GRAINS/EAR	391.7	406
MAXIMUM LAI (m2/m2)	2.26	2.13
BIOMASS (kg/ha) AT ANTHESIS	3643	-99
BIOMASS N (kg N/ha) AT ANTHESIS	82	-99
BIOMASS (kg/ha) AT HARVEST MAT.	9188	8957
STALK (kg/ha) AT HARVEST MAT.	3933	3760
HARVEST INDEX (kg/kg)	.572	.580
FINAL LEAF NUMBER	24.16	-99
GRAIN N (kg N/ha)	92	-99
BIOMASS N (kg N/ha)	117	-99
STALK N (kg N/ha)	25	-99
SEED N (%)	1.74	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.071	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.044	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.057	.144
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.022	.054
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.000	.000

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 5255 kg/ha [DRY WEIGHT]

*GROWTH ASPECTS OUTPUT FILE

```
*RUN   1            : RESPONSE OF MAIZE ON N
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASV2002 MZ    VALIDATION OF DSSAT ON MAIZE CROP
 TREATMENT  1       : RESPONSE OF MAIZE ON N

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  4.0      ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :      100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;       0 kg/ha IN     0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW  = A    .00  WIND= A    .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
```

!YR	Days	Leaf	Grow			Dry Weight				Grain	Kern.		
! and	after	Num	Stage	LAI	Leaf	Stem	Grain	Root	Crop	per	wght	HI	
! DOY	plant				³<---------		kg/Ha		--------->³	m2	mg		K
@DATE	CDAY	L#SD	GSTD	LAID	LWAD	SWAD	GWAD	RWAD	CWAD	G#AD	GWGD	HIAD	
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000	
82193	7	4.0	1	.04	14	8	0	10	22	0	.0	.000	
82200	14	9.0	2	.28	140	8	0	30	148	0	.0	.000	
82207	21	13.0	3	.93	612	37	0	69	650	0	.0	.000	
82214	28	17.0	3	1.60	1192	338	0	115	1531	0	.0	.000	
82221	35	21.0	3	2.05	1617	913	0	166	2530	0	.0	.000	
82228	42	24.0	4	2.15	1811	1437	0	222	3643	0	.0	.000	
82235	49	24.0	4	2.07	1610	1755	0	274	4555	0	.0	.000	
82242	56	24.0	5	1.96	1599	1648	1265	264	5702	1567	80.8	.222	
82249	63	24.0	5	1.79	1588	1514	2543	255	6835	1567	162.3	.372	
82256	70	24.0	5	1.56	1577	1320	3815	247	7901	1567	243.5	.483	
82263	77	24.0	5	1.14	1566	1183	4902	238	8840	1567	312.9	.555	
82269	83	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572	
82270	84	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572	
82277	91	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572	
82281	95	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572	

*WATER BALANCE OUTPUT FILE

```
*RUN   1            : RESPONSE OF MAIZE ON N
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASV2002 MZ    VALIDATION OF DSSAT ON MAIZE CROP
 TREATMENT  1       : RESPONSE OF MAIZE ON N

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 - □□□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :   4.0      ROW SPACING :   50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :       100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A     .00  SRAD= A     .00  TMAX= A     .00  TMIN= A     .00
                      RAIN= A     .00  CO2  = R330.00  DEW  = A     .00  WIND= A     .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
```

!YR	Days	Daily	Evapotran.		PESW		Cumulative			Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<--------	mm	--------	-->³	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.02	1.38	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.34	.97	3.35	127.6	.0	.0	1	33	10.1	37.5	28.0
82207	21	.65	2.82	2.82	110.0	.0	23.0	1	58	10.0	34.9	27.1
82214	28	1.26	2.80	2.80	109.1	.0	44.3	1	98	10.0	35.4	26.6
82221	35	1.45	2.56	2.56	107.9	41.9	81.4	97	98	9.8	32.2	25.9
82228	42	1.46	2.37	2.37	127.0	66.3	133.4	209	98	9.6	29.7	24.6
82235	49	1.48	2.42	2.42	128.9	68.5	158.9	256	98	9.5	32.8	24.6
82242	56	1.40	2.35	2.35	108.2	68.5	169.5	262	98	9.2	32.4	25.6
82249	63	1.28	2.23	2.23	145.9	85.4	188.6	351	98	9.0	30.1	23.6
82256	70	1.08	2.01	2.01	155.4	214.3	311.0	626	98	8.6	26.0	21.1
82263	77	.98	2.06	2.06	126.3	214.5	348.9	650	98	8.3	30.2	21.8
82269	83	.82	2.06	2.06	119.1	215.1	362.2	669	98	8.1	31.7	21.8
82270	84	.75	1.96	1.96	117.1	215.1	363.6	670	98	7.9	30.0	20.0
82277	91	.82	1.99	2.00	99.3	215.1	367.5	670	98	7.9	31.8	19.8
82281	95	1.04	1.53	1.92	93.2	215.1	367.5	670	98	7.6	31.9	18.6

*NITROGEN BALANCE OUTPUT FILE

```
*RUN    1           : RESPONSE OF MAIZE ON N
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASV2002 MZ    VALIDATION OF DSSAT ON MAIZE CROP
 TREATMENT  1       : RESPONSE OF MAIZE ON N

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 - □□□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  4.0     ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :          98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :        100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :      0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days		Nitrogen		Nitrogen		Inorg	Fix	Up-	leach	Soil	Soil
! and	After	Crop	Grain	Veg.	Grain	Veg.	N Fert		take		Inorg	Org
! DOY	Plant	³<---	Kg/Ha	-->³	³<-- %	-->³	³<-------------		kg/ha		------------	--->³
@DATE	CDAY	CNAD	GNAD	VNAD	GN%D	VN%D	NAPC	NFXC	NUPC	NLCC	NIAD	NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	.9	.0	.9	.00	4.26	0	.0	.2	.0	52.1	4456
82200	14	5.7	.0	5.7	.00	3.83	0	.0	5.2	.0	48.7	4454
82207	21	21.5	.0	21.5	.00	3.31	0	.0	21.4	4.9	29.4	4452
82214	28	29.3	.0	29.3	.00	1.91	0	.0	29.4	8.2	20.1	4450
82221	35	50.6	.0	50.6	.00	2.00	100	.0	51.3	10.7	29.9	4449
82228	42	81.8	.0	81.8	.00	2.52	100	.0	83.4	12.8	61.3	4447
82235	49	81.8	.0	81.8	.00	2.43	100	.0	83.4	14.0	64.3	4445
82242	56	81.8	22.6	59.2	1.79	1.82	100	.0	83.4	14.7	65.6	4443
82249	63	89.0	45.0	44.0	1.77	1.42	100	.0	90.9	16.5	57.6	4442
82256	70	102.9	66.7	36.2	1.75	1.25	100	.0	104.8	32.4	28.8	4440
82263	77	114.5	85.5	29.0	1.74	1.05	100	.0	116.3	35.6	15.6	4439
82269	83	117.1	91.6	25.5	1.74	.93	100	.0	121.1	36.1	14.0	4437
82270	84	117.1	91.6	25.5	1.74	.93	100	.0	121.9	36.2	14.2	4437
82277	91	117.1	91.6	25.5	1.74	.93	100	.0	127.1	36.3	15.6	4436
82281	95	117.1	91.6	25.5	1.74	.93	100	.0	130.1	36.3	16.3	4435

```
*EXP.DETAILS: MASE2002MZ APPLICATION OF DSSAT IN PREDICTING YIELD OF MAIZE

*GENERAL
@PEOPLE
 M.ARUL SELVAM T.O,M.TECH(IWM)
@ADDRESS
 WRDTC,IIT ROORKEE.
@SITE
 DEMOFARM.
@ PAREA  PRNO  PLEN  PLDR  PLSP  PLAY HAREA  HRNO  HLEN HARM...........
   10.0     8   4.0   -99   100   RBD   4.0     2   2.0 MANUAL
@NOTES
 IT IS A DISSERTATION WORK FOR THE AWARD OF THE DEGREE OF M.TECH
 IN IRRIGATION AND WATER MANAGEMENT.

*TREATMENTS                        -------------FACTOR LEVELS------------
@N R O C TNAME.................... CU FL SA IC MP MI MF MR MC MT ME MH SM
 1 0 0 0  N1S1                      1  1  1  1  1  1  1  0  0  1  1  1  1
 2 0 0 0  N1S2                      1  1  1  1  2  1  1  0  0  1  1  1  1
 3 0 0 0  N1S3                      1  1  1  1  3  1  1  0  0  1  1  1  1
 4 0 0 0  N2S1                      1  1  1  1  1  1  2  0  0  1  1  1  1
 5 0 0 0  N2S2                      1  1  1  1  2  1  2  0  0  1  1  1  1
 6 0 0 0  N2S3                      1  1  1  1  3  1  2  0  0  1  1  1  1
 7 0 0 0  N3S1                      1  1  1  1  1  1  3  0  0  1  1  1  1
 8 0 0 0  N3S2                      1  1  1  1  2  1  3  0  0  1  1  1  1
 9 0 0 0  N3S3                      1  1  1  1  3  1  3  0  0  1  1  1  1

*CULTIVARS
@C CR INGENO CNAME
 1 MZ IB0071 hybrid corn 4212

*FIELDS
@L ID_FIELD WSTA....  FLSA  FLOB  FLDT  FLDD  FLDS  FLST SLTX   SLDP ID_SOIL
 1 DEMOFARM WRDF       0.0     0 DR000     0     0 -99   SALO     90 WR00820001
@L ...........XCRD ...........YCRD .....ELEV .............AREA .SLEN .FLWR .SLAS
 1         0.00000         0.00000    252.00             10.0     0   1.6   0.0

*SOIL ANALYSIS
@A SADAT  SMHB  SMPX  SMKE
 1 82186 SA011 SA009 SA009
@A  SABL  SADM  SAOC  SANI  SAHW  SAHB  SAEX  SAKE
 1    30  1.48  0.09  0.09   7.5 -99.0  15.0  45.0
 1    30  1.54  0.01  0.01   7.5 -99.0  15.0  45.0
 1    30  1.59  0.00  0.00   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 82186    20   -99  1.00  1.00 -99.0   -99   -99   -99   -99   -99
@C  ICBL  SH2O  SNH4  SNO3
 1    30 0.250   0.5   4.4
 1    60 0.278   0.5   0.5
 1    90 0.270   0.5   4.5
```

```
*PLANTING DETAILS
@P PDATE EDATE  PPOP  PPOE  PLME  PLDS  PLRS  PLRD  PLDP  PLWT  PAGE  PENV  PLPH
 1 82186 82190   4.0   4.0     S     R    50    90   3.0    30     0 -99.0   2.0
 2 82186 82190   5.0   5.0     S     R    50    90   3.0    30     0 -99.0   2.0
 3 82186 82190   6.0   6.0     S     R    50    90   3.0    30     0 -99.0   2.0

*IRRIGATION AND WATER MANAGEMENT
@I  EFIR  IDEP  ITHR  IEPT  IOFF  IAME  IAMT
 1  1.00     2    50   100 GS009 IR003   -99
@I IDATE  IROP IRVAL
 1 82200 IR001    33
 1 82204 IR001    25
 1 82210 IR001    40

*FERTILIZERS (INORGANIC)
@F FDATE  FMCD  FACD  FDEP  FAMN  FAMP  FAMK  FAMC  FAMO  FOCD
 1 82221 FE005 AP001     2     0     0     0     0     0     0
 2 82221 FE005 AP001     2    50     0     0     0     0     0
 3 82221 FE005 AP001     2   100     0     0     0     0     0

*TILLAGE AND ROTATIONS
@T TDATE TIMPL  TDEP
 1 82178 TI002    30
 1 82181 TI013    30

*ENVIRONMENTAL MODIFICATIONS
@E ODATE EDAY  ERAD  EMAX  EMIN  ERAIN ECO2  EDEW EWIND
 1 82186 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 82281 GS006 H     A     100.0  45.0

*SIMULATION CONTROLS
@N GENERAL     NYERS NREPS START SDATE RSEED SNAME....................
 1 GE              1     1     P 82186  2150 YIELD OF MAIZE CROP
@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
 1 OU              Y     Y     Y     7     Y     Y     Y     Y     N     N     N

@  AUTOMATIC MANAGEMENT
@N PLANTING    PFRST PLAST PH2OL PH2OU PH2OD PSTMX PSTMN
 1 PL          81179 81193    40   100    30    40    10
@N IRRIGATION  IMDEP ITHRL ITHRU IROFF IMETH IRAMT IREFF
 1 IR             30    50   100 GS000 IR001    10  1.00
@N NITROGEN    NMDEP NMTHR NAMNT NCODE NAOFF
 1 NI             30    50    25 FE001 GS000
@N RESIDUES    RIPCN RTIME RIDEP
 1 RE            100     1    20
@N HARVEST     HFRST HLAST HPCNP HPCNR
 1 HA              0 82186   100     0
```

```
*SIMULATION OVERVIEW FILE

*RUN  1             :  N1S1
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  1       :  N1S1

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  4.0     ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :        0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

*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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	-	kg/ha-->	43.3	6.9	4458

```
 SOIL ALBEDO     :  .13          EVAPORATION LIMIT :  9.60       MIN. FACTOR  : 1.00
 RUNOFF CURVE # :76.00          DRAINAGE RATE      :   .40       FERT. FACTOR : 1.00

 MAIZE       CULTIVAR :IB0071-hybrid corn 4212    ECOTYPE :□□□□□□-□□□□□□□□□□□□□□□
 P1      : 185.00  P2       :  .4000  P5      : 775.00
 G2      : 836.00  G3       : 12.000  PHINT   : 38.900
```

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 1 N1S1

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	16	.00	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	89	.19	8.0	16	1	0	98	3	3.8	.09	.00
22 JUL	17	Floral Ini	295	.50	11.0	28	1	33	109	13	4.5	.02	.01
16 AUG	42	75% Silkin	3458	2.12	24.2	93	209	98	127	38	1.1	.00	.10
24 AUG	50	Beg Gr Fil	4449	2.00	24.2	112	256	98	120	41	.9	.00	.12
26 SEP	83	Maturity	7254	.87	24.2	183	669	98	119	47	.6	.00	.41
8 OCT	95	Harvest	7254	.87	24.2	205	670	98	93	47	.6	.00	.56

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@	VARIABLE	PREDICTED	MEASURED
	FLOWERING DATE (dap)	42	-99
	PHYSIOL. MATURITY (dap)	83	-99
	GRAIN YIELD (kg/ha;dry)	3531	-99
	WT. PER GRAIN (g;dry)	.2981	-99
	GRAIN NUMBER (GRAIN/m2)	1185	-99
	GRAINS/EAR	296.1	-99
	MAXIMUM LAI (m2/m2)	2.23	-99
	BIOMASS (kg/ha) AT ANTHESIS	3458	-99
	BIOMASS N (kg N/ha) AT ANTHESIS	38	-99
	BIOMASS (kg/ha) AT HARVEST MAT.	7254	-99
	STALK (kg/ha) AT HARVEST MAT.	3723	-99
	HARVEST INDEX (kg/kg)	.487	-99
	FINAL LEAF NUMBER	24.16	-99
	GRAIN N (kg N/ha)	33	-99
	BIOMASS N (kg N/ha)	47	-99
	STALK N (kg N/ha)	14	-99
	SEED N (%)	.93	-99

*ENVIRONMENTAL AND STRESS FACTORS

--DEVELOPMENT PHASE--	-TIME- DURATION days	--WEATHER-- TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	-WATER- (STRESS) PHOTO SYNTH	GROWTH	-NITROGEN- (STRESS) PHOTO SYNTH	GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.071	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.044	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.089	.222
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.123	.308
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.385	.647

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 3531 kg/ha [DRY WEIGHT]

```
*RUN   2          :  N1S2
 MODEL            : GECER980 - MAIZE
 EXPERIMENT       : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  2     :  N1S2

 CROP             : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982    PLANTS/m2 :  5.0     ROW SPACING :  50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :       98 mm IN     3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :         0 kg/ha IN     0 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

*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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	-	kg/ha-->	43.3	6.9	4458

```
 SOIL ALBEDO     :  .13        EVAPORATION LIMIT :  9.60        MIN. FACTOR  : 1.00
 RUNOFF CURVE # :76.00         DRAINAGE RATE     :   .40        FERT. FACTOR : 1.00

 MAIZE       CULTIVAR :IB0071-hybrid corn 4212   ECOTYPE :□□□□□□-□□□□□□□□□□□□□□□□
 P1      : 185.00  P2      :  .4000  P5      : 775.00
 G2      : 836.00  G3      : 12.000  PHINT   : 38.900
```

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 2 N1S2

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	STRESS N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	20	.00	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	110	.23	8.0	16	1	0	98	4	3.8	.08	.00
22 JUL	17	Floral Ini	352	.61	11.0	28	1	33	109	16	4.5	.01	.01
16 AUG	42	75% Silkin	3653	2.34	24.2	93	209	98	127	39	1.1	.00	.11
24 AUG	50	Beg Gr Fil	4628	2.21	24.2	112	256	98	120	41	.9	.00	.13
26 SEP	83	Maturity	7487	.97	24.2	183	669	98	120	48	.6	.00	.42
8 OCT	95	Harvest	7487	.97	24.2	205	670	98	93	48	.6	.00	.57

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
FLOWERING DATE (dap)	42	-99
PHYSIOL. MATURITY (dap)	83	-99
GRAIN YIELD (kg/ha;dry)	3597	-99
WT. PER GRAIN (g;dry)	.3053	-99
GRAIN NUMBER (GRAIN/m2)	1178	-99
GRAINS/EAR	235.7	-99
MAXIMUM LAI (m2/m2)	2.46	-99
BIOMASS (kg/ha) AT ANTHESIS	3653	-99
BIOMASS N (kg N/ha) AT ANTHESIS	39	-99
BIOMASS (kg/ha) AT HARVEST MAT.	7487	-99
STALK (kg/ha) AT HARVEST MAT.	3889	-99
HARVEST INDEX (kg/kg)	.481	-99
FINAL LEAF NUMBER	24.16	-99
GRAIN N (kg N/ha)	33	-99
BIOMASS N (kg N/ha)	48	-99
STALK N (kg N/ha)	15	-99
SEED N (%)	.91	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.067	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.035	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.102	.255
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.137	.342
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.394	.658

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 3597 kg/ha [DRY WEIGHT]

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*RUN   3          :  N1S3
 MODEL            : GECER980 - MAIZE
 EXPERIMENT       : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  3     :  N1S3

 CROP             : MAIZE            CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982      PLANTS/m2 :   6.0     ROW SPACING :  50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001       TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :        98 mm IN     3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :        0 kg/ha IN     0 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;        0 kg/ha IN     0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A     .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A     .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

*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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	- kg/ha-->		43.3	6.9	4458

```
SOIL ALBEDO     :  .13          EVAPORATION LIMIT :  9.60        MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00           DRAINAGE RATE     :   .40        FERT. FACTOR : 1.00

MAIZE        CULTIVAR :IB0071-hybrid corn 4212    ECOTYPE :□□□□□□-□□□□□□□□□□□□□□□□
P1       : 185.00  P2        :  .4000  P5       : 775.00
G2       : 836.00  G3        : 12.000  PHINT    : 38.900
```

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 3 N1S3

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	STRESS N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	24	.01	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	129	.27	8.0	16	1	0	98	5	3.8	.08	.00
22 JUL	17	Floral Ini	402	.70	11.0	29	1	33	109	18	4.5	.01	.01
16 AUG	42	75% Silkin	3764	2.52	24.2	93	209	98	127	39	1.0	.00	.12
24 AUG	50	Beg Gr Fil	4726	2.38	24.2	113	256	98	120	42	.9	.00	.14
26 SEP	83	Maturity	7587	1.04	24.2	183	669	98	120	48	.6	.00	.42
8 OCT	95	Harvest	7587	1.04	24.2	205	670	98	93	48	.6	.00	.57

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@	VARIABLE	PREDICTED	MEASURED
	FLOWERING DATE (dap)	42	-99
	PHYSIOL. MATURITY (dap)	83	-99
	GRAIN YIELD (kg/ha;dry)	3606	-99
	WT. PER GRAIN (g;dry)	.3020	-99
	GRAIN NUMBER (GRAIN/m2)	1194	-99
	GRAINS/EAR	199.0	-99
	MAXIMUM LAI (m2/m2)	2.65	-99
	BIOMASS (kg/ha) AT ANTHESIS	3764	-99
	BIOMASS N (kg N/ha) AT ANTHESIS	39	-99
	BIOMASS (kg/ha) AT HARVEST MAT.	7587	-99
	STALK (kg/ha) AT HARVEST MAT.	3981	-99
	HARVEST INDEX (kg/kg)	.475	-99
	FINAL LEAF NUMBER	24.16	-99
	GRAIN N (kg N/ha)	33	-99
	BIOMASS N (kg N/ha)	48	-99
	STALK N (kg N/ha)	16	-99
	SEED N (%)	.90	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.064	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.027	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.112	.281
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.146	.360
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.396	.661

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 3606 kg/ha [DRY WEIGHT]

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 4 N2S1

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	STRESS N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	16	.00	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	89	.19	8.0	16	1	0	98	3	3.8	.09	.00
22 JUL	17	Floral Ini	295	.50	11.0	28	1	33	109	13	4.5	.02	.01
16 AUG	42	75% Silkin	3633	2.15	24.2	93	209	98	127	81	2.2	.00	.06
24 AUG	50	Beg Gr Fil	4707	2.03	24.2	112	256	98	120	81	1.7	.00	.02
26 SEP	83	Maturity	8876	.89	24.2	183	669	98	119	95	1.1	.00	.11
8 OCT	95	Harvest	8876	.89	24.2	205	670	98	93	95	1.1	.00	.37

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
FLOWERING DATE (dap)	42	-99
PHYSIOL. MATURITY (dap)	83	-99
GRAIN YIELD (kg/ha;dry)	4952	-99
WT. PER GRAIN (g;dry)	.3161	-99
GRAIN NUMBER (GRAIN/m2)	1567	-99
GRAINS/EAR	391.6	-99
MAXIMUM LAI (m2/m2)	2.26	-99
BIOMASS (kg/ha) AT ANTHESIS	3633	-99
BIOMASS N (kg N/ha) AT ANTHESIS	81	-99
BIOMASS (kg/ha) AT HARVEST MAT.	8876	-99
STALK (kg/ha) AT HARVEST MAT.	3924	-99
HARVEST INDEX (kg/kg)	.558	-99
FINAL LEAF NUMBER	24.16	-99
GRAIN N (kg N/ha)	78	-99
BIOMASS N (kg N/ha)	95	-99
STALK N (kg N/ha)	17	-99
SEED N (%)	1.57	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.071	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.044	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.060	.151
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.022	.054
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.086	.182

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 4952 kg/ha [DRY WEIGHT]

```
*RUN   5           :  N2S2
MODEL              : GECER980 - MAIZE
EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
TREATMENT  5       :  N2S2

CROP               : MAIZE          CULTIVAR : hybrid corn 4212 - ||||||||||||||||||||
STARTING DATE      : JUL  5 1982
PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  5.0     ROW SPACING :  50.cm
WEATHER            : WRDF   1982
SOIL               : WR00820001     TEXTURE : SALO  - SANDY LOAM
SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
IRRIGATION         :        98 mm IN     3 APPLICATIONS
NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER       :        50 kg/ha IN     1 APPLICATIONS
RESIDUE/MANURE     : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                     RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	-	kg/ha-->	43.3	6.9	4458

```
SOIL ALBEDO     :  .13       EVAPORATION LIMIT :  9.60      MIN. FACTOR  : 1.00
RUNOFF CURVE # :76.00        DRAINAGE RATE     :   .40      FERT. FACTOR : 1.00

MAIZE       CULTIVAR :IB0071-hybrid corn 4212   ECOTYPE :□□□□□□-□□□□□□□□□□□□□□□
P1      : 185.00  P2      :  .4000  P5      : 775.00
G2      : 836.00  G3      : 12.000  PHINT   : 38.900
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*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 5 N2S2

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	20	.00	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	110	.23	8.0	16	1	0	98	4	3.8	.08	.00
22 JUL	17	Floral Ini	352	.61	11.0	28	1	33	109	16	4.5	.01	.01
16 AUG	42	75% Silkin	3813	2.37	24.2	93	209	98	127	82	2.2	.00	.07
24 AUG	50	Beg Gr Fil	4889	2.24	24.2	112	256	98	120	82	1.7	.00	.02
26 SEP	83	Maturity	9116	.98	24.2	183	669	98	119	96	1.1	.00	.13
8 OCT	95	Harvest	9116	.98	24.2	205	670	98	93	96	1.1	.00	.39

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
FLOWERING DATE (dap)	42	-99
PHYSIOL. MATURITY (dap)	83	-99
GRAIN YIELD (kg/ha;dry)	5028	-99
WT. PER GRAIN (g;dry)	.3062	-99
GRAIN NUMBER (GRAIN/m2)	1642	-99
GRAINS/EAR	328.4	-99
MAXIMUM LAI (m2/m2)	2.49	-99
BIOMASS (kg/ha) AT ANTHESIS	3813	-99
BIOMASS N (kg N/ha) AT ANTHESIS	82	-99
BIOMASS (kg/ha) AT HARVEST MAT.	9116	-99
STALK (kg/ha) AT HARVEST MAT.	4088	-99
HARVEST INDEX (kg/kg)	.552	-99
FINAL LEAF NUMBER	24.16	-99
GRAIN N (kg N/ha)	78	-99
BIOMASS N (kg N/ha)	96	-99
STALK N (kg N/ha)	18	-99
SEED N (%)	1.56	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	WATER: PHOTO SYNTH	WATER: GROWTH	NITROGEN: PHOTO SYNTH	NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.067	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.035	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.070	.176
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.022	.054
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.099	.205

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 5028 kg/ha [DRY WEIGHT]

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*RUN    6           :  N2S3
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  6       :  N2S3

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :   6.0     ROW SPACING :   50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001      TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :        50 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2  = R330.00  DEW  = A    .00  WIND= A    .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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	-	kg/ha-->	43.3	6.9	4458

```
 SOIL ALBEDO     :  .13        EVAPORATION LIMIT :  9.60       MIN. FACTOR  : 1.00
 RUNOFF CURVE #  :76.00        DRAINAGE RATE     :   .40       FERT. FACTOR : 1.00

 MAIZE      CULTIVAR :IB0071-hybrid corn 4212   ECOTYPE :□□□□□□-□□□□□□□□□□□□□□□
 P1      : 185.00  P2      :  .4000  P5      : 775.00
 G2      : 836.00  G3      : 12.000  PHINT   : 38.900
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*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 6 N2S3

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	24	.01	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	129	.27	8.0	16	1	0	98	5	3.8	.08	.00
22 JUL	17	Floral Ini	402	.70	11.0	29	1	33	109	18	4.5	.01	.01
16 AUG	42	75% Silkin	3936	2.55	24.2	93	209	98	127	83	2.1	.00	.08
24 AUG	50	Beg Gr Fil	5011	2.41	24.2	113	256	98	120	83	1.7	.00	.02
26 SEP	83	Maturity	9267	1.05	24.2	183	669	98	119	96	1.0	.00	.14
8 OCT	95	Harvest	9267	1.05	24.2	205	670	98	93	96	1.0	.00	.41

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
FLOWERING DATE (dap)	42	-99
PHYSIOL. MATURITY (dap)	83	-99
GRAIN YIELD (kg/ha;dry)	5070	-99
WT. PER GRAIN (g;dry)	.2968	-99
GRAIN NUMBER (GRAIN/m2)	1708	-99
GRAINS/EAR	284.7	-99
MAXIMUM LAI (m2/m2)	2.68	-99
BIOMASS (kg/ha) AT ANTHESIS	3936	-99
BIOMASS N (kg N/ha) AT ANTHESIS	83	-99
BIOMASS (kg/ha) AT HARVEST MAT.	9267	-99
STALK (kg/ha) AT HARVEST MAT.	4197	-99
HARVEST INDEX (kg/kg)	.547	-99
FINAL LEAF NUMBER	24.16	-99
GRAIN N (kg N/ha)	78	-99
BIOMASS N (kg N/ha)	96	-99
STALK N (kg N/ha)	18	-99
SEED N (%)	1.54	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	TEMP MIN øC	SOLAR RAD MJ/m2	PHOTOP [day] hr	STRESS – WATER: PHOTO SYNTH	WATER: GROWTH	NITROGEN: PHOTO SYNTH	NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.064	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.027	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.079	.198
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.022	.054
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.109	.221

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 5070 kg/ha [DRY WEIGHT]

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*RUN  7            :  N3S1
 MODEL             : GECER980 - MAIZE
 EXPERIMENT        : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  7      :  N3S1

 CROP              : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□
 STARTING DATE     : JUL  5 1982
 PLANTING DATE     : JUL  5 1982    PLANTS/m2 :  4.0     ROW SPACING :  50.cm
 WEATHER           : WRDF   1982
 SOIL              : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION        :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER      :      100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE    : INITIAL :      0 kg/ha ;        0 kg/ha IN     0 APPLICATIONS
 ENVIRONM. OPT.    : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                     RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	- kg/ha-->		43.3	6.9	4458

```
 SOIL ALBEDO     :  .13        EVAPORATION LIMIT :  9.60        MIN. FACTOR  : 1.00
 RUNOFF CURVE # :76.00         DRAINAGE RATE     :   .40        FERT. FACTOR : 1.00

 MAIZE      CULTIVAR :IB0071-hybrid corn 4212   ECOTYPE :□□□□□□-□□□□□□□□□□□□□□□□□
 P1      : 185.00  P2      :  .4000  P5      : 775.00
 G2      : 836.00  G3      : 12.000  PHINT   : 38.900
```

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 7 N3S1

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	STRESS N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	16	.00	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	89	.19	8.0	16	1	0	98	3	3.8	.09	.00
22 JUL	17	Floral Ini	295	.50	11.0	28	1	33	109	13	4.5	.02	.01
16 AUG	42	75% Silkin	3643	2.15	24.2	93	209	98	127	82	2.2	.00	.06
24 AUG	50	Beg Gr Fil	4716	2.03	24.2	112	256	98	120	82	1.7	.00	.02
26 SEP	83	Maturity	9188	.89	24.2	183	669	98	119	117	1.3	.00	.00
8 OCT	95	Harvest	9188	.89	24.2	205	670	98	93	117	1.3	.00	.00

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@ VARIABLE	PREDICTED	MEASURED
FLOWERING DATE (dap)	42	-99
PHYSIOL. MATURITY (dap)	83	-99
GRAIN YIELD (kg/ha;dry)	5255	-99
WT. PER GRAIN (g;dry)	.3354	-99
GRAIN NUMBER (GRAIN/m2)	1567	-99
GRAINS/EAR	391.7	-99
MAXIMUM LAI (m2/m2)	2.26	-99
BIOMASS (kg/ha) AT ANTHESIS	3643	-99
BIOMASS N (kg N/ha) AT ANTHESIS	82	-99
BIOMASS (kg/ha) AT HARVEST MAT.	9188	-99
STALK (kg/ha) AT HARVEST MAT.	3933	-99
HARVEST INDEX (kg/kg)	.572	-99
FINAL LEAF NUMBER	24.16	-99
GRAIN N (kg N/ha)	92	-99
BIOMASS N (kg N/ha)	117	-99
STALK N (kg N/ha)	25	-99
SEED N (%)	1.74	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.071	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.044	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.057	.144
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.022	.054
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.000	.000

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 5255 kg/ha [DRY WEIGHT]

*RUN 8 : N3S2
MODEL : GECER980 - MAIZE
EXPERIMENT : MASE2002 MZ APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
TREATMENT 8 : N3S2

CROP : MAIZE CULTIVAR : hybrid corn 4212 - □□□□□□□□□□□□□□□
STARTING DATE : JUL 5 1982
PLANTING DATE : JUL 5 1982 PLANTS/m2 : 5.0 ROW SPACING : 50.cm
WEATHER : WRDF 1982
SOIL : WR00820001 TEXTURE : SALO - SANDY LOAM
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.3kg/ha NH4: 6.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 98 mm IN 3 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 100 kg/ha IN 1 APPLICATIONS
RESIDUE/MANURE : INITIAL : 0 kg/ha ; 0 kg/ha IN 0 APPLICATIONS
ENVIRONM. OPT. : DAYL= A .00 SRAD= A .00 TMAX= A .00 TMIN= A .00
RAIN= A .00 CO2 = R330.00 DEW = A .00 WIND= A .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

*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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	-	kg/ha-->	43.3	6.9	4458

SOIL ALBEDO : .13 EVAPORATION LIMIT : 9.60 MIN. FACTOR : 1.00
RUNOFF CURVE # :76.00 DRAINAGE RATE : .40 FERT. FACTOR : 1.00

MAIZE CULTIVAR :IB0071-hybrid corn 4212 ECOTYPE :□□□□□□-□□□□□□□□□□□□□□□
P1 : 185.00 P2 : .4000 P5 : 775.00
G2 : 836.00 G3 : 12.000 PHINT : 38.900

*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 8 N3S2

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	20	.00	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	110	.23	8.0	16	1	0	98	4	3.8	.08	.00
22 JUL	17	Floral Ini	352	.61	11.0	28	1	33	109	16	4.5	.01	.01
16 AUG	42	75% Silkin	3825	2.37	24.2	93	209	98	127	86	2.2	.00	.07
24 AUG	50	Beg Gr Fil	4902	2.24	24.2	112	256	98	120	86	1.8	.00	.02
26 SEP	83	Maturity	9513	.98	24.2	183	669	98	119	120	1.3	.00	.00
8 OCT	95	Harvest	9513	.98	24.2	205	670	98	93	120	1.3	.00	.02

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@	VARIABLE	PREDICTED	MEASURED
	FLOWERING DATE (dap)	42	-99
	PHYSIOL. MATURITY (dap)	83	-99
	GRAIN YIELD (kg/ha;dry)	5414	-99
	WT. PER GRAIN (g;dry)	.3297	-99
	GRAIN NUMBER (GRAIN/m2)	1642	-99
	GRAINS/EAR	328.4	-99
	MAXIMUM LAI (m2/m2)	2.50	-99
	BIOMASS (kg/ha) AT ANTHESIS	3825	-99
	BIOMASS N (kg N/ha) AT ANTHESIS	86	-99
	BIOMASS (kg/ha) AT HARVEST MAT.	9513	-99
	STALK (kg/ha) AT HARVEST MAT.	4099	-99
	HARVEST INDEX (kg/kg)	.569	-99
	FINAL LEAF NUMBER	24.16	-99
	GRAIN N (kg N/ha)	94	-99
	BIOMASS N (kg N/ha)	120	-99
	STALK N (kg N/ha)	26	-99
	SEED N (%)	1.74	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.067	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.035	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.067	.168
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.022	.054
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.001	.002

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 5414 kg/ha [DRY WEIGHT]

```
*RUN   9          :  N3S3
 MODEL            : GECER980 - MAIZE
 EXPERIMENT       : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  9     :  N3S3

 CROP             : MAIZE          CULTIVAR : hybrid corn 4212 - [illegible]
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982    PLANTS/m2 :   6.0     ROW SPACING :  50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :       100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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 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	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
5- 15	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
15- 30	.127	.250	.353	.123	.250	1.00	1.48	7.50	4.40	.50	.09
30- 45	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
45- 60	.152	.278	.371	.126	.278	.50	1.54	7.50	.50	.50	.01
60- 90	.144	.270	.369	.126	.270	.20	1.59	7.50	4.50	.50	.00
TOT- 90	12.7	23.9	32.8	11.3	23.9	<--cm	-	kg/ha-->	43.3	6.9	4458

```
 SOIL ALBEDO     :  .13         EVAPORATION LIMIT : 9.60        MIN. FACTOR  : 1.00
 RUNOFF CURVE # :76.00          DRAINAGE RATE     :  .40        FERT. FACTOR : 1.00

 MAIZE       CULTIVAR :IB0071-hybrid corn 4212    ECOTYPE :[illegible]
 P1       : 185.00  P2       :  .4000  P5       : 775.00
 G2       : 836.00  G3       : 12.000  PHINT    : 38.900
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*SIMULATED CROP AND SOIL STATUS AT MAIN DEVELOPMENT STAGES

RUN NO. 9 N3S3

DATE	CROP AGE	GROWTH STAGE	BIOMASS kg/ha	LAI	LEAF NUM.	ET mm	RAIN mm	IRRIG mm	SWATER mm	CROP kg/ha	N %	STRESS H2O	STRESS N
5 JUL	0	Sowing	0	.00	.0	3	1	0	111	0	.0	.00	.00
5 JUL	0	Start Sim	0	.00	.0	3	1	0	111	0	.0	.00	.00
6 JUL	1	Germinate	0	.00	.0	6	1	0	108	0	.0	.00	.00
9 JUL	4	Emergence	24	.01	2.4	11	1	0	103	1	4.4	.00	.00
17 JUL	12	End Juveni	129	.27	8.0	16	1	0	98	5	3.8	.08	.00
22 JUL	17	Floral Ini	402	.70	11.0	29	1	33	109	18	4.5	.01	.01
16 AUG	42	75% Silkin	3952	2.55	24.2	93	209	98	127	89	2.2	.00	.08
24 AUG	50	Beg Gr Fil	5027	2.41	24.2	113	256	98	120	89	1.8	.00	.02
26 SEP	83	Maturity	9736	1.05	24.2	183	669	98	119	122	1.3	.00	.01
8 OCT	95	Harvest	9736	1.05	24.2	205	670	98	93	122	1.3	.00	.04

*MAIN GROWTH AND DEVELOPMENT VARIABLES

@	VARIABLE	PREDICTED	MEASURED
	FLOWERING DATE (dap)	42	-99
	PHYSIOL. MATURITY (dap)	83	-99
	GRAIN YIELD (kg/ha;dry)	5525	-99
	WT. PER GRAIN (g;dry)	.3234	-99
	GRAIN NUMBER (GRAIN/m2)	1708	-99
	GRAINS/EAR	284.7	-99
	MAXIMUM LAI (m2/m2)	2.68	-99
	BIOMASS (kg/ha) AT ANTHESIS	3952	-99
	BIOMASS N (kg N/ha) AT ANTHESIS	89	-99
	BIOMASS (kg/ha) AT HARVEST MAT.	9736	-99
	STALK (kg/ha) AT HARVEST MAT.	4211	-99
	HARVEST INDEX (kg/kg)	.567	-99
	FINAL LEAF NUMBER	24.16	-99
	GRAIN N (kg N/ha)	96	-99
	BIOMASS N (kg N/ha)	122	-99
	STALK N (kg N/ha)	26	-99
	SEED N (%)	1.74	-99

*ENVIRONMENTAL AND STRESS FACTORS

DEVELOPMENT PHASE	TIME: DURATION days	WEATHER: TEMP MAX øC	WEATHER: TEMP MIN øC	WEATHER: SOLAR RAD MJ/m2	WEATHER: PHOTOP [day] hr	STRESS WATER: PHOTO SYNTH	STRESS WATER: GROWTH	STRESS NITROGEN: PHOTO SYNTH	STRESS NITROGEN: GROWTH
Emergence-End Juvenile	8	38.00	27.94	10.18	13.76	.000	.064	.002	.006
End Juvenil-Floral Init	5	35.50	27.40	10.10	13.66	.000	.027	.002	.005
Floral Init-End Lf Grow	25	32.90	26.04	9.84	13.36	.000	.000	.075	.188
End Lf Grth-Beg Grn Fil	8	32.81	24.56	9.49	12.95	.000	.000	.022	.054
Grain Filling Phase	31	29.92	22.90	8.71	12.38	.000	.000	.002	.005

(0.0 = Minimum Stress
1.0 = Maximum Stress)

MAIZE YIELD : 5525 kg/ha [DRY WEIGHT]

*GROWTH ASPECTS OUTPUT FILE

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*RUN  1             :  N1S1
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  1       :  N1S1

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 - □□□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :   4.0      ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :         0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :      0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR ! and ! DOY @DATE	Days after plant CDAY	Leaf Num L#SD	Grow Stage GSTD	LAI LAID	Dry Weight Leaf LWAD	Stem SWAD	Grain GWAD	Root RWAD	Crop CWAD	Grain per m2 G#AD	Kern. wght mg GWGD	HI HIAD
					³<----------		kg/Ha		---------->³			K
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000
82193	7	4.0	1	.04	14	8	0	10	22	0	.0	.000
82200	14	9.0	2	.28	140	8	0	30	148	0	.0	.000
82207	21	13.0	3	.93	612	37	0	69	650	0	.0	.000
82214	28	17.0	3	1.60	1192	338	0	115	1531	0	.0	.000
82221	35	21.0	3	2.05	1617	913	0	166	2530	0	.0	.000
82228	42	24.0	4	2.12	1775	1325	0	230	3458	0	.0	.000
82235	49	24.0	4	2.04	1578	1623	0	278	4302	0	.0	.000
82242	56	24.0	5	1.93	1567	1618	989	277	5275	1185	83.5	.187
82249	63	24.0	5	1.77	1556	1479	1955	268	6091	1185	165.0	.321
82256	70	24.0	5	1.53	1545	1133	2916	258	6695	1185	246.2	.436
82263	77	24.0	5	1.12	1534	1093	3373	250	7101	1185	284.7	.475
82269	83	24.0	7	.87	1530	1093	3531	246	7254	1185	298.1	.487
82270	84	24.0	7	.87	1530	1093	3531	246	7254	1185	298.1	.487
82277	91	24.0	7	.87	1530	1093	3531	246	7254	1185	298.1	.487
82281	95	24.0	7	.87	1530	1093	3531	246	7254	1185	298.1	.487

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*RUN    2             :  N1S2
MODEL                 : GECER980 - MAIZE
EXPERIMENT            : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
TREATMENT  2          :  N1S2

CROP                  : MAIZE          CULTIVAR : hybrid corn 4212 -
STARTING DATE         : JUL  5 1982
PLANTING DATE         : JUL  5 1982    PLANTS/m2 :  5.0      ROW SPACING :  50.cm
WEATHER               : WRDF   1982
SOIL                  : WR00820001     TEXTURE : SALO  - SANDY LOAM
SOIL INITIAL C        : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
WATER BALANCE         : IRRIGATE ON REPORTED DATE(S)
IRRIGATION            :        98 mm IN      3 APPLICATIONS
NITROGEN BAL.         : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER          :         0 kg/ha IN     0 APPLICATIONS
RESIDUE/MANURE        : INITIAL :       0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
ENVIRONM. OPT.        : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                        RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR ! and ! DOY @DATE	Days after plant CDAY	Leaf Num L#SD	Grow Stage GSTD	LAI LAID	Dry Weight Leaf ³<---------- LWAD	Stem SWAD	Grain kg/Ha GWAD	Root ---------- RWAD	Crop >³ CWAD	Grain per m2 G#AD	Kern. wght mg GWGD	HI HIAD
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000
82193	7	4.0	1	.05	18	10	0	12	28	0	.0	.000
82200	14	9.0	2	.35	169	10	0	36	179	0	.0	.000
82207	21	13.0	3	1.10	707	42	0	78	749	0	.0	.000
82214	28	17.0	3	1.82	1320	359	0	126	1679	0	.0	.000
82221	35	21.0	3	2.27	1745	948	0	177	2693	0	.0	.000
82228	42	24.0	4	2.34	1905	1381	0	225	3653	0	.0	.000
82235	49	24.0	4	2.25	1686	1679	0	273	4480	0	.0	.000
82242	56	24.0	5	2.14	1674	1673	991	274	5453	1178	84.1	.182
82249	63	24.0	5	1.95	1662	1543	1952	265	6272	1178	165.6	.311
82256	70	24.0	5	1.70	1651	1217	2908	256	6891	1178	246.8	.422
82263	77	24.0	5	1.24	1639	1140	3435	247	7329	1178	291.5	.469
82269	83	24.0	7	.97	1634	1140	3597	243	7487	1178	305.3	.481
82270	84	24.0	7	.97	1634	1140	3597	243	7487	1178	305.3	.481
82277	91	24.0	7	.97	1634	1140	3597	243	7487	1178	305.3	.481
82281	95	24.0	7	.97	1634	1140	3597	243	7487	1178	305.3	.481

```
*RUN   3          :  N1S3
 MODEL            : GECER980 - MAIZE
 EXPERIMENT       : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  3     :  N1S3

 CROP             : MAIZE          CULTIVAR : hybrid corn 4212 - □□□□□□□□□□□□□□
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982    PLANTS/m2 :   6.0      ROW SPACING :   50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :        0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR ! and ! DOY @DATE	Days after plant CDAY	Leaf Num L#SD	Grow Stage GSTD	LAI LAID	Dry Weight Leaf ³<--------- LWAD	Stem SWAD	Grain kg/Ha GWAD	Root RWAD	Crop --------->³ CWAD	Grain per m2 G#AD	Kern. wght mg GWGD	HI HIAD K
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000
82193	7	4.0	1	.06	21	12	0	14	33	0	.0	.000
82200	14	9.0	2	.41	197	12	0	43	209	0	.0	.000
82207	21	13.0	3	1.23	783	47	0	88	829	0	.0	.000
82214	28	17.0	3	1.99	1417	372	0	138	1788	0	.0	.000
82221	35	21.0	3	2.46	1839	969	0	189	2808	0	.0	.000
82228	42	24.0	4	2.52	1992	1400	0	236	3764	0	.0	.000
82235	49	24.0	4	2.42	1757	1700	0	284	4578	0	.0	.000
82242	56	24.0	5	2.30	1745	1682	1007	283	5555	1194	84.4	.181
82249	63	24.0	5	2.10	1733	1541	1981	273	6376	1194	165.9	.311
82256	70	24.0	5	1.82	1721	1209	2951	264	7001	1194	247.1	.421
82263	77	24.0	5	1.33	1709	1157	3436	255	7422	1194	287.7	.463
82269	83	24.0	7	1.04	1704	1157	3606	251	7587	1194	302.0	.475
82270	84	24.0	7	1.04	1704	1157	3606	251	7587	1194	302.0	.475
82277	91	24.0	7	1.04	1704	1157	3606	251	7587	1194	302.0	.475
82281	95	24.0	7	1.04	1704	1157	3606	251	7587	1194	302.0	.475

```
*RUN    4           :   N2S1
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  4       :   N2S1

 CROP               : MAIZE           CULTIVAR : hybrid corn 4212 -  □□□ □□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982     PLANTS/m2 :   4.0      ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001      TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :         98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :         50 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A     .00  SRAD= A     .00  TMAX= A     .00  TMIN= A     .00
                      RAIN= A    .00   CO2 = R330.00   DEW = A     .00  WIND= A     .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
```

!YR	Days	Leaf	Grow			Dry Weight				Grain	Kern.	
! and	after	Num	Stage	LAI	Leaf	Stem	Grain	Root	Crop	per	wght	HI
! DOY	plant				³<---------		kg/Ha		--------->³	m2	mg	K
@DATE	CDAY	L#SD	GSTD	LAID	LWAD	SWAD	GWAD	RWAD	CWAD	G#AD	GWGD	HIAD
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000
82193	7	4.0	1	.04	14	8	0	10	22	0	.0	.000
82200	14	9.0	2	.28	140	8	0	30	148	0	.0	.000
82207	21	13.0	3	.93	612	37	0	69	650	0	.0	.000
82214	28	17.0	3	1.60	1192	338	0	115	1531	0	.0	.000
82221	35	21.0	3	2.05	1617	913	0	166	2530	0	.0	.000
82228	42	24.0	4	2.15	1809	1431	0	221	3633	0	.0	.000
82235	49	24.0	4	2.07	1608	1749	0	273	4545	0	.0	.000
82242	56	24.0	5	1.96	1597	1642	1265	264	5692	1567	80.8	.222
82249	63	24.0	5	1.79	1586	1508	2543	255	6825	1567	162.3	.373
82256	70	24.0	5	1.56	1575	1287	3814	246	7864	1567	243.5	.485
82263	77	24.0	5	1.14	1564	1178	4715	238	8644	1567	301.0	.545
82269	83	24.0	7	.89	1559	1178	4952	234	8876	1567	316.1	.558
82270	84	24.0	7	.89	1559	1178	4952	234	8876	1567	316.1	.558
82277	91	24.0	7	.89	1559	1178	4952	234	8876	1567	316.1	.558
82281	95	24.0	7	.89	1559	1178	4952	234	8876	1567	316.1	.558

```
*RUN   5           :  N2S2
 MODEL             : GECER980 - MAIZE
 EXPERIMENT        : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  5      :  N2S2

 CROP              : MAIZE          CULTIVAR : hybrid corn 4212 - ￭￭￭￭￭￭￭￭￭￭￭￭￭￭￭
 STARTING DATE     : JUL  5 1982
 PLANTING DATE     : JUL  5 1982    PLANTS/m2 :  5.0     ROW SPACING :  50.cm
 WEATHER           : WRDF   1982
 SOIL              : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION        :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER      :       50 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE    : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.    : DAYL= A     .00  SRAD= A     .00  TMAX= A     .00  TMIN= A     .00
                     RAIN= A     .00  CO2 = R330.00   DEW = A     .00  WIND= A     .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
```

!YR	Days	Leaf	Grow				Dry Weight			Grain	Kern.		
! and	after	Num	Stage	LAI	Leaf	Stem	Grain	Root	Crop	per	wght	HI	
! DOY	plant				³<---------		kg/Ha		--------->³	m2	mg		K
@DATE	CDAY	L#SD	GSTD	LAID	LWAD	SWAD	GWAD	RWAD	CWAD	G#AD	GWGD	HIAD	
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000	
82193	7	4.0	1	.05	18	10	0	12	28	0	.0	.000	
82200	14	9.0	2	.35	169	10	0	36	179	0	.0	.000	
82207	21	13.0	3	1.10	707	42	0	78	749	0	.0	.000	
82214	28	17.0	3	1.82	1320	359	0	126	1679	0	.0	.000	
82221	35	21.0	3	2.27	1745	948	0	177	2693	0	.0	.000	
82228	42	24.0	4	2.37	1933	1476	0	234	3813	0	.0	.000	
82235	49	24.0	4	2.28	1712	1800	0	286	4725	0	.0	.000	
82242	56	24.0	5	2.16	1700	1655	1326	276	5895	1642	80.8	.225	
82249	63	24.0	5	1.98	1688	1486	2665	267	7053	1642	162.3	.378	
82256	70	24.0	5	1.72	1676	1228	3998	258	8115	1642	243.5	.493	
82263	77	24.0	5	1.25	1665	1215	4790	249	8882	1642	291.7	.539	
82269	83	24.0	7	.98	1660	1215	5028	245	9116	1642	306.2	.552	
82270	84	24.0	7	.98	1660	1215	5028	245	9116	1642	306.2	.552	
82277	91	24.0	7	.98	1660	1215	5028	245	9116	1642	306.2	.552	
82281	95	24.0	7	.98	1660	1215	5028	245	9116	1642	306.2	.552	

```
*RUN    6           :  N2S3
MODEL               : GECER980 - MAIZE
EXPERIMENT          : MASE2002 MZ     APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
TREATMENT   6       :  N2S3

CROP                : MAIZE           CULTIVAR : hybrid corn 4212 -
STARTING DATE       : JUL  5 1982
PLANTING DATE       : JUL  5 1982     PLANTS/m2 :   6.0      ROW SPACING :  50.cm
WEATHER             : WRDF   1982
SOIL                : WR00820001      TEXTURE : SALO   - SANDY LOAM
SOIL INITIAL C      : DEPTH: 90cm EXTR. H20:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
WATER BALANCE       : IRRIGATE ON REPORTED DATE(S)
IRRIGATION          :        98 mm IN      3 APPLICATIONS
NITROGEN BAL.       : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER        :        50 kg/ha IN      1 APPLICATIONS
RESIDUE/MANURE      : INITIAL :       0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
ENVIRONM. OPT.      : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Leaf	Grow		Dry Weight					Grain	Kern.		
! and	after	Num	Stage	LAI	Leaf	Stem	Grain	Root	Crop	per	wght	HI	
! DOY	plant				<----------	kg/Ha		---------->		m2	mg		K
@DATE	CDAY	L#SD	GSTD	LAID	LWAD	SWAD	GWAD	RWAD	CWAD	G#AD	GWGD	HIAD	
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000	
82193	7	4.0	1	.06	21	12	0	14	33	0	.0	.000	
82200	14	9.0	2	.41	197	12	0	43	209	0	.0	.000	
82207	21	13.0	3	1.23	783	47	0	88	829	0	.0	.000	
82214	28	17.0	3	1.99	1417	372	0	138	1788	0	.0	.000	
82221	35	21.0	3	2.46	1839	969	0	189	2808	0	.0	.000	
82228	42	24.0	4	2.55	2023	1503	0	245	3936	0	.0	.000	
82235	49	24.0	4	2.45	1784	1831	0	298	4845	0	.0	.000	
82242	56	24.0	5	2.32	1772	1649	1379	288	6030	1708	80.8	.229	
82249	63	24.0	5	2.13	1760	1443	2773	278	7204	1708	162.3	.385	
82256	70	24.0	5	1.85	1747	1238	4037	268	8251	1708	236.3	.489	
82263	77	24.0	5	1.35	1735	1238	4830	259	9032	1708	282.8	.535	
82269	83	24.0	7	1.05	1730	1238	5070	255	9267	1708	296.8	.547	
82270	84	24.0	7	1.05	1730	1238	5070	255	9267	1708	296.8	.547	
82277	91	24.0	7	1.05	1730	1238	5070	255	9267	1708	296.8	.547	
82281	95	24.0	7	1.05	1730	1238	5070	255	9267	1708	296.8	.547	

```
*RUN   7            :  N3S1
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  7       :  N3S1

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982     PLANTS/m2 :   4.0      ROW SPACING :   50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001      TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :          98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :        100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A     .00  SRAD= A     .00  TMAX= A     .00  TMIN= A     .00
                      RAIN= A     .00  CO2 = R330.00  DEW = A     .00  WIND= A     .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
```

!YR ! and ! DOY @DATE	Days after plant CDAY	Leaf Num L#SD	Grow Stage GSTD	LAI LAID	Dry Weight Leaf LWAD	Stem SWAD	Grain GWAD	Root RWAD	Crop CWAD	Grain per m2 G#AD	Kern. wght mg GWGD	HI HIAD
					³<---------	kg/Ha			--------->³			K
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000
82193	7	4.0	1	.04	14	8	0	10	22	0	.0	.000
82200	14	9.0	2	.28	140	8	0	30	148	0	.0	.000
82207	21	13.0	3	.93	612	37	0	69	650	0	.0	.000
82214	28	17.0	3	1.60	1192	338	0	115	1531	0	.0	.000
82221	35	21.0	3	2.05	1617	913	0	166	2530	0	.0	.000
82228	42	24.0	4	2.15	1811	1437	0	222	3643	0	.0	.000
82235	49	24.0	4	2.07	1610	1755	0	274	4555	0	.0	.000
82242	56	24.0	5	1.96	1599	1648	1265	264	5702	1567	80.8	.222
82249	63	24.0	5	1.79	1588	1514	2543	255	6835	1567	162.3	.372
82256	70	24.0	5	1.56	1577	1320	3815	247	7901	1567	243.5	.483
82263	77	24.0	5	1.14	1566	1183	4902	238	8840	1567	312.9	.555
82269	83	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572
82270	84	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572
82277	91	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572
82281	95	24.0	7	.89	1561	1183	5255	234	9188	1567	335.4	.572

*RUN 8	:	N3S2
MODEL	:	GECER980 - MAIZE
EXPERIMENT	:	MASE2002 MZ APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
TREATMENT 8	:	N3S2
CROP	:	MAIZE CULTIVAR : hybrid corn 4212 - [illegible]
STARTING DATE	:	JUL 5 1982
PLANTING DATE	:	JUL 5 1982 PLANTS/m2 : 5.0 ROW SPACING : 50.cm
WEATHER	:	WRDF 1982
SOIL	:	WR00820001 TEXTURE : SALO - SANDY LOAM
SOIL INITIAL C	:	DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.3kg/ha NH4: 6.9kg/ha
WATER BALANCE	:	IRRIGATE ON REPORTED DATE(S)
IRRIGATION	:	98 mm IN 3 APPLICATIONS
NITROGEN BAL.	:	SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER	:	100 kg/ha IN 1 APPLICATIONS
RESIDUE/MANURE	:	INITIAL : 0 kg/ha ; 0 kg/ha IN 0 APPLICATIONS
ENVIRONM. OPT.	:	DAYL= A .00 SRAD= A .00 TMAX= A .00 TMIN= A .00
		RAIN= A .00 CO2 = R330.00 DEW = A .00 WIND= A .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

!YR	Days	Leaf	Grow				Dry Weight			Grain	Kern.		
! and	after	Num	Stage	LAI	Leaf	Stem	Grain	Root	Crop	per	wght	HI	
! DOY	plant				<---------		kg/Ha		--------->	m2	mg		K
@DATE	CDAY	L#SD	GSTD	LAID	LWAD	SWAD	GWAD	RWAD	CWAD	G#AD	GWGD	HIAD	
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000	
82193	7	4.0	1	.05	18	10	0	12	28	0	.0	.000	
82200	14	9.0	2	.35	169	10	0	36	179	0	.0	.000	
82207	21	13.0	3	1.10	707	42	0	78	749	0	.0	.000	
82214	28	17.0	3	1.82	1320	359	0	126	1679	0	.0	.000	
82221	35	21.0	3	2.27	1745	948	0	177	2693	0	.0	.000	
82228	42	24.0	4	2.37	1936	1484	0	234	3825	0	.0	.000	
82235	49	24.0	4	2.28	1715	1808	0	287	4738	0	.0	.000	
82242	56	24.0	5	2.16	1703	1664	1326	277	5908	1642	80.8	.224	
82249	63	24.0	5	1.98	1691	1494	2666	268	7066	1642	162.3	.377	
82256	70	24.0	5	1.72	1679	1285	3999	258	8178	1642	243.5	.489	
82263	77	24.0	5	1.25	1667	1222	5046	249	9150	1642	307.3	.551	
82269	83	24.0	7	.98	1662	1222	5414	246	9513	1642	329.7	.569	
82270	84	24.0	7	.98	1662	1222	5414	246	9513	1642	329.7	.569	
82277	91	24.0	7	.98	1662	1222	5414	246	9513	1642	329.7	.569	
82281	95	24.0	7	.98	1662	1222	5414	246	9513	1642	329.7	.569	

```
*RUN   9            :  N3S3
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  9       :  N3S3

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 - 
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :   6.0     ROW SPACING :   50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :      100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :      0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR ! and ! DOY @DATE	Days after plant CDAY	Leaf Num L#SD	Grow Stage GSTD	LAI LAID	Dry Weight Leaf LWAD	Stem SWAD	Grain GWAD	Root RWAD	Crop CWAD	Grain per m2 G#AD	Kern. wght mg GWGD	HI HIAD	K
					³<----------	kg/Ha		---------->³					
82186	0	.0	0	.00	0	0	0	0	0	0	.0	.000	
82193	7	4.0	1	.06	21	12	0	14	33	0	.0	.000	
82200	14	9.0	2	.41	197	12	0	43	209	0	.0	.000	
82207	21	13.0	3	1.23	783	47	0	88	829	0	.0	.000	
82214	28	17.0	3	1.99	1417	372	0	138	1788	0	.0	.000	
82221	35	21.0	3	2.46	1839	969	0	189	2808	0	.0	.000	
82228	42	24.0	4	2.55	2026	1513	0	246	3952	0	.0	.000	
82235	49	24.0	4	2.46	1788	1841	0	299	4861	0	.0	.000	
82242	56	24.0	5	2.33	1775	1659	1380	289	6046	1708	80.8	.228	
82249	63	24.0	5	2.13	1763	1453	2773	279	7221	1708	162.3	.384	
82256	70	24.0	5	1.85	1751	1246	4118	269	8346	1708	241.0	.493	
82263	77	24.0	5	1.35	1738	1246	5147	260	9363	1708	301.3	.550	
82269	83	24.0	7	1.05	1733	1246	5525	256	9736	1708	323.4	.567	
82270	84	24.0	7	1.05	1733	1246	5525	256	9736	1708	323.4	.567	
82277	91	24.0	7	1.05	1733	1246	5525	256	9736	1708	323.4	.567	
82281	95	24.0	7	1.05	1733	1246	5525	256	9736	1708	323.4	.567	

*WATER BALANCE OUTPUT FILE

```
*RUN  1            :  N1S1
 MODEL             : GECER980 - MAIZE
 EXPERIMENT        : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  1      :  N1S1

 CROP              : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE     : JUL  5 1982
 PLANTING DATE     : JUL  5 1982    PLANTS/m2 :  4.0      ROW SPACING :  50.cm
 WEATHER           : WRDF   1982
 SOIL              : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION        :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER      :         0 kg/ha IN     0 APPLICATIONS
 RESIDUE/MANURE    : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.    : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                     RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Daily	Evapotran.		PESW	Cumulative				Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	<----	mm	---->	mm	<-------	---mm---	-------	---->	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.02	1.38	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.34	.97	3.35	127.6	.0	.0	1	33	10.1	37.5	28.0
82207	21	.65	2.82	2.82	110.0	.0	23.0	1	58	10.0	34.9	27.1
82214	28	1.26	2.80	2.80	109.1	.0	44.3	1	98	10.0	35.4	26.6
82221	35	1.45	2.56	2.56	107.9	41.9	81.4	97	98	9.8	32.2	25.9
82228	42	1.45	2.37	2.37	126.9	66.3	133.4	209	98	9.6	29.7	24.6
82235	49	1.46	2.42	2.42	129.1	68.6	158.6	256	98	9.5	32.8	24.6
82242	56	1.39	2.36	2.36	108.6	68.6	169.0	262	98	9.2	32.4	25.6
82249	63	1.27	2.23	2.23	146.0	85.8	188.0	351	98	9.0	30.1	23.6
82256	70	1.08	2.01	2.01	155.5	214.8	310.5	626	98	8.6	26.0	21.1
82263	77	.98	2.06	2.06	126.6	215.0	348.1	650	98	8.3	30.2	21.8
82269	83	.81	2.06	2.06	119.4	215.6	361.3	669	98	8.1	31.7	21.8
82270	84	.74	1.96	1.96	117.5	215.6	362.7	670	98	7.9	30.0	20.0
82277	91	.76	2.00	2.00	99.5	215.6	366.6	670	98	7.9	31.8	19.8
82281	95	1.09	1.54	1.92	93.4	215.6	366.6	670	98	7.6	31.9	18.6

```
*RUN    2          :  N1S2
 MODEL             : GECER980 - MAIZE
 EXPERIMENT        : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  2      :  N1S2

 CROP              : MAIZE          CULTIVAR : hybrid corn 4212 - □□□□□□□□□□□□□□□□□
 STARTING DATE     : JUL  5 1982
 PLANTING DATE     : JUL  5 1982    PLANTS/m2 :   5.0      ROW SPACING :   50.cm
 WEATHER           : WRDF   1982
 SOIL              : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION        :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER      :        0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE    : INITIAL :      0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.    : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                     RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Daily	Evapotran.		PESW		Cumulative			Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<---------	mm	---------	->³	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.02	1.39	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.41	1.03	3.34	127.2	.0	.0	1	33	10.1	37.5	28.0
82207	21	.76	2.80	2.80	110.1	.0	22.5	1	58	10.0	34.9	27.1
82214	28	1.41	2.78	2.78	109.1	.0	44.0	1	98	10.0	35.4	26.6
82221	35	1.54	2.55	2.55	108.0	42.1	80.9	97	98	9.8	32.2	25.9
82228	42	1.53	2.36	2.36	127.0	66.7	132.9	209	98	9.6	29.7	24.6
82235	49	1.54	2.41	2.41	129.2	69.1	158.0	256	98	9.5	32.8	24.6
82242	56	1.46	2.35	2.35	108.6	69.1	168.6	262	98	9.2	32.4	25.6
82249	63	1.34	2.22	2.22	146.1	86.3	187.5	351	98	9.0	30.1	23.6
82256	70	1.14	2.00	2.00	155.5	215.5	310.0	626	98	8.6	26.0	21.1
82263	77	1.03	2.05	2.05	126.7	215.7	347.5	650	98	8.3	30.2	21.8
82269	83	.86	2.05	2.05	119.6	216.2	360.7	669	98	8.1	31.7	21.8
82270	84	.81	1.95	1.95	117.6	216.2	362.1	670	98	7.9	30.0	20.0
82277	91	.85	1.99	1.99	99.8	216.2	366.0	670	98	7.9	31.8	19.8
82281	95	1.05	1.68	1.91	93.0	216.2	366.0	670	98	7.6	31.9	18.6

```
*RUN  3          :  N1S3
 MODEL           : GECER980 - MAIZE
 EXPERIMENT      : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  3    :  N1S3

 CROP            : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□
 STARTING DATE   : JUL  5 1982
 PLANTING DATE   : JUL  5 1982    PLANTS/m2 :  6.0      ROW SPACING :  50.cm
 WEATHER         : WRDF   1982
 SOIL            : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C  : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE   : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION      :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.   : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER    :        0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE  : INITIAL :     0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.  : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                   RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Daily	Evapotran.		PESW		Cumulative			Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<--------	mm	--------	-->³	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.03	1.39	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.48	1.08	3.33	126.8	.0	.0	1	33	10.1	37.5	28.0
82207	21	.84	2.79	2.79	110.3	.0	21.9	1	58	10.0	34.9	27.1
82214	28	1.45	2.77	2.77	109.3	.0	43.6	1	98	10.0	35.4	26.6
82221	35	1.60	2.54	2.54	108.2	42.3	80.3	97	98	9.8	32.2	25.9
82228	42	1.58	2.35	2.35	127.0	67.0	132.4	209	98	9.6	29.7	24.6
82235	49	1.59	2.41	2.41	129.2	69.4	157.5	256	98	9.5	32.8	24.6
82242	56	1.51	2.34	2.34	108.7	69.4	168.1	262	98	9.2	32.4	25.6
82249	63	1.39	2.21	2.21	146.1	86.7	187.1	351	98	9.0	30.1	23.6
82256	70	1.18	2.00	2.00	155.5	215.9	309.5	626	98	8.6	26.0	21.1
82263	77	1.07	2.04	2.04	126.7	216.2	347.1	650	98	8.3	30.2	21.8
82269	83	.86	2.05	2.05	119.6	216.7	360.2	669	98	8.1	31.7	21.8
82270	84	.78	1.95	1.95	117.7	216.7	361.7	670	98	7.9	30.0	20.0
82277	91	.83	1.99	1.99	99.8	216.7	365.6	670	98	7.9	31.8	19.8
82281	95	1.11	1.70	1.91	93.0	216.7	365.6	670	98	7.6	31.9	18.6

```
*RUN   4            :  N2S1
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  4       :  N2S1

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  4.0     ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :        50 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;        0 kg/ha IN     0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Daily	Evapotran.		PESW	Cumulative				Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<--------	--mm--	--------	-->³	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.02	1.38	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.34	.97	3.35	127.6	.0	.0	1	33	10.1	37.5	28.0
82207	21	.65	2.82	2.82	110.0	.0	23.0	1	58	10.0	34.9	27.1
82214	28	1.26	2.80	2.80	109.1	.0	44.3	1	98	10.0	35.4	26.6
82221	35	1.45	2.56	2.56	107.9	41.9	81.4	97	98	9.8	32.2	25.9
82228	42	1.46	2.37	2.37	127.0	66.3	133.4	209	98	9.6	29.7	24.6
82235	49	1.48	2.42	2.42	128.9	68.5	158.9	256	98	9.5	32.8	24.6
82242	56	1.40	2.35	2.35	108.1	68.5	169.6	262	98	9.2	32.4	25.6
82249	63	1.28	2.23	2.23	145.9	85.3	188.7	351	98	9.0	30.1	23.6
82256	70	1.08	2.01	2.01	155.5	214.1	311.2	626	98	8.6	26.0	21.1
82263	77	.98	2.06	2.06	126.3	214.3	349.1	650	98	8.3	30.2	21.8
82269	83	.82	2.06	2.06	119.1	214.9	362.4	669	98	8.1	31.7	21.8
82270	84	.75	1.96	1.96	117.1	214.9	363.8	670	98	7.9	30.0	20.0
82277	91	.82	1.99	2.00	99.2	214.9	367.8	670	98	7.9	31.8	19.8
82281	95	1.07	1.52	1.92	93.1	214.9	367.8	670	98	7.6	31.9	18.6

```
*RUN   5          :  N2S2
 MODEL            : GECER980 - MAIZE
 EXPERIMENT       : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  5     :  N2S2

 CROP             : MAIZE          CULTIVAR : hybrid corn 4212 -  ||||||||||||||||||
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982    PLANTS/m2 :  5.0      ROW SPACING :  50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :       50 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Daily	Evapotran.		PESW	Cumulative				Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Precip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<--------	--mm--	--------	-->³	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.02	1.39	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.41	1.03	3.34	127.2	.0	.0	1	33	10.1	37.5	28.0
82207	21	.76	2.80	2.80	110.1	.0	22.5	1	58	10.0	34.9	27.1
82214	28	1.41	2.78	2.78	109.1	.0	44.0	1	98	10.0	35.4	26.6
82221	35	1.54	2.55	2.55	108.0	42.1	80.9	97	98	9.8	32.2	25.9
82228	42	1.53	2.36	2.36	127.0	66.6	132.9	209	98	9.6	29.7	24.6
82235	49	1.55	2.41	2.41	129.0	68.9	158.4	256	98	9.5	32.8	24.6
82242	56	1.47	2.35	2.35	108.3	68.9	169.1	262	98	9.2	32.4	25.6
82249	63	1.35	2.22	2.22	145.9	85.8	188.1	351	98	9.0	30.1	23.6
82256	70	1.14	2.00	2.00	155.5	214.8	310.7	626	98	8.6	26.0	21.1
82263	77	1.04	2.05	2.05	126.4	215.0	348.5	650	98	8.3	30.2	21.8
82269	83	.87	2.05	2.05	119.2	215.5	361.8	669	98	8.1	31.7	21.8
82270	84	.82	1.95	1.95	117.2	215.5	363.3	670	98	7.9	30.0	20.0
82277	91	.85	1.99	1.99	99.4	215.5	367.2	670	98	7.9	31.8	19.8
82281	95	1.09	1.61	1.91	92.9	215.5	367.2	670	98	7.6	31.9	18.6

```
*RUN   6            :  N2S3
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  6       :  N2S3

 CROP               : MAIZE          ; CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982     :
 PLANTING DATE      : JUL  5 1982      PLANTS/m2 :   6.0      ROW SPACING :   50.cm
 WEATHER            : WRDF    1982
 SOIL               : WR00820001       TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :         98 mm IN     3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :         50 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;         0 kg/ha IN       0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A     .00  SRAD= A     .00  TMAX= A     .00  TMIN= A     .00
                      RAIN= A     .00  CO2 = R330.00   DEW = A     .00  WIND= A     .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
```

!YR ! and ! DOY @DATE	Days after Plant CDAY	Daily Plant ³<---- EPAA	Evapotran. Total mm ETAA	 Pot. ---->³ EOAA	PESW mm SWXD	Cumulative RunOff ³<------- ROFC	 Drain --mm-- DRNC	 Prcip ------- PREC	 Irr --->³ IRRC	Ave Sol MJ/m2 SRAA	Temp. Max C TMXA	Temp Min C TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.03	1.39	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.48	1.08	3.33	126.8	.0	.0	1	33	10.1	37.5	28.0
82207	21	.84	2.79	2.79	110.3	.0	21.9	1	58	10.0	34.9	27.1
82214	28	1.45	2.77	2.77	109.3	.0	43.6	1	98	10.0	35.4	26.6
82221	35	1.60	2.54	2.54	108.2	42.3	80.3	97	98	9.8	32.2	25.9
82228	42	1.59	2.35	2.35	127.0	66.9	132.5	209	98	9.6	29.7	24.6
82235	49	1.60	2.41	2.41	129.0	69.2	157.9	256	98	9.5	32.8	24.6
82242	56	1.52	2.34	2.34	108.3	69.2	168.6	262	98	9.2	32.4	25.6
82249	63	1.40	2.21	2.21	146.0	86.2	187.7	351	98	9.0	30.1	23.6
82256	70	1.19	2.00	2.00	155.5	215.3	310.2	626	98	8.6	26.0	21.1
82263	77	1.08	2.04	2.04	126.5	215.5	348.0	650	98	8.3	30.2	21.8
82269	83	.87	2.05	2.05	119.3	216.0	361.3	669	98	8.1	31.7	21.8
82270	84	.78	1.95	1.95	117.3	216.0	362.8	670	98	7.9	30.0	20.0
82277	91	.83	1.98	1.98	99.4	216.0	366.8	670	98	7.9	31.8	19.8
82281	95	1.11	1.60	1.90	93.0	216.0	366.8	670	98	7.6	31.9	18.6

```
*RUN 7            :  N3S1
 MODEL            :  GECER980 - MAIZE
 EXPERIMENT       :  MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  7     :  N3S1

 CROP             : MAIZE           CULTIVAR : hybrid corn 4212 -
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982     PLANTS/m2 :  4.0      ROW SPACING :  50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001      TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H20:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :       98 mm IN     3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :      100 kg/ha IN     1 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Daily	Evapotran.		PESW		Cumulative			Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<--------	mm	---------	>³	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.02	1.38	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.34	.97	3.35	127.6	.0	.0	1	33	10.1	37.5	28.0
82207	21	.65	2.82	2.82	110.0	.0	23.0	1	58	10.0	34.9	27.1
82214	28	1.26	2.80	2.80	109.1	.0	44.3	1	98	10.0	35.4	26.6
82221	35	1.45	2.56	2.56	107.9	41.9	81.4	97	98	9.8	32.2	25.9
82228	42	1.46	2.37	2.37	127.0	66.3	133.4	209	98	9.6	29.7	24.6
82235	49	1.48	2.42	2.42	128.9	68.5	158.9	256	98	9.5	32.8	24.6
82242	56	1.40	2.35	2.35	108.2	68.5	169.5	262	98	9.2	32.4	25.6
82249	63	1.28	2.23	2.23	145.9	85.4	188.6	351	98	9.0	30.1	23.6
82256	70	1.08	2.01	2.01	155.4	214.3	311.0	626	98	8.6	26.0	21.1
82263	77	.98	2.06	2.06	126.3	214.5	348.9	650	98	8.3	30.2	21.8
82269	83	.82	2.06	2.06	119.1	215.1	362.2	669	98	8.1	31.7	21.8
82270	84	.75	1.96	1.96	117.1	215.1	363.6	670	98	7.9	30.0	20.0
82277	91	.82	1.99	2.00	99.3	215.1	367.5	670	98	7.9	31.8	19.8
82281	95	1.04	1.53	1.92	93.2	215.1	367.5	670	98	7.6	31.9	18.6

```
*RUN  8             :  N3S2
MODEL               : GECER980 - MAIZE
EXPERIMENT          : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
TREATMENT  8        :  N3S2

CROP                : MAIZE          CULTIVAR : hybrid corn 4212 -
STARTING DATE       : JUL  5 1982
PLANTING DATE       : JUL  5 1982    PLANTS/m2 :  5.0     ROW SPACING :  50.cm
WEATHER             : WRDF   1982
SOIL                : WR00820001     TEXTURE : SALO  - SANDY LOAM
SOIL INITIAL C      : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
WATER BALANCE       : IRRIGATE ON REPORTED DATE(S)
IRRIGATION          :        98 mm IN      3 APPLICATIONS
NITROGEN BAL.       : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER        :      100 kg/ha IN      1 APPLICATIONS
RESIDUE/MANURE      : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
ENVIRONM. OPT.      : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Daily	Evapotran.		PESW	Cumulative				Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<--------	mm	--------->³		MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.02	1.39	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.41	1.03	3.34	127.2	.0	.0	1	33	10.1	37.5	28.0
82207	21	.76	2.80	2.80	110.1	.0	22.5	1	58	10.0	34.9	27.1
82214	28	1.41	2.78	2.78	109.1	.0	44.0	1	98	10.0	35.4	26.6
82221	35	1.54	2.55	2.55	108.0	42.1	80.9	97	98	9.8	32.2	25.9
82228	42	1.53	2.36	2.36	127.0	66.7	132.9	209	98	9.6	29.7	24.6
82235	49	1.55	2.41	2.41	129.0	69.0	158.4	256	98	9.5	32.8	24.6
82242	56	1.47	2.35	2.35	108.3	69.0	169.0	262	98	9.2	32.4	25.6
82249	63	1.35	2.22	2.22	145.9	86.0	188.1	351	98	9.0	30.1	23.6
82256	70	1.14	2.00	2.00	155.5	215.0	310.5	626	98	8.6	26.0	21.1
82263	77	1.04	2.05	2.05	126.5	215.2	348.3	650	98	8.3	30.2	21.8
82269	83	.87	2.05	2.05	119.2	215.7	361.6	669	98	8.1	31.7	21.8
82270	84	.82	1.95	1.95	117.2	215.7	363.1	670	98	7.9	30.0	20.0
82277	91	.86	1.99	1.99	99.4	215.7	367.0	670	98	7.9	31.8	19.8
82281	95	1.09	1.63	1.91	92.9	215.7	367.0	670	98	7.6	31.9	18.6

*RUN 9 : N3S3
MODEL : GECER980 - MAIZE
EXPERIMENT : MASE2002 MZ APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
TREATMENT 9 : N3S3

CROP : MAIZE CULTIVAR : hybrid corn 4212 -
STARTING DATE : JUL 5 1982
PLANTING DATE : JUL 5 1982 PLANTS/m2 : 6.0 ROW SPACING : 50.cm
WEATHER : WRDF 1982
SOIL : WR00820001 TEXTURE : SALO - SANDY LOAM
SOIL INITIAL C : DEPTH: 90cm EXTR. H2O:112.5mm NO3: 43.3kg/ha NH4: 6.9kg/ha
WATER BALANCE : IRRIGATE ON REPORTED DATE(S)
IRRIGATION : 98 mm IN 3 APPLICATIONS
NITROGEN BAL. : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
N-FERTILIZER : 100 kg/ha IN 1 APPLICATIONS
RESIDUE/MANURE : INITIAL : 0 kg/ha ; 0 kg/ha IN 0 APPLICATIONS
ENVIRONM. OPT. : DAYL= A .00 SRAD= A .00 TMAX= A .00 TMIN= A .00
RAIN= A .00 CO2 = R330.00 DEW = A .00 WIND= A .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

!YR	Days	Daily	Evapotran.		PESW	Cumulative				Ave	Temp.	Temp
! and	after	Plant	Total	Pot.		RunOff	Drain	Prcip	Irr	Sol	Max	Min
! DOY	Plant	³<----	mm	---->³	mm	³<--------	--mm--	--------	-->³	MJ/m2	C	C
@DATE	CDAY	EPAA	ETAA	EOAA	SWXD	ROFC	DRNC	PREC	IRRC	SRAA	TMXA	TMNA
82186	0	.00	2.80	2.80	111.1	.0	.0	1	0	10.2	32.0	24.0
82193	7	.03	1.39	3.21	101.4	.0	.0	1	0	10.2	36.6	26.6
82200	14	.48	1.08	3.33	126.8	.0	.0	1	33	10.1	37.5	28.0
82207	21	.84	2.79	2.79	110.3	.0	21.9	1	58	10.0	34.9	27.1
82214	28	1.45	2.77	2.77	109.3	.0	43.6	1	98	10.0	35.4	26.6
82221	35	1.60	2.54	2.54	108.2	42.3	80.3	97	98	9.8	32.2	25.9
82228	42	1.59	2.35	2.35	127.0	66.9	132.5	209	98	9.6	29.7	24.6
82235	49	1.60	2.41	2.41	129.0	69.3	157.9	256	98	9.5	32.8	24.6
82242	56	1.52	2.34	2.34	108.4	69.3	168.5	262	98	9.2	32.4	25.6
82249	63	1.40	2.21	2.21	145.9	86.4	187.6	351	98	9.0	30.1	23.6
82256	70	1.19	2.00	2.00	155.5	215.4	310.0	626	98	8.6	26.0	21.1
82263	77	1.08	2.04	2.04	126.5	215.7	347.9	650	98	8.3	30.2	21.8
82269	83	.87	2.05	2.05	119.3	216.2	361.1	669	98	8.1	31.7	21.8
82270	84	.79	1.95	1.95	117.3	216.2	362.6	670	98	7.9	30.0	20.0
82277	91	.83	1.98	1.98	99.4	216.2	366.6	670	98	7.9	31.8	19.8
82281	95	1.12	1.63	1.90	92.9	216.2	366.6	670	98	7.6	31.9	18.6

*NITROGEN BALANCE OUTPUT FILE

```
*RUN    1           :  N1S1
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  1       :  N1S1

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  4.0     ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H20:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :        0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A     .00  SRAD= A     .00  TMAX= A     .00  TMIN= A     .00
                      RAIN= A     .00  CO2 = R330.00  DEW = A     .00  WIND= A     .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
```

!YR	Days		Nitrogen		Nitrogen		Inorg	Fix	Up-	leach	Soil	Soil
! and	After	Crop	Grain	Veg.	Grain	Veg.	N Fert		take		Inorg	Org
! DOY	Plant	³<---	Kg/Ha	-->³	³<--	% -->³	³<------------		kg/ha			------------>³
@DATE	CDAY	CNAD	GNAD	VNAD	GN%D	VN%D	NAPC	NFXC	NUPC	NLCC	NIAD	NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	.9	.0	.9	.00	4.26	0	.0	.2	.0	52.1	4456
82200	14	5.7	.0	5.7	.00	3.83	0	.0	5.2	.0	48.7	4454
82207	21	21.5	.0	21.5	.00	3.31	0	.0	21.4	4.9	29.4	4452
82214	28	29.3	.0	29.3	.00	1.91	0	.0	29.4	8.2	20.1	4450
82221	35	35.0	.0	35.0	.00	1.38	0	.0	35.3	10.7	13.4	4449
82228	42	38.3	.0	38.3	.00	1.24	0	.0	38.7	11.3	11.0	4447
82235	49	40.4	.0	40.4	.00	1.26	0	.0	40.8	11.3	10.6	4445
82242	56	42.2	11.6	30.6	1.17	.96	0	.0	42.8	11.3	10.6	4443
82249	63	43.7	20.9	22.8	1.07	.75	0	.0	44.4	11.3	10.5	4442
82256	70	45.0	28.5	16.5	.98	.62	0	.0	45.8	11.3	10.5	4440
82263	77	46.5	31.7	14.8	.94	.56	0	.0	47.3	11.3	10.5	4439
82269	83	47.1	32.8	14.4	.93	.55	0	.0	48.8	11.3	11.3	4437
82270	84	47.1	32.8	14.4	.93	.55	0	.0	49.0	11.3	11.6	4437
82277	91	47.1	32.8	14.4	.93	.55	0	.0	50.7	11.3	13.2	4436
82281	95	47.1	32.8	14.4	.93	.55	0	.0	51.6	11.3	13.9	4435

```
*RUN   2          :  N1S2
 MODEL            : GECER980 - MAIZE
 EXPERIMENT       : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  2     :  N1S2

 CROP             : MAIZE          CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982    PLANTS/m2 :   5.0     ROW SPACING :   50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :        98 mm IN     3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :         0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;        0 kg/ha IN       0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR ! and ! DOY @DATE	Days After Plant CDAY	Nitrogen Crop ³<--- CNAD	 Grain Kg/Ha GNAD	 Veg. -->³ VNAD	Nitrogen Grain ³<-- % GN%D	 Veg. -->³ VN%D	Inorg N Fert ³<--- NAPC	Fix NFXC	Up- take kg/ha NUPC	leach NLCC	Soil Inorg NIAD	Soil Org --->³ NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	1.2	.0	1.2	.00	4.26	0	.0	.2	.0	52.0	4456
82200	14	6.9	.0	6.9	.00	3.83	0	.0	6.3	.0	47.6	4454
82207	21	22.4	.0	22.4	.00	2.99	0	.0	22.2	4.8	28.8	4452
82214	28	30.1	.0	30.1	.00	1.79	0	.0	30.1	8.1	19.6	4450
82221	35	35.7	.0	35.7	.00	1.33	0	.0	35.8	10.4	13.2	4449
82228	42	39.0	.0	39.0	.00	1.19	0	.0	39.1	11.0	10.9	4447
82235	49	41.0	.0	41.0	.00	1.22	0	.0	41.2	11.0	10.6	4445
82242	56	42.8	11.2	31.5	1.14	.94	0	.0	43.1	11.0	10.6	4443
82249	63	44.4	20.4	23.9	1.05	.75	0	.0	44.8	11.0	10.5	4442
82256	70	45.7	27.9	17.7	.96	.62	0	.0	46.2	11.0	10.5	4440
82263	77	47.1	31.6	15.5	.92	.56	0	.0	47.7	11.0	10.5	4439
82269	83	47.8	32.7	15.1	.91	.54	0	.0	49.1	11.0	11.3	4437
82270	84	47.8	32.7	15.1	.91	.54	0	.0	49.4	11.0	11.6	4437
82277	91	47.8	32.7	15.1	.91	.54	0	.0	51.1	11.0	13.2	4436
82281	95	47.8	32.7	15.1	.91	.54	0	.0	52.0	11.0	13.9	4435

```
*RUN   3            :  N1S3
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  3       :  N1S3

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  6.0      ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :         0 kg/ha IN      0 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :      0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                      RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR ! and ! DOY @DATE	Days After Plant CDAY	Nitrogen Crop ³<--- CNAD	 Grain Kg/Ha GNAD	 Veg. -->³ VNAD	Nitrogen Grain ³<-- % GN%D	 Veg. -->³ VN%D	Inorg N Fert ³<------- NAPC	Fix NFXC	Up- take kg/ha NUPC	leach NLCC	Soil Inorg NIAD	Soil Org ---->³ NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	1.4	.0	1.4	.00	4.26	0	.0	.3	.0	52.0	4456
82200	14	8.0	.0	8.0	.00	3.83	0	.0	7.3	.0	46.6	4454
82207	21	23.1	.0	23.1	.00	2.79	0	.0	22.7	4.7	28.4	4452
82214	28	30.7	.0	30.7	.00	1.72	0	.0	30.5	8.0	19.3	4450
82221	35	36.2	.0	36.2	.00	1.29	0	.0	36.1	10.2	13.2	4449
82228	42	39.4	.0	39.4	.00	1.16	0	.0	39.4	10.8	10.9	4447
82235	49	41.4	.0	41.4	.00	1.20	0	.0	41.5	10.8	10.6	4445
82242	56	43.2	11.3	31.9	1.12	.93	0	.0	43.4	10.8	10.6	4443
82249	63	44.8	20.5	24.3	1.03	.74	0	.0	45.1	10.8	10.5	4442
82256	70	46.1	28.0	18.1	.95	.62	0	.0	46.5	10.8	10.5	4440
82263	77	47.5	31.4	16.1	.91	.56	0	.0	48.0	10.8	10.5	4439
82269	83	48.2	32.6	15.6	.90	.55	0	.0	49.4	10.8	11.3	4437
82270	84	48.2	32.6	15.6	.90	.55	0	.0	49.6	10.8	11.6	4437
82277	91	48.2	32.6	15.6	.90	.55	0	.0	51.3	10.8	13.2	4436
82281	95	48.2	32.6	15.6	.90	.55	0	.0	52.3	10.8	13.9	4435

```
*RUN   4            :  N2S1
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  4       :  N2S1

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :  4.0     ROW SPACING :  50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :        98 mm IN     3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :        50 kg/ha IN     1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :      0 kg/ha ;        0 kg/ha IN     0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A     .00  SRAD= A     .00  TMAX= A     .00  TMIN= A    .00
                      RAIN= A     .00  CO2 = R330.00  DEW = A     .00  WIND= A    .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
```

!YR ! and ! DOY	Days After Plant	Nitrogen Crop	Nitrogen Grain	Nitrogen Veg.	Nitrogen Grain	Nitrogen Veg.	Inorg N Fert	Fix	Up- take	leach	Soil Inorg	Soil Org
		³<---	Kg/Ha	-->³	³<-- %	-->³	³<------------		kg/ha		------------>³	
@DATE	CDAY	CNAD	GNAD	VNAD	GN%D	VN%D	NAPC	NFXC	NUPC	NLCC	NIAD	NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	.9	.0	.9	.00	4.26	0	.0	.2	.0	52.1	4456
82200	14	5.7	.0	5.7	.00	3.83	0	.0	5.2	.0	48.7	4454
82207	21	21.5	.0	21.5	.00	3.31	0	.0	21.4	4.9	29.4	4452
82214	28	29.3	.0	29.3	.00	1.91	0	.0	29.4	8.2	20.1	4450
82221	35	42.9	.0	42.9	.00	1.69	50	.0	43.3	10.7	21.6	4449
82228	42	81.1	.0	81.1	.00	2.50	50	.0	82.7	11.5	15.3	4447
82235	49	81.1	.0	81.1	.00	2.42	50	.0	82.7	11.7	18.2	4445
82242	56	81.1	22.6	58.5	1.79	1.81	50	.0	82.7	11.9	20.1	4443
82249	63	88.7	45.0	43.7	1.77	1.41	50	.0	90.6	12.1	13.6	4442
82256	70	92.5	65.4	27.1	1.71	.95	50	.0	94.4	12.6	10.6	4440
82263	77	94.1	75.7	18.4	1.61	.67	50	.0	96.0	12.6	10.5	4439
82269	83	94.9	77.9	17.0	1.57	.62	50	.0	97.5	12.6	11.3	4437
82270	84	94.9	77.9	17.0	1.57	.62	50	.0	97.7	12.6	11.6	4437
82277	91	94.9	77.9	17.0	1.57	.62	50	.0	99.4	12.6	13.1	4436
82281	95	94.9	77.9	17.0	1.57	.62	50	.0	100.3	12.6	13.8	4435

```
*RUN  5              :  N2S2
 MODEL               : GECER980 - MAIZE
 EXPERIMENT          : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  5        :  N2S2

 CROP                : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE       : JUL  5 1982
 PLANTING DATE       : JUL  5 1982    PLANTS/m2 :  5.0     ROW SPACING :  50.cm
 WEATHER             : WRDF   1982
 SOIL                : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C      : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE       : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION          :        98 mm IN     3 APPLICATIONS
 NITROGEN BAL.       : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER        :        50 kg/ha IN     1 APPLICATIONS
 RESIDUE/MANURE      : INITIAL :     0 kg/ha ;       0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.      : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A   .00
                       RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A   .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
```

!YR ! and ! DOY @DATE	Days After Plant CDAY	Nitrogen Crop CNAD	Nitrogen Grain GNAD	Nitrogen Veg. VNAD	Nitrogen Grain % GN%D	Nitrogen Veg. % VN%D	Inorg N Fert NAPC	Fix NFXC	Up-take NUPC	leach NLCC	Soil Inorg NIAD	Soil Org NOAD
		<---	Kg/Ha	--->	<--	% -->	<-----	-----	kg/ha	-----	-----	----->
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	1.2	.0	1.2	.00	4.26	0	.0	.2	.0	52.0	4456
82200	14	6.9	.0	6.9	.00	3.83	0	.0	6.3	.0	47.6	4454
82207	21	22.4	.0	22.4	.00	2.99	0	.0	22.2	4.8	28.8	4452
82214	28	30.1	.0	30.1	.00	1.79	0	.0	30.1	8.1	19.6	4450
82221	35	44.1	.0	44.1	.00	1.64	50	.0	44.3	10.4	21.7	4449
82228	42	82.2	.0	82.2	.00	2.41	50	.0	83.6	11.1	14.9	4447
82235	49	82.2	.0	82.2	.00	2.34	50	.0	83.6	11.4	17.7	4445
82242	56	82.2	23.7	58.5	1.79	1.74	50	.0	83.6	11.5	19.6	4443
82249	63	90.9	47.2	43.8	1.77	1.38	50	.0	92.8	11.6	11.9	4442
82256	70	93.5	67.6	25.9	1.69	.89	50	.0	95.3	11.8	10.6	4440
82263	77	95.1	76.1	19.0	1.59	.66	50	.0	96.9	11.8	10.5	4439
82269	83	95.8	78.2	17.6	1.56	.61	50	.0	98.3	11.8	11.3	4437
82270	84	95.8	78.2	17.6	1.56	.61	50	.0	98.6	11.8	11.6	4437
82277	91	95.8	78.2	17.6	1.56	.61	50	.0	100.2	11.8	13.1	4436
82281	95	95.8	78.2	17.6	1.56	.61	50	.0	101.2	11.8	13.9	4435

```
*RUN  6            :  N2S3
 MODEL             : GECER980 - MAIZE
 EXPERIMENT        : MASE2002 MZ   APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  6      :  N2S3

 CROP              : MAIZE         CULTIVAR : hybrid corn 4212 -  □□□□□□□□□□□□□□□□□
 STARTING DATE     : JUL  5 1982
 PLANTING DATE     : JUL  5 1982   PLANTS/m2 :  6.0      ROW SPACING :  50.cm
 WEATHER           : WRDF   1982
 SOIL              : WR00820001    TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C    : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE     : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION        :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.     : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER      :        50 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE    : INITIAL :      0 kg/ha ;        0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.    : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                     RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days	Nitrogen			Nitrogen		Inorg	Fix	Up-	leach	Soil	Soil
! and	After	Crop	Grain	Veg.	Grain	Veg.	N Fert		take		Inorg	Org
! DOY	Plant	³<---	Kg/Ha	-->³	³<-- %	-->³	³<------------		kg/ha		-----------	-->³
@DATE	CDAY	CNAD	GNAD	VNAD	GN%D	VN%D	NAPC	NFXC	NUPC	NLCC	NIAD	NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	1.4	.0	1.4	.00	4.26	0	.0	.3	.0	52.0	4456
82200	14	8.0	.0	8.0	.00	3.83	0	.0	7.3	.0	46.6	4454
82207	21	23.1	.0	23.1	.00	2.79	0	.0	22.7	4.7	28.4	4452
82214	28	30.7	.0	30.7	.00	1.72	0	.0	30.5	8.0	19.3	4450
82221	35	44.8	.0	44.8	.00	1.60	50	.0	45.0	10.2	21.8	4449
82228	42	82.8	.0	82.8	.00	2.35	50	.0	84.0	10.9	14.7	4447
82235	49	82.8	.0	82.8	.00	2.29	50	.0	84.0	11.1	17.5	4445
82242	56	82.8	24.7	58.1	1.79	1.70	50	.0	84.0	11.2	19.5	4443
82249	63	92.1	49.1	43.0	1.77	1.34	50	.0	93.8	11.3	11.2	4442
82256	70	94.1	67.9	26.1	1.68	.88	50	.0	95.8	11.4	10.6	4440
82263	77	95.6	76.2	19.4	1.58	.65	50	.0	97.3	11.4	10.5	4439
82269	83	96.3	78.3	18.0	1.54	.61	50	.0	98.8	11.4	11.3	4437
82270	84	96.3	78.3	18.0	1.54	.61	50	.0	99.0	11.4	11.6	4437
82277	91	96.3	78.3	18.0	1.54	.61	50	.0	100.7	11.4	13.1	4436
82281	95	96.3	78.3	18.0	1.54	.61	50	.0	101.6	11.4	13.8	4435

```
*RUN   7          :  N3S1
 MODEL            : GECER980 - MAIZE
 EXPERIMENT       : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  7     :  N3S1

 CROP             : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE    : JUL  5 1982
 PLANTING DATE    : JUL  5 1982    PLANTS/m2 :  4.0     ROW SPACING :  50.cm
 WEATHER          : WRDF   1982
 SOIL             : WR00820001     TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C   : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:  6.9kg/ha
 WATER BALANCE    : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION       :       98 mm IN     3 APPLICATIONS
 NITROGEN BAL.    : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER     :      100 kg/ha IN     1 APPLICATIONS
 RESIDUE/MANURE   : INITIAL :      0 kg/ha ;       0 kg/ha IN     0 APPLICATIONS
 ENVIRONM. OPT.   : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                    RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR ! and ! DOY @DATE	Days After Plant CDAY	Nitrogen Crop ³<--- CNAD	 Grain Kg/Ha GNAD	 Veg. -->³ VNAD	Nitrogen Grain ³<-- % GN%D	 Veg. -->³ VN%D	Inorg N Fert ³<---- NAPC	Fix NFXC	Up- take kg/ha NUPC	leach NLCC	Soil Inorg NIAD	Soil Org --->³ NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	.9	.0	.9	.00	4.26	0	.0	.2	.0	52.1	4456
82200	14	5.7	.0	5.7	.00	3.83	0	.0	5.2	.0	48.7	4454
82207	21	21.5	.0	21.5	.00	3.31	0	.0	21.4	4.9	29.4	4452
82214	28	29.3	.0	29.3	.00	1.91	0	.0	29.4	8.2	20.1	4450
82221	35	50.6	.0	50.6	.00	2.00	100	.0	51.3	10.7	29.9	4449
82228	42	81.8	.0	81.8	.00	2.52	100	.0	83.4	12.8	61.3	4447
82235	49	81.8	.0	81.8	.00	2.43	100	.0	83.4	14.0	64.3	4445
82242	56	81.8	22.6	59.2	1.79	1.82	100	.0	83.4	14.7	65.6	4443
82249	63	89.0	45.0	44.0	1.77	1.42	100	.0	90.9	16.5	57.6	4442
82256	70	102.9	66.7	36.2	1.75	1.25	100	.0	104.8	32.4	28.8	4440
82263	77	114.5	85.5	29.0	1.74	1.05	100	.0	116.3	35.6	15.6	4439
82269	83	117.1	91.6	25.5	1.74	.93	100	.0	121.1	36.1	14.0	4437
82270	84	117.1	91.6	25.5	1.74	.93	100	.0	121.9	36.2	14.2	4437
82277	91	117.1	91.6	25.5	1.74	.93	100	.0	127.1	36.3	15.6	4436
82281	95	117.1	91.6	25.5	1.74	.93	100	.0	130.1	36.3	16.3	4435

```
*RUN   8             :  N3S2
 MODEL               : GECER980 - MAIZE
 EXPERIMENT          : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  8        :  N3S2

 CROP                : MAIZE           CULTIVAR : hybrid corn 4212 -
 STARTING DATE       : JUL  5 1982
 PLANTING DATE       : JUL  5 1982     PLANTS/m2 :  5.0      ROW SPACING :  50.cm
 WEATHER             : WRDF   1982
 SOIL                : WR00820001      TEXTURE : SALO  - SANDY LOAM
 SOIL INITIAL C      : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE       : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION          :       98 mm IN      3 APPLICATIONS
 NITROGEN BAL.       : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER        :      100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE      : INITIAL :       0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.      : DAYL= A    .00  SRAD= A    .00  TMAX= A    .00  TMIN= A    .00
                       RAIN= A    .00  CO2 = R330.00  DEW = A    .00  WIND= A    .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
```

!YR	Days		Nitrogen		Nitrogen		Inorg	Fix	Up-	leach	Soil	Soil
! and	After	Crop	Grain	Veg.	Grain	Veg.	N Fert		take		Inorg	Org
! DOY	Plant	³<---	Kg/Ha	-->³	³<--	% -->³	³<-----	-----	kg/ha	-----	-----	---->³
@DATE	CDAY	CNAD	GNAD	VNAD	GN%D	VN%D	NAPC	NFXC	NUPC	NLCC	NIAD	NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	1.2	.0	1.2	.00	4.26	0	.0	.2	.0	52.0	4456
82200	14	6.9	.0	6.9	.00	3.83	0	.0	6.3	.0	47.6	4454
82207	21	22.4	.0	22.4	.00	2.99	0	.0	22.2	4.8	28.8	4452
82214	28	30.1	.0	30.1	.00	1.79	0	.0	30.1	8.1	19.6	4450
82221	35	52.3	.0	52.3	.00	1.94	100	.0	52.8	10.4	30.3	4449
82228	42	85.9	.0	85.9	.00	2.51	100	.0	87.5	12.4	57.9	4447
82235	49	85.9	.0	85.9	.00	2.44	100	.0	87.5	13.5	60.9	4445
82242	56	85.9	23.7	62.2	1.79	1.85	100	.0	87.5	14.2	62.3	4443
82249	63	92.3	47.2	45.1	1.77	1.42	100	.0	94.2	15.8	55.1	4442
82256	70	106.9	69.9	37.0	1.75	1.25	100	.0	108.7	30.7	26.8	4440
82263	77	117.7	88.0	29.7	1.74	1.03	100	.0	119.5	33.5	14.7	4439
82269	83	120.0	94.3	25.7	1.74	.89	100	.0	123.5	34.0	13.5	4437
82270	84	120.0	94.3	25.7	1.74	.89	100	.0	124.1	34.0	13.7	4437
82277	91	120.0	94.3	25.7	1.74	.89	100	.0	128.3	34.1	15.2	4436
82281	95	120.0	94.3	25.7	1.74	.89	100	.0	130.7	34.1	15.9	4435

```
*RUN    9           :  N3S3
 MODEL              : GECER980 - MAIZE
 EXPERIMENT         : MASE2002 MZ    APPLICATION OF DSSAT IN PREDICTING YIELD OF MAI
 TREATMENT  9       :  N3S3

 CROP               : MAIZE          CULTIVAR : hybrid corn 4212 -
 STARTING DATE      : JUL  5 1982
 PLANTING DATE      : JUL  5 1982    PLANTS/m2 :   6.0      ROW SPACING :   50.cm
 WEATHER            : WRDF   1982
 SOIL               : WR00820001     TEXTURE : SALO   - SANDY LOAM
 SOIL INITIAL C     : DEPTH: 90cm EXTR. H2O:112.5mm  NO3: 43.3kg/ha  NH4:   6.9kg/ha
 WATER BALANCE      : IRRIGATE ON REPORTED DATE(S)
 IRRIGATION         :        98 mm IN      3 APPLICATIONS
 NITROGEN BAL.      : SOIL-N & N-UPTAKE SIMULATION; NO N-FIXATION
 N-FERTILIZER       :       100 kg/ha IN      1 APPLICATIONS
 RESIDUE/MANURE     : INITIAL :       0 kg/ha ;         0 kg/ha IN      0 APPLICATIONS
 ENVIRONM. OPT.     : DAYL= A     .00   SRAD= A     .00   TMAX= A     .00   TMIN= A     .00
                      RAIN= A     .00   CO2 = R330.00   DEW = A     .00   WIND= A     .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
```

!YR ! and ! DOY	Days After Plant	Nitrogen Crop	Nitrogen Grain	Nitrogen Veg.	Nitrogen Grain	Nitrogen Veg.	Inorg N Fert	Fix	Up-take	leach	Soil Inorg	Soil Org
		<---	Kg/Ha	--->	<-- %	-->	<------------		kg/ha			------------>
@DATE	CDAY	CNAD	GNAD	VNAD	GN%D	VN%D	NAPC	NFXC	NUPC	NLCC	NIAD	NOAD
82186	0	.0	.0	.0	.00	.00	0	.0	.0	.0	50.5	4458
82193	7	1.4	.0	1.4	.00	4.26	0	.0	.3	.0	52.0	4456
82200	14	8.0	.0	8.0	.00	3.83	0	.0	7.3	.0	46.6	4454
82207	21	23.1	.0	23.1	.00	2.79	0	.0	22.7	4.7	28.4	4452
82214	28	30.7	.0	30.7	.00	1.72	0	.0	30.5	8.0	19.3	4450
82221	35	53.4	.0	53.4	.00	1.90	100	.0	53.7	10.2	30.5	4449
82228	42	88.8	.0	88.8	.00	2.51	100	.0	90.2	12.1	55.6	4447
82235	49	88.8	.0	88.8	.00	2.45	100	.0	90.2	13.2	58.5	4445
82242	56	88.8	24.7	64.1	1.79	1.87	100	.0	90.2	13.8	59.9	4443
82249	63	94.6	49.1	45.6	1.77	1.42	100	.0	96.4	15.4	53.4	4442
82256	70	109.5	72.0	37.4	1.75	1.25	100	.0	111.2	29.5	25.6	4440
82263	77	119.9	89.8	30.1	1.74	1.01	100	.0	121.5	32.1	14.1	4439
82269	83	121.9	96.1	25.8	1.74	.87	100	.0	125.2	32.5	13.2	4437
82270	84	121.9	96.1	25.8	1.74	.87	100	.0	125.8	32.6	13.4	4437
82277	91	121.9	96.1	25.8	1.74	.87	100	.0	129.8	32.6	14.9	4436
82281	95	121.9	96.1	25.8	1.74	.87	100	.0	132.0	32.6	15.6	4435

SUMMARY AND CONCLUSION

Maize is one of the most important cereals of the world both for human and animal consumption. It occupies 6.30 million hectares with a production of 10.80 million tones. Over 85 percent of its production in the country is consumed directly as food in various forms, such as chapattis, roasted ears, popcorn etc. The maize is also used as feed for poultry and in the starch industry.

Hybrid corn 4212 was sown in the experimental plot (16.0x15m) size of demonstration farm, WRDTC, I.I.T. Roorkee on 05.07.2002. Before sowing, the plot was ploughed with the help of Tiller. The plot was divided in to 9 numbers of subplots each of which is 4.0 x2.5m size. The maize was sown in rows spacing of 50 cm and plant to plant spacing of 50 cm maintained. The seeding depth was 2-3 cm with 2 seeds per hill. A uniform dose of Diamonium phosphate (DAP) was applied on the plot at the rate of 50 kg per ha. The maize crop was irrigated with 98mm of water in 3 applications. There after due to rain at regular interval no irrigation was needed till harvesting. Urea was applied on 09.08.2002 @ 220 kg/ha when the crop was at knee high stage. The crop was harvested on 08.10.02 and the yield and Attributes were recorded.

The field result showed that the average Grain yield was 5197 kg/ha where as the DSSAT crop model has predicted the Grain yield of 5255 kg/ ha. This implies that the model has predicted 58 kg higher grain yield, which is acceptable. The predicted yield attributes and other development variables such as per grain weight, grains per cob, grain number per m^2, max LAI, biomass at harvest stage, byproduct etc of the crop model were also compared with the field results. It has been observed that the crop model has predicted the value of the said attributes on a slightly higher side than the field results, except the number of Grains per m^2 and per cob. The extent of the variability was well with in the acceptable limit. The water and Nitrogen stress of the crop during the main development stage was also noticed. The crop was subjected to water and nitrogen stress of 9%, 6% when the crop was at the age of 12 days and 42 days respectively.

Since the variability of the DSSAT crop model predicted was with in the acceptable limits, the validated programme was further extended under different Agronomical practices and predictions were made on account of Grain Yield. The Experiment Treatment combination consists of three levels of Nitrogen (0, 50, 100kg N/ha) with three levels of Plant populations (4, 5, and6/m^2). The other inputs were assumed the same as that used for validation. The Result are summarized below:

(1) Increasing the plant population increased grain yield, but decreased the unit weight grain and the number of grain per cob. Increasing the plant population from 4 to 5 and 6/ m^2increases the grain yield

(a) To 1.87%, 2.12% when No Nitrogen was applied.

(b) To 1.53%, 2.38% when 50kg Nitrogen was applied

(c) To 3.03%, 5.14% when 100kg Nitrogen was applied

(2) Increasing the Nitrogen application increased grain yield as well as the unit weight of the grain and the number of grain per cob. Increasing the Nitrogen application from 0 to 50 and 100kg N/ha increased grain yield

(a) To 39.80-40.60% when 50kg N was applied.

(b) To 48.80-53.20% when 100kg N was Applied.

Keeping in view the above DSSAT findings, the variability of the attributes predicted and field observed results are within the acceptable limits. It is concluded that DSSAT can satisfactorily predict the yield of maize in soil climatic conditions of Roorkee, therefore may be accepted as validated at Roorkee for growing maize. However, further studies with different aspects of management can be carried out at different sites to validate the accuracy and reliability of the DSSAT crop model. This is useful to the planners to forecast maize crop yield to enable the government to take policy decision on advance planning of internal food distribution, relief measures, and grain storage etc.

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Weather data for the month of June 2002 **Annexure-I**

Date	Day of year	Max.temp °C	Min.temp °C	Rainfall mm	SunshineHours
01.06.02	82152	38.00	21.00	24.20	12.50
02.06.02	82153	39.00	22.00	0.00	12.20
03.06.02	82154	37.00	20.00	0.00	12.00
04.06.02	82155	37.50	24.00	0.00	12.50
05.06.02	82156	37.50	25.50	0.00	12.50
06.06.02	82157	36.00	24.50	0.00	12.50
07.06.02	82158	35.50	25.00	0.00	11.00
08.06.02	82159	37.00	26.00	0.00	8.00
09.06.02	82160	38.00	25.00	0.00	10.00
10.06.02	82161	39.00	25.50	0.00	12.50
11.06.02	82162	38.00	25.00	0.00	12.00
12.06.02	82163	30.50	21.50	24.40	12.50
13.06.02	82164	36.00	21.00	0.00	8.00
14.06.02	82165	35.00	27.00	4.00	12.00
15.06.02	82166	34.50	26.00	0.00	11.00
16.06.02	82167	34.00	22.00	20.00	11.50
17.06.02	82168	34.00	19.50	0.00	6.00
18.06.02	82169	34.00	26.00	0.00	10.00
19.06.02	82170	33.50	25.50	0.00	10.50
20.06.02	82171	34.00	25.00	0.00	11.00
21.06.02	82172	35.00	26.00	0.00	10.00
22.06.02	82173	33.50	26.50	0.00	10.50
23.06.02	82174	34.00	27.00	0.00	11.00
24.06.02	82175	27.00	24.00	12.20	11.00
25.06.02	82176	36.50	25.00	0.00	4.00
26.06.02	82177	35.00	24.50	1.20	11.50
27.06.02	82178	35.50	24.00	5.80	10.50
28.06.02	82179	36.00	24.00	0.00	10.00
29.06.02	82180	36.00	25.00	0.00	8.00
30.06.02	82181	35.00	25.50	0.00	11.00

Weather data for the month of July 2002 Annexure-II

Date	Day of year	Max.temp °C	Min.temp °C	Rainfall mm	SunshineHours
01.07.02	82182	36.50	28.00	0.00	10.00
02.07.02	82183	34.00	29.00	0.00	8.00
03.07.02	82184	34.50	27.00	0.00	5.00
04.07.02	82185	33.00	23.00	38.00	4.00
05.07.02	82186	32.00	24.00	1.40	2.00
06.07.02	82187	34.00	24.00	0.00	2.00
07.07.02	82188	36.00	25.00	0.00	9.00
08.07.02	82189	37.00	26.00	0.00	11.00
09.07.02	82190	36.00	28.00	0.00	10.00
10.07.02	82191	37.00	27.50	0.00	11.00
11.07.02	82192	38.00	27.50	0.00	12.00
12.07.02	82193	38.00	28.00	0.00	10.00
13.07.02	82194	38.50	28.50	0.00	11.00
14.07.02	82195	38.00	28.00	0.00	10.00
15.07.02	82196	39.50	27.50	0.00	8.00
16.07.02	82197	39.00	28.50	0.00	8.00
17.07.02	82198	37.00	28.00	0.00	7.00
18.07.02	82199	36.50	27.50	0.00	9.00
19.07.02	82200	34.00	28.00	0.00	9.00
20.07.02	82201	35.00	27.00	0.00	8.00
21.07.02	82202	35.00	26.50	0.00	10.00
22.07.02	82203	34.50	27.00	0.00	10.00
23.07.02	82204	35.00	26.00	0.00	5.00
24.07.02	82205	34.50	28.00	0.00	9.00
25.07.02	82206	34.50	27.00	0.00	10.00
26.07.02	82207	36.00	28.00	0.00	8.00
27.07.02	82208	35.00	27.00	0.00	8.50
28.07.02	82209	36.00	27.00	0.00	10.00
29.07.02	82210	36.50	26.00	0.00	11.00
30.07.02	82211	36.50	26.50	0.00	12.00
31.07.02	82212	36.00	26.50	0.00	10.00

Weather data for the month of August 2002 **Annexure-III**

Date	Day of year	Max.temp °C	Min.temp °C	Rainfall mm	Sunshine Hours
01.08.02	82213	33.50	26.00	0.00	9.00
02.08.02	82214	34.00	27.00	0.00	10.00
03.08.02	82215	29.00	27.00	0.80	9.00
04.08.02	82216	28.00	23.50	95.00	7.00
05.08.02	82217	29.00	24.00	0.00	9.00
06.08.02	82218	31.50	24.00	0.00	9.00
07.08.02	82219	36.00	27.00	0.00	8.00
08.08.02	82220	35.50	28.50	0.00	11.00
09.08.02	82221	36.50	27.50	0.00	11.00
10.08.02	82222	32.00	28.00	0.00	9.00
11.08.02	82223	28.00	23.50	40.00	2.00
12.08.02	82224	28.00	24.50	11.20	0.00
13.08.02	82225	28.00	24.50	11.00	0.00
14.08.02	82226	28.00	23.50	49.80	0.00
15.08.02	82227	31.00	23.50	0.00	0.00
16.08.02	82228	33.00	24.50	0.00	3.00
17.08.02	82229	33.00	26.00	0.00	9.00
18.08.02	82230	32.50	25.50	1.00	9.50
19.08.02	82231	33.00	24.50	9.00	6.00
20.08.02	82232	34.00	25.00	15.40	7.00
21.08.02	82233	32.00	23.50	6.00	10.00
22.08.02	82234	32.00	23.50	15.20	9.00
23.08.02	82235	33.00	24.00	0.00	8.00
24.08.02	82236	34.00	24.50	0.00	7.00
25.08.02	82237	33.50	25.00	0.00	9.30
26.08.02	82238	33.50	25.50	3.00	9.00
27.08.02	82239	31.50	25.50	1.80	10.00
28.08.02	82240	32.50	26.00	0.00	9.00
29.08.02	82241	30.50	26.00	0.00	7.00
30.08.02	82242	31.50	26.50	1.60	8.00
31.08.02	82243	31.00	26.00	2.00	8.50

Weather data for the month of September 2002 **Annexure-IV**

Date	Day of year	Max.temp °C	Min.temp °C	Rainfall mm	Sunshine Hours
01.09.02	82244	32.50	23.50	0.00	8.00
02.09.02	82245	34.00	24.50	14.80	7.00
03.09.02	82246	25.00	23.50	46.40	4.00
04.09.02	82247	32.00	22.00	2.20	0.00
05.09.02	82248	32.00	23.50	0.00	10.00
06.09.02	82249	24.50	22.00	23.80	9.00
07.09.02	82250	23.00	20.00	132.00	0.00
08.09.02	82251	22.00	19.50	82.00	0.00
09.09.02	82252	30.00	20.00	0.00	4.00
10.09.02	82253	31.00	22.50	0.00	8.00
11.09.02	82254	26.00	23.00	0.00	9.00
12.09.02	82255	23.00	21.50	21.00	5.00
13.09.02	82256	27.00	21.50	40.00	0.00
14.09.02	82257	32.00	21.50	8.40	6.00
15.09.02	82258	30.00	20.00	2.20	3.00
16.09.02	82259	31.00	23.50	0.60	9.00
17.09.02	82260	25.50	24.00	0.00	10.00
18.09.02	82261	30.00	20.50	10.30	7.00
19.09.02	82262	31.00	20.50	0.90	8.00
20.09.02	82263	32.00	22.50	1.00	10.00
21.09.02	82264	32.50	23.50	0.00	9.00
22.09.02	82265	31.50	21.00	16.20	7.00
23.09.02	82266	32.00	21.00	0.80	8.00
24.09.02	82267	32.50	21.00	0.40	10.00
25.09.02	82268	31.00	23.50	0.90	9.00
26.09.02	82269	30.50	20.50	0.60	9.30
27.09.02	82270	30.00	20.00	1.40	10.00
28.09.02	82271	30.50	20.50	0.00	9.50
29.09.02	82272	30.00	21.00	0.00	9.50
30.09.02	82273	31.00	20.00	0.00	10.00

Weather data for the month of October2002 **Annexure-V**

Date	Day of year	Max.temp °C	Min.temp °C	Rainfall mm	Sunshine Hours
01.10.02	82274	33.50	20.00	0.00	10.00
02.10.02	82275	32.00	20.50	0.00	10.00
03.10.02	82276	33.00	19.00	0.00	10.15
04.10.02	82277	32.50	17.50	0.00	10.15
05.10.02	82278	32.00	18.00	0.00	9.50
06.10.02	82279	31.50	18.50	0.00	10.00
07.10.02	82280	32.00	19.50	0.00	10.00
08.10.02	82281	32.00	18.50	0.00	10.25

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	

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
SH2O	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.) SO

@CDE	DESCRIPTION	IB
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)	

*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 (Nezara 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                                                       SO
@CDE   DESCRIPTION                                                        IB
C      Canopy                                                             IB
L      Leaves                                                             IB
H      Harvest product

*Harvest size categories                                                  SO
@CDE   DESCRIPTION                                                        IB
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

*Methods - Fertilizer and Chemical Applications                           SO
@CDE   DESCRIPTION                                                        IB
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)   SO
@CDE   DESCRIPTION                                                        IB
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

*Methods - Soil Analysis                                                  SO
@CDE   DESCRIPTION                                                        IB
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

*Planting Material/Method                                                 SO
@CDE   DESCRIPTION                                                        IB
PM001  Dry seed                                                           IB
PM002  Transplants                                                        IB
PM003  Vegetative cuttings                                                IB
PM004  Pregerminated seed
```

```
*Plant Distribution                                SO
@CDE   DESCRIPTION                                 IB
R      Rows                                        IB
H      Hills                                       IB
U      Uniform

*Residues and Organic Fertilizer                   SO
@CDE   DESCRIPTION                                 IB
RE001  Crop residue                                IB
RE002  Green Manure                                IB
RE003  Barnyard Manure                             IB
RE004  Liquid Manure

*Rotation                                          SO
@CDE   DESCRIPTION                                 IB
RO001  Continuous arable crops                     IB
RO002  Rotation with forages

*Soil Texture                                      SO
@CDE   DESCRIPTION                                 IB
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

*Tillage Implements                                SO
@CDE   DESCRIPTION                                 IB
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
```

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)			

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

@CDE	LABEL	DESCRIPTION	LOCAL CODE	SO SE
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
GH%M	GRAIN H2O %	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

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	

*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 Annexure-ix

TRT	Treatment
FLO	Flowering date
dap	Days after planting
MAT	Physiological maturity
TOPWAT	Total plant weight at harvest maturity
SEEDW	Grain yield or Seed weight (kg/ha)
TRAIN	Total Rainfall
TIRR	Total Rainfall
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.