EFFECT OF ROW-DIRECTION AND ORGANIC MANURING ON GROWTH, DEVELOPMENT AND YIELD OF HYBRID MAIZE

A DISSERTATION

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

of

MASTER OF TECHNOLOGY

in

IRRIGATION WATER MANAGEMENT

By

ASHOK KUMAR SINGH KUSHWAH

WATER RESOURCES DEVELOPMENT TRAINING CENTRE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE-247 667 (INDIA)

JUNE, 2004

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the dissertation entitled **EFFECT OF ROW-DIRECTION AND ORGANIC MANURING ON GROWTH, DEVELOPMENT AND YIELD OF HYBRID MAIZE,** in partial fulfillment of the requirement for the award of degree of Master of Technology in Irrigation Water Management (IWM) submitted in the Department of Water Resources Development Training Centre of the Indian Institute of Technology, Roorkee is an authentic record of my own work carried out at WRDTC Demonstration Farm station during the period from June 2003 to June 2004, under the supervision of **Dr. S. K. Tripathi,** Professor, WRDTC, IIT-Roorkee

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

(Er. A . K . SINGH KUSHWAHA)

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

(Dr. S. K. Tripathi)
Professor, WRDTC
Indian Institute of Technology
Roorkee-247667

Place: Roorkee
Date: 24th June 2004

ACKNOWLEDGEMENT

I with my profound sense of gratitude and regards to **Dr. S. K. Tripathi,** Professor WRDTC, IIT-Roorkee (INDIA) for his best & inspiring guidance and constant encouragement, persuasion and time management during field experiments, observations and analysis. I am also thankful to him for due efforts in preparing the dissertation and in the scrutiny of this manuscript.

I am also greatly thankful to Dr. U. C. Chaube, Professor and Head of Deptt. WRDTC, IIT-Roorkee for extending the diverse facilities in completion of this Dissertation-work.

I am also grateful to my friends & colleague Er. R.N.P. Yadav (Nepal) for extending help in the due course of work. My friends Mr. Umesh Singh, Mr. A. K. Shukla, Mr. Prakash, Mr. J. S. Jamwal and Mr. Subhash for their well-wishes and encouragement.

I wish to express my heartily thanks to Er. Rao Balraj Singh, (Retired) Engineer-in-chief, M.P. Water Resources Department, for his valuable suggestions & timely guidance pursuing this course. I am also greatly thankful to E-in-C & Ministry (WRD) M.P. Govt. for provided this opportunity and ' SPONSORSHIP' for this M. Tech. (IWM) course at WRDTC, IIT-Roorkee, U.A. (INDIA).

I can't forget to express my profound gratitude and indebtedness to my Late Parents, as a matter of this M.Tech. course is dedicated to them. I also wish to be indebted to my wife Smt. Suman & my both sons (Mr. Vikrant & Mr. Suryansh) who inspired me to pursue the work in spite of their inconvenience & difficulties

It would be unworthy, if I do not express my cordial thanks to my colleagues Er. P. N. Zamidar (Batch Leader), and all my batch mats for their help during the entire course. Sh. Bir Singh chauhan S.T. & Mr. Satyapal to their help in experimentation.

Lastly, I am thankful to all staff-members of WRDTC, who have extended cooperation to me for completion of this work.

Er. A . K . SINGH KUSHWAHA
M.TECH.(IWM)
WRDTC, I I T – ROORKEE
(INDIA)

CONTENTS

CHAPTER – 6: SUMMARY AND CONCLUSION

SYNOPSIS

The maize is the most widely grown cereal crop in America and 3rd order crop of the world. No other crop has utility as the maize can be utilized since its vegetative growth stage to post harvest stage. Maize is very adaptable to diverse environment at present its demand is felt worldwide. In this way the maize has became a most widely grown cereal crop useful for both human and animal consumption.

It occupies 138.6 million ha area with a production of 603.0 million tones every year. Over 85% of its production in the country is consumed directly as food in various form, i.e. chapattis, roasted with popcorn and also used as feed for poultry & in the starch industry.

Maize has also a good tolerance of pH of soil within range 7.5 – 8.5 and temperature $21^0C – 27^0C$ for its proper growth and development.

The study entitled "Effect of Row-Direction and Organic Manuring on Growth, Development and Yield of Hybrid Maize", has been carried out with the following objectives:

- To compare the grain–yield of maize under the influence of row direction and organic manuring.
- To compare the growth and development of hybrid maize growth under the treatments of row-direction and organic manuring.
- To recommend a suitable row-direction and organic manuring.
- Level for the cultivation of maize in soil climatic conditions.

The dissertation divided into chapter as follows:

2. Chapter I - Introduction provides justification of work and sets the objective of study.
3. Chapter II - Review of Literature
4. Chapter III - Materials & Methods describes the methodology adopted and material used in the conduct of field experimentation.
5. Chapter IV- Observation describes the data recorded and analysis made statistically.
6. Chapter V- Results and discussion has discussed the logic of the results obtained.

7. Chapter VI- Summary and Conclusions summarizes the experimentation and its findings. Practices suitable for the soil climatic conditions of Roorkee recommended and future course of action is suggested.

   References – Various literature cited are referred.

The experiment entitled "Effect of Row Direction and Organic Manuring on Growth, Development and Yield of Hybrid Maize", was conducted on factorial design with 4 direction of planting and 3 levels of organic manuring and 3 replications. Observation recorded indicated that rows of maize in East-West direction recorded highest yield. Addition of organic manuring (FYM) increased grain yield progressively with increase the organic manuring.

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

aMSL	Above means sea level
ANOVA	Analysis of variance
CGR	Crop growth rate
CO_2	Carbon-di-oxide
^0C	Degree Celsius
DAS	Days after sowing
ETo	Evapotranspiration
FYM	Farm yard manure
GE	Genetically engineered (corn)
ha	Hectare
HI	Harvest index
Ht.	Height
K	Potassium
LAI	Leaf area index
LPR	Leaf production rate
Max.	Maximum
Min.	Minimum
N	Nitrogen
P	Phosphorus
q	Quintal
Rep.	Replication

RF	Rate of flowering
RGR	Relative growth rate
Rh	Relative humidity
RR	Round ready (corn)
RRF	Recommended rate of fertilizer
SSR	Simple sequence repeat
Temp.	Temperature
Treat.	Treatments
WACE	Weeks after crop emergence
WRDTC	Water Resources Development Training Centre
Wt.	Weight

Showing experimental site of hybrid maize at Demo-Farm
WRDTC, IIT ROORKEE

INTRODUCTION

1.1 HISTORY OF MAIZE

The origin of maize was accepted in Haiti, America where it was named "Mahiz". Cristopher Columbus carried maize from America to Europe, later on it was introduced in Africa and Asia , in the 16 – 17th centuries .The above chain of origin to maize all over the world is still a mystery but one of the most accepted thing about the maize is that the direct predecessor of maize is the " Teosinte" grass. The maize plant has the distichuos leaves (two ranks of single leaf borne in alternate position) .The external surface of the leaves blades is adapted for the absorption of solar energy by little hairy structure and the internal surface is shiny and hairless with numerous stomata for breathing .

Maize is one of the greatest cereal crop in the United states, Mexico, China and Brazil, "Corn has always been America's most efficient crop for converting sun's energy into food." Very often it is said that the productivity of maize is due to its large leaf area and the modification of its photosynthesis pathway. Actually this modification is common in other tropical species, resistant to drought periods, is known as the "c4 syndrome. "This term means, an efficient mechanism to exchange water vapour for atmospheric carbon-dioxide, therefore c4 -species are capable to produce more dry matter per unit of water transferred than normal plants as c3–syndrome [Ref. 9] . The maize has wider varieties, some tropical varieties of maize grow as tall as 7.5m and may have until 4 to 5 ears per stalk but may be dwarf as short as only 0.9 m. maize is cultivated at latitude 50^0 N and S, and slightly. Higher from the Equator. It may grow up to altitude 3600- 4000 meters elevation. The main characteristics are good adaptation qualities (i.e. tolerance, edurance and resistance etc). It is a versatile crop, and it also has tremendous genetic variability, which enables it to thrive well under lowland tropical, subtropical and temperate climates. It is grown in many countries than any other cereals, U. S. farmers, seed men and scientists were jointly worked and developed outstanding open-pollinated varieties, and intensive research in plant breeding offers improvement in crop- yield. Today hybrid maize is the greatest practical achievement of plant genetics. According to recorded data, in the period from 2000 to 2002 about 600 million tons of maize was produced in the world, on 1.39 million hectares of area.

1.2 REQUIREMENTS OF MAIZE CROPPING:

The maize requirements for cropping & availability of what extent on the experimental site are summerise as:

SEED: The seed should be required a new hybrid diversified quality for the high grain yield in typical climatic conditions. I have already used the hybrid maize variety name"K-25 kanchan ganga" for my experiment.

SOIL: Generally maize can be grown on any type of soil ranging from deep clay to light sandy stones. However it require soil containing ph ranging 7.5-8.5.The soil ideally suited for the hybrid maize would have good water holding capacity &provide good drainage. The soil of experimental site, WRDTC Demonstration Farm IIT-Roorkee is found sandy-loam, hence it would be come under the normal category of soil.

1.3 AGROCLIMATIC FACTORS

The climatic factors which would be affecting to the agriculture or crop growth, development and ultimately to the yield of the crop (hybrid maize) are as under :

- Temperature:-It is the radiant energy emerges from sunlight which useful in photosynthesis but temperature is responsible for evapotranspiration & the main function of temperature is to rapening of grain at maturity . If mean daily temperature greater than 20^0c the early grain variety taken 80 –110 days , when mean daily temperature below 20^0c the maturity will be extend 10 –20 days for each 0.5^0c decrease depending upon the variety of crop . The optimum mean daily temperature would be 10^0c for germination & 10^0c – 20^0c for growth and good maturity. The mean daily temperature being existed 20^0c – 25^0c during entire crop-period at experimental site.

- Rainfall (Precipitation):- Precipitation may be in the form of rain, frost, fog and dew etc. but the rainfall play the bitter role for the growth of any crop by meet-out the crop water requirement of maize.

  In the present experimental hybrid maize crop has obtained near-about 650 mm rainfall in this vicinity and during the crop – period , but extra water requirement has met-out by two time irrigation of 173mm . The general water - requirement for maize should be 600-800mm.

- Wind-Speed:-It is also a important agroclimatic factor which is responsible for pollination of settling of seed as well as evapotranspiration. If the wind velocity more than 5 m/sec, it would be create problem in falling & setting of pollen on silk, ultimately the full fertilization would not take-place & 'Drift' problem will also arise. In such situation the seed-setting on the cobs would be less, therefore yield will be reduces. The high wind also increases the evaporation from the soil surface. Thus, for water-conservation point of view, the wind should be less 1–3km/hr. for justified yield, therefore during the pollination the wind speed should be minimum.
- Photo-Days:-It is also called the available duration of sun-shine hours. This factor is very essential for photosynthesis process of plants, ultimately it is responsible for the growth & development (juvenile stage) of plants but during pollination and fertilization the process would be inversely-proportional to duration of sun-shine. The sugar-cane and maize are the crops utilize more solar energy . In my experiment, the solar-energy have already been found in sufficient quantity. The solar-radiation between 0.30 to 0.55μm has good photoperiodic effect and 0.40 to 0.70μm most effective to photosynthesis [Ref.22].
- Relative-Humidity:- Relative-humidity affects the water relation of plants by influencing evaporation. Low Rh increases leaf water potential due to high evaporation and vice-versa. The high Rh turgor pressure of leaves increases because of less transpiration, it results into cell enlargement & leaf enlargement. Humidity indirectly affects leaf growth, photosynthesis and pollination. Moderately low air Rh is also favorable for seed-setting. In low Rh, the water deficit in plant leaves will closes the 'stomata'

1.4 OBJECTIVES OF THIS STUDY

The main objectives of this study entitled " Effect of Row-Direction and Organic Manuring on Growth, Development and Yield of Hybrid Maize," are as follows :-

- To compare the grain yield of maize under the influence of row-direction and organic manuring.
- To compare the growth and development of hybrid maize growth under the treatment of row-direction and FYM.
- To recommend a suitable row-direction and organic manuring.
- Level for the cultivation of maize in soil climatic conditions.

REVIEW OF LITERATURE

Agarwal et al.(2001) they developed a model for wheat and rice grown in Madhya Pradesh (India).This model is about yield forecast based on weather variables & agriculture input on agro-climatic zone basis. The data on weather parameter were collected from various districts from1971 to 1990 .They also collected other data 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 15 years data when crops were 12 weeks old i.e. two months before harvest.

Ameta et al. (2000) they have conducted a field survey and reported about the winter maize responded to nitrogen levels with regard to varying of row spacing and plant population density. They were carried experiment during 1988-89 in Rajasthan ,comprise to row spacing (60 and 75 cm) four plant population density (65,75,85,95 thousands plants per ha.) and used five levels of nitrogens (60,90,120,150and 180kg N /ha.).They found results that the closer row (60cm.) spacing gave 4.12% higher grain yield than wider row (75cm.).It shows that the grain and stover yield linearly increased with successive increase in population density and nitrogen levels upto the limit of 85thousands plants / ha.&150 kg/ ha nitrogen respectively and got 58.97 and 60.68 q /ha of grain yield. During the both years they found the significant interaction between plant population & nitrogen levels.

Antonopoulos (2001) studied and reported about the simulation of soil water 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/s soil for NO_3 – N. Different procedures for getting the characteristics curves resulted in differing water contents and nitrogen concentrations in the soil.

Balthazar et al.(2003):reported that gene flow in maize (Zea maize L.ssp. mays), among genotype with varying levels of hybridization and stages of evaluation, including the wild relative teosinte is not new. He discussed that a teosinte plant with at least 15 tassels distributed along the stems is also a large pollen producer compare to a hybrid plant ,with a large number of spikelet,3921 per plant as compared to 769 for a modern maize hybrid. They also concluded in his experiment that cross pollination has occurred at a maximum distance 200 m from the source planting and that very limited cross pollination occurred at 100m. but they did not observe any cross –pollination at 300m .They also highlighted the factors to controlling the process of transgenes by out crossing pollination. This report & guidelines would be beneficial for producing new hybrid maize varieties in future.

Chandrashekhara et al.(2000) studied about the response of maize to organic manure with inorganic fertilizer. A field experiment conducted in Arabhavi, Karnataka (India) during Kharif of 1996. They used four treatments comprising organic manure(10 t. on poultry manure/ha , 2.5 ton vermi compost/ha and 10 ton FYM /ha)with recommended rates of fertilizer (RRF,150 kg N/ha) in three doses, 75 kg P/ha,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) yield than vermi compost with RRF, FYM with RRF and control treatments .They reported the percent increase in grain yield with application of poultry manure , vermicompost and FYM were 33.16 and 14% compared with control . Application of poultry manure with RRF produce taller plant (187.5), longer cobs(14.35cm) with bigger dia.(15.6cm) and heavier cob weight (170.50 gram/cob) than with control .The percent increase in cob length, cob girth, and grain weight per plant with the application of poultry manure was 13.1,13.8, and 53.2%respectively compared with control.

Fernando et al. (2002) reported that response of grain yield to narrow rows can be analyzed in terms of the effect on the amount of radiation intercepted by the crops. The objective of this work was to study the effect of row spacing on grain yield and radiation interception (RI) during the critical period for grain set in three crop species. Ten experiments were conducted with maize (Zea mays L), sunflower (helianthusannuus L), or soybean Glycinemax (L) Merr. Under irrigation or under dry and conditions without severe drought during flowering and grain fillings. The treatments consisted of two row distances combined with other factors such as plant density, cultivar, defoliation, etc. grain yield responses to decrease distance between rows were inversely proportional to RI achieved with the wide-row control treatment during the critical period for grain number determination (r^2= 0.62, 0.54, and 0.86 for maize, soybean, and sunflower, respectively). Moreover, when row spacing was reduced, grain yield increases and RI increases during the critical periods for grain set were significantly and directly correlated in the three crop species (r^2 = 0.71, 0.64, and 0.94 for maize, soybean, and sunflower, respectively). For the conditions of these experiments, grain yield increase in responses to narrow rows was closely related to the improvement in light interception during the critical period for grain set.

Fund et al.(2003) reported that production of maize and more specifically to hybrid corn plants with certain advantages phenotypes resulting from interaction of the haploid genetic contributions of inbred parental lines. They reported that all corn as we know it today, zea mays is a result of human manipulation. It was never a natural plant .They reported that ,unfortunately, reduction in yield performance and the appearance of other plant characteristics which are undesirable accompanies inbreding. In addition ,progressive selfing reduce plant vigor. Many of these deleterious effects are caused by homozygosity for deleterious recessive gene whose effects are unmarked by loss of desirable dominant alleles. They also described about the first generation(F.sub.1)and (F.sub.2) etc. This invention addressed some of the shortcomings in the prior art of corn hybridization, and discloses a corn hybrid genetic complement & characterize to increased yield and root lodging.

Grazia et al. (1999) studied about the plant population and fertilizer effect on sweet corn crop yield .Their field study at Hernandez, Argentina in 1996-97,sweet corn cv, freshy was grown at 4,6 on 8 per m giving plant population of 56800, 85200 and 113600 plant per ha respectively. The crop were given no fertilizer 100 kg mono ammonium phosphate at sowing plus 100kg urea spread when plant had eight leaves expanded. They reported that yield was highest with 6 plants per metre plus mono ammonium phosphate and urea. The highest plant density gave lowest yield and at this density the higher fertilizer application also decreased the yield.

Jaya et al.(2001) studied and reported that the maize is one of the row crops often selected for inter cropping to provide shelter to understorey crops because of its wide adaptation over a range of climates .They concluded that leaf area index (L AI) but not by row-orientation .It is also highlighted that the maize row oriented N-S absorbed radiation higher in the canopy then E-W oriented plants. It is also concluded that the temperature reduction was associated with a reduction of irradiance up to 70% the reduction especially in temperature, was highly sensitive to row-orientation and at some combinations resulted in increased in temperature.

Joanne et al.(2003) reported that molecular genetic variation , influences pedigree, adaptation and migration in the genetic make-up of concerned corn-Belt ,Dent related germplasm. Plant sampled from 57 assession represented corn-Belt Dents, Northern flints, southern Dents, plus 12 public inbreds, where genotyped at 20 simple sequence repeat(SSR) loci, for 47 of the accessions, between 5 and 23 plants per accession were genotyped (mean =9.3).Mean number of alleles per locus was 6.5 overall, 3.17 within accession and 3.2 within pooled inbreds. Mean gene diversity was 0.53 within accession and 0.61 within pooled inbreds. Open pollinated accesions showed a tendency towards inbreading and 85 %of genetic variation was shared among them. They found mentel test revealed significant correlation between genetic distance and geographical ($r = 0.54$, $p = 0.04$) or maturity zone($r = 0.33$, $p = 0.03$). They found a significant correlation ($r = 0.76$, $p < 0.01$)between days to pollen shed and maturity zone of accession origin . Pedigree , rather than migration or selection ,has most influenced the genetic structure of the extent representatives of the open pollinated cultivars at these SSR loci. Leaf orient can switch from a random distribution in nearly isolated plants (i,e. 3 plants m^{-2}) to a distich distribution where the leave are placed perpendicular to rows when the plant are grown at commercial crop densities (i,e. 3 plants m^{-2}) Girardin, 1992, Stewart and Dwyer, 1993. Girardin and Collinear, 1994. Maddonni et al. 2001a) thus, maize canopies may adopt a no isotropic structure with a preferential across-row orientation of the leaves. Both field measurements and computer simulations indicate that maize canopies with leaves perpendicular to the rows may present increased light interception (about 10 % higher) and grain yield (about et al., 1999, Maddonni et al, 2001 b) therefore, it is of importance to understand the mechanisms that drive leaf reorientation.

Musambasi et.al. (2003) conducted a experiment in chumyika resettlement area to determine the effect of ridging treatments and two maize cultivars (R215 and SC 501) on striga as asitica density and maize grains yield during 1995-96 rainy reasons. They reported that the ridging plots planted to R215 supported fewer (1 plant m2) emerged, while it resulted in the highest number (3 plants /m2) in plots during 1994-95 season at eight –weeks after crop emergence. However particular cultivar is plants were in plots where the two maize cultivars were planted. During the 1995 -96 season, ridging at 5 weeks after cops emergence resulted in the last number emerged 5 asiatica plants at chinyudze and chibandes. Planting SC 501 on the flat resulted in the least grain – yield (123 kg/ha) during 1994 -95 season while planning it on ridges gave the highest grain yield (5197 kg/ha) during 1995 -96 season.

Manoj et.al. (2003) conducted at field experiment during rainy season (kharif) of 2000 at SASRID under rained condition of Negaland, to study the effect on nitrogen and phosphorus levels on yield and nutrient uptake on maize (zea maysh) cv. Vijay. The treatments comprised four nitrogen levels (No, N50, N100 and N150) and there phosphom levels (P0, P40 and P80). The stover and grain yield increased significantly with the increasing level of nitrogen and phosphorus. The highest stover grain yields were recorded 64.92 and 30 q/ha respectively, with the highest level of nitrogen and phosphorus (N150 and P50) combination did not show any significant effect on stover and grain yields the nitrogen & phespphrus uptake.

Maddonni et al.(2002) reported that commercial crops, maize (zea mays) plants are typical grown at a larger distance between rows (70 cm) than within the same row (16-23 cm). This rectangular arrangement creates a heterogeneous environment in which the plants receive higher red light (R) far-red light (FR) rations from the outer row spaces. In field crops, the hybrid Dekalb 696 (DK969) showed an increased proportion of leaves toward inter row spaces, whereas the experimental hybrid 980 (Exp980) retained random leaf orientation. Mirrors reflecting FR were placed close to isolated plants to simulate the presence of neighbors in the field. In addition, localized FR was applied to target leaves in a growth chamber. During their expansion, the leave of DK 696 turned away from the low R to FR ratio signal, whereas Exp 980 leaves remained unaffected. On the country, tailoring reduced and plant height was increased by low R to FR rations in Exp 980 but not in DK 969. isolated plants preconditioned with low R/FR-simulating neighbors in a North-South row showed reduced mutual shading among leaves when the plants were actually grouped in North-South rows. These observations contradict the current view that phytochrome-mediated responses to low R/FR are a relic from wild conditions, detrimental for crop yield.

The R to FR ratio signals are perceived by phytochromes, a family of photoreceptors with two photo-interconvertible forms, Pr and Pfr (Smith, 2000). High R to FR ratios increase the proportion of phytochromes in the biologically active Pfr from. Phytochromes modulate growth and development throughout plant development, including seed germination, seedling de-etiolation, shoot morphology, and flowering (Ballare and Casal, 2000, Casal, 2002)

Pandey et al.(2003) reported that an experiment was conducted during the rainy season 1998-99 at research Farm of Rajendra Agricultural University, Pusa(Bihar) to study the effect of maize (zea mays L.) based intercropping systems on maize yield under rainfed condition. They concluded that wherever the intercropping system reduced the values of yield attributes and grain yield of maize than sole cropping of maize but significant reduction in cob length, kernels/row , grains/cob and grain yield was recorded only with sesame (sesamum indicum L.), turmeric (curcuma lenga L.) and forage meth but act intercropping systems recorded significantly higher maize-equivalent yield, productivity(kg / ha /day) and significant reduction in weed dry-biomass than sole cropping of maize. Among the intercropping system; maize + turmeric showed significantly higher maize-equivalent yield and productivity (kg/ha/day), however significantly lower values of these were associated with maize + sesame. Maize + forage meth recorded the lowest weed population, weed dry-biomass and highest weed control efficiency but these all were found with maize + pigeon pea (cajanus cajan L. millsp.) intercropping system.

Paskiewicz et al.(2003) reported that higher plant population increases competition among individual plants for water, sunlight and soil nutrients. They suggested that the higher plant population may lower the individual plant-yield but increases yield per hectare by optimizing the relationship between the key yield components: Number of cobs per hectare, Number of kernels per cob and weight of each kernels(test weight kg/no. or kernel density).The new pioneer planting rate recommendation are provided by potential yield environment ,offering growers the opportunity to improve yields by increasing plant population, particularly in medium & high yield environment. They optimized & found plant population for maximizing grain yield between 104,000 to 110,000 plants / ha for individual hybrid, with little difference between the hybrid maturity groups tested .

Rusu et al.(1999) studied about long term fertilizer treatments on maize to determine the effect on maize grain yield of yield of yearly application of same nitrogen, phosphorus and potassium rates on organic mineral soil. Such experiment had been initiated in 1962 on typical chennozem and brown-lubic soil in Romania. The yield & soil chemical properties had also been determined in 1963 to 1997. 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 chemozem. En 1985,five ton per ha calcium carbonate was applied on brown –luvi soil .Afterward in 1993,10kg Zn/ha,2kgMo/ha and 2 kg B/ha were applied on both the soil types on chemozem,15 kg Mn was also applied. Maize yield varied with fertilizer treatment, weather and soil type. Yield was higher on unfertilized chemozone than on brown-luvic soil with difference greater in unfertilized control than where fertilizers were applied.

1. How to maintain access to genetic resources.
2. How to maintain access to cutting edge technology.

3. How to maintain access to genomic data-bases and other sources of information needed for biotechnology-assisted crop improvement research.
4. How to maintain and stabilize funding. CIMMYT concluded that " over- one third of the developing word's maize area is still planted to farm-saved seed of uncertain genetic background and variable quality. In many instances, farmers continue to use farm-saved seed not because MVs are unavailable; rather the problem is that small-scale, subsistence-oriented farmers located in isolated rural areas are not well integrated into the market economy. As CIMMYT and its partners look to the future, they will be challenged to come-up with creative approaches to reaching the millions of non-commercial farmers who will do not enjoy full access to the fruits of the international breeding system." This report shows that the yield of maize among the developing countries is comparatively very less while these countries allotting a major part of their total cultivated area. In Indian agriculture, there are 2 / 3rd farmers having small–holdings and they used to traditional seeds & cultivation methods, hence if my subject based method would be successful in any climate and anywhere in the world, this will be the best technique to increase grain yield of new hybrid varieties of maize in addition to other inputs.

Saha et al. (2001) conducted a field experiment to find-out the suitable dose of fertilizer for hybrid- maize (var. sohag), two planting system and four fertilizer levels were used as treatment variables. They had been found highest grain yield of maize from the appropriate dose of fertilizer. The yield attributes increased with the increased fertilizer dose in maize but reverse in soybean from economic point of view, the highest benefit-cost-ratio was obtained from the fertilizer dose 250-120 , 120-40 and 40-5 of N, P2O5, K 2 O, S and Zn Kg/ ha in both normal and paired row system of Joydebpur of Bangladesh.

Selvam (2002): conducted a field experiment for M. tech dissertation on Application of 'DSSAT' for prediction of yield of maize. They found and reported that the grain-yield of maize increased with the increasing off plant population up to some extant from 4 to 6 plant/m^2 but dectased the number of grains per crop and unit weight of grain. He also found and reported that the maize grain yield increased, unit weight of grain (karnels) and number of grains per cob with the increasing levels of nitrogen 0 to 100kgN/ha. The other inputs were assumed & results summarized as:

1. Increasing the plant population increased grain yield with increased plant population 4-6 plant/m^2.

   (a) To 1.87 %, 2.12% when no nitrogen was applied.

   (b) To 1.53 %, 2.38% when 50 kg/ha nitrogen applied.

   (c) To 3.03 %, 5.14 % with the 100 kg N/ha nitrogen was applied.

2. The maize grain yield increased with the application of nitrogen for 0 to 100 kg/ha.

   (a) To 39.50-40.60 % when 50 kg N/ha was applied.

   (b) To 48.80 – 53.20 % when 100 kg N/ha was applied.

There above DSSAT findings were predicated almost similar to observed result within the acceptable limits.

Stewart et al. (2003) conducted & reported about the amount and distribution of leaf area and leaf angle in a crop canopy determine how photo synthetically active radiation (PAR) is intercepted ad consequently influences canopy photosynthesis and yield. Factors such as plant shape, plant populations, and row width will affect these leaf distributions and can occur in an almost infinite number of different combinations. To supplement experimentation, a mathematical mode, was developed to use measurements of leaf area and leaf angle in two dimensions (with height and across the row) to calculate PAR interception and canopy photosynthesis. The extreme phenotypes leaf and reduced stature were included to very plant height and number of leaves above the ear. Measure elements of average PAR at various levels were made in seven different canopies and compared with calculations from the model (R^2 of 0.68 and 0.92 for two sets of data). As well, measurements of PAR at 20-cm increment on transects perpendicular of the row were made in three canopy type a three levels and compared with theoretical calculations ($R^2 = 0.74$). A simple numerical experiment was run to demonstrate the utility of the model where daily canopy photosynthesis wads calculated for two row widths and seven plant types. One result was that depending on row widths, plants with very upright levels can have both the smallest and largest daily canopy photosynthesis.

William et al., (2003) reported that in narrow rows at high plant densities and N fertility evaluated first-year, second-year and continuous corn in field scale studies at 0.76- and 0.38-m row spacing at recommended densities (85000) plants ha^{-1}) and N fertility (165 kg/ha^{-1}) and at 0.38-m spacing at high densities (100000 $plant/ha^{-1}$) and N fertility (225 kg/ha^{-1}) in 1998, 1999, and 2000 to determine if narrow-row com at high vs. recommended densities and N fertility had similar soil NO_3-3 concentrations in the upper 0.3-m depth and whole-plant N concentrations at the sixth leaf stage of com (V6) as well as similar ear-leaf N concentrations at silking in eight of the nine site-year comparisons. All treatments were above critical concentration for soil NO_3-N concentrations (<25 mg kg^{-1}), whole-plant N concentration (>35 g kg^{-1}), and ear-leaf N concentration (25> g mg^{-1}), except in the cool 2000 season). Consequently, narrow-row com at high vs. recommended densities and N fertility had similar dry matter yield and quality in eight site-year comparisons. Furthermore, narrow-row com at high vs. recommended densities and N fertility had greater residual soil NO_3-N concentrations in three site-year comparisons. They recommended that dairy producers in the north eastern USA grow narrow-row com forage at recommended plant densities and N fertility.

William et al., (2002) reported alert plant density level and row width for corn grain yield may very with location, primarily latitude, in the com belt. This study was conducted to evaluate com grain yield, harvest moisture, test weight, and stalk lodging with modern com hybrid, as affected by row width and plant density in the northern Com Belt. At six locations in 1998 and 1999, four hybrid differing in relative maturity. Ear type, plant height, and leaf orientation were planted at row widths of 76, 56, and 38 cm and five plant density levels ranging from 56000 to 90000 plants ha^{-1}. Plots were arranged randomly in a split-split plot configuration. Result show that corn grain yield increased 2 and 4% and harvest moisture decreased by a factor of 2.1% when row width was narrowed from 76 cm to 56 cm and 38 cm, respectively. The highest plant density evaluated, 90000 plants ha^{-1}, had the highest grain yield. Grain moisture decreased and grain test weight increases slightly as plant density increased. A hybrid x row width interaction was not observed indicating that hybrid that yield well in conventional 76-cm row systems will also yield well in narrow systems.

METHODOLOGY

3.1 GENERAL SITE INFORMATION

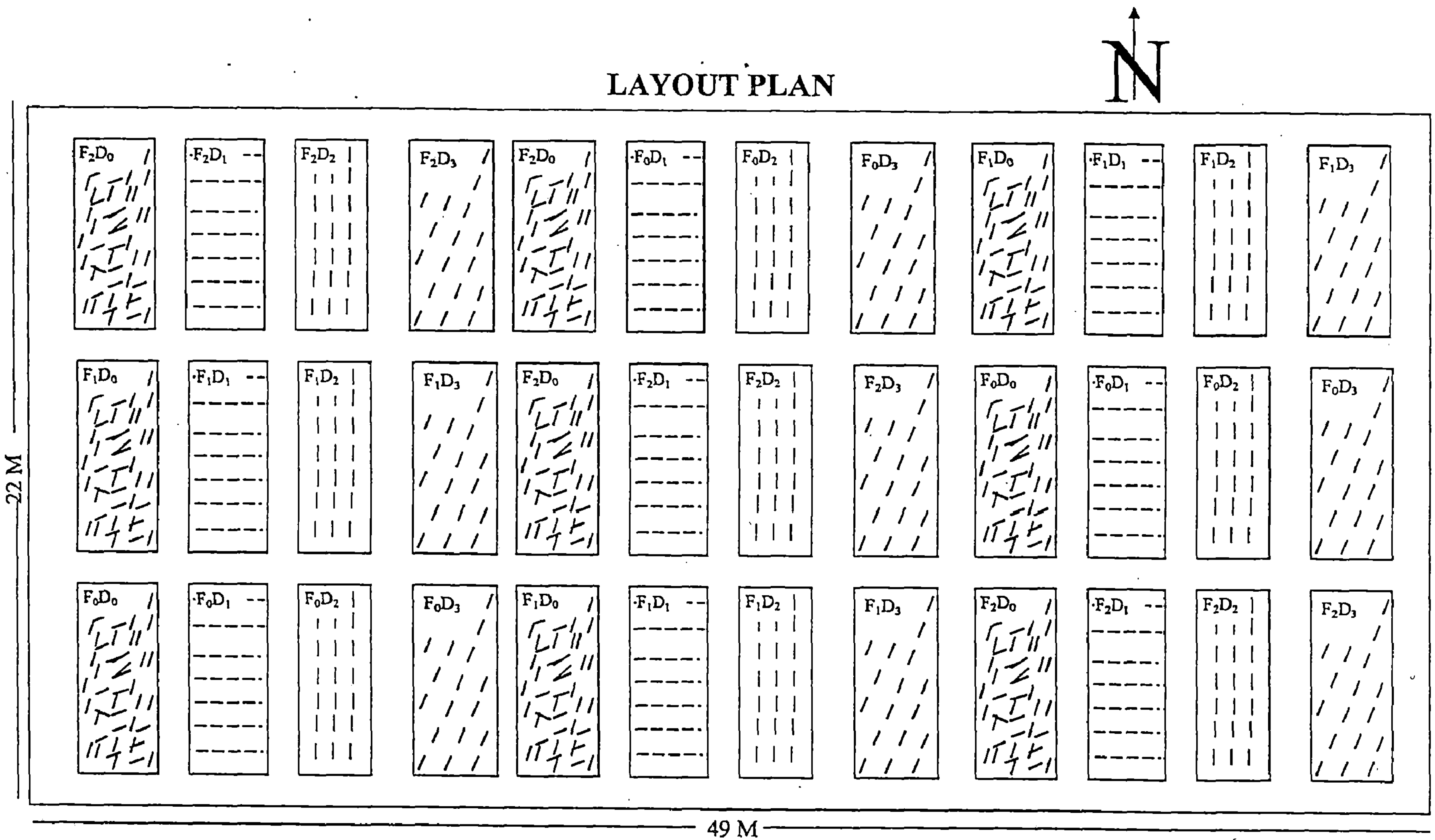
The plan was prepared according to the subject title and experimentation at WRDTC, Demonstration Farm, IIT-R campus, Roorkee (India) .The details of my field site as well as initial work are as follows:-

Experimented duration	:	19.06.2003 to 25.09.2003
Location of site	:	WRDTC Demonstrations farm IIT-R
Latitude	:	29^0 –52′ N
Longitude	:	77^0 -54′ E
Altitude	:	252.00m (above MSL)
Preparation of field	:	19.06.2003 and 21.06.2003
Date of Layout	:	21.06.2003
Date of sowing	:	22.06.2003
Number of observation plots	:	36 nos.
Variety of seed	:	Hybrid – maize " K-25 (kanchan Ganga)
Date of weeding	:	12.07.2003
Date flowering	:	04.08.2003
Date of harvesting	:	20.9.2003

3.2 FIELD PREPARATION AND LAYOUT

The selected part of Demonstration Farm was ploughed by tractor on 19.06.2003 and 21.06.2003, thereafter the field manually cleared free from the previous root residuals. On 21.06.2003. The layout has been demarcated as per plan with the help of measuring tape, string and pegs (Fig. 3.1 and 3.2). We laid the experimental plots and allotted its serial numbers so that we would differentiate among them. We also applied the organic manure (FYM) @8 t / ha in F1 type plots and @16.5 t / ha in F2 type plots but F0 type plots were keep without FYM.

LAYOUT PLAN



TREATMENTS:

Farmyard manure

F_0 = 0 (without FYM applications)
F_1 = 8.0 t/ha (FYM applied)
F_2 = 16.5 t/ha. (FYM applied)

Row- directions

D_0 = Random row-direction planting.
D_1 = East-West row-direction planting
D_2 = North-South row-direction planting
D_3 = NE-SW row-direction planting

FIG-3.1Showing the layout plan of experimental plots of hybrid maize at Demonstration farm WRDTC, IIT-Roorkee.

Fig. 3.2: Showing the preparation of field and mixing of organic manure

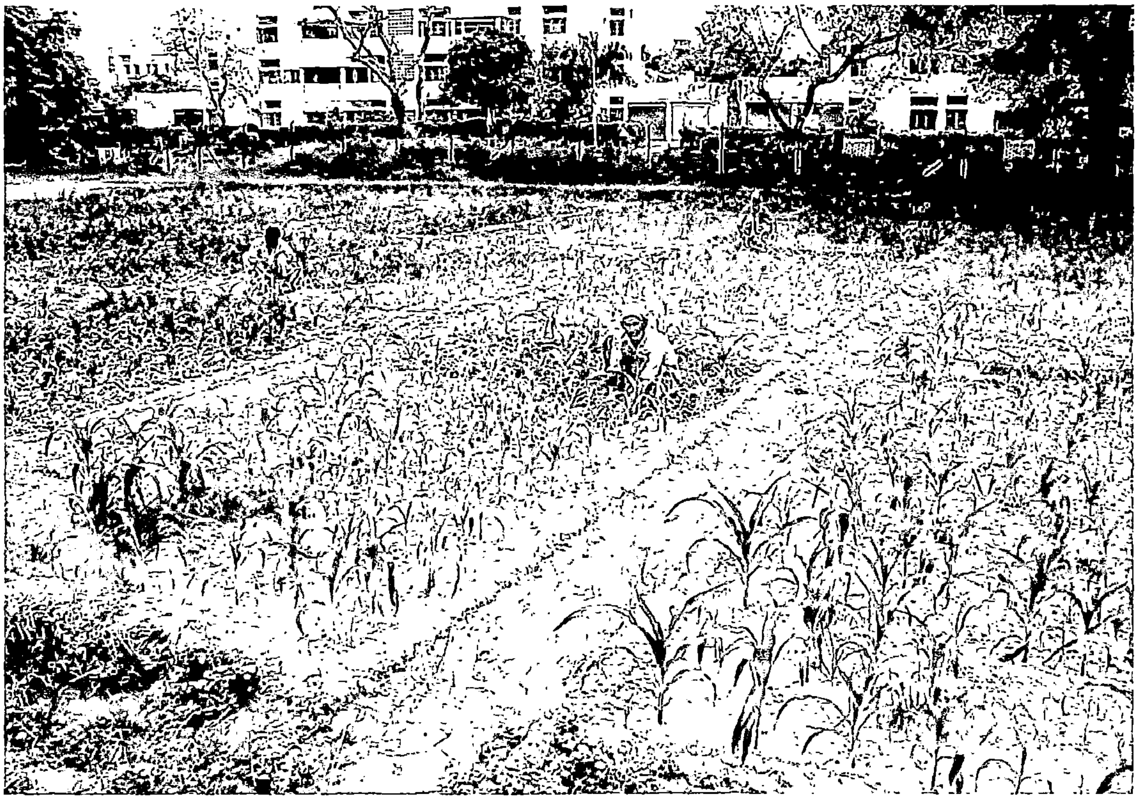


Fig. 3.3: Showing weed removing from plots of hybrid maize at demo farm
WRDTC IIT-ROORKEE

3.3 PLOTS – INFORMATION

The details of plots may summaries as under:

Number of observation plots	:	36 nos.
Area of each plot	:	18 sq.m
Size of each plot	:	6 m X 3 m
Plant to plant spacing	:	25 cm
Row to Row spacing	:	50cm
Replications	:	3 nos.

TABLE 3.1 : Showing the Designation and Serial Number of Experimental Plots

Plot No.	Designation	Plot No.	Designation	Plot No.	Designation
1	F2 D0	13	F1 D0	25	F0 D0
2	F2 D1	14	F1 D1	26	F0 D1
3	F2 D2	15	F1 D2	27	F0 D2
4	F2 D3	16	F1 D3	28	F0 D3
5	F0 D0	17	F2 D0	29	F1 D0
6	F0 D1	18	F2 D1	30	F1 D1
7	F0 D2	19	F2 D2	31	F1 D2
8	F0 D3	20	F2 D3	32	F1 D3
9	F1 D0	21	F0 D0	33	F2 D0
10	F1 D1	22	F0 D1	34	F2 D1
11	F1 D2	23	F0 D2	35	F2 D2
12	F1 D3	24	F0 D3	36	F2 D3

3.4 TREATMENTS

It has already been discussed: F0, F1 and F2 are the treatments :

Farm yard manure (FYM) :

F0 - Plots without application of FYM.

F1 –Plots applied FYM @ 8.0 ton / ha.

F2 –Plots applied FYM@ 16 ton / ha.

Row – Directions:

D0 –Random row –direction.

D1 –East - West row –direction.

D2 – North –South row-direction.

D3 –N E - SW row- direction.

3.5 CULTIVARS

There are hundreds of varieties of hybrid maize available in the market. The variety used for this experiment is **K-25, Kanchan-Ganga** which is developed by the private company from Hydrabad (A.P.)

3.6 INITIAL CONDITIONS

The field was fallow after previous wheat crop. It was prepared properly as mentioned in 3.2. The root residuals were picked-up manually and removed from field after ploughing. The climate was dry during sowing.

3.7 SOWING (OR PLANTING) DETAILS

When the experimental field had been prepared properly and laid-out as per plan. The prescribed seed were sowed by 'hill-sowing method' in experimental plots on 22.06.2003, the details are as under:-

Method of sowing adopted	: Hill-sowing
Seed / hill	: 2 nos.
Depth of sowing	: 3.5 cm.
Hill to hill (plant to plant) spacing	: 25 cm.
Row to row spacing	: 50 cm.
Seed-rate	: 30 kg / ha.

3.8 WEEDING

Weeding or weed removing is a process to pick-up undesirable vegetation from crop, otherwise it will compete with the crop. In presence of weeds the growth & development of crop would be effected, ultimately the yield of crop will be reduce. In this experiment, weed removal has been done at 20 DAS (on 11. 07. 2003), Just before the first irrigation. There were reasons to choose this stage as weeding first to curtail the competitors for water & nutrients removed from soil. The other reason for weeding is to increase the soil porosity for easy infiltration of irrigation - water in to the soil. This process came under intercultural.

3.9 IRRIGATION

The irrigation is an artificial supply of water to the crop for meeting-out the water-requirement of crops. In this experiment the water-stress was experienced by the symptoms on leaf. The crop was uniformly irrigated on 12.07.2003 (85 mm) and on 08.08.2003 (85 mm).

3.10 WATER MANAGEMENT AND ENVIRONMENTAL IMPACT

The water stress in maize generally found (20 DAS or 40 – 47 DAS) at growth, flowering and silking stages, therefore the above dates have been chosen in absent of 'rain'. Water is a prime in dispensable, finite and vulnerable natural resources. Water travels from sea and land to the air and back to the sea and land by hydrological cycle [22]. Kharif crop of maize is generally grown under rainfed conditions as maize required water 500 – 800 mm during the crop – period. If it grown in rainy (kharif) season, the maximum water requirement will be meet out through natural rain. Thus water-storage will be save and utilize in other crops. The soil erosion may be reduce through maize crop during rainy season. The water management techniques including drainage practices to raise a good crop of maize with higher yield. The depth interval of frequency of irrigation depends on climatic situations.

Maize is a good crop to utilize as environmental impact as this is one of the C-4 syndrom crop. Thus it is best removal of CO_2 from surroundings hence it will diminishing to green house effect. Hence the maize (kharif) crop may be used as water management and environmental impact tool.

3.11 WEATHER DATA

At the WRDTC, Demonstration Farm, the weather station (observatory) has already been installed. The daily weather data i.e. Temperature, humidity, rain-fall, wind-speed, pan-evaporation and ground-water table which may influence to yield of hybrid maize. The data-Tables of experimentation (entire crop-period) site are shown in Table 3.2 - 3.5, and figures, 3.2-3.5 are given in Annexure.

Table 3.2 : Showing Daily weather data of cropping period of Hybrid Maize

(From 22-6-2003 to 20-9-2003)

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

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

Month-June

Date	Julian Day	T. max. ^{0}C	T. min. ^{0}C	Solar Radiation MJ/m^2 day	Rainfall mm	Sunshine Hrs.
1/06/03	73152	41.5	25	28.1	0	12
2/06/03	73153	43	25	28.8	0	12.3
3/06/03	73154	42.5	24.5	28.8	0	12.3
4/06/03	73155	41	27	28.8	0	12.3
5/06/03	73156	38.5	24.5	25.1	0	10
6/06/03	73157	39	27.5	28.1	0	12
7/06/03	73158	40	26	28.1	0	12
8/06/03	73159	38	26.5	26.6	0	11
9/06/03	73160	37.5	24.5	25.1	0	10
10/06/03	73161	39.5	29	25.1	0	10
11/06/03	73162	41	26	23.6	0	9
12/06/03	73163	41	28.5	26.6	0	11
13/06/03	73164	41	27	26.6	0	11
14/06/03	73165	40	26	27.4	0	11.3
15/06/03	73166	39.5	26.5	28.1	0	12
16/06/03	73167	39	26	28.1	0	12
17/06/03	73168	37	26.5	28.1	0	12
18/06/03	73169	28	22	26.6	24	11
19/06/03	73170	33	22.5	14.8	0	3
20/06/03	73171	29	27	14.8	0	3
21/06/03	73172	29.5	25	25.1	0	10
22/06/03	73173	30	24.5	26.6	0	11
23/06/03	73174	30	23.5	28.1	13	12
24/06/03	73175	35.5	26.5	20.7	0	7
25/06/03	73176	34.5	25.5	26.6	0	11
26/06/03	73177	37	27	26.6	0	11
27/06/03	73178	32	24	27.3	5.6	11.3
28/06/03	73179	31.5	22	26.6	6.4	11
29/06/03	73180	32	23	23.6	0	9
30/06/03	73181	32.5	25	22.1	9.4	8

Table 3.3: Showing Daily weather data of cropping period of Hybrid Maize

(From 22-6-2003 to 20-9-2003)

Month: JULY

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

Table 3.4: Showing Daily weather data of cropping period of Hybrid Maize

(From 22-6-2003 to 20-9-2003)

Month: AUGUST

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

Table 3.5: Showing Daily weather data of cropping period of Hybrid Maize

(From 22-6-2003 to 20-9-2003)

Month: SEPTEMBER

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

3.12 GROWTH AND DEVELOPMENT OBSERVATION

3.12.1 Plant Physiology

Plant number, plant height, leaves number / plant, leaves length, leaf breadth etc. Those observations were recorded at 20 days intervals (cm), 40 DAS, 60 DAS and 80 DAS.

3.12.2 Dry Weight

Dry weight was observed at 20 days intervals (40 DAS, 60 DAS and 80 DAS). Dry-weight of plant was observed recorded.

3.12.3 Rooting Depth

Soil samples was collected at 40, 60 and 80 DAS, between two hills of plant upto depth of 90 cm and 1.20 m. Those samples were collected by hand auger in the block of 15 cm from each plot and observed the root depth in different layers and root density.

The biotic and abiotic factor which are responsible to influence the growth of hybrid maize were observed as below.

(a) Plant Number : The observation was taken at emergent stage or at 40 DAS, 60 and 80 DAS (almost at flowering)

(b) Leaf area index (LAI): Leaf area is important for photosynthesis. Leaf area per unit of land area is important for analysis of crop production. It is called leaf area index (LAI).

$$LAI = \frac{\text{Total Leaf area}}{\text{Ground area}}$$

$$LAI = \frac{\text{Hillno./M}^2 \times \text{leafno/hill} \times \text{Av.leaf length} \times \text{Av.leafwidth} \times \text{Shape factor}}{10^4}$$

(c) Crop Growth Rate (CGR)

It is defined as the rate of crop growth, expressed as gram of dry matter productions per day. The effect of row –direction & FYM on CGR has shown [Ref. A-V].

$$CGR = \frac{W_2 - W_1}{t_2 - t_1}$$

where as W_1 and W_2 are dry matter weights at time t_1 and t_2

(d) Relative growth rate (RGR)

It is defined as the rate of growth per unit dry matter and expressed as gram (g) of dry matter produced by a gram of existing dry matter in a day.

$$RGR = \frac{\log_e W_1 - \log_e W_1}{t_2 - t_1}$$

where W_1 and W_2 are the dry matter of plants at time t_1 and t_2.

(e) Days to 50% of flowering and silking.

It is the number of days in which 50% the plants flowered. The observations have taken & found 50% flowering at 43-46 DAS.

(f) Days to Maturity

It is the number of days in which the plants attain maturity for harvesting. This crop observed matured at 87 DAS and harvested on 20.09.2003 as mentioned in 3.1.

3.13 YIELD ANALYSIS

The analysis of yield was as under.

(i) Grain yield

Grain yield was recorded after the harvest of the crop in q / ha. Globally status of Grain-yield shown [Plate. A- III].

(ii) Yield Attributes

(a) Grain/ cob

Grains were counted and recorded as numbers / cob.

(b) Test weight

The 100 grains weight was recorded (g).

3.14 ANALYSIS OF VARIANCE (ANOVA)

All observed and recorded data on growth and development at every 20 days interval (w.e.f. 40 DAS) and yield attribute at harvest were nalysed statistically with factorial design. The ANOVA table used as format below:

Source of variance	D.f.	Sum of square	Mean sum square	F. value	F. Tabulated		C.D. (P = 0.05)
					95%	99%	

OBSERVATIONS AND ANALYSIS

4.1. OBSERVATIONS

The observations of the field experiment started since sowing. The weather observation have taken and recorded from 22nd may 2003 from weather observatory of W.R.D.T.C. Demo. Farm i.e. minimum & maximum temperature, relative humidity, Rainfall, wind velocity etc. As shown in fig. 4.1.

4.2. PLANT PHYSIOLOGY

This type of observation would be started since seedling or emergent stage to harvest, in different stages i.e. 40 DAS, 60 DAS and 80 DAS and different components of crop plant height, Leaf Length, Leaf breadth Leaves numbers, Dry-weight and yield attributes etc.

4.2.1. Plant Number

The plant numbers were observed at 40 DAS, 60 DAS and 80 DAS and data presented is Table 4.1 to 4.3.

4.2.2. Leaves Number

Leaves number per plant have observed at 40 DAS, 60 Das and 80 DAS data is presented in Table 4.4 to 4.6.

4.2.3 Plant Height

Plant height observations were also taken at 40 DAS, 60 DAS and 80 DAS. Data presented in Table 4.7 to 4.9

4.2.4Leaves Length

The leaf length observations are essential to study the LAI, therefore these observations were taken at 40 DAS, 60 DAS and 80 DAS and data presented in Table 4.10 to 4.12.

4.2.5 Leaves Breadth

The leaf breadth is also required for calculating LAI. The observation recorded and presented in Table 4.13 to 4.15.

FIG - 4.1: Showing the observation at silking stage of hybrid maize at Demo. Farm
WRDTC IIT-ROORKEE

4.2.6 Plant Dry-Weight

Plant dry weight observations were taken at 40 DAS, 60 DAS and 80 DAS. The data is presented in Table 4.16 to 4.18

4.2.7 Rooting Depth

The observation were also taken at 40 DAS, 60 DAS and 80 DAS. Data presented in Table 4.19 to 4.21.

Page no:30

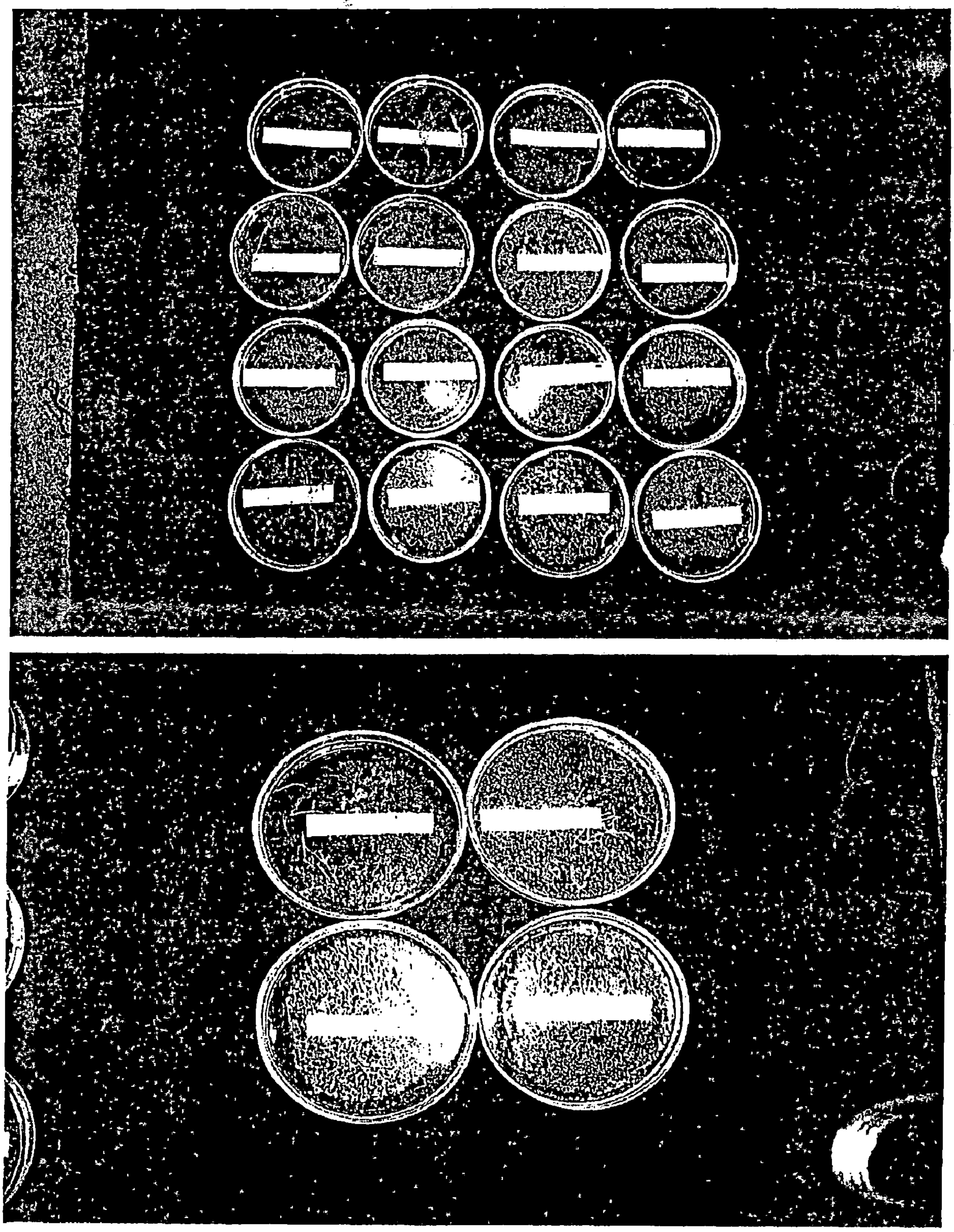


FIG- 4.2: Showing the observation of Rooting depth and density of hybrid maize

4.2.8 Cob Survivability

The observation has been taken plot-wise as Table 4.24

4.2.9 Grains/Cob

The observation taken and averaged (i.e. 371.25 grains/cob) as shown Fig 4.3

FIG- 4.3: showing the Grains/Cob observation of hybrid maize at site

4.2.10 Grain Test Weight

The grain test weight (100 grains) were observed were taken and recorded in table 4.22.

4.2.11 Grain Yield

The plot wise weights of grain were taken recorded and testified by Analysis of variance method as in Table 4.23. The effect of row-direction & FYM application on Grain-yield has shown [A- IV].

Table- 4.1: Showing the Plant Number at 40 DAS influenced with row direction and organic manuring in Hybrid Maize

PLANT NUMBER AT 40 DAS

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	138.00	136.00	139.00	413.00		56861.00		170569.00	2256004.00	137.67
F0D1	128.00	125.00	128.00	381.00		48393.00		145161.00	2232036.00	127.00
F0D2	126.00	121.00	129.00	376.00		47158.00		141376.00	2301289.00	125.33
F0D3	108.00	109.00	108.00	325.00		35209.00		105625.00	0	108.33
F1D0	139.00	139.00	134.00	412.00		56598.00		169744.00	0	137.33
F1D1	128.00	129.00	128.00	385.00		49409.00		148225.00	0	128.33
F1D2	124.00	124.00	134.00	382.00		48708.00		145924.00	0	127.33
F1D3	109.00	109.00	110.00	328.00		35862.00		107584.00	0	109.33
F2D0	140.00	138.00	137.00	415.00		57413.00		172225.00	0	138.33
F2D1	126.00	130.00	124.00	380.00		48152.00		144400.00	0	126.67
F2D2	124.00	123.00	132.00	379.00		47929.00		143641.00	0	126.33
F2D3	112.00	111.00	114.00	337.00		37861.00		113569.00	0	112.33
TOTAL	1502.00	1494.00	1517.00	4513.00	565754.69	569553.00	3798.31	3592.97	22.72	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	413	381	376.00	325.00	1495	2235025.00	1537600.00		124.58
F1	412.00	385.00	382.00	328.00	1507.00	2271049.00	1313316.00		125.58
F2	415.00	380.00	379.00	337.00	1511.00	2283121.00	1292769.00		125.92
	0	0	0	0	0	0.00	980100.00		
TOTAL	1240	1146	1137.00	990.00	4513	11.56	3554.75	26.67	
Av.(Dir.)	137.78	127.33	126.33	110.00					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	22.72	11.36	1.37			
F	2	11.56	5.78	0.70	3.44	5.72	2.43
D	3	3554.75	1184.92	142.75	3.05	4.82	2.81
F*D	6	26.67	4.44	0.54	2.55	3.76	4.87
Error	22	182.61	8.30				
TOTAL	35	3798.31	1214.80				

Table- 4.2: Showing the Plant Number at 60 DAS influenced with row direction and organic

PLANT NUMBER AT 60 DAS

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	136.00	134.00	136.00	406.00		54948.00		164836.00	2155024.00	135.33
F0D1	125.00	123.00	122.00	370.00		45638.00		136900.00	2166784.00	123.33
F0D2	122.00	119.00	126.00	367.00		44921.00		134689.00	2172676.00	122.33
F0D3	105.00	107.00	105.00	317.00		33499.00		100489.00	0	105.67
F1D0	135.00	136.00	131.00	402.00		53882.00		161604.00	0	134.00
F1D1	124.00	128.00	126.00	378.00		47636.00		142884.00	0	126.00
F1D2	122.00	123.00	129.00	374.00		46654.00		139876.00	0	124.67
F1D3	107.00	107.00	106.00	320.00		34134.00		102400.00	0	106.67
F2D0	138.00	136.00	132.00	406.00		54964.00		164836.00	0	135.33
F2D1	124.00	129.00	120.00	373.00		46417.00		139129.00	0	124.33
F2D2	121.00	121.00	130.00	372.00		46182.00		138384.00	0	124.00
F2D3	109.00	109.00	111.00	329.00		36083.00		108241.00	0	109.67
TOTAL	1468.00	1472.00	1474.00	4414.00	541205.44	544958.00	3752.56	3550.56	1.56	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	406	370	367.00	317.00	1460	2131600.00	1473796.00		121.67
F1	402.00	378.00	374.00	320.00	1474.00	2172676.00	1256641.00		122.83
F2	406.00	373.00	372.00	329.00	1480.00	2190400.00	1238769.00		123.33
	0	0	0	0	0	0.00	933156.00		
TOTAL	1214	1121	1113.00	966.00	4414	17.56	3501.44	31.56	
Av.(Dir.)	134.89	124.56	123.67	107.33					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	1.56	0.78	0.09			
F	2	17.56	8.78	0.96	3.44	5.72	2.55
D	3	3501.44	1167.15	128.10 **	3.05	4.82	2.95
F*D	6	31.56	5.26	0.58	2.55	3.76	5.10
Error	22	200.44	9.11				
TOTAL	35	3752.56	1191.07				

Table- 4.3: Showing the Plant Number at 80 DAS influenced with row direction and organic

PLANT NUMBER AT 80 DAS

Rep./Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	136.00	134.00	135.00	405.00		54677.00		164025.00	2152089.00	135.00
F0D1	124.00	123.00	120.00	367.00		44905.00		134689.00	2102500.00	122.33
F0D2	122.00	118.00	124.00	364.00		44184.00		132496.00	2099601.00	121.33
F0D3	105.00	104.00	103.00	312.00		32450.00		97344.00	0	104.00
F1D0	135.00	134.00	130.00	399.00		53081.00		159201.00	0	133.00
F1D1	124.00	123.00	121.00	368.00		45146.00		135424.00	0	122.67
F1D2	122.00	121.00	126.00	369.00		45401.00		136161.00	0	123.00
F1D3	107.00	106.00	105.00	318.00		33710.00		101124.00	0	106.00
F2D0	138.00	134.00	130.00	402.00		53900.00		161604.00	0	134.00
F2D1	124.00	126.00	119.00	369.00		45413.00		136161.00	0	123.00
F2D2	121.00	120.00	128.00	369.00		45425.00		136161.00	0	123.00
F2D3	109.00	107.00	108.00	324.00		34994.00		104976.00	0	108.00
TOTAL	1467.00	1450.00	1449.00	4366.00	529498.78	533286.00	3787.22	3623.22	17.06	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	405	367	364.00	312.00	1448	2096704.00	1454436.00		120.67
F1	399.00	368.00	369.00	318.00	1454.00	2114116.00	1218816.00		121.17
F2	402.00	369.00	369.00	324.00	1464.00	2143296.00	1214404.00		122.00
	0	0	0	0	0	0.00	910116.00		
TOTAL	1206	1104	1102.00	954.00	4366	10.89	3587.00	25.33	
Av.(Dir.)	134.00	122.67	122.44	106.00					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	17.06	8.53	1.28			
F	2	10.89	5.44	0.82	3.44	5.72	2.18
D	3	3587.00	1195.67	179.01 **	3.05	4.82	2.52
F*D	6	25.33	4.22	0.63	2.55	3.76	4.37
Error	22	146.94	6.68				
TOTAL	35	3787.22	1220.54				

Table 4.4 Showing the Leaf Number per plant influenced with row direction and organic manuring at 40 DAS

LEAVES NUMBER PER PLANT AT 40 DAS (nos.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	13.00	13.00	14.00	40.00		534.00		1600.00	27556.00	13.33
F0D1	14.00	15.00	15.00	44.00		646.00		1936.00	27225.00	14.67
F0D2	14.00	15.00	15.00	44.00		646.00		1936.00	28561.00	14.67
F0D3	14.00	14.00	15.00	43.00		617.00		1849.00	0	14.33
F1D0	13.00	13.00	14.00	40.00		534.00		1600.00	0	13.33
F1D1	14.00	16.00	14.00	44.00		648.00		1936.00	0	14.67
F1D2	14.00	13.00	14.00	41.00		561.00		1681.00	0	13.67
F1D3	14.00	13.00	13.00	40.00		534.00		1600.00	0	13.33
F2D0	17.00	13.00	13.00	43.00		627.00		1849.00	0	14.33
F2D1	13.00	11.00	15.00	39.00		515.00		1521.00	0	13.00
F2D2	14.00	13.00	13.00	40.00		534.00		1600.00	0	13.33
F2D3	12.00	16.00	14.00	42.00		596.00		1764.00	0	14.00
TOTAL	166.00	165.00	169.00	500.00	6944.44	6992.00	47.56	12.89	0.72	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	40	44	44.00	43.00	171	29241.00	15129.00		14.25
F1	40.00	44.00	41.00	40.00	165.00	27225.00	16129.00		13.75
F2	43.00	39.00	40.00	42.00	164.00	26896.00	15625.00		13.67
	0	0	0	0	0	0.00	15625.00		
TOTAL	123	127	125.00	125.00	500	2.39	0.89	9.61	
Av.(Dir.)	13.67	14.11	13.89	13.89					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	0.72	0.36	0.23			
F	2	2.39	1.19	0.77	3.44	5.72	1.05
D	3	0.89	0.30	0.19	3.05	4.82	1.21
F*D	6	9.61	1.60	1.04	2.55	3.76	2.10
Error	22	33.94	1.54				
TOTAL	35	47.56	5.00				

Table 4.5 Showing the Leaf Number per plant influenced with row direction and organic manuring at 60 DAS

LEAVES NUMBER PER PLANT AT 60 DAS (nos.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	11.00	12.00	13.00	36.00		434.00		1296.00	20164.00	12.00
F0D1	11.00	11.00	12.00	34.00		386.00		1156.00	20449.00	11.33
F0D2	13.00	12.00	12.00	37.00		457.00		1369.00	20449.00	12.33
F0D3	12.00	13.00	11.00	36.00		434.00		1296.00	0	12.00
F1D0	13.00	12.00	13.00	38.00		482.00		1444.00	0	12.67
F1D1	13.00	13.00	12.00	38.00		482.00		1444.00	0	12.67
F1D2	12.00	12.00	11.00	35.00		409.00		1225.00	0	11.67
F1D3	11.00	10.00	11.00	32.00		342.00		1024.00	0	10.67
F2D0	13.00	12.00	11.00	36.00		434.00		1296.00	0	12.00
F2D1	11.00	13.00	13.00	37.00		459.00		1369.00	0	12.33
F2D2	10.00	12.00	13.00	35.00		413.00		1225.00	0	11.67
F2D3	12.00	11.00	11.00	34.00		386.00		1156.00	0	11.33
TOTAL	142.00	143.00	143.00	428.00	5088.44	5118.00	29.56	11.56	0.06	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	36	34	37.00	36.00	143	20449.00	12100.00		11.92
F1	38.00	38.00	35.00	32.00	143.00	20449.00	11881.00		11.92
F2	36.00	37.00	35.00	34.00	142.00	20164.00	11449.00		11.83
	0	0	0	0	0	0.00	10404.00		
TOTAL	110	109	107.00	102.00	428	0.06	4.22	7.28	
Av.(Dir.)	12.22	12.11	11.89	11.33					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	0.06	0.03	0.03			
F	2	0.06	0.03	0.03	3.44	5.72	0.76
D	3	4.22	1.41	1.73	3.05	4.82	0.88
F*D	6	7.28	1.21	1.49	2.55	3.76	1.53
Error	22	17.94	0.82				
TOTAL	35	29.56	3.49				

Table 4.6 Showing the Leaf Number per plant influenced with row direction and organic manuring at 80 DAS

LEAVES NUMBER PER PLANT 80DAS (nos.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	15.00	14.00	14.00	43.00		617.00		1849.00	30976.00	14.33
F0D1	15.00	15.00	16.00	46.00		706.00		2116.00	32400.00	15.33
F0D2	15.00	16.00	15.00	46.00		706.00		2116.00	32400.00	15.33
F0D3	14.00	15.00	15.00	44.00		646.00		1936.00	0	14.67
F1D0	14.00	15.00	14.00	43.00		617.00		1849.00	0	14.33
F1D1	15.00	16.00	16.00	47.00		737.00		2209.00	0	15.67
F1D2	15.00	14.00	17.00	46.00		710.00		2116.00	0	15.33
F1D3	14.00	16.00	14.00	44.00		648.00		1936.00	0	14.67
F2D0	16.00	14.00	13.00	43.00		621.00		1849.00	0	14.33
F2D1	14.00	15.00	15.00	44.00		646.00		1936.00	0	14.67
F2D2	15.00	14.00	16.00	45.00		677.00		2025.00	0	15.00
F2D3	14.00	16.00	15.00	45.00		677.00		2025.00	0	15.00
TOTAL	176.00	180.00	180.00	536.00	7980.44	8008.00	27.56	6.89	0.89	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	43	46	46.00	44.00	179	32041.00	16641.00		14.92
F1	43.00	47.00	46.00	44.00	180.00	32400.00	18769.00		15.00
F2	43.00	44.00	45.00	45.00	177.00	31329.00	18769.00		14.75
	0	0	0	0	0	0.00	17689.00		
TOTAL	129	137	137.00	133.00	536	0.39	4.89	1.61	
Av.(Dir.)	14.33	15.22	15.22	14.78					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	0.89	0.44	0.49			
F	2	0.39	0.19	0.22	3.44	5.72	0.80
D	3	4.89	1.63	1.81	3.05	4.82	0.93
F*D	6	1.61	0.27	0.30	2.55	3.76	1.60
Error	22	19.78	0.90				
TOTAL	35	27.56	3.44				

Table. 4.7: Showing effect of row-direction and FYM on plant height at 40 DAS

PLANT HEIGHT AT 40DAS (cm.)

ep /Trea	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	106.00	107.00	127.00	340.00		38814.00		115600.00	1968409.00	113.33
F0D1	125.00	129.00	137.00	391.00		51035.00		152881.00	2131600.00	130.33
F0D2	111.00	123.00	134.00	368.00		45406.00		135424.00	2289169.00	122.67
F0D3	126.00	127.00	130.00	383.00		48905.00		146689.00	0	127.67
F1D0	104.00	116.00	126.00	346.00		40148.00		119716.00	0	115.33
F1D1	105.00	158.00	128.00	391.00		52373.00		152881.00	0	130.33
F1D2	149.00	113.00	116.00	378.00		48426.00		142884.00	0	126.00
F1D3	115.00	119.00	126.00	360.00		43262.00		129600.00	0	120.00
F2D0	132.00	111.00	108.00	351.00		41409.00		123201.00	0	117.00
F2D1	116.00	108.00	121.00	345.00		39761.00		119025.00	0	115.00
F2D2	114.00	136.00	129.00	379.00		48133.00		143641.00	0	126.33
F2D3	100.00	113.00	131.00	344.00		39930.00		118336.00	0	114.67
TOTAL	1403.00	1460.00	1513.00	4376.00	531927.11	537602.00	5674.89	1365.56	504.39	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTIO	Average(om)
F0	340	391	368.00	383.00	1482	2196324.00	1075369.00		123.50
F1	346.00	391.00	378.00	360.00	1475.00	2175625.00	1270129.00		122.92
F2	351.00	345.00	379.00	344.00	1419.00	2013561.00	1265625.00		118.25
	0	0	0	0	0	0.00	1181569.00		
TOTAL	1037	1127	1125.00	1087.00	4376	198.72	594.22	572.61	
Av.(Dir.)	115.22	125.22	125.00	120.78					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	504.39	252.19	1.46			
F	2	198.72	99.36	0.57	3.44	5.72	11.11
D	3	594.22	198.07	1.15	3.05	4.82	12.83
F*D	6	572.61	95.44	0.55	2.55	3.76	22.23
Error	22	3804.94	172.95				
TOTAL	35	5674.89	818.02				

Table. 4.8: Showing effect of row-direction and FYM on plant height at 60 DAS

PLANT HEIGHT AT 60 DAS (cm.)

ep /Trea	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	187.00	190.00	195.00	572.00		109094.00		327184.00	5837056.00	190.67
F0D1	194.00	210.00	205.00	609.00		123761.00		370881.00	6290064.00	203.00
F0D2	200.00	205.00	190.00	595.00		118125.00		354025.00	6175225.00	198.33
F0D3	193.00	198.00	195.00	586.00		114478.00		343396.00	0	195.33
F1D0	205.00	212.00	205.00	622.00		128994.00		386884.00	0	207.33
F1D1	208.00	218.00	220.00	646.00		139188.00		417316.00	0	215.33
F1D2	190.00	205.00	215.00	610.00		124350.00		372100.00	0	203.33
F1D3	197.00	200.00	210.00	607.00		122909.00		368449.00	0	202.33
F2D0	232.00	225.00	220.00	677.00		152849.00		458329.00	0	225.67
F2D1	213.00	230.00	225.00	668.00		148894.00		446224.00	0	222.67
F2D2	190.00	210.00	205.00	605.00		122225.00		366025.00	0	201.67
F2D3	207.00	205.00	200.00	612.00		124874.00		374544.00	0	204.00
TOTAL	2416.00	2508.00	2485.00	7409.00	1524813.36	1529741.00	4927.64	3638.97	382.06	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	TERACTIO	Average(om)
F0	572	609	595.00	586.00	2362	5579044.00	3500641.00		196.83
F1	622.00	646.00	610.00	607.00	2485.00	6175225.00	3697929.00		207.08
F2	677.00	668.00	605.00	612.00	2562.00	6563844.00	3276100.00		213.50
	0	0	0	0	0	0.00	3258025.00		
TOTAL	1871	1923	1810.00	1805.00	7409	1696.06	1041.64	901.28	
Av.(Dir.)	207.89	213.67	201.11	200.56					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	382.06	191.03	4.64			
F	2	1696.06	848.03	20.58	3.44	5.72	5.42
D	3	1041.64	347.21	8.43	3.05	4.82	6.26
F*D	6	901.28	150.21	3.65	2.55	3.76	10.85
Error	22	906.61	41.21				
TOTAL	35	4927.64	1577.69				

Table. 4.9: Showing effect of row-direction and FYM on plant height at 80 DAS

PLANT HEIGHT AT 80 DAS (in cm.)

ep /Trea	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	192.00	192.00	195.00	579.00		111753.00		335241.00	6230016.00	193.00
F0D1	198.00	208.00	291.50	697.50		167440.25		486506.25	6594624.00	232.50
F0D2	209.00	209.00	207.00	625.00		130211.00		390625.00	7211910.25	208.33
F0D3	194.00	198.00	208.00	600.00		120104.00		360000.00	0	200.00
F1D0	212.00	220.00	220.00	652.00		141744.00		425104.00	0	217.33
F1D1	209.00	220.00	230.00	659.00		144981.00		434281.00	0	219.67
F1D2	210.00	210.00	235.00	655.00		143425.00		429025.00	0	218.33
F1D3	199.00	209.00	212.00	620.00		128226.00		384400.00	0	206.67
F2D0	220.00	226.00	225.00	671.00		150101.00		450241.00	0	223.67
F2D1	218.00	236.00	230.00	684.00		156120.00		467856.00	0	228.00
F2D2	228.00	232.00	220.00	680.00		154208.00		462400.00	0	226.67
F2D3	207.00	208.00	212.00	627.00		131057.00		393129.00	0	209.00
TOTAL	2496.00	2568.00	2685.50	7749.50	1668187.51	1679370.25	11182.74	4748.58	1525.01	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	579	697.5	625.00	600.00	2501.5	6257502.25	3617604.00		208.46
F1	652.00	659.00	655.00	620.00	2586.00	6687396.00	4163640.25		215.50
F2	671.00	684.00	680.00	627.00	2662.00	7086244.00	3841600.00		221.83
	0	0	0	0	0	0.00	3411409.00		
TOTAL	1902	2040.5	1960.00	1847.00	7749.5	1074.35	2285.08	1389.15	
Av.(Dir.)	211.33	226.72	217.78	205.22					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	1525.01	762.51	3.42			
F	2	1074.35	537.17	2.41	3.44	5.72	12.62
D	3	2285.08	761.69	3.41	3.05	4.82	14.58
F*D	6	1389.15	231.53	1.04	2.55	3.76	25.25
Error	22	4909.15	223.14				
TOTAL	35	11182.74	2516.04				

Table 4.10 Showing the Leaf length influenced with row direction and organic manuring at 40 DAS

LEAVES LENGTH AT40 DAS (cm.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	84.00	74.00	78.00	236.00		18616.00		55696.00	1030225.00	78.67
F0D1	91.00	82.00	88.00	261.00		22749.00		68121.00	948676.00	87.00
F0D2	86.00	75.00	87.00	248.00		20590.00		61504.00	985989.42	82.67
F0D3	83.00	84.00	83.00	250.00		20834.00		62500.00	0	83.33
F1D0	79.00	81.00	80.70	240.70		19314.49		57936.49	0	80.23
F1D1	90.00	84.00	86.00	260.00		22552.00		67600.00	0	86.67
F1D2	89.00	86.00	84.30	259.30		22423.49		67236.49	0	86.43
F1D3	91.00	88.00	86.30	265.30		23472.69		70384.09	0	88.43
F2D0	79.00	80.00	78.00	237.00		18725.00		56169.00	0	79.00
F2D1	88.00	79.00	82.67	249.67		20819.33		62335.11	0	83.22
F2D2	75.00	76.00	77.30	228.30		17376.29		52120.89	0	76.10
F2D3	80.00	85.00	81.70	246.70		20299.89		60860.89	0	82.23
TOTAL	1015.00	974.00	992.97	2981.97	247004.03	247772.18	768.15	483.96	70.17	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	236	261	248.00	250.00	995	990025.00	509367.69		82.92
F1	240.70	260.00	259.30	265.30	1025.30	1051240.09	593932.25		85.44
F2	237.00	249.67	228.30	246.70	961.67	924809.19	541107.36		80.14
	0	0	0	0	0	0.00	580644.00		
TOTAL	713.7	770.67	735.60	762.00	2981.97	168.83	223.89	91.24	
Av.(Dir.)	79.30	85.63	81.73	84.67					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	70.17	35.09	3.61			
F	2	168.83	84.41	8.68 **	3.44	5.72	2.64
D	3	223.89	74.63	7.67 **	3.05	4.82	3.04
F*D	6	91.24	15.21	1.56	2.55	3.76	5.27
Error	22	214.02	9.73				
TOTAL	35	768.15	219.06				

Table 4.11 Showing the Leaf length influenced with row direction and organic manuring at 60 DAS

LEAVES LENGTH AT 60 DAS (cm.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	79.50	75.00	78.00	232.50		18029.25		54056.25	912025.00	77.50
F0D1	86.50	82.50	84.00	253.00		21344.50		64009.00	941870.25	84.33
F0D2	91.50	89.00	90.50	271.00		24483.50		73441.00	947702.25	90.33
F0D3	79.00	82.50	80.00	241.50		19447.25		58322.25	0	80.50
F1D0	76.50	78.00	80.50	235.00		18416.50		55225.00	0	78.33
F1D1	77.50	79.00	81.00	237.50		18808.25		56406.25	0	79.17
F1D2	75.50	78.50	80.00	234.00		18262.50		54756.00	0	78.00
F1D3	72.00	82.00	81.50	235.50		18550.25		55460.25	0	78.50
F2D0	77.00	78.00	76.50	231.50		17865.25		53592.25	0	77.17
F2D1	84.00	82.50	78.00	244.50		19946.25		59780.25	0	81.50
F2D2	75.50	79.00	81.50	236.00		18583.50		55696.00	0	78.67
F2D3	80.50	84.50	82.00	247.00		20344.50		61009.00	0	82.33
TOTAL	955.00	970.50	973.50	2899.00	233450.03	234081.50	631.47	467.81	16.43	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	232.5	253	271.00	241.50	998	996004.00	488601.00		83.17
F1	235.00	237.50	234.00	235.50	942.00	887364.00	540225.00		78.50
F2	231.50	244.50	236.00	247.00	959.00	919681.00	549081.00		79.92
	0	0	0	0	0	0.00	524176.00		
TOTAL	699	735	741.00	724.00	2899	137.39	114.75	215.67	
Av.(Dir.)	77.67	81.67	82.33	80.44					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	16.43	8.22	1.23			
F	2	137.39	68.69	10.26	3.44	5.72	2.19
D	3	114.75	38.25	5.72	3.05	4.82	2.52
F*D	6	215.67	35.94	5.37	2.55	3.76	4.37
Error	22	147.24	6.69				
TOTAL	35	631.47	157.80				

Table 4.12 Showing the Leaf length influenced with row direction and organic manuring at 80 DAS

LEAVES LENGTH AT 80 DAS (cm.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	83.40	84.00	79.00	246.40		20252.56		60712.96	1036120.41	82.13
F0D1	90.00	85.60	87.00	262.60		22996.36		68958.76	1030428.01	87.53
F0D2	85.60	90.00	92.00	267.60		23891.36		71609.76	1015056.25	89.20
F0D3	84.10	86.00	82.00	252.10		21192.81		63554.41	0	84.03
F1D0	80.00	81.50	81.00	242.50		19603.25		58806.25	0	80.83
F1D1	89.10	90.00	84.10	263.20		23111.62		69274.24	0	87.73
F1D2	89.20	83.00	85.00	257.20		22070.64		66151.84	0	85.73
F1D3	90.00	87.00	86.00	263.00		23065.00		69169.00	0	87.67
F2D0	80.50	82.00	78.20	240.70		19319.49		57936.49	0	80.23
F2D1	89.00	82.00	85.00	256.00		21870.00		65536.00	0	85.33
F2D2	76.00	78.00	84.00	238.00		18916.00		56644.00	0	79.33
F2D3	81.00	86.00	84.20	251.20		21046.64		63101.44	0	83.73
TOTAL	1017.90	1015.10	1007.50	3040.50	256795.56	257335.73	540.17	356.15	4.83	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	246.4	262.6	267.60	252.10	1028.7	1058223.69	532316.16		85.73
F1	242.50	263.20	257.20	263.00	1025.90	1052470.81	611211.24		85.49
F2	240.70	256.00	238.00	251.20	985.90	971998.81	581863.84		82.16
	0	0	0	0	0	0.00	587215.69		
TOTAL	729.6	781.8	762.80	766.30	3040.5	95.55	160.76	99.84	
Av.(Dir.)	81.07	86.87	84.76	85.14					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	4.83	2.41	0.30			
F	2	95.55	47.77	5.87 **	3.44	5.72	2.41
D	3	160.76	53.59	6.58 **	3.05	4.82	2.78
F*D	6	99.84	16.64	2.04	2.55	3.76	4.82
Error	22	179.19	8.14				
TOTAL	35	540.17	128.56				

Table 4.13 Showing the Leaf breadth influenced with row direction and organic manuring at 40 DAS

LEAF-BREADTH AT 40 DAS (cm.)

	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	8.10	8.75	9.05	25.90		224.08		670.81	10302.25	8.63
F0D1	7.50	8.60	9.70	25.80		224.30		665.64	11295.44	8.60
F0D2	8.05	9.40	9.50	26.95		243.41		726.30	11577.76	8.98
F0D3	8.85	9.20	8.60	26.65		236.92		710.22	0	8.88
F1D0	8.20	8.10	8.70	25.00		208.54		625.00	0	8.33
F1D1	8.65	9.50	10.30	28.45		271.16		809.40	0	9.48
F1D2	9.50	8.70	8.65	26.85		240.76		720.92	0	8.95
F1D3	9.65	8.35	8.25	26.25		230.91		689.06	0	8.75
F2D0	8.00	8.90	9.25	26.15		228.77		683.82	0	8.72
F2D1	8.80	8.50	8.65	25.95		224.51		673.40	0	8.65
F2D2	7.90	9.23	8.30	25.43		216.49		646.68	0	8.48
F2D3	8.30	9.05	8.65	26.00		225.62		676.00	0	8.67
TOTAL	101.50	106.28	107.60	315.38	2762.90	2775.48	12.57	2.85	1.72	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	25.9	25.8	26.95	26.65	105.3	11088.09	5936.70		8.78
F1	25.00	28.45	26.85	26.25	106.55	11352.90	6432.04		8.88
F2	26.15	25.95	25.43	26.00	103.53	10718.46	6277.39		8.63
	0	0	0	0	0	0.00	6225.21		
TOTAL	77.05	80.2	79.23	78.90	315.38	0.38	0.58	1.89	
Av.(Dir.)	8.56	8.91	8.80	8.77					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	1.72	0.86	2.36			
F	2	0.38	0.19	0.53	3.44	5.72	0.51
D	3	0.58	0.19	0.53	3.05	4.82	0.59
F*D	6	1.89	0.32	0.87	2.55	3.76	1.02
Error	22	8.00	0.36				
TOTAL	35	12.57	1.92				

Table 4.14 Showing the Leaf breadth influenced with row direction and organic manuring at 60 DAS

LEAF BREADTH AT 60 DAS (cm.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	9.50	9.80	9.30	28.60		272.78		817.96	12893.60	9.53
F0D1	9.40	9.60	9.90	28.90		278.53		835.21	13305.62	9.63
F0D2	8.80	9.85	10.00	28.65		274.46		820.82	13759.29	9.55
F0D3	8.70	9.30	9.85	27.85		259.20		775.62	0	9.28
F1D0	9.50	9.35	10.00	28.85		277.67		832.32	0	9.62
F1D1	10.00	9.60	9.80	29.40		288.20		864.36	0	9.80
F1D2	9.90	10.20	9.85	29.95		299.07		897.00	0	9.98
F1D3	9.70	9.50	9.90	29.10		282.35		846.81	0	9.70
F2D0	10.00	9.05	9.30	28.35		268.39		803.72	0	9.45
F2D1	9.65	9.40	9.50	28.55		271.73		815.10	0	9.52
F2D2	8.90	10.30	10.20	29.40		289.34		864.36	0	9.80
F2D3	9.50	9.40	9.70	28.60		272.70		817.96	0	9.53
TOTAL	113.55	115.35	117.30	346.20	3329.29	3334.44	5.15	1.13	0.59	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	28.6	28.9	28.65	27.85	114	12996.00	7361.64		9.50
F1	28.85	29.40	29.95	29.10	117.30	13759.29	7542.92		9.78
F2	28.35	28.55	29.40	28.60	114.90	13202.01	7744.00		9.58
	0	0	0	0	0	0.00	7318.80		
TOTAL	85.8	86.85	88.00	85.55	346.2	0.49	0.42	0.23	
Av.(Dir.)	9.53	9.65	9.78	9.51					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	0.59	0.29	1.88			
F	2	0.49	0.24	1.56	3.44	5.72	0.33
D	3	0.42	0.14	0.89	3.05	4.82	0.39
F*D	6	0.23	0.04	0.24	2.55	3.76	0.67
Error	22	3.43	0.16				
TOTAL	35	5.15	0.87				

Table 4.15 Showing the Leaf breadth influenced with row direction and organic manuring at 80 DAS

LEAF BREADTH AT 80 DAS (cm.)

Rep /Treat	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	8.30	9.70	9.30	27.30		249.47		745.29	12611.29	9.10
F0D1	8.80	9.20	10.40	28.40		270.24		806.56	13202.01	9.47
F0D2	9.50	9.80	10.70	30.00		300.78		900.00	14448.04	10.00
F0D3	9.30	9.60	9.50	28.40		268.90		806.56	0	9.47
F1D0	8.40	9.50	10.00	27.90		260.81		778.41	0	9.30
F1D1	10.10	10.00	9.80	29.90		298.05		894.01	0	9.97
F1D2	9.90	10.20	10.30	30.40		308.14		924.16	0	10.13
F1D3	10.00	9.30	9.50	28.80		276.74		829.44	0	9.60
F2D0	8.60	8.50	10.10	27.20		248.22		739.84	0	9.07
F2D1	9.70	9.60	10.50	29.80		296.50		888.04	0	9.93
F2D2	10.40	9.50	10.60	30.50		310.77		930.25	0	10.17
F2D3	9.30	10.00	9.50	28.80		276.74		829.44	0	9.60
TOTAL	112.30	114.90	120.20	347.40	3352.41	3365.36	12.95	4.92	2.70	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	27.3	28.4	30.00	28.40	114.1	13018.81	6789.76		9.51
F1	27.90	29.90	30.40	28.80	117.00	13689.00	7761.61		9.75
F2	27.20	29.80	30.50	28.80	116.30	13525.69	8262.81		9.69
	0	0	0	0	0	0.00	7396.00		
TOTAL	82.4	88.1	90.90	86.00	347.4	0.38	4.28	0.27	
Av.(Dir.)	9.16	9.79	10.10	9.56					

ANOVA TABLE

E

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	2.70	1.35	5.58			
F	2	0.38	0.19	0.79	3.44	5.72	0.42
D	3	4.28	1.43	5.89	3.05	4.82	0.48
F*D	6	0.27	0.04	0.18	2.55	3.76	0.83
Error	22	5.33	0.24				
TOTAL	35	12.95	3.25				

Table 4.16 Showing the Plant dry-weight influenced with row direction and organic manuring at 40 DAS

PLANT DRY-WEIGHT 40 DAS (g)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	19.80	18.25	19.75	57.80		1115.17		3340.84	58042.45	19.27
F0D1	20.05	19.12	20.00	59.17		1167.58		3501.09	56805.96	19.72
F0D2	19.95	20.01	19.65	59.61		1184.53		3553.35	57513.63	19.87
F0D3	20.10	20.21	20.05	60.36		1214.46		3643.33	0	20.12
F1D0	19.68	19.30	19.40	58.38		1136.15		3408.22	0	19.46
F1D1	20.25	20.21	20.21	60.67		1226.95		3680.85	0	20.22
F1D2	19.95	20.11	20.05	60.11		1204.42		3613.21	0	20.04
F1D3	19.98	20.30	19.91	60.19		1207.70		3622.84	0	20.06
F2D0	20.00	20.12	20.10	60.22		1208.82		3626.45	0	20.07
F2D1	20.31	20.33	20.25	60.89		1235.87		3707.59	0	20.30
F2D2	20.42	20.18	20.25	60.85		1234.27		3702.72	0	20.28
F2D3	20.43	20.20	20.20	60.83		1233.46		3700.29	0	20.28
TOTAL	240.92	238.34	239.82	719.08	14363.22	14369.37	6.15	3.70	0.28	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	57.8	59.17	59.61	60.36	236.94	56140.56	31116.96		19.75
F1	58.38	60.67	60.11	60.19	239.35	57288.42	32663.33		19.95
F2	60.22	60.89	60.85	60.83	242.79	58946.98	32605.52		20.23
	0	0	0	0	0	0.00	32898.70		
TOTAL	176.4	180.73	180.57	181.38	719.08	1.44	1.72	0.54	
Av.(Dir.)	19.60	20.08	20.06	20.15					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	0.28	0.14	1.42			
F	2	1.44	0.72	7.33	3.44	5.72	0.26
D	3	1.72	0.57	5.84	3.05	4.82	0.31
F*D	6	0.54	0.09	0.92	2.55	3.76	0.53
Error	22	2.16	0.10				
TOTAL	35	6.15	1.62				

Table 4.17 Showing the Plant dry-weight influenced with row direction and organic manuring at 60 DAS

PLANT DRY-WEIGHT 60 DAS (g)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	57.98	58.32	60.15	176.45		10380.93		31134.60	751584.96	58.82
F0D1	66.90	68.82	69.50	205.22		14042.05		42115.25	763421.59	68.41
F0D2	65.75	65.93	66.52	198.20		13094.74		39283.24	770603.07	66.07
F0D3	66.52	66.42	65.90	198.84		13179.34		39537.35	0	66.28
F1D0	74.70	74.30	73.05	222.05		16436.88		49306.20	0	74.02
F1D1	77.80	78.45	78.91	235.16		18434.03		55300.23	0	78.39
F1D2	76.20	75.43	74.30	225.93		17016.61		51044.36	0	75.31
F1D3	74.20	76.92	77.69	228.81		17458.06		52354.02	0	76.27
F2D0	77.80	78.31	79.59	235.70		18519.86		55554.49	0	78.57
F2D1	80.21	79.83	78.72	238.76		19003.31		57006.34	0	79.59
F2D2	72.80	73.12	74.41	220.33		16183.22		48545.31	0	73.44
F2D3	76.08	77.89	79.10	233.07		18111.83		54321.62	0	77.69
TOTAL	866.94	873.74	877.84	2618.52	190462.42	191860.87	1398.45	1371.92	5.05	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	176.45	205.22	198.20	198.84	778.71	606389.26	402209.64		64.89
F1	222.05	235.16	225.93	228.81	911.95	831652.80	461231.14		76.00
F2	235.70	238.76	220.33	233.07	927.86	860924.18	415328.69		77.32
	0	0	0	0	0	0.00	436550.92		
TOTAL	634.2	679.14	644.46	660.72	2618.52	1118.10	128.74	125.08	
Av.(Dir.)	70.47	75.46	71.61	73.41					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	5.05	2.53	2.59			
F	2	1118.10	559.05	572.53	3.44	5.72	0.84
D	3	128.74	42.91	43.95	3.05	4.82	0.96
F*D	6	125.08	20.85	21.35	2.55	3.76	1.67
Error	22	21.48	0.98				
TOTAL	35	1398.45	626.31				

Table 4.18 Showing the Plant dry-weight influenced with row direction and organic manuring at 80 DAS

PLANT DRY-WEIGHT 80DAS (g)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	102.30	101.78	100.90	304.98		31005.27		93012.80	3342754.02	101.66
F0D1	131.30	132.40	133.51	397.21		52594.37		157775.78	3230970.30	132.40
F0D2	158.00	154.83	152.81	465.64		72287.23		216820.61	3319647.56	155.21
F0D3	142.10	145.95	148.28	436.33		63480.77		190383.87	0	145.44
F1D0	148.10	149.82	150.25	448.17		66954.70		200856.35	0	149.39
F1D1	181.61	181.10	180.75	543.46		98449.96		295348.77	0	181.15
F1D2	152.40	143.96	154.80	451.16		67913.28		203545.35	0	150.39
F1D3	140.00	120.20	137.89	398.09		53061.69		158475.65	0	132.70
F2D0	160.50	162.97	163.40	486.87		79019.03		237042.40	0	162.29
F2D1	160.60	159.57	177.00	497.17		82583.94		247178.01	0	165.72
F2D2	178.01	176.71	163.00	517.72		89482.98		268034.00	0	172.57
F2D3	173.40	168.20	159.40	501.00		83767.16		251001.00	0	167.00
TOTAL	1828.32	1797.49	1821.99	5447.80	824403.47	840600.40	16196.93	15421.39	44.19	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	304.98	397.21	465.64	436.33	1604.16	2573329.31	1537649.60		133.68
F1	448.17	543.46	451.16	398.09	1840.88	3388839.17	2067383.87		153.41
F2	486.87	497.17	517.72	501.00	2002.76	4011047.62	2057847.63		166.90
	0	0	0	0	0	0.00	1783346.58		
TOTAL	1240	1437.84	1434.52	1335.42	5447.8	6697.87	2955.16	5768.36	
Av.(Dir.)	137.78	159.76	159.39	148.38					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	44.19	22.09	0.66			
F	2	6697.87	3348.94	100.74	3.44	5.72	4.87
D	3	2955.16	985.05	29.63	3.05	4.82	5.63
F*D	6	5768.36	961.39	28.92	2.55	3.76	9.74
Error	22	731.35	33.24				
TOTAL	35	16196.93	5350.72				

Table 4.19 Showing the Rooting depth influenced with row direction and organic manuring at 40 DAS

ROOTING DEPTH AT 40 DAS (cm.)

R/Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	35.00	32.00	30.00	97.00		3149.00		9409.00	164836.00	32.33
F0D1	38.00	37.00	37.00	112.00		4182.00		12544.00	156420.25	37.33
F0D2	25.00	34.00	40.00	99.00		3381.00		9801.00	171396.00	33.00
F0D3	38.00	32.00	34.00	104.00		3624.00		10816.00	0	34.67
F1D0	34.00	35.00	33.00	102.00		3470.00		10404.00	0	34.00
F1D1	37.00	34.50	35.00	106.50		3784.25		11342.25	0	35.50
F1D2	29.00	28.00	34.00	91.00		2781.00		8281.00	0	30.33
F1D3	35.00	29.00	37.00	101.00		3435.00		10201.00	0	33.67
F2D0	29.00	34.00	33.00	96.00		3086.00		9216.00	0	32.00
F2D1	39.00	35.00	34.00	108.00		3902.00		11664.00	0	36.00
F2D2	33.00	31.00	32.00	96.00		3074.00		9216.00	0	32.00
F2D3	34.00	34.00	35.00	103.00		3537.00		10609.00	0	34.33
TOTAL	406.00	395.50	414.00	1215.50	41040.01	41405.25	365.24	127.74	14.35	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	97	112	99.00	104.00	412	169744.00	87025.00		34.33
F1	102.00	106.50	91.00	101.00	400.50	160400.25	106602.25		33.38
F2	96.00	108.00	96.00	103.00	403.00	162409.00	81796.00		33.58
	0	0	0	0	0	0.00	94864.00		
TOTAL	295	326.5	286.00	308.00	1215.5	6.10	103.02	18.63	
Av.(Dir.)	32.78	36.28	31.78	34.22					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	14.35	7.17	0.71			
F	2	6.10	3.05	0.30	3.44	5.72	2.69
D	3	103.02	34.34	3.39	3.05	4.82	3.11
F*D	6	18.63	3.10	0.31	2.55	3.76	5.38
Error	22	223.15	10.14				
TOTAL	35	365.24	57.81				

Table 4.20 Showing the Rooting depth influenced with row direction and organic manuring at 60 DAS

ROOTING DEPTH OF PLANT AT 60 DAS (cm.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	48.00	58.00	50.00	156.00		8168.00		24336.00	727609.00	52.00
F0D1	54.00	75.00	80.00	209.00		14941.00		43681.00	711998.44	69.67
F0D2	60.00	68.00	82.00	210.00		14948.00		44100.00	817396.81	70.00
F0D3	76.00	68.00	77.00	221.00		16329.00		48841.00	0	73.67
F1D0	76.00	74.80	79.00	229.80		17612.04		52808.04	0	76.60
F1D1	78.00	77.00	82.00	237.00		18737.00		56169.00	0	79.00
F1D2	78.00	83.00	80.00	241.00		19373.00		58081.00	0	80.33
F1D3	77.00	34.00	76.00	187.00		12861.00		34969.00	0	62.33
F2D0	65.00	64.00	62.90	191.90		12277.41		36825.61	0	63.97
F2D1	82.00	79.00	81.50	242.50		19607.25		58806.25	0	80.83
F2D2	80.00	81.00	78.00	239.00		19045.00		57121.00	0	79.67
F2D3	79.00	82.00	75.70	236.70		18695.49		56026.89	0	78.90
TOTAL	853.00	843.80	904.10	2600.90	187907.80	192594.19	4686.39	2680.46	175.89	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	156	209	210.00	221.00	796	633616.00	333737.29		66.33
F1	229.80	237.00	241.00	187.00	894.80	800667.04	474032.25		74.57
F2	191.90	242.50	239.00	236.70	910.10	828282.01	476100.00		75.84
	0	0	0	0	0	0.00	415638.09		
TOTAL	577.7	688.5	690.00	644.70	2600.9	639.29	926.38	1114.79	
Av.(Dir.)	64.19	76.50	76.67	71.63					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	175.89	87.94	1.06			
F	2	639.29	319.64	3.84	3.44	5.72	7.71
D	3	926.38	308.79	3.71	3.05	4.82	8.90
F*D	6	1114.79	185.80	2.23	2.55	3.76	15.42
Error	22	1830.04	83.18				
TOTAL	35	4686.39	985.36				

Table 4.21 Showing the Rooting depth influenced with row direction and organic manuring at 80 DAS

ROOTING DEPTH AT 80 DAS (cm.)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	85.00	89.00	88.00	262.00		22890.00		68644.00	1343281.00	87.33
F0D1	90.00	87.00	97.00	274.00		25078.00		75076.00	1377102.25	91.33
F0D2	91.00	86.50	89.10	266.60		23702.06		71075.56	1577033.64	88.87
F0D3	90.50	87.00	88.70	266.20		23626.94		70862.44	0	88.73
F1D0	88.00	92.00	90.00	270.00		24308.00		72900.00	0	90.00
F1D1	95.00	86.00	120.00	301.00		30821.00		90601.00	0	100.33
F1D2	92.00	95.00	102.00	289.00		27893.00		83521.00	0	96.33
F1D3	108.00	98.00	102.00	308.00		31672.00		94864.00	0	102.67
F2D0	110.00	109.00	112.00	331.00		36525.00		109561.00	0	110.33
F2D1	108.00	115.00	122.00	345.00		39773.00		119025.00	0	115.00
F2D2	105.00	119.00	120.00	344.00		39586.00		118336.00	0	114.67
F2D3	96.50	110.00	125.00	331.50		37037.25		109892.25	0	110.50
TOTAL	1159.00	1173.50	1255.80	3588.30	357663.80	362912.25	5248.45	3788.95	454.27	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	262	274	266.60	266.20	1068.8	1142333.44	744769.00		89.07
F1	270.00	301.00	289.00	308.00	1168.00	1364224.00	846400.00		97.33
F2	331.00	345.00	344.00	331.50	1351.50	1826552.25	809280.16		112.63
	0	0	0	0	0	0.00	820292.49		
TOTAL	863	920	899.60	905.70	3588.3	3428.67	196.38	163.90	
Av.(Dir.)	95.89	102.22	99.96	100.63					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	454.27	227.14	4.97			
F	2	3428.67	1714.34	37.52	3.44	5.72	5.71
D	3	196.38	65.46	1.43	3.05	4.82	6.60
F*D	6	163.90	27.32	0.60	2.55	3.76	11.42
Error	22	1005.23	45.69				
TOTAL	35	5248.45	2079.94				

Table 4.22 Showing the Test-weigth of grains influenced with row direction and organic manuring at 80 DAS

TEST- WEIGHT OF GRAINS (100 g)

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	22.10	22.82	22.92	67.84		1534.26		4601.59	80031.84	22.61
F0D1	25.47	23.66	23.71	72.84		1770.79		5305.96	75801.10	24.28
F0D2	22.55	23.42	22.43	68.39		1559.84		4677.74	78638.74	22.80
F0D3	25.13	22.59	22.06	69.78		1628.60		4869.67	0	23.26
F1D0	23.59	22.08	21.20	66.87		1493.63		4472.13	0	22.29
F1D1	24.41	25.23	24.04	73.68		1810.07		5428.01	0	24.56
F1D2	23.95	23.18	23.58	70.71		1667.03		5000.19	0	23.57
F1D3	22.29	21.61	24.37	68.26		1557.22		4659.29	0	22.75
F2D0	24.40	21.71	22.27	68.38		1562.58		4675.69	0	22.79
F2D1	23.92	24.14	23.47	71.53		1705.60		5116.11	0	23.84
F2D2	21.85	22.25	25.25	69.35		1610.25		4809.98	0	23.12
F2D3	23.25	22.64	25.12	71.01		1684.20		5042.56	0	23.67
TOTAL	282.90	275.32	280.43	838.65	19536.82	19584.07	47.25	16.15	2.49	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	67.835	72.842	68.39	69.78	278.854	77759.55	41244.74		23.24
F1	66.87	73.68	70.71	68.26	279.52	78131.43	47543.19		23.29
F2	68.38	71.53	69.35	71.01	280.27	78551.83	43455.57		23.36
	0	0	0	0	0	0.00	43703.16		
TOTAL	203.09	218.044	208.46	209.05	838.645	0.08	12.81	3.26	
Av.(Dir.)	22.57	24.23	23.16	23.23					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	2.49	1.24	0.96			
F	2	0.08	0.04	0.03	3.44	5.72	0.96
D	3	12.81	4.27	3.28 *	3.05	4.82	1.11
F*D	6	3.26	0.54	0.42	2.55	3.76	1.93
Error	22	28.61	1.30				
TOTAL	35	47.25	7.40				

Table 4.23 Showing the Grain yield influenced with row direction and organic manuring in Hybrid Maize

GRAIN YIELD OF HYBRID MAIZE (q/ha).

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	39.59	42.49	46.32	128.40		5518.31		16486.56	349328.28	42.80
F0D1	52.17	53.41	52.25	157.83		8304.40		24910.31	355812.25	52.61
F0D2	44.93	45.98	50.32	141.23		6664.97		19945.91	414349.69	47.08
F0D3	53.83	47.71	54.09	155.63		8099.64		24220.70	0	51.88
F1D0	48.82	44.37	51.70	144.89		7024.98		20993.11	0	48.30
F1D1	51.26	55.61	58.05	164.92		9089.86		27198.61	0	54.97
F1D2	53.66	55.38	53.83	162.87		8844.01		26526.64	0	54.29
F1D3	43.98	47.43	53.55	144.96		7051.45		21013.40	0	48.32
F2D0	51.72	46.04	48.98	146.74		7193.68		21532.63	0	48.91
F2D1	53.27	52.72	52.88	158.87		8413.39		25239.68	0	52.96
F2D2	48.82	50.87	67.06	166.75		9468.19		27805.56	0	55.58
F2D3	48.99	54.49	54.67	158.15		8357.99		25011.42	0	52.72
TOTAL	591.04	596.50	643.70	1831.24	93151.11	94030.87	879.76	477.07	139.74	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	128.4	157.83	141.23	155.63	583.09	339993.95	176425.20		48.59
F1	144.89	164.92	162.87	144.96	617.64	381479.17	231957.82		51.47
F2	146.74	158.87	166.75	158.15	630.51	397542.86	221699.72		52.54
	0	0	0	0	0	0.00	210442.39		
TOTAL	420.03	481.62	470.85	458.74	1831.24	100.22	240.57	136.27	
Av.(Dir.)	46.67	53.51	52.32	50.97					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	139.74	69.87	5.85			
F	2	100.22	50.11	4.19 *	3.44	5.72	2.92
D	3	240.57	80.19	6.71**	3.05	4.82	3.37
F*D	6	136.27	22.71	1.90	2.55	3.76	5.84
Error	22	262.95	11.95				
TOTAL	35	879.76	234.84				

Table 4.24 : Showing the effect of row-direction & FYM on cob-survivability % in hybrid-maize

SURVIVABILITY % OF COBS

Rep /Treat.	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	79.30	64.40	83.60	227.30		17424.81		51665.29	788899.24	75.77
F0D1	75.30	58.80	78.00	212.10		15211.53		44986.41	667652.41	70.70
F0D2	68.50	60.00	66.50	195.00		12714.50		38025.00	694222.24	65.00
F0D3	63.50	69.90	63.90	197.30		13001.47		38927.29	0	65.77
F1D0	82.80	78.40	71.40	232.60		18100.36		54102.76	0	77.53
F1D1	71.60	69.50	66.30	207.40		14352.50		43014.76	0	69.13
F1D2	60.00	74.50	64.50	199.00		13310.50		39601.00	0	66.33
F1D3	72.80	63.20	62.90	198.90		13250.49		39561.21	0	66.30
F2D0	85.40	70.30	78.00	233.70		18319.25		54615.69	0	77.90
F2D1	80.30	64.60	64.40	209.30		14768.61		43806.49	0	69.77
F2D2	77.70	70.00	67.70	215.40		15520.58		46397.16	0	71.80
F2D3	71.00	73.50	66.00	210.50		14799.25		44310.25	0	70.17
TOTAL	888.20	817.10	833.20	2538.50	178999.51	180773.85	1774.34	671.60	231.65	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	227.3	212.1	195.00	197.30	831.7	691724.89	481080.96		69.31
F1	232.60	207.40	199.00	198.90	837.90	702076.41	395389.44		69.83
F2	233.70	209.30	215.40	210.50	868.90	754987.21	371368.36		72.41
	0	0	0	0	0	0.00	368084.89		
TOTAL	693.6	628.8	609.40	606.70	2538.5	66.20	547.57	57.83	
Av.(Dir.)	77.07	69.87	67.71	67.41					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	231.65	115.83	2.93			
F	2	66.20	33.10	0.84	3.44	5.72	5.32
D	3	547.57	182.52	4.61 *	3.05	4.82	6.14
F*D	6	57.83	9.64	0.24	2.55	3.76	-
Error	22	871.10	39.60				
TOTAL	35	1774.34	380.68				

RESULT & DISCUSSION

5.1 GENERAL

This chapter deals with discussion on the result obtained which are presented in Table 5.1-5.4 and Fig. 5.1-5.4.

5.1.1 Plant Height

Plant height in general was recorded as 121.56, 205.81 and ~~207.15~~ 215.25 cms. At 40, 60 and 80 days after slowing (table – 5.1 & Fig- 5.1). The effect on Plant height at 40 DAS due to FYM application or row-direction treatment was insignificant. It became remarkable at 60 DAS and 80 DAS. Application of FYM recorded improved plant height at 60 and 80 DAS. Row-direction also affected the plant height and the beigest plant height was recorded with east-west planting of maize. Positive response of FYM application and east-west row-direction planting has also been reported by Hussein et at. (2003) had found significant results about taller plant (197.7 cm and 196.4 cm) respectively due to different varieties and level of nitrogen, Chandra Shekhar et al. (2002), Stewart et al. (2002) reported about plants physiology and Antonopoulos et al.(2001)

5.1.2 Plant Dry Weight

Plant-dry-weight also changed significantly with the application of FYM and fixing the row-direction of planting at all the stages of growth. Lowest dry matter production was recorded when FYM was not applied and rowing was random (Table 5.1, Fig. 5.2.). Positive response of FYM application on dry matter production of maize crop has also been reported contradictory by Rusu et al. (1999), Agarwal et al.(2001), Bavee et al. (2001), Badran et al.(2001) and Singh et al. (2002).

GROWTH STAGE :-

TABLE - 5.1 : Showing the growth (Plant height (cm), Dry-weight (g)) influenced of Row-direction & FYM in Hybrid-maize.

	Plant-height (cm.)			Dry-weight (g)		
TREATMENT	40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS
$F_0 D_0$	113.33	190.67	128.00	19.27	58.82	101.67
$F_0 D_1$	130.33	203.00	207.00	19.72	68.41	132.40
$F_0 D_2$	122.67	198.33	208.00	19.87	66.07	155.21
$F_0 D_3$	127.67	195.33	200.00	20.12	66.28	145.44
Average	**123.50**	**196.83**	**185.75**	**19.75**	**64.90**	**133.68**
$F_1 D_0$	115.33	207.33	217.00	19.46	74.02	149.39
$F_1 D_1$	130.33	215.33	220.00	20.22	78.39	181.15
$F_1 D_2$	126.00	203.33	218.00	20.04	75.31	150.39
$F_1 D_3$	120.00	202.33	207.00	20.06	76.27	132.70
Average	**122.92**	**207.08**	**215.50**	**19.95**	**76.00**	**153.41**
$F_2 D_0$	117.00	225.67	224.00	20.07	78.57	162.29
$F_2 D_1$	115.00	222.67	228.00	20.30	79.59	165.72
$F_2 D_2$	126.33	201.67	227.00	20.28	73.44	172.57
$F_2 D_3$	114.67	204.00	209.00	20.28	77.69	167.00
Average	**118.25**	**213.50**	**222.00**	**20.23**	**77.32**	**166.90**
Overall Av.	**121.56**	**205.81**	~~**207.75**~~	**19.97**	**72.74**	**151.33**
Test of significant			215.25			
(i)FYM	N.S	Sig	N.S.	Sig.	Sig.	Sig.
(II)Row-dir.	N.S	Sig	Sig	Sig.	Sig.	Sig.
(ii)Interaction	N.S	Sig	N.S.	N.S.	Sig.	Sig.
Critical-difference						
(i) FYM	-	5.42	12.62	0.26	0.84	4.87
(II)Row-dir.	-	6.26	14.58	0.31	0.96	5.63
(iii)Interaction	-	10.85	-	-	1.67	9.74

DEVELOPMENT STAGE :-

TABLE -5.2 : Showing the development (Age at 50% flowering & silking, Cobs survivability) influenced with Row-Direction and FYM in Hybrid maize.

TREATMENT	Age of 50 %		Cobs Survivability %
	Flowering	Silking	
$F_0 D_0$	45 Days	51 Day	75.77
$F_0 D_1$	44 ,,	50 ,,	70.70
$F_0 D_2$	44 ,,	52 ,,	65.00
$F_0 D_3$	43 ,,	51 ,,	65.77
Average			**69.31**
$F_1 D_0$	44 ,,	50 ,,	77.53
$F_1 D_1$	43 ,,	49 ,,	69.13
$F_1 D_2$	43 ,,	50 ,,	66.33
$F_1 D_3$	45 ,,	52 ,,	66.30
Average			**69.83**
$F_2 D_0$	46 ,,	52 ,,	77.90
$F_2 D_1$	44 ,,	50 ,,	69.77
$F_2 D_2$	44 ,,	50 ,,	71.80
$F_2 D_3$	45 ,,	51 ,,	70.17
Average			**72.41**
Overall Av.			**70.51**
Test of significant			
(i)FYM			NS
(II)Row-dir.			Sig.
(ii)Interaction			NS
Critical-difference			
(i) FYM			-
(II)Row-dir.			6.1
(iii)Interaction			-

YIELD :-

TABLE- 5.3 : Yield (grain-yield (kg)) influenced with Row-direction and organic manuring in Hybrid maize.

TREATMENT	Grain-yield (kg / ha)
$F_0 D_0$	4280.20
$F_0 D_1$	5261.00
$F_0 D_2$	4706.10
$F_0 D_3$	5187.90
Average	**4858.80**
$F_1 D_0$	4830.00
$F_1 D_1$	5497.40
$F_1 D_2$	5428.90
$F_1 D_3$	4832.00
Average	**5147.08**
$F_2 D_0$	4893.00
$F_2 D_1$	5295.00
$F_2 D_2$	5558.20
$F_2 D_3$	5271.50
Average	**5254.43**
Overall Av.	**5086.77**
Test of significant	
(i)FYM	Sig.
(II)Row-dir.	Sig.
(ii)Interaction	NS
Critical-difference	
(i) FYM	2.92
(II)Row-dir.	3.37
(iii)Interaction	-

YIELD-ATTRIBUTES :-

TABLE- 5.4 : Showing the yield-attributes (cobs/plant, grains/cob, Test-weight) influenced of Row-direction and FYM in Hybrid maize.

Treatment	cobs / plant	Grains / cob	Test-weight (g)
$F_0 D_0$	0.90	315.00	22.61
$F_0 D_1$	0.85	378.00	24.28
$F_0 D_2$	0.83	371.00	22.80
$F_0 D_3$	0.97	397.00	23.26
Average	**0.89**	**365.25**	**23.24**
$F_1 D_0$	0.86	343.00	22.29
$F_1 D_1$	0.88	368.00	24.56
$F_1 D_2$	0.89	418.00	23.57
$F_1 D_3$	1.01	355.00	22.75
Average	**0.91**	**371.00**	**23.29**
$F_2 D_0$	0.83	349.00	22.79
$F_2 D_1$	0.87	373.00	23.84
$F_2 D_2$	0.85	408.00	23.12
$F_2 D_3$	0.98	380.00	23.67
Average	**0.88**	**377.50**	**23.36**
Overall Av.	**0.89**	**371.25**	**23.30**
Test of significant			
(i)FYM			NS
(II)Row-dir.			Sig.
(ii)Interaction			NS
Critical-difference			
(i) FYM			0.96
(II)Row-dir.			1.11
(iii)Interaction			1.93

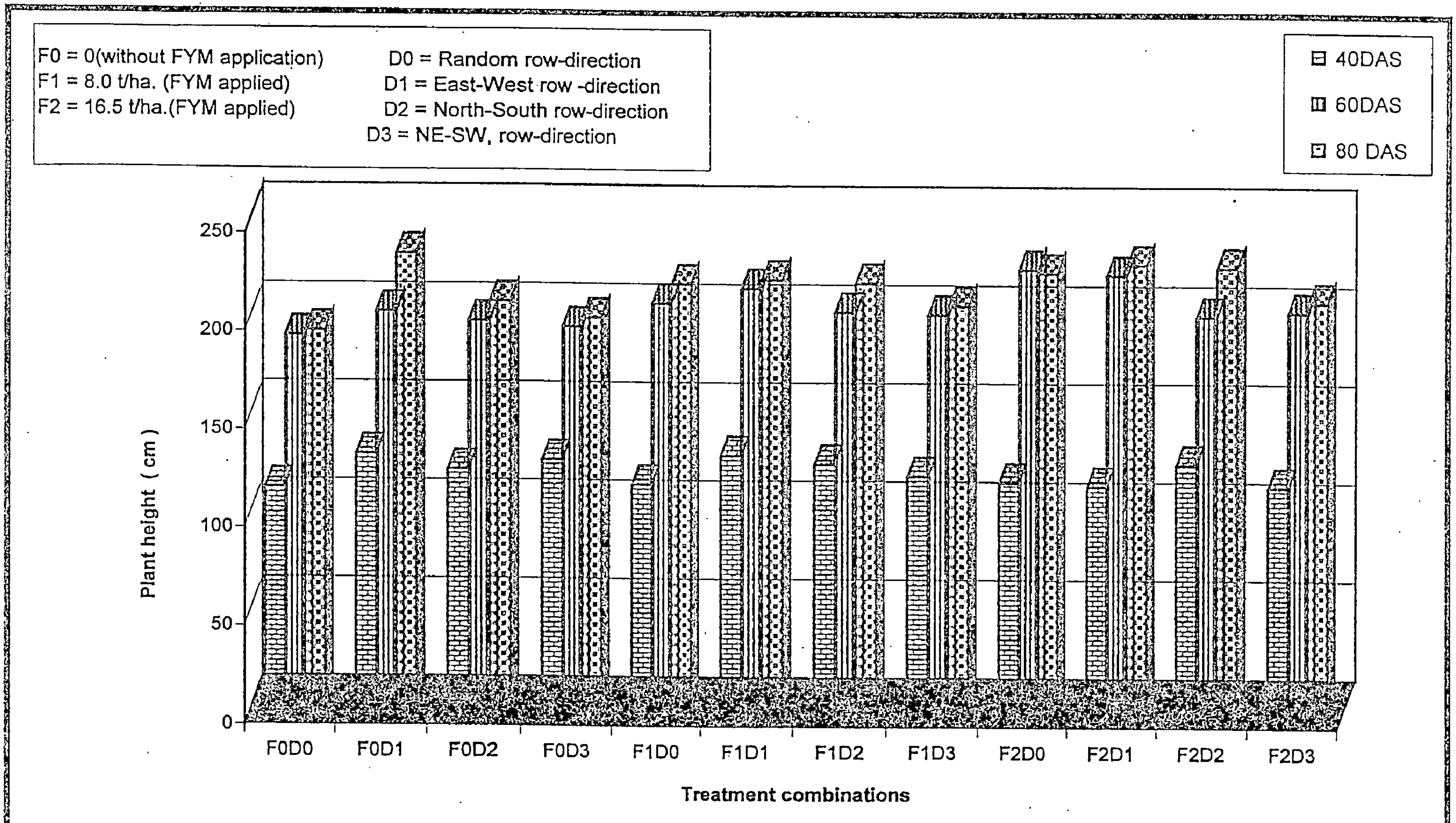
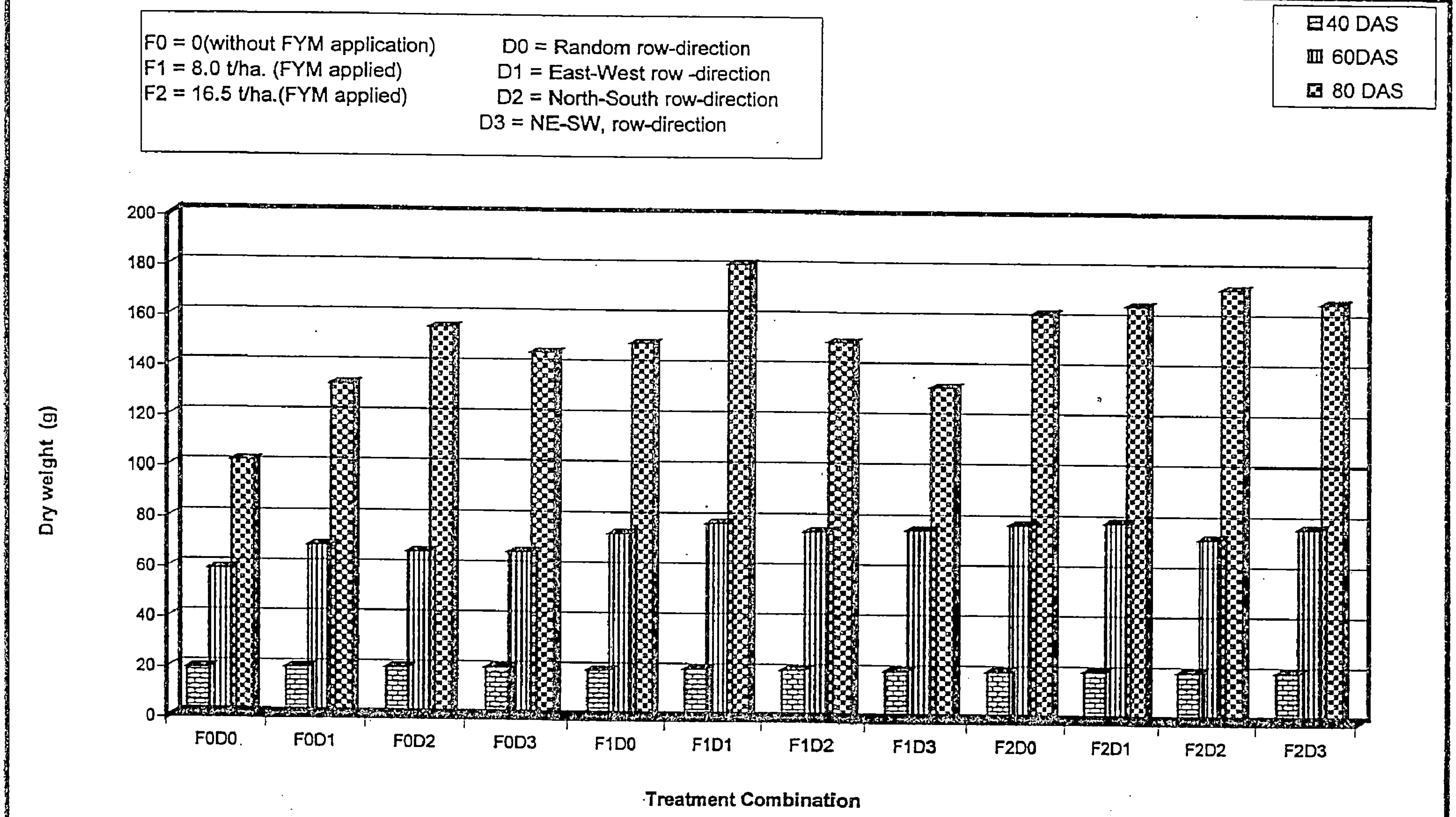


Fig 5.1 : Showing the effect of row-direction & FYM application on plant height (cm) at different stages of growth in Hybrid-maize



Fiig 5.2 : Showing the effect of row-direction & FYM application on Plant dry-weight (g) at different stages of Hybrid maize.

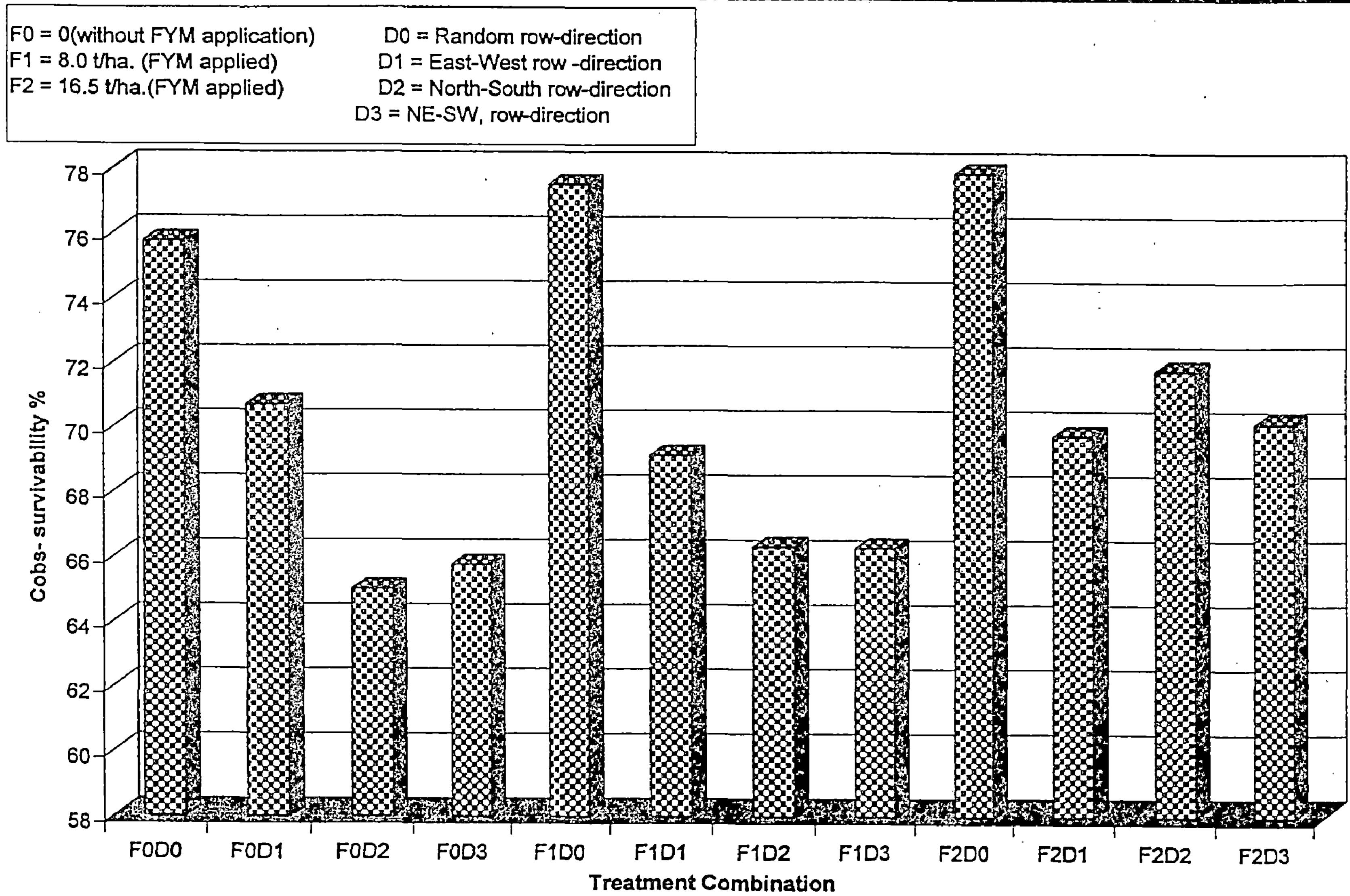


Fig 5.3: Showing the effect row direction and FYM application on Cobs-survivability of hybrid maize

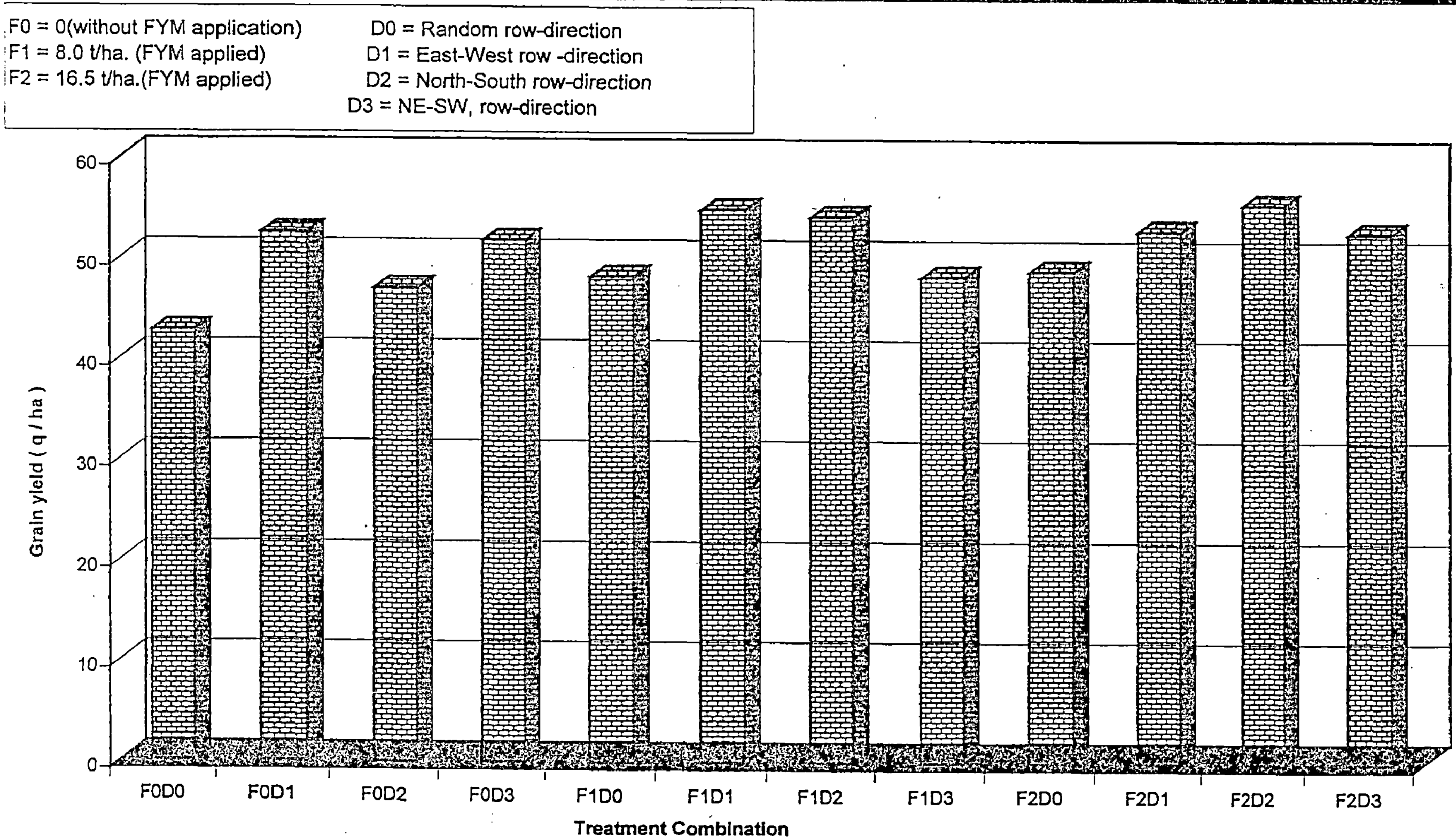


Fig 5.4 : Showing the effect of Row-direction and FYM application on Grain-yield of Hybrid maize.

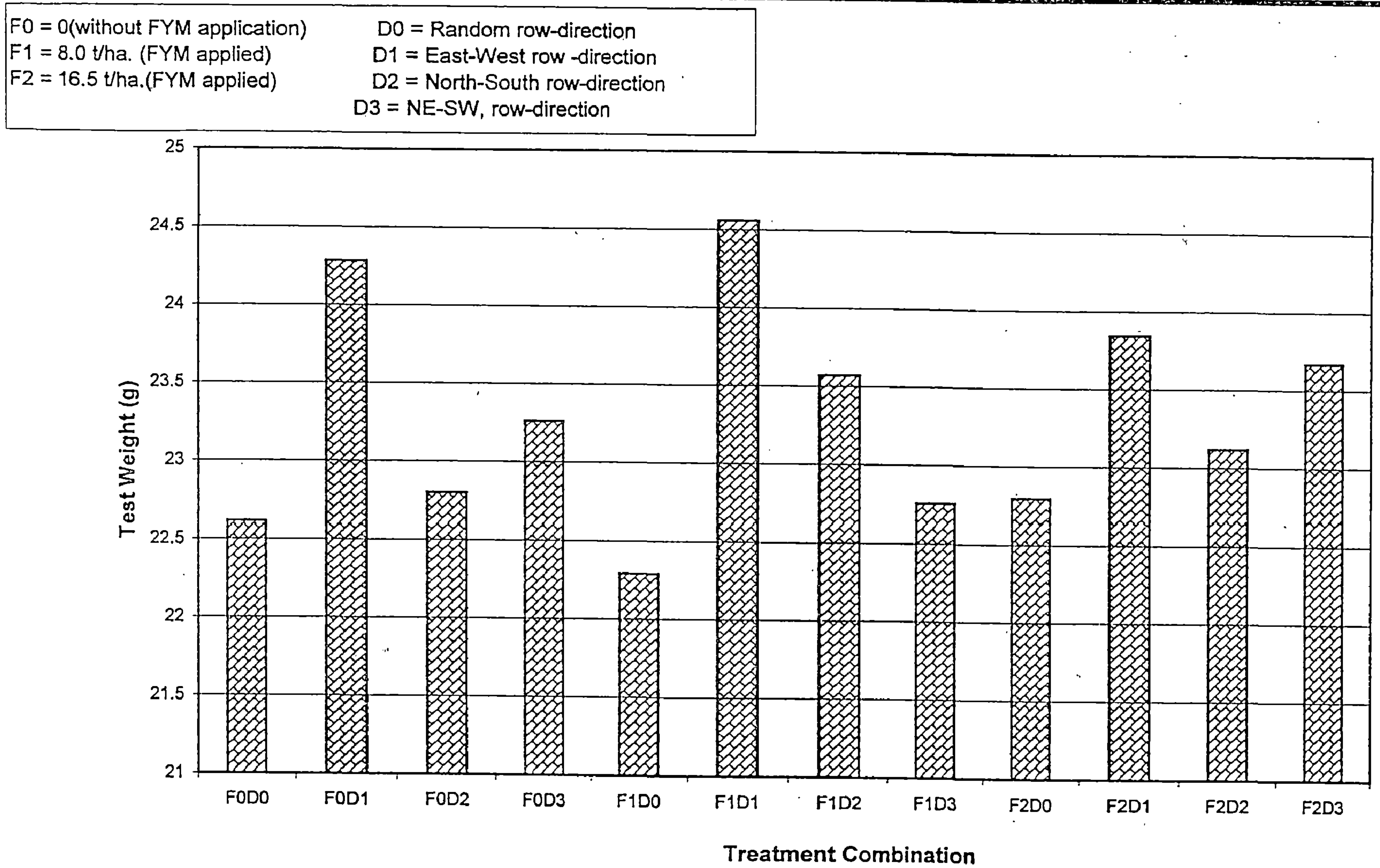


FIG 5.5: Showing the effect of row-direction & FYM application on test weight in hybrid maize

5.1.3 50% Silking and Flowering

This was not affected significantly at any stage of growth probably day length and light length or (photoperiod) were not a linking factor for the hybrid maize variety taken for experimentation (Fig. 5.2). The brief description reported by Gupta (1978), Baltazar et al. (2003) and Maddonni et al. (2002)

5.1.4 Cob Survivability

Result are present in table 5.2 and Fig. 5.4. The result showed that the increasing FYM dose progressively, decreased the cobs survivability irrespective of the direction of planting. Randomly transplanted treatments recorded maximum survivability of cobs. This could be attributed to the fact that cobs being shall in randomly planted treatment give equal opportunity to other cobs. The containing big and bold cobs had supposing effect on the other cobs. The discussion reported by Jonne et al. (2003) about cob survivability & pollination. Pandey et al. (2003) also concluded cobs & total yield increased with intercropping.

5.1.5 Grain Yield

Result obtained on grain yield presented in table 5:3 and Fig.5.5 This grain-yield recorded in east-west (E-W) and north-south planted treatments was significantly superior over that ~~[App. A (II)]~~ of random or diagonally planted treatment. This could be attributed to better sunshine availability in the east-west and north-south planted rows of maize. Application of FYM positively affected to the grain yield. This increased with increasing the amount of FYM application could be attributed to increased reorient and micronutrients availability to maize plants. Positive response on grain yield of maize grown under FYM and east-west (sowing) planting has also been reported by Fernando et al. (2002) obtained similar result due to effect of increased radiation interception (RI) with decreased row spacing, Chandrasekhar et al. (2002) also studied & reported about the organic manuring effect of grain yield of hybrid maize. Ameta et al. (2002) also obtained higher grain-yield response with plant density (85 thousands plant/ha and nitrogen levels 150 kg/ha, Selvam (2002) reported increased grain yield, plants 4 to 6 plant/m^2 and nitrogen level 0 to 100 kg/ha, Jaya et al. (2001) Grazia et al. (1999), Mahal et al.(2000), Manoj et al. (2003), Musambasi et al.(2003), Paskiewicz et al. (2003). Rusu et al. (1999), Willam et al. (2000),

5.1.6 Cobs/Plant

In general Average 0.89 cobs were produced/plant. Diagonally planted rows recorded highest number of cobs/plant the application of FYM could not influence it systematically. This result is countrary to the reports concluded by Fund et al. (2003), Singh et al.(2002) and Tripathi S.K. (1994).

Probably, this contradiction may be because of the change of soil and management conditions of this crop.

5.1.7. Grains/Cobs

In general 371.25 grain/cob were observed. Increasing the dose of FYM, progressively increased the grains/cob out of the numbers planted treatment randomly planted crop recorded lowest and row planted recorded the highest as (table 5.4). This could be attributed to the husk of the plant. The results about the yield attributes have also been reported by Saha et al (2001) with application of fertilizer dose. Pabio et al. (2000) and Jemison et al.(2001). Binder et al. (2001), Danilo (2003), Baltazar (2003).

5.1.8 Test Weight (100 Grains)

There was no effect found due to FYM application. However, sowing (planting) row-direction affected to the test-weight systematically. East-west planted rows recorded highest test-weight. The effect of organic manuring on test- weight has also been reported by Musambasi et al. (2003). and Willam et al. (2002) and Ferreira et al.(2000) concluded the effect of plant density, longitude- latitude on test weight of hybrid corn and stewart et al. (2002).

CHAPTER – 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

The study entitled **Effect of Row-direction and Organic Manuring on Growth, Development and Yield of Hybrid Maize,** was conducted during kharif (rainy) cropping season (June to September 2003) at Demonstration Farm of WRDTC, IIT Roorkee, Uttaranchal, India.

The experiment was conducted in (3 x 4) factorial blocks. During the process three farm yard manuring treatments F_o, F_1 and F_2 and four row direction(sowing) planting treatments namely D_o, D_1, D_2 and D_3 respectively, considered are as under:

FYM Treatments	Row-direction treatments
F_0 = 0 (without FYM applications)	D_o = Random row direction.
F_1 = 8.0 t/ha. (FYM applied)	D_1 = East-west, plants-row direction.
F_2 = 16.5 t/ha.(FYM applied)	D_2 = North-South plants row-direction.
	D_3 = NE – SW, row-direction.

Each treatment included three replications, thus the total experiment plots were 36 nos. The crop was uniformly irrigated twice (i.e. 85 mm each) during entire crop-season of hybrid maize cv K-25. The obtained results summarized are as under:

6.2 GROWTH STAGE

6.2.1 The average plant – heights at 40, 60 and 80 days after sowing were obtained 121.56 cm, 205.81 cm, and ~~207.75~~ 215.25 cm. The highest plant height at 80 DAS was recorded and the effect of FYM application F_0, F_1 and F_2 were obtained 185.75 cm, 215.50 cm and **222.00 cm** plant heights respectively. The row-direction effect also found significant and remarkable at 80 DAS. **226.72** cm in **East-west** row-direction, but effect at 40 DAS was insignificant.

6.2.2 The average plant **dry-weight** at 40, 60 and 80 DAS were recorded 19.97, 72.74 and 151.83 (g). The highest dry-matter weight was found due to maximum FYM treatment F_2 **(i.e. 166.90 g)** at 80 DAS and **east-west** row-direction planting D_1 **(159.76 g)**. Therefore FYM effect is in increasing order and more significant.

6.3 DEVELOPMENT STAGE

6.3.1 Age at 50% Flowering and Silking

This phenomenon was not found significant due to any treatment. The flowering was started 43 – 46 DAS and silking was at 49 – 52 DAS.

6.3.2 Cobs Survivability Percentage

Cob-survivability percentage found maximum in F_2 **treatment** (i.e. **72.41%**) showed progressive order of FYM application but in row-orientation planting, the **random direction** treatment D_0 obtained highest.

6.4 YIELD

The **grain yields** of hybrid maize were found significant results influenced by FYM and row-direction planting. The highest grain yield was recorded **53.51 q/ha in east-west row-direction** planting and **52.54 q/ha** due to highest level of Farm yard manuring **(F_2)**.

6.5 YIELD ATTRIBUTES

6.5.1 Cobs / Plants

In general average cobs produced **0.89** cobs/plant. The **NE-SW (diagonal)** row-direction recorded highest result.

6.5.2 Grains / Cob

The grains observed and counted average **371.25 grains/cob.**

6.5.3 Test – Weight (100 grains)

The test weight of 100 grains were found significant and influenced with row-direction planting in **east-west** row-direction and obtained highest **24.23 g,** perhaps it was due to light interception, but the FYM effect was insignificant.

6.6 CONCLUSION

The above summary and results of the conducted field experiment entitled "Effect of Row-Direction and Organic Manuring on Growth Development and Yield of Hybrid Maize", is concluded that there were found the significant influence of row-direction sowing (planting) and FYM application in the all stages i.e. growth, development and yield of 'K-25' hybrid maize variety except the age of 50% flowering and silking. This study has achieved the main objective to compare the highest grain yield of K-25 hybrid maize (i.e. **53.51 q/ha**), under the influence of **east-west row-direction** sowing (planting) at specified experimental site WRDTC, Demonstration Farm station IIT-Roorkee, U.A. India.

6.7 SUGGESTION FOR FUTURE WORK

(1) The present study has brought about the significant results, however it is recommended that the same study may be carried out under different set of conditions are as given below:

- (i) Different locations with respect to latitude and longitudes.
- (ii) Under different solar azimuths.
- (iii) Multiple cropping seasons should be considered.
- (iv) Compare the adaptability of various hybrid varieties to the unique set of conditions.
- (v) Adaptability of single hybrid variety to various set of conditions.

The level of significance of the out comes under the mentioned conditions will a attest the level of universal validity of the present study.

(2) The present study may play the vital role in the management of natural resources (i.e. solar energy, sunshine and rain) in cultivation of different crops. Hence it is advisable to carry out future study in this concern.

(3) The row-direction sowing method should be used as an additive to the other inputs (i.e. irrigation, manure or fertilizer and insecticides - pest etc.)

REFERENCES

(1) Agarwal R., R. C. Jain, and S. C. Mehta, (2001). "Yield Forecast Model Based on Weather Variables and Agricultural Inputs on Agro-Climatic Zone Basis", Indian Journal of Agricultural Sciences, 71:7, 487-490, India.

(2) Ameta G. S. and L. L. Dhakar, (2000). "Response of Winter Maize to Nitrogen Levels in Relation to Varying Population Journal of Tropical Agricultures, 18:4, 395-398, India.

(3) Antonopoulos, V.Z. (2001). "Simulation of Water and Nitrogen Balances of Irrigated and Fertilized Corn Crop Soil", Journal of Irrigation and Drainage Engineering, 127:2, 77-83, Greece.

(4) Baltazer M. B. and John B. Scooper, (2003). Crop-to-Crop Gene Flow: Dispersal of Transgenes in Maize during Field Test and Commercialization", Pioneer Hybrid international Mexico.

(5) Binder D.L., D.H. Sander and D. T. Walters, (2001). "Maize Response to Time of Nitrogen Application as Effected by Level of Nitrogen Deficiency", Agronomy Journal 92:6, 1228-1236.

(6) Badran M. S. S., (2001). "Response of some Maize Cultivars to Biofertilizer", Alexandria Journal of Agricultures Research 45:1, 129-141, Egypt.

(7) Bavee, F. and M. Brvee, (2001). "Effect of Maize Plant Double Spacing on Nutrient Uptakes Leaf Area Index and Yield", Rosti-Lina Vyroba, 47:3, 135-140, Slovenia.

(8) Chandra Shekhara C.P., S. I. Harlapur, S. Murali Krishana and G. K. Girijesh, (2000). Response of Maize to Organic Manures with Inorganic Fertilizer", Karanataka J. of April. Sci. 13:1, 144-146, India.

(9) Danilo Mejia, (2003). "Post–Harvest Operation": AGST/ FAO (Technical).

(10) Fund P., John H. (1991). "Hybrid Genetic Complement and Corn Plant Dk 570". Title of Invention, U.S. Plant Number: 05436389

(11) Fernando, H. Andrade, Pablo Calvino, Alfredo Cirilo and Pablo Barbieri, (2002). " Yield Responses to Narrow Rows Depend On Increased Radiation Interception". Agronomy Journal 94: 975-980.

(12) Griesh M.H, G.M. Yakaut, W.J, Horst, M.K. Schenk, A. Burkert, N. Classen, and H. Flessa, (2001). "Effect of Plant Population Density and Nitrogen Fertilization on Yield and Yield Components of some White and Yellow Hybrids under Drip Irrigation System in Sandy Soil", Fourteenth International Plant Nutrition Colloquium Hanover, Germany 810-811.

(13) Huseyin Gozulenli, Okain Sener, Omer Konuskan & Mehmetkiling (2003). "Effect of Hybrid and Plant Density an Grain Yield Compound of Maize" Indian Journal of Agronomy 48 (3): 203-205.

(14) Jaya K.D., C.J. Bell and P.W. Sale, (2001). "Modification of Within Canopy Microclimate in Maize for Intercropping in the Lowland Tropics". Proceedings of the 10th Australian Agronomy Conference, Hobart.

(15) Joanne A. Labate, Kendall R. Lamky, Sharon E. Mitichell, Stephen Kresovich, Hallary Sullivan and John S.C.Smith, (2003). "Molecular and Historical Aspect of Corn Belt Dent Diversity Crop Science", 43: 80-91.

(16) Jemison John M.J. and Michael E. and Vayda, (2001). Cross-Pollination from Genetically Engineered Corn and Wind Transport and Seed Source", AgBio Forum 4(2):87-92.

(17) Mahal S.S., D.G. Dejenu, and M.S. Gill, (2000). "Growth and Yield of Maize as Influenced by Flood under Different Planting Methods and Nitrogen levels Environment and Ecology", 18(4): 789-792, India.

(18) Maddonni Gustavo Angle, Maria Elena Otgui, Bruno Andrieu, Michael Chelle and Jorge J. Casal, (2002). "Maize Leaves Turn Away from Neighbors", Plant Physiol. 130 (3) : 1181-1189.

(19) Manoj Kumar and M. Singh, 2003. " Effect of Nitrogen and Phosphorus Level on Yield and Nutrient Uptake in Maize (Zea. Mays L) under Rainfed Conditions of Nagaland", Crop Res. 25 (1) : 46- 49, India.

(20) Musambasi D, Chivinge O.A, Mariga I.K., 2003. " Effect of Ridging Treatments and Two Early Maturity Maize Cultivar on Witchweed [Striga Asiatica (L.) Kuntze.]", Crop Res.25 (1) : 37- 45, Zimbabwe.

(21) Paskiewicz and Butzen (2003), "Pioneer Decade Study", Number 341.

(22) Pandey I.B., V.bharti and S.S. Mishra, (2003). "Effect of Maize (zca Mays) Based Intercropping Systems on Maize Yield and Associated Weeds under Rained Condition". Indian Journal of Agronomy 48(1): 30-33.

(23) Rusu C., D. Dornesu, and E. Istrati, (1999). "The Influence of Long Term Fertilization on Maize Yield and on Maize Yield and on the Evolution of the Main Agrochemical Soil Indices". Analele Institute de Circuitry Pantry Cereal Si Plant Technic. Fundulea, 66: 201-221, Romania.

(24) Selvarn M.A., (2002). "Application of DSSAT for Prediction of Yield of Maize ", M. Tech. Dissertation IIT-Roorkee, INDIA.

(25) Saha R.R., M.A. Quayyum, S. Alom, P.C., Sarker, A. Khayer and A.F.M.F. Rehman, (2000). "Fertilizer Management in Hybrid Maize with Soybean Intercropping System under Irrigated Condition", Online Journal of Biological Science, 1 (9): 812-814.

(26) Singh N.P., Singh R.A., (2002). "Scientific Crop Production". Text Book: P.111-117, India.

(27) Stewart, D.W., C. Costa, L.M. Dwyer, D.L. Smith, R.L. Hamiltion and B.L. Ma, (2002). "Canopy Structure, Light Interception, and Photosynthesis in Maize", Argon J 95: 1465-1474.

(28) Thorne D.W. and Thorne M.D., (1979), "Soil Water and Crop Production : Text Book".

(29) Tripathi S.K., (1994). "Manual on Agronomy for Engineers, for P.G. Training Programmed in Water Use Management WRDTC", University of Roorkee. (New IIT - Roorkee) INDIA: 49-52, 146-159.

(30) Willium J. Cox and Debbie J.R. Cherney, (2004). "Within Row–Plant Spacing", Variability does not Affect Corn Yield. Agron. J 94: 275-280.

APPENDICES

PLANT GIRTH AT 80 DAS (in cm.)

Rep /Treat	R1	R2	R3	TOTAL	CF	SS	TSS	Tr.SS	Rep.SS	Average Rep.
F0D0	1.48	1.46	1.49	4.43		6.54		19.62	357.21	1.48
F0D1	1.51	1.53	1.50	4.54		6.87		20.61	356.83	1.51
F0D2	1.71	1.65	1.70	5.06		8.54		25.60	355.70	1.69
F0D3	1.63	1.58	1.61	4.82		7.75		23.23	0	1.61
F1D0	1.56	1.54	1.58	4.68		7.30		21.90	0	1.56
F1D1	1.71	1.73	1.69	5.13		8.77		26.32	0	1.71
F1D2	1.40	1.43	1.42	4.25		6.02		18.06	0	1.42
F1D3	1.63	1.60	1.61	4.84		7.81		23.43	0	1.61
F2D0	1.52	1.50	1.50	4.52		6.81		20.43	0	1.51
F2D1	1.55	1.62	1.54	4.71		7.40		22.18	0	1.57
F2D2	1.60	1.64	1.59	4.83		7.78		23.33	0	1.61
F2D3	1.60	1.61	1.63	4.84		7.81		23.43	0	1.61
TOTAL	18.90	18.89	18.86	56.65	89.15	89.40	0.25	0.24	0.00	

F /D	D0	D1	D2	D3	TOTAL	omSS	Dir SS	INTERACTION	Average(om)
F0	4.43	4.54	5.06	4.82	18.85	355.32	185.78		1.57
F1	4.68	5.13	4.25	4.84	18.90	357.21	206.78		1.58
F2	4.52	4.71	4.83	4.84	18.90	357.21	199.94		1.58
	0	0	0	0	0	0.00	210.25		
TOTAL	13.63	14.38	14.14	14.50	56.65	0.00	0.05	0.19	
Av.(Dir.)	1.51	1.60	1.57	1.61					

ANOVA TABLE

SV	Df	SS	MSS	F.Cal.	F.Tab.		CD
					95%	99%	(P=0.05)
Rep.	2	0.00	0.00	0.06			
F	2	0.00	0.00	0.12	3.44	5.72	0.02
D	3	0.05	0.02	28.66**	3.05	4.82	0.02
F*D	6	0.19	0.03	54.53**	2.55	3.76	0.04
Error	22	0.01	0.00				
TOTAL	35	0.25	0.05				

Table : Nutrients removed from the soil

Plant part	Yield (tones/ Ha)	Nutrients Extracted Kg/Ha.				
		N	P	K	Ca	Mg
Grain yield	1.0	25	6	15	3.0	2.0
Stover	1.5	15	3	18	4.5	3.0
Total	2.5	40	9	33	7.5	5.0
Grain yield	4.0	63	12	30	8	6
Stover	4.0	37	6	38	10	8
Total	8.0	100	18	68	18	14
Grain yield	7	128	20	37	14	11
Stover	7	72	14	93	17	13
Total	14	200	34	130	31	24

[Ref. 9]

APPENDIX–A (II-ii)

Table: Showing the variety, maturity period and yield.

S.No.	Season	Maturity period	Yield t/ha
1.	Full season variety	100-110 days	4.5-6.5
2.	Medium maturity	90-100 days	3.5-4.5
3.	Early maturity	85-90 days	2.5-3.5
4.	Extra early maturity	75-85 days	2.0-2.5

The 20 Largest Maize Producers, 2000-2002			
Country	**Area (million ha)**	**Yield (t/ha)**	**Production (million t)**
USA	28.6	8.4	240.7
China, People Rap	23.9	4.5	97.2
Brazil	11.9	3.1	36.3
Mexico	7.6	2.5	18.9
France	1.8	8.8	16.2
Argentina	2.8	5.6	15.6
India	6.5	1.9	12.5
Italia	1.1	10.0	10.8
South Africa	3.5	2.7	9.5
Indonesia	3.3	2.7	9.4
Canada	1.2	6.6	7.7
Romania	2.8	2.6	7.5
Egypt	0.9	7.8	6.7
Yugoslavia	1.2	4.0	4.8
Nigeria	4.1	1.1	4.7
Spain	0.5	9.7	4.5
Philippines	2.5	1.8	4.5
Thailand	1.2	3.6	4.2
Ukraine	1.2	3.6	3.9
Germany	0.4	9.0	3.4
Source: FAOSTAT, 2002 .			

Ref. [9]