Response of Rice Variety : Lakshmi (Kayamkulam-I) to different dates of Planting and Plant Density

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture

Kerala Agricultural University

Department of Agronomy

COLLEGE OF AGRICULTURE

Vellayani - Trivandrum

1989

DECLARATION

I hereby declare that this thesis entitled "Response of rice variety: Lakshmi (Kayamkulam-1) to different dates of planting and plant density" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellayani,
16.9.89

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CERTIFICATE

Certified that this thesis, entitled "Response of rice variety: Lakshmi (Kayamkulam-1) to different dates of planting and plant density" is a record of research work done independently by Sri. S. Moni Perumal under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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ACKNOWLEDGEMENTS

I express my deep sense of gratitude to Dr. Lekha Sreekantan, Assistant Professor of Agronomy for her meticulous and gracious guidance, sustained interest, constant inspiration , invaluable help, affectionate advice and forbearance all through this research work.

I indebt to Sri. V. Ramachandran Nair, Sri. E.P. Koshi, Sri. K.P. Madhavan Nair and Dr. G. Raghavan Pillai, Professors of Agronomy, members of my advisory committee for their valuable guidance in designing and formulating the research study in the initial stage.

I owe a large debt to Professor P. Chandrasekharan, Head of Department of Agronomy, for his elderly advise, technical help and critical comments from his wide research experience insights whose worth cannot be weighed.

I sincerely acknowledge Dr. V. Muraleedharan Nair, Professor of Agronomy and Sri. R. Balakrishnan Asan, Assistant Professor of Statistics for their constant encouragement, advice and valuable guidance at every stage for this research study.

I also want to express my gratitude to Mr. Ajith Kumar, Jr. Programmer, Department of Agriculture Statistics for his generous help in getting the data analysed within a short period of time.

My sincere thanks and deep sense of gratitude and indebtedness are due to Dr. S. Bhaskaran and Sri. S. Mothilal Nehru, Associate Professors of Agricultural Extension for their valuable suggestions and helps during the preparation of this thesis.

My sincere thanks are due to Mr. S.M. Shahul Hameed, Associate Professor of Agronomy and Mr. V. Jayakrishna Kumar, Junior Assistant Professor of Agronomy for their valuable help during the preparation of this thesis.

I express my gratitude and indebtedness to the members of my family especially my wife Mrs. Meena Perumal and little daughter M. Pappa Rajam and son M. Retnamani who cheerfully underwent the sacrifice demanded of them during the preparation of this thesis.

My sincere thanks are due to Sri. V. Murukan Pillai, Proprietor, Academy of Typewriting and Shorthand, Nedumangad for his generous help in getting the thesis typed within a short period of time.

Finally I am grateful to the Department of Agriculture, Government of Kerala for deputing me to undergo this Post-graduate course in Agronomy.

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INTRODUCTION

1. INTRODUCTION

Rice is the most extensively cultivated food crop of India and grows under a wide range of rainfall and soil conditions. The scope for further extensive cultivation is very limited because of many constraints like water logging, drought, soil conditions such as acidity alkalinity etc., including high pressure of population on land and the consequent reduction in the per capita availability of land. All these factors have contributed for the reduction in the coverage of area under high yielding varieties of rice.

Rice is cultivated in the state in about 6.78 lakhs ha. (1985-86 figures) and the production is approximately 12 lakhs tons (1985-86 figures). The total production of rice is insufficient to meet the requirement of the state.

During Mundakan (Rabi) season 1985-86 the coverage under high yielding varieties of rice in Kerala was 0.41 lakh ha., out of the total area of 3.13 lakh ha. This works out to 13.1% whereas it was 30% during Virippu (Kharif) season of 1985-86. In Trivandrum District only 1.08% of the total area was brought under high yielding varieties during the Mundakan (Rabi) season of 1985-86. (Anon, 1988).

Cheradi, the photosensitive traditional tall variety grown during the second crop season is very popular in the southern tracts of Kerala. Although the traditional varieties yield less, other factors like better cooking quality, high straw yield and ability to thrive well in adverse conditions, have always prompted the farmers to prefer these varieties for Mundakan season. The Kerala Agricultural University had been trying to evolve varieties suited to these situations and as a result Lakshmi (Kayamkulam-1), a high yielding variety of rice was evolved at the Rice Research Station, Kayamkulam, and is now popular in South Kerala, eventhough it was released to meet the special requirements of sandy soils of Onattukara tract. It is found to be a better substitute for Cheradi. The parentage of this variety is Kottarakkara-1 x Poduvai and the colour of the rice is red. It has high yielding potential and wide adaptability to suit the local conditions. The manurial requirement of this variety has been studied. But, no study has been conducted on the optimum time of planting. In the T & V Workshop of Trivandrum District, it has been reported that the yield of Cheradi and Lakshmi varieties have gone down in certain situations and it is believed that one of the reasons for the reduction in yield is the delay in [illegible] planting. Suggestions were made that the University may take up a research project to study the optimum time of planting in relation to the planting density, as changes in planting density could compensate yield variations due to changes in time of planting.

Hence the present study was taken up with the following objectives.

1. To find out the optimum time of planting of Lakshmi variety of rice in relation to plant density.

2. To find out the effect of planting time and density on the morphological characters, yield components, yield and quality of rice.

3. To work out the economics of cultivation of the variety Lakshmi at varying spacings and time of planting.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

An experiment was conducted to study the effect of different times of planting and spacing on growth and yield of rice variety: Lakshmi (Kayamkulam-1) in the second crop season in the College of Agriculture, Vellayani, Trivandrum. Literatures related to this study are reviewed hereunder.

2.1. Time of planting

2.1.1. Effect of growth characters and nutrient uptake

Urkurkar (1984) reported that the water use efficiency for dry matter production was highest, between 11th and 21st July in rice cv. Asha, when transplanted during monsoon season between 1st June and 30th August, at 10 days interval.

Pan et al. (1987) revealed that 4 cv. of different maturity of indica rice at 3 seedling ages grown during second crop season on 27th July, 6th and 10th August had a longer growth period in the older seedling age treatments with the same transplanting date, but it was shortened by delaying the transplanting date at the same seedling age. The maturing and heading dates were delayed both by decreasing seedling age and by delaying transplanting. Panicle of the late and intermediate late cv. failed to emerge before the critical safe heading date with late transplanting (16th August) and small seedlings.

Ramaiah et al. (1987) revealed that among the three dates of planting at three levels of nitrogen on two rice cv. (RNR. 1446 and RNR. 36626) transplanting during second crop season on 15th July increased the dry matter production and total number of tillers per m^2 and uptake of 'N' as compared to other dates of planting.

Trivedi and Kwatra (1987) in their study on 'effect of dates of transplanting of rice cv. Patel--85 reported that growth of crop was significantly higher, when planted on June 30th, during first crop season.

Reddy et al. (1988) showed that in their trials during three wet season, the early transplanted rice had adverse effects on stand, tillers and panicles.

2.1.2. Yield component

Subbarayalu (1979) reported that the delayed sowing (July, 8th) was reduced the number of panicles per m^2 and got less number of grains per panicle and lower test weight, when compared with earlier sowing (June 8th).

Reddy and Narayana (1984) showed that when 20, 30 or 40 day-old rice seedlings were transplanted during second crop season, on 10, 20 or 30th July or 9th August, the numbers of panicle/m^2 and filled grain/panicle and the test weight decreased significantly with each 10 days increase in seedling age. Spikelet stability was higher with earlier transplanting.

Ramaiah et al. (1987) revealed that among the three dates of planting at 3 levels of nitrogen on 2 rice cv. (RNR. 1446 and RNR. 36626) transplanting on 15th July was increased the number of panicles per m^2, panicle weight and number of filled grains/panicle.

Trivedi and Kwatra (1987) reported that the rice Cv. Patel-85, when planted on 30th June, 15th and 30th July and 14th August, the delayed planting, decreased the yield components.

2.1.3. Yield

Trials conducted at Agricultural Research Station, Palur during second crop season (Samba) revealed that the time of planting 25th September was given maximum yield (1981 Kg. per ha.) followed by 4th October planting which gave 4620 Kg. per ha. The best time for planting IR 20 was between 25th September and 4th October (Anon, 1978).

Subbarayalu (1979) reported that highest grain yield was obtained when paddy sown during first crop season on

8th June. The yield was declined correspondingly with delayed sowing.

Dixit et al. (1979) revealed that the paddy yields of the flood resistant rice cv. Madhukar were similar when sown during first crop season on 29th May and 8th June and were decreased with further delay in sowing 10 day intervals upto 8th July.

Rao (1980) reported that the rice cv. GEB 24) transplanted at 15 day intervals between 16th July and 1st October and given 0 to 120 Kg. N per ha. gave the highest paddy yields, when transplanted on 16th August.

Studies conducted at Kerala Agricultural University Research Station, Mannuthy revealed that early planting was found to be more conducive for better yield. It is also observed that the optimum time of planting for Jaya and Sabari in Mundakan season was from late September to mid October (Anon, 1983).

Trials conducted in three seasons at Kerala Agricultural University Research Station, Mannuthy showed that only short duration variety responded significantly to date of planting and maximum yield was noted for early planting in the season (Anon, 1983).

Ding and Chai (1983) found that rice seedlings transplanted during second crop season, on 2, 6, 10 and 14 August showed a significant negative correlation between transplanting date and yields in all 3 tested cv. However the reduction rate varied with the growing periods of cv. and the optimum transplanting dates were 8, 6 and 10 August for Nonghu No. 6, Janong No. 15 and Hira hangazao, respectively.

Reddy and Narayana (1984) in their studies during second crop season, revealed that the grain yields with 10th and 20th July transplanting dates were 6.18 and 6.36 t. per ha, respectively and transplanting on 30th July and 9th August reduced the yields by 8.9 and 13.2% respectively. Straw yields were significantly lower with 40--than 30-or 20--day old seedlings and with two later transplanting dates.

Urkurkar (1984) reported that optimum yields were obtained in rice cv. Asha during monsoon season, between 11th and 21st July.

Saroja and Raju (1985) reported through their experiment conducted in Tamil Nadu, that the short duration rice cv. TM. 8089, planted during December--May and April-August cropping seasons, on 30th January had lowest grain damage by _Leptocorisa acuta_ and yielded highest. Very early and very late rice crops were prone to panicle bug attack.

Azad et al. (1986) found in their field experiment that the maximum grain yield a short duration varieties IET 1410, PC. 16, PC. 54 and PC 169 could be obtained during first crop season, when their transplanting was completed by 5th July. When they were planted at 10 day-intervals commencing from 25th June to 25th July at a uniform spacing 20 x 10 cm. Further delay in planting exhibited reduction in grain yield which again resulted in more diminishing yield, if planted beyond 15th July.

Harans Singh et al. (1986) revealed that in rice varieties Jaya, PC 19, and Pb. 1 which were transplanted during first crop season at 10-day intervals from 15th June to 15th July at 15 x 20 cm spacing, the cv. Jaya planted by 15th June gave significantly superior grain yield over other dates of planting.

Akram et al. (1987) in their experiment during first crop season concluded that in rice cv. Kashmir-Basmati grown with 4 fertilizer rates and transplanted on 24th May, 8th June, 24th June or 8th July was got the highest average yield, when planted on 8th June.

Dhaliwal et al. (1987) found that the late sowing and transplanting rice cv. Jaya, PR 106 and Pb Basmati No. 1 were reduced the grain yield.

Harans Singh et al. (1987) reported that there were great variation in yield data between two years (1981 and 1982) particularly in case of planting during Kharif season, on July 15th and 25th. However, early planting on 5th July in both years recorded highest yields than late planting (July 15th and 25th) in all the test cultivators (PC 10, PC 16, AC 42, K-39, K-1039 and DET 1410) at 20 x 10 cm spacing. Among them PC. 16 appeared promising with highest mean yield in both the years.

Ramaiah et al. (1987) revealed that among the three dates of planting at three levels of nitrogen on two rice cv. (RNR. 1446) and RNR 36626), transplanting on 15th July was increased the grain and straw yield to other dates of planting.

Reddy and Reddy (1987) showed that the rice cv. NLR. 9672, NLR. 9674, NLR 9672-96 and NLR 27999, when transplanted September 5 and September 20, gave higher grain yields than transplanted in August or October. Cultivar NLR, 9672-96 gave significantly higher yield 5.1 t. per ha. than the other cultivars tested when planted on September 20th. NLR 27999 was-suitable for later transplanting upto October without any reduction in grain yield.

Trivedi and Kwatra (1987) reported that the rice cv. Patel 85, when planted during first crop season, on 30th

June, 15th and 30th July and 14th August, gave significantly higher yield on 30th June.

Viswambaran et al. (1987) reported that rice cv. Jaya and I.R. 8 were yielded 1.0 to 4.6 t. per ha. and 0.7 to 4.4 t. per ha. respectively, when transplanted between 22nd August and 12th November on 7 dates, during the second crop season.

Maithy and Mahapatra (1988) revealed that in different rice varieties grown on four transplanting times at 15-day intervals from 5th December to 10th December the time of planting was affected the yield and transplantings on 25th December and January, produced the highest yield. Late and early planting reduced the yield, perhaps because of temperature.

Reddy et al. (1988) found that during wet seasons, early transplanted rice was yielded higher than late transplanted one.

Suharto and Noch (1988) showed that the incidence of leaf folder was lower on late transplanted rice (2nd March) than on early transplanted rice (30th December) or that transplanted on 30th January and the infestation of rice bugs was highest on late transplanted rice. The yield of late transplanted rice was significantly lower than that of rice transplanted on either of the other two dates.

2.1.4. Grain Protein and quality of rice

Akram et al. (1987) revealed that the sowing date did not affect the grain protein and the highest average protein content obtained was 9.3%.

Dhaliwal et al. (1987) found that the late transplanting increased the fatty acid content in grain of rice and the grain crude protein.

2.2. Plant density (spacing)

2.2.1. Effect on growth characters and nutrient uptake

Panda and Leeuwrik (1971) reported through their experimental studies at Rice Research Station, Chiplima that the closer the spacing (10 x 10 cm) greater was the plant height (90.2 cm) and number of effective tillers per unit area(228 per m^2).

Chandra and Rao (1986) observed during Kharif season that the plants at closer spacing (10 x 10 cm) were significantly taller and the spacings did not affect plant height, when compared with other spacings (10 x 15 cm, 10 x 20 cm, 15 x 20 cm and 20 x 20 cm).

Lin and Lin (1986) depicted that the rice cv. Taichung Sen-3 and Taiwan-5 (TN. 5) grown at spacings of 30 x 10 cm, the closer spacing resulted in higher tiller number (TLN) and LAI, except that TN.5 possessed smaller LAI during grain filling, in the first crop season.

Debata and Murthy (1987) reported that the relative sequence of leaf was lower in Ratna at a density of 25 plants per m^2 and of panicle in 'Pallavi' compared with 100 plants per m^2.

Wagh and Thorat (1987) in their experiment obtained a significantly higher dry matter at closer spacing of 15 x 10 cm.

Mohammed Ayub et al. (1988) recorded the number of tillers per hill, decreased with increasing plant density, but plant height was not affected.

2.3. Yield components

Panda and Leeuwrik (1971) in their experiment conducted during Kharif season revealed that the length of panicle, number of fertile and sterile panicles and 1000 grains weight were increased with increase in spacing. The widest spacing had the lmngest panicle of 21 cm maximum, maximum 99 grains and 25 sterile spikelets per panicle and maximum 1000 grain weight of 23 g.

Payari et al. (1982) proved that the grain weight per hill was found increased significantly (from 2.2 to 2.7 g.) with a increase of spacing from 10 x 10 cm to 15 x 10 cm and from 15 x 10 cm to 25 x 10 cm.

Wagh and Thorat (1987) obtained a significantly higher number of panicle per unit area and higher panicle weight from rice cv. R. 24 in Konkan region of Maharashtra at a closer spacing (15 x 10 cm) than the other spacings (15 x 15 cm and 15 x 20 cm).

Liou (1988) concluded in his trial at spacings of 12.5 x 12.5 cm, 25 x 25 cm are 15 x 15 cm that the close spacing (12.5 x 12.5 cm) markedly decreased panicle length, number of primary branches and number of grains on secondary branches. Close spacing also changed the ear type with more grain intermediate than basal positions, spacing could not affect the number of grains on primary branches.

Pedroso (1988) in his trial conducted for irrigated rice, found that the widest row spacing gave more panicles and heavier grains.

2.2.3. Yield

Kamda and Kalizaki (1958) from Japan observed that maximum grain yield per unit land area was obtained when the ratio of spacing between rows to planting in the rows was 2:1 or 3:1.

Vachhani et al. (1961) obtained significantly higher yield under a close spacing 15 x 15 cm at CRRI, Cuttack.

Significant high yields were obtained when planted with a spacing of either 10" x 10" or 8" x 8" rather than 6" x 8" 5" x 20" and 6" x 18" spacings. (Relwani, 1962 and Relwani, 1963).

Sahu and Lanka (1966) studied the different spacings of 15" x 15", 20" x 20" and 25" x 25" and concluded that 15" x 15" spacing was superior.

Rami Reddy (1967) reported that for medium duration rice varieties, a spacing of 8" x 6" was found to be ideal, with highest yield.

Nair (1968) reported that closer spacing of 15 x 15 cm was superior to a wider spacing of 22.5 x 22.5 cm and recorded the highest yield of grain in the case of IR. 8 in 15 x 15 cm under Trivandrum condition in Kharif season.

Raghavan Pillai and George (1969), while studying the performance of rice variety IR. 8 under varying levels of nitrogen and spacing at the model Agronomic Research Station, Karamana found that there was no significant difference in yield due to spacings tried.

Singh and Modgel (1970) reported that the grain yield was not influenced by plant spacing but negligible difference in grain and straw yield between row spacing was reported by Bathkal and Patil (1970).

Panda and Leeuwrik (1971) revealed that the closer spacing of 10 x 10 cm gave relatively more yield of 2345 Kg. per ha.

Subramanyam (1971) showed that single row spacing recorded significantly increase grain yield over double raw method of planting, even though the population M -2 was same.

Bhattacharya (1977) observed that the closer row spacing with wider plant distance yielded higher.

Results of trial conducted in the Rice Reseach Station. Pattambi, second crop season (treatments with 4spacings 10 x 10 cm, 10 x 10 20 cm and 20 x (10 x 10 cm) showed that the plant density was not significant, but relatively more yield was obtained from hills, planted very close (10 x 10 cm), (Anon, 1977).

Singh and Modgal (1979) observed in their study with indica rice varieties that the change in spacing from 1 15 x 15 cm to 20 x 20 are 25 x 25 cm had no significant effect on yield in dwarf and tall cultivars.

Abdul Majid et al. (1980) in their study with three rice varieties viz. Basmathi-370, Basmathi-198 and IR, 6-945, with optimum stand densities revealed that the tall varieties Basmathi-370 and Basmathi-198 gave their highest yield at a spacing of 9 x 5.5 inches, while the shortest variety IR 6-945 gave highest yield and out-yielded the other varieties at a spacing of 6 x 6 inches.

Reddy (1980) revealed that among the direct sown eight rice varieties at row spacings of 10 and 15 cm or transplanted at row spacings of 10 and 10 cm and a between plant spacing of 10 cm cultivar Rajendra with a duration of 105 days gave the highest grain yield of 5986 Kg. Per ha.

Reddy (1980) in his fertility level intra-row spacings and water management studies showed that paddy yields of rice cultivar Sona decreased with increase in between plant spacing from 5 to 10 and 15 cm in rows and 15 cm apart.

Payari et al. (1982) proved that the various spacings did not influence the per ha. yield significantly. However the wide spacing of 15 x 10 cm. enhanced the grain yield by 2.35 quintals per ha. as compared to the closest spacing of 10 x 10 cm.

Venugopal and Singh (1985) proved through their field experiment during wet season that all the seedling ages, the wider spacing of 20 x 20 cm resulted in higher grain and straw yield.

Chandra and Rao (1986) observed that grain yields were not affected significantly within the spacing range of 150 to 400 cm2.

Gulati et al. (1987) found that grain and straw yield increased with irrespective of spacings. However closer spacing (15 x 10 cm) of plainting produced comparatively higher yield than the wider spacing (30 x 10 cm).

Sobral and Oliveira (1987) reported that the lowest grain yield (1.39 t. per ha.) was obtained by spacing of 34 cm with 45 or 60 Kg. seed per ha. and the highest grain yield (1.55 t. per ha) was obtained at a row spacing of 34 cm and 60 Kg. seed per ha.

Thorat and Patil (1987) observed that paddy yields of 5 rice cv. increased with decrease in spacing between plants from 20 to 15 and 10 cm in rows and 12 cm apart.

Zia (1987) recorded the highest yield at 20 x 20 cm spacing and the lowest at 40 x 25 cm spacing at National Agricultural Research Centre, Islamabad.

Chandra and Rao (1988) observed that the rice cv. Vijaya grown at a spacings of 15 x 10, 15 x 15, 15 x 20 and 20 x 20 cm (feeding area ranging from 150 to 400 cm2 per plant) gave similar paddy yields of 4.02 to 4.20 t. per ha. When grown at a constant feeding area (300 cm2 per plant) there was no significant differences in yields at 20 x 15 cm (3.76 t. per ha.) and 25 x 12 cm (3.79 t. per ha.) and they were significantly higher than at 30 x 10 cm (3.46 t. per ha.)

Raghuwanshi et al. (1988) observed that the rice seedlings transplanted at a spacing of 20 x 15 cm gave higher paddy yields than when transplanted at 20 x 20 cm or 15 x 15 cm.

Rao and Raju (1988) revealed that a spacing of 10 or 15 cm between plants in rows 15 cm apart gave yields of 3.89, 5.38 and 6.18 t. per ha., respectively.

Wagh et. al. (1988) reported that there was no significant difference in grain yield when the crop was transplanted with 15 x 10 cm and 20 x 15 cm spacings.

2.3. Time and spacing interactions

Gautam and Sharma (1983) in their field trials conducted during Kharif season found that the optimum plant density was 100 hills per m2 for Jaya and 400 hills per m2 for Ratna Ravi and Cauvery at all sowing dates (10th June, 20th June, 5th July and 10th July).

Gautam and Sharma (1987) reported that the paddy yield was positively correlated with maximum LAI, total area duration and total Dry matter production, when 4 rice cultivars of different growth periods were plainted either on same date for different growth periods or planted either on the same date for different maturity dates or on different dates for coinciding their maturity dates using three plant densities (15 x 10 cm, 20 x 10 and 10 x 15

Reddy and Reddy (1987) ascertained in field experiment that the optimum time of planting and spacing for IET 2508 transplanted during early part of June gave high yield and the grain yield drastically reduced when transplanted beyond June, 10 and before May. The ideal spacings found for optimum yield were 10 x 10 cm and 15 x 10 cm.

Gautam and Sharma (1988) reported that in three short duration cultivars (Ratna, Rasi and Cauvery) at three plant densities (high, medium and low) under two planting schemes (Scheme I - same planting date (10th June) for all the cultivars and Scheme - II different dates, but the same maturity date for different cultivars), the time taken to panicle initiation, heading and maturity decreased with increasing plant density. Length of different grwoth phases was also affected by different planting schemes.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

A field experiment was conducted in the year 1985-86 from September to February, to find out the "Response of Rice Variety: Lakshmi (Kayamkulam-1) to different dates of planting and plant density.

3.1. Experimental site

The location of the experimental site was selected in the paddy fields located on the western side of the instructional farm, College of Agriculture, Vellayani, Trivandrum District.

3.2. Soil

The texture of the soil of experimental field is sandy clay and the physico-chemical characters of the soil are presented in the Table 1.

3.3. Weather

The experimental site enjoyed humid tropical weather and received a good amount of rainfall. The weather data during the crop period were collected from the Meteorological Station attached to Agronomy Division, College of Agriculture, Vellayani. The weekly rainfall, mean maximum and minimum temperature and relative humidity for the cropping period from 16--9--1985 to 11--2--1986 (ie. starting from the 37th standard week of 1985 to the 6th standard week of 1986) are presented in the Appendix and graphically represented in Fig. 1.

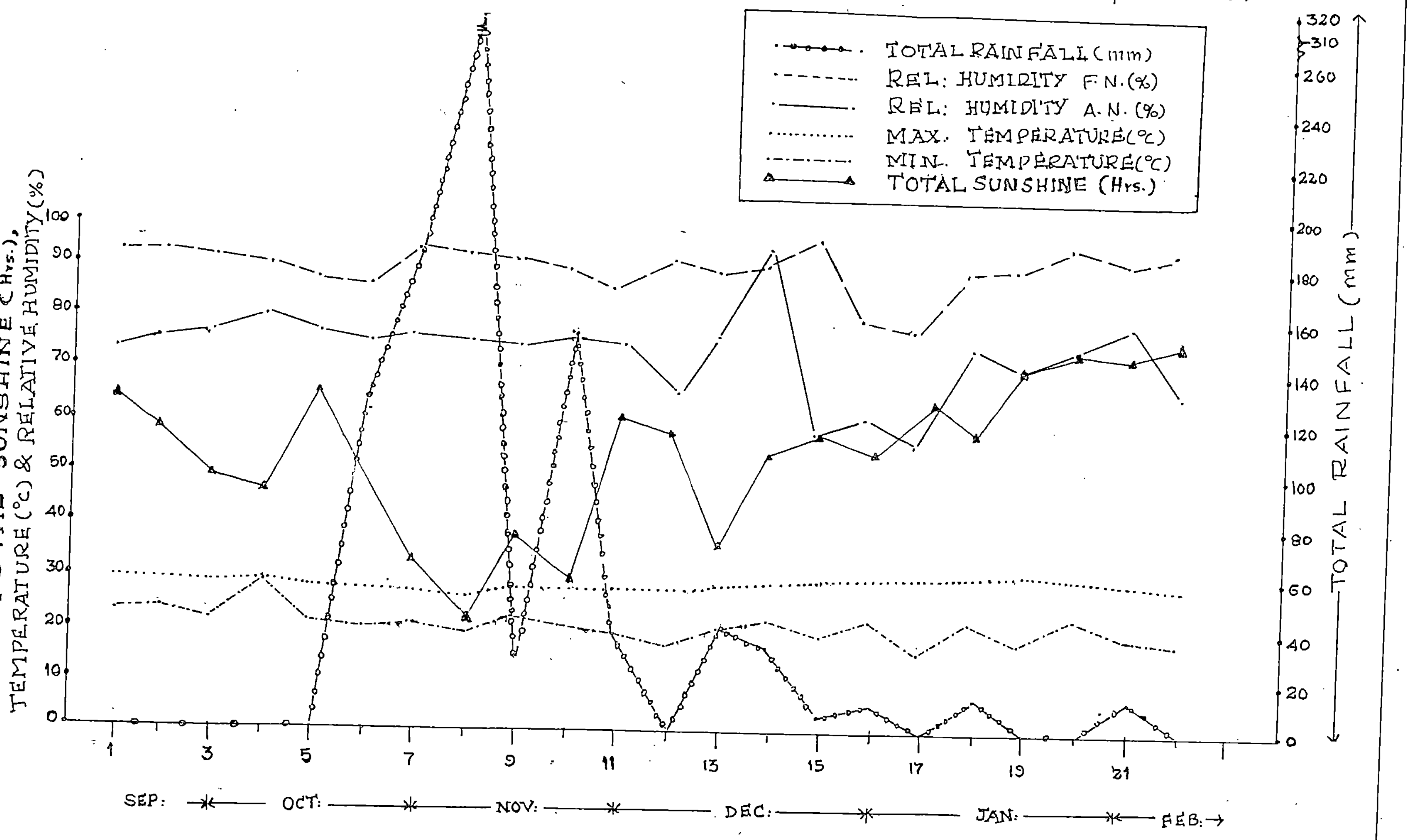
Table 1. Physical and Chemical properties of the soil of the experimental field

A. Physical properties :	
Texture	: Sandy clay
Coarse sand	: 42%
Fine Sand	: 15.28%
Silt	: 7.8%
Clay	: 31.2%
B. Chemical properties:	
Available Nitrogen	: 184 Kg./ha.
Available Phosphorus	: 16 Kg/ha.
Available Potassium	: 176 Kg/ha.
P.H. of soil	: 5.3

3.4 Cropping Season

The experiment was conducted during the second crop of Mundakan season, 1985-86 (ie. from 16-9-85 to 11-2-86). The first date of transplanting and the last date of harvesting were 16-9-85 and 11-2-86, respectively.

FIG: 1. WEATHER CONDITIONS DURING THE CROP SEASON (10th Sept: To 11th Feb)



3.5. Cropping history of the field

The experimental area was under bulk crop of rice during the previous season (Virippu 1984-85).

3.6. Variety

The variety used for the experiment was Lakshmi (Kayamkulam 1), a cross between Kottarakara-1 and Poduvai. The good qualities of Kottarakara-1 to thrive well in ill-drained soils with its higher production potential and the panicle characters of Poduvai are combined in this variety. It is a tall (135 to 140 cms ht.) Photosensitive, long duration (165-185 days) variety, evolved at the Rice Research Station, Kayamkulam. The panicle is compact and is of the exerted type with medium bold and red coloured grains. This variety was found well suited for the second crop season in the sandy tracts of Onattukara, eastern laterite regions of Alleppey and Quilon districts and the southern parts of Trivandrum district.

3.7. Fertilizers

Urea, Superphosphate and Muriate of Potash containing 46% N, 18% P_2O_5 and 60% K_2O respectively were used to supply nitrogen, phosphoros and potassium to the crop. The fertilizer recommendation adopted was 50:35:35 Kg. of NPK respectively per hectare.

3.8. Design and layout

The experiment was laid out in a split plot design There were 18 treatments and 3 replications. The layout plan of the experimental site is given in Fig. 2.

3.8.1. Treatments

Different times of planting constituted the main plot treatment while varying spacings constituted the sub plot treatments.

3.8.1.1. Time of planting (Main plot)

i.	Normal date of planting	16.9.1985	- T_1
ii.	Ten days after the normal date of planting	26.9.1985	- T_2
iii.	Ten days after the 2nd transplanting	6.10.1985	- T_3
iv.	Ten days after the 3rd transplanting	16.10.1985	- T_4
v.	Ten days after the 4th transplanting	26.10.1985	- T_5
vi.	Ten days after the 5th transplanting	5.11.1985	- T_6

3.8.1. Spacing and plant density (sub plot)

1.	20 x 10 cm (50 hills/ Sq.m.)	-- S_1
ii.	15 x 10 cm (67 hills/ Sq.m.)	-- S_2
iii.	10 x 10 cm (100 hills/ sq.m.)	-- S_3

3.8.2. Treatment combinations

Treatment of combinations were 18 and are listed below.

T_1S_1	-- T_1S_2	-- T_1S_3
T_2S_1	-- T_2S_2	-- T_3S_3
T_3S_1	-- T_3S_2	-- T_3S_3
T_4S_1	-- T_4S_2	-- T_4S_3
T_5S_1	-- T_5S_2	-- T_5S_3
T_6S_1	-- T_6S_2	-- T_6S_3

3.8.3. Replications

Total number of replications were three and hence, the total number of plots were 54 (18 x 3)

3.8.4. Plot size and Spacing

The gross plot size was $24m^2$ (6x4 m.) with net plot size of $17.28m^2$ (4.8 x 3.6 m.) $18.36m^2$ (5.1x3.6m.) and $19.44m^2$ (5.4 x 3.6m.) for 20 x 10 cm. 15 x 10 cm., and 10 x 10 cm spacing treatments respectively.

3.9. Border rows

Two rows of plants were left as border rows all around the plot. One additional destructive row was left on the breadthwise side to facilitate sampling of the plants and

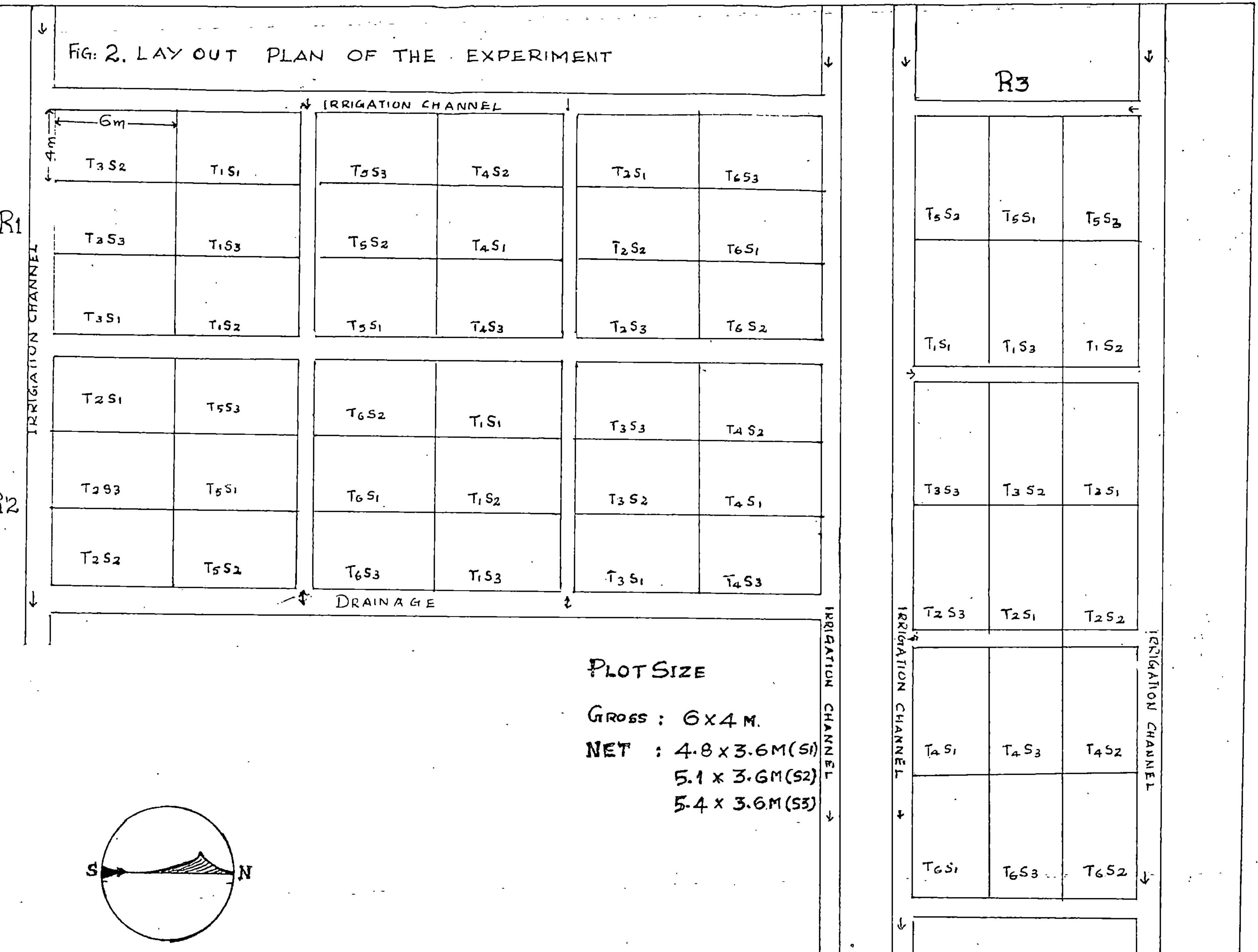


FIG: 2. LAY OUT PLAN OF THE EXPERIMENT

the row adjacent to it was also excluded from the net plot to avoid sampling effects.

3.10. Details of field cultivation

3.10.1. Nursery

The seeds for raising the nursery were collected from a progressive farmer. Seedlings were raised in wet nurseries at 10 days intervals with following cultural operations as per package of practices of Kerala Agricultural University. A total of six nurseries were raised to facilitate six dates of planting in the main field.

3.10.2. Main field

The package of practices recommendations were followed for the cultivation during the cropping period. The main field was dug and levelled well and laid out into blocks and plots of 6 x 4 m. size. Main and sub irrigation channels were provided wherever necessary. Individual plots were dug and levelled well. Fifty six day old seedlings were used for transplanting. Two seedlings were planted per hill and the gap filling was done on the seventh day after transplanting in each case.

Nitrogen in the form of urea and potash in the form of muriate of potash were applied in three split doses as basal and top dressings on the 20th day after transplanting and at panicle initiation stage. The entire dose of phosphorus in the form of superphosphate was applied as basal.

3.10.4. Plant Protection

Two prophylactic sprayings were given with Bavastin and Paramar against Leaf spots, leaf roller and rice bugs.

3.10.5. Weeding

Two hand weedings were given for each plot on the 20th day and 40th day after transplanting.

3.10.6. Harvest

The crop was harvested at different times according to the time of planting. Harvests were carried out on the 187th day, 177th day, 167th day, 166th day, and 156th day after sowing for the treatments T_1, T_2, T_3, T_4, T_5 and T_6, respectively.

All the border row plants along with the plants in the row left for destructive sampling and those in the row left beyond the sampling row in all individual plots were harvested first. Thereafter, the net area of individual plot was harvested separately, and the grains threshed, cleaned, dried, weighed and yield per plot recorded.

3.11. Observations recorded

3.11.1. Biometric Observations

The sample units of 2 hills x 2 hills were randomly selected in each plot as suggested by Gomez (1972) and the following observations were recorded.

3.11.1.1. Height of plants

The height of plant was measured from ground level to the tip of the tallest leaf at 30th and 60th day and at flowering stages. At harvest, the height of the plant was measured from ground level to the tip of the tallest panicle.

3.11.1.2. Number of tillers per hill

The total number of tillers per hill from three sample units were taken and then the average number of tillers per hill was recorded.

3.11.1.3. Leaf area index

Leaf area index was computed at the flowering stage. Ten sample hills were randomly selected in each plot and the number of tillers was counted in each hill. The length and maximum width of leaves in the middle tiller of all the sample hills were measured separately and leaf area was computed based on the length-width method.

Leaf area = k x l x w, where 'k' is the adjustment factor (0.75), 'l' is the length and 'w' is the width. Thereafter the leaf area per hill and leaf index were calculated using the following formulae.

Leaf area per hill = Total leaf area of middle tiller x total number of tillers

$$\text{Leaf area index} = \frac{\text{Sum of leaf area/hill of 'n' sample hills (Sq. cm)}}{\text{Area of land covered by 'n' hills (Sq. cm)}}$$

3.11.1.4. Dry matter production

Dry matter production was estimated at different growth stages. Five sample hills were randomly selected and uprooted from the sampling row and the soil from the roots was thoroughly washed off and the roots were removed. Thereafter the samples were first dried in the sun and then oven dried to constant weight. Dry matter production was computed and expressed in t/ha. at 30th day and 60th day after transplanting and at flowering. At harvest the sum total yield of grain and straw was taken as the dry matter production.

3.12. <u>Post harvest observations</u>

3.12.1. Yield components

As suggested by Gomez (1972), the following yield components were computed.

3.12.1.1. Length of Panicle

The length of the middle panicle of each hill was measured and the mean length was computed for each treatment.

3.12.1.2. Weight of panicle

All the panicles from 12 hills were weighed and mean weight was computed.

3.12.1.3. Number of filled grains per panicle

The main culm panicles from all the 12 hills were separated based on the height of individual panicles, and were threshed and number of filled grains (f), number of unfilled grains (u) and weight of filled grains (W) were calculated. The rest of the panicles from all the 12 hills were also threshed and number of unfilled grains (u) and weight of filled grains (w) were assessed.

From the above data, the number of filled grains per panicle was calculated using the following formula. Number

Number of filled grains/panicle $= f/w \times \frac{W \times w}{P}$

where P is the total number of panicles from all the 12 hills.

3.12.1.4. Number of spikelets per panicle

The number of spikelets in all the panicles from the 12 hills were counted and the mean number of spikelets per panicle was computed.

3.12.1.5. Percentage of unfilled grains

The percentage of unfilled grains was worked out using the formula given below

Percentage of unfilled grains = $\frac{U + u}{f\ (W+w)\ w + U+u} \times 100$

3.12.1.6. Thousand grain weight

Thousand grain weight was calculated and adjusted to 14% moisture using the following formula.

$$1000 \text{ grain weight} = \frac{100-M}{86} \times \frac{W}{f} \times 1000$$

Where M is the moisture content of filled grains

3.13. Yield

3.13.1. Grain Yield

Yield of grain from the net area was recorded and adjusted to 14% moisture, using the adjustment co-efficient given by Gomez (1972) and expressed in t/ha.

Adjusted grain weight = A x W, where A is the adjustment co-efficient and W is the dry weight of grain.

3.13.2. Straw yield

Straw obtained from the net area was uniformly dried, weighed and the yield of straw was expressed in t/ha.

3.14. Chemical analysis

3.14.1. Plant analysis

3.14.1.1. Total nitrogen

Total nitrogen concentration of plant samples at 30th day, 60th day, 90th day after transplanting and that of grain and straw at harvest were determined by Micro-kjeldhal digestion method, as suggested by Jackson (1967).

3.14.1.2. Total phosphorus

Total phosphorus concentration of the plant samples at 30th day, 60th day and 90th day after transplanting and that of grain and straw at harvest was determined through triple acid extraction (9:2:1 = HNO_3 : H_2SO_4 : $HClO_4$) and thereafter estimating calorimetrically by developing vanadomolybdophosphoric acid yellow colour and read in spectronic 2000 spectrophotometer at a wave length of 470 mm. (Jackson, 1967).

3.14.1.3. Total potassium

Total potassium concentration of the plant samples, at 30th day, 60th day, 90th day and that of grain and straw at harvest were determined through triple acid extraction read in EEL-Flame Photometer (Jackson, 1973).

3.14.1.4. Protein content

The nitrogen concentration of grain was estimated and the protein content was calculated by multiplying the nitrogen concentration by a factor 6.25 (Simpson et al. 1965).

3.14.1.5. Uptake of nitrogen, phosphorus, potassium

The nitrogen, phosphorus and potassium concentrations of plant samples at 30th, 60th and 90th day after transplanting were multiplied with dry matter yield at the respective stages and uptake was computed. At harvest stage, the nitrogen phosphorus and potassium concentration of the grain and the straw were multiplied with their corresponding yields and the values thus obtained were added to get total uptake of nitrogen, phosphorus and potassium.

3.14.2. Soil analysis

Soil samples were collected from the field plots prior to planting and immediately after harvest and were dried in shade and processed before analysis.

3.14.2. Available nitrogen

The available nitrogen in the soil prior to the experiment and in post harvest soil samples was estimated using alkaline permanganate method as suggested by Subbiah and Asija (1956).

3.14.2.2. Available phosphorus

Available phosphorus in the soil prior to the experiment and in post harvest soil samples was estimated by extracting with Bray No. 1 solution and thereafter developing chloromolybdic acid blue colour and read in Klett-Summersion photoelectric colorimeter. (Jackson, 1967).

3.14.2.3. Available potassium

Available potassium in the soil before and after the experiment was extracted with neutral normal ammonium acetate solution and estimated using EEL-Flame photometer. (Jackson, 1973).

3.15. Statistical analysis

Data relating to different characters were analysed statistically by applying the technique of analysis of variance and significance was tested by 'F' test. (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

The present investigation reveals the effect of different times of planting and varying plant densities on the growth and yield of rice variety 'Lakshmi' in the mundakan season. The results of the study are discussed below.

4.1. Growth characters

4.1.1. Plant height

The mean plant height taken on the 30th day, 60th day, at flowering and at harvest are presented in Table 2.

On the 30th day, the treatment T_3 gave the maximum plant height and was on par with T_1, T_2 and T_4. On the 60th day, at flowering and at harvest, treatment T_1 resulted in the production of tallest plants and it was on par with T_2 on the 60th day and with T_2 and T_3 at flowering and at harvest. At all stages of observation, the treatment T_6 produced the shortest plants.

Varying spacings had significant influence on plant height only in the early stages of observation ie. 30th day and 60th day. The spacing of 10 x 10 cm resulted in the tallest plants on the 30th day followed by the treatments S_2 and S_1. On the 60th day, S_1 gave the tallest plant followed by S_2 and S_3. However, eventhough the effect was not significant during the later stages of growth, treatment S_2

(15 x 10 cm spacing) gave taller plants consistently during flowering and at harvest.

Interactions also exerted significant influence on plant height only on the 30th day observation. The combination T_1S_3 gave maximum plant height on the 30th day and was on par with T_3S_3, T_4S_3 and T_3S_2 while the treatment T_6S_3 resulted in the shortest plant height on par with T_6S_2 and T_6S_1.

It could be noticed that plants were taller when they were planted early as the treatment T_1 which was the normal date of planting by the middle of September gave higher values for plant height consistently at all stages of observation. On the other hand, T_6, which was the most delayed transplanting gave the shortest plants at all stages of observation. Perhaps the weather parameters prevailing during the growth stages would have exerted their influence on plant height bringing about this difference. Trivedi and Kwatra (1987) had also reported that plant height in rice was significantly influenced by the time of planting.

Spacing of 10 x 10 cm resulted in the tallest plants on the 30th day while on the 60th day plants spaced at 20 x 10 cm gave higher values for plant height. In the early stages when moisture and nutrients might not yet have been limiting for densely planted crop, the plants would have grown taller for getting more light. However, with further growth of the plants and root spread accompanied by greater crop requirements for nutrients and water, the very closely planted S_3 treatment gave the shortest plants perhaps because of the high intra row competition while the plants spaced widely at 20 x 10 cm spacing could put forth better growth resulting in taller plants. However, during flowering and harvest, plants spaced at 15 x 10 cm resulted in fairly tall plants may be because this intermediate treatment was positively influenced by the factors contributing to plant height at all stages of growth.

In the early stages of the crop (30th day) normal date of planting combined with closest spacing gave maximum plant height perhaps because the effects of weather parameters for the normal planting coupled with the height promoting influence of the closest spacing could play a very positive rôle on this characteristic.

Panda and Leeuwrik (1971) reported through their experimental studies at Rice Research Station, Chiplima that the closer the spacing (10 x 10 cm) greater was the plant height (90.2 Cm).

4.1.2. Number of tillers

The mean number of tillers per hill at different stages of observation are presented in Table 3.

Time of planting had significant influence on the number of tillers per hill, only on the 30th day. On the 30th day, T_2 gave the highest number of tillers per hill. It was on par with T_4 and T_1.

Table 2. Height of plant (cm)

Treatments	30th day	60th day	At flowering	At harvest
Main Factors				
T1	58.44	105.43	144.04	148.28
T2	58.24	102.60	140.97	144.36
T3	58.66	96.22	137.09	142.63
T4	55.49	79.16	129.87	137.24
T5	44.36	68.68	126.38	134.82
T6	43.43	57.61	91.12	117.47
SE	1.244	1.516	4.356	2.187
CD (0.05)	3.937	4.798	13.785	7.239
S1	51.84	86.50	126.42	137.39
S2	53.52	84.56	131.06	138.55
S3	55.45	83.83	125.75	136.46
SE	0.580	0.679	2.765	1.199
CD (0.05)	1.693	1.981	N S	N S
TXS interactions				
T1S1	52.37	105.93	140.82	144.98
T1S2	59.17	103.80	140.47	150.35
T1S3	63.80	106.53	141.83	149.62
T2S1	59.23	100.33	136.25	138.75
T2S2	57.40	104.67	143.55	146.45
T2S3	58.10	102.80	143.10	147.88
T3S1	54.33	99.79	138.50	142.62
T3S2	59.93	97.39	139.82	144.77
T3S3	61.70	91.48	132.96	140.52
T4S1	51.83	81.40	130.37	141.28
T4S2	53.90	79.20	129.97	137.08
T4S3	60.73	76.87	129.23	133.35
T5S1	48.03	70.71	120.42	137.45
T5S2	46.20	67.35	140.22	134.37
T5S3	47.83	67.99	118.50	132.63
T6S1	45.27	60.79	92.17	119.23
T6S2	44.50	84.56	92.33	118.30
T6S3	40.53	83.80	88.87	114.88
SE	1.421	1.662	6.772	2.36
CD(0.05)	4.148	N S	N S	N S

With regard to the spacing treatments, there was no significant influence on the 30th day, 60th day and at harvest. However, at flowering 20 x 10 cm spacing (S_1) gave significantly more number of tillers per hill which was on par with S_2. The treatment S_3 gave the lowest number of tillers per hill. Interactions had no significant effect on number of tillers at any stage.

During the early part of crop growth (30th day) alone there was marked difference in the number of tillers perhaps because it is at this stage soon after active tillering that the effect becomes pronounced by the production of large number of tillers. During the later part of growth some of these tillers could have died out thereby, diminishing the effect. Planting during the last week of September, T_2 gave maximum number of tillers. From a perusal of the weather parameters (Fig. 1 and Appendix) it is evident that temperatures were fairly high with consistently higher values for minimum temperature readings also. This could have influenced tiller production favourably for the crop planted as per the treatment T_2. Slightly higher minimum temperature could have resulted in the production of more number of tillers in T_1 also. Whereas increasing amounts of rainfall could have been the contributing factor in the case of T_4.

During the early stages, spacing treatments did not have significant influence because the competition between plants for nutrients and water would not have set in. At flowering when the effects of competition would have become manifest, the widely spaced plants (20 x 10 cm) and (15 x 10 cm) could maintain more tillers than the closely planted crop of treatment S_3. Tiller die back would have reduced the difference between treatments to below significant levels after flowering.

Ramaiah et al. (1987) had also observed that tiller number in rice was significantly influenced by the time of planting while Mohammed Ayub et. al. (1988) recorded that the number of tillers per hill, decreased with increasing plant density.

4.1.3. Leaf area index

The mean values for leaf area index (L A I) observed at flowering are presented in Table 4.

Time of planting had no significant influence on the LAI. Similarly, varying spacing as well as the interaction between time of planting and spacing also did not exert significant influence on the LAI.

However in general it could be observed that late planting (T5 and T6) and closer spacings (S_2 and S_3) gave slightly higher LAI values.

Though there was no marked influence by treatments on the leaf area index, the slightly higher LAI values for

Table 3. Number of tillers per hill

Treatments	30th day	60th day	At flowering	At harvest
Main factors				
T1	4.89	5.67	5.78	5.56
T2	5.56	7.44	6.67	5.89
T3	4.78	7.00	7.00	5.67
T4	5.11	6.78	6.33	5.11
T5	4.33	5.44	5.22	5.33
T6	3.67	6.00	5.78	5.22
SE	0.241	0.522	0.484	0.237
CD(0.05)	0.762	N S	N S	N S
S1	4.67	6.44	6.56	5.67
S2	4.67	6.00	6.06	5.56
S3	4.83	6.56	5.78	5.17
SE	0.160	0.196	0.180	0.155
CD(0.05)	N S	N S	N S	N S
TXS interactions				
T1S1	4.33	5.33	6.00	5.67
T1S2	5.00	5.33	5.67	5.67
T1S3	5.33	6.33	5.67	5.33
T2S1	5.67	7.67	7.33	6.33
T2S2	5.33	6.33	6.33	6.67
T2S3	5.67	6.33	6.33	4.67
T3S1	5.00	7.33	7.67	5.33
T3S2	4.67	7.00	7.00	6.00
T3S3	4.67	6.67	6.33	5.67
T4S1	5.33	6.67	6.33	5.67
T4S2	5.00	6.33	6.33	4.67
T4S3	5.00	7.33	6.33	4.67
T5S1	4.33	5.00	5.67	5.67
T5S2	4.33	5.33	5.00	5.00
T5S3	4.33	5.67	5.00	5.33
T6S1	3.33	6.33	6.33	5.33
T6S2	3.67	5.67	6.00	5.33
T6S3	4.83	5.00	5.00	5.00
SE	0.393	0.481	0.441	0.381
CD(0.05)	N S	N S	N S	N S

Table 4. Leaf area index

	T1	T2	T3	T4	T5	T6	Mean
S1	2.21	2.32	2.35	2.42	2.33	2.39	2.34
S2	2.35	2.62	2.57	2.31	2.79	2.41	2.51
S3	2.18	2.40	2.13	2.45	2.41	2.57	2.36
Mean	2.25	2.45	2.35	2.39	2.51	2.46	..

	T	S	TXS
SE	0.095	0.063	0.154
CD (0.05)	N S	N S	N S

late planting may be due to the influence of weather parameters. Larger number of plants per unit area could have contributed to the slightly higher values of LAI observed for closer spacings.

Pothiraj, Morachan and Subbiah (1977) observed that the LAI at all stages was reduced by increasing number of seedlings per hill.

4.1.4. Dry matter production

The mean values of dry matter production at the 30th and 60th days, at flowering and at harvest are presented in Table 5. (Fig. 3 and 4).

Time of planting and different spacings tried, did not have significant influence on the dry matter production at all stages of observation.

It could be noted even though there was no marked effect at all stages of observation, T_5 followed by T_6 and T_2 gave slightly higher values for dry matter production. Similarly, the spacing treatment S_2 also consistently gave higher values.

The interactions of different times of planting and spacings also did not exert significant influence on the dry matter production at all stages.

Although significant influence could not be noticed, T_5 followed by T_6 and T_2 gave slightly higher values for dry matter production perhaps because of better growth of plants in these treatments which also gave high values of LAI.

The greater values of LAI combined with the larger number of plants in S_2 which could grow without as much competition as in S_3 might have been the reason for higher dry matter production in the former spacing treatment, although the effect was not significant here again.

Urkurkar (1984) reported that dry matter production was significantly influenced by the planting time in rice cv. Asha, when transplanted between 1st June and 30th August 10 days interval.

Wagh and Thorat (1987) in their experiment obtained a significantly higher dry matter at closer spacing of 15 x 10 cm

4.2. Nutrient uptake

4.2.1. Nitrogen

The mean values of nitrogen uptake by the crop at different stages are presented in Table. 6.

Varying time of planting and spacing and the interactions of these treatments did not significantly influence nitrogen uptake by the crop at any stage of observation. However, it

Table 5. Dry matter production at different growth stages (ton/ha)

Treatments	30th day	60th day	At flowering	At harvest
Main factors				
T1	0.74	2.76	7.24	8.05
T2	0.81	3.01	7.26	8.77
T3	0.80	2.99	7.20	8.69
T4	0.80	2.98	7.19	8.68
T5	0.83	3.09	7.44	8.99
T6	0.81	3.02	7.29	8.80
SE	0.029	0.110	0.270	0.320
CD (0.05)	N S	N S	N S	N S
S1	0.78	2.91	7.30	8.46
S2	0.83	3.10	7.48	9.02
S3	0.78	2.92	7.05	8.51
SE	0.021	0.078	0.206	0.229
CD (0.05)	N S	N S	N S	N S
TXS interactions				
T1S1	0.73	2.71	8.28	7.89
T1S2	0.78	2.89	6.98	8.42
T1S3	0.72	2.69	6.48	7.82
T2S1	0.76	2.86	6.89	8.32
T2S2	0.87	3.23	7.79	9.40
T2S3	0.79	2.95	7.11	8.59
T3S1	0.83	3.08	7.43	8.98
T3S2	0.86	3.23	7.79	9.40
T3S3	0.71	2.65	6.38	7.70
T4S1	0.80	2.98	7.19	8.68
T4S2	0.76	2.84	6.83	8.25
T4S3	0.84	3.13	7.55	9.11
T5S1	0.77	2.87	6.92	8.36
T5S2	0.92	3.48	8.28	9.99
T5S3	0.79	2.86	7.14	8.62
T6S1	0.79	2.93	7.07	8.57
T6S2	0.80	2.97	7.19	8.65
T6S3	0.85	3.16	7.61	9.19
SE	0.051	0.192	0.504	0.560
CD (0.05)	N S	N S	N S	N S

FIG3 EFFECT OF TIME OF PLANTING ON DRYMATTER PRODUCTION AT DIFFERENT GROWTH STAGES

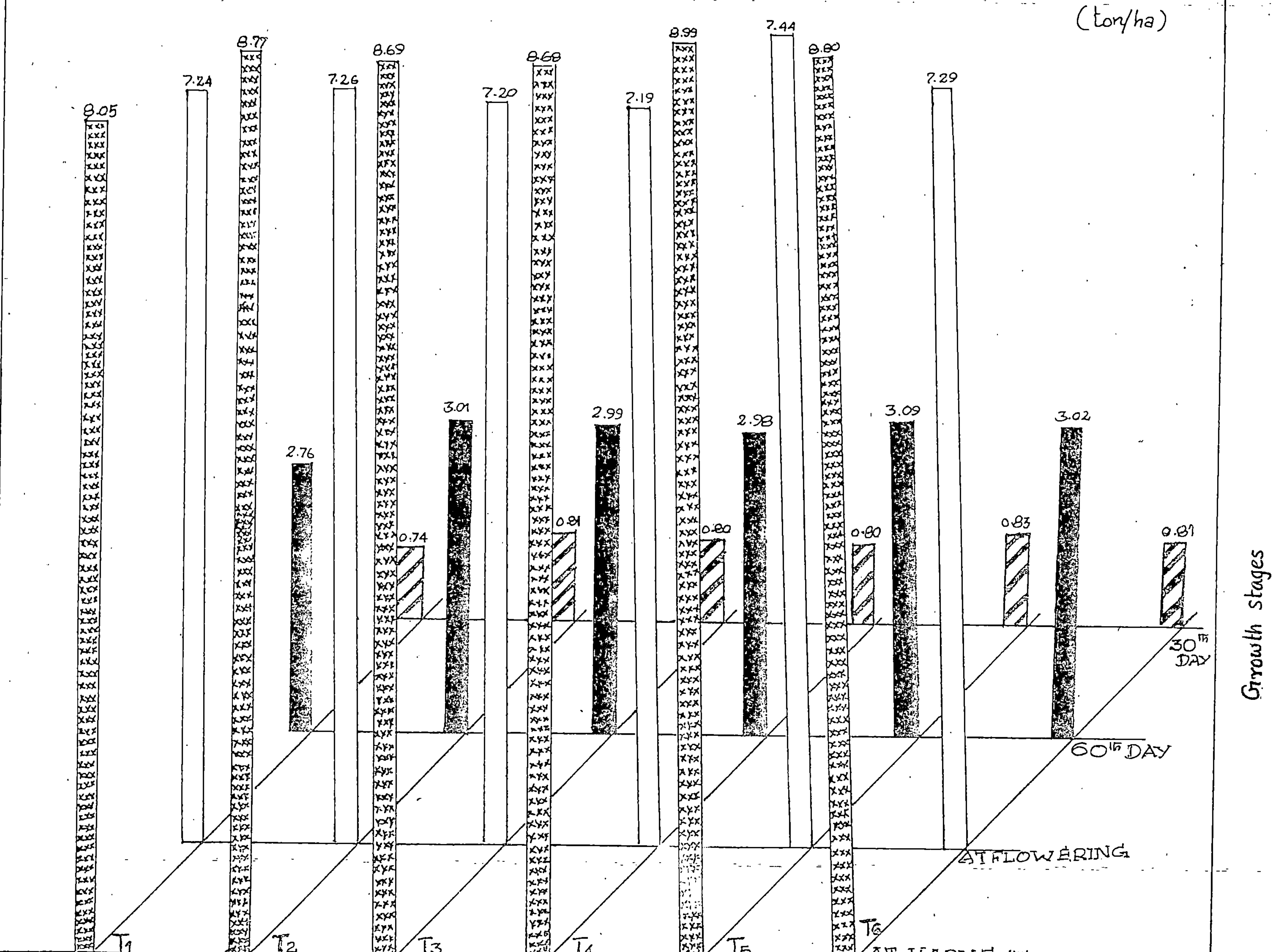


FIG. 4 EFFECT OF SPACINGS ON DRYMATTER PRODUCTION AT DIFFERENT GROWTH STAGES (ton/ha)

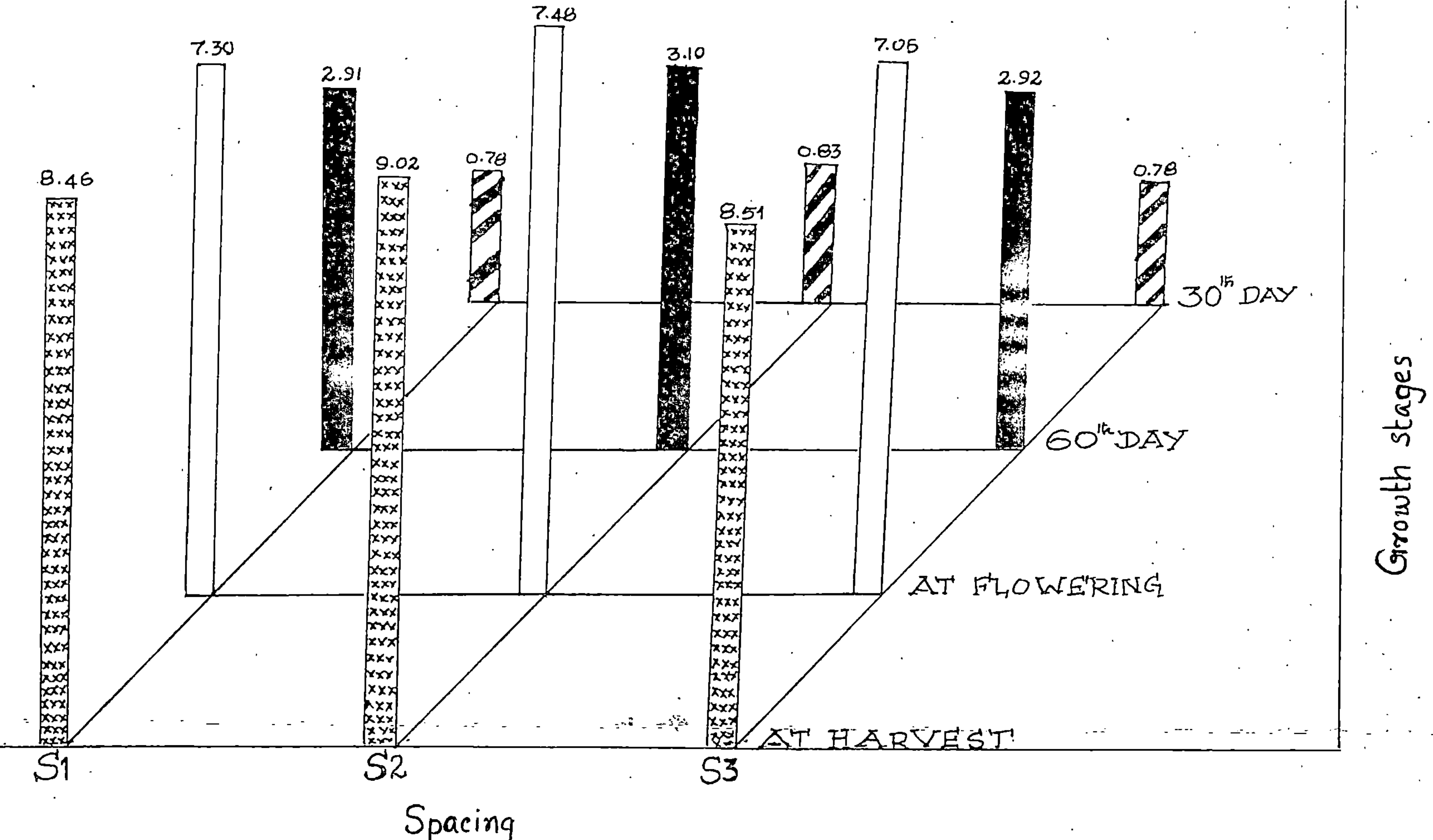


Table 6. Uptake of nitrogen at different growth stages (Kg/ha)

Treatment	30th day	60th day	90th day	at harvest
Main factors				
T1	16.09	35.38	40.23	46.69
T2	17.53	38.56	43.83	50.18
T3	17.38	38.24	43.47	50.45
T4	17.36	38.18	43.40	50.37
T5	17.99	38.54	44.38	52.16
T6	17.58	38.68	43.97	51.34
SE	0.639	1.409	1.675	1.769
CD (0.05)	N S	N S	N S	N S
S1	16.92	37.21	42.30	49.10
S2	18.04	39.67	44.82	51.99
S3	17.01	37.41	42.53	49.36
SE	0.457	1.003	1.223	1.311
CD (0.05)	N S	N S	N S	N S
TXS interactions				
T1S1	15.78	34.72	39.47	45.81
T1S2	16.85	37.06	42.12	45.89
T1S3	15.63	34.39	39.09	45.37
T2S1	16.63	36.57	41.58	48.26
T2S2	18.80	41.34	47.00	52.43
T2S3	17.17	37.78	42.94	49.85
T3S1	17.95	39.48	44.88	52.09
T3S2	18.80	44.35	47.01	54.56
T3S3	15.40	38.89	38.52	44.71
T4S1	17.35	38.16	43.38	50.35
T4S2	16.50	36.30	41.26	47.89
T4S3	18.22	40.08	45.56	52.88
T5S1	16.76	36.75	41.78	48.49
T5S2	19.97	43.95	48.29	57.98
T5S3	17.23	37.90	43.08	50.01
T6S1	17.08	37.56	42.70	49.57
T6S2	17.29	38.04	43.24	50.19
T6S3	18.88	40.43	45.96	53.35
SE	1.119	2.456	2.995	3.211
CD (0.05)	N S	N S	N S	N S

could be seen that among the main plot treatments, T_5 and T_6 secured comparatively higher values at all stages of observations. The same could be said about S_2 from among the sub plot treatments and T_5S_2 from among the interactions. T_1 consistently gave the minimum N uptake at all stages and same was the case with S_1 among the sub plot treatments. It could also be observed that T_1S_3 and T_3S_3 among the interactions gave minimum values of N uptake in most stages.

The higher dry matter production in the treatments T_5 and T_6 and the spacing treatment S_2 could have brought higher N uptake eventhough not at significant levels. Moreover the later planting could have reduced N loss through leaching as rains were less at later stages. (Fig. 1). The combined influence of T_5 and S_2 could thus have given greater N uptake in the combination treatment of these two.

4.2.2. Phosphorus

The mean values of phosphorus uptake by the crop at the 30th day, 60th day and at harvest are presented in Table 7.

As in the case of nitrogen uptake, treatments and their interactions had no significant influence on the uptake of phosphorus by the crop at any stage studied. Again, as in the case of nitrogen uptake, the main plot treatments T_5 and T_6, the sub plot treatment S_2 and the interaction T_5S_2 gave relatively higher values of P uptake consistently at all

Table 7. Uptake of phosphorus at different growth stages (Kg/ha)

Treatment	30th day	60th day	90th day	At harvest
Main factors				
T1	1.43	6.81	18.75	19.25
T2	1.55	7.41	20.44	20.99
T3	1.54	7.35	20.26	20.80
T4	1.54	7.34	20.43	20.54
T5	1.60	7.61	21.01	21.50
T6	1.56	7.44	20.64	21.06
SE	0.056	0.271	0.795	0.765
CD (0.05)	N S	N S	N S	N S
S1	1.50	7.16	19.89	20.13
S2	1.60	7.63	21.05	21.58
S3	1.51	7.20	19.83	20.36
SE	0.041	0.193	0.552	0.557
CD (0.05)	N S	N S	N S	N S
TXS interactions				
T1S1	1.40	6.68	18.40	18.88
T1S2	1.49	7.13	19.63	20.18
T1S3	1.38	6.61	18.22	18.70
T2S1	1.47	7.03	19.38	19.89
T2S2	1.67	7.94	21.91	22.49
T2S3	1.52	7.27	20.02	20.55
T3S1	1.59	7.59	20.92	21.47
T3S2	1.67	7.95	21.91	22.49
T3S3	1.37	6.52	17.96	18.43
T4S1	1.54	7.34	20.80	20.09
T4S2	1.47	6.98	19.24	19.74
T4S3	1.61	7.91	21.24	21.80
T5S1	1.50	7.07	19.48	19.99
T5S2	1.77	8.45	23.47	23.90
T5S3	1.50	7.29	20.09	20.62
T6S1	1.52	7.23	20.33	20.43
T6S2	1.53	7.32	20.16	20.69
T6S3	1.63	7.78	21.43	22.04
SE	0.099	0.473	1.351	1.364
CD (0.05)	N S	N S	N S	N S

stages of observation, eventhough not at significant levels. Similarly, the time of planting T_1 the spacing S_1 and the interactions T_3S_3 and T_1S_3 gave minimum values of P uptake at all stages of observation eventhough not manifested at a significant level.

As in the case of N uptake eventhough there was no significant effect, treatments T_5 and T_6 and the spacing treatment S_2 gave slightly higher P uptake values. This again may be because of the greater plant growth in these treatments as evinced by the dry matter production. In this case as well, the combined effect of T_5 and S_2 could have contributed to the larger P uptake in T_5S_2.

4.2.3. Potassium

The mean values of potassium uptake at different stages by the crop are presented in Table 8.

Treatments did not exert significant influence on the uptake of potassium at all stages considered. However, T_5 from the main plot treatments, S_2 from the sub plot treatments and T_5S_2 from the interactions gave higher values consistently at all stages though not at significant level. Similarly, the main plot treatment T_1, and the interaction T_3S_3 gave relatively minimum values at all stages consistently, though not at a significant level.

The larger dry matter production could again have been the contributing factor to greater K uptake in T_5, S_2 and T_5S_2.

Table 8. Uptake of potassium at different growth states (Kg/ha)

Treatments	30th day	60th day	90th day	At harvest
Main factors				
T1	9.37	27.92	37.04	38.50
T2	10.22	26.11	41.10	42.40
T3	10.12	26.34	40.14	40.49
T4	10.11	26.22	39.90	41.54
T5	10.47	25.83	41.60	42.93
T6	10.03	26.25	40.74	40.97
SE	0.418	1.29	1.53	1.62
CD (0.05)	N S	N S	N S	N S
S1	9.86	26.34	39.06	40.48
S2	10.50	26.64	41.75	42.01
S3	9.80	26.36	39.45	40.92
SE	0.251	0.377	1.109	1.068
CD (0.05)	N S	N S	N S	N S
TXS interactions				
T1S1	9.20	27.83	36.38	37.77
T1S2	9.82	28.16	38.47	14.31
T1S3	9.11	27.78	36.26	37.41
T2S1	9.69	25.58	36.53	39.79
T2S2	10.95	26.85	43.88	44.98
T2S3	10.01	23.90	40.89	42.44
T3S1	10.46	26.71	41.22	42.95
T3S2	10.92	27.16	43.97	41.65
T3S3	8.98	25.16	35.24	36.86
T4S1	10.11	26.30	40.52	41.52
T4S2	9.61	25.80	37.83	39.49
T4S3	10.62	26.57	41.36	43.60
T5S1	9.74	25.69	38.52	39.99
T5S2	11.64	25.74	46.04	47.58
T5S3	10.02	26.05	40.23	41.23
T6S1	9.95	25.91	39.06	40.87
T6S2	10.08	26.14	41.75	38.06
T6S3	10.05	26.69	39.45	43.99
SE	0.616	0.923	2.718	2.617
CD (0.05)	N S	N S	N S	N S

4.3. Yield components

4.3.1. Productive tillers

The mean values of productive tillers per hill are given in Table 9. (Fig. 5 and 6).

Different times of planting and spacings as well as their interactions did not significantly influence the number of productive tillers per hill. But relatively higher values were given by the main plot treatments T_2 and T_3 the sub plot treatment S_1 and the interaction T_3S_2.

Productive tillers were slightly higher in T_2 and T_3, may be because, right from active tillering and panicle initiation stages of plants in these treatments upto flowering, they would have received sufficient rains and the other weather parameters could also have been beneficial.

Widely spaced plants in S_1 gave greater productive tillers may be because of minimised competition. It may also be noted that S_1 had given significantly higher total tiller number at flowering (Table 3).

Palaniswamy and Gomez (1979) revealed that the tiller number was increased with increasing number of seedlings per hill.

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Table 9. Productive tillers, length of panicle and weight of panicle

Treatments	Number of productive tillers per hill	Length of panicle (cm)	Weight of panicle (g)
Main factors			
T1	4.33	30.11	2.12
T2	4.78	26.22	2.31
T3	4.67	26.61	2.29
T4	4.33	25.06	2.28
T5	4.33	27.33	2.37
T6	4.22	22.94	2.40
SE	0.246	0.726	0.086
CD (0.05)	N S	2.298	N S
S1	4.50	27.17	2.23
S2	4.61	26.58	2.42
S3	4.22	25.39	2.24
SE	0.173	0.815	0.061
CD (0.05)	N S	N S	N S
TXS interactions			
T1S1	4.33	32.00	2.08
T1S2	4.67	29.17	2.22
T1S3	4.00	29.17	2.06
T2S1	5.00	24.33	2.19
T2S2	5.33	27.17	2.48
T2S3	4.00	27.17	2.26
T3S1	4.33	25.83	2.36
T3S2	6.00	27.33	2.48
T3S3	4.67	26.67	2.03
T4S1	5.00	28.50	2.28
T4S2	4.00	24.17	2.17
T4S3	4.00	22.50	2.40
T5S1	4.33	28.83	2.20
T5S2	4.33	26.33	2.63
T5S3	4.33	26.83	2.27
T6S1	4.00	23.50	2.25
T6S2	4.33	25.33	2.52
T6S3	4.33	20.00	2.42
SE	0.423	1.996	0.149
CD (0.05)	N S	N S	N S

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4.3.2. Length and weight of panicles

The mean length and weight of panicles that resulted from the various treatments are given in Table 9. (Fig. 5 and 6)

Length of panicle was significantly influenced by different times of planting while spacing treatments and the interactions did not manifest any significant effect. Normal date of planting (T_1) resulted in the production of longer panicles and the latest planting (T_6) gave the shortest panicles.

Weight of panicles was not significantly affected by the changing times of planting, spacings, as well as their interactions. However, the main plot treatments T_6 and T_5, the sub plot treatment S_2 and the interaction T_5S_2 gave relatively heavier panicles.

Normal date of planting (T_1) gave longer panicles while T_6 gave the shortest, may be because of the influence of weather parameters and length of growing period. Although treatments did not manifest any significant influence on the weight of panicles, T_6 and T_5 from the main plot treatments and S_2 from the sub plot treatments and the interactions T_5S_2 gave relatively heavier panicles may be because of the slightly greater number of spikelets per panicle and thousand grain weight in these treatments (Table 10).

4.3.3. Number of spikelets and thousand grain weight

The mean values pertaining to the number of spikelets per panicle and thousand grain weight are presented in Table 10. (Fig. 5 and 6).

The results show that the number of spikelets per panicle and the weight of thousand grains were not significantly influenced by the different time of planting, spacings as well as their interactions. Yet, eventhough there was no marked effect, the planting times T_5 and T_6, the spacing S_2 and the interactions T_5S_2 gave slightly higher values than the other treatments.

The slightly larger number of spikelets and thousand grain-weight in the treatments T_5 and T_6 and the spacing treatment S_2 and the interaction T_5S_2 may be attributed to the higher nutrient uptake and dry matter production in these treatments.

4.3.4. Number of filled grains and percentage of unfilled grains

The mean values of the above characters are presented in Table. 11. (Fig. 5 and 6).

It is evident that both these characters were not markedly influenced by the different times of planting, spacings, and their interactions. Here again it could be observed that the time of planting treatments T_5 and T_6,

Table 10. Number of spikelets and thousand grain weight

Treatments	Number of spikelets per panicle	Thousand grain weight (g)
Main factors		
T1	92.74	25.30
T2	101.08	27.59
T3	100.22	27.66
T4	100.06	27.32
T5	103.64	28.28
T6	101.38	27.67
SE	3.695	0.987
CD (0.05)	N S	N S
S1	97.52	26.61
S2	103.98	28.38
S3	98.05	26.92
SE	2.628	0.724
CD (0.05)	N S	N S
TXS interactions		
T1S1	91.00	24.80
T1S2	97.11	26.51
T1S3	90.11	24.60
T2S1	95.86	26.17
T2S2	108.35	29.58
T2S3	99.02	27.03
T3S1	103.47	28.24
T3S2	108.38	29.59
T3S3	88.81	25.16
T4S1	100.02	27.30
T4S2	95.14	25.97
T4S3	105.03	28.67
T5S1	96.32	26.29
T5S2	115.18	31.44
T5S3	99.33	27.12
T6S1	98.46	26.88
T6S2	99.71	27.22
T6S3	105.97	28.93
SE	6.437	1.775
CD (0.05)	N S	N S

Table 11. Number of filled grains and percentage of unfilled grains

Treatments	Number of filled grains per panicle	Percentage of unfilled grains
Main factors		
T1	72.94	13.67
T2	79.02	14.90
T3	78.46	14.77
T4	77.64	14.74
T5	81.11	15.27
T6	79.36	14.94
SE	2.929	0.544
CD (0.05)	N S	N S
S1	76.34	14.37
S2	81.58	15.32
S3	76.36	14.45
SE	1.785	0.387
CD (0.05)	N S	N S
TXS interactions		
T1S1	71.24	13.41
T1S2	77.02	14.31
T1S3	70.56	13.28
T2S1	75.04	14.13
T2S2	84.82	15.97
T2S3	74.18	14.59
T3S1	81.00	15.25
T3S2	84.85	15.97
T3S3	69.52	13.09
T4S1	78.30	14.71
T4S2	74.54	14.02
T4S3	80.17	15.48
T5S1	75.41	14.20
T5S2	90.17	16.98
T5S3	77.76	14.64
T6S1	77.07	14.51
T6S2	78.06	14.70
T6S3	82.96	15.62
SE	4.862	0.947
CD (0.05)	N S	N S

FIG: 5 EFFECT OF TIME OF PLANTING ON YIELD COMPONENTS

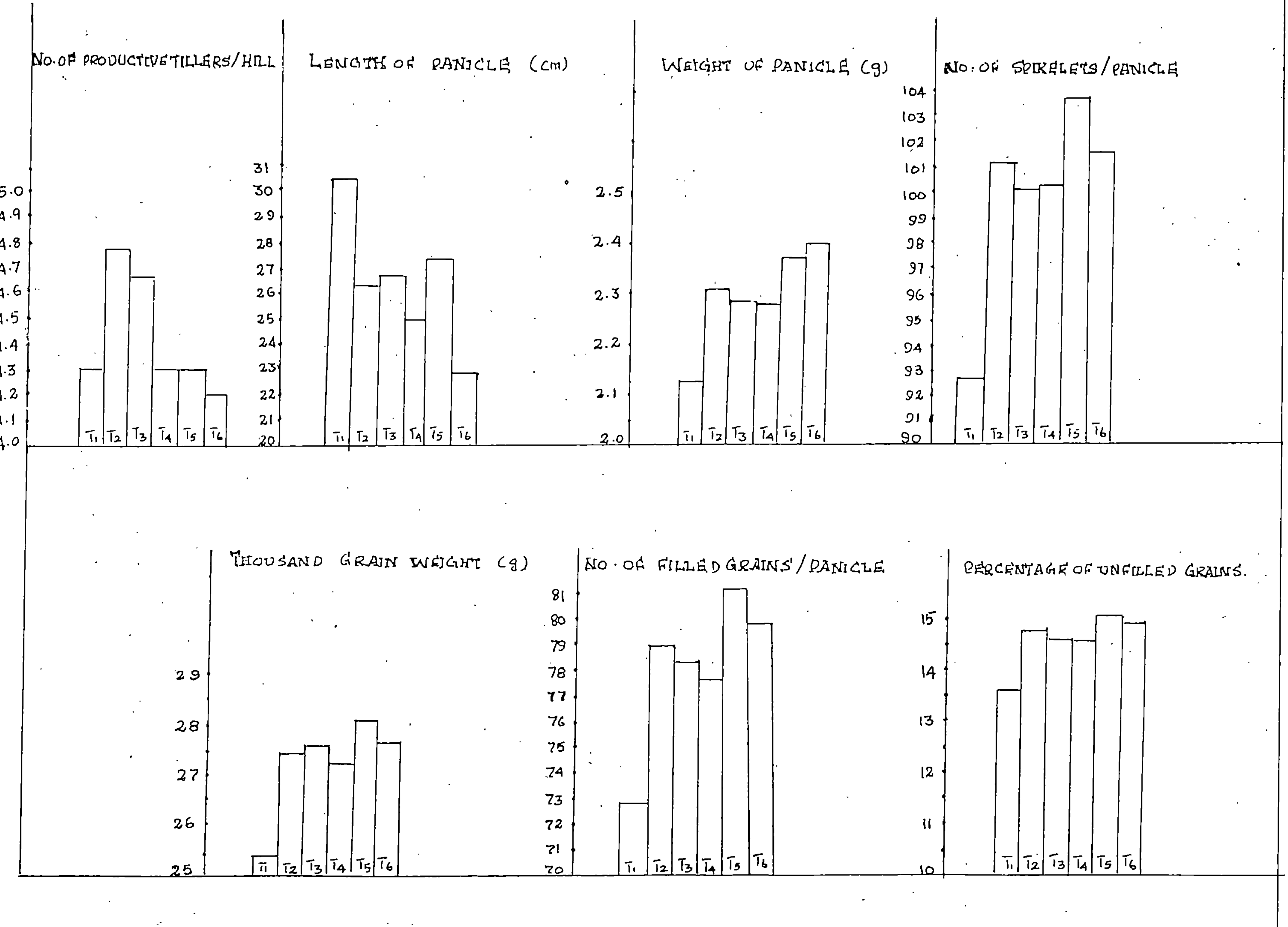
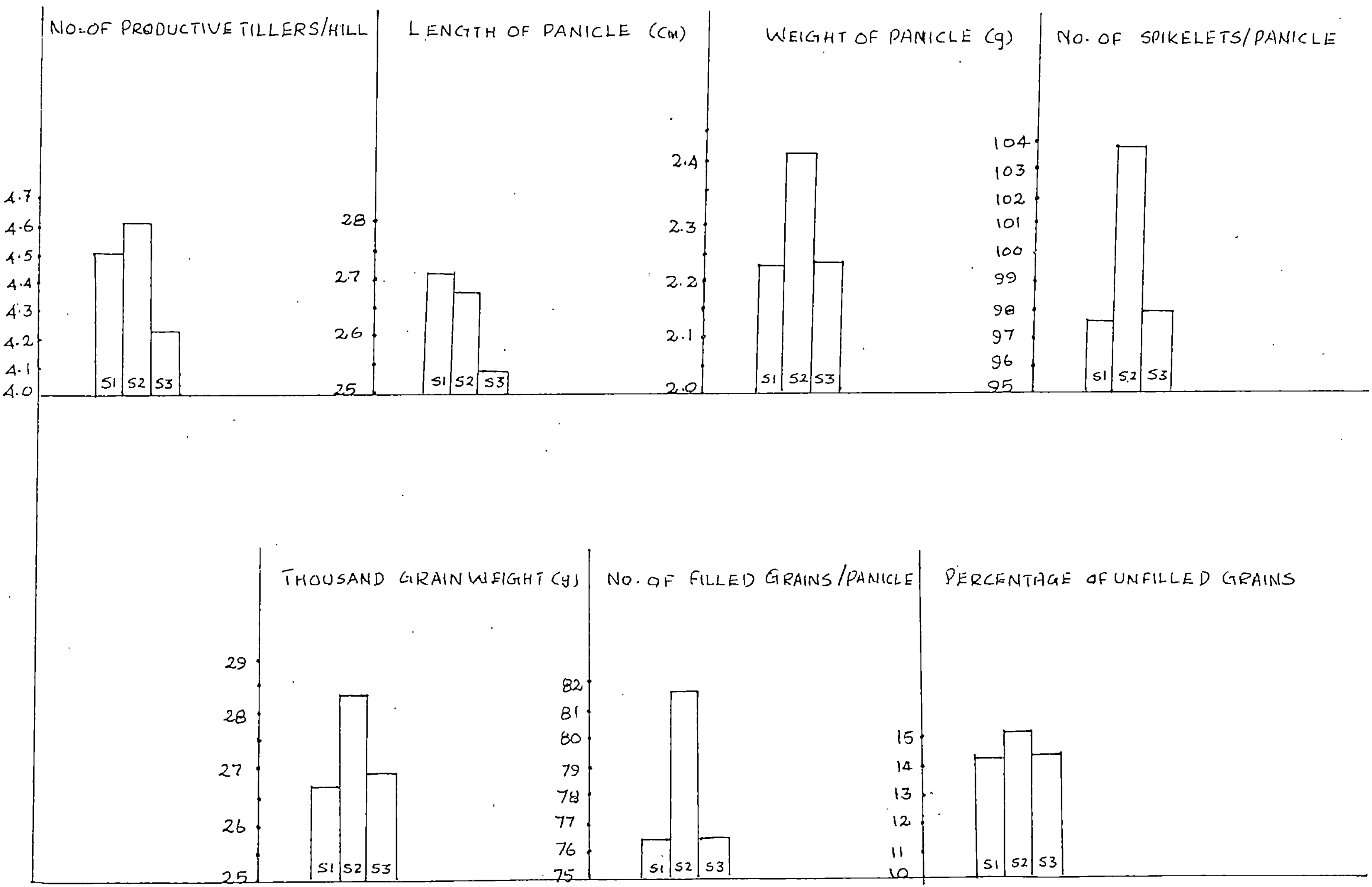


FIG. 6 EFFECT OF SPACING ON YIELD COMPONENTS



the spacing treatment S_2 and the treatment combination T_5S_2 gave slightly higher values for both number of filled grains and percentage of unfilled grains eventhough the effect was not significant.

The slightly higher values for filled grains per panicle in the Treatments T_5T_6 and the spacing treatment S_2 and the interaction T_5S_2 may have been brought about by the high dry matter production in these treatments. Thus total grain production in the panicles would have been higher in the above treatments from which some would have become unfilled thereby resulting in larger number of filled grains per panicle as well percentage of unfilled grains.

4.4. Yield

4.4.1. Grain Yield

Table 12 (Fig. 7) gives the mean values of grain yield. It is evident from the analysis that though different planting times had no pronounced effect on grain yield, adjusting the spacings had significant influence on this character. Interactions also did not exert any marked effect on grain yield. Among the different times of planting T_5 and T_6 gave comparatively higher grain yields and T_1 the lowest, though the effect was not significant.

The spacings 20 x 10 cm (S_1) and 15 x 10 cm (S_2) were definitely superior to the 10 x 10 cm (S_3) spacing with the former two being on par giving grain yields of 1.9 ton per ha. Eventhough the effect was not significant, it is noteworthy that the time of planting and spacing combination of T_5S_2 gave relatively higher grain yields while the lowest yield was recorded by T_3S_3.

Though not significant T_5 and T_6 gave higher grain yields. This is quite understandable from the fact that it was these same treatments that had given greater dry matter production, nutrient uptake, heavier panicles, number of spikelets, thousand grain weight and filled grains per panicle. Thus the best times of planting for Lakshmi at Vellayani can be said to be last fortnight of October upto which the grain yield showed increasing trend and beyond which it declined.

Wide spacings 20 x 10 cm and 15 x 10 cm gave higher grain yields. Under conditions of wider spacing the conditions might have been congenial for better growth of plants with minimum competition which in turn resulted in higher yields. From the study, it has been revealed that going in for planting during the last fortnight of October (T_5) gave the highest grain yield (2.12 t.) when the spacing was 15 x 10 cm. It is also evident that beyond a point there is no added benefit in adjusting the spacing.

Table 12. Grain yield and straw yield (t/ha)

Treatments	Grain yield	Straw yield
Main factors		
T1	1.74	7.87
T2	1.85	7.04
T3	1.86	7.06
T4	1.86	5.53
T5	1.95	4.58
T6	1.89	3.17
SE	0.070	0.666
CD (0.05)	N S	2.109
S1	1.92	5.94
S2	1.92	5.99
S3	1.73	5.70
SE	0.049	0.196
CD (0.05)	0.145	N S
TXS interactions		
T1S1	1.79	7.97
T1S2	1.85	7.97
T1S3	1.59	7.67
T2S1	1.87	6.08
T2S2	1.94	7.76
T2S3	1.72	7.29
T3S1	2.00	7.49
T3S2	2.01	6.66
T3S3	1.58	7.02
T4S1	1.01	5.63
T4S2	1.74	5.54
T4S3	1.84	5.41
T5S1	1.91	5.36
T5S2	2.12	4.81
T5S3	1.81	3.58
T6S1	1.97	3.09
T6S2	1.85	3.18
T6S3	1.86	3.23
SE	0.121	0.480
CD (0.05)	N S	N S

Studies conducted at International Rice Research Institute, Philipines revealed that rice yields increased with increase in plant density and gave significantly higher yields with 20 x 10 cm spacing (4.2 t/ha.) than with 40 x 5 cm spacing (3.8 t./ha.). (Anon, 1980).

Maithy and Mahapatra (1988) revealed that in different rice varieties grown on four transplanting times at 15 day interveals from 5th December to 10th December the time of planting affected the yield and transplantings on 25th December and January, produced the highest yield. Late and early planting reduced the yield, perhaps due to the ill effects of temperature.

Raghuwanshi et. al. (1988) observed that the rice seedlings transplanted at a spacing of 20 x 15 cm gave higher paddy yields than when transplanted and 20 x 20 cm or 15 x 15 cm.

Rao and Raju (1988)revealed that a spacing of 10 or 15 cm between plants in rows 15 cm apart gave yields of 3.89, 5.38 and 6.18 t. per ha., respectively.

4.4.2. Straw yield

Mean straw yields are presented in Table 12 and Fig. 8. recorded under various treatments. Varying the times of planting had significant effect on straw yields, though

FIG. 7. EFFECT OF PLANTING TIME & SPACING ON GRAIN YIELD (Kg/ha)

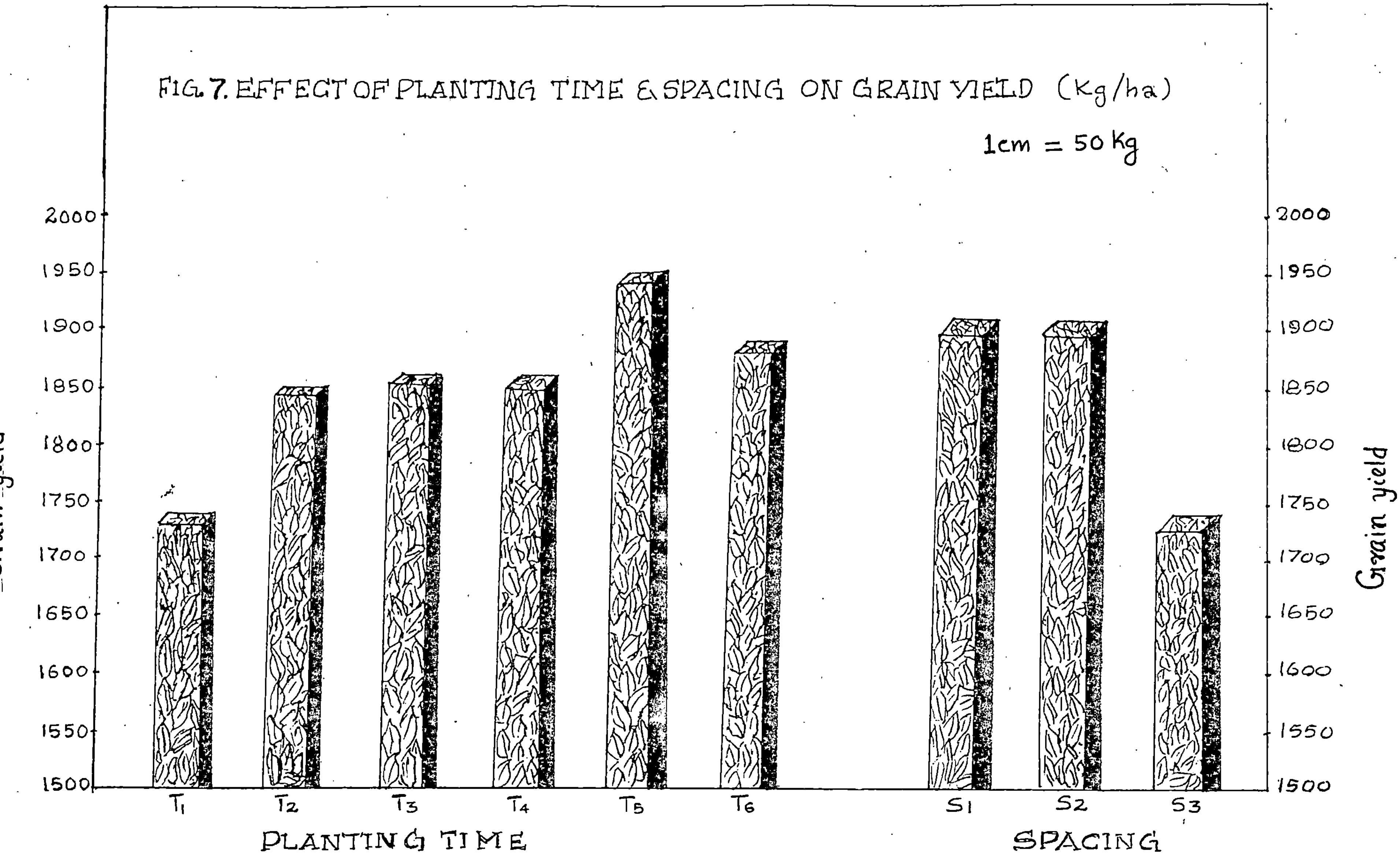
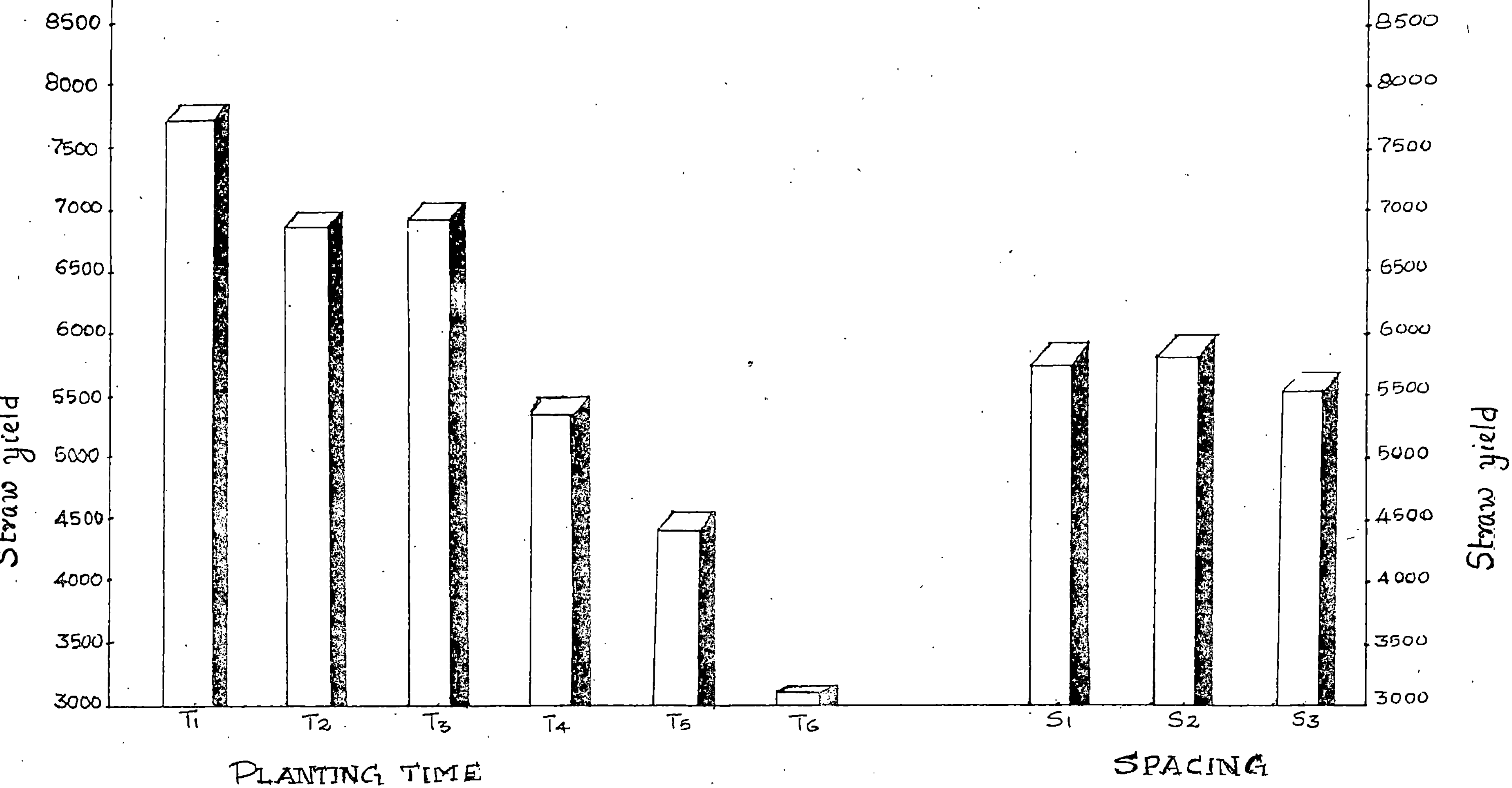


FIG. 8 EFFECT OF PLANTING TIME & SPACING ON STRAW YIELD (kg/ha)



the different spacings tested and the interactions did not exhibit any pronounced effect. Straw yield was highest with normal date of planting (T_1) and was on par with T_3 and T_2 which were 20 days and 10 days later to T_1, respectively. The lowest straw yields were recorded with later plantings of T_6, T_5 and T_4.

Straw yields were higher in the early planted crops perhaps because the growth put forth by plants in these treatments was not effectively converted to grain production.

4.5. <u>Grain quality</u>

4.5.1. Protein content of grains

The mean protein contents of grain expressed as percentages are presented in Table 13.

Varying the times of planting, spacings and their different combinations did not affect the grain protein content in any pronounced manner. However, it can be observed that eventhough not significant, later plantings (T_5 and T_6), 15 x 10 cm spacing and the combinations T_5S_2 gave slightly higher values.

T_5 and T_6 from among the main plot treatments S_2 from the spacing treatments and T_5S_2 interactions gave slightly higher protein content of grains may be because of the higher uptake of N in these treatments as discussed earlier (Table 6).

Table 13. Protein content of grain (%)

	T1	T2	T3	T4	T5	T6	Mean
S1	5.33	5.61	6.12	5.86	5.64	5.76	5.72
S2	5.69	6.34	6.35	5.57	6.74	5.84	6.09
S3	5.28	5.80	5.20	6.15	5.82	6.20	5.74
Mean	5.43	5.92	5.89	5.86	6.07	5.94	..

	T	S	TXS
SE	0.219	0.154	0.377
CD (0.05)	N S	N S	N S

Akram et. al. (1987) revealed that the sowing date did not affect grain protein.

4.6. Post harvest soil nutrient status

4.6.1. Available nitrogen, phosphorus and potassium

The mean values of available nitrogen, phosphorus and potassium contents in the soil after the experiment are given in Table 14.

It is revealed from the analysis that times of planting, spacings, and their different combinations had no significant effect on the levels of major nutrients in the soil after the experiment.

Treatments did not have significant influence on the post harvest soil nutrient status may be because fertiliser application was uniform in all the treatments.

4.7. Economics of cultivation

Planting during the last week of September with 15 x 10 cm (T_2S_2) gave the maximum net return followed by T_1S_2 and T_3S_1 (Table 15). From Benefit cost ratios it was evidenced that the normal date of planting (T_1) was profitable. (Table 16). Profit in terms of Benefit cost ratio was reduced. Progressively with lateness in planting times. Benefit cost ratio was not improved by closer planting treatments T_1S_2 and T_2S_2 gave maximum benefit

Table 14. Available nitrogen, phosphorus and potassium in soil after the experiment (Kg/ha)

Treatments	Available Nitrogen	Available Phosphorus	Available Potassium
Main factors			
T1	147.33	10.57	217.33
T2	139.11	8.50	180.89
T3	148.00	7.46	195.56
T4	147.11	11.68	201.33
T5	142.67	9.19	191.11
T6	144.44	11.6	237.33
SE	2.831	1.380	18.955
CD (0.05)	N S	N S	N S
S1	147.11	10.34	190.00
S2	144.00	9.29	193.78
S3	143.22	9.88	228.00
SE	2.687	0.734	18.998
CD (0.05)	N S	N S	N S
TXS interactions			
T1S1	150.67	11.57	189.33
T1S2	140.00	11.30	176.00
T1S3	151.33	8.83	286.67
T2S1	137.33	8.13	166.67
T2S2	140.00	6.33	180.00
T2S3	140.00	11.03	196.00
T3S1	153.33	8.67	186.67
T3S2	148.00	6.83	180.00
T3S3	142.67	6.87	220.00
T4S1	145.33	10.90	184.00
T4S2	156.00	10.30	206.67
T4S3	140.00	13.83	213.33
T5S1	145.33	11.07	186.67
T5S2	137.33	10.53	202.67
T5S3	145.33	5.97	184.00
T6S1	150.67	11.73	226.67
T6S2	142.67	10.47	217.38
T6S3	140.00	12.77	268.00
SE	6.583	1.798	46.536
CD (0.05)	N S	N S	N S

Table 15. Economics (1) Cost of cultivation total returns and Net returns (Rupees per ha.)

Treatment combinations	Cost of cultivation	Total returns	Net returns
T_1S_1	5970	12445	6475
T_1S_2	6000	12595	6595
T_1S_3	6060	11645	5585
T_2S_1	5970	10755	4785
T_2S_2	6000	12610	6610
T_2S_3	6060	11590	5530
T_3S_1	5970	12490	6520
T_3S_2	6000	11685	5685
T_3S_3	6060	10970	4910
T_4S_1	5970	8155	2185
T_4S_2	6000	9840	3840
T_4S_3	6060	10010	3950
T_5S_1	5970	10135	4165
T_5S_2	6000	10110	4110
T_5S_3	6060	8105	2045
T_6S_1	5970	8015	2045
T_6S_2	6000	7805	2045
T_6S_3	6060	7880	1820

Labour Charges

Price of Grain : Rs. 2/- per Kg. Men : Rs.30/- per day

Price of straw : Rs. 1/- per Kg. Women : Rs.25/- per day

Table 16. Economics (2) Benefit cost ratio

	T_1	T_2	T_3	T_4	T_5	T_6	Mean
S_1	2.09	1.80	2.09	1.79	1.70	1.34	1.80
S_2	2.10	2.10	1.95	1.65	1.69	1.30	1.80
S_3	1.92	1.91	1.81	1.65	1.34	1.30	1.66
Mean	2.04	1.94	1.95	1.70	1.58	1.31	..

	T	S	TXS
SE	0.105	3.507	8.577
CD (0.05)	0.332	0.102	0.250

cost ratio. Thus it is clear that the T_2S_2 (planting 26th September with 15 x 10 cm spacing) can be considered to be the most profitable. It might be because of the higher straw yield obtained in the treatment combination along with fairly good grain yield that T_2S_2 was most profitable.

SUMMARY

5. SUMMARY

A study was carried out in the paddy fields at the Instructional Farm, College of Agriculture, Vellayani, Trivandrum district during the Mundakan (rabi) season of 1985-86, to find out the optimum time of planting of Lakshmi (Kayamkulam-1) variety of rice in relation to plant density. The treatments included different times of planting constituting the main plot treatments while varying spacings constituted the sub plot treatments. The experiment was laid out in a split plot design with 18 treatment combinations in 3 replications.

The findings are summarised below

1. T_1 (Normal date of planting) gave higher values for plant height consistently at all stages of observations while T_6 (most delayed transplanting) gave shortest plants. Spacings of 10 x 10 cm gave tallest plants on 30th day while on 60th day, plants spaced at 20 x 10 cm gave taller plants.

2. Planting during last week of September (26-9-1985) T_2 gave maximum tillers. S_3 produced maximum tillers compared to S_1 and T_2.

3. There was no marked influence of treatments on LAI.

4. Dry matter production was not significantly influenced by the treatments carried.

5. Uptake of N, P, and K were not favourably influenced by the treatments studied.

6. Productive tillers number was more in widely spaced plants compared to closely spaced ones.

7. Normal date of planting gave longer panicles while T_6 (latest transplanting) gave panicles of shortest length.

8. Larger number of spikelets and 1000 grain weight were observed in treatments T_5 and T_6. (26-10-1985 and 5-11-1985) and S_2 (15 x 10 cm).

9. Higher values for filled grains per panicle was observed in T_5 and T_6 and S_2.

10. Higher grain yields were observed in treatments T_5 and T_6. Grain yield was higher in plants spaced at 15 x 10 cm.

11. Higher straw yields were noticed in early planted crops.

12. Protein content of grains was higher in plants grown in T_5 and T_6 and S_2 though there was no significant effect.

13. Treatments studied did not have any significant influence on the post harvest soil nutrient status.

Future line of work

The experiment has to be repeated for a minimum period of three years before definite recommendation with regard to time of planting and spacing can be fixed because the results are very much influenced by climatic parameters beyond human control.

In the present study nutrient application was uniform for all treatments. It would be worthwhile to study the combined effect of varying levels of nutrients also along with the different times of planting and spacing.

Concluding recommendations:

The result of the study shows clearly that higher grain yield was obtained in late planting with the planting density of 67 hill/Sq.m (15 x 10 cm). At the same time higher straw yield was obtained in early planting. While working out the cost-benefit analysis, the result indicates that the maximum net return was obtained during the planting period of last fortnight of september with 15 x 10 cm (67 hill/Sq.m.). It further indicates that the closer planting either in early or late period of planting gives only lesser net return.

Hence, it may be worthwhile to suggest to plant Lakshmi-Paddy variety during the last fortnight of september with the spacing of 15 x 10 cm in Trivandrum District.

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6. REFERENCES

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APPENDIX

APPENDIX

Weather data during the crop period (16-9-1985 to 11-2-1986)

Standard Week No.	Periods	Temperature Maximum (°C)	Temperature Minimum (°C)	Relative humidity Forenoon (%)	Relative humidity Afternoon (%)	Total rainfall (mm)	Total sunshine (hrs.)
37	10/9-16/9	30.4	23.2	93.3	73.3	-	63.9
38	17/9-23/9	30.4	23.5	93.3	75.6	-	57.9
39	24/9-30/9	29.9	23.4	90.7	75.6	-	48.9
40	1/10-7/10	30.3	22.5	89.7	78.1	-	46.5
41	8/10-14/10	30.4	22.9	86.0	74.6	-	65.8
42	15/10-21/10	29.5	22.4	85.0	73.0	128.0	62.5
43	22/10-28/10	29.6	23.1	90.9	74.1	155.0	33.0
44	29/10-4/11	29.2	22.6	90.0	72.9	311.0	21.4
45	5/11-11/11	30.1	23.9	89.0	71.6	34.8	38.1
46	12/11-18/11	29.6	23.3	87.1	74.3	152.2	28.9
47	19/11-25/11	29.7	22.8	82.7	71.3	45.8	61.0

APPENDIX (Contd.)

Sl. No.	Standard Week No.	Periods	Temperature Maximum (°C)	Temperature Minimum (°C)	Relative humidity Forenoon (%)	Relative humidity Afternoon (%)	Total rainfall (mm)	Total sunshine (hrs.)
12	48	26/11-2/12	30.0	21.2	88.9	65.1	-	58.3
13	49	3/12-9/12	30.4	23.4	86.9	74.4	45.6	36.0
14	50	10/12-16/12	31.0	24.1	88.0	91.4	39.7	54.1
15	51	17/12-23/12	31.1	22.4	92.5	57.7	8.1	58.3
16	52	24/12-31/12	31.5	23.5	78.9	57.8	9.4	54.1
17	1	1/1-7/1	32.2	20.7	77.9	55.3	-	64.7
18	2	8/1-14/1	31.9	22.7	22.7	74.3	13.2	57.9
19	3	15/1-21/1	32.8	20.9	86.6	67.4	-	70.1
20	4	22/1-28/1	32.5	23.1	89.9	68.7	-	74.2
21	5	29/1-4/2	32.1	21.6	86.6	74.9	8.4	73.0
22	6	5/2-11/2	32.0	20.6	87.1	64.7	-	76.1

Source: Agrl. Meteorology, College of Agriculture, Vellayani.

Response of Rice Variety : Lakshmi (Kayamkulam-I) to different dates of Planting and Plant Density

By

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ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirement for the degree

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture

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COLLEGE OF AGRICULTURE

Vellayani - Trivandrum

1989

ABSTRACT

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A study on "Optimum time of planting of Lakshmi (Kayamkulam-1) variety of rice in relation to plant density" with 18 treatment combinations in three replications in a split plot design was conducted in the Instructional farm, Vellayani during mundakan season, 1985-1986. The main plot treatments were planting on 16th September, 1985 at ten days' interval (T_1, T_2, T_3, T_4, T_5 and T_6). The three sub plot treatments were spacings of 20 x 10 cm, 15 x 10 cm and 10 x 10 cm. (S_1, S_2 and S_3 respectively).

It was observed that planting during last week of September (26-9-1985) T_2 and S_2 (15 x 10 cm) spacing gave a marked influence on maximum productive tillers.

The longer panicles were noticed in the normal date of planting (T_1) while latest transplanting (T_6) gave panicles of shortest length. Among the treatments 40 days after normal date of planting (26-10-1985) and 50 days after normal date of planting (5-11-1985), (T_5 and T_6, respectively) and S_2 spacing (15 x 10 cm) had a significant influence on larger number of spikelets, 1000 grain weight and higher filled grains per panicle.

Grain yields were highest in the treatments T_5 (26-10-1985), T_6 (5-11-1985) and S_2 spacing (15 x 10 cm) while higher straw yields were noticed in the early planted crops.