STUDIES ON MANURIAL REQUIREMENT OF PADDY I.R-8 IN RELATION TO SPACING UNDER DIFFERENT DATES OF PLANTING

TRINATH BISWAL, B. Sc. (Ag.)

THESIS SUBMITTED TO
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURE (AGRONOMY)

C E R T I F I C A T E.

I cortify that the thesis entitled " Studies on Manurial requirement of paddy IR-8 in relation to spacing under different dates of planting" submitted in partial fulfilment of the requirements for the award of the Master of Science in Agriculture(Agronomy) of the Orissa University of Agriculture and Technology, Bhubaneswar, a faithful record of bonafide research work carried out by Sri Trinath Biswal, under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma or published in any other form. It is further certified that such help or information as has been availed during the course of this investigation, has been duly acknowledged by him.

13.10.69.

(N. Hati)
Assistant Professor, Agronomy,
College of Agriculture,
Bhubaneswar.

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Trinath Biswal
13.X.69.
(T. Biswal)

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CHAPTER I

INTRODUCTION.

INTRODUCTION

Orissa is one of the principal rice growing states in India. Out of 6.04 million hectares of total cultivable land, 4.33 million hectares are devoted to the cultivation of rice. But per hectare yield of rice in Orissa is the lowest being 8,660 kg against an average production of 10,000 kg in India. To meet the present crisis of food shortage it is necessary to increase per hectare production of food grain or to bring more area under cultivation. Since, the cultivable land area is limited it warrants the necessity of adopting multiple cropping, to raise per hectare production of food grain, but this is limited by the availability of irrigation, funds and other resources. With the existing local varieties, the yield per hectare can hardly be increased with better agronomic practices as their yield potential is low. I.R-8 is one of the most promising among the varieties with high yield potential, recently introduced.

Every year, Orissa is subjected to either flood or drought in early or late monsoon period. Due to the occurance of natural calamities, some times transplanting of paddy is not possible in early Kharif. In order to, fit-in with the cropping pattern early or late planting of paddy may also be necessary. To over-come these difficulties, it is desired that a variety with good yield potential must be adoptable to seasonal variation or change of weather conditions.

INTRODUCTION

Orissa is one of the principal rice growing states in India. Out of 6.04 million hectares of total cultivable land, 4.33 million hectares are devoted to the cultivation of rice. But per hectare yield of rice in Orissa is the lowest being 8660 kg against an average production of 10,000 kg in India. To meet the present crisis of food shortage it is necessary to increase per hectare production of food grain or to bring more area under cultivation. Since, the cultivable land area is limited it warrants the necessity of adopting multiple cropping, to raise per hectare production of food grain, but this is limited by the availability of irrigation, funds and other resources. With the existing local varieties, the yield per hectare can hardly be increased with better agronomic practices as their yield potential is low. I.R-8 is one of the most promising among the varieties with high yield potential, recently introduced.

Every year, Orissa is subjected to either flood or drought in early or late monsoon period. Due to the occurance of natural calamities, some times transplanting of paddy is not possible in early Kharif. In order to, fit-in with the cropping pattern early or late planting of paddy may also be necessary. To over-come these difficulties, it is desired that a variety with good yield potential must be adoptable to seasonal variation or change of weather conditions.

For fullest manifestation, a variety must be given proper scope for its growth and development which can be achieved by providing good fertility condition and better agronomic practices. Spacing is one of the most important agronomic practices influencing the yield. To show its proper vigour, a variety must be properly spaced.

I.R-8 performs better only under high fertility status of soil. But the soils of Orissa in general are not so fertile as to provide a good base for showing its vigour and performances. This necessiates the application of chemical fertilisers in proper doses, which may vary under different spacings adopted and variations in planting time.

In view of the above consideration, an experiment entitled " Studies on manurial requirement of paddy I.R-8 in relation to spacing under different dates of planting" was undertaken with the following objectives.

To find out

(i) the best time, optimum and limiting time for transplanting I.R-8 in Kharif.

(ii) the optimum spacing.

(iii) the best fertiliser combination.

(iv) the combined effect of dates of planting, spacings and fertility levels on the yield of grain and straw, and

(v) to study the economics of different factors.

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CHAPTER- II

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

Application of adequate amount of fertilizers give better crops. But cultural practices like date of planting and spacing influence the internal physico-characters which constitute the vital characteristics of the plant. This is reflected on the final yield of the crop.

2.1. Effects of dates of planting on growth and yield.

2.1.1. Height:

Earlier transplanting produced greater height of shoot than later(Relwani, 1963 and Sahu and Lenka, 1966). Langfield *et al.*(1960) have reported that the height of the crop was the lowest with plantings made early in the dry season and highest with plantings made late in the dry season.

2.1.2. Tiller number.

Relwani (1963) reported that transplanting in late July favoured the formation of more number of effective tillers than early, but on the contrary, Sahu and Lenka(1966) reported that early July planting induced more number of ear bearing tillers.

2.1.3. Earhead characters.

Relwani(1963) has reported that earlier planting (5th July) produced greater length of panicle and late planting in 20th July favoured the formation of greater number of fertile spikelets and more weight of grains per panicle.

2.1.4. Effect on yield.

(i) Grain: A variety has its own range of planting period and it is within that critical period the variety shows full manifestation of its yield abilities(Pillai,1958). This has been proved from the results of the trials conducted on rice at different centres in India. Ghose et al. (1956) found that in the Eastern Zone comprising Orissa, Assam, Bihar and West Bengal the optimum period of transplanting is in the month of July. Relwani (1963) also reported that transplanting on 20th July produced 3.38 maunds per acre higher yield than the 5th July planting. This corroborates the findings of Mallik and Behera (1965) and Sahu and Lenka (1966) who, reported that the middle of July is the optimum time of transplanting rice in Orissa.

But Vasistha (1961) and Sing and Sing (1962) have obtained greater yields from June planted crops than that of July. Planting delayed beyond middle of August gives a poor crop yielding only about 50% of the normal yield (Ghose et al ., 1956). Similar observations were made by Basak and Klemme (1959) who reported that planting at 5 dates from mid- July to mid-September resulted in progressive decrease in grain yield and the average grain yield from mid-September planting was only one-third of that from Mid-July planting. Graufurd (1964) opined that in order to obtain highest yield the sowing date should be as near the longest day as possible.

ii) Yield of Straw.

In early sown varieties due to the development of taller plants and more leaves the straw grain ratio remains high. Even in late sowing a high ratio is obtained due to shrivelled and lesser number of grains per ear(Adair, 1940). This is in accordance with the findings of Vasistha et al.(1961), who, reported that the yield of straw was increased as the transplanting was delayed.

2.2. Effect of spacing on growth and yield.

2.2.1. Height.

Height is an index of growth of plant and is related to spacing due to the competition of plants for light and nutrients in a limited area. Vachhani (1961) reported that plant height increased from 6 inches spacing to 12 inches, beyond which no further increase was noticed. In a similar experiment on rice, Relwani (1963) obtained increased yield from 6 x 6 inch to 10 x 10 inch.

2.2.2. Tiller.

Ramiah (1937), Hedaytullah et al.(1944), Vachhani et al.(1961), Relwani (1963), Sahu and Lenka (1966) and Pandey and Tripathy (1967) have reported that in rice as the spacing increases the maximum number of tillers and effective tillers per clump continue to increase.

2.2.3. Ear-head characters:

i) Length of Panicle:

The length of panicle continues to increase as the spacing increases (Ramiah, 1937; Vachhani, 1961; Patel, 1965 and Sahu and Lenka, 1966).

ii) Effect on spikelet sterility.

Hedaytullah (1947) reported that the number of fertile spikelets per panicle increased as the spacing increased from 6 inches to 15 inches. This is in confirmatory with the results obtained by Patel(1965), who observed, lower number of spikelets with 6 inches spacing than that of 9 inches.

2.2.4. Effect of spacing on yield.

i) Yield of grain:- Spacing is the most important agronomic practice influencing the yield in rice (Ramiah, 1937).

Till the recent days, it was the common concept with the cultivators that wider spacing gives better yield. This concept has also been supported by many workers. In Japan Kirano *et al.* (1952) obtained yields twice as large from rice planted in hills spaced 24 cm x 18 cm apart. Relwani(1963) and Patel (1965) obtained significantly superior yields at 10" x 10" and 9" x 9" spacings respectively over 6" x 6" spacing.

The work of Rasher (1959) on swamp rice in Trinidad revealed that increased yield could be obtained by spacing hills much closer than the 12 inch x 12 inch to 18 inch x 18 inch commonly used. Similar observations were made by Vachhani *et al.*(1961) ; Singh and Singh (1962); Enyi(1965); Bains and Sing(1967), who, reported that the closer spacing of 6 inch x 6 inch gave significantly higher yield than wider spacing. Co-ordinated trials on rice conducted through out India during 1965-66 with spacings of 15 cm x 10 cm, 15cm x 20cm and 15cm x 30 cm revealed that wider spacing of the Polnaai types noticeably depressed the yields.

2.3. Combined effect of date of planting and spacing on the yield of rice

For better production of rice it is always necessary that including all other agronomic operations transplanting must be done in proper time. If the planting is delayed unavoidably the only way of counteracting the evil effects of later season is to plant the seedlings closer(Ramiah,1937). Hedaytullah(1944) observed for a closer spacing of 6 x 6 inch the best date of planting is in the second half of July and with 9 x 9 inch spacing is the Ist half of July. But Sing and Sing (1962) reported that in early planting of June 15th all the spacings such as 6 x 6 inch, 9 x 9 inch and 12 x 12 inch gave identical yields and with the advancement of transplanting season closer spacing become more beneficial and essential.

2.4. Effect of fertilization on growth and yield.

2.4.1. Height: Presence and availability of different plant food materials have profound influence in height of plant (Adair, 1936).

Nitrogen is the most important plant nutrient which produces conspicuous difference in vigour of the plants between low and high levels (Mishra and Samantray,1958). This is in agreement with the findings of Baba,1961; Enyi,1965; Srinivasulu and Pawar, 1965; Bathkaland Patil,1968 and Padhi and Mishra, 1968.

Plant height is greatly affected by the amount of available phosphorus (Fusiwara, 1959). Sircar and Sen (1941) have reported that less availability of phosphorus leads to pogressive reduction in height of plants. Tanaka et al. (1959) had also the similar observation and opinioned that phosphate deficiency resulted in stunted growth of the plants.

Sircar and Dutta (1952) and Noguchi (1954) have reported that potassium deficiency causes reduction in height of the plant.

2.4.2. Tiller :-

Higher rate of fertilizer application increases the number of panicle bearing clumps in an unit area (Patel, 1966 and Pandey and Tripathy, 1967).

Russel and Watson (1940) reported encouraged tillering due to the application of nitrogen. As observed by Chavan et al. (1957) number of tillers per clump increased as the dose of nitrogen increased up to 64 pounds per acre. In a similar study Relwani (1962) reported that higher dose of nitrogen increased the number of tillers per clump and 60 pounds of nitrogen showed highest number of tillers over 30 pounds and control. But Bathkal and Patil(1968) have observed that the number of effective tillers increased progressively with the increase in nitrogen dose up to 100 kg. per hectare.

From a Sand culture experiment Sircar et al. (1941) obtained porgressive reduction of tiller number with increased phosphorus deficiency. Watson(1948), Mann(1956) and Tanaka et al. (1958) have reported that application of phosphorus increased the number of tillers per clump.

As observed by Sircar *et al.* (1952), Noguchi(1954), Potassium deficiency also reduces tiller number.

2.4.3. Leaf number and area

Leaf is the main seat of photosynthesis in plant. Leaf area of plant has a direct bearing on the quantity of photosynthetic product. Therefore, dry matter production is directly related to the number of leaves per plant and their sizes.

As stated by Watson (1947) all phases of leaf growth, leaf number and leaf area are affected by nitrogen. Appadurai (1961) observed that increase in yield was always influenced by increase in leaf area. The relationship between leaf area and dry matter production with yield was linear except at higher ranges of fertilization, where, net assimilation rate was depressed due to mutual shading of lower leaves. Increase in dose of nitrogen increased leaf area in rice crop (Rath, 1965; Ray, 1966 and Rout,1966).

Application of phosphorus increases leaf area in cereals (Watson, 1947). Ishizuka and Tanaka (1960) reported that deficiency of nitrogen and phosphorus decreased leaf number. Rath (1965), Ray (1966) and Rout (1966) could not observe any significant effect of phosphorus on leaf area.

2.4.4. Root Characters:

Roots are the chief organs of water and nutrient absorption. Development of root characters depend closely on the nutrition of the tissues. Sufficient supply of nitrogen helps the development and maintenance of young roots which are mainly responsible for absorption of nutrients maintaining oxidation status of the root environment (Okajima, 1961). Sethi (1931) found that the development of root size and length is directly proportional to the amount of nitrogen applied to the soil. Fuji (1957) and Urano et al. (1959) had also similar findings.

Kmoch et al. (1957) and Baba and Katsuni(1958) reported that new roots develop in the greater number at the stage of maximum tillering phase when absorption of nitrogen, phosphorus and potash is at the maximum. Ishizuka and Tanaka (1960) observed that with the deficiency of nitrogen and phosphorus elongation of roots was stimulated but their number decreased. In contrast, deficiency of potassium decreased root elongation.

Urano et al.(1959) reported increased weight of root by the application of nitrogen. Similar observations were made by Srinivasulu and Pawar (1965), who found that highest root weight of 14.83 grams was obtained with 90 kg. nitrogen per hectare as compared to 7.05 grams under no notrogen (control).

2.4.5. Earhead characters.

Nitrogen enhances the length of panicle and increase in dose of nitrogen causes relative increase in length of earhead (Urano,1950; Srinivasan and Rajagopalan,1955; Chavan et al.1957 ; Ghose, 1960; Relwani, 1963; Srinivasulu and Pawar, 1965; Pandey and Tripathy, 1967 and Basu and Chaudhuri,1968). Patel and Joshi (1955-56) observed that length of earhead was increased when 'N' and 'P' were applied in combination.

ii) Number of fertile and sterile spikelets:

Tanaka et al. (1958) have observed that higher levels of nitrogen decreased the number of fertile grains per panicle. Similar finding has been obtained by Patel(1965), who reported that higher rate of fertilization exerted significantly deteriorating effect on the number of spikelets per panicle. On the other hand, Basu and Chaudhuri(1968) working on Taichung-65 and Taichung Native-1, reported considerable increase in number of fertile grains per panicle with the increase in fertility levels.

iii) 1,000 grain weight:

Higher nitrogen level decreases the weight of 1,000 grains (Tanaka, 1958). This corroborates the findings of Ishizuka and Tanaka (1960) and Baba (1961), who, reported that higher rate of fertilizer application exerted a significantly deteriorating effect on 1,000 grain weight.

But Ishizuka and Tanaka (1960), Basu (1968) and Bathkal and Patil (1968) observed no effect of nitrogen levels on 1,000 grain weight. Phosphate also brought about no change in weight (Russel, 1939).

A deficient supply of potash to rice plants caused decrease in 1,000 grain weight(Noguchi,1954).

2.4.6. Effect of fertilization on yield.

i) Grain yield:

" Fertilizers increase ~~the~~ grain yield in cereals" has been established long since. Among the fertilizers, nitrogen has a remarkable influence on the yield. It increases as the levels of nitrogen increase up to a certain range, after which, depression in grain yields of Indica varieties are seen. But Japonica varieties how-ever, utilise nitrogen efficiently under high manuring condition and give greater yield (Tanaka,1958).

Highest grain yield was obtained with the highest dose of 136 kg nitrogen per hectare, in an experiment conducted at IRRI during 1964. A similar experiment conducted at IRRI during 1965 revealed that varieties with better plant type responded to added nitrogen resulting in increased grain yield. Under Orissa condition Lenka(1967) reported that paddy variety IRRI-8-288-3 responded well up to 120 kg/ha at CRRI and at Bhubaneswar dwarf Ponlai varieties responded up to 120 kg N/ha in Kharif and 160 kg N/ha in Rabi season. From a similar experiment, Basu and Chaudhury (1968) reported marked and consistent increase in grain yield per plot in Taichung-65 as the fertilizer applications were increased from 0 to 140 kg N/ha and in Taichung Native-1 up to 112 kg N/ha. With IR-8 Srinivasan et al. (1968) could obtain a grain yield of 5817 kg/hectare in Kharif with a fertiliser application of 200 kg N/ha.

Under Indian conditions, crops do not always respond to potassic fertilisers, when grown in soils containing 0.2% or more of K_2O (Ignatieff,1951). But Sircar and Dutta (1952) found reduction in yield with the decreased supply of potash.

Sing and Sing (1962) have reported that phosphorus alone or in conjuction with nitrogen had shown practically no effect on grain yield of rice. An experiment at International Rice Research Institute during 1965, with Chianung-242 and Chianung 9792, revealed that phosphorus or potassium applied alone or in combination with nitrogen did not significantly effect the grain production of both the varieties. Mahapatra and Padalia (1963) have observed that the difference in grain yield due to application of P and K either alone or in combinations were not statistically significant.

Assessing the fertilizer requirement of rice under Philippine conditions, Reyes et al.(1962) reported that 119 kg N, 37 kg P_2O_5 and 161 kg K_2O/ha were absorbed by the rice plant for an average production of 135.5 bushels grain. Yamasaki (1963) reported that prise winner in the high rice yield contest, who obtained paddy yield of 10 tons/ha, applied fertilizer of about 250 KgN, 180 kg P_2O_5 and 260 kg K_2O/ha in addition to 19 tons of F.Y.M. Reports from Pattambi (Anonymous, 1963) revealed significant response of Tainan-3 to nitrogen. There was better response to application of P_2O_5 and moderate response to addition of K_2O. Highest yields were obtained with fertilizer levels 120-0-40 and 80-80-40 yielding 3241 kg/ha each.

ii) Straw yield:

Nitrogen induces vegetative growth and an excess application results in luxuriance, which is reflected in increased yield of straw. Works of Yamade(1953), Digar(1958) and Ghose(1963) have been found to be in confirmity with the that a lower dose of 30 lb. nitrogen produced twice yield with 20th July than with 5th July but at higher dose (60lb) 5th July planted crop produced an additional response of 2.34 maunds per acre. Sahu and Lenka (1966) corroborate such findings. They observed that application of nitrogen to the late (30th July) planted crop is twice as efficient as that for early (Ist July) planted crop. They opined that heavy manuring of late planted crop is necessary to obtain a good yield.

2.6:- <u>Interaction between spacing and fertilizer levels.</u>

Requirement of fertilizer is intimately related with spacing. In wider spacing generally more fertilizer application is recommended. This view has been supported by Matsue (1955), who, also reported that to meet the fertilizer shortage closer spacing was recommended in Japan during the war years. Sing and Singh (1962) found that in case of heavy manuring closer spacing proved to be the worst. Relwani (1962) reported 10"x 10" spacing between hills with application of 60 lb N/acre to be the best agronomic practice in obtaining good yield. This is in confirmity with the findings of of Patel(1965), who, obtained high grain yield with higher dose of fertilization at 9" spacing.

2.7. <u>Interaction between dates of planting, spacings and fertilizer levels.</u>

To obtain a good yield optimum fertilizer dose must be combined with optimum time of planting and spacing. Experiment conducted by Panse and Khanna(1963) revealed that the best yield was obtained when the crop was sown early with 15 cm x 15cm spacing, which was found to be better than 20 cm x 20 cm or 20 cm x 25 cm spacing. Interactions between planting dates and spacings and fertilizer responses were not very consistent at different centres but generally the response to nitrogen was the highest. When the crop was planted early or at the normal time, closer or medium spacing gave the best response to nitrogen and phosphorus(anonymous,1964). Experiment conducted at International Rice Research Institute during 1964 showed that Taichung Native-1 produced best yield with July planting in combination with a spacing of 15 cm x 15 cm.

2.8. Soil fertility.

(i) pH of the soil:- Fertilizers influence the pH of the soil, has been established long since. Kanwar(1962) has reported that manures and fertilizers decrease the pH of the soil in many places. As observed by Salonen *et al.* (1963) application of superphosphate had no significant effect on soil pH.

ii) Organic carbon: Chemical fertilizers do not change the percentage of organic carbon in the soil appreciably (Russel, 1940). Co-workers (1949-50) have reported that a Balance dose of chemical fertilizers increased the carbon content of the soil to a smaller extent over the control.

iii) Nitrogen status of the soil:- Nitrogen is the most flexible nutrient in the soil, which under goes rapid change. It is lost from the soil in larger quantities through cropping and leaching. Young *et al.* (1960) reported that total nitrogen content declined in check plots than the manured plots. Manures and fertilizers vary in degree of influence on availability of nitrogen (Kanwar,1962).

Phosphate status of the soil:-

Soil phosphate is used off by cropping and is not available to the crop due to fixation. But the availability of phosphate goes up with each increase in the level of P_2O_5(Motiramani *et al.*(1964). Young *et al.*(1960) observed appreciable decline in extractable phosphate in check plot than manured plots.

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CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1. Experimental site :- The investigation was undertaken in the experimental farm of Agronomy Division, Orissa University of Agriculture and Techonology, Bhubaneswar, during the Kharif 1968-69. The topography of the area was fairly uniform and level with good drainage.

3.2. Soil: The physical and chemical composition of soil as determined from a composite sample collected from a depth of 15 cm. before transplanting the crop, has been presented in the Table-1.

Table:- 1. Mechanical and chemical composition of surface soil(15 cm)

Mechanical		Chemical	
Particulars	Percentage composition	Particulars	Percentage composition
Course Sand	50.38	Total Nitrogen	0.053
Fine Sand	26.36	Available P_2O_5	11.6 kg/ha
Silt	13.40	Available K_2O	55.6 kg/ha
Clay	9.86	Organic Carbon	0.66
		C:N.ratio	12.4
Textural Class-Sandy loam		pH	5.4

The following methods were adopted to analyse the soil for different ingradients.

1. Mechanical analysis by hydrometer method.
2. Total Nitrogen by Kjeldahl's method.
3. Available phosphorus by Bray's method.
4. Available potassium by Morgan's method.

5. Organic Carbon by Walkley and Black's rapid titration method.

6. pH determination by Beckman's pH Meter.

From the analysis it is observed that the soil is acidic, low in nitrogen and phosphorus and belongs to sandy loam[1] textural class.

3.3. Weather Conditions :-

Bhubaneswar is situated 64 Kms. away from West of Bay of Bengal in the State of Orissa, the latitude and logitude being 20^{o}- 15' N and 85^{o}- 52' E respectively and at an altitude of 25.5 meters above the mean sea level. The mean annual precipitation approximates to 1360 mm of which 1253 mm is received from June to October. Mean maximum temperature ranges from 35^{o}c to 39^{o}c during the hottest months of May and June, whereas the mean minimum temperature in the coldest part of January varies from 13^{o}c to 15^{o}c.

The weather condition as recorded at the Meteorological observatory, University farm, over the experimental period i.e. from June to December 1988 with the average of 10 years data is presented in Table -2 and figure 1.

(a) Rainfall:

Rainfall recorded during the growth period of the crop from June to November was 1755.2 mm., spread over 97 days.

(b) Temperature :

Mean maximum temperature was higher than the normal during the months of July, August, September, where as, during June, October, November, and December, it was below normal. The mean minimum temperature was higher than the normal during the months of July, August, September, and November, but during June, October and December , it was below normal.

Sum of daily mean temperature from sowing to harvest with respect to different dates of planting were also recorded and presented in table-3.

(c) Humidity :

The relative humidity at 7 A.M. was lower than normal during the month of August and September, higher than normal during June, October, November and December. The relative humidity at 1 P.M. was higher than normal during the month of June, October, November and December and was lower than the normal during the month of July, August and September.

(d) Bright Sunshine hours :-

Bright sunshine hours was lower than the normal during the month of August, October and November and was higher than the normal during the month of July, September and December.

Summation of sunshine hours during the life cycle of the crop with respect to different dates of planting were recorded and presented in table- 3.

Table 2:- Meteorological data from June to December 1968 at Bhubaneswar

Month	Mean Maximum temperature in °C: Current year	Mean Maximum temperature in °C: Deviation from normal	Mean Minimum temperature in °C: Current year	Mean Minimum temperature in °C: Deviation from normal	Relative humidity percentage, 7 A.M: Current year	Relative humidity percentage, 7 A.M: Deviation from normal	Relative humidity percentage, 1 P.M.: Current year	Relative humidity percentage, 1 P.M.: Deviation	Mean rainfall in MM: Current year	Mean rainfall in MM: Deviation from normal	Number of rainy days: Current year	Number of rainy days: Deviation from normal	Sunshine hours: Current year	Sunshine hours: Deviation from normal
June	33.9	0.9 (34.8)	25.0	-0.6 (26.5)	88	2 (86)	67	7 (60)	245.0	95.5 (149.5)	18	4 (14)	56	- (5.5)
July	31.9	1.1 (30.8)	25.9	0.6 (25.3)	92	- (92)	76	-4 (80)	305.7	70.3 (376.0)	22	- (22)	4.9	0.4 (4.5)
August.	31.6	0.4 (31.2)	25.9	0.3 (25.6)	91	-2 (93)	75	-5 (80)	160.3	-148.0 (309.2)	21	-1 (22)	4.4	-0.4 (4.8)
Sept.	32.0	0.83 (31.2)	25.3	0.1 (25.2)	92	-1 (93)	77	- (77)	413.9	126 (287.9)	18	1 (17)	7.2	1.2 (6.0)
October	30.2	-0.5 (30.7)	22.8	-0.1 (22.9)	93	1 (92)	69	3 (66)	537.0	363.3 (173.7)	13	2 (11)	7.0	-1 (8.0)
Nov.	28.1	-1.5 (29.6)	18.7	0.6 (18.1)	93	3 (90)	60	12 (48)	93.3	75.5 (17.8)	5	4 (1)	8.5	-1 (9.5)
Dec.	26.7	-0.8 (27.5)	14.1	-0.4 (14.5)	90	3 (87)	41	1 (40)	-	- (2.6)	x-	- (1)	9.7	0.3 (9.4)

Notes- Figures in the bracket indicate average data of ten years.

FIG. 1 CLIMATIC CONDITIONS OF BHUBANESWAR, ORISSA.

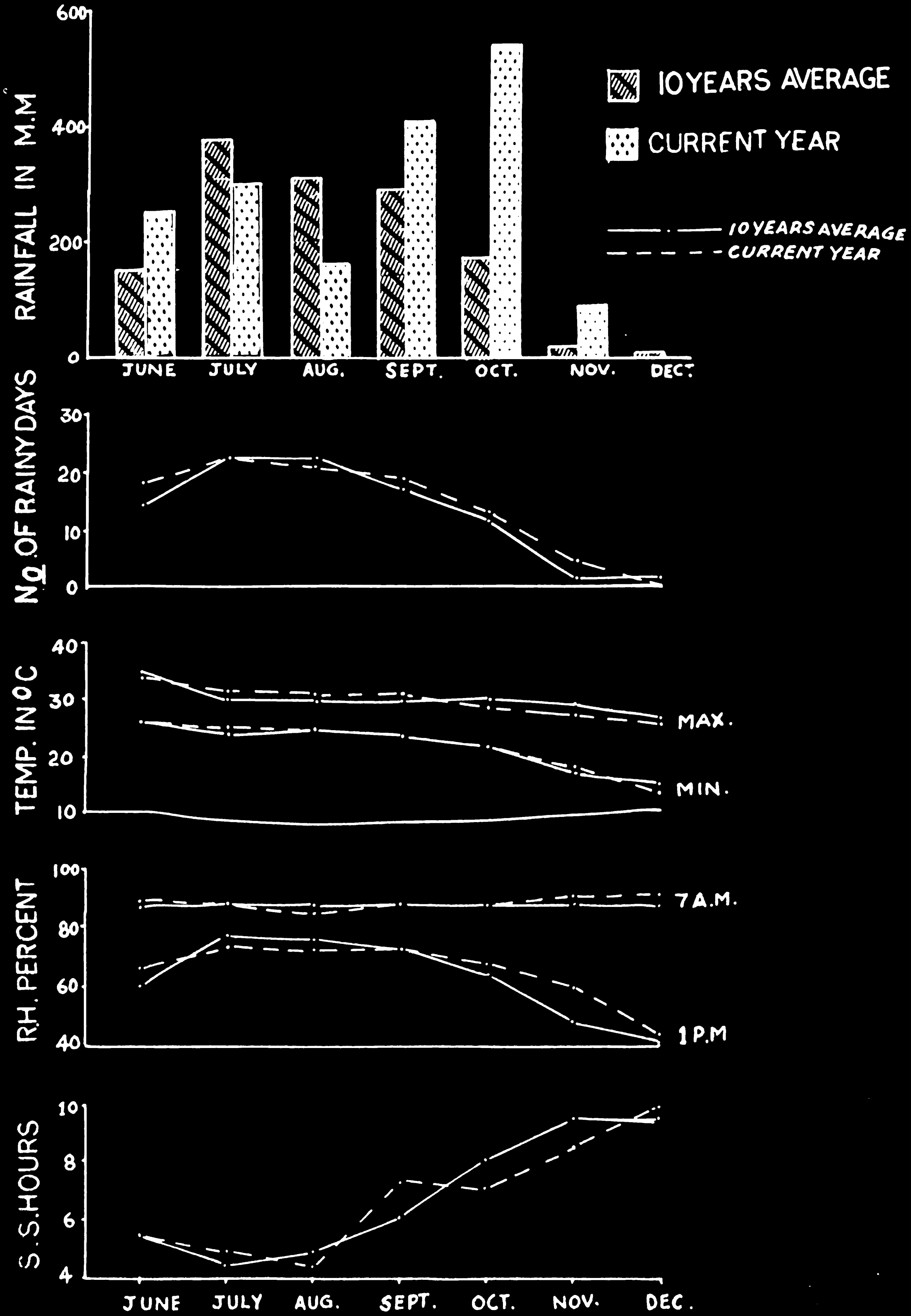

Table- 3.

Date of planting	Summation of temperature in ^oC	Summation of sunshine hours
D_1	3606.6	661.2
D_2	3527.3	746.7
D_3	3500.5	788.2
D_4	3397.4	806.6
D_5	3420.8	963.3
D_6	3148.2	1044.1

3.4. Previous cropping history of the plot:

Previous cropping history of the experimental plot, for the last 3 years along with the current year is presented in table- 4.

Table-4. Cropping history of the plot:

Year	Crop grown	
	Kharif	Rabi
1965-66	Paddy	Fallow
1966-67	Paddy	Paddy
1967-68	Paddy	Paddy
1968-69	Experiment under investigation	—

3.5. Experimental layout :-

The experiment was laid out in a split plot design with the planting dates and spacings in the main plots, and levels of fertilizers in sub-plots. There were altogether fourty eight treatment combinations which were replicated twice and the treatments were randomly allocated to each sub-plot by using the Fisher's and Yate's random table. The treatments are given below. The plan of layout is given in the figure-2.

TREATMENT:

A. Main Plot :

(i) Dates of planting.

		Symbol used
Planting on 30 th June	-	D_1
" on 15th July	-	D_2
" on 30th July	-	D_3
" on 15th August	-	D_4
" on 30th August	-	D_5
" on 15th September	-	D_6

(ii) Spacing.

a) 15 cm x 10 cm	-	S_1
b) 20 cm x 10 cm	-	S_2

B. Sub-plot:(Levels of fertilization)

Levels of fertilizer combination.

N	P_2O_5	K_2O (in Kg/ha)	Symbol used
80	40	40	L_1
120	60	60	L_2
160	80	80	L_3
200	100	100	L_4

Design. Strip cum Split-plot.

Replications- 2

Plot size (sub-plot)

Gross 6M x 4M = 1/416 hectare.

FIG. 2

PLAN OF LAYOUT

N

REPLICATION I

$D_3S_1L_1$	$D_3S_1L_3$	$D_3S_1L_4$	$D_3S_1L_2$	$D_3S_2L_1$	$D_3S_2L_2$	$D_3S_2L_3$	$D_3S_2L_4$
$D_2S_1L_1$	$D_2S_1L_3$	$D_2S_1L_2$	$D_2S_1L_4$	$D_2S_2L_4$	$D_2S_2L_1$	$D_2S_2L_3$	$D_2S_2L_2$
$D_1S_1L_4$	$D_1S_1L_2$	$D_1S_1L_1$	$D_1S_1L_3$	$D_1S_2L_3$	$D_1S_2L_4$	$D_1S_2L_1$	$D_1S_2L_2$
$D_5S_1L_3$	$D_5S_1L_4$	$D_5S_1L_1$	$D_5S_1L_2$	$D_5S_2L_3$	$D_5S_2L_2$	$D_5S_2L_1$	$D_5S_2L_4$
$D_6S_1L_3$	$D_6S_1L_2$	$D_6S_1L_4$	$D_6S_1L_1$	$D_6S_2L_1$	$D_6S_2L_2$	$D_6S_2L_4$	$D_6S_2L_3$
$D_4S_1L_2$	$D_4S_1L_4$	$D_4S_1L_1$	$D_4S_1L_3$	$D_4S_2L_2$	$D_4S_2L_4$	$D_4S_2L_1$	$D_4S_2L_3$

REPLICATION II

$D_3S_2L_3$	$D_3S_2L_1$	$D_3S_2L_4$	$D_3S_2L_2$	$D_3S_1L_4$	$D_3S_1L_3$	$D_3S_1L_1$	$D_3S_1L_2$
$D_4S_2L_4$	$D_4S_2L_1$	$D_4S_2L_2$	$D_4S_2L_3$	$D_4S_1L_3$	$D_4S_1L_4$	$D_4S_1L_2$	$D_4S_1L_1$
$D_2S_2L_2$	$D_2S_2L_4$	$D_2S_2L_1$	$D_2S_2L_3$	$D_2S_1L_3$	$D_2S_1L_2$	$D_2S_1L_4$	$D_2S_1L_1$
$D_1S_2L_1$	$D_1S_2L_2$	$D_1S_2L_3$	$D_1S_2L_4$	$D_1S_1L_3$	$D_1S_1L_2$	$D_1S_1L_4$	$D_1S_1L_1$
$D_5S_2L_2$	$D_5S_2L_4$	$D_5S_2L_1$	$D_5S_2L_3$	$D_5S_1L_1$	$D_5S_1L_2$	$D_5S_1L_4$	$D_5S_1L_3$
$D_6S_2L_3$	$D_6S_2L_4$	$D_6S_2L_2$	$D_6S_2L_1$	$D_6S_1L_4$	$D_6S_1L_2$	$D_6S_1L_1$	$D_6S_1L_3$

MAIN PLOT TREATMENTS

A - DATES OF PLANTING

- D_1 - 30th JUNE
- D_2 - 15th JULY
- D_3 - 30th JULY
- D_4 - 15th AUG.
- D_5 - 30th AUG.
- D_6 - 15th SEPT.

B - SPACINGS

- S_1 - 15 cm X 10 cm
- S_2 - 20 cm X 10 cm

SUB PLOT TREATMENTS

FERTILIZER LEVELS

	N	P_2O_5	K_2O IN KG/HA
L_1	80	40	40
L_2	120	60	60
L_3	160	80	80
L_4	200	100	100

Net S_1 = 1/462 hectare

S_2 = 1/470 hectare

Variety used - IR- 8

Age of seedlings = 25 days (in each planting)

3.6. Manurial Schedule:

Nitrogen, phosphate and Potash were applied in the form of calcium Ammonium Nitrate, Super Phosphate and Muriate of Potash respectively. Whole amount of super, Muriate of potash and half of calcium ammonium nitrate were applied at the time of final land preparation before planting. The balance amount of calcium ammonium nitrate was topdressed in two splits, half at 25 days after transplanting and the rest at panicle initiation.

3.7. Schedule of Cultural Operations :

The Schedule of various cultural operations followed during the growth of the crop are presented in the table-5.

3.8. Irrigation and Drainage:

The crop was irrigated and draining was done as and when necessary.

3.9. Control diseases and pests:

Attack of Gall midge (Pachydiplosis Oryzae W.) and Stem borer (Tryporyza incertulas) was noticed. Attack due to stem borer was very mild and gallfly was severe at certain times. For control of diseases and pests, 5 sprayings were given at an interval of 10 days after transplanting, with Taf-drain 20 Ec and Folidol alternatively. Two sprayings with Phytolon @ 2 Kg in 100 gallons of water were given. As the gallfly attack was more intense, counts were taken with respect to affected clumps.

3.10. Harvesting and Threshing:

The crop was harvested. One row of border plants from all the sides of each sub-plot were removed before harvesting the net plot. The harvested crop was bundled and labelled treatmentwise. Threshing was done with the help of Akshat Paddy Thresher.

3.11. Pre-harvest Observations :-

Sampling technique :

The technique of random sampling was adopted to study the different agronomic characters such as height, and number of tillers per clump etc. Ten plants in each plot were selected in accordance with the random numbers of Fisher's and Yate's random table. These plants were fixed permanently till harvest and bio-metric observations were recorded for the sample plants at an interval of 15 days.

(i) Height: The height of the plants were recorded from the base of the plants up to the auricle of the top most leaf.

(ii) Tillering : Counting of tillers was done from 15th day after transplanting to 60th day and effective tillers before the harvest.

(iii) Leaf number : The total number of green leaves per plant was recorded.

(iv) Leaf area: The leaf area of the 3rd leaf from the

Table-6: Schedule of cultural operations

Sl No.	Name of operations	Particulars	DATES	OF		PLANTING		
			30th June	15th July	30th July	15th August	30th August	15th September
A.	Sowing in Nursery.		6.6.68	21.6.68	6.7.68	21.7.68	6.8.68	21.8.68
B.	Transplanting.		30.6.68	15.7.68	30.7.68	15.8.68	30.8.68	15.9.68
C.	Interculture							
	(i) Ist Weeding	Weeding by Japanese rotary weeder and hand weeding.	25.7.68	10.8.68	25.8.68	11.9.63	25.9.68	10.9.68
	(ii) 2nd weeding	Hand weeding.	25.8.68	10.9.68	20.9.68	11.10.68	20.10.68	9.10.68
D.	Manuring.							
	(i) Ist topdressing	C.A.N.	25.7.68	10.8.68	25.3.68	11.9.68	25.9.68	10.9.63
	(ii) 2nd topdressing		26.8.68	9.9.68	24.9.68	11.10.68	25.10.68	12.11.68
E.	Plant protection.							
	Ist spraying	Endrex 20 E.C phytolon	10.7.68	25.7.68	10.8.68	25.8.88	10.9.68	25.9.68
	2nd "	Folidol	20.7.68	5.8.68	20.8.68	5.9.68	20.9.68	5.10.68
	3rd "	Endrex 20 EC Phytolon	30.7.68	15.8.68	30.8.68	15.9.69	30.9.68	15.10.68
	4th "	Folidol	10.8.68	25.8.68	10.9.68	25.9.68	10.10.68	25.10.68
	5th "	Endrex	20.8.68	5.9.68	30.9.68	5.10.68	20.10.68	5.11.68
F.	Harvesting and thrasning.							
	(i) Harvesting.		9.10.68	23.10.68	8.11.68	22.11.68	15.12.68	31.12.68
	(ii) Thressing.		16.10.68	30.10.68	18.11.68	30.11.68	25.12.68	8.1.69

top of the plant was recorded by taking the length and breadth of the lamina. The leaf area was calibrated by the halp of planometer. The factor was found out by taking the formula.

$$\text{Factor} = \frac{\text{Area measured by Planometer}}{\text{Area measured by Motor Scale}}$$

(v) Observation on flowering :- Dates of flowering for different dates of planting were recorded.

Post-harvest observations:

3.12(a) Root study: Root study was made at harvest of the crops. The soil particles sticking to the roots were carefully removed by washing in running water. Following studies were made.

i) Length of the longest root was measured.

ii) Weight of the root was taken after oven drying.

3.12(b) Yield component: 10 earheads from each plot were collected after the harvest. The length of ear-head, number of fertile and sterile grains per ear and the weight of one thousand grains were recorded.

ii) Yield of grain and straw: Initial weight of the grain and straw was recorded immediately after threshing and their final weights after drying under sun.

3.13. Soil fertility study: Soil samples were taken from 96 plots separately and composite samples were made. Samples were analysed for pH , Carbon, total nitrogen, available P_2O_5 and available K_2O.

3.14. Statistical analysis of the data.

The data were analysed by standard statistical method of Analysis of variance. Standard error for each factor was worked out and critical difference (C.D) was found out at 5% level of significance and are given where ever needed to compare the treatment means. The standard error of means (S.Em) and critical difference (C.D) were calculated and presented where ever necessary.

3.15. Correlation studies:

For finding out the correlation co-efficient of different characters, the following formula was used.

$$r = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{N}}{\sqrt{\left\{\Sigma x^2 - \frac{(\Sigma x)^2}{N}\right\}\left\{\Sigma y^2 - \frac{(\Sigma y)^2}{N}\right\}}}$$

Where x and y are the values of variable characters.

Σ = Sum of products.

N = Total number of observations.

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CHAPTER - IV

EXPERIMENTAL FINDINGS

EXPERIMENTAL FINDINGS.

During the course of the present investigation observations were recorded on various plant characters to study the growth and yield response of high yielding rice IR-8, to different dates of planting, spacings and levels of fertilization. The relevant data recorded were statistically analysed and the results are presented in this chapter with the treatment means, S.Em and C.D. at 5% level of significance. The analysis of variance table for different characters have been presented in the Appendix.

PRE-HARVEST STUDIES

4.1.1. Plant height:

Height of the plant is an index of vegetative growth of the crop, hence, its study is essential. Periodic observations on height have been recorded at five stages of growth, at fortnight intervals to study the effect of dates of planting, spacings and levels of fertilization on the growth and development of the crop. The relevant data have been presented in table-6 and illustrated in Fig.3.

Examination of the data revealed that the height increased progressively at successive days after transplanting and was the maximum at harvest.

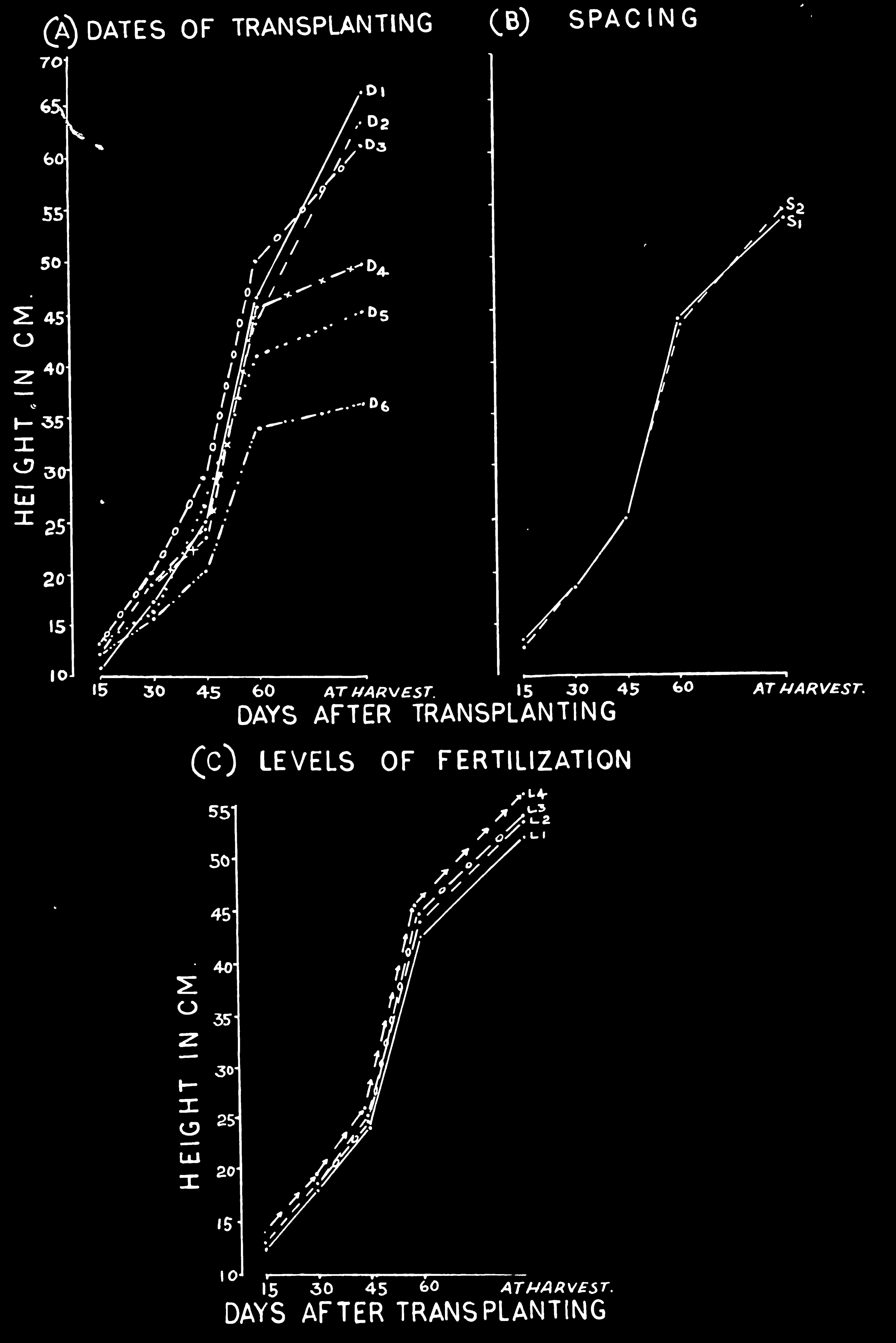
With the dates of transplanting significant difference in mean height of plants was observed. Planting in 30th June recorded the maximum average height of 65.8cm. Height decreased gradually with late plantings and was minimum (36.2 cm) with the September 15th planting.

A wider spacing of 20 x 10 cm induced greater height than closer spacing (15 x 10 cm) and difference was statistically significant.

Table- 6. Mean height of plant (in cm) at successive stages of growth.

Treatments	DAYS AFTER TRANSPLANTING				
	15	30	45	60	At harvest
Dates of transplanting:					
D_1	11.1	17.5	24.9	46.6	65.8
D_2	12.0	18.9	24.7	44.1	63.0
D_3	15.8	21.5	29.6	50.3	61.3
D_4	12.6	19.3	24.0	47.3	49.1
D_5	14.7	17.3	26.1	42.7	45.2
D_6	12.2	17.0	20.5	33.8	36.2
'F' test.	Sig*	Sig*	Sig*	Sig*	Sig*
S.Em ±	0.58	0.72	1.21	1.85	0.53
C.D.(0.05)	2.10	2.59	4.35	6.66	1.90
Spacing:					
S_1	13.4	18.5	24.9	44.3	53.0
S_2	12.7	18.7	25.0	44.0	53.9
'F' test.	Not Sig	Not Sig	Not Sig	Not Sig	Sig.*
S.Em ±	0.22	0.34	0.50	0.64	0.01
C.D(0.05)	-	-	-	-	0.17
Levels of fertilization:					
L_1	12.4	18.3	24.1	42.7	52.2
L_2	13.0	18.5	25.2	44.7	53.5
L_3	13.1	18.5	24.6	43.3	53.7
L_4	13.7	19.1	25.9	45.2	54.3
'F' test.	Sig*	Sig*	Sig*	Sig*	Sig*
S.Em ±	0.19	0.21	0.37	0.53	0.46
C.D.(0.05)	0.54	0.59	1.06	1.51	1.31

FIG.3. MEAN HEIGHT AT DIFFERENT STAGES OF GROWTH



Levels of fertilization increased the plant height significantly. Highest height of 54.3 cm was recorded with L_4 and lowest of 52.2 cm with L_1, L_2 and L_3 were at par with each other at all stages of growth but at 60th day and at harvest L_2, L_3 and L_4 were at par with each other and significantly superior to L_1 in inducing growth in height.

Inter-actions were not significant. However, planting dates with varying levels of fertility produced considerable influence on height of plant. June 30th(D_1) planting with L_3 (160 kg N, 80 kg P_2O_5 and 80 Kg K_2O/ha) produced the maximum mean height (67.8 cm).

The interaction of dates, spacings and fertility levels were not significant. 30th June planting with a spacing of 15 x 10 cm (S_1) showed the maximum mean height (69.6) at the fertility level L_3.

4.1.2. Number of tillers per clump:

The data on number of tillers per clump at successive stages of growth after transplanting as affected by different dates of planting, spacings and fertilizer levels are presented in table- 7 and illustrated in Fig. 4.

Number of tillers per clump increased up to 60th day of transplanting in all the dates except 30th June planting, in which case, increase was up to 45th day. Increase was very rapid from 15th to 30th day and further increase was at a diminishing rate. From 60th day to harvest a rapid reduction in number of tillers was observed. The percentage of survival of the number of effective tillers decreased with the delayed transplantings. With June 30th planting the percentage of survival was the highest (70.1%), where as, with September 15th planting it was the lowest (27%).

Planting at different dates influenced the number of tillers significantly. At 60th day, the average total number of tillers was minimum and maximum with June 30th and September 15th plantings respectively. Plantings in July 15th, July 30th, August 15 and August 30th were at par with each others.

Spacing affected the number of total tillers per clump significantly. Wider spacing produced greater number of total tillers per clump (12.5) than closer. Same trend was also observed in case of effective tillers; however, the difference was not significant.

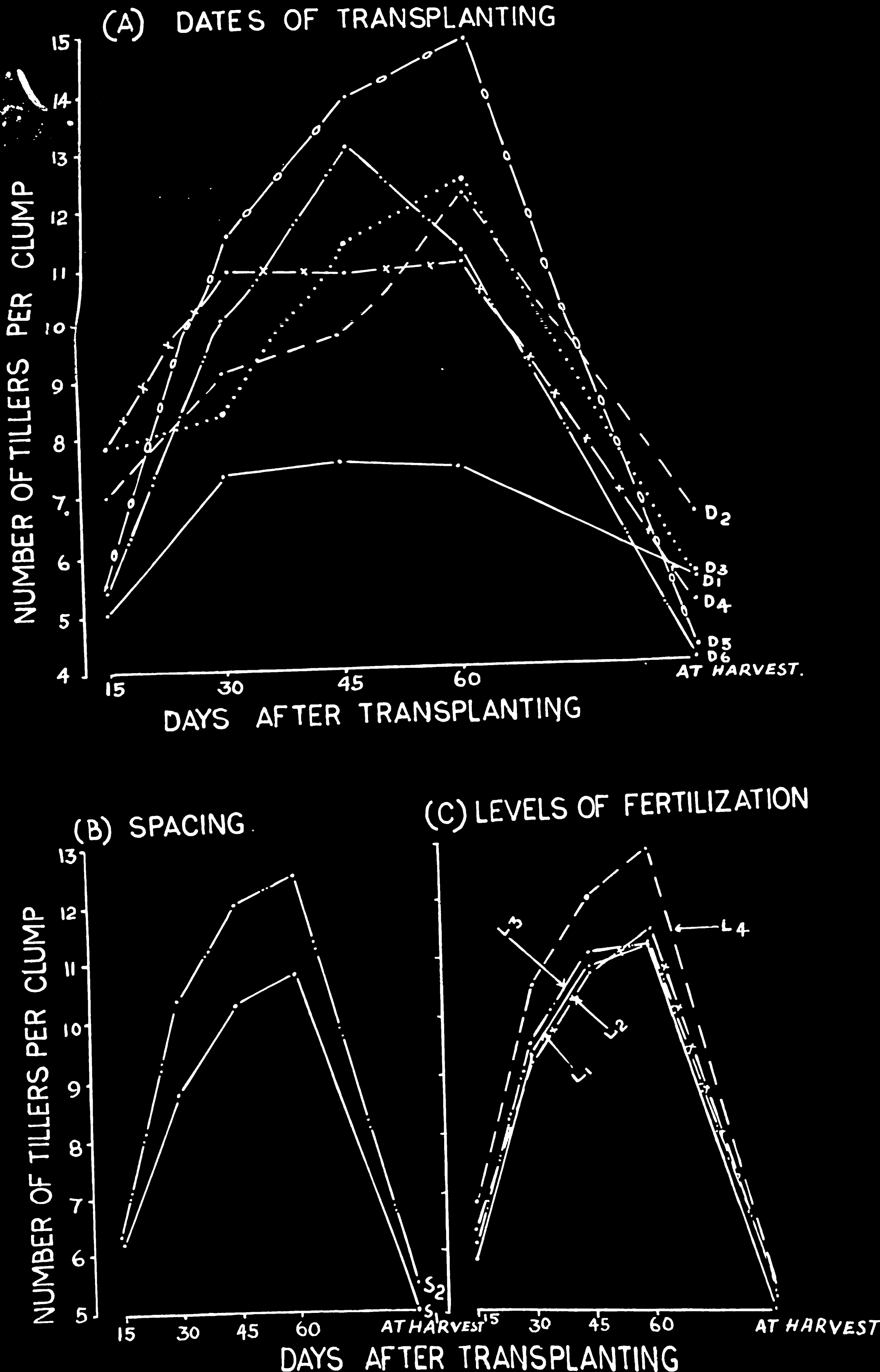
Significant difference in number of total tillers per clump was observed. L_4 showed the highest number of tillers. L_1,L_2 and L_3 were at par with each other. No significant difference could be observed in effective tillers but L_3 showed the highest number of effective tillers (5.4) per clump.

The interactions were not significant with respect to effective tillers but July 15th planting with L_3 level of fertilization showed the maximum number of effective tillers (6.8).

Table- 7. Number of tillers per clump at different stages of growth.

Treatments.	DAYS AFTER TRANSPLANTING 15	30	45	60	AT HARVEST Effective tillers.	% of survival
Dates of transplanting.						
D_1	4.9	7.3	7.5	7.4	5.5	70
D_2	7.0	9.1	9.7	12.4	6.6	53
D_3	7.8	8.4	11.5	12.6	5.5	44
D_4	7.1	11.0	11.0	11.1	5.1	46
D_5	5.4	10.1	13.2	13.4	4.3	32
D_6	5.5	11.6	14.0	15.0	4.1	27
'F' test.	Sig*	Not Sig	Not Sig	Sig*	Sig*	
S.Em ±	0.33	0.74	2.43	0.88	0.24	
C.D(0.05)	1.19	-	-	3.19	0.87	
Spacing:						
S_1	6.2	8.8	10.3	10.8	4.9	
S_2	6.3	10.4	12.0	12.5	5.5	
'F' test.	Not Sig	Not Sig	Sig.*	Sig.*	Not Sig	
S.Em ±	0.47	0.12	0.059	0.11	0.22	
C.D(0.05)	-	-	1.05	1.97	-	
Levels of fertilization:						
L_1	5.8	9.3	10.8	11.1	5.0	
L_2	6.3	9.2	10.7	11.4	5.2	
L_3	6.1	9.4	11.0	11.2	5.4	
L_4	6.8	10.5	12.0	12.8	5.2	
'F' test.	Sig.*	Sig.*	Not Sig	Sig.*	Not Sig	
S.Em ±	0.24	0.13	0.40	0.53	0.48	
C.D(0.05)	0.68	0.37	-	1.51	-	

FIG 4. TILLERS PER CLUMP AT DIFFERENT STAGES OF GROWTH



4.1.3. Leaf area:

Data on leaf area as affected by different treatments were analysed and presented in table-8 and illustrated in figure-5.

An increase in leaf area was observed from 15th to 60th day after transplanting.

Dates of planting influenced the leaf area significantly. Earlier plantings produced greater lamina than late and mean area of leaves gradually decreased as the planting time was delayed. June 30th planting showed highest leaf area of 48.5 sq. cm, where as, it was only 28.8 sq. cm with September 15th planting. Plantings between June 30th to August 30th were at par with each other.

No significant difference in leaf area could be observed due to spacing.

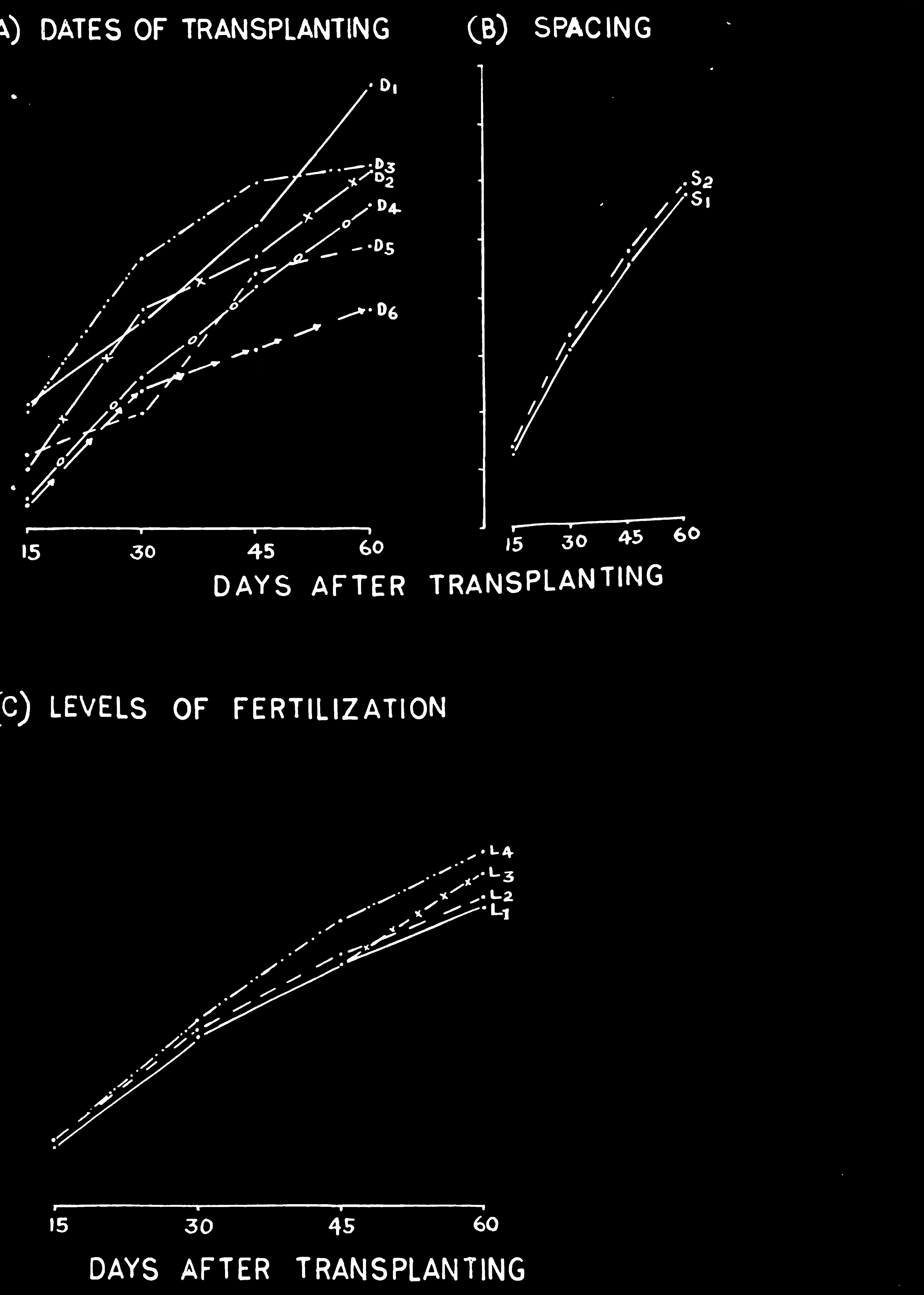
Fertilizer levels produced significant effect in increasing the leaf area. L_4 showed the highest leaf area of 41.3 sq. cm and was at par with L_3. L_3 was significantly superior to L_2, where as, the later was significant over L_1.

Dates of planting under varying levels of fertility had considerable affect on leaf area. 30th June planting with L_3 (160 kg N, 80 Kg P_2O_5 and 80 Kg K_2O/ha) produced the highest leaf area (50.8sq.cm) followed by D_1L_4. September 15th planting with L_1 showed the lowest mean leaf area.

Table-8 Mean leaf area (in sq. cm) at different stages of growth.

Treatments.	DAYS AFTER TRANSPLANTING 15	30	45	60
Dates of transplanting:				
D_1	20.6	28.0	25.9	48.5
D_2	14.8	29.3	33.8	40.9
D_3	20.0	32.3	40.0	41.1
D_4	12.5	22.8	30.9	38.3
D_5	16.3	20.2	32.0	34.7
D_6	12.3	22.3	25.6	28.8
Mean	16.0	25.8	33.0	38.7
'F' test.	Sig*	Sig*	Sig*	Sig*
S.Em ±	1.18	0.77	2.05	2.12
C.D(0.05)	4.28	2.79	7.44	7.69
Spacing:				
S_1	15.8	25.1	32.5	38.4
S_2	16.4	26.5	33.6	39.1
'F' test.	Not Sig.	Not Sig.	Not Sig.	Not Sig.
S.Em ±	0.74	0.53	0.47	1.45
Levels of fertilization.				
L_1	15.8	25.3	31.7	36.5
L_2	16.0	26.0	32.5	37.4
L_3	16.0	25.3	32.5	39.6
L_4	15.8	26.7	35.5	41.3
'F' test.	Not Sig.	Not Sig.	Sig.*	Sig.*
S.Em ±	0.34	0.56	0.74	0.81
C.D(0.05)	-	-	2.10	2.30

FIG 5. LEAF AREA AT DIFFERENT STAGES OF GROWTH



The date, spacing and fertility interactions were conspicuous though not significant. 30th June planting (D_1) with S_2 (20 x 10 cm) and L_3 produced the highest mean leaf area (51.0 sq. cm) followed by D_1 S_1 L_3 and D_1 $S_1 L_4$.

Interactions of spacing with levels of fertilization had no influence on leaf area.

4.1.4. Number of leaves per plant:

The number of leaves per plant under different treatments as recorded on 15th, 30th, 45th and 60th day after transplanting is presented in table-9.

With the growth of the plant the number of green leaves per plant increased. This increase was only up to 45th day, after which there was a reduction in the number, due to the death of leaves. The number of green leaves per plant varied significantly with the dates of planting. From the observation taken at 45th day which coincides with the maximum growth phase, it was evident that plantings in June 30th, July 15th, July 30th and August 15th were at par with each other and were significantly superior to plantings on 30th August and 15th September. The later were at par with each other.

The leaf number was not affected by spacing or levels of fertilization or the interactions of these factors.

Table - 9 Number of leaves at different stages of growth.

Treatments.	DAYS AFTER TRANSPLANTING			
	15	30	45	60
Dates of transplanting:				
D_1	3.5	4.7	5.8	5.5
D_2	3.9	4.5	5.0	5.0
D_3	3.7	4.8	5.1	5.0
D_4	3.3	4.5	5.0	3.8
D_5	3.6	4.2	4.3	3.1
D_6	3.6	3.9	4.1	3.8
Mean	3.6	4.4	4.8	4.3
'F' test.	Sig.*	Sig.*	Sig.*	Sig.*
S.Em ±	0.07	0.11	0.12	0.17
C.D(0.05)	0.25	0.39	0.43	0.61
Spacing:				
S_1	3.6	4.5	4.9	4.4
S_2	3.6	4.4	4.9	4.3
'F' test.	Not Sig.	Not Sig.	Not Sig.	Not Sig.
S.Em ±	0.0089	0.054	0.02	0.014
Levels of fertilization :				
L_1	3.6	4.4	4.8	4.3
L_2	3.5	4.4	4.9	4.3
L_3	3.6	4.4	4.9	4.3
L_4	3.7	4.4	4.9	4.3
'F' test.	Not Sig.	Not Sig.	Not Sig.	Not Sig.
S.Em ±	0.18	0.26	0.20	0.13

4.1.5. Area of flag leaf:

The data on area of flag leaf as affected by different treatments are presented in table- 10.

Table- 10. Area of flag leaf (sq. cm) as affected by different treatments.

Treatments.	Area	'F' test	S.Em ±	C.D. at 5%
Dates of transplanting:				
D_1	38.7			
D_2	34.2	Sig.*	1.18	4.28
D_3	35.2			
D_4	28.1			
D_5	22.2			
Spacing:				
S_1	32.6			
S_2	33.6	Not Sig	0.70	-
Levels of fertilization:				
L_1	31.1			
L_2	33.2	Sig.*	0.73	2.09
L_3	33.9			
L_4	34.3			

Significant variation in area of flag leaf was observed due to planting dates. June 30th planting produced flag leaf with largest mean area of 38.7 sq.cm. As the planting date was delayed significant reduction in area of flag leaf was observed. July 15th, July 30th and August 15th plantings were at par with each other. They produced significantly larger flag leaf area than August 30th which was also significantly superior to September 15th planting. No significant difference could be observed in flag leaf area due to the effects of spacings.

Increase in area of flag leaf was observed from low fertility (L_1) to high fertility (L_4) level. L_1, L_2 and L_3 were at par with each other but L_4 was significantly superior to the above three levels increasing the leaf area.

4.1.6. Date of flowering and maturity:

The data on dates of flowering and maturity are presented in table-11.

Flower initiation with respect to all the plantings dates were by 82 to 83 days after sowing. Planting in 30th June, 15th July, 30th July and 15th August matured in 125-126 days but August 30th and September 15th plantings matured a week days later i.e. 132 and 133 days respectively.

4.1.7. Pest attack:

Counts on the gall midge affected shoots were taken as the attack due to them were conspicuous and due to other insects, were quite low and negligible. The data were analysed and presented in table- 12.

No significant difference in gall midge affected shoots were seen due to planting in different dates and spacings but however, planting in 30th June and 15th July encouraged the attack of gall midge. Less gall midge attack was noticed with delayed plantings.

Table - 11 Date of flowering and maturity.

Date of sowing.	Date of transplanting.	Date of panicle initiation.	Date of completion of flower-ing.	No. of days taken for completion.	Date of harvest.	Duration.
D_1- 6.6.68	30.6.68	27.8.68	10.9.68	15	9.10.68	125
D_2- 21.6.68	15.7.68	11.9.68	29.9.68	15	23.10.68	125
D_3- 6.7.68	30.7.68	26.9.68	11.10.68	16	8.11.68	126
D_4- 21.7.68	15.8.68	12.10.68	28.10.68	17	22.11.68	126
D_5- 6.8.68	30.8.68	28.10.68	14.11.68	18	15.12.68	132
D_6- 21.8.68	15.9.68	12.11.68	1.12.68	20	31.12.68	133

Table- 12. Number of shoots as affected by gall midge under different treatments.

Treatments.		'F' test.	S.Em ±	C.D.at 5%
Dates of planting.				
D_1	4.6			
D_2	4.5			
D_3	3.7	Not Sig	0.65	
D_4	3.6			
D_5	4.1			
D_6	2.1			
Spacing.				
S_1	3.5			
S_2	4.0	Not Sig	-	
Levels of fertilization.				
L_1	3.7			
L_2	3.3	Sig.	0.27	0.76
L_3	2.7			
L_4	4.4			

Significantly highest attack was observed with highest level of fertilization i.e. L_4.

The interactions were not significant but planting in 30th June with L_4 showed the highest number of affected shoots followed by July 15th planting with L_3.

POST HARVEST STUDIES

4.2.1. Root study:-

Data recorded on length of root and weight of root were statistically analysed and presented in table 13 and 14 respectively.

4.2.1(a). Length of root :-

No significant variation could be observed in length of root due to dates of planting, and levels of fertilization or their interactions. Spacing could only influenced the length significantly. Wider spacing of 20 x 10 cm could produced longer roots than closer spacing 15 x 10 cm.

Table- 13. Length of root (in cm) as affected by different treatments.

Treatments.	Length.	'F' test.	S.Em ±	C.D. at 5%
Dates of planting.				
D_1	15.6			
D_2	15.5			
D_3	16.4			
D_4	13.3	Not Sig	0.47	-
D_5	14.4			
D_6	14.5			
Spacing.				
S_1	14.4	Sig.*	0.12	0.35
S_2	15.5			
Levels of fertilization.				
L_1	14.8			
L_2	15.1	Not Sig	0.24	-
L_3	15.3			
L_4	14.7			

Table- 14. Weight of root (in gms) as affected by different treatments.

Treatments.	Weight	'F' test.	S.Em ±	C.D. at 5%
Dates of planting.				
D_1	30.3			
D_2	27.5			
D_3	27.3	Sig.*	2.06	2.47
D_4	23.0			
D_5	17.5			
D_6	17.5			
Spacing.				
S_1	22.2	Not Sig.	0.67	-
S_2	25.5			
Levels of fertilization.				
L_1	23.3			
L_2	22.9	Not Sig.	0.74	-
L_3	24.0			
L_4	25.2			

4.2.1(b) Weight of root:

A significant variation in root weight was observed with dates of planting. 30th June planting produced, highest root weight. The root weight decreased significantly with the delayed planting. D_2, D_3 and D_4

were at par with each other, so also D_5 and D_6.

Spacing and levels of fertilization or interactions were not found to have any significant effect on root weight.

4.2.2. Earhead study:

Data recorded on panicle length, number of fertile and sterile grains per panicle, sterility percentage and 1,000 grain weight were statistically analysed and presented in table- 15. and illustrated in fig. 6 and 7 respectively.

4.2.2.(a). Panicle length.

Panicle length decreased with delayed planting. Planting in 30th June and 15th July were at par with each other and significantly superior to other plantings. Whereas, 30th August, 15th September were at par with each other and were significantly inferior to other dates.

Significant difference in panicle length was observed due to spacing. Wider spacing (20 x 10 cm) produced longer panicle than the closer.

Fertilizer levels could not influence any variation in length of panicle.

Interactions of the above factors were not significant.

4.2.2(b) Number of grains per panicle.

(i) Fertile grains:

Planting in July 15th produced the maximum number of fertile grains per panicle and was at par with that of June 30th. The number of fertile grains decreased significantly with further delay in planting. D_4, D_5 and D_6 were at par with each other in producing the fertile grains per panicle.

No significant change in number of fertile grains was observed due to spacing. But wider spacing showed an increase in fertile grains over closer spacing.

Levels of fertilization could not influence the number of fertile grains per panicle significantly but an increase in fertility of grains was observed due to increase in fertilizer effects.

There was no significant effects of interactions over number of fertile grains per panicle.

(ii) Sterile grains and percentage of sterility:

June 30th planting gave significantly less number of sterile grains per panicle than (D_2) 15th July, (D_3) 30th July and (D_4) 15th August and was at par with(D_5) 30th August and (D_6) 15th September. D_2,D_3 and D_4 were at par with each other.

Highest percentage of sterile grains (32.0) were obtained with August 15th planting. No significant difference in sterility percentage was seen due to different dates of planting. Both the number of sterile grains per panicle and the percentage of sterile grains were not affected by spacing, fertilizer levels or their interactions.

4.2.2(c) 1,000 grain weight:

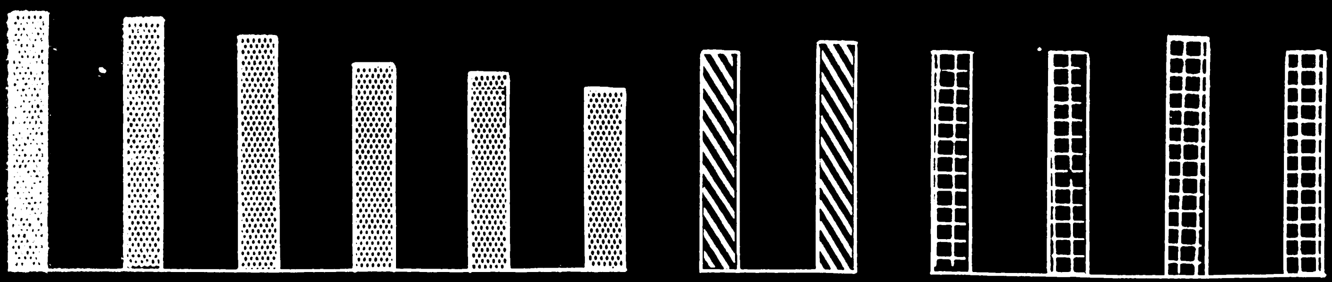
Planting in 30th June produced grains with

Table- 15. Effect of different treatments on earhead charters.

Treatments.	Length of panicle (in cm)	Number of grains/panicle			1,000 grain weight. (in gm)
		Fertile	Sterile	Sterility%	
Dates of planting.					
D_1	21.9	84.9	26.0	15.2 (22.9)	30.48
D_2	21.6	86.3	15.7	22.7 (28.4)	28.03
D_3	20.6	67.9	20.6	23.4 (28.9)	28.50
D_4	18.7	47.3	22.7	32.0 (34.4)	25.10
D_5	18.1	55.7	11.9	17.2 (24.5)	25.99
D_6	17.1	50.8	15.6	23.3 (23.8)	25.21
'F' test.	Sig.*	Sig.*	Sig.*	Not Sig.	Sig.*
S.Em ±	0.30	4.06	1.76	0.11 (1.9)	0.63
C.D. (0.05)	1.08	14.73	6.38	-	2.28
Spacing.					
S_1	19.6	64.8	18.3	22.0 (27.9)	27.22
S_2	20.0	66.2	19.1	22.1 (28.0)	27.55
'F' test.	Sig.*	Not Sig	Not Sig	Not Sig	Not Sig
S.Em ±	0.014	1.25	0.76	0.02 (0.70)	0.044
Levels of fertilization.					
L_1	19.6	62.7	19.0	23.3 (28.8)	26.95
L_2	19.6	66.1	17.6	20.8 (27.1)	27.49
L_3	20.3	67.3	17.5	20.2 (26.7)	27.76
L_4	19.7	65.8	20.9	24.2 (29.4)	27.35
'F' test.	Not Sig	Not Sig	Not Sig	Not Sig	Not Sig
S.Em ±	0.47	2.24	1.17	0.98	0.27

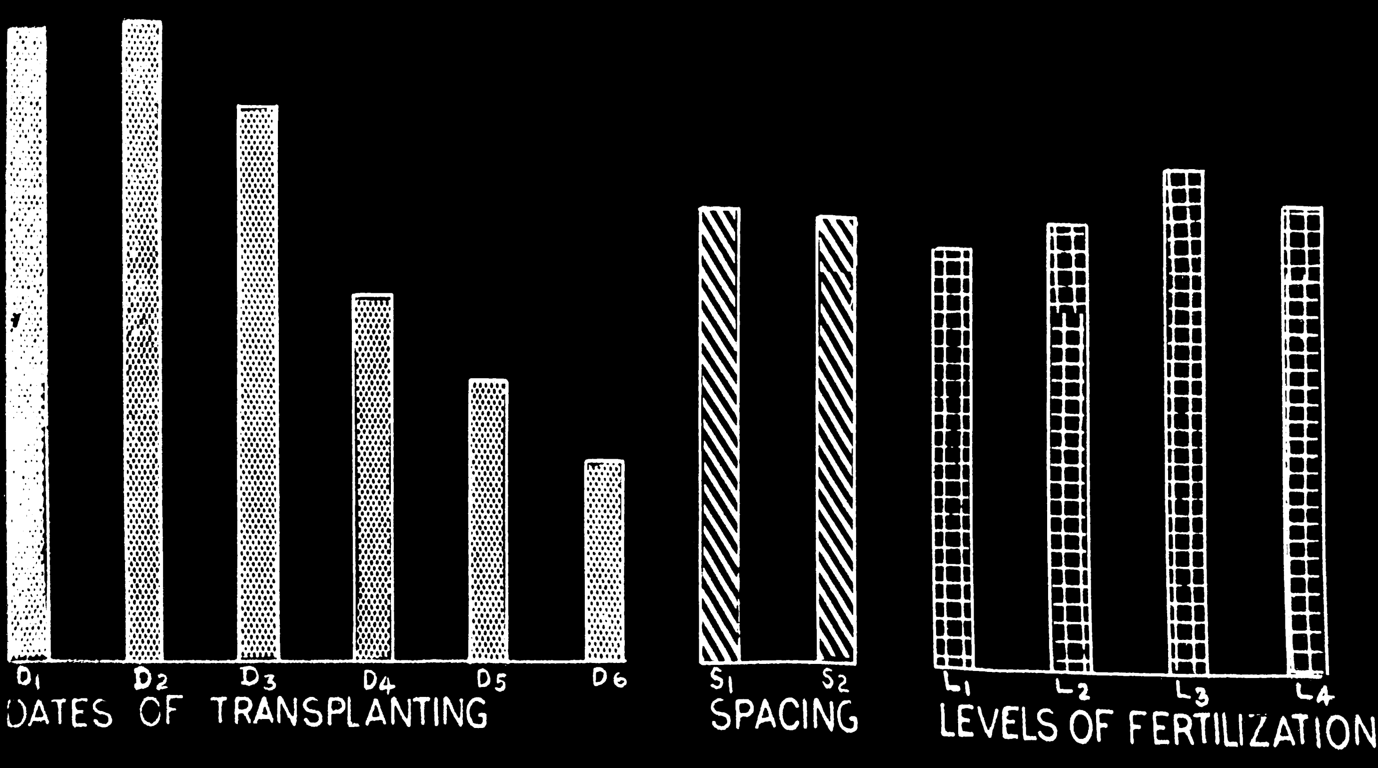
N.B. Figures within bracket indicate the corresponding angular values.

'IG.6 LENGTH OF PANICLE



7 NUMBER OF FERTILE & STERILE GRAINS PER PANICLE

G. 8 STRAW YIELD



highest 1,000 grain weight of 30.48 gms. 15th July and 30th July plantings were at par with each other and were significantly inferior to 30th June. Late plantings of 15th August, 30th August and 15th September were at par with each other and the 1,000 grain weight was only about 25 gms.

The spacings, the levels of fertilization and the interactions had no significant effect on 1,000 grain weight.

4.2.3. Yield of grain and straw in kg. per hectare.

Data on yield of grain and straw were recorded and statistically analysed, presented in table 16,17(a), 17(b), 17(c) and 17(d) and illustrated in fig.9 and 8 respectively.

4.2.3(a) Grain yield:

Yield decreased linearly as the planting dates were delayed from June 30th to September 15th. Planting in 30th June gave the highest yield of 3849 kg, where as, September 15th planting gave the lowest yield of 1162 kg per hectare which was only 30.2 of the former. June 30 th was at par with July 15th and 30th plantings, where as, August 15th, 30th and September 15th plantings were at par with each other. The former three plantings were significantly superior to the later three. The reduction in yield between two consecutive planting dates of 30th June to 15th July were negligible (2.7%) but between 15th July and 30th July it was 24.6%.

The difference was highest (33.7%) between July 30th and August 15th planting. After August 15th the difference decreased and was 21.8% between August 15th and August 30th, 20.9% between August 30th and September 15 plantings.

No significant difference in yield could be observed due to the spacings, but however, closer spacing (15 x 10 cm) gave 2% extra yield over wider spacing (20 x 10 cm).

The yield of grain increased due to fertilizer application over L_1. Significantly highest increase of 359 kg/ha was obtained with L_3 i.e. 15.5% above L_1. With the still higher fertilizer application of (L_4) 200 kg N, 100 kg P_2O_5 and 100 K_2O/ha the yield decreased by 182 kg/ha from that of L_3.

None of the interactions were significant. But however, planting in 30th June with fertilizer application of 150 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha (L_3) gave the highest yield. L_3 with spacing 15 x 10 cm (S_1) proved to be the best.

Considering the interaction of dates x spacings x levels, D_2 S_1 L_3 gave the highest yield of 4250 Kg/ha followed by D_1 S_2 L_4 and D_1 S_1 L_3 which gave yields of 4249 kg and 4181 kg respectively.

Table-16. Yield of grain and straw in Kg/ha under different treatments.

Treatments	Grain	Percentage	Straw	Percentage
Dates of transplanting.				
D_1	3849	100	4630	100
D_2	3747	97.3	4732	101.5
D_3	2828	73.4	4133	88.6
D_4	1877	48.7	2881	61.8
D_5	1469	38.2	2372	50.9
D_6	1162	30.2	1806	38.7
'F' test.	Sig.*		Sig.*	
S.Em. ±	307		308	
C.D. at 5%	1114		1118	
Spacing.				
S_1	2512	100	3489	100
S_2	2465	98.1	3373	96.6
'F' test.	Not Sig.		Not Sig.	
S.Em. ±	97		134	
Levels of fertilization.				
L_1	2310	100	3202	100
L_2	2489	107.7	3358	104.8
L_3	2669	115.5	3727	116.3
L_4	2487	107.6	3436	107.3
'F' test.	Sig.*		Sig.*	
S.Em. ±	74		99	
C.D(0.05)	213		282	

Table- 17 Effect of different interactions on grain yield.

17(a) Dates of planting x spacing.

Treatments.	D_1	D_2	D_3	D_4	D_5	D_6	Mean
S_1	3840	3782	2777	1957	1610	1108	2512
S_2	3859	3713	2878	1797	1327	1216	2465
Mean	3849	3747	2827	1877	1468	1162	

S.Em ± for
(i) Dates at same spacing = 640
(ii) Spacings at same date = 307

17(b) Dates of planting x levels of fertilization.

Treatments.	D_1	D_2	D_3	D_4	D_5	D_6	Mean.
L_1	3772	3415	2761	1444	1302	1165	2309
L_2	3726	3855	2899	1817	1546	1049	2489
L_3	4088	3969	2890	2234	1503	1329	2668
L_4	3812	3750	2761	2014	1524	1060	2487
Mean	3849	3747	2827	1877	1468	1162	

S.Em ± for
(i) Levels at same date = 182
(ii) Dates at same level = 270

17(c) Spacings x levels of fertilization.

Treatments.	L_1	L_2	L_3	L_4	Mean.
S_1	2317	2602	2706	2425	2512
S_2	2303	2377	2632	2549	2465
Mean	2310	2489	2669	2487	

S.Em ± for
(i) Levels at same spacing = 106
(ii) Spacings at same level = 105

17(d) **Dates of planting x spacing x levels of fertilization.**

Treatments.	L_1	L_2	L_3	L_4	Mean.
D_1S_1	3950	3857	4181	3372	3840
D_1S_2	3595	3595	3995	4249	3859
D_2S_1	3187	3926	4250	3765	3782
D_2S_2	3642	3783	3689	3736	8713
D_3S_1	2702	3049	2725	2633	2777
D_3S_2	2820	2749	3065	2890	·878
D_4S_1	1455	1778	2517	2078	1957
D_4S_2	1433	1856	1950	1950	1797
D_5S_1	1501	1347	1432	1663	1610
D_5S_2	1104	1245	1574	1386	1327
D_6S_1	1108	1154	1131	1039	1108
D_6S_2	1222	1034	1527	1081	1216
Mean	2310	2489	2668	2487	

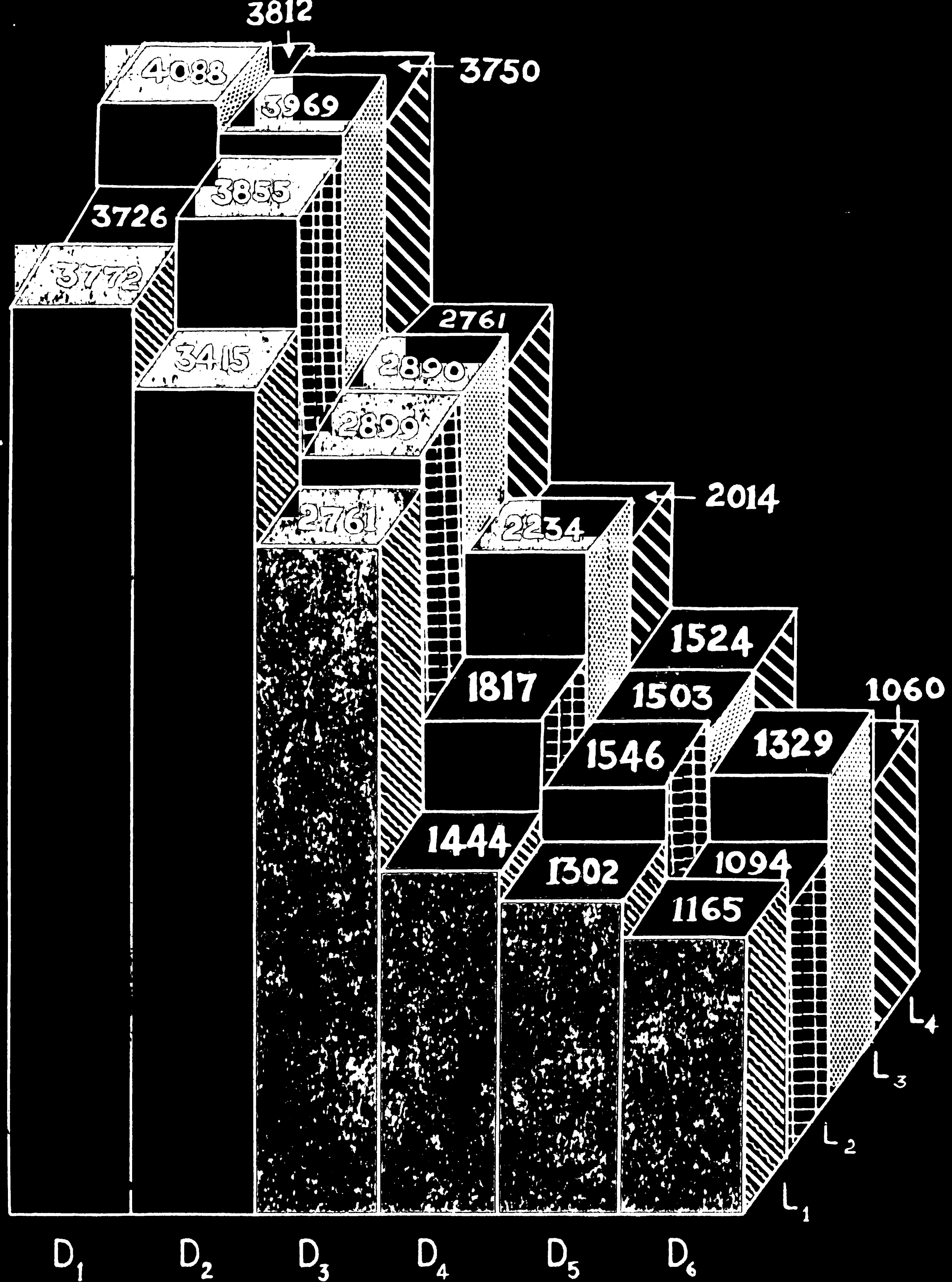
S.Em $\pm$ for

(i) Levels at same D x S = 262

(ii) Dates at same S x L = 391

(iii) Spacing at same D x L = 270

FIG 9. EFFECT OF DATES OF PLANTING & FERTILIZER LEVELS ON GRAIN YIELD (IN Kg/ha)



4.2.3(b) Straw yield.

Highest yield of 4732 kg/ha was obtained with 15th July planting. Straw yields of 30th June, 15th July and 30th July were at par with each other. Similar relations existed between August 15th, August 30th and September 15th plantings. First three plantings were significantly superior to other three. 15th September planting gave the lowest yield of 1806 kg/ha which was only 38.7 % of 30th June.

Spacing 15 x 10 cm(S_1) gave 116 kg/ha of extra straw over S_2 and the difference was not statistically significant.

The straw yield increased with the increase in fertility levels from L_1 to L_3. L_3 produced significantly highest yield over L_1,L_2 and L_4. L_1 and L_2 were at par with each other.

Interactions were not significant. But however, D_1S_2, D_2L_3,S_1L_3 and D_2 S_1 L_3 showed the highest production of straw i.e. 4788kg, 5005 kg, 3792 kg and 5428 kg per hectare respectively.

4.2.3(c) Straw: grain ratio.

Data on straw/grain ratio were statistically analysed and presented in table -18.

Neither the main treatments nor their interactions could influence the straw: grain ratio significantly.

The ratio increased linearly with the planting dates from D_1 to D_6, only at D_6 a slight decrease was observed.

Table- 18. Effect of different treatments on straw: grain ratio.

Treatments.	Ratio	'F' test.	S.Em ±	C.D.at 5%
Dates of planting.				
D_1	1.23			
D_2	1.28	Not Sig.	0.07	-
D_3	1.46			
D_4	1.58			
D_5	1.62			
D_6	1.59			
Spacing.				
S_1	1.45			
S_2	1.47	Not Sig.	0.044	-
Levels of fertilization.				
L_1	1.49			
L_2	1.42	Not Sig	0.064	-
L_3	1.47			
L_4	1.46			

S_1 showed narrower ratio than S_2 which signifies greater production of grain in the former.

Practically, no difference could be observed due to the levels of fertility. L_1 produced comparatively higher ratio than L_2. L_3 and L_4 were almost equal and showed wider ratio than L_2.

4.3. Correlation study:

Correlation is the relation of one character to the other and the degree of association is expressed as the co-efficient of correlation(r).

Temperature and light hours are the two important environmental factors. Temperature is one of the limiting factors in rice cultivation. It greatly influence not only the duration of growth but also the growth pattern of the rice plant. During the growing season the temperature summation (sum of daily mean temperatures) and summation of sunshine hours or combination of these might have considerable effect on grain yield and other yield attributing characters. Keeping these in view, temperature summation and summation of sunshine hours, prevailed during the life period of the crop with respect to different planting dates were recorded and presented in table 3.

The grain yields from different plantings, the mean height, number of effective tillers, and the mean leaf area have been correlated with summation of temperature and the results are presented in table- 19.

Table- 19. Correlation co-efficients of temperature with grain yield, yield attribute and other plant characters.

Sl.No.	Factors correlated with temperature.	Co-efficient of correlation Observed value 'r'	Table value at 5%
1.	Grain yield	(+) 0.35	0.70
2.	Planting height	(+) 0.93	"
3.	Number of effective tillers.	(+) 0.23	"
4.	Mean leaf area.	(+) 0.93	"

Temperature showed significant positive correlation with yield of grain, height, and leaf area. Its relation with number of effective tillers was positive, though not statistically significant. Highest grain yield, length in height, number of effective tillers and leaf area was obtained with temperature summation of 3848 C combined with 661 hours of sunshine.

4.4. ECONOMICS

Calculations of the expenditure, gross income, net profit per hectare and the profit or loss per rupee invested were made with respect to four levels of fertilization under six dates of planting. The data presented in table 20 revealed that the highest net profit of rupees 1434 per hectare and 1.23 rupees per rupee invested was obtained by planting in 30th June followed by 15th July which gave a net profit of rupees 1372 and 1.17 per rupee invested. The difference in profit between 30th June and 15th July was negligible but with 30th July planting the net profit was reduced remarkably almost half of that obtained by the above plantings. Planting in 15th August gave a net profit of rupees 119 and 0.10 per rupee invested which was quite negligible. Planting beyond 15th August i.e. in 30th August and 15th September incurred a loss of rupees 160 and 396 respectively.

By the application of higher fertilizer levels beyond L_1 (80 Kg N, 40 Kg P_2O_5 and 40 kg K_2O/ha) the average net profit decreased linearly and the lowest of rupees 256 per hectare was obtained with L_4(200-100-100).

Though, the highest gross income of rupees 2783 was obtained with 30th June planting under L_3 (160-80-30), yet, the highest net profit (rupees 1647) and profit per rupeeinvested (1.73) was obtained with 30th June planting under L_1 (80-40-40) L_1. The net profit (Rs. 1510.00) obtained due to planting in 15th July with L_2 was next in order. 15th August planting with higher level of fertilization i.e. L_3 gave the highest net profit of rupees 283 per hectare in comparision to other level under the same date. A loss of rupees 48 per hectare was obtained when there was shifting from L_3 to L_4. 30th August and 15th September with all levels of fertilization incurred losses.

4.5. <u>Soil fertility Study:</u>

The soil samples collected after each harvest

Table -20 Economics of dates of planting and levels of fertilization (in rupees per hectare)

…tes of planting	L_1				L_2				L_3				L_4				Mean	
	Total expenditure	Gross income	Nett profit or loss	Profit or loss/ rupee invested	Total expenditure	Gross income	Nett profit or loss	Profit or loss rupee invested	Total expenditure	Gross income	Nett profit or loss	Profit or loss per rupee invested	Total expenditure	Gross income	Net profit or loss	Profit or loss per rupee invested	Net profit or loss	Profit per rupee invested
(30th June)	947	2594	1647	1.75	1121	2566	1445	1.28	1295	2765	1940	1.15	1466	2621	1155	0.78	1454	1.23
(15th July)	947	2375	1428	1.50	1121	2651	1510	1.34	1205	2752	1459	1.11	1466	2580	1114	0.75	1572	1.17
(30th July)	947	1926	970	1.03	1121	2057	916	0.81	1295	2048	755	0.58	1466	1963	497	0.31	779	0.66
(15th Aug)	947	1046	99	0.10	1121	1265	144	0.12	1205	1576	283	0.21	1466	1418	(-)48	(-)0.03	119	0.10
(30th Aug)	947	919	(-)28	(-)0.02	1121	1102	(-)0.19	(-)0.01	1295	1089	(-)204	(-)0.15	1466	1077	(-)389	(-)0.026	(-)180	(-)0.11
(15th Sept)	947	821	(-)126	(-)0.13	1121	770	(-)351	(-)0.31	1205	944	(-)549	(-)0.27	1466	758	(-)758	(-)0.51	(-)396	(-)0.30
			666.00	0.70			607.00	0.53			589.00	0.43			258.00	0.17		

were analysed for pH, organic carbon, total nitrogen, available P_2O_5 and available K_2O and the data are presented in table 21,22,23,24 and 25 respectively.

(i) pH:

Variation in pH of soil was observed both due to variation in dates of planting and fertility levels. The pH decreased with the delayed plantings.

Higher levels of fertility showed reduction in pH. Lowest pH of 4.4 was observed with L_4, while L_1 showed the highest of pH 5.0.

(ii) Organic carbon percentage:

Earlier planting in the month of June and July showed higher percentage of carbon while it decreased gradually with the delayed plantings. The increases were above the initial status (0.66%), while decreases were below it.

No marked change in % of carbon was observed due to the higher levels of fertilization.

No variation was observed in carbon content due to spacing.

(iii) Total nitrogen.

Earlier plantings (June 30th, July 15th and July 30th) showed low percentage of residual nitrogen in soil while the later dates showed a comparatively higher percentage.

The percentage of residual nitrogen increased with the higher levels of fertilization, while, at L_1 the nitrogen status remained at the same level as initial (0.053).

No difference in nitrogen levels was seen between the spacings.

(iv). Available phosphorus:

No consistent change in available phosphate content of soil was noticed due to the dates of planting. But a depression in phosphate level than the initial was observed with respect to all the dates.

At L_1, the residual phosphate content of soil was 7.7 kg/ha against the initial status of 11.6 kg/ha. A gradual increase was noticed due to the higher levels of fertilization. At L_2 available phosphate was below the initial, while, at L_3 it was near about and at L_4 an increase was seen above the initial.

Closer spacing showed comparatively lower residual phosphate level than the wider.

(v). Available potash.

No consistent variation in available K_2O status of soil was noticed due to different dates of planting.

Remarkable decrease in K_2O content of soil below the initial status of 55.6 kg/ha was observed with L_1 and L_2. At L_3 the K_2O content was in the same level as the initial and ait increased considerably at L_4.

Closer spacing decreased the K_2O level in soil.

-ooOoo-

Table -21 pH status of the soil after harvest of the crop
(Initial soil pH 5.4)

Treatments	L_1			L_2			L_3			L_4			Mean		
	S_1	S_2	Mean	S_1	S_2	Mean.	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
D_1	5.2	5.5	5.3	5.4	5.3	5.3	4.9	5.2	5.0	4.9	4.9	4.9	5.1	5.2	5.1
D_2	5.2	5.6	5.4	5.2	4.9	4.9	5.7	4.8	5.2	4.3	4.2	4.5	5.2	4.8	5.0
D_3	4.7	4.9	4.8	4.7	4.7	4.7	4.4	4.6	4.4	4.6	4.4	4.5	4.6	4.6	4.6
D_4	4.9	5.0	4.9	4.7	4.9	4.8	4.8	4.7	4.7	4.5	4.6	4.5	4.7	4.8	4.7
D_5	4.8	5.0	4.9	4.5	4.7	4.6	4.1	4.5	4.3	4.2	4.4	4.3	4.4	4.6	4.5
D_6	4.8	5.0	4.9	4.4	4.3	4.3	4.3	4.4	4.3	4.5	4.2	4.3	4.5	4.4	4.4
Mean S_1	4.9			4.8			4.7			4.6			4.7		
Mean S_2		5.1			4.7			4.6			4.4			4.7	
Mean			5.0			4.7			4.6			4.5			4.7

Table- 22. Organic carbon status of soil after harvest of the crop. (Initial organic carbon content was 0.66%)

Treatments.	L_1			L_2			L_3			L_4			Mean		Mean
	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	
D_1	0.68	0.75	0.71	0.75	0.74	0.74	0.86	0.82	0.84	0.77	0.83	0.80	0.76	0.78	0.77
D_2	0.69	0.58	0.63	0.76	0.67	0.71	0.79	0.75	0.77	0.77	0.76	0.76	0.75	0.69	0.72
D_3	0.65	0.69	0.67	0.66	0.73	0.69	0.79	0.86	0.82	0.72	0.90	0.81	0.70	0.79	0.74
D_4	0.62	0.61	0.61	0.63	0.59	0.61	0.65	0.65	0.65	0.66	0.67	0.66	0.64	0.63	0.63
D_5	0.61	0.52	0.56	0.63	0.53	0.56	0.65	0.61	0.63	0.67	0.67	0.67	0.64	0.58	0.61
D_6	0.58	0.49	0.53	0.58	0.50	0.54	0.60	0.63	0.61	0.65	0.65	0.65	0.60	0.56	0.58
Mean S_1	0.63			0.66			0.72			0.70			0.67		
Mean S_2		0.60			0.62			0.72			0.74			0.67	
Mean			0.61			0.64			0.72			0.72		0.67	

Table -23. Total nitrogen status of soil after harvest of the crop (Initial total nitrogen content 0.053%)

Treatments	L_1			L_2			L_3			L_4			Mean.		Mean
	S_1	S_2	Mean	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	
D_1	0.049	0.047	0.048	0.052	0.048	0.050	0.055	0.055	0.055	0.058	0.062	0.060	0.053	0.053	0.053
D_2	0.049	0.048	0.048	0.062	0.072	0.067	0.048	0.063	0.055	0.063	0.068	0.065	0.055	0.062	0.058
D_3	0.051	0.047	0.049	0.062	0.053	0.057	0.063	0.059	0.061	0.065	0.061	0.063	0.060	0.055	0.057
D_4	0.058	0.059	0.058	0.063	0.062	0.062	0.065	0.067	0.066	0.066	0.068	0.067	0.063	0.064	0.063
D_5	0.050	0.052	0.051	0.062	0.063	0.062	0.071	0.071	0.071	0.077	0.079	0.078	0.065	0.066	0.065
D_6	0.055	0.052	0.053	0.072	0.059	0.065	0.080	0.072	0.076	0.078	0.071	0.074	0.066	0.063	0.064
Mean S_1	0.052			0.062			0.063			0.067			0.061		
Mean S_2		0.050			0.059			0.064			0.068			0.060	
Mean			0.051			0.060			0.063			0.067			0.060

Table-24. Available phosphorus status of soil after harvest of the crop(Initial phosphorus content 11.6 kg/ha)

Treatments.	L_1			L_2			L_3			L_4			Mean.		Mean
	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	
D_1	4.4	9.6	7.0	5.2	8.0	6.6	6.0	12.0	9.0	12.8	15.2	14.0	7.1	11.2	9.1
D_2	6.8	9.4	8.1	7.6	16.8	12.2	12.8	17.6	15.2	12.8	16.8	14.8	10.0	15.1	12.5
D_3	5.4	6.4	5.9	8.2	5.2	6.6	11.2	7.6	9.4	14.5	8.4	11.4	9.8	6.9	8.3
D_4	7.2	8.2	7.7	8.5	10.5	9.5	9.6	12.3	10.9	13.2	13.2	13.2	9.6	11.0	10.3
D_5	9.5	10.5	10.0	10.2	11.0	10.6	11.1	12.5	11.8	15.3	14.2	14.7	11.5	12.0	11.7
D_6	7.0	8.5	7.7	10.0	9.6	9.8	13.2	12.6	12.9	16.5	14.8	15.6	11.6	11.3	11.4
Mean S_1	6.7			8.2			10.6			14.1			9.9		
Mean S_2		8.7			10.1			12.4			13.7			11.2	
Mean			7.7			9.1			11.5			13.9			10.5

Table- 25. Available potash status of the soil after harvest of the crop (Initial potash content- 55.6 kg/ha)

Treatments.	L_1			L_2			L_3			L_4			Mean.		Mean
	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	Mean.	S_1	S_2	
D_1	24.1	34.1	29.1	24.2	36.3	30.2	39.2	33.3	36.2	55.8	48.3	52.0	35.8	38.0	36.9
D_2	41.6	34.5	38.0	33.2	39.6	36.4	58.2	50.8	54.5	75.2	48.1	61.6	52.0	43.2	47.6
D_3	29.1	58.2	43.6	38.3	74.8	56.5	60.4	83.2	71.8	54.0	91.8	72.9	45.4	77.0	61.2
D_4	45.3	49.1	47.2	50.4	55.0	52.7	48.4	60.5	54.4	60.2	62.1	60.1	51.0	56.6	53.8
D_5	50.3	59.3	54.8	52.4	60.5	56.4	58.3	62.7	60.5	60.1	65.0	62.5	55.2	61.8	58.5
D_6	48.5	47.2	47.8	50.2	50.5	50.3	53.1	55.4	54.2	60.0	59.3	59.6	52.9	52.4	52.6
Mean S_1	39.8			41.4			52.9			60.8			48.7		
Mean S_2		47.0			52.7			57.6			62.4			54.9	
Mean			43.4			47.0			55.2			61.6			51.8

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CHAPTER - V

DISCUSSION.

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DISCUSSION

In the preceding Chapter, growth, yield responses of I.R-8 and change in fertility status of soil with respect to different dates of planting, spacings and under varying levels of fertility, have been presented. In this chapter, an attempt has been made to establish cause and effect relationship existing with the results obtained and to assign plausible reasons for the variations recorded.

Dates of planting :-

A variety has its own range of planting period and within that critical period it shows full manifestation of its yield abilities (Pillai,1958). 30th June planting gave highest grain yield of 3849 kg/ha and was at par with July 15th and 30th plantings. 15th July and 30th July produced respectively 2.7 and 24.6 percent lower yield than 30th June. This corroborates the findings of Vasisth (1961) and Sing and Sing (1962), who obtained greater yields from June planted crop than that of July. Planting from 30th June to 15th July seemed to be optimum without much variation in yield. This is in confirmity with the previous findings in Orissa condition by Mallik and Behera (1965) and Sahu and Lenka (1966). They reported that middle of July is the optimum time of planting rice in Orissa. The yield decreased significantly by 15th August planting, which gave only 48.7% of that obtained by 30th June. progressive significant decreases were observed as the planting dates were delayed. 15th September gave the lowest grain yield of 1162 kg/ha which was less than one-third (30.2%) of the yield obtained in 30th June planting. This agrees with the observations made by Basak and Klemme (1959). They reported progressive decrease in grain yield in a trial with five dates from mid-July to mid-September and the average grain yield from mid-September planting was only one-third of that from mid-July planting.

A cursory analysis of the number effective tillers per clump, which is one of the most important yield attributes, would show that 15th July planting produced significantly highest number of effective tillers per clump(6.6). Tiller numbers were higher by the June and July plantings, progressively decreased with successive planting. Sahu and Lenka(1966) had similar findings. They reported that early July planting induced more number of ear-bearing tillers.

Other yield attributes such as length of panicle number of fertile grains per panicle and 1,000 grain weight were also maximum with 30th June, progressively reduced with the advancement of dates of planting and were minimum with 15th September planting.

30th June and July plantings were at par, with respect to the above characters. In an experiment with two planting dates in July, Relwani(1963) reported that 15th July planting produced greater length of panicle and 20th July favoured the formation of greater number of fertile spikelets and more weight of grain per panicle.

The differences in yield and its attributes so observed may be ascribed to the differential manifestation in growth habit of the crop during different planting time, i.e. under varied conditions of temperature and light hours. The summation of temperature and light hours in 30th June planting were 3306 °C and 361 hours of sunshine respectively. The temperature summation decreased with the advancement of planting date and decrease in day length. This may be ascribed to the decrease in yield and its attributes. Ara Kawa (1957) also had similar opinion that low rice yields are the resultant of low temperature. It is therefore, necessary that in order to obtain highest yield planting date should be as near the longest day as possible for kharif (craufurd, 1964).

The plant height, number and area of leaves which contribute to the production of straw and the straw yield were maximum with 30th June planting. They remained at fairly higher levels with plantings in 15th July and 30th July and progressively decreased there after, till attained minimum level with 15th September planting. By early plantings, due to the development of taller plants and more leaves the straw: grain ratio also remained at higher level (Adair 1940).

Spacing:-

Spacing is the most important agronomic practice influencing the yield in rice (Ramiah, 1937). But in the present investigation, both the spacings (15 x 10 cm and 20 x 10 cm) could not influence significant change with respect to yield of grain, straw, vegetative characters and other yield attributes. However, closer spacing (15 x 10 cm) gave respectively 2% and 3.4% extra grain and straw yield over wider (20 x 10 cm). This confirms the observations made by Vachhani *et al.* (1961) Sing and Sing (1962).

Fertilizer levels :-

The grain yield increased significantly with successive increase in levels of fertilization up to L_3 (160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha). L_3 produced the maximum yield of 2669 kg grain per hectare. Though yield attributing characters were not significantly influenced, yet, increases were observed with respect to effective tillers, length of panicle, number of fertile grains per panicle, 1,000 grain weight and decrease in percentage of grain sterility up to L_3. L_4 (200-100-100) gave significantly lower yield than L_3 and was just the same as L_2(120-60-60). There was increase in grain sterility and decrease in other yield attributes. This shows that an application of 160 kg N, 80 kg P_2O_5 and 80 kg K_2O per hectare seems to be the best combination for getting a higher yield with IR-8. Similar observations were made by Padhi and Mishra (1968). They reported that Taichung Native-1, produced highest yield with 160 kg N/ha under Bhubaneswar condition. From Paddy breeding station Coimbatore, Srinivasan _et al._ (1968) have also reported that a fertilizer schedule of 160 kg N/ha, over a basal dressing of 50 kg P_2O_5 and 50 kg K_2O/ha can be recommended for IR-8, T.N.-I, and Tainan-3 for soils of average fertility.

A corresponding highest straw yield of 3727 kg/ha was observed with L_3 (160-80-80) as in case of grain. With further increase in level up to L_4(200-100-100), the straw yield decreased significantly. Similar observations were made by Lenka (1967), who, obtained increase straw yield of dwarf _indica_ and polnai varieties with increased levels of nitrogen up to 120 kg N/ha. Increase in straw yield with the higher levels of fertilization may be attributed to the increase in vegetative characters such as height of plants, total number of tillers per clump and the leaf area. The high amount of nitrogen in the lovel induced vegetative growth and excess application resulted in luxuriance which was reflected in increased yield of straw (Yamade, 1953, Digar,1958 and Ghose, 1963).

Interactions.

Yields with S_1 (15 x 10 cm) and S_2(20 x 10 cm) were identical under 30th June planting, but with the advancement of planting time, closer spacing of 15 x 10 cm gave higher yield over wider. This confirms the earlier reports of Sing and Sing (1962), who, observed that in early planting of June 15th, spacings such as 6"x6", 9"x9" and 12"x12" gave identical yields and with the advancement of transplanting closer spacing became more beneficial and essential. Ramiah (1937) also opined that if planting is delayed unavoidably the only way of counteracting the evil effects of later season is to plant the seedlings closer.

At a particular level of fertilization, under D_1 and D_2 the yields were identical and no significant differences could also be observed between the levels in earlier plantings. The yield decreased gradually with the advancement of planting date. L_1 (80-40-40) was two the three times efficient with earlier plantings of June and July, than the higher levels in late plantings of August and September. A higher dose of 160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha (L_3) gave about 14% higher yield over 80 kg N, 40 kg P_2O_5 and 40 kg K_2O/ha (L_1) with late planting of September 15th. This is in confirmity with the observations made by Sahu and Lenka(1966), who opined that heavy manuring of late planted crop is necessary to obtain a good yield. Sing and Sing (1962) also reported that with the advancement of planting season the effects of nitrogen on rice yield increased progressively.

An application of 160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha with closer spacing of 15 x 10 cm produced 2706 kg of grain per hectare. Though no significant differences could be observed with the interactions, yet, closer spacing (S_1) with lower levels of L_1 and L_2 gave identical yields with wider spacing (S_2) under higher levels of L_2 and L_3 respectively. This agrees with the recommendation of Matsue (1950), who, recommended closer spacing in Japan during the war years to meet the fertiliser shortage. An application of 200 kg N, 100 kg P_2O_5 abd 100 kg K_2O/ha with closer spacing (15 x 10 cm) badly affected the yield and higher yield was obtained with wider spacing (20 x 10 cm), This observation is in line with that of Sing and Sing(1962). They found that in case of heavy manuring closer spacing proved to be the wrost. The decrease in yield with the heavy fertilization may be due to heavy vegetative growth i.e. highest increase in height and leaf area which had the shading effect, affecting photosynthetic activities, there by decreasing the length of panicle, number of fertile grains, and increasing the percentage of sterility in grains.

Planting in 15th July with a spacing of 15 x 10 cm and an application of 160 kg N, 80 Kg P_2O_5 and 80 kg K_2O/ha gave the maximum grain yield of 4250 kg/ha, which seems to be the best combination for getting the highest yield with IR-8. This was followed by $D_1S_2L_4$ and $D_1S_1L_3$. This observation confirms the earlier findings made by (Anonymous, 1964), which revealed that when the crop was planted early or at the normal time closer or medium spacing gave the best response to nitrogen and phosphorus.

Economics.

Early planting of June 30th gave the highest net profit of 1434 rupees per hectare, which was gradually reduced with the advancement of planting and was limited by the planting in 15th August, which seemed to be the critical period of transplanting IR-8. Further plantings incurred loss with geometrical progression. The difference between June and July planting was negligible and June planting gave only tweenty three paise higher net profit per rupee invested. This shows that though higher yields were obtained with June planting, yet, the optimum time for planting IR-8 lies between 30th June to 15th July. This corroborates the earlier findings of Mallik and Behera (1965) and Sahu and Lenka (1966), under Orissa Condition.

Highest net profit (Rs 666.00) and profit (Rs.70) per rupee invested with an application of lowest level i.e. 80 kg N, 40 kg P_2O_5 and 40 kg K_2O/ ha and the profits decreased with the increasing levels, which show as economics is concerned, the appropriate dose for IR-8 is 80 kg N, 40 kg P_2O_5 and 40 kg K_2O/ ha to get the maximum economic return. This agrees with the previous recommendation of Mahapatra (1969). He recommended 80- 100 kg N/ha during the Kharif season for high yielding varieties of rice.

Though planting in 30th June with an application of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O/ha gave the highest net profit (Rs 1647.00) and profit (Rs 1.73) per rupee invested yet, planting within 30th June to 30th July, gave more or less similar profits irrespective of the levels(L_1, L_2 or L_3), but with late planting of August, profits increased with the levels and highest was with L_3. Hence, planting in August 15th with heavier application of fertilizer of 160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha may be recommended to obtain marginally higher net profit.

Planting in 30th June, with closer spacing (15 x 10 cm) and at lower level of fertilization (L_1) gave the highest net profit of Rs. 1774/- per hectare followed by planting in 15th June, with closer spacing(S_1) in combination with higher level of fertilization(L_3) and wider spacing with lower level of fertilization (L_1) which amunted to net profits of rupees 1691 and 1633 per hectare respectively. If planting is delayed beyond 15th August a closer spacing with higher level of fertilization(L_3) is advocated. After August 15th, closer spacing with 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha are required to get the maximum net profit.

Soil fertility.

The initial pH of soil was 5.4. A general decrease in pH was observed due to fertilization. It decreased gradually with subsequent higher level of fertilization and was the lowest of 4.4, with an application of 200 kg N, 100 kg P_2O_5 and 100 kg K_2O per hectare. This decrease in pH may be due to the acidic reaction of the fertilizers applied. This agrees with the observations made by Kanwar(1962), who, after examining the results from different places, reported that manures and fertilizers decrease pH of the soil.

Earlier plantings in the month of June and July showed a high rate of carbon content over the initial (0.66), while, it decreased with the delayed plantings. This may be due to the growth of longer roots and significantly which might have contributed to increased carbon content of the soil. With the higher levels of fertilization the percentage of organic carbon in the soil did not change appreciably(Russel, 1940).

The total nitrogen, available phosphate and potash content of the soil, as observed after harvest of the crop, were low with the earlier plantings of June and July. This may be due to increased removal of more nutrients through crops. The reverse is true for the late plantings of August and September, which showed higher content of the above nutrients.

Low levels showed lower residual nutrient content, while higher contents of N, P, and K were seen with subsequent higher levels of fertilization. This may be due to the residual added nutrients, in the form of increased levels. This agrees with the observations made by Young et al.(1960), who, reported that the nitrogen and phosphate content declined in check plots than manured plots. The nutrient content of the soil remained in an equal level with the initial status at 80 kg N/ha (L_1) and at 80 kg both of P_2O_5 and K_2O per hectare (L_3) with respect to nitrogen, phosphate and potash respectively. This gives an indication that a combination of 80 kg N, 80 kg P_2O_5 and 80 kg K_2O /ha may be the optimum dose for IR-8 to maintain the soil fertility at a specified level without any depletion under, Bhubaneswar, condition.

Closer spacing removed comparatively higher amounts of nutrients than the wider which may be attributed to the production of more grain and straw with the former.

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CHAPTER-VI

SUMMARY AND CONCLUSION.

SUMMARY AND CONCLUSION

The results of the experiment entitled " studies on Manurial requirement of paddy I.R-8 in relation to spacing under different dates of planting," have been summarised and the salient findings are as follows :-

1). The best time for transplanting IR-8 is 30th June, producing highest plant height, total number of tillers per clump, leaf area, length of panicle, number of fertile grains per panicle, 1,000 grain weight resulting in maximum yield of grain and straw.

2). The optimum time for transplanting IR-8, was found to be June 30th to July 15th. The yield was reduced by one-fourth with 30th July, half with 15th August and with 30th August and September 15th it was only one-third of 30th June.

3). To get higher yield, a temperature summation of 3600°C with about 700 hours of sunshine is the optimum for kharif.

4). No significant difference either in plant characters or in yields were observed due to spacings.

5). With the increase in fertility levels, yield increased and maximum grain yield of 2669 kg/ha was obtained with 160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha. A further rise caused a reduction in yield.

6). Earlier plantings of June and July with 80 kg N, 40 kg P_2O_5 and 40 kg K_2O/ ha (L_1) proved to be two to three times efficient over higher levels (L_2 or L_3) in late plantings of August and September.

7). With the delayed plantings, application of higher level of fertilizer (L_3) was essential to get a good yield.

8). Planting in 15th July with a spacing of 15 x 10 cm and an application of 160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ ha gave the highest yield of 4250 kg grain with the corresponding highest straw yield of 5428 kg per hectare.

9). Early planting gave higher net profit and profit per rupee invested.

10). 15th August was found to be the critical period for planting IR-8. Further delay incurred loss.

11a). Early plantings within 30th June to 30th July gave more or less similar profits irrespective of the levels (L_1, L_2 or L_3).

11b). Late planting of August 15th, gave higher net profit with higher level of fertilisation (L_3).

12). Earlier planting of 30th June with closer spacing (15 x 10 cm) under lowest level of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O / ha, gave the highest net profit of rupees 1774 per hectare.

CONCLUSION.

Under Bhubaneswar conditions, planting within 30th June to 15th July with closer spacing of 15 x 10 cm and an application of 160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha may be recommended for the higher production of grain and straw but from the economic point of view, application of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O/ha is recommended. For higher marginal profit, late planting of August 15th necessiates an application of 160 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha and further increase in levels of fertilization or delay in planting incurs loss.

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Characters	Dates(D)	Error(a)	Spacing (S)	Error(b)	DXS	Level	DXL	SXL	DXSXL	Error(c)
1. Height.										
a) 15 days after transplanting.	51.39	5.61	10.80	2.60	5.93	6.76	2.17	1.96	0.35	0.92
b) 30 days after transplanting.	46.91	8.41	0.44	6.15	5.23	2.84	1.02	0.13	0.83	1.17
c) 45 days after transplanting.	138.26	23.87	0.03	12.03	7.08	14.14	3.51	2.54	4.84	3.35
d) 60 days after transplanting.	517.07	54.33	1.75	20.08	18.41	27.77	7.37	4.13	3.00	6.97
e) At harvest.	2211.300	4.700	20.720	0.005	7.800	19.380	6.670	5.940	7.600	5.35
2. Tiller.										
a) 15 days after transplanting.	21.05	1.34	0.19	11.14	1.45	4.22	0.36	0.63	0.10	1.47
b) 30 days after transplanting.	40.47	3.87	61.92	0.72	3.63	8.86	2.29	0.43	7.24	0.41
c) 45 days after transplanting.	92.01	97.32	72.62	0.17	1.11	8.30	3.45	1.81	1.66	3.99
d) 60 days after transplanting.	100.22	12.54	65.13	0.66	1.69	14.76	3.11	0.39	2.19	6.97
e) At harvest (Effective tillers)	12.51	1.07	10.01	2.47	0.03	0.59	0.38	0.04	1.06	5.76

Characters	Dates (D)	Error (a)	Spacing (S)	Error(b)	D X S	Level (L)	D X L	S X L	DXSXL	Error(c)
3. Leaf Area										
a) 15 days after transplanting.	205.98	22.42	10.01	26.88	28.21	3.07	5.93	1.30	5.96	3.03
b) 30th days after transplanting.	355.83	9.74	43.64	14.38	28.71	9.35	3.99	0.68	3.26	8.00
c) 45 days after transplanting.	379.21	67.50	33.09	11.44	35.48	67.43	21.14	31.72	17.75	13.47
d) 60 days after transplanting.	707.59	71.56	11.53	101.22	32.47	114.08	23.71	15.91	24.29	16.49
4. Leaf Number.										
a) 15 days after transplanting.	0.760	0.090	0.020	0.004	0.03	0.07	0.03	0.06	1.61	0.72
b) 30 days after transplanting.	1.64	0.21	0.44	0.15	0.07	0.01	0.06	0.01	0.05	1.57
c) 45 days after transplanting.	5.96	0.24	0.04	0.02	0.11	0.05	0.04	0.04	0.04	0.90
d) 60 days after transplanting.	14.05	0.47	0.60	0.01	0.09	0.12	0.05	0.06	0.03	0.41
5. Flag leaf area.	759.27	22.59	22.20	23.59	5.18	50.52	17.66	2.08	15.06	12.23
6. Gall midge affected shoots.	12.84	6.96	7.43	-	3.17	4.57	1.25	1.00	0.66	1.86

Characters.	Dates (b)	Error (a)	Spacing (s)	Error (b)	D X S	Level (L)	D X L	S X L	DX SX L	Error (c)
7. Length of roots	18.65	5.76	27.84	0.02	2.59	1.69	0.81	1.12	1.00	1.50
8. Weight of Roots.	471.69	66.01	256.76	22.04	17.52	25.75	15.40	17.99	26.24	12.71
9. Length of Ear head.	52.96	1.44	4.66	0.01	2.30	2.48	0.71	1.00	1.62	5.12
10. Fertile grains per panicle.	4874.87	285.47	49.16	75.68	399.20	92.95	84.15	11.55	132.12	117.54
11. Sterile grains per panicle.	440.10	50.20	15.77	28.05	45.83	59.37	24.19	28.79	35.16	30.86
12. Sterility %.	258.45	62.59	0.15	24.20	48.20	42.17	17.09	14.43	18.06	23.48
13. One thousand grain weight.	63.39	6.49	2.50	0.10	2.20	2.74	5.14	0.95	1.39	3.19
14. Yield of grain.	2152.06	151.27	5.34	48.29	9.54	51.55	8.08	12.56	15.77	13.44
15. Yield of straw.	2484.20	151.40	52.21	163.64	28.39	116.07	13.21	2.74	17.90	23.57
16. Straw grain ratio.	0.48	0.11	0.01	0.10	0.05	0.01	0.07	0.04	0.05	0.09
D.F.	5	5	1	1	5	3	15	3	15	41

Appendix

Cost of cultivation for high yielding paddy I.R-8/ha
(Translated)

(Excluding fertilizer cost)

Particulars	Quantity	Cost Rs.
A. Nursery		
1. Preparation of Nursery	1 plough	6.50
2. Labour charges	6 male labourers	15.00
3. Weeding	4 female "	8.00
	6 female "	12.00
4. Cost of seed	50 K.G.	29.00
5. Cost of fertilizers	C.A.N. = 25 Kg	15-00
	S/P = 25 KG	11.00
	M/P = 10 Kg	6.00
6. Uprooting seedlings	12 female labourers	24.00
B. Main field.		
1. Land preparation.	15 ploughs	90.00
2. For application of fertilizers.	5 male labourers	12.50
3. Holding rope	10 Boy labourers	15.00
4. Transplanting	40 female labourers	30.00
5. Weeding and topdressing	30 female labourers	60.00
	10 Male labourers	25.00
C. Harvesting and threshing.		
1. Harvesting.	30 female labourers	60.00
2. Bundling and carrying	2 carts	16.00
	6 male labourers	15.00
3. Threshing	20 male labourers	50.00
D. Cost of Insecticides and fungicide.		50.00
		Total = 600.00

Cost of cultivation of IR-8 with different fertilizer levels.

Fertilizer level.	Cost of fertilizers C.A.N.	Super	Potash	Total	Cost of cultivation excluding fertilizer cost.	Total cost of cultivation
L_1-80-40-40	192.00	115.00	40.00	347.00	600.00	Rs 947.00
L_2-120-60-60	288.00	172.00	61.00	521.00	600.00	Rs1121.00
L_3-160-80-80	384.00	229.00	80.00	693.00	600.00	Rs1293.00
L_4-200-100-100	480.00	286.00	100.00	766.00	600.00	Rs1466.00

Cost of cultivation calculated on the basis of following rates.

(i) One plough (working hours 8/day) = Rs 6.50

(ii) One Male labourer per day = Rs 2.50

(iii) One Female labourer per day = Rs 2.00

(iv) One Boy labourer per day = Rs 1.50

(v) 1 quintal paddy = Rs 58.00

(vi) Hire charge of one cart per day = Rs 8.00

(vii) C.A.N(20% N) per quintal = Rs 48.00

(viii) Super phosphate per quintal = Rs 46.00

(ix) Muriate of Potash per quintal = Rs 60.00

(x) Cost of Endrox 20 E.C per litre = Rs 20.00

(xi) Cost of Folidol per litre. = Rs 50.40

Appendix

Mean Height (in cm) at harvest as affected by different treatments.

(a) Dates of planting x levels of fertilization.

Treatments.	L_1	L_2	L_3	L_4	Mean.
D_1	63.2	66.2	67.8	66.1	65.8
D_2	61.0	63.4	62.4	65.2	63.0
D_3	60.4	60.6	62.4	61.9	61.3
D_4	48.1	47.9	50.5	50.0	49.1
D_5	43.8	46.6	43.5	46.8	45.1
D_6	36.7	36.7	35.5	35.9	36.2
Mean	52.2	53.5	53.6	54.3	

S.Em ± for(i) Levels at same date = 1.15
(ii)Dates at same level = 1.14

(b) Dates of planting x spacing x levels of fertilization

Treatments.	L_1	L_2	L_3	L_4	Mean
D_1S_1	60.8	63.9	69.6	65.7	65.0
D_1S_2	65.7	68.6	66.0	66.5	66.7
D_2S_1	62.2	62.4	62.9	64.7	63.0
D_2S_2	59.9	64.4	62.0	65.7	63.0
D_3S_1	61.5	60.0	62.2	62.9	61.6
D_3S_2	59.3	61.2	62.7	61.0	61.0
D_4S_1	46.0	46.8	49.8	50.8	48.3
D_4S_2	50.2	49.1	51.3	49.3	49.9
D_5S_1	43.8	46.2	45.4	45.7	45.2
D_5S_2	43.8	47.1	41.7	48.0	45.1
D_6S_1	36.8	35.5	33.0	33.4	34.6
D_6S_2	36.6	37.8	38.0	38.5	37.7
Mean	52.2	53.5	53.6	54.3	

S.Em ± for
(i) Levels at same DXS = 1.63
(ii)Dates at same SXL =1.62
(iii) Spacing at same DXL = 1.60

Mean leaf area (in sq.cm) at 60th day, as affected by different treatments.

(a) Dates of planting x levels of fertilization.

Treatments.	L_1	L_2	L_3	L_4	Mean.
D_1	46.7	46.7	50.8	50.0	48.5
D_2	38.9	39.9	40.6	44.7	41.0
D_3	42.2	39.2	41.9	41.1	41.8
D_4	34.4	34.7	38.8	45.5	38.3
D_5	30.8	36.5	33.1	38.2	34.6
D_6	26.4	27.4	32.7	28.7	28.8
Mean	36.5	37.4	39.6	41.3	

S.Em ± (i) Dates at same level = 2.90
(ii) Levels at same date = 2.03

(b) Dates of planting x spacing x levels of fertilization.

Treatments.	L_1	L_2	L_3	L_4	Mean.
D_1S_1	44.4	45.3	50.6	50.9	47.8
D_1S_2	48.3	48.2	51.0	49.2	49.1
D_2S_1	39.4	37.3	41.6	44.6	40.7
D_2S_2	38.5	42.6	39.5	44.0	41.1
D_3S_1	46.6	37.6	44.6	45.2	43.5
D_3S_2	37.8	40.7	39.1	37.0	38.6
D_4S_1	35.1	36.7	37.3	39.2	37.0
D_4S_2	33.7	32.6	40.2	49.9	39.1
D_5S_1	30.6	33.2	33.8	37.0	33.6
D_5S_2	31.1	39.7	32.4	39.4	35.6
D_6S_1	25.1	25.1	28.7	30.6	27.3
D_6S_2	27.6	29.7	36.6	26.9	30.2
Mean	36.5	37.4	39.6	41.3	

S.Em ± for
(i) Levels at same D X S = 2.80
(ii) Dates at same S X L = 3.40
(iii) Spacing at same D X L = 3.10

Yield of straw (in kg/ha) as affected by different interactions.

(a) Date of planting x spacing.

Treatments.	D_1	D_2	D_3	D_4	D_5	D_6	Mean
S_1	4533	4735	4332	3060	2512	1761	3488
S_2	4788	4729	3936	2702	2232	1850	3372
Mean ±	4660	4732	4734	2881	2372	1805	

S.Em ± for (i) Dates at same spacing = 661
(ii)Spacings at same date = 484

(b) Date of planting x levels of fertilization.

Treatments.	D_1	D_2	D_3	D_4	D_5	D_6	Mean
L_1	4427	4662	3834	2560	1977	1746	3202
L_2	4716	4543	4249	2503	2503	1632	3357
L_3	4721	5005	4484	3375	2678	2097	3727
L_4	4777	4718	3957	3086	2330	1748	3436
Mean ±	4660	4732	4134	2881	2372	1805	

S.Em ± for (i) Levels at same date = 242
(ii)Dates at same level = 314

(c) Spacing x levels of fertilization.

Treatments.	L_1	L_2	L_3	L_4	Mean.
S_1	3272	3445	3792	3445	
S_2	3133	3270	3662	3427	
Mean	3202	3357	3727	3436	

S.Em ± for

(i) Levels at same spacing = 140
(ii)Spacings at same level = 156

(d) Dates of planting x spacing x levels of fertilization.

Treatments.	L_1	L_2	L_3	L_4	Mean
D_1S_1	4389	4851	4273	4620	4533
D_1S_2	4465	4582	5170	4935	4788
D_2S_1	4389	4504	4528	4620	4735
D_2S_2	4935	4582	4582	4817	4729
D_3S_1	3927	4504	4504	4389	4331
D_3S_2	3760	3995	4465	3525	3939
D_4S_1	2772	2656	3696	3118	3060
D_4S_2	2350	2350	3055	3055	2702
D_5S_1	2310	3656	2772	2310	2512
D_5S_2	1645	2350	2585	2350	2232
D_6S_1	1848	1501	2079	1617	1761
D_6S_2	1645	1762	2115	1880	1850
Mean	3202	3357	3727	3436	

S.Em ± for (i) Levels at same D X S = 343
(ii) Dates at same S X L = 444
(iii) Spacings at same D X L = 383

Mean number of effective tillers as affected by different treatments.

Dates of planting x levels of fertilization.

Treatments.	L_1	L_2	L_3	L_4	Mean
D_1	5.5	5.2	6.0	5.8	5.8
D_2	6.7	6.3	6.8	6.5	6.5
D_3	5.2	5.6	5.1	6.1	5.5
D_4	4.6	5.3	5.4	4.8	5.4
D_5	4.0	4.3	4.7	4.4	4.3
D_6	4.1	4.3	4.3	3.9	4.1
Mean	5.0	5.1	5.3	5.3	5.2

S.Em ± (i) Dates at same level = 1.20
(ii) Levels at same date = 1.13

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