EFFECT OF VARYING LEVELS OF NITROGEN ON GROWTH, YIELD AND QUALITY OF MEDIUM DURATION HIGH YIELDING PADDY VARIETIES

By :

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THESIS

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JAWAHARLAL NEHRU KRISHI VISHWA VIDYALAYA

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C E R T I F I C A T E

This is to certify that the thesis entitled " Effect of varying levels of nitrogen on growth, yield and quality of medium duration high yielding paddy varieties " submitted by Vilas Bhagwan Kalmegh in partial fulfilment of the requirements for the award of the degree of Master of Science in Agronomy, Faculty of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, M.P. is a faithful record of the bonafide research work carried out under my guidance and supervision. No part of the thesis has been submitted for any other degree of diploma.

Dated : 16th August/1974

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Dated :

We hereby recommend that the thesis entitled " Effect of varying levels of nitrogen on growth, yield and quality of medium duration high yielding paddy varieties " submitted by Vilas Bhagwan Kalmegh be accepted in partial fulfilment of the requirements for the degree of Master of Science in Agriculture in Agronomy.

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CONTENTS

INTRODUCTION

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India, the land of perpetual sunshine, bountiful rains and vivid climate conducive to the healthy growth of plants of various kinds, is making an all out effort to solve her critical age old food shortage by way of leaving the conventional agricultural methods and varieties and accepting the new values of change - the high yielding fertilizer responsive varieties of wheat, rice, maize, sorghum etc. with matching advances in water use pattern together with judicious manuring and other modern agricultural techniques.

In the link of scientific break through offing in the mid 1960s, rice production potentials are also revolutionized to the extent never attained before. This becomes quite evident from the review of level of production of rice from the begining of the 20th century. Levels of production in 1900 were insufficient to supply needs of the expanding population well before mid-century. Production increased about 3 % per year from 1952-53 to 1964-65 with increased area accounting for perhaps 1.2 % and increased yield only 1.1 %. Production increases were not large enough to satisfy increased food demands caused by the continuous population increase of 2.2 % annually. It seems that production at 1950 levels had increased primarily by an expansion in area and had not yet been affected by new technologies. It was only from 1964-65 when the information on plant type became available, India recognised new horizons for increasing rice yields. The high yielding varieties from introduced material and selections from Indian crossing programmes with simultaneous corresponding advances in fertilizer and water use technology gave new dimension to the cultivation of rice. All the old yield barriers were broken and

new values, very much insight and in the realm of reality were established. This dynamic changes in rice production and its corresponding adoptation by the agriculturist have ushered new vistas in rice production and placed India in the most exciting place in the world to-day.

The new varieties of rice, however, are very much precise in their nutrients, moisture, temperature, light and cultural operations requirement. This suggests judicious and efficient use of fertilizers and other crop management practices to be imperative for the realisation of maximum production potential of these varieties.

The new plant type of rice are known to possess the trait of high responsiveness towrards heavy application of fertilizers. Since, these dwarf varieties have short thick stem with erect broad and deep green leaves, they are capable of assimilating nutrients, particularly nitrogen applied at higher rates which ultimately results into higher grain and straw yield. Though sizeable reports of researches are available on various aspects of fertilizer need and use on rice (tall) but to keep pace with the fast changing and developing in quick succession of rice varieties, continuous research on requirement of optimum dose of fertilizer is necessary.

Due to edapho-climatic factors behaviour of any plant type is different in various places in respect of nutrient requirement. Therefore, fertilizer doses recommended for a particular variety in a particular place will not hold true for other place. This suggests the need to conduct varietal cum manurial experiments at different places to meet the local requirement.

Keeping the above point of consideration in view and to confirm the result of preceeding year experiment, a field experiment entitled " Effect of varying levels of nitrogen on growth yield and quality of medium duration high yielding paddy varieties " on yield growth and quality of dwarf rice was undertaken at the Central Rice Research Station Farm, Raipur during Kharif 1973.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Of all the essential elements required by the plant for substancial growth and enhanced production of crop like paddy, it is established, the first place goes to nitrogen. Because the dwarf varieties of rice particularly of Indica group are known to possess the quality of high responsiveness towards heavy fertilizer application and since these varieties have short tick stem (non lodging) with erect, broad and deep green leaves, they are capable of utilizing higher rates of nitrogen. Increase in the yield depends on corresponding increase in doses of fertilizer up to optimum limit. This limit may very according to the duration of variety and different variety of the same duration and in accordance to the different agro-climatic conditions. As the Indica varieties of rice are of recent introduction to the country and to the state of M.P. very little work is reported on the response of these varieties to various levels of nitrogen. However a review of available research on the response of rice varieties to nitrogen in India and abroad is summarised in the following paragraphs.

Effect of nitrogen on growth yield and quality:

Effect on growth :

Pathi and Mishra (1968) observed the height of paddy variety Tinnon-3 to increase significantly by increase in levels of nitrogen up to 100 kg N/ha. Observations in the similar line were reported by Anonymous (1969) who also found the plant height to be increased significantly under nitrogen application up to level of about 100 kg/ha.

Singh (1971) reported increased plant height by increase in

level of nitrogen even up to 160 kg N/ha.

Ramanujam and Rao (1971) pointed out the influence of nitrogen levels in manifestation of shoot height higher. Sumbali and Gupta (1972) also noticed the increase in plant height by successive increase in levels of nitrogen.

Dixit et al. (1967) reported higher levels of nitrogen to result in to higher number of tillers than the lower one. Same way Bathkal and Patil (1968) also found the application of nitrogen to increase the number of tillers/plant. Similarly. Padhi and Mishra (1968) reported that increased levels of nitrogen up to 100 kg N/ha increased significantly the number of tillers in variety Tianon-3. Perege and Leonzio (1969) have findings in similar line i.e. higher rates of nitrogen so also phosphorous and potash gave increased number of stems/m^2 as compared to the lower rates of fertilizer. Findings of Shrivastava et al. (1970) coincide with that of Padhi and Mishra (1968). An application of 100 kg N/ha was recorded to increase the number of tiller of dwarf rice.

Pagade and DeDutta (1971) visualised the nitrogen in general to increase the number of tillers of dwarf varieties however the effect was seen to be more clear in dry condition than in wet condition.

Ramanujam and Rao (1971) and Sumbali and Gupta (1972) also stressed the higher number of tillers with higher nitrogen levels. Likewise, Singh (1971) reported the increase in number of tillers with increase in nitrogen level from 0 to 160 kg N/ha. Whereas, Pandey and Tilak (1970) found the number of tillers to increase

significantly up to 60 kg N/ha only.

Singh and Verma (1971) observed the heavy application of nitrogen to produce high percentage of unproductive tillers.

Effect of nitrogen on yield :

Yamada and Kirinda (1958) reported the application of 60 kg nitrogen per hectare in a single dose, three weeks after sowing, to give 33 % higher yield than the yield of untreated (control). Basak et al. (1962) demonstrated increase in average and maximum yield of grain and grain to straw ratio in cultivators field in West Bengal due to increase in nitrogen. Mahapatra and Sahu (1963) found significantly higher yield of rice grains due to nitrogenous fertilizers over control (no nitrogenous fertilizer). The yield varied from 24 to 81 kg/ha.

Vachhani et al. (1963) recorded the significant increase in yield up to 40 kg N/ha beyond which the yield decreased.

Anonymous (1967) reported that application of 30 kg N/ha gave yield increases from 1.89 to 3.91 q/ha over yield due to control. Increases were significant in Amritsar when the level of nitrogen was doubled. At Karnal district also Anonymous (1967) observed the response to application of 60 kg N/ha over control to be significant in increasing the yields. Dixit et al. (1967) also reported higher grain yields of early strains due to higher fertility level. From Gwalior it was reported (Anonymous, 1967) that local varieties showed good response at 500 and 865 kg grain yield/ha to 30 and 60 kg N/ha respectively.

Pande and Bhan (1966) obtained higher grain yield signifi-

cantly due to 80 kg N/ha over lower rates. Thakur et al.(1971) found the grain yield increased by increasing the doses of nitrogen from 0 to 40 and 40 to 80 kg/ha. The increase in yield due to 120 kg N/ha was not appreciable. Whereas, best response to paddy yield even by application of 120 kg N/ha was noted (Anonymous, 1967).

Significantly increased grain and straw yield more in hybrid varieties than in common Indian varieties were obtained due to higher levels of nitrogen (Hussain and Mustafa, 1969). Sood et al. (1969) ad shown grain yield response to nitrogen up to 120 kg/ha. Whereas, Patnaik (1967) observed the linear grain yield response to nitrogen application from 0 to 120 kg N/ha. DeDutta et al. (1968) also observed greater grain production due to 120 kg N/ha for variety CV. IR 8. Similarly Shreedharan and George (1968) also found progressive increase in the yield with increase in the rates of nitrogen. Increase in average grain yield of 14 rice CV. from 3.63 in the untreated (control) to 6.97 t/ha due to increasing nitrogen level from 0 to 120 kg N/ha was reported from IRRI. (Anonymous, 1968). Increased response significantly in grain yield at 120 kg N/ha and increased straw yield due to increasing level of nitrogen was obtained for variety TN-1 (Lakhdive and Prasad, 1970). The same opinion conclusively was expressed about the paddy yields in response to nitrogen application by Kulandivelu and Kaliappa (1971).

Patnaik et al. (1968) suggested to try increasing of rates of nitrogen to reach the optimum dose of nitrogen both from the point of view of grain yield and balanced nitrogen nutrition.

Basu and Raichoudhary (1968) observed the increase in grain yield with application of nitrogen from 0 to 140 kg N/ha and yield

decrease beyond.

Bathkal and Patil (1968) on the basis of two years data on the grain yield of rice in summer season, reported the progressive yield response to the application of nitrogen up to 100 kg N/ha, whereas, for CV. Dodga, BK 70 and Basmati the response to rates of nitrogen was limited up to 50 kg N/ha.

Choudhary et al. (1969) observed in an investigation of the effect of different levels of nitrogen in winter paddy at Arundhutinagar, Tripura in 1967-68 that the application of nitrogen affected the yield of crop significantly and the response to fertilizer was linear.

Krishnamraj and Rao (1969) noticed that AIT 27 variety of rice responded to increasing levels of nitrogen up to 90 kg N/ha.

Padmakumari et al. (1969) reprorted the grain yield response to N, P and K up to 130 kg, 100 kg and 100 kg/ha respectively. Bathkal and Patil (1970) observed that increasing rates of nitrogen from 50 to 200 kg/ha produced linear increase in average paddy yields from 3.13 to 4.34 tons/ha. The optimim nitrogen rate was 150 kg nitrogen/ha. Similarly Mahapatra (1969) concluded that the grain yield of dwarf Indica and Japonica CV. increased linearly as nitrogen rates increased up to 200 kg/ha, whereas yield of tall Indica CV. responded to nitrogen levels up to 120 kg/ha.

Singh and Verma (1971) reported the yield response of paddy significantly up to 160 kg nitrogen per hectare.

Anonymous (1970) reported the results of AICRIP and stated

that 0 to 100 kg N/ha successively increased the grain yield. Above this level small increase was observed which was not justifiable economically. Higher nitrogen levels increased the panicle number but panicle weight declined under the highest nitrogen rate.

Choubey et al. (1970) concluded from two years result at Adhartal Farm, Jabalpur that levels of nitrogen (0, 30, 45 and 60 kg N/ha) could not bring about significant differences in grain yield of medium duration variety.

Daniel (1970) reported that the higher rate of nitrogen resulted in significantly higher grain yields than the lowest in topdressed variety PTB-9.

Gupta et al. (1970) noted that nitrogen when applied from 0 to 135 kg/ha increased the paddy yield in IR 8.

Gupta et al. (1970) recorded the yields of paddy variety CV. Kalibora also to be increased with increasing rates of nitrogen from 0 to 45 kg N/ha.

Mohite and Shingte (1970) noted the increasing levels of nitrogen increased the yield of grains, significantly. Falling on the same line Jindal and Kalia (1971) also observed the each successive level of fertility to increase the paddy yield significantly, over the preceeding level.

Ramanujam and Rao (1971) found that the paddy yield decreased with application of 790 kg N/ha.

Sumbali and Gupta (1972) reported that nitrogen levels at

which highest grain yield obtained was 155 kg N/ha.

Singh (1971) reported the grain yield per hectare to increase by increasing the level of nitrogen from 0 to 160 kg N/ha.

TenHave (1972) found that grain yield decreased with very high level of nitrogen.

Verma and Shrivastava (1972) noticed yield of high yielding variety to increase up to the level of 160 kg N/ha.

Anonymous (1969) reported the results of AICRIP to give higher straw ratio with nitrogen application beyond 50 kg/ha. Similar findings were reported by Patel et al. (1969) who found significantly greater straw produce under two higher levels of nitrogen (66 and 99 kg N/ha) alone and in combination with P_2O_5 and K_2O over control and lower levels of nitrogen.

Mervyn et al. (1971) also observed higher straw yield of variety H-4 due to increase in the levels of nitrogen. Ramanujam and Rao (1971) found the straw yield to be increased significantly up to application of 790 kg N/ha. TenHave (1971) also opined similarly that increasing nitrogen levels from 0 to 150 kg N/ha increased the yield of straw. Sumbali and Gupta (1972) likewise reported the increased straw produce under 155 kg N/ha.

Yield attributes viz. effective tillers, panicle weight, number of fertile grains/panicle, length of panicel were increased due to increasing levels of nitrogen (Bredero, 1965; Velly and Latrille, 1967; Bathkal and Patil, 1968; Choudhary et al., 1969; Anonymous, 1969; Anonymous, 1970; Gupta et al., 1970; Mervyn et al.

1971; Ramanujam and Rao, 1971; Singh, 1971; Singh and Verma, 1971; and Sumbali and Gupta, 1972).

Effect of nitrogen on quality :

Basu and Raichoudhary (1968) observed that with the higher levels of nitrogen application, the 1000 grain weight was not much influenced. Similarly Padmakumari et al. (1969) pointed out no effect of nitrogen levels on 1000 grain weight.

Anonymous (1969) found 1000 grain weight increase with nitrogen application up to level of about 100 kg N/ha.

Shrivastava et al. (1970) noticed that 100 kg N/ha in dwarf rice CV. TN-1 decreased the 1000 grain weight significantly over no nitrogen application. Likewise Ramanujam and Rao (1971) also found, 1000 grain weight of paddy to decrease by nitrogen application of 790 kg N/ha. Findings of Singh and Verma (1971) fall in the similar line as that of Ramanujam and Rao (1971) i.e. heavy nitrogen application at the rate of 200 kg N/ha, reduced the 1000 grain weight.

Dry matter increase due to higher levels of nitrogen was seen by Ramanujam and Rao (1971), Mohite and Singte (1970) and DeDutta et al. (1968).

Effect of paddy varieties on growth, yield and quality :

Medium varieties of paddy produced more tillers than earlier strains under the same nitrogen level (Dixit et al., 1967).

Anonymous (1967) reported that yields of paddy variety TN-1 was 1.18 q/ha more than Jhona 349 in the absence of fertilizer.

Anonymous(1967) found that the dwarf paddy varieties were considerably superior to the locally improved varieties. Variety IR 8 gave 5.8 q/ha more yield than TN-1 which inturn yielded 2.5 q/ha more than locally improved variety.

Anonymous (1968) reported that dwarf paddy varieties IR 8 and Tinan-3 performed better than CO-29 and ASD-5. Variety IR 8 gave in general highest grain yield ranging from 22 to 62 q/ha.

DeDutta et al. (1968) observed that grain production and total drymatter production was more in CV. IR 8 than TN-1.

Anonymous (1971) noticed that early group varieties Bala, CR 44-36 and Pusa 2-21 proved superior over others while in late maturing group Jaya continued to prove superior.

TenHave (1971) conclusively reported the yields of dwarf varieties to be distinctly superior over tall varieties.

Effect of paddy variety x nitrogen on growth and yield :

Dixit et al. (1967) found tillers of early and medium strains of paddy to be affected favourably under higher levels of nitrogen. The effect was more pronounced in medium strains. Findings of Shrivastava et al. (1970) coincide with that of Dixit et al. (1967). Tillers per plant of variety TN-1 was increased considerably under increasing levels of nitrogen.

TenHave (1971) concluded that the dwarf varieties, always exhibited a much better grain yield response to nitrogen than tall varieties. However, grain straw ratio decreased with nitrogen levels beyond 150 kg N/ha.

Mervyn *et al.* (1971) reported more number of panicle and straw produce of variety H-4 under increasing levels of nitrogen. For variety Marunga Kayan-302 decline trend in respect of panicle number under higher nitrogen level was noticed.

MATERIAL AND METHODS

MATERIAL AND METHODS

This chapter deals with a concise description of the material used and the techniques adopted during the course of investigation.

The present investigation on " effect of varying levels of nitrogen on growth, yield and quality of medium duration high yielding paddy varieties " was conducted at the Research Farm of J.N.Krishi Vishva Vidyalaya, College of Agriculture, Raipur, Madhya Pradesh under All India Co-ordinated Rice Improvement Project, during Kharif (1st July to 15th November) 1973 with the following objectives.

1. To see the response of rice to nitrogen.
2. To find out the best suited variety of rice for this region.
3. To find out the optimum fertilizer dose for rice.

Experimental site :

The experiment was conducted at Labhandi Farm on Block No. 5 in field No. B_2 , C_2 and D_2 . The gross area under experiment was 2439.06 sq meters with irrigation facilities through the field to provide good drainage facility.

Soil :

The soil of the experimental field was clay loam, locally known as "Dorsa soil ". The field possessed moderate basic fertility. Thus the site of experiment was quite suitable for exploring the potential of high yield rice varieties. Composite soil samples were taken before the experiment was laid out, from five spots. Each replication was selected at random to take soil samples from 0.25 cm depth. The collected soil samples of three replications were thoroughly mixed-up to make composite, soil sample of one kg for

chemical as well as mechanical analysis. The analysis was done in soil testing laboratory, Raipur. The results are presented in table No. 1 and 2.

Table 1. Mechanical and chemical analysis of the soil of experimental field.

S.No.	Particulars	Analytical values
1.	Mechanical analysis :	
	a) Sand	22.95 %
	b) Silt	31.40 %
	c) Clay	36.70 %
2.	Chemical analysis :	
	a) Organic carbon	0.61 %
	b) Available nitrogen	165.00 kg N/ha
	c) Available phosphorous	8.40 P_2O_5/ha
	d) Available potash	450.00 kg K_2O /ha
	e) p^H	6.9
	f) E.C.	0.607

Chemical analysis data revealed that the soil was neutral and low in nitrogen, low in phosphorous and high in potassium. The figures of mechanical analysis indicate that the percentage of clay is fairly high followed by sand and silt, indicating clearly clay loam soil.

Climate :

Topographically this farm is 293 meter high from the mean

sea level and located at 21.41°N lattitude, 81.30°E longitude in Raipur.

The average climatic conditions prevailing during the time of investigation and the meteorological data recorded during the period of study have been presented below in table No. 3. and shown in graph, Fig. 1.

Table 2. Meteorological data from July to November 1973.

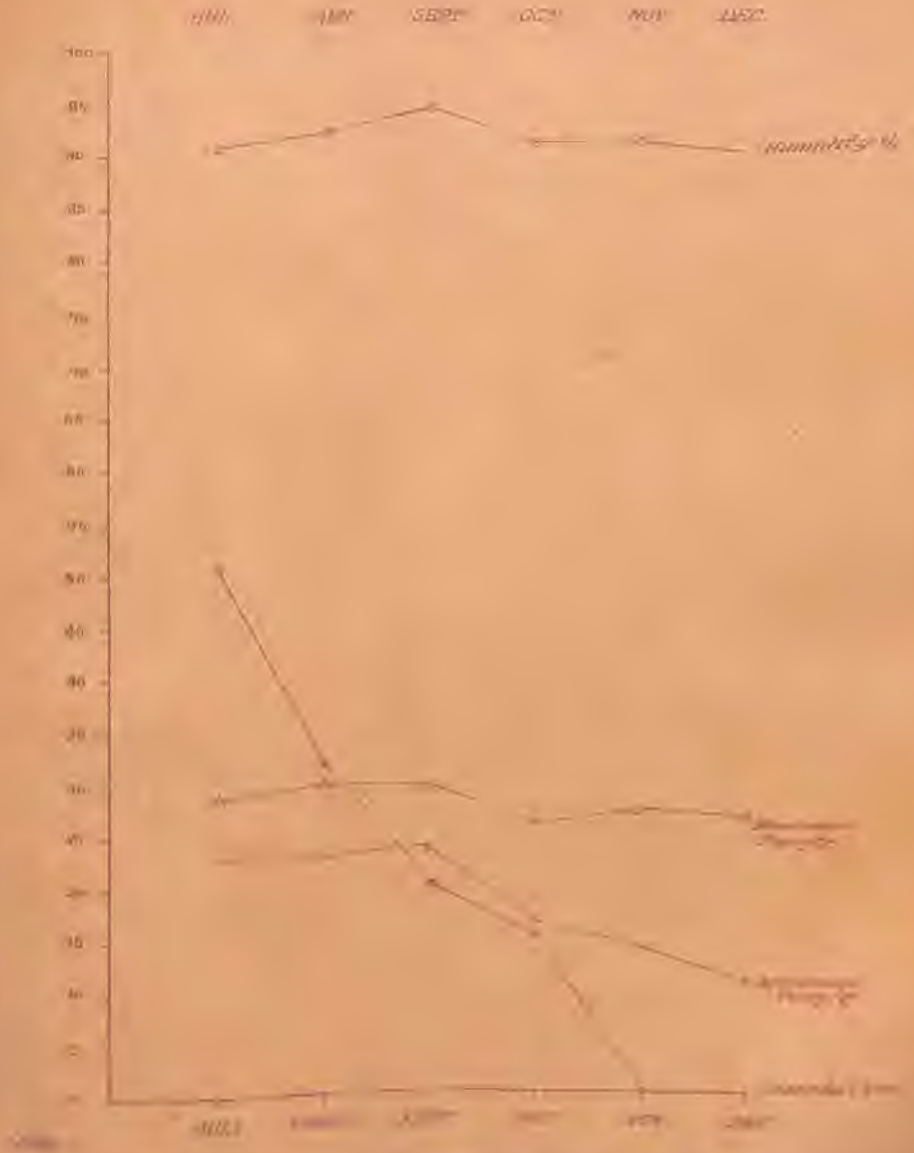
S.No.	Month	Total Rainfall in mm	Mean Temperature in °C		Mean relative humidity in %
			Maximum	Minimum	
1.	July	510.0	29.6	23.6	91
2.	August	318.6	29.9	23.4	92
3.	September	201.0	29.5	23.7	94
4.	October	154.2	26.4	16.5	91
5.	November	0.0	27.7	14.1	91

Previous history of the field :

The cropping history of the experimental field for three years period preceeding the experiment has been given in the table No. 3.

Table 3. Cropping history of the experimental field.

Year	crop under Kharif	crop under Rabi
1970-71	Paddy	Fallow
1971-72	Paddy	Fallow
1972-73	Paddy	Fallow



Experimental Details :

(a) Lay out :

The experiment was laid out in split plot design with varieties in the main plot and fertilizers in the sub-plot to determine the effeciency of the nitrogen doses in high yielding dwarf varieties. The actual plan of lay out is given in fig. 2.

(b) Treatments :

In this experiment two variable factors i.e. varieties and nitrogen were studied. Varieties were kept under main plots, while nitrogen doses were put under sub-plot. The main emphasis was laid to find out the comparative effeciency of nitrogen doses on varieties.

(i) Varieties :

Following eight varieties were taken in the experiment :-

Table 4.

Notation of Varieties	Name
V_1	Jaya
V_2	IET 2295
V_3	IET 1991
V_4	IET 2254
V_5	IET 1038
V_6	IET 2885
V_7	IET 1996
V_8	Ratna

(ii) Nitrogen levels :-

There were five levels of nitrogen viz. 0, 40, 80, 120 and 160 kg/ha.

Source of N :- Ammonium sulphate.

Table 5. Time of application of nitrogen in kg/ha.

No.	Total	Basal	Tillering	Panicle Initiation
N_1	0	0	0	0
N_2	40	20	10	10
N_3	80	40	20	20
N_4	120	60	30	30
N_5	160	80	40	40

(c) Other experimental details :

1.	Experimental area	2439.06 sq m
2.	Area under one replication	700.92 sq m
3.	Number of replication	3
4.	Design	split plot design
5.	Size of main plot	80.24 sq m
6.	Number of main plot	24
7.	Gross size of sub-plot	14.96 sq m
8.	Net size of sub-plot	10.26 sq m
9.	Block border	2 meter
10.	Row to row distance	20 cm
11.	Plant to plant distance	15 cm
12.	Number of seedling per hill	2
13.	Total number of plot	120

FIG 3 PLAN OF LAY-OUT

(d) Basal dose of fertilizers :-

80 kg P_2O_5/ha and 50 kg K_2O/ha was applied uniformly as basal dressing.

(e) Salient features of the varieties included in the investigation:-

JAYA :- It is cross between T 141 x T (N)1 with bold grains, high yield potential and yield stability. Thousand grain weight is 32 g. Resistant to blast diseases. Days to maturity are 130 days.

IET 2295 :- It is cross between IR 8 x CR 1014 with good grain type, tillering, plant height and good yield though sterility percentage is somewhat more. It is mid-early duration variety with 125 days to maturity.

IET 1991 :- It is cross between GEB 24 x T(N)1 with superfine grain, high yield potential and translucent kernels. Medium duration variety with 130 days to maturity.

IET 2254 :- It is cross between T 90 x IR 8 with long slender grain, high yield potential, good tillering and good cooking quality. Moderately resistant to Bacterial leaf blight. Mid-early duration variety having 125 days to maturity.

IET 1039 :- It is cross between T 90 x IR 8 with long slender grains, good yield potential and good tillering. Sterility percentage of grains is more. Medium duration variety with 135 days to maturity.

IET 2885 :- It is cross between IR 8 x Siam 29. Medium duration variety with high yield potential, and coarse grains. Resistant to gall midge and tollerant to Bacterial leaf blight.

IET 1986 :- It is cross between T(N)1 x CO 29, with long slender grain, high yield potential, resistant to blast disease. Medium duration variety and days required to maturity are 125-130 days.

RATNA :- It is cross between TKM 6 x IR 8 with long slender grains. One thousand grain weight of the variety is 22.1 g. Susceptible to blast and grain shattering. Days to maturity are 115-120 days as it is mid-early duration variety.

(f) Cultural operations :

(i) Preparation of nursery :

Field selected for raising nursery was ploughed three times followed by cross ploughing with deshi plough. Before making 1.20 meter wide raised nursery beds, the beds were fertilized @ 150 kg N, 50 kg P_2O_5 and 50 kg K_2O/ha. Trenches made between the beds were used to irrigate the beds as well as to drain out the excess water. 3 kg seed of each variety was treated with 2 gm ceresan and was then sown on respective seed beds on 2nd July 1973. The seed beds were irrigated with the help of bazera (water cans) just after sowing and were kept moist afterwards.

(ii) Preparation of main fields :

(a) Preparatory tillage :- The field under experiment was thoroughly prepared for transplantation by two ploughings and one cross ploughing on 1st June 1973. Puddling was done on 29nd July with the help of tractor. Levelling was done before the transplanting with the help of bullock driven datari and pata. Levelled field was laid out as per plan given in Fig. 2. The fifty percent of the scheduled doses of nitrogen and entire quantity of P_2O_5 and K_2O to be applied was just applied as basal dose just before transplanting in accordance to the treatments.

(b) Fertilizer application :- The supply of Nitrogen, Phosphorous and Potassium was done through ammonium sulphate, super phosphate and muirate of potash respectively as given in the table 6.

Table 6.

Treatment	Fertilizer/plot		
	Ammonium sulphate in g	Super phosphate in g	Muirate of Potash in g
N_1	0 + 0 + 0	750	125
N_2	150 + 75 + 75	750	125
N_3	300 + 150 + 150	750	125
N_4	450 + 225 + 225	750	125
N_5	600 + 300 + 300	750	125

(c) Transplanting :- The transplanting was done 24 days after sowing the seeds in nursery i.e. on 26th July 1973. The seedlings were uprooted from the nursery beds. Two seedlings per hill were planted in the field at 20 x 15 cm spacings. A rope marked at every 15 cm was used for planting the seedlings in straight lines and to maintain the required distance between the two plants.

(d) Irrigation :- Two irrigations were given on 10-10-73 and 29-10-73.

(e) Gap filling :- Gap filling for missing hills was done on 3-8-73 and 7-8-73.

(f) After care :-

(i) Weeding :- In order to keep the field free from weeds, three hand weedings were done, by manual labour at an interval of 15 to 17 days after transplanting i.e. on 10-8-73, 26-8-73 and 14-9-73.

(ii) Plant protection measures :- The schedule of plant protection measures adopted during experiment for control of insect pests and diseases has been shown in the table 7.

Table 7. Plant protection measures taken during experiment.

S.No.	Pesticides	Strength of spray solution	For control	Date
1.	Endrin 20 E.C.	0.04 % a.i.	Leaf hoppers (Nephotettix spp.)	12-8-73
2.	Endrin 20 E.C. + Zineb	0.04 % a.i.	Leaf hoppers (Nephotettix spp.) Blast (Pyricularia oryzae Cav.)	6-9-73
3.	Endrin 20 E.C. +Dimecron	0.04 % a.i.	Plant hoppers (Sogatella furcifera)	14-9-73
4.	Thimet 10 G	10 kg granules/ha	Stem borer (Tryporyza incertulas)	6-10-73
5.	Folidol	0.04 % a.i.	Cut worm (Mythimna separata W.) and Army worm(Pseudoletia separata Walk)	16-10-73

(g) Tondressing :- The first top-dressing of nitrogen N_2 (10 kg N/ha), N_3 (20 kg N/ha), N_4 (30 kg N/ha), N_5 (40 kg N/ha) was done at the tillering stage on 17th August 1973. Second top-dressing of remaining nitrogen N_2 (10 kg N/ha), N_3 (20 kg N/ha), N_4 (30 kg N/ha), N_5 (40 kg N/ha) was done at panicle initiation stage i.e. on 15th September 1973.

Harvesting :

The harvesting stage of the crop was determined after 35 days of flowering when rice kernels become harder and foliage turned yellow. About 4-5 days before harvesting the water was drained off from the field. Harvesting of the crop was done on different dates according to maturity period of varieties. On 27th October 1973, variety Ratna, on 8th November 1973, variety Jaya, IET 2295, IET 2254, IET 2285 and on 16th November 1973 varieties IET 1991, IET 1039, IET 1996 were harvested after leaving 2 border rows from each side and spread over the respective plots for sundrying upto 3 days.

Threshing, winnowing and weighing :

Threshing, winnowing and weighing of grains and straw of various varieties was done by manual labour to avoid mechanical mixture and loss of grains during these processes. Winnowing was done with the help of supa to remove sterile grains and straw from healthy seeds. Weight of individual plot yield was recorded very carefully in Kilogram and gram.

Observations :

The following observations and studies were done during crop growth.

(a) Pre harvest studies :

(i) Height of the plant in centimeters.

(ii) Number of tillers per quadrant.

(iii) Number of panicles per quadrant.

(iv) Number of days required for maturity of the crop.

(b) Post harvest studies :

(i) Length of panicle (ear head).

(ii) Number of spikelets per panicle.

(iii) Number of filled grain/panicle.

(iv) Sterility percentage.

(v) Weight per panicle.

(vi) Thousand grain weight (Test weight).

(vii) Yield of grain in kg/ha.

(viii) Yield of straw in kg/ha.

(ix) Grain to straw ratio.

Sampling technique :

Representative samples were taken from the two quadrants of 40 x 45 cm which were randomly selected in each plot for observations of tillers/quadrants, panicles per quadrant and height of the plant in cm.

Observations on various plant characters were taken as follows :

(a) Pre harvest studies :

(i) Height of plant :- Observations on height of plants were taken at an interval of 10 days approximately one and half month after transplanting of selected plants. Height was measured in

centimeters from the ground level upto tip of the flag leaf and at matured tip of the panicle.

(ii) Number of tillers per quadrant :-Total number of tillers per quadrant of 40 x 45 cm size were counted before harvesting. Then afterwards the tillers per sq meter were calculated.

(iii) Number of panicles per quadrant :- Prior to harvest of the crop, the ear bearing tillers per quadrant were counted and then calculated in per sq meter.

(iv) Number of days required for maturity of the crop :- The number of days needed to complete maturity of the crop were recorded.

(b) Post harvest studies :

(i) Length of panicle (ear head) :- For measuring the length of earheads, ten main earheads were selected randomly from ten ramdom hills in each plot to represent the length of earheads. The measurement was done in centimeters from the ring node upto tip of the earhead. The length of ten earheads were recorded and then was averaged out in to single earhead length in cm.

(ii) Number of spikelets per panicle :- Ten panicles selected for length were used to count fertile and sterile spikelets per panicle.

(iii) Weight per panicle :- Ten selected panicles per plot were weighed to record the weight per panicle.

(iv) Sterility percentage :- Total number of sterile grains observed in a sample were converted in to percentage to denote the percentage sterility.

(v) Thousand grain weight (Test weight) :- From each plot, thousand filled grains were counted and weighed in grams.

(vi) Yield of grains per plot :- After winnowing the grain

yield was recorded in Kilogram and gram per plot and then the yield was converted in kg/ha.

(vii) Straw yield :- After separation of grains from the produce of single plot, straw yield in Kilograms per plot was recorded and converted in to Kilograms per hectare.

(viii) Grain to straw ratio :- Grain to straw ratio was calculated by dividing the grain yield per plot with straw yield per plot.

Statistical analysis :

Observations of pre-harvest and post-harvest characters were tabulated and analysed. The observations were analysed according to the method given in the book " Statistical Methods for Agricultural Workers " by Panse and Sukhatme.

The calculated "F" value was compared with "F" tabulated value at 5 % and 1 % level of significance. For comparing the individual treatments when the "F" test showed significance, C.D. at 5 % and 1 % level was used. The Skeleton ANOVA and various S.E.(d) and C.D. used are given below.

Skeleton A.V. Table

Source of variation	d.f.	S.S.	M.S.S.	F.	Table 'F' value 5%	1%
Replication	(r-1)	R	R/Ea			
Main treatment	(m-1)	M	M/Ea			
Error (a)	(r-1)(m-1)	Ea				
Sub treatment	(b-1)	S	S/Eb			
Main x sub (Int.)	(m-1)((b-1)	M x SM x S/Eb				
Error (b)	m(b-1)(r-1)	Eb				
TOTAL	(r.m.b-1)					

Mean sum of square (M.S.S.)

It was calculated by dividing the sum of square by the appropriate degrees of freedom :-

$$M.S.S. = \frac{S.S.}{d.f.}$$

M.S.S. = Mean sum of square.

S.S. = Sum of squares.

d.f. = Degrees of freedom.

'F' value of variance ratio

The 'F' value was calculated according to the following formula :-

$$F = \frac{\text{treatment M.S.S.}}{\text{error M.S.S.}}$$

Standard Error (Mean)

It was calculated as :-

(i) S.Em. for main plot treatment:

$$= \sqrt{\frac{\text{Error m.s. (a)}}{r \times b}}$$

(ii) S.Em. for sub treatment :

$$= \sqrt{\frac{\text{Error m.s. (b)}}{r \times a}}$$

(iii) S.Em. for two sub treatments in one main treatment:

$$= \sqrt{\frac{\text{Error m.s. (b)}}{r}}$$

Critical differences (C.D.) :

It was calculated as given below.

C.D. for 5 % = S.E.(d) x t (0.05) at Error d.f.

C.D. for 1 % = S.E.(d) x t (0.01) at Error d.f.

where

C.D. is critical difference

't'(E. d.f.) is 't' value (tabulated) at error degrees of freedom at 0.05 or 0.01 level.

E = Error M.S.

r = Number of replication

a = Number of main plot treatment

b = Number of sub-plot treatment

EXPERIMENTAL FINDINGS

EXPERIMENTAL FINDINGS

The text of the present chapter deals with the results of the experiment entitled " Effect of varying levels of nitrogen on growth yield and quality of medium duration high yielding paddy varieties " , carried out during Kharif 1973-74.

Growth studies :

Observations on growth characters viz. plant height, number of tillers per square meter at the final stage and number of days to maturity were subjected to statistical analysis. The analysis of variance of the above growth attributes are given in Appendix III. The main effects of variety, nitrogen and interactions in respect of height, number of tillers/m^2 and days to maturity are summarised in tables 8, 9 and 10 respectively and depicted in figures 4, 6 and 8.

Height of plant :

The statistical analysis of the data (appendix III) revealed that the differences in height of plant due to varieties and nitrogen levels were significant. Interaction was non significant.

Table 8. Mean height of plant at maturity as affected by different varieties, levels of nitrogen and interaction.

Treatments	N1	N2	N3	N4	N5	Mean
V1	79.92	92.02	102.05	103.07	102.84	95.98
V2	79.48	91.39	96.16	98.21	100.10	93.05
V3	82.92	96.35	93.38	99.58	102.37	94.88
V4	81.87	86.28	92.20	94.08	95.81	90.01
V5	73.55	87.03	90.89	92.17	97.04	88.05
V6	80.00	92.54	96.28	98.13	97.23	92.79
V7	79.94	88.42	93.24	92.93	95.80	89.71
V8	82.37	92.23	95.95	97.30	101.40	93.80
Mean	80.00	90.67	94.93	96.85	98.97	

	Variety	Nitrogen	Interaction
S.Em. ±	1.07	0.58	1.63
C.D.)(0.05)	3.25	1.64	

Variety (V_1) Jaya being at par with (V_3) IET 1991, (V_8) Ratna, (V_2) IET 2295 and (V_6) IET 2885 showed significantly more plant height than (V_4) IET 2854, (V_7) IET 1996 and (V_5) IET 1039. Varieties (V_2) IET 2295 and (V_6) IET 2885 being similar to (V_4) IET 2854 and (V_7) IET 1996 gave more plant height than (V_5) IET 1039 being analogous

Which too

SCALE
2·5 Cm. = 10 Cm Plant ht
1·5 Cm = 10 Days Interval

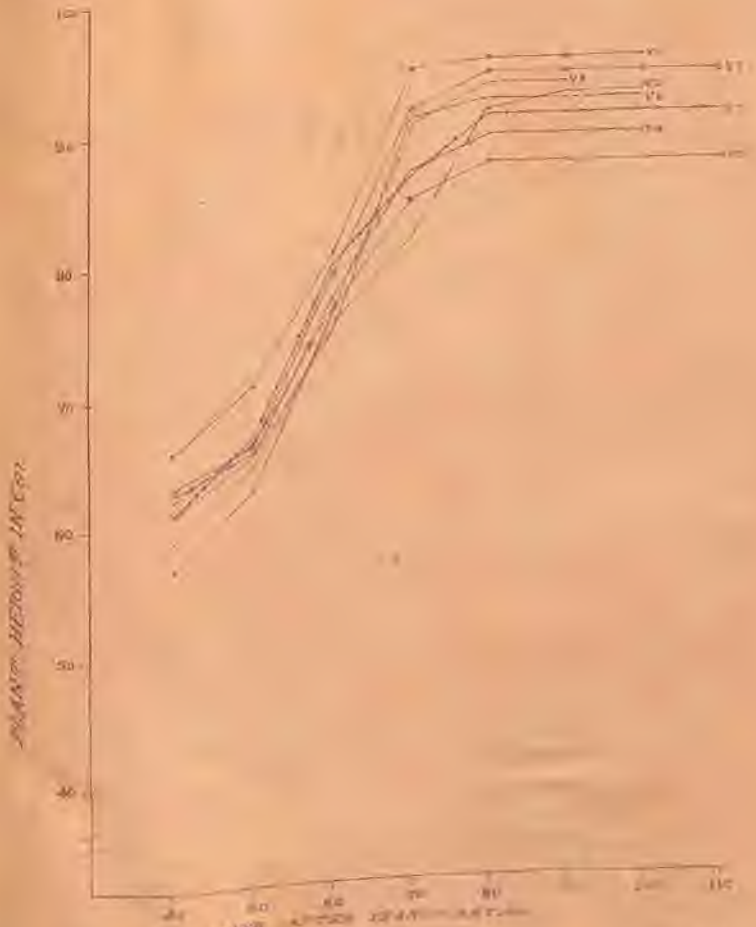
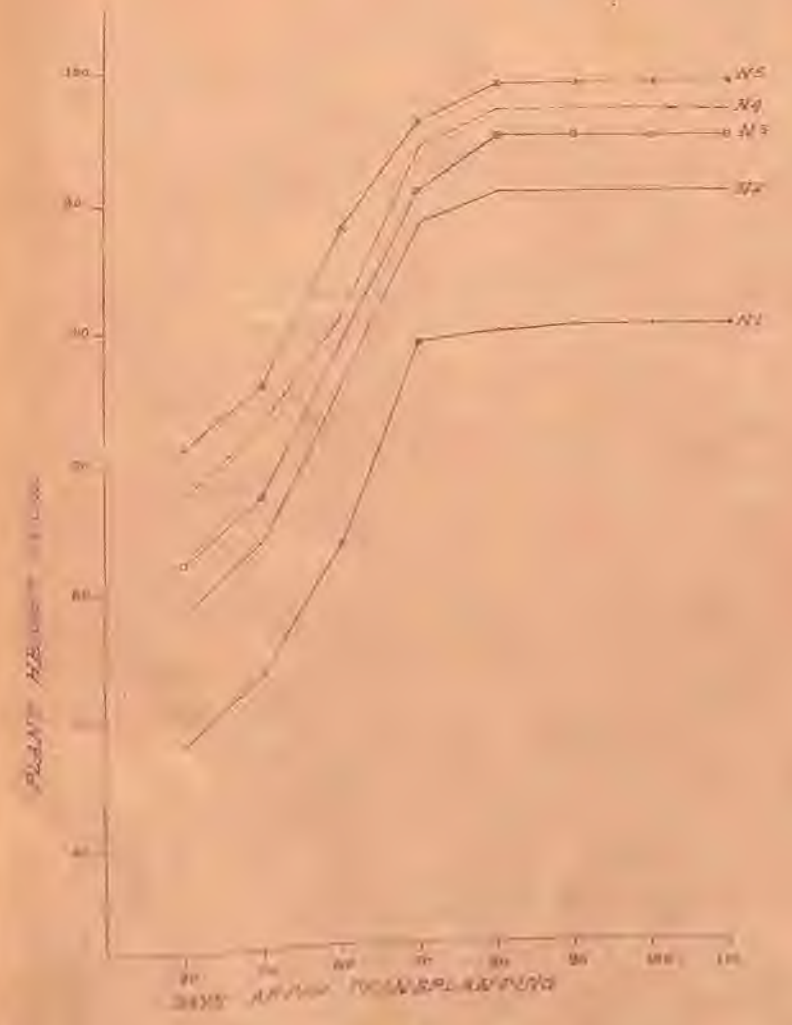


Fig. 1 HEIGHT OF PLANTS AT DIFFERENT INTERVALS DUE TO DIFFERENT

SCALE

2.5 Cm = 10 Cm Plant Height.

1.5 Cm = 10 Days Interval.



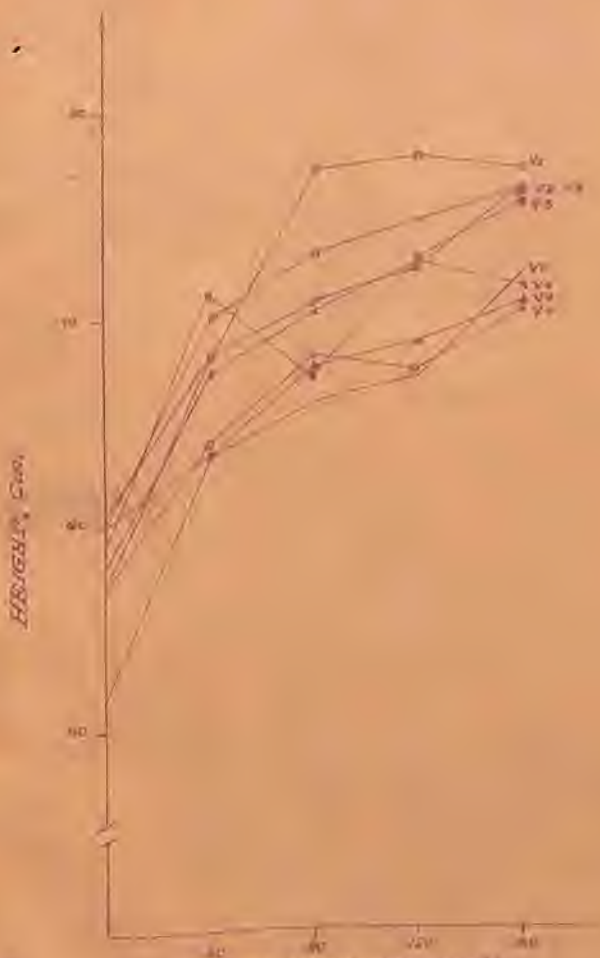


FIG. 4

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON REMOTE PLANTS

with (V_4) IET 2254 and (V_7) IET 1996 gave lower plant height than (V_8) IET 2285.

Each increase in dose of nitrogen increased the plant height significantly from 0 to 40, 40 to 80, 80 to 120 and from 120 to 160 kg/ha correspondingly.

Number of tillers per sq. meter :

The 'F' test (appendix III) indicated that differences in total tillers/m^2 were significant due to varieties and nitrogen levels. The interaction effect was not significant.

Table 9. Mean number of tillers/m^2 as affected by various treatments (at final stage).

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	277.20	344.40	351.86	407.86	419.06	360.07
V_2	327.60	398.53	420.00	508.66	575.86	446.13
V_3	263.20	368.26	364.93	430.26	459.20	321.17
V_4	370.53	393.86	441.46	468.53	510.53	436.98
V_5	362.80	441.46	485.33	516.13	560.00	471.14
V_6	295.86	392.00	442.40	479.73	551.60	432.31
V_7	320.13	426.53	455.46	520.80	518.00	448.18
V_8	293.06	364.00	399.46	449.86	466.66	394.60
Mean	312.54	393.63	420.11	472.73	507.61	

	Variety	Nitrogen	Interaction
S.Em. ±	12.98	6.83	19.34
C.D. (0.05)	39.29	19.34	

FIG. 6

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON NUMBER OF TILLERS PER Sq. m.

SCALE : 1 Cm = 25 Tillers

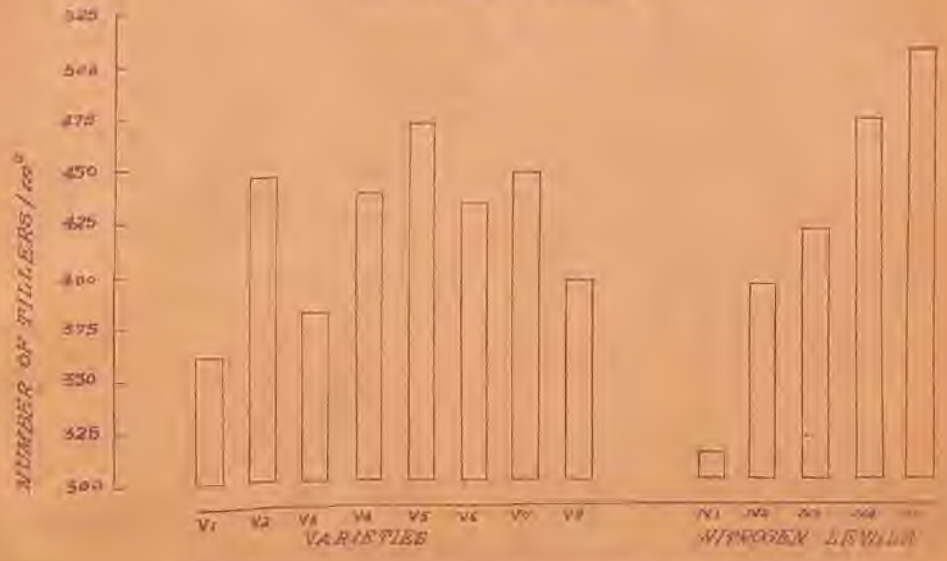
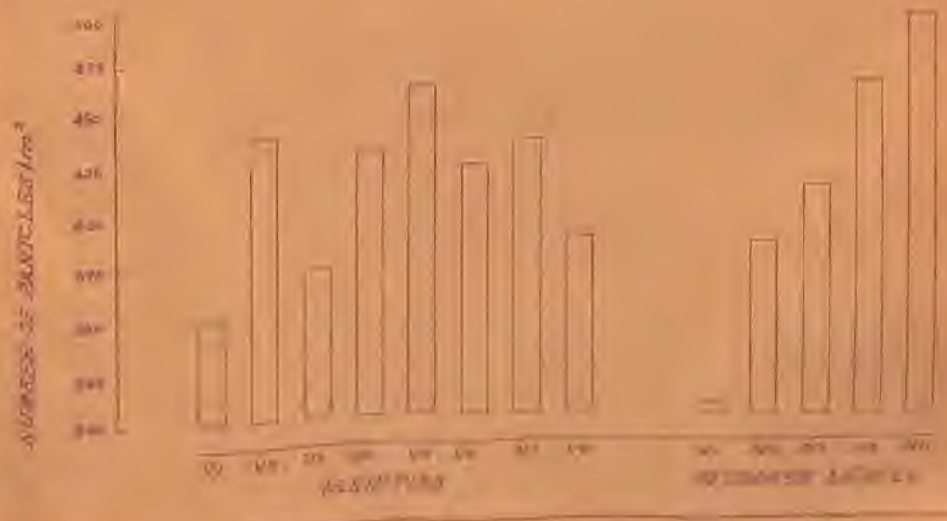


FIG. 7

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON NUMBER OF PANICLES PER Sq. m.

SCALE : 1 Cm = 25 Panicles



Varieties (V5) IET 1939, (V7) IET 1996, (V_2) IET 2295 and (V_4) IET 2254 being analogous among themselves and with variety (V_6) IET 2285 produced significantly more number of tillers/m^2 than (V8) Ratna, (V3) IET 1991 and (V_1) Jaya. Varieties (V_6) IET 2285 and (V8) Ratna though similar with each other gave more number of tillers/m^2 than (V3) IET 1991 and (V_1) Jaya which inturn were identical in number of tillers/m^2.

Significant increase in number of tillers/m^2 was obtained with each increase in dose of nitrogen from 0 to 40, 40 to 80, 80 to 120 and 120 to 160 kg N/ha.

Number of days to maturity :

It is evident from the 'F' test (appendix III) that the differences in number of days to maturity were significant due to varieties and nitrogen levels. The interaction effect was also found to be significant.

Table 10. Mean number of days to maturity as affected by different varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	125.3	124.3	125.3	127.0	127.0	125.8
V_2	126.0	126.3	126.3	128.0	128.0	126.9
V3	134.3	134.3	134.6	135.0	135.0	134.6
V_4	125.6	126.0	126.3	127.3	127.6	126.6
V5	133.6	134.0	133.6	134.3	135.0	134.1
V_6	125.0	126.3	127.0	128.0	128.0	126.8
V7	133.3	133.6	133.6	134.3	135.0	133.9
V8	115.0	114.3	113.3	116.0	116.0	114.9
Mean	127.3	127.4	127.5	128.7	128.9	

	Variety	Nitrogen	Interaction
S.Em. ±	0.29	0.12	0.33
C.D.(0.05)	0.87	0.34	0.96

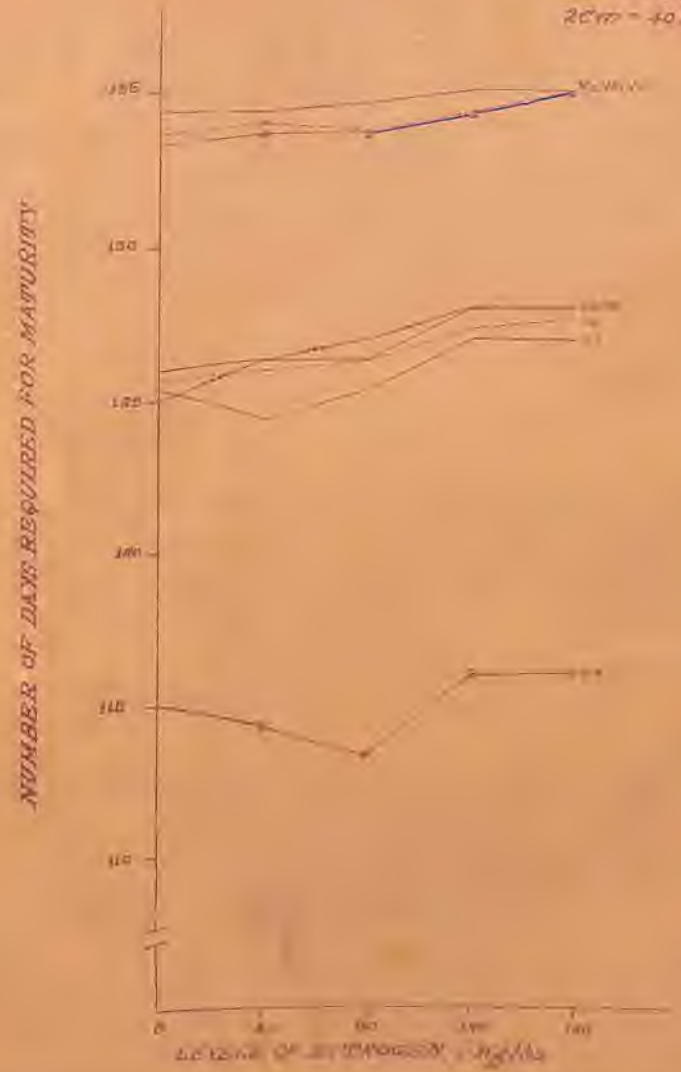


FIG. 8

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON NUMBER OF DAYS TO MATURITY

Varieties (V_3) IET 1991, (V_5) IET 1030 and (V_7) IET 1996 showing identical maturity period among themselves all the three required significantly more number of days to maturity than rest of the varieties. Varieties (V_2) IET 2295 and (V_6) IET 2885 having similar maturity period between themselves as also with variety (V_4) IET 2254 required more number of days to mature than (V_1) Jaya and (V_8) Ratna. Varieties (V_4) IET 2254 and (V_1) Jaya being at par in maturity period both of it required more number of days to mature than variety (V_8) Ratna which required significantly minimum number of days to mature as compared to all other varieties.

40 kg N/ha (N_2) and 80 kg N/ha(N_3) nitrogen application did not induced lengthening in maturity as maturity in this case was similar to that of no nitrogen (N_1) application. Higher doses of nitrogen i.e. 120 and 160 kg N/ha being identical in their effects proved better to bring about delay in maturity having significantly more number of days to maturity in its favour.

Interaction between varieties and doses of nitrogen was as follows.

Variety (V_1) Jaya recorded the lowest number of days to maturity with 40 kg N/ha (N_2) where-as 80 kg N/ha (N_3) needed similar number of days as in no nitrogen application (N_1) which were less than 120 kg N/ha (N_4) and 160 kg N/ha (N_5). Varieties (V_2) IET 2295 and (V_4) IET 2254 took similar number of days to maturity till 80 kg N/ha (N_3) and further higher dose of 120 kg N/ha (N_4) lengthen the period of maturity. Beyond this dose the effect was stand still. In case of varieties (V_5) IET 1030 and (V_7) IET 1996 application of

no nitrogen (N_1), 40 kg N/ha (N_2) and 80 kg N/ha (N_3) required similar number of days to maturity as 120 kg N/ha (N_4) but less than for 160 kg N/ha (N_5). Variety (V_6) IET 2885 recorded lowest number of days to maturity with no nitrogen (N_1). With 40 kg N/ha (N_2) and 80 kg N/ha (N_3), the number of days to maturity required were similar but less than required with application of 120 kg N/ha (N_4) and 160 kg N/ha (N_5) which in turn were identical in themselves. Variety (V_8) Ratna matured earlier when grown with 80 kg N/ha (N_3) which was earlier than 40 kg N/ha (N_2) or no nitrogen (N_1) application. These doses required less days to maturity than 120 kg N/ha (N_4) and 160 kg N/ha (N_5). Variety (V_3) IET 1991 was not influenced due to nitrogen application in respect to the period of maturity.

Progressive Growth :

The data recorded on height of the plant and number of tillers/ m² periodically during the life cycle of the crop are presented in Appendices I, II and depicted graphically in figures 3(a), 3(b) and 5.

It is obvious from the data relating to successive height and graphical representation (fig 3(a) and 3(b)) that curves of plant height due to various varieties and doses of nitrogen rose gradually between 40 and 50 days after transplanting, followed by an abrupt rise between interval 50 to 60 and 60 to 70 days after transplanting. The pace of growth slackened up to 80 days after transplanting and almost cessation beyond. Differences in plant height due to different varieties became discernible from the first date of observation i.e. 40 days after transplantation except for varieties (V_6) IET 2885 and (V_7) IET 1996 on first observation (40 days after transplantation) and varieties (V2) IET 2295 and (V_8) Ratna on third observation (60 days after transplantation) in which case height of these varieties was at par. Order of the curve in the case of different varieties was fluctuating on different observation date. However, it can be noted that the height of the varieties (V1) Jaya (V3) IET 1991 (V_5) Ratna and (V_4) IET 2254 in general was on the higher order. At the final stage of growth the order of the curve was (V1) Jaya > (V3) IET 1991 > (V8) Ratna > (V_2) IET 2295 > (V_6) IET 2885 > (V4) IET 2254 > (V_7) IET 1996 > (V_5) IET 1039.

Curves of the plant height as affected by different levels

of nitrogen were very much distinguishable from the first date of observation (40 days after transplantation). Order of the curve since first observation till final stage was (N_5) 160 kg > (N_4) 120 kg > (N_3) 80 kg > (N_2) 40 kg nitrogen per hectare > (N_1) No nitrogen.

As evinced from the data of progressive growth and graph depicted in respect of number of tillers/m², curves due to various varieties and doses of nitrogen were at its pick on the first date of observation (i.e. 40 days after transplanting). There was gradual to sharp fall in number of tillers/m² on onward observation date up to 70 days after transplanting beyond which the values were almost constant up to last observation.

Differences in number of tillers/m² due to different varieties so also the levels of nitrogen were quite conspicuous from the start of the observation (40 days after transplantation) and till the last observation. Order of the curve on maximum tillering (40 days after transplanting) due to varying varieties was (V_2) IET 2295 > (V_8) IET 1030 > (V_6) IET 2885 > (V_4) IET 2254 > (V_7) IET 1996 > (V_8) Ratna > (V_3) IET 1991 > (V_1) Jaya. On the second observation (50 days after transplanting) this situation changed a little, variety (V_8) Ratna exhibited more number of tillers/m² than (V_3) IET 1991 and rest other position remained unchanged. There was again change in varieties stand in respect of number of tillers/m² on third observation. Variety (V_5) IET 1030 pushed forward to surpass (V_2) IET 2295. Similarly (V_7) IET 1996 superseded varieties (V_4) IET 2254 and (V_6) IET 2885. Again there was supple in the position of curves of number of tillers/m² of different varieties on fourth observation (70 days after transplantation). The order of the curve was variety

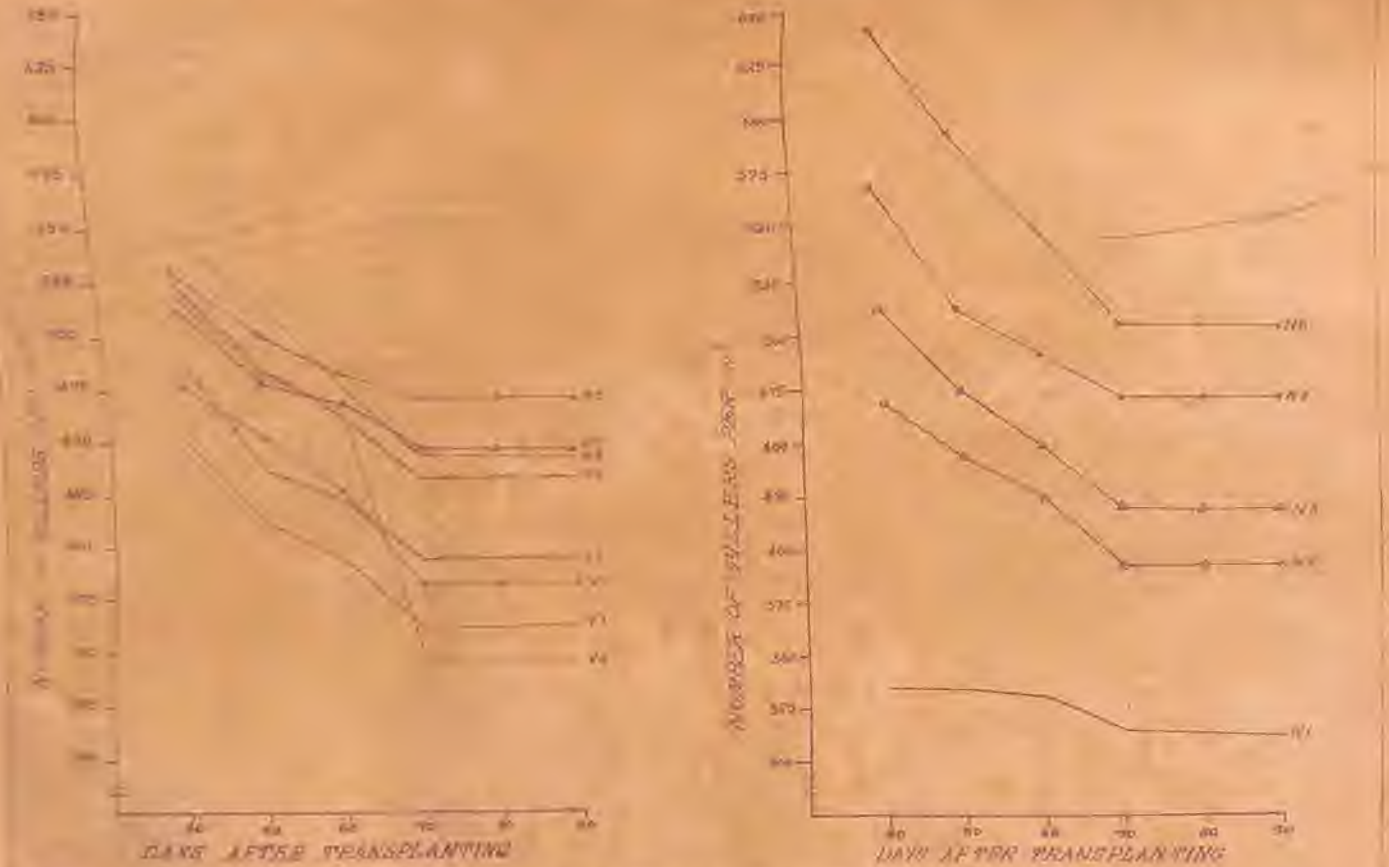


FIG-5 NUMBER OF TILLERS AT DIFFERENT INTERVALS FOR TWO VARIETIES AND LEVELS OF NITROGEN

(V_5) IET 1039 > (V_7) IET 1996 > (V_9) IET 2295 > (V_6) IET 2885 > (V_8) Ratna > (V_3) IET 1991 > (V_1) Jaya > (V_4) IET 2254. This situation continued till maturity.

Differences in number of tillers/m² as affected by different levels of nitrogen were quite apparent from the first observation. Greater number of tillers/m² was accorded with higher doses of nitrogen. The order of the curve through out the growing period was (N_5) 160 kg > (N_4) 120 kg > (N_3) 80 kg > (N_2) 40 kg nitrogen per hectare > (N_1) no nitrogen.

Yield and yield attributes :

The data relating to final yield grain, straw, total produce and yield attributing characters, viz. number of panicles/m² (effective tillers/m²), length of panicle, number of spikelets per panicle, filled grains per panicle, weight per panicle, sterility percent, test weight and grain to straw ratio were analysed statistically. Analysis of variance of different yield and yield attributing characters studied are given in appendices III, IV, V, VI and the main effects of varieties and levels of nitrogen and their interaction effects on grain and straw yield and total produce and yield attributing characters are portrayed in tables 10, 16, 17, 11, 12, 14, 15, 13, 16, 21, 20 and depicted in figures 16, 15, 14, 7, 9, 11, 12, 10, 13, 18 and 17 respectively.

Number of panicles per square meter :

The 'F' test (appendix IV) indicated that differences in panicles/m² were significant due to varieties and nitrogen levels. Interaction was not significant.

Table 11. Mean number of panicles/m² as affected by different varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	266.0	235.0	343.4	398.5	407.8	350.1
V_2	320.1	390.1	423.4	499.3	566.5	437.8
V_3	255.7	380.8	357.4	420.0	449.8	372.7
V_4	364.0	386.4	434.0	459.2	499.3	428.5
V_5	342.5	431.2	476.9	505.8	549.7	461.2
V_6	286.5	385.4	434.9	470.4	541.3	423.7
V_7	307.0	415.3	445.2	509.6	506.8	436.7
V_8	285.6	356.5	392.0	441.4	457.3	386.5
Mean	303.4	385.0	412.1	463.0	497.3	

	Variety	Nitrogen	Interaction
S.Em ±	12.64	6.82	19.30
C.D. (0.05)	38.26	19.30	

Varieties (V_5) IET 1030, (V_2) IET 2295, (V_7) IET 1996 and (V_4) IET 2254 borne on significantly greater number of panicles/m² than (V_8) Ratna, (V_3) IET 1991 and (V_1) Jaya and similar as (V_6) IET 2285. The latter one inturn being at par with (V_8) Ratna recorded more number of panicles/m² than varieties (V_3) IET 1991, and (V_1) Jaya which were also similar to (V_8) Ratna in producing panicles/m².

The number of panicles/m² was increased significantly by increasing the levels of nitrogen from 0, 40 to 160 kg N/ha exhibiting maximum panicles obtained with application of 160 kg N/ha (N_5).

Length of panicle :

In accordance to the 'F' test (appendix IV) the main effects of varieties and levels of nitrogen were significant on length of panicle. The interaction was not significant.

Table 12. Mean length of panicle in cm as affected by varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	22.90	23.74	24.77	25.01	24.47	24.38
V_2	19.50	21.17	22.74	23.33	23.51	22.05
V_3	23.74	24.83	26.15	26.66	26.55	25.58
V_4	21.74	22.57	24.48	24.92	24.81	23.71
V_5	21.91	23.43	24.74	24.86	24.81	23.95
V_6	22.14	24.83	25.70	25.38	25.41	24.69
V_7	22.79	24.20	25.18	25.50	25.20	24.57
V_8	22.09	23.84	24.88	24.76	24.82	24.10
Mean	22.10	23.57	24.83	25.05	25.07	

	Variety	Nitrogen	Interaction
S.Em ±	0.17	0.09	0.28
C.D. (0.05)	0.53	0.28	

Variety (V_3) IET 1991 measured significantly longer panicle than all other varieties. (V_8) IET 2885 gave panicle length larger than rest of the varieties except (V_7) IET 1996 and (V_1) Jaya; (V_7) IET 1996 also being similar to (V_8) Ratna gave larger panicle than (V_5) IET 1039, (V_4) IET 2254 and (V_2) IET 2295. Varieties (V_8) Ratna and (V_5) IET 1039 were analogous to (V_4) IET 2254 also. (V_2) IET2295 gave lowest panicle length significantly as compared to all other

FIG. 9

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON LENGTH OF PANICLE

SCALE: 1·5 Cm = 1·0 Cm length of Panicle

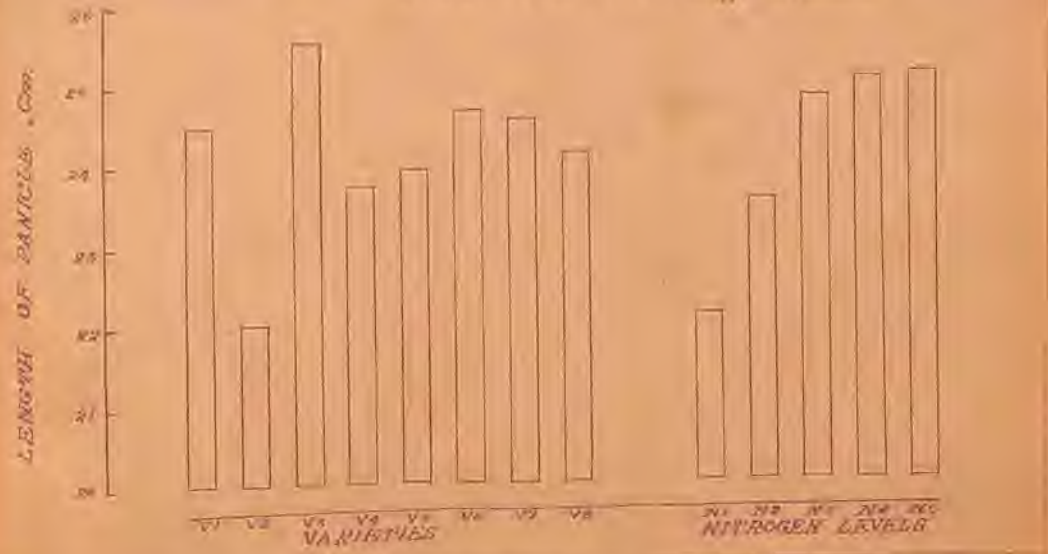
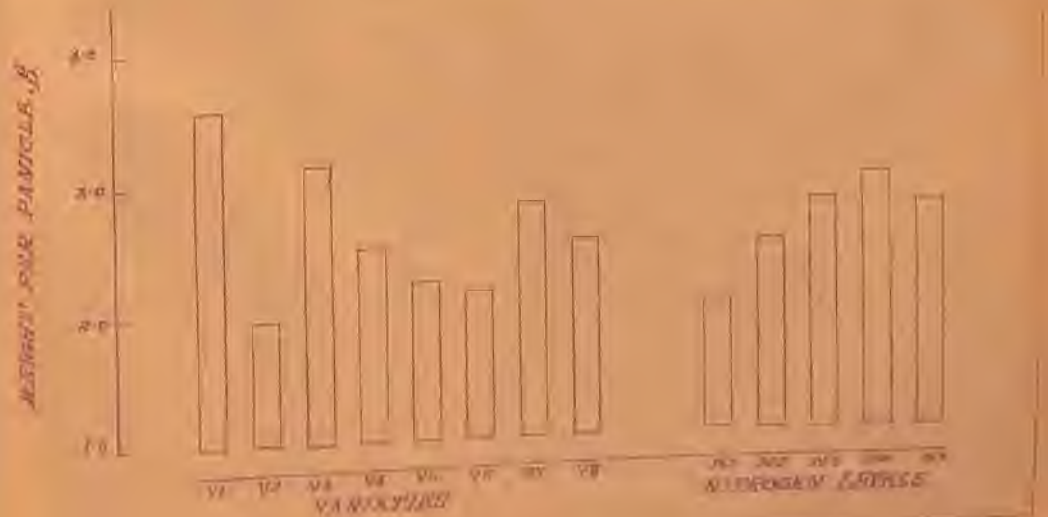


FIG. 10

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON WEIGHT PER PANICLE

SCALE: 1 Cm = 1 gm wt. of Panicle



varieties.

Application of nitrogen from 0 to 40 and 40 to 80 kg N/ha (N_3) increased the length of panicle significantly and further increase in the level of nitrogen was not significant in its effect.

Weight per panicle :

As it is clear from the analysis of variance (appendix V) main effects of varieties and nitrogen were significant. The interaction was not found to be significant.

Table 13. Mean weight per panicle in g as effected by varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	2.67	3.01	3.62	4.85	3.74	3.574
V_2	1.52	1.76	2.08	2.17	2.21	1.948
V_3	2.29	3.04	3.34	3.52	3.45	3.128
V_4	1.99	2.41	2.79	2.82	2.52	2.506
V_5	1.73	2.12	2.41	2.48	2.41	2.230
V_6	1.73	2.23	2.34	2.31	2.16	2.154
V_7	2.33	2.81	2.98	3.03	3.02	2.834
V_8	1.91	2.46	2.77	2.76	2.64	2.508
Mean	2.021	2.480	2.791	2.992	2.768	

	Variety	Nitrogen	Interaction
S.Em ±	0.084	0.063	0.190
C.D. (0.05)	0.250	0.180	

The highest weight per panicle was obtained under variety (V1)

Jaya followed by (V3) IET 1991 and (V7) IET 1996 which were differenciating significantly among themselves and all the three superior to rest of the varieties. Varieties (V8) Ratna and (V4) IET 2254 were similar among themselves but superior to varieties (V5) IET 1039, (V6) IET 2285 and (V2) IET 2295 which gave similar weight per panicle in turn.

Increase in nitrogen level from 0 to 40, 40 to 80 and 80 to 120 kg N/ha increased the panicle weight significantly. Further increase in the level of nitrogen reduced the weight of panicle significantly, less than that due to N_4 (i.e. 120 kg N/ha).

Number of spikelets per panicle :

It is evident from 'F' test (appendix IV) that the differences in number of spikelets per panicle were significant due to varieties and nitrogen levels. The interaction effect was also analysed to be significant.

Table 14. Mean number of spikelets per panicle as affected by varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V^1	160.3	166.7	170.2	185.2	187.9	174.1
V^2	91.0	11.1	133.3	137.2	135.9	121.7
V^3	136.7	137.8	156.8	178.2	206.0	163.1
V4	110.0	110.8	150.3	143.4	132.3	129.3
V5	144.9	145.0	154.7	163.4	197.0	161.0
V6	98.2	138.2	130.0	144.7	142.2	130.6
V7	131.0	138.3	149.6	157.8	162.1	144.7
V8	98.0	125.8	139.2	136.9	139.0	127.8
Mean	121.2	134.2	148.0	156.8	162.8	

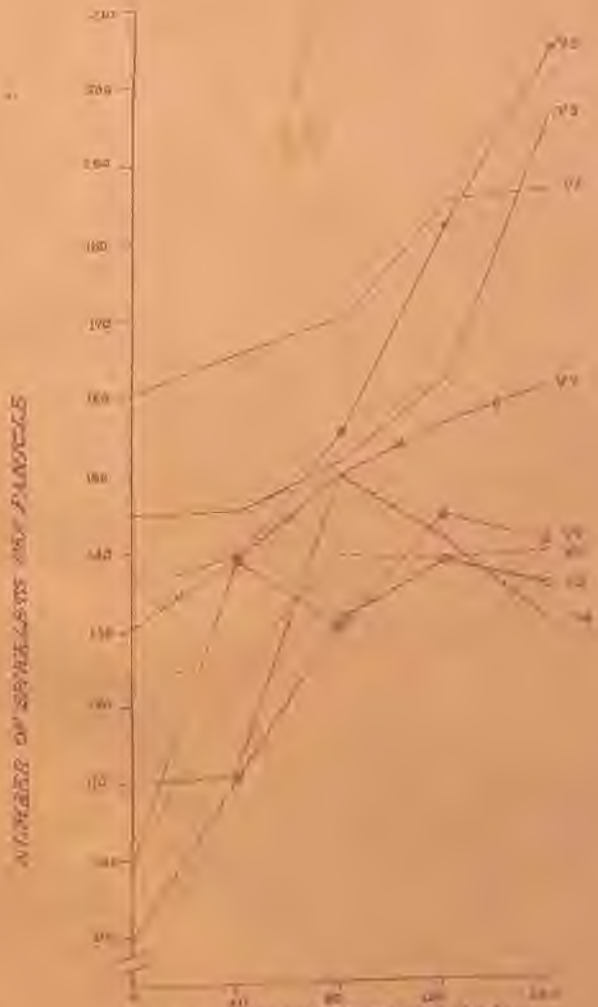


FIG 11

ANALYSIS OF DIFFERENTIAL EFFECTS OF NITROGEN AND PHOSPHORUS ON NUMBER OF SPIKELETS PER PANICLE

	Variety	Nitrogen	Interaction
S.Em ±	0.72	0.93	2.64
C.D. (0.05)	2.11	2.64	7.48

Variety (V_1) Jaya produced significantly higher number of spikelets per panicle than all other varieties. Varieties (V_3) IET 1991 and (V_5) IET 1039 were similar and produced more spikelets than varieties (V_7) IET 1996, (V_6) IET 2285, (V_4) IET 2254, (V_8) Ratna and (V_2) IET 2295. Variety (V_7) IET 1996 being next but having significant variation with varieties (V_3) IET 1991 and (V_5) IET 1039 was similar as these varieties in its effect over rest other varieties. Variety (V_6) IET 2285 though similar to (V_4) IET 2254 produced more spikelets than (V_8) Ratna. Variety (V_2) IET 2295 produced significantly lower number of spikelets per panicle than all other varieties.

Each increase in level of nitrogen 0-40-80 up to highest dose i.e. 160 kg N/ha increased significantly the number of spikelets per panicle.

Interaction showed that all the varieties were influenced due to nitrogen application. The values being similar between (N_1) 0 and (N_2) 40 kg N/ha, each further increase in level of nitrogen up to highest dose i.e. 160 kg N/ha produced significantly greater number of spikelets per panicle under varieties (V_3) IET 1991 and (V_5) IET 1039. In case of variety (V_1) Jaya spikelets per panicle increased significantly only with application of 120 kg N/ha and further increase in dose of nitrogen was alike. In variety (V_4) IET 2254, nitrogen level (N_3) 80 kg N/ha gave highest number of spikelets per panicle and significantly superior over rest other doses except (N_4) 120 kg N/ha. The declining effects were obtained with addition of nitrogen

beyond 80 kg N/ha. Varieties (V_2) IET 2295 and (V_8) Ratna did not show any significant response with more than 80 kg N/ha (N_3) nitrogen application.

Number of filled grains per panicle :

The differences in filled grains per panicle as affected by varieties and levels of nitrogen were significant. Interaction effect was not significant (appendix IV).

Table 15. Mean number of filled grains per panicle as affected by varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	122.40	133.33	140.26	151.46	155.06	140.50
V_2	64.63	88.33	107.13	111.76	107.60	95.89
V_3	104.40	113.40	126.86	144.13	136.46	125.05
V_4	79.66	80.73	126.13	96.80	93.33	95.33
V_5	63.60	101.60	114.40	122.66	105.66	101.58
V_6	76.80	107.53	113.00	126.00	118.93	108.45
V_7	104.33	122.00	136.93	132.33	136.40	126.39
V_8	82.93	102.83	113.66	109.66	110.46	103.88
Mean	87.34	106.20	122.29	124.35	120.48	

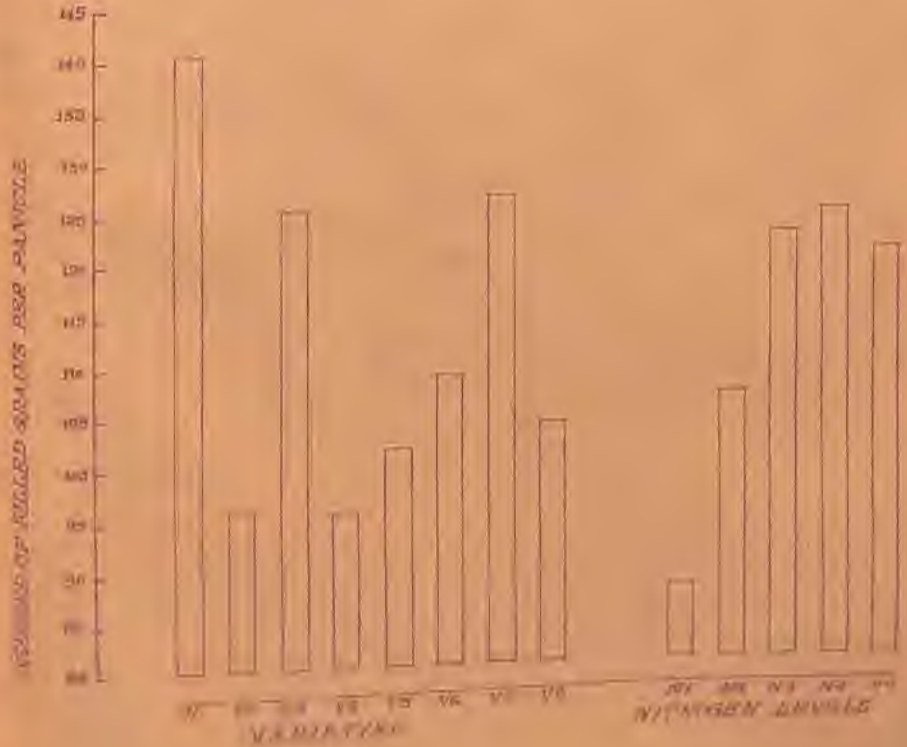
	Variety	Nitrogen	Interaction
S.Em ±	0.90	2.76	7.82
C.D. (0.05)	2.73	7.82	

Variety (V_1) Jaya counted significantly more filled grains than all other varieties. Varieties (V_7) IET 1996 and (V_3) IET 1991 were similar but superior to rest of the varieties. Variety (V_6) IET 2885 gave significant by more filled grains than (V8) Ratna and (V_5) IET 1039 which in turn was superior over (V_4) IET 2254 and

FIG. 18

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON NUMBER OF GRAINS PER PANICLE

SCALE - 1 cm = 5 Real Grains



(V_2) IET 2295.

Each addition of nitrogen doses from (N1) o to (N_2) 40 and (N2) 40 to (N3) 80 kg/ha increased the number of filled grains per panicle significantly. Application of 120 kg N/ha (N_4) increased the variation with (N_3) 80 kg N/ha was not significant. Addition of filled grains but the number of further dose of nitrogen decreased the number of filled grains per panicle, though the variations with the preceeding two doses i.e. 120 and 80 kg N/ha were not significant.

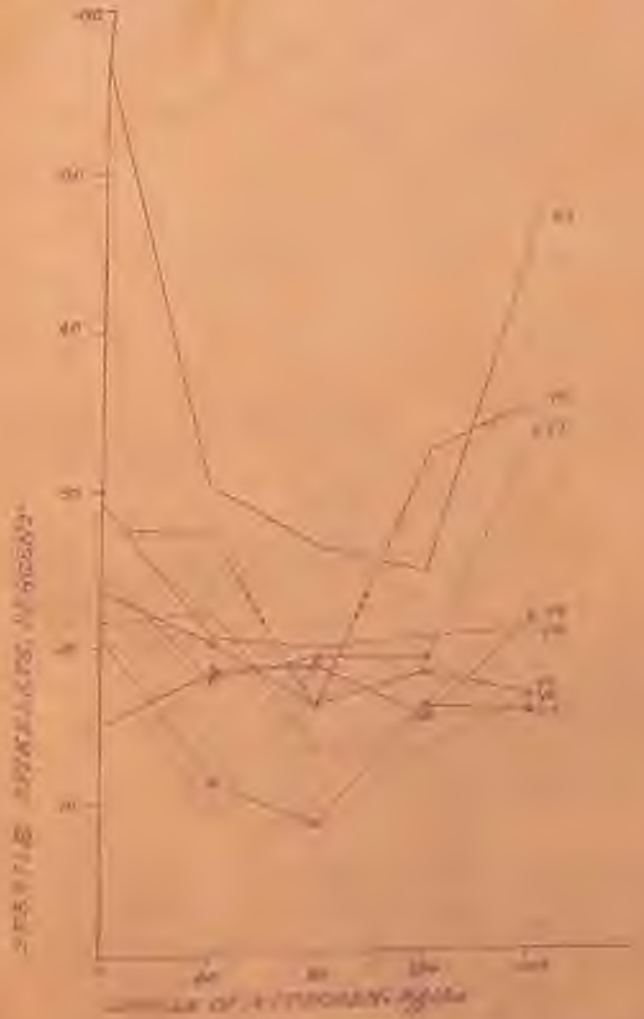
Sterility percent:

From the statistical analysis (appendix VI) it was clear that the sterility percent varied significantly due to varieties and nitrogen levels. Interaction was also found to be affecting the sterility percentage significantly.

Table 16. Mean sterility percent as affected by varieties, levels of nitrogen and interaction.

Treatments	N	N	N	N	N	Mean
V_1	23.65	20.04	16.04	18.17	16.53	18.88
V_2	29.08	20.57	19.69	20.55	20.81	22.14
V_3	23.70	17.71	19.09	19.16	33.77	22.68
V_4	27.57	27.13	15.91	32.55	35.53	27.74
V_5	56.34	29.94	26.07	24.88	47.03	36.85
V_6	21.80	22.19	13.07	12.95	16.39	17.28
V_7	20.35	11.80	8.46	16.17	15.88	14.53
V_8	15.03	18.38	18.41	15.86	21.64	17.86
Mean	27.19	20.97	17.09	20.03	25.94	

	Varitey	Nitrogen	Interaction
S.Em ±	0.65	0.25	0.72
C.D. (0.05)	1.96	0.72	2.04



Variety (V7) IET 1996 gave significantly lowest sterility percent. Varieties (V_1) Jaya, (V_8) Ratna and (V_6) IET 2885 were similar among themselves and gave lower sterility percent significantly than the remaining varieties. Varieties (V_3) IET 1991 and (V_2) IET 2295 though similar among themselves gave lower sterility percent significantly than (V_4) IET 2954 which in turn gave significantly lower sterility percent than (V_5) IET 1039.

With increase in nitrogen level from (N_1) 0 to (N_2) 40 and (N_2) 40 to (N_3) 80 kg N/ha the percentage of sterility decreased, but due to further application of nitrogen, sterility percentage was increased. The variation in each case was significant.

In all the varieties sterility percent was reduced due to nitrogen application except in variety (V_8) Ratna. It behaved differently than all other varieties. Lower sterility percent was observed with no nitrogen (N_1) application which was similar to 120 kg N/ha (N_4) and all other doses of nitrogen gave more sterility percent than no nitrogen (N_1) and 120 kg N/ha (N_4). Variety (V_1) Jaya gave less sterility percent with 80 kg N/ha (N_3) than 120 kg N/ha (N_4) and 40 kg N/ha (N_2) though similar to 160 kg N/ha (N_5) nitrogen application. In case of varieties (V_2) IET 2295 and (V_5) IET 1039, there was reduction in sterility percent with application of nitrogen with difference that variety (V_2) IET 2295 gave no significant increase in sterility percent due to nitrogen levels where as in variety (V_5) IET 1039 application of 120 kg N/ha (N_4) and 80 kg N/ha (N_3) gave less sterility percent than 40 kg N/ha (N_2) which gave less than 160 kg N/ha (N_5). Variety (V_3) IET 1991 gave lower sterility percent with 40 kg N/ha (N_2), 80 kg N/ha (N_3) and 120 kg N/ha (N_4). Highest dose of nitrogen

i.e. 160 kg N/ha (N_5) resulted in increase in sterility percent. Variety (V4) IET 2254 had reduction in sterility percent with 80 kg N/ha (N_3) and further increase in nitrogen application resulted in increase in sterility more than no nitrogen application (N_1), whereas in variety (V7) IET 1996 though lowest sterility was with 80 kg N/ha (N_3), higher doses of nitrogen application increased the sterility percent which was less than that of no nitrogen application(N_1). Variety (V_6) IET 2885 gave lower steility percent with 120 kg N/ha (N_4) or 80 kg N/ha (N_3). Nitrogen application of 160 kg N/ha (N_5) though gave more sterility percent than 120 kg N/ha (N_4) and 80 kg N/ha (N_3) it was less than that of no nitrogen (N_1) or 40 kg N/ha (N_2) which recorded similar sterility percent.

Total produce in g / ha :

The variations in total produce due to different varieties and due to levels of nitrogen were significant. The interaction whereas, was not found to be significant (appendix V).

Table 17. The mean total produce in q /ha as affected by different varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	74.71	90.96	113.70	131.57	133.19	108.83
V_2	74.71	128.32	144.57	157.56	170.56	135.14
V_3	77.97	110.45	123.45	134.82	151.07	119.55
V_4	84.46	110.45	126.70	136.45	144.57	120.53
V_5	74.71	100.71	129.95	134.82	147.81	117.60
V_6	77.97	120.20	131.57	149.44	164.06	128.65
V_7	84.46	113.70	131.57	146.19	155.26	126.24
V_8	71.47	100.71	110.45	128.32	123.45	106.88
Mean	68.62	109.44	126.49	139.90	148.74	

	Variety	Nitrogen	Interaction
S.Em ±	4.48	1.94	5.75
C.D. (0.05)	13.76	5.65	

The maximum total produce/ha was recorded under variety (V_2) IET 2295 which was greater significantly than the total produce/ha of all other varieties except (V_6) IET 2885 and (V_7) 1996 ; the variation in whichcase was at par. Varieties (V_6) IET 2885 and (V_7) IET 1996 being similar with each other were superior over varieties (V_1) Jaya and (V_8) Ratna in respect of total produce. Variations in total produce for rest other varieties were not significant.

With the increase in level of nitrogen from 0 to 40, 40 to 80, 80 to 120 and 120 to 160 correspondingly higher total produce significantly was obtained. The highest total produce of 149 q /ha was obtained due to 160 kg N/ha (N_5) which was 116, 37, 18 and 6 percent greater than than (N_1) no nitrogen, (N_2) 40 kg, (N_3) 80 kg and (N_4)

FIG. 14

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON TOTAL PRODUCE (GRAIN + STRAW)

SCALE :- 1 Cm. = 10 q. of Total Produce

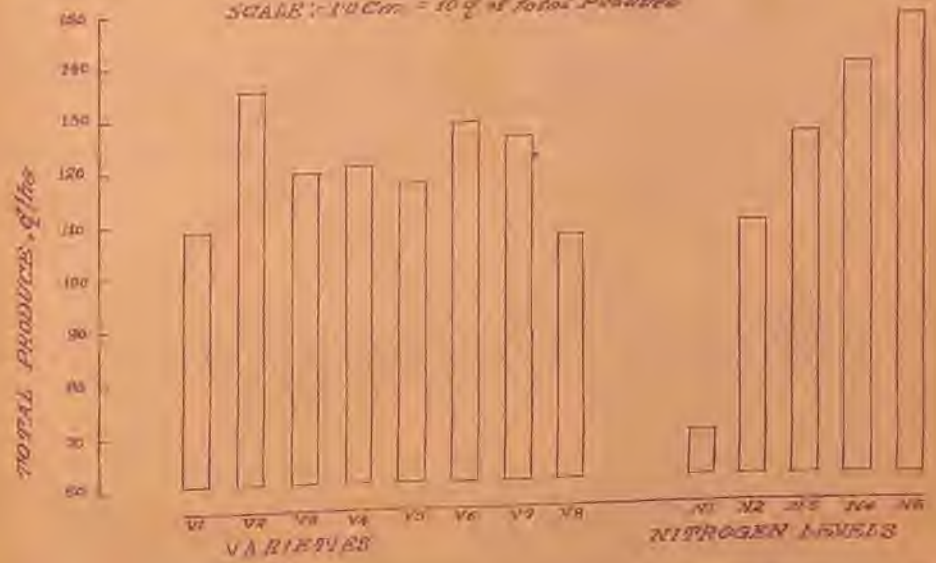
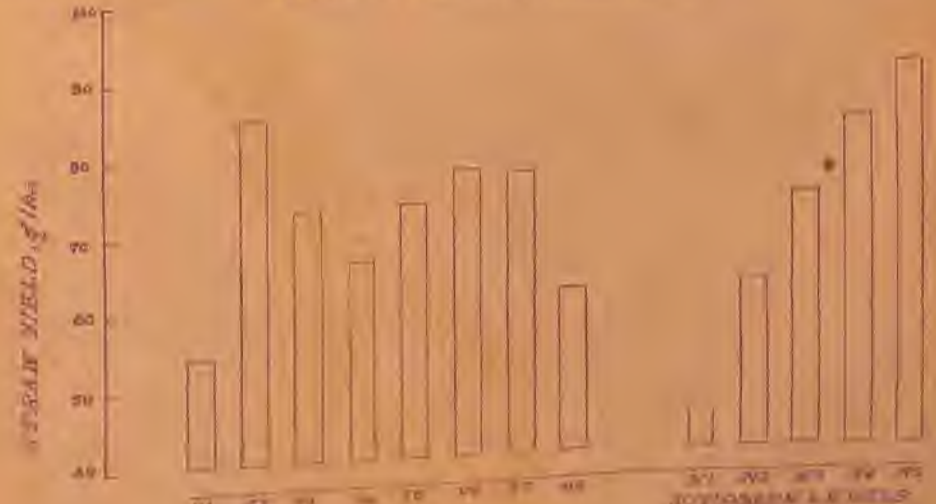


FIG. 15.

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON STRAW YIELD

SCALE :- 1 Cm = 10 q. Straw yield



120 kg nitrogen per hectare respectively.

Yield of straw (in q/ha):

It is clearly indicated from the data (appendix V) that the differences in straw weight per hectare due to varieties and due to nitrogen levels were significant where as interaction effect was not significant.

Table 18. Mean straw yield in q /ha as affected by different varieties, varying levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	37.52	39.96	56.53	68.51	67.05	53.91
V_2	45.80	79.43	93.37	98.44	107.50	84.91
V_3	46.29	66.08	73.19	84.30	93.56	72.68
V_4	44.63	57.79	67.83	76.80	82.84	65.98
V_5	48.24	63.35	80.40	82.94	91.42	73.27
V_6	49.70	67.34	75.04	92.88	102.92	77.58
V_7	51.46	67.25	80.89	91.13	94.34	77.01
V_8	35.67	57.79	61.01	71.73	81.18	61.48
Mean	44.91	62.37	73.53	83.34	90.10	

	Variety	Nitrogen	Interaction
S.Em ±	4.77	1.56	4.68
C.D. (0.05)	14.60	4.48	

Variety (V_2) IET 2295 being at par with varieties (V_6) IET 2886, (V_7) IET 1996, (V_5) IET 1039 and (V_3) IET 1991 was significantly superior over varieties (V_4) IET 2254, (V_8) Ratna and (V_1) Jaya in respect of straw produce per hectare. Varieties (V_6) IET 2886 and

(V7) IET 1996 having analogous values between themselves gave significantly higher straw yield than varieties (Vg) Ratna and (V1) Jaya. Variety (V5) IET 1039 and (V3) IET 1991 having similar straw produce between them, both of it accounted for significantly greater yield of straw than variety (V_1) Jaya. The other comparisons between different varieties were not significant.

Correspondingly higher straw produce was obtained with successive increase in levels of nitrogen from 0 to 40, 40 to 80, 80 to 120 and 120 to 160 kg/ha. The highest dose i.e. 160 kg N/ha produced 90 quintals of straw/ha which was in terms of percentage 100, 45, 22 and 8 extra over 0, 40, 80 and 120 kg N/ha.

Yield of grains (in q / ha) :

From statistical analysis of data corresponding to the yield of grains (appendix V), it is evident that the variations in yield of grains due to varieties and levels of nitrogen were significant. The interaction effect was not seen to be significant.

Table 19. Mean yield of grains in q /ha as affected by different varieties, varying levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V1	37.13	50.97	57.11	62.96	66.08	54.85
V2	28.84	45.90	51.16	59.06	62.96	49.59
V3	31.67	44.34	50.19	60.03	57.50	48.75
V4	39.76	52.63	58.77	62.86	61.69	55.14
V5	26.41	37.32	49.51	51.75	56.33	44.26
V6	28.26	52.72	56.53	59.55	61.06	51.61
V7	32.94	46.30	49.99	55.06	60.91	49.06
V8	35.67	42.88	49.31	52.63	42.20	44.54
Mean	32.59	46.64	52.82	57.99	58.58	

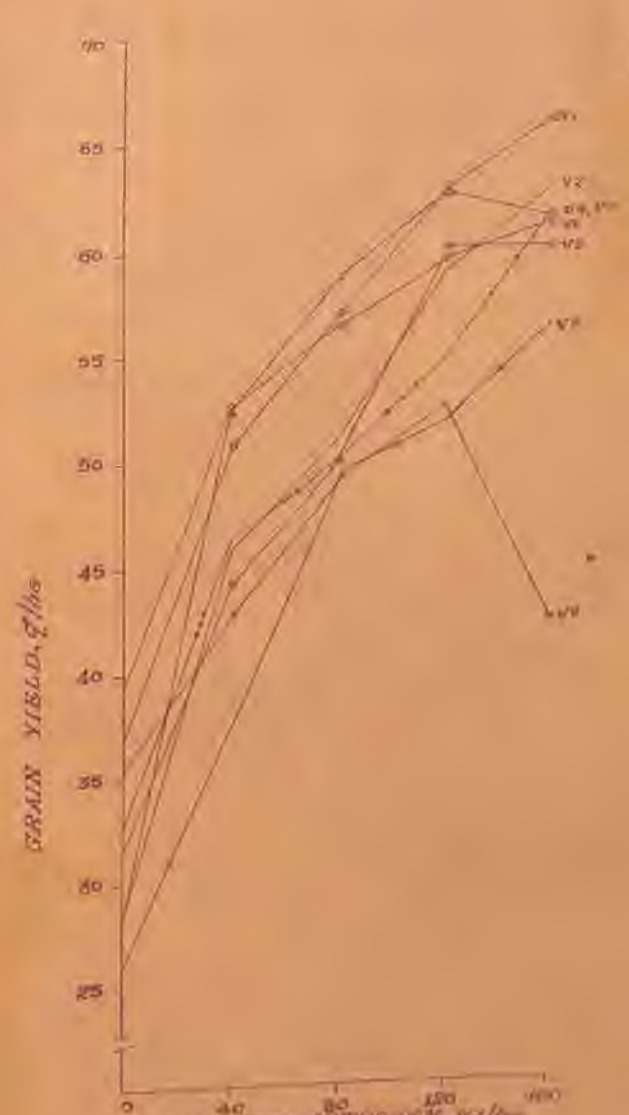


Fig. 10

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIATIONS OF GRAIN YIELD

	Varieties	Nitrogen	Interaction
S.Em ±	1.73	0.87	2.72
C.D. (0.05)	5.42	2.73	

Yield of grains due to variety (V4) IET 2254 was higher over all other varieties. Comparisons of yield of this variety with other varieties under study were significant except for varieties (V1) Jaya and (V_6) IET 2885 in which case variations in yield were at par.

An extra yield produced by variety (V4) IET 2254 was 10.88, 10.60, 7.39, 6.55, 6.08, 4.53 and 0.29 quintals per hectare over varieties (V5) IET 1039, (V8) Ratna, (V3) IET 1991, (V2) IET 2295, (V7) IET 1996, (V6) IET 2885 and (V1) Jaya respectively. Expressed on the percentage basis the corresponding extra yields were of the order of 24.58, 23.80, 15.16, 13.21, 12.39, 8.78 and 0.55 respectively. Variety (V1) Jaya was similar to varieties (V6) IET 2885 and (V2) IET 2295 and superior to (V7) IET 1996, (V3) IET 1991, (V8) Ratna and (V5) IET 1039 in grain yield per hectare. Variety (V6) IET 2295, (V7) IET 1996, and (V3) IET 1991 gave significantly higher grain yield than varieties (V8) Ratna and (V5) IET 1039. Varieties (V_7) IET 1996, (V3) IET 1991, (V8) Ratna and (V_5) IET 1039 were analogous among themselves in yield of grain per hectare.

It may thus be inferred that under agro-climatic conditions of Raipur, varieties (V4) IET 2254, (V1) Jaya and (V_6) IET 2885 may be grown for reasonably higher grain yield.

The yield data in respect of the effect of levels of nitrogen show that the grain yield per hectare correspondingly increased with the successive increase in dose of nitrogen from 0 to 40, 40 to 80 and

80 to 120 kg/ha. Beyond this level the increase in yield of grain was not significant. The corresponding extra yield with the successive higher doses of nitrogen was 14.05, 6.18, 5.17 and 0.59 quintals per hectare. Expressed in terms of percentage it was 43, 13, 10 and 1.

Grain to straw ratio :

The 'F' test for grain to straw ratio (appendix VI) apparently show that the grain to straw ratio was affected significantly due to varieties and levels of nitrogen. Interaction was not significant.

Table 20. The mean grain to straw ratio as affected by different varieties, levels of nitrogen and interaction.

Treatments	N1	N2	N3	N4	N5	Mean
V_1	1.058	1.337	1.043	0.953	1.025	1.083
V_2	0.641	0.583	0.554	0.599	0.594	0.592
V_3	0.708	0.672	0.689	0.757	0.612	0.687
V_4	0.942	0.958	0.881	0.837	0.748	0.873
V_5	0.544	0.603	0.613	0.625	0.619	0.601
V_6	0.579	0.783	0.754	0.648	0.577	0.668
V_7	0.648	0.690	0.616	0.630	0.669	0.650
V_8	1.068	0.745	0.812	0.734	0.519	0.775
Mean	0.773	0.796	0.745	0.722	0.669	

	Variety	Nitrogen	Interaction
S.Em ±	0.077	0.028	0.077
C.D. (0.05)	0.235	0.080	

Variety (V_1) Jaya resulted in to more grain to straw ratio than other varieties except (V_4) IET 2254 which in turn gave more grain to

FIG. 1A

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON GRAIN TO STRAW RATIO

SCALE :- 1·5 Cm = 0·2 Grain / Straw ratio

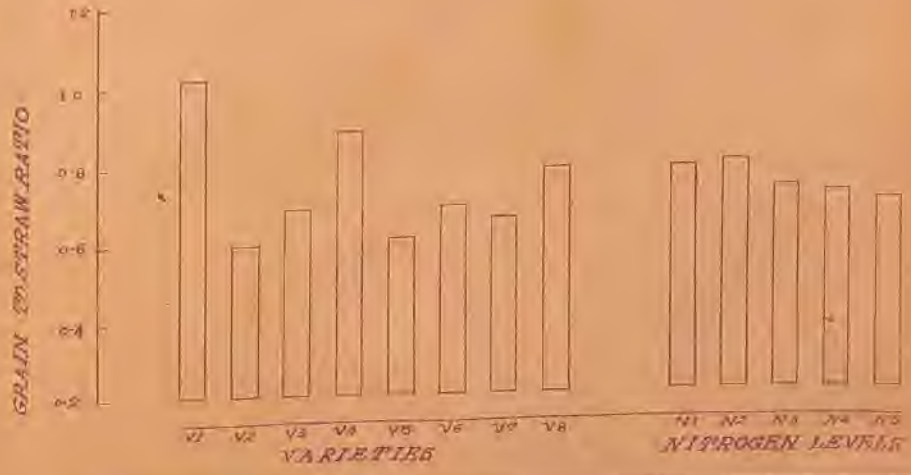
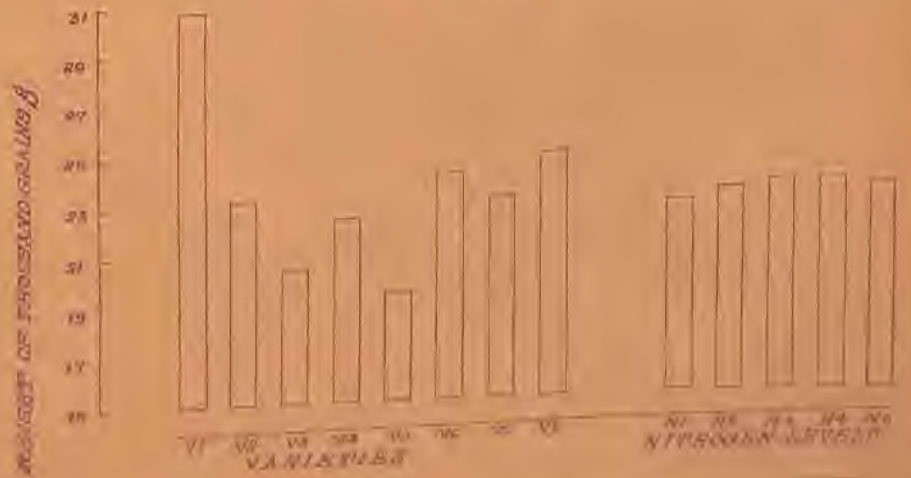


FIG. 1B

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND VARIETIES ON THOUSAND GRAIN WEIGHT

SCALE :- 1·0 Cm = 2·0 g. Thous. wt.



Straw ratio than (V5) IET 1039 and (V_2) IET 2295. The remaining varieties gave similar grain to straw ratio.

40 kg (N_2) and no nitrogen (N_1) produced the similar grain to straw ratio but significantly greater than that of 160 kg N/ha (N_5). Similar grain to straw ratio was observed due to application of 80 kg N (N_3), 120 kg N (N_4) and 160 kg N/ha (N_5).

Test weight (thousandgrain weight):

The 'F' test (appendix VI) shows that the differences in the weight of thousand grains due to varieties to be significant and levels of nitrogen and interaction effects not significant.

Table 21. Mean weight of thousand grains in g as affected by varieties, levels of nitrogen and interaction.

Treatments	N_1	N_2	N_3	N_4	N_5	Mean
V_1	29.520	30.620	31.086	31.360	30.916	30.680
V_2	22.490	23.180	23.580	23.510	23.100	23.172
V_3	20.153	20.333	20.566	20.203	20.540	20.359
V_4	21.743	22.050	22.760	22.733	22.673	22.391
V_5	18.916	19.266	19.590	19.546	19.350	19.353
V_6	23.576	24.033	24.303	24.266	24.000	24.035
V_7	22.896	22.920	23.000	23.050	22.936	22.960
V_8	23.400	23.393	23.973	24.010	23.793	23.713
Mean	22.836	23.224	23.607	23.597	23.401	

	Variety	Nitrogen	Interaction
S.Em ±	0.127	0.360	1.024
C.D. (0.05)	0.385		

Variety (V_1) Jaya recorded significantly higher thousand grain

weight than all other varieties. There was no significant difference among (V_6) IET 2885 and (V_8) Ratna which gave more test weight than rest of the varieties (V_2) IET 2295 gave significantly more thousand grain weight than (V_4) IET 2254 though similar to (V_7) IET 1996 which in turn was similar to (V_4) IET 2254 also. Variety (V_5) IET 1039 showed significantly lower thousand grain weight than all other varieties.

DISCUSSION

D I S C U S S I O N

The findings of the present investigation, entitled " Effect of varying levels of nitrogen on growth yield and quality of medium duration high yielding paddy varieties", described in the preceding chapter are discussed here in order to find out possible explainations in the light of review of literature cited, for the results obtained.

Yield is the ultimate expression of the growth characters and the yield attributes. Therefore, it is important to study the effects of various treatments on the growth characters and how the growth characters have affected the various yield attributes manifested in to yield finally.

Grain yield of 55.14 quintal/ha was obtained under the variety (V_4) IET 2254, which was the highest yielder amongst the varieties under studies followed by (V1) Jaya (V6) IET 2885, (V2) IET 2295, (V_7) IET 1996, (V_3) IET 1991, (V8) Ratna and (V5) IET 1039 (the lowest yielder) with an yield of 54.85, 51.61, 49.59, 49.06, 48.75, 44.54, and 44.26 quintals/ha respectively. Variations in yield of variety (V_4) IET 2254 with rest other varieties except (V_1) Jaya and (V_6) IET 2885 were significant. Variety (V1) Jaya did not show any significant variation in yield with (V_2) IET 2295 also, keeping rest other results similar to (V4) IET 2254. Whereas, variety (V_6) IET 2885 was significantly superior in yield only over (V_8) Ratna and (V_5) IET 1039.

Yield per unit area in dwarf rice, as in any other crop under uniform plant stand per hectare is mainly governed by behaviour of the crop variety in respect of developmental characters (viz. number of panicles, length of panicle, weight per panicle, number of spikelets

per panicle, filled grains per panicle, sterility percentage, test weight and grain straw ratio) which have got direct bearing in plant yield. It may be pointed out here that the variety (V4) IET 2254 was placed in lower series in respect of length of panicle, number of spikelets per panicle, filled grains per panicle and test weight. Grain sterility percentage under this variety was also quite high. But number of panicle/m2 and grain to straw ratio both being very predominant characters in grain yield were on the higher order and weight per panicle an equally important yield bearing character was of intermediate value under the variety (V_4) IET 2254. This favourable situation of the variety due to number of panicles/m2, weight per panicle and grain to straw ratio not only made good the draw back due to other developmental characters but also placed the variety on the top in respect of yield. As regards variety (V1) Jaya, almost all the yield characters except length of panicle and number of panicles/m² were most conducively affected under the variety. The length of panicle was of intermediate value. But the number of panicles/m2 - a dominant yield contributing character counted to be the lowest under the variety lower ed considerably the favourable effects of rest other yield characters and the yield of the variety of course not varying significantly was placed next to (V_4) IET 2254 in final yield.

In respect of variety (V_5) IET 2285, length of panicle and test weight were second to (V3) IET 1991 and (V_1) Jaya respectively. Number of panicles/m² and filled grains / panicle were of intermediate value. The variety was having less sterility percentage but rest other yield attributes were adversely affected under the variety to bring the variety in third position, of-course the yield variations with

varieties (V4) IET 2954 and (V_1) Jaya were not significant.

Grain yield of varieties (V2) IET 2295 (V_7) IET 1996, (V3) IET 1991, (V_8) Ratna and (V_5) IET 1039 were lower because of the values of lower order of length, weight, number of filled grains per panicle and grain to straw ratio under variety (V2) IET 2295; test weight and grain to straw ratio under (V_7) IET 1996; number of panicles/m^2 and test weight under (V3) IET 1991; number of panicles per m^2, length, number of spikelets and filled grains/panicle and grain to straw ratio under (V_8) Ratna; length, weight and filled grains/panicle, test weight and grain to straw ratio under (V_5) IET 1039; and higher grain sterility percent under varieties (V_5) IET 1039, (V3) IET 1991 and (V2) IET 2295. Good effects of intermediate to higher orders brought about due to rest other yield characters under these varieties did not compensate the loss in yield to these varieties due to aforesaid characters, ultimately expressing these varieties as lower yielder comperatively.

Variation in yield and yield attributes of different varieties may be ascribed to the genetical behaviour of the respective varieties.

Perceptible variations in grain yield were found due to levels of nitrogen. Each increase in dose of nitrogen from 0 to 40, 40 to 80 and 80 to 120 kg/ha increased the grain yield significantly. Beyond 120 kg N/ha, the yield increase was not significant. The highest grain yield of 58.58 quintals per hectare was obtained under the highest dose of nitrogen (160 kg N/ha) included in the experiment followed by 120, 80, 40 kg N/ha and no nitrogen (control) with an yield of 57.99, 52.82, 46.64 and 32.69 quintals per hectare respectively.

Under corresponding higher doses of nitrogen almost all the yield attributes viz. number of panicle, weight of panicle (up to 120 kg N/ha), length of panicle, number of spikelet per panicle, filled grain per panicle (up to 80 kg N/ha) and grain to straw ratio (not significant) were favourably affected. Grain sterility percent was lowest under 80 kg N/ha followed by 120 kg, 40 kg, 160 kg N/ha and no nitrogen (variations were significant with each other). All the growth contributing characters viz. height of the plant, number of tillers and maturity (beyond 80 kg N and up to 120 kg N/ha) were also conducive significantly to successive higher doses of nitrogen. The aforesaid conducive effects in favour of successive higher doses of nitrogen up to 120 kg N/ha led to corresponding higher produce of grains per hectare finally under increasing doses of nitrogen from 0 to 40, 40 to 80 and 80 to 120 kg N/ha and non perceptible increase in yield beyond this dose.

It is an established fact that the nitrogen quickly enhances the yield by way of stimulating vegetative growth in terms of height and tillers (more number of tillers result into greater no. of leaves). The number of functioning leaves represents the photosynthetic capacity of plants. Nitrogen application delays maturity means delays the senescence of the leaves and believed to increase the leaf area, thereby to increase the photosynthetic capacity of the plant for longer duration. Generally flow of assimilates from leaves lead towards the ear to strengthen the head characters and ultimately the yield.

In the present experiment successive higher doses of nitrogen resulted in to greater plant height and higher number of tillers. Maturity also was delayed due to higher nitrogen levels. These might

have conducively affected the leaf area thereby photosynthetic capacity of the plant resulting in to higher production of photosynthate in the plants treated with higher doses of nitrogen. Higher photosynthate assimilation in plants and its transmission to ear might have resulted in to favourable head characters expressing in to higher grain yield under increasing doses of nitrogen up to 120 kg nitrogen per hectare. Similar findings were reported by Anonymous, 1967; Anonymous, 1968; Sood et al., 1969 ; Lakhdive and Prasad, 1970; and Kulandivelu and Kaliappa, 1971.

Straw yield ude to variety (V2) IET 2295 was the highest considered to straw produce of various varieties under study. Straw produce comparisons of this variety with (V4) IET 2254 (V8) Ratna and (V1) Jaya were significant. Variety (V6) IET 2285 and (V7) IET 1996 over (V1) Jaya and (V8) Ratna and variety (V5) IET 1039 and (V3) IET 1991 over (V1) Jaya were significant in straw produce.

Height, number of tillers and the maturity period of the plant are solely the factors contributing towards straw produce. In the present investigation height under varying varieties was compared to be more or less similar where as number of tillers was favourably affected under variety (V2) IET 2295 to give distinct variation with varieties (V8) Ratna and (V1) Jaya and statistically similar but higher in position with (V_4) IET 2254. Variety (V_2) IET 2295 also proved to be late maturing over varieties (V8) Ratna and (V1) Jaya. Variety (V2) was late maturing even compared with (V4) IET 2254 however, variation being not significant. This conducive effect of more number of tillers and greater number of days required to mature to the variety (V2) IET 2295 pushed the variety to be on the highest

position in respect of straw yield.

In respect of varieties (V_6) IET 2885 and (V7) IET 1996 it may be pointed out here that variety (V_8) Ratna and (V_1) Jaya showed greater height over them. Whereas, in respect of number of tillers and number of days to maturity, variety (V_6) IET 2885 and (V7) IET 1996 were observed on higher position than varieties (V8) Ratna and (V_1) Jaya. Thus lacking of the varieties (V_6) IET 2885 and (V7) IET 1996 due to hight was make up by the favourable situation in respect of number of tillers and days to maturity to produce ultimately higher straw than varieties (V8) Ratna and (V_1) Jaya.

As for variety (V5) IET 1039 is concerned higher number of tillers was exhibited under the variety and greater number of days required to mature compared to the variety (V_1) Jaya. Variety (V_1) Jaya showed significantly greater height over (V5) IET 1039 but this effect of height under the variety (V_5) IET 1039 was countered by the very favourable effect of number of tillers and days to maturity under the variety (V5) IET 1039 to place it in higher position than variety (V_1) Jaya in straw produce per hectare.

Straw produce of an variety as in the case of grain yield is a behaviour of the genetical character of that particular variety.

Subsequent increase in the dose of nitrogen from 0 to 40, 40 to 80, 80 to 120 and 120 to 160 kg N/ha increased the produce of straw correspondingly. All the growth characters i.e. height of plant, number of tillers/m^2 and days to maturity were favourably affected under the increasing doses of nitrogen resulted into greater produce of straw under higher doses of nitrogen.

Explanation which may be offered for the results are the same as given for grain yield per hectare (discussed earlier). The results are in confirmity with the findings of Hussain and Mustafa, 1967; and Lakhdive and Prasad, 1970.

Total produce was recorded to be highest under the variety (V_8) IET 2295. This produce was at par with the produce of the varieties (V_6) IET 2285 and (V_7) IET 1996 which in turn gave significantly higher total produce over (V1) Jaya and (V_5) Ratna.

Increases in doses of nitrogen from 0 to 40, 40 to 80, 80 to 120 and 120 to 160 kg N/ha subsequently increased the total produce.

The reasons offered to explain the results of grain and straw produce under varying varieties and under levels of nitrogen will hold true combinedly for corresponding total produce under varying varieties and different levels of nitrogen.

Progressive growth :

The increase in vegetative growth is supposed to influence the yield of a crop as most of the food material is manufactured during vegetative growth period of the plant. Growth observations indicate that the vegetative growth as evinced by growth characters was quite luxuriantly affected throughout the growing period under the successive higher doses of nitrogen. The maximum vegetative growth of plants was up to 40 and 70 days after transplanting (70 days only the height). The number of tillers decreased beyond 40 days after transplanting due to death of few tillers. The increase in plant height was more up to 70 days after transplanting, therefore, it was slow. The reasons for slow increase of plant height 70 days after

transplanting may be that during this stage plant starts coming in reproductive phase. Thus the food material which was consumed for development of height was transferred for development of grain.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

The investigation was carried out during the Kharif season of 1973-74 at the Research Farm of J.N.Krishi Vishva Vidyalaya, College of Agriculture, Raipur, Madhya Pradesh under All India Co-ordinated Rice Improvement Project. The experiment consisted of eight varieties x five levels of nitrogen, laid out in a split plot design with three replications. The main findings are summarised below.

Effect of varieties :

1. Variety (V_4) IET 2254, highest yielder, giving an yield of 55 q /ha out yielded rest other varieties excepting (V_1) Jaya and (V_6) IET2885. Variety Jaya (V_1) gave more yield than varieties (V7) IET 1996, (V3) IET 1991, (V8) Ratna and (V5) IET 1039. Whereas, variety (V_6) IET 2885 was superior only to the latter two.
2. Straw produce was the highest (85 q /ha) under the variety (V_2) IET 2295. The straw produce was substantially higher over varieties (V_4) IET 2254, (V8) Ratna and (V_1) Jaya and similar with the rest. Varieties (V_6) IET 2885 and (V_7) IET 1996 also were higher straw producer than (V8) Ratna (V_1) Jaya. Whereas, varieties (V5) IET 1039 and (V3) IET 1991 resulted in to higher straw only over the (V_1) Jaya.
3. Most of the yield attributing characters were affected favourably under varieties (V_4) IET 2254, (V_1) Jaya and (V_6) IET 2885.
4. Growth characters were conducive in general under varieties (V_2) IET 2295, (V6) IET 2885 and (V7) IET 1996.

Effect of levels of nitrogen :

1. The grain yield increased substantially with successive increase in dose of nitrogen from 0 to 40, 40 to 80 and 80 to 120 kg/ha.

Beyond this dose the yield increase was not appreciable. The highest yeild (58 q /ha) was recorded under the highest dose (160 kg N/ha).

2. Like grain yield straw produce was conducively affected due to increase in doses of nitrogen from 0-40-80-120 to 160 kg N/ha. Highest straw produce of 90 q /ha was found under (N_5) 160 kg N/ha.

3. Almost all the yield attributes and growth characters were affected in favour of successive higher levels of nitrogen.

Interaction effects of varieties x level of nitrogen were significant for the characters- spikelets/panicle, grain sterility percent and days to maturity.

Conclusions :

1. Under the edapho-climatic conditions of Raipur, varieties IET 2254, Jaya and IET 2885 may be recommended for higher grain yields, still straw produce can not be neglected so, the varieties IET 2295, IET 2885 and IET 1996 may be advocated for higher straw produce alongwith fairly higher grain yields.

2. The nitrogen dose of 120 kg/ha is suitable for optimum yield of dwarf rice, but to safe guard the interest of cultivators, higher dose of 160 kg N/ha may be practiced to obtain higher straw produce as well as higher grain yield.

3. The experiment should be repeated to confirm the findings.

ABSTRACT

EFFECT OF VARYING LEVELS OF NITROGEN ON GROWTH, YIELD AND QUALITY OF MEDIUM DURATION HIGH YIELDING PADDY VARIETIES

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A B S T R A C T

The present experiment was conducted at the Research Farm of College of Agriculture, Raipur (M.P.) during Kharif 1973-74. The experiment was laid-out in split plot design keeping eight varieties viz. Jaya, IET 2295, IET 1991, IET 2254, IET 1039, IET 2885, IET 1996 and Ratna in main plot and five levels of nitrogen viz. 0, 40, 80, 120 & 160 kg/ha in sub plot, replicated three times. The experiment was conducted under the scheduled programme of All India Coordinated Rice Improvement Project with objectives- to find out suitable variety for the region and optimum dose of nitrogen for the variety. The soil was clay loam in texture, neutral in reaction, low in available nitrogen, low in phosphorus and high in potash. 80 kg of P_2O_5 and 80 kg K_2O per hectare was applied uniformly as basal dressing.

Amongst varieties highest yield (55 q /ha) was accorded under variety IET 2254 which was 25 % extra over the lowest yield (44 q /ha) due to variety IET 1039. In respect of straw produce the variety IET 2295 exhibited the highest yield (85 q /ha) i.e. 31 q /ha extra over the lowest straw produce (54 q /ha) of the variety Jaya. Among the different levels of nitrogen the highest yield both grain (59 q /ha) and straw (90 q /ha) was found under the highest dose of nitrogen (160 kg/ha) which was 80 % and 100 % greater respectively than the grain and straw produce due to the lowest dose (no nitrogen). Threshhold of the present study indicated best combination for promising

grain yield.to be 160 kg N/ha (the highest dose) under variety Jaya (almost similar yielder as that of the highest yielding variety IET 2254). The best combination for straw produce was 160 kg N/ha under IET 2295.

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APPENDICES

APPENDIX I

Cumulative mean height in cm as affected by different varieties and levels of nitrogen.

Treatments	Days after transplanting							
	40	50	60	70	80	90	100	110
V_1	66.0	71.4	81.5	95.0	95.2	95.9	95.9	-
V_2	59.0	64.8	76.8	81.9	91.8	93.0	93.0	-
V_3	63.6.	66.8	79.6	92.1	94.8	94.8	94.8	94.8
V_4	62.8	67.5	77.8	87.6	90.0	90.0	90.0	-
V_5	56.9	63.0	77.1	85.4	88.0	88.0	88.0	88.0
V_6	61.4	65.6	75.6	91.6	92.7	92.7	92.7	-
V_7	61.4	67.2	80.1	87.3	89.7	89.7	89.7	89.7
V_8	62.6	67.6	76.8	91.0	93.8	93.8	-	-
N_1	48.2	53.7	63.8	79.1	79.8	80.0	80.0	80.0
N_2	58.6	63.9	76.2	88.1	90.6	90.6	90.6	90.6
N_3	62.5	67.6	79.2	90.6	94.9	94.9	94.9	94.9
N_4	67.7	72.9	81.2	94.1	96.8	96.8	96.8	96.8
N_5	71.5	76.1	87.9	95.9	98.9	98.9	98.9	98.9

APPENDIX II

Cumulative mean tillers/m² as affected by different varieties and levels of nitrogen.

Treatments	Days after transplanting							
	40	50	60	70	80	90	100	110
V_1	449.9	412.5	393.8	362.0	362.0	360.0	360.0	-
V_2	551.6	517.0	477.4	446.5	446.1	446.1	446.1	-
V_3	476.8	454.3	427.3	383.5	383.5	381.1	381.1	381.1
V_4	550.3	492.3	465.8	347.0	346.9	346.9	346.9	-
V_5	528.0	501.0	486.7	471.4	471.1	471.1	471.1	471.1
V_6	526.9	484.0	464.2	432.5	432.5	432.3	432.3	-
V_7	512.6	477.4	467.5	448.5	448.3	448.1	448.1	448.1
V_8	487.8	436.7	424.0	394.8	394.6	394.6	-	-
N_1	332.7	331.6	330.5	313.0	312.5	312.5	312.5	312.5
N_2	467.5	440.0	425.7	393.7	393.6	393.6	393.6	393.6
N_3	514.2	470.2	452.1	420.3	420.1	420.1	420.1	420.1
N_4	573.6	517.0	492.8	472.7	472.7	472.7	472.7	472.7
N_5	644.6	594.0	552.9	508.8	507.6	507.6	507.6	507.6

APPENDIX III

Source of variation	d.f.	Mean sum of squares		
		Mean plant height.	Mean number of tillers/m².	Mean number of days to maturity.
Replication	2	238.12	16726.44	1.760
Variety	7	107.32**	21988.99**	638.618**
Error (a)	14	14.84	2530.66	1.310
Nitrogen	4	948.45**	136136.14**	15.197**
Variety x Nitrogen (Interaction)	28	13.14**	1394.24	0.757**
Error (b)	64	7.54	1122.75	0.356
Total	119	1329.41	178777.47	657.998

APPENDIX IV

Source of variation	d.f.	Mean sum of squares			
		Mean number of panicles/m2	Mean length of panicle in cm	Mean number of spikelets/panicle	Mean number of filled grains/ panicle.
Replication	2	16258.79	0.95	130.19	252.38
Variety	7	21706.42**	15.51**	5838.82**	4101.77**
Error (a)	14	2400.13	0.49	7.42	12.30
Nitrogen	4	134377.86**	39.80**	6736.95**	5832.58**
Variety x Nitrogen (Interaction)	28	1415.38	0.35	347.86**	196.31
Error (b)	64	1118.39	0.24	21.08	183.77
Total	119	177278.97	57.34	13082.32	10579.11

APPENDIX V

Source of variation	d.f.	Mean sum of squares			
		Mean yield of grains in q/ha	Mean yield of straw in q/ha	Mean total produce in q/ha	Mean weight in g/panicle.
Replication	2	10.06	2.44	18.32	0.27
Variety	7	2.64**	14.81*	14.54**	4.43**
Error (a)	14	0.53	3.74	3.34	0.12
Nitrogen	4	29.01**	80.78**	200.62**	3.33**
Variety x Nitrogen (Interaction)	28	0.42	0.84	1.24	0.16
Error (b)	64	0.25	0.68	1.07	0.11
Total	119	42.91	103.30	239.13	8.42

APPENDIX VI

Source of variation	d.f.	Mean sum of squares		
		Mean sterility percentage of spikelets.	Test weight in g (thousand grain weight).	Grain to straw ratio.
Replication	2	15.10	0.55	0.186
Variety	7	763.89**	172.18**	0.415*
Error (a)	14	6.41	0.25	0.103
Nitrogen	4	427.21**	2.44	0.057*
Variety x Nitrogen (Interaction)	28	98.52**	0.16	0.027
Error (b)	64	1.56	3.19	0.020
Total	119	1312.39	178.77	0.808

* Significant at 5 %

** Significant at 1 %