EFFECT OF SPLIT APPLICATION OF NITROGEN AND PHOSPHORUS DOSES RELATED TO CROP REQUIREMENT IN IRRIGATED WHEAT

THESIS

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BY

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CERTIFICATE - I

This is to certify that the thesis entitled "EFFECT OF SPLIT APPLICATION OF NITROGEN AND PHOSPHORUS DOSES RELATED TO CROP REQUIREMENT IN IRRIGATED WHEAT" submitted in partial fulfilment of the requirement for the degree of "MASTER OF SCIENCE IN AGRICULTURE(AGRONOMY)" of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by Shri RAM BHAROSE SINGH TOMAR, I.D.No.4032/71 under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate, award etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

(Dr. S.S.Pathak)
CHAIRMAN OF THE ADVISORY COMMITTEE

PLACE:INDORE
DATE : 28.2.1986

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

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(RAM BHAROSE SINGH TOMAR)

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CONTENTS

INTRODUCTION

CHAPTER - I

INTRODUCTION

Wheat occupies an important position among the food crops in the world because of its diversified use. In India it is the second most important food crop after rice covering a total area of 22.10 million hectares and total grain production of 43 million tonnes, giving an average yield of 19.5 quintal per hectare (1983-84).

To feed ever increasing population, the increase in production of food grain is a must. The increase in production can be achieved by increasing the production per unit area per unit time which may be achieved by increasing the area under double or multiple croping system involving high yielding varieties and by adopting package of practices.

The yield of wheat crop is influenced by a number of factors hence for obtaining higher yields, the three important factors are the selection of most suitable variety, correct application of manures and fertilizers and sound water management of the crop. In crop production, suitable variety is an important factor around which all other aspects of production revolve. Likewise, proper dose of fertilizer and correct time of application are very important to achieve maximum response. Thus proper water and fertilizer use efficiency of the 11 million hectares of irrigated tract will go a long way in improving national production.

The recovery and efficiency of fertiliser in our country have been low, it is therefore essential to use each and every unit of fertilizer most judiciously, to obtain maximum return in respect of yield and monetary gain.

Nitrogen and phosphorus are two most important plant nutrients and are required in comparatively larger quantity than any other nutrient. Out of the total 6.8 million tonnes of fertilizers consumed in India during 1983-84 4.8 million tonnes was nitrogen, 1.35 million tonnes phosphorus and 0.6 million tonnes of potassium (India, 1984).

The main source of plant nutrients is the soil so it is necessary that fertilizers should be applied in sufficient quantity to maintain its status. The soil is poor in nitrogen, low to medium in phosphorus and high in potash. These nutrients can be supplied by nitrogenous, phosphatic and potasic fertilizers which are the most important inputs responsible for boosting the crop yield.

Split application of phosphorus caused beneficial effect due to better root development and reduction are carried phosphorus fixation caused due to faster uptake of the available nutrients. This is corroborated by the fact that number of effective tillers were significantly increased, as well as by reduction in mortality percentage of tillers.

Among the major plant nutrients nitrogen is required by the field crops through out the growth period and as it is a mobile nutrient it should be applied only at peak period of crop requirement, because nitrates are very soluble and can not be retained by clay particles. Nitrates move with soil water and are liable to leach down the soil profile. The uptake efficiency of nitrogen fertilizers by crop or N availability to crop is only 30 to 50 per cent due to loss of N through the process of leaching, volatilisation and denitrification as established by various workers.

Moreover, nitrogenous fertilizers when applied in a large amount at initial stage i.e. sowing, a sizable part is lost through leaching and volatilisation due to prevailing high temperature in this tract and very few plant roots to absorb nutrients ions (Gill and Batra, 1962 and Sandhu and Gill, 1972). On the contrary when a large amount is applied at later stages of plant growth the leaching loss is markedly reduced by root absorbtion and assimilation of nitrate ions. Nitrogen translocation to the shoot was highest on the 22nd day from sowing to 79 days (Simpson, 1982). Nitrogen applied at vegetative stage will also cater to the increased demand of nutrient at that stage (Sewa Ram et al., 1978). Again many scientists are of the view that plant utilises soil N upto tillering stage, fertiliser nitrogen being absorbed mainly during the tillering period to ear emergence (Balba et al., 1972). Keeping these established facts it is advisable to apply relatively small amount of N fertilizer at initial stage (i.e. sowing) if the soil content is very low and comparatively larger amount at later stages.

Thus lower initial fertilizer input at the initial stage and relatively large amount at subsequent stages will solve different problems of fertilizer use in the country viz., poor financial status of the farmers as kharif produce is invariably not sold prior to plantation of rabi, checking fertilizer loss and scientific adoption of full package of recommended practice.

Thus an experiment on "Effect of split application of nitrogen and phosphorus doses related to crop requirement in irrigated wheat" was conducted in rabi season 1984-85 at the Jawaharlal Nehru Krishi Vishwa Vidyalaya,College of Agriculture Farm, Indore M.P.

The main objectives of the experiment are out lined as under:

1. To study effect of no fertilizer application at sowing against existing method.
2. To study effect of different nitrogen and phosphorus doses on wheat.
3. To study effect of different nitrogen and phosphorus combinations applied in split application on wheat.
4. To study effect of new split methods against existing recommendation.

REVIEW OF LITERATURE

CHAPTER - II

REVIEW OF LITERATURE

Much work has been done on nitrogen levels with lower initial nitrogen application and subsequent high doses at later stages in wheat crop. But so not in case of phosphorus spliting. A brief resume of the research work done on different methods of spliting nitrogen and phosphorus levels in India as well as abroad is reviewed herewith.

Research work on growth, development and yield of high yield durum variety Raj 1555 is also being briefly reviewed.

A. Effect of N and P levels on yield:

Verma et al. (1970) reported that a dose of 67 kg N/ha gave significantly better yield over other doses. Similarly application of 35.5 kg P_2O_5/ha yielded better over control and combination of 67 kg N/ha and 33.5 kg P_2O_5/ha appeared to be optimum dose of fertiliser for higher yield of wheat.

Gupta et al. (1970) found that the higher grain yield were obtained when the basal dressing of 22 kg each of P_2O_5 and K_2O/ha was done and the grain yield increased linearly with increase in N rate from 60 to 100 kg/ha.

Singh et al. (1972) found that grain and straw yields were increased by N at the rates up to 160 kg/ha and P at 75 kg/ha but were not affected by K.

Randhawa and Singh (1972) reported that average grain yield increased from 2.22 t with no N to 4.03 t/ha with 120 kg N/ha and from 2.93 t with no P to 3.49 t/ha with 80 kg P_2O_5/ha, K had no effect on grain yields. Application of 120 kg N + 80 kg P_2O_5/ha gave the highest grain yield 4.41 t/ha.

Das et al. (1972) found that the maximum response was of the order of 3.330 kg/ha to fertilizer dose of N, P and K at 80, 60 and 60 kg/ha, respectively.

Singh et al. (1972) revealed that 100 kg N + 40 as well as 80 kg P_2O_5/ha were found to be the optimum doses for Kharchia variety of wheat, but K had no response.

Pathak and Tiwari (1973) found that dwarf wheat cv. Kalyansona given various rates of N, P_2O_5 and K_2O in different combinations, applications of 120 kg N + 60 kg P_2O_5 + 60 kg K_2O/ha increased average grain yield 2.13 fold compared with no fertilizer application.

Randhawa (1973) reported that wheat cv. C-273 given 0, 28 and 56 kg/ha each of N, P_2O_5 and K_2O in all combinations, gave the highest average grain yield of 2.71 t/ha on plots given 56 kg N + 56 kg P_2O_5/ha compared with 1.8 t/ha on plots given no fertilizer. The N/P interaction was significant and there was no yield response to applied K.

Agrawal and Singh (1976) revealed that application of

120 kg nitrogen in conjuction with 60 kg P_2O_5 and 60 kg K_2O per hectare gave the maximum grain yields.

Gahlot et al. (1977) found that 94 kg N + 47 kg P_2O_5 + 47 kg K_2O/ha was the optimum fertilizer rate for cv HD 2009, with an expected yield of 4.16 t/ha and a yield response of 4.42 kg grain/unit NPK. While Singh and Sharma (1977) found that 142.5 kg N + 71.3 kg P_2O_5 + 53.6 kg K_2O/ha was the optimum fertilizer rate for dwarf wheat.

Kasimov et al. (1979) revealed that the optimum economic fertiliser rate was 120 kg N + 120 kg P_2O_5 + 60 kg K_2O/ha.

Prasad et al. (1979) found that the maximum yield was obtained on applying 100 kg N + 50 kg P_2O_5 + 50 kg K_2O in comparison to doses applying 50 kg N + 25 kg P_2O_5 + 25 kg K_2O and 200 kg N + 100 kg P_2O_5 + 100 kg K_2O/ha.

Agrawal (1980) observed yield response to the application up to 160 kg N/ha. Response to applied P_2O_5 up to 40 and 80 kg/ha was observed in soils from E. and W. regions of U.P., respectively.

Aloshochenko (1981) found that application of 150 kg N + 120 kg P_2O_5 increased average grain yield from 3.16 t to 4.10 but when 60 kg K_2O/ha was added to this NP level, the yield increased to 4.18 t/ha.

Rana et al. (1982) found that the economic fertilizer rates were 137 and 123 kg N/ha for low and medium organic soils and 57 and 45 kg P_2O_5/ha for low and medium P soils but K had no response.

Anonymous (1983) indicated that a trend of getting as good yield as that of the check treatment (20, 40 kg P_2O_5/ha basal) when the 'P' was top dressed at the 1st irrigation or the 2nd irrigation. Total 120 kg N and 40 kg P_2O_5 was top dressed at 1st irrigation or in split ½ at 1st irrigation + ½ at 2nd irrigation.

B. Effect of nitrogen split on growth development and yield of crop:

Linser (1962) reported that best treatment consisted of nitrogen supplied in three equal splits viz., 1/3rd at beginning of growing season, 1/3rd during growth and 1/3rd before heading. The yield and backing quality were increased by such a split application.

Petrova (1963) found that top dressing between sowing and beginning of vegetative period gave grater increase in yield. However, split application of fertilizer during the vegetative phase was not more effective than single split.

Umarani and Sreeniwas (1968-69) observed that spliting the total nitrogen into two i.e. sowing and tillering increased plant height and grain yield by 19.6 % compared with full dose at sowing. However, spliting beyond tillering did not increase yield. Sinha (1973) reported similar findings.

Thakur and Shrivastava (1971) carried out an experiment including 11 treatments in which different combinations of nitrogen were made at sowing, 3 leaf stage, tillering, ear emergence and maturity. Maximum yield was obtained with N applied as ¼th at sowing + ½ at three leaf stage + ¼th at tillering.

Mukhtar and Mian (1971) reported that split application of N upto 2nd irrigation gave better yield response than when some of the N was applied even after 2nd irrigation.

Sandhu and Gill (1972) observed that maximum yield was obtained when full N was applied as basal in case of lower doses. But in case of higher doses like 120 kg N/ha, N applied in two splits gave maximum yield.

Singh and Sinha (1976) found that two or three split application of N showed some additional advantage in yield over single or four split application.

Agrawal and Singh (1976) concluded that application of N in four splits, ¼th at sowing, ¼th each at 1st, 2nd and 3rd irrigation gave highest yield.

Agrawal and Moolani (1978) reported that N applied as ½ at sowing + ½ at 2nd irrigation and 1/3rd at sowing + 1/3rd at 1st irrigation + 1/3rd at tillering through foliar method gave significantly higher grain and straw yield.

Sandhu and Brar (1978) found that application of N ½ basal + ½ at 1st or 2nd irrigation proved superior than full basal. Moreover the results tended to be in favour of applying second half of N at 1st rather than 2nd irrigation.

Chaubey, et al. (1980) while discussing efficient use of fertilizer suggested split application of nitrogenous fertilizers specially urea to reduce losses due to leaching and volatilization.

Riga, et al. (1980) found that ammonium sulphate when applied in 3 split levels increased the uptake of soil N by 25 %. N content of grain was also found to be more in 3 splits rather than two splits.

Reddy (1981) reported that when N was applied at eight different times including four stages of plant growth, application in three equal splits at planting, ear emergence and boot gave significantly higher yield.

Kashla and Raghee (1981) reported that application of 2/3rd N as basal and 1/3rd N at CRI stage was significantly superior to 1/3rd N as basal and 2/3rd N equally distributed over irrigations.

Malik (1981) found that the grain yield increased with increasing levels of N upto 120 kg/ha whereafter there was no increase.

Singh, et. al. (1982) concluded that yield increased with N applied as top dressing at 1st irrigation than at sowing.

Masle-Maynard (1982) reported that by application of nitrogen after cease of tiller development, number of existing tillers was reduced due to N becoming limiting.

Gupta and Pathak (1982) reported significant effect of N splits on tillering, number of spikelets/spike, number of grains/spike and number of grains/spikelet and also reduction in mortality percentage of tillers. Low initial N produced significantly higher grain yield than the recommended practice of 50 % as basal and 50 % at CRI stage.

Watkings (1931) Remy (1938) and Carpenter et al. (1962) observed that in small grain crop the pace of nutrient removal was rapid until plant reached the blooming stage, from blooming onwards the rate was slowed down. From 90 to 120 days period the plant produced 51.9 % of its total drymatter. In general the effect of nitrogen application lasts for about two months. Thus it is clear that application of nitrogen at 60 days stage is most beneficial.

Anonymous (1984) indicated that split application of 120 kg N/ha at the rate of 10 % at the sowing + 60 % at

CRI and 30 % at the late jointing gave 10 % increase in grain yield.

Singh (1965) reported 10 % more yield of wheat at 7 centres out of 12 by application of 120 kg N/ha in splits of 10 % at sowing 60 % at CRI and 30 % at late jointing.

C. Effect of split application of phosphorus on yield wheat and other crops:

There has not been much research work on split application of phosphorus pertaining to wheat crop. Hence there is insufficient literature available on split application of phosphorus on wheat crop. An attempt has been made to review research work done on split application of phosphorus on wheat and other crops.

Deshpande and Bathkal (1965) observed a linear increase in mung grain yield with increasing levels i.e. 20, 40 and 60 lb P_2O_5/ha as basal dose with 10 lb P_2O_5/acre as foliar spray.

Mehta and De (1971) concluded that half soil plus half foliar application of phosphorus to cowpea at any given rate of fertiliser proved superior to full basal or full foliar application and extra grain yield of 2.25 q/ha over basal and 0.94 q/ha over full foliar was obtained.

Khedkar (1972) indicated that highest yield of grain in gram was recorded with the application of P_2O_5 @ 50 kg/ha when applied half as soil application at sowing and remaining half as foliar application.

Gorde and Kibe (1973) studied the response of soil or foliar application of phosphorus @ 0, 20 and 40 lb P_2O_5/acre to moong crop. Foliar sprays were applied in single or split doses at different days after sowing. In general a single foliar application of 20 lb P_2O_5/acre on the 25th day after sowing gave the highest seed yield.

Verma (1973) noted that foliar application of phosphorus could be beneficial particularly on a soil low to medium in phosphorus. Its application half through foliar in two equal sprays gave best results.

Goud-reddy et al. (1973) in a field experiment observed increased yield and high economic return by the soil application of 60 kg P_2O_5 or the foliar application of 20 kg P_2O_5/ha. Significant increase in straw yield by the application of 40 kg P_2O_5 was also reported by Color et al. (1976).

Gupta et al. (1974) reported that in pot experiment of wheat values for grain yield and P uptake were greater with ^{32}P super phosphate applied at high rates in split dressing than in a single dressing but values were similar with low P rates applied singally.

Singh et al. (1974) revealed that groundnut given 40 kg P_2O_5/ha (drilling 20 kg P_2O_5/ha at sowing and 20 kg P_2O_5

per hectare at the peg formation stage) gave the highest yield of unshelled nuts.

Rana et al. (1978) reported that average grain yield increased by given N and Zn increasing the rates of applied P_2O_5 from 0 to 90 kg/ha increase the average grain yield from 3.48 to 4.42 t. Yields were similar when the full P was applied at sowing or when P was applied in 2 equal split dressing at sowing and as a top dressing. But the plant P contents at harvest were higher with P applied in split dressing.

Singh (1980) reported that wheat was given no fertilizer, 120 kg N + 30-60 kg P_2O_5/ha applied in 6 treatment involving different dates and methods of application, N increased DM production at different growth stages but effect of addition of P to N on dry matter production was significant at the boot stage only. Grain yield with N and N + 30 and 60 kg P_2O_5/ha was 5.79, 6.28 and 6.82 t/ha, respectively, compared with 2.63 t without NP. Yields were highest when all the NP was placed at the 1st irrigation (6.67 t) or when applied in 2 equal split dressing by placement at sowing and top dressing at the 1st irrigation (6.65 t).

D. Varietal character:

Stepanishchev (1972) found in an experiment that durum performed better as compared to aestivums.

Vora and Pathak (1979) concluded that Raj 1555, a durum was significantly superior to all other varieties and yielded 6.65 % higher grain than best aestivum WH-147.

Nagar and Pathak (1980) found that Raj 1555 proved superior to Malav Raj in plant height, length of ear, number of spikelets/spike, test weight and grain as well as straw yield.

Gupta and Pathak (1982) concluded that durum (Raj 1555) produced significantly higher grain yield than aestivum (WH 147) variety.

E. Yield contributing attributes:

Bhardwaj et al. (1971) reported that straw yield was positively correlated with height and tillering of plant in semi dwarf and dwarf wheat varieties.

Shrivastava et al. (1971) found that number of effective tillers, length of spike and number of grain/spike has positive and significant correlation with grain yield in S-308 variety.

Gupta (1979) reported that the test weight and number of grain/spike were direct and grain weight/spike was indirect components of grain yield in durum wheat.

Sinha and Sharma (1980) showed that length of spike had no significant correlation with grain yield, number of fertile spikelets/spike and number of grains/spike in HW-884 wheat variety.

F. Effect of temperature on yield:

Asana and Williams (1965) generalised the reduction in grain size to be 16.4 % for every 6°C rise in temperature between the limits 24°C and 31°C.

Wattal (1965) noted that during the first fortnight after anthesis, grain size increased with an increase in temperature from 27.9°C to 31.4°C. However, grain weight per ear declined by 17.31 % for every 5°C rise in the mean maximum temperature (between 27.6 and 32.3°C) during the whole growth period.

MATERIALS AND METHODS

CHAPTER - III

MATERIALS AND METHODS

A new project on "Effect of split applications of nitrogen and phosphorus doses as related to crop requirement in irrigated wheat" was started from rabi season of 1984-85 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Agriculture College Farm, Indore M.P.

Indore is situated at an altitude of 555.5 metres above mean sea level in the Malwa plateau of M.P. It is geographically located at latitude 22.44° North and longitude 75.76° East. Indore experiences a sub-tropical climate i.e. summer and winter both being mild or moderate. The average temperature during the extreme hot months of April and May is 34-36°C and during the extreme cold months of December and January is 8-10°C. However, the temperature as high as 40-42°C in summer and as low as 0-4°C in winter are also being noted sometimes. This year the temperatures were unusually low in spells through-out the crop growth period as a result of extensive snowfall in the North and change in wind direction to North-West.

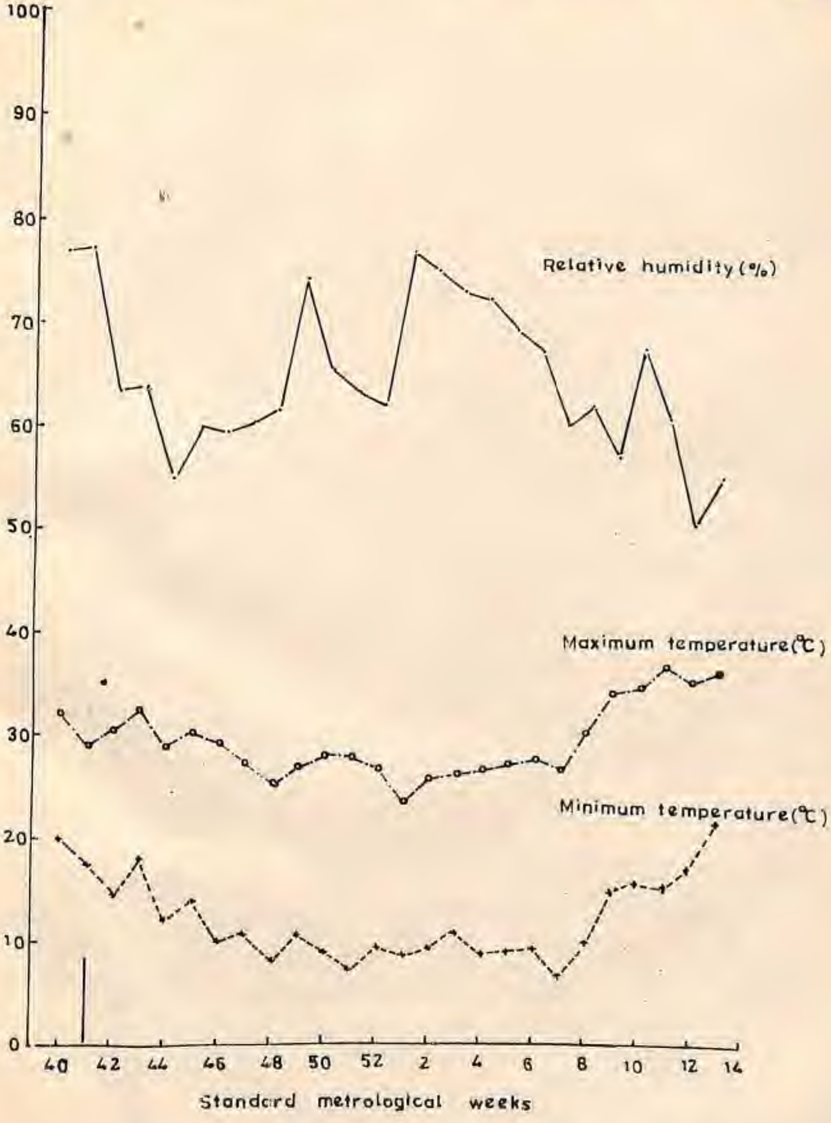
The total rainfall during the year 1984-85 at Indore was only about 885 mm (997.41 mm during the year 1983-84) major portion is received during the monsoon months from June to September. Shortfall in rains are hopefully expected during uncertain winter months of November to February but are uncertain, these winter rains are locally known as 'Mawtha'.

Meteorological parameters recorded at Indore during the crop season October, 1984 to March, 1985 are given in Table 3.1 which show the data for weekly averages of rainfall, relative humidity, maximum and minimum temperature.

Table 3.1 Meteorological parameter for crop season October 1984 to March 1985

Month	Standard week	Temperature °C Max.	Min.	Relative humidity(%)	Rainfall (mm)
Oct.1 to 7	40	32.29	20.29	78.79	0.00
	41	29.00	27.86	78.67	8.63
	42	30.71	14.78	63.71	-
	43	32.71	18.14	63.74	-
Oct.29 to Nov.4	44	29.24	12.00	55.24	-
	45	30.71	14.29	60.74	-
	46	29.60	10.20	59.90	-
	47	27.50	10.80	60.10	-
Nov.26 to Dec.2	48	25.50	8.42	61.38	-
	49	27.00	10.50	74.78	-
	50	28.14	9.42	65.65	-
	51	28.00	7.42	63.01	-
	52	27.00	9.40	62.00	-
Jan.1 to 7	1	23.57	8.71	78.64	-
	2	25.64	9.35	76.42	-
	3	26.21	10.57	73.14	-
	4	26.71	8.71	72.00	-
Jan.29 to Feb.4	5	27.71	9.14	67.57	-
	6	28.07	9.21	64.28	-
	7	27.14	6.78	60.00	-
	8	30.42	9.52	62.14	-
Feb.26 to March 4	9	34.21	14.57	57.66	-
	10	34.85	15.57	66.28	-
	11	38.66	15.30	61.33	-
	12	35.42	17.07	50.28	-

Fig MEAN WEEKLY METROLOGICAL DATA (Oct 84 to March 85)



Experimental site and soil:

The experiment was laid out in field No.2 North of the College of Agriculture Farm, Indore. The soil of the field is representative of typical medium black soils of Malwa tract, with medium fertility status. Available N is low, available phosphorus is low to medium and available potash is high. Analysis of representative soil sample collected from a composite soil sample (prepared by mixing soil from nine different places in the field) was done. The samples were taken from a depth of 15 to 20 cm with the help of soil auger after preparation of the field and before applying fertiliser or planting the crop.

Table 3.2 Chemical analysis of experimental soil

SN	Components	Values	Methods used
1.	Soil pH	7.7	pH meter (glasselectrod)
2.	Electric conductivity	0.4 hos/cm	Conductivity meter at 25^{o}C
3.	Organic carbon	0.533	Walkley and Black's method
4.	Available nitrogen	213.2 kg/ha	Alkaline paramogenate
5.	Available phosphorus	18.8 kg/ha	Colourimeterically
6.	Available potash	610 kg/ha	Flame photometerically

Cropping history of the field:

Study of the cropping history of a field is essential to judge its productivity potential. Following table indicates the previous crop history of experimental field for last six years:

Table 3.3

SN	Year	Kharif	Rabi
1.	1979-80	Black soybean	Wheat
2.	1980-81	Yellow soybean	Wheat
3.	1981-82	Soybean	Wheat
4.	1982-83	Fallow	Wheat
5.	1983-84	Fallow	Triticale
6.	1984-85	Fallow	Wheat (Experiment)

The treatments under study were distributed in a factorial block design.

1. Nitrogen levels
2. Phosphorus levels
3. Method of split application.

These are grouped under 3 factors.

1. Nitrogen levels:

Levels	Notation
0 kg/ha	N_0
50 kg/ha	N_1
100 kg/ha	N_2
150 kg/ha	N_3

2. Phosphorus levels:

Levels	Notation
60 kg/ha	P_1
90 kg/ha	P_2

3. Method of split application:

Notation	Percentage of split application	Different split application were adopted are given below
M_1	10 + 60 + 30	No Nitrogen and P at sowing 10 % 7 days after germination + 60 % at 21 days after germination and 30 % 56 days after germination late jointing stage of wheat crop.
M_2	50 + 50	No Nitrogen and phosphorus at sowing 50 % at 21 days after germination and 50 % 56 days after germination.
M_3	60 + 40	No Nitrogen and P at sowing time 60 % at 21 days after germination and 40 % 56 days after germination.

Thus all the 24 treatment combinations formed are shown in Table 3.4.

Table 3.4

SN	Treatment combination	SN	Treatment combination
1.	$N_0P_1M_1$	13.	$N_0P_2M_1$
2.	$N_0P_1M_2$	14.	$N_0P_2M_2$
3.	$N_0P_1M_3$	15.	$N_0P_2M_3$
4.	$N_1P_1M_1$	16.	$N_1P_2M_1$
5.	$N_1P_1M_2$	17.	$N_1P_2M_2$
6.	$N_1P_1M_3$	18.	$N_1P_2M_3$
7.	$N_2P_1M_1$	19.	$N_2P_2M_1$
8.	$N_2P_1M_2$	20.	$N_2P_2M_2$
9.	$N_2P_1M_3$	21.	$N_2P_2M_3$
10.	$N_3P_1M_1$	22.	$N_3P_2M_1$
11.	$N_3P_1M_2$	23.	$N_3P_2M_2$
12.	$N_3P_1M_3$	24.	$N_3P_2M_3$

Experimental design and other details:

Experimental design	-	Factorial experiment in Randomized block design
No. of replications	-	4
No. of treatments	-	24
Total No. of plots	-	24 x 4 = 96
Gross plot size	-	5 x 2.3 m = 11.50 sq m
Net plot size	-	4 x 1.84 m = 7.36 sq m
Distance between replications	-	1 m
Distance between treatment in a replication	-	0.50 m

R IV

$N_3P_2M_3$	$N_0P_2M_2$	$N_1P_1M_2$
$N_2P_1M_3$	$N_2P_2M_1$	$N_0P_1M_2$
$N_3P_2M_2$	$N_3P_2M_1$	$N_1P_1M_1$
$N_2P_2M_3$	$N_2P_1M_1$	$N_1P_2M_2$
$N_0P_2M_3$	$N_1P_2M_1$	$N_1P_2M_3$
$N_2P_2M_2$	$N_1P_1M_3$	$N_3P_1M_1$
$N_0P_1M_1$	$N_2P_1M_2$	$N_3P_1M_3$
$N_3P_1M_2$	$N_0P_1M_3$	$N_0P_2M_1$

R I

$N_1P_2M_1$	$N_0P_2M_2$	$N_3P_2M_2$
$N_3P_1M_3$	$N_1P_1M_3$	$N_3P_2M_1$
$N_1P_2M_2$	$N_2P_1M_3$	$N_0P_2M_1$
$N_1P_1M_1$	$N_1P_1M_2$	$N_0P_1M_3$
$N_0P_2M_3$	$N_2P_1M_2$	$N_2P_2M_3$
$N_3P_2M_3$	$N_2P_1M_1$	$N_0P_1M_1$
$N_3P_1M_1$	$N_1P_2M_3$	$N_2P_2M_1$
$N_0P_1M_2$	$N_3P_1M_2$	$N_2P_2M_2$

R III

$N_2P_2M_2$	$N_3P_2M_1$	$N_3P_2M_2$
$N_0P_2M_3$	$N_2P_1M_2$	$N_2P_2M_1$
$N_2P_1M_1$	$N_0P_1M_2$	$N_1P_2M_3$
$N_1P_2M_2$	$N_0P_2M_1$	$N_3P_1M_2$
$N_1P_1M_1$	$N_0P_1M_3$	$N_0P_1M_1$
$N_3P_1M_3$	$N_3P_1M_1$	$N_0P_2M_2$
$N_1P_1M_3$	$N_1P_1M_2$	$N_2P_2M_3$
$N_2P_1M_3$	$N_3P_2M_3$	$N_1P_2M_1$

R II

$N_1P_2M_2$	$N_3P_1M_3$	$N_2P_2M_3$
$N_0P_2M_1$	$N_2P_1M_3$	$N_3P_2M_2$
$N_1P_2M_1$	$N_0P_2M_3$	$N_3P_2M_1$
$N_1P_1M_1$	$N_3P_1M_2$	$N_2P_2M_1$
$N_0P_1M_2$	$N_0P_1M_3$	$N_2P_1M_1$
$N_1P_1M_3$	$N_3P_1M_1$	$N_2P_2M_2$
$N_0P_2M_2$	$N_3P_2M_3$	$N_2P_1M_2$
$N_0P_1M_1$	$N_1P_1M_2$	$N_1P_2M_3$

LAYOUT PLAN OF THE EXPERIMENT
(Randomize block design)

Row to row distance - 23 cm

No. of row/gross plot - 10

No. of row/net plot - 8

Block size - 18.4 x 15 m = 276.0 sq m

Total experimental area- 36.8 x 30 m = 1104 sq m

Preparatory tillage:

The field was cultivated twice with tractor drawn cultivator followed by disking and harowing and planking to bring the field in fine tilth. Stubbles were collected and irrigation channels prepared as per requirement.

Seed:

Good quality seed of the variety Raj1555 free from damaged and affected grains were taken from the seed of previous year.

Seed rate:

Test weight of the variety worked out and seed rate was calculated. The test weight of the variety obtained are given below: 57.8 g weight of the 1000 grain seed rate standard on the base of 100 kg/ha of W.H.147 was adopted as germination percentage of both varieties was uniform at 96 %. The worked out seed rate is reproduced here under:

Raj1555 - 128.08 kg/ha and 145 g/plot.

Date of sowing:

Sowing was done on 19th November 1984.

Method of sowing:

Dry sowing was done by seed placement with hand i.e. dibbling in previously drawn furrows 23 cm apart. At a depth of 2-3 cm and covered by soil.

Manurial schedule:

The details are given as under:

M_1 10 % 7 days after germination + 60 % 21 days after germination + 30 % 56 days after germination.

M_2 50 % 21 days after germination + 50 % 56 days after germination. This method is the existing recommended practice (control method).

M_3 60 % 21 days after germination + 40 % at 56 days after germination.

Nitrogen levels		Phosphorus levels	
N levels	kg/ha	P levels	kg/ha
N_0	0	P_1	60
N_1	50	P_2	90
N_2	100		
N_3	150		

Potash @ 30 kg/ha and Zinc sulphate @ 25 kg/ha was given in basal dose before sowing.

Nitrogen was applied as urea. Phosphorus as single super phosphate and potash by muriate of potash.

Irrigation:

First irrigation was given immediately after sowing as initial soil moisture was insufficient for germination. Subsequent irrigations were given as shown in the schedule of pre and post sowing operations.

Interculture operations:

Hand mulching with the help of khurpi was done after 15 days of sowing in order to remove the weeds present in the field.

Harvesting and post-harvesting operation:

For the purpose of statistical studies, harvesting of the net plots was done separately after removing the two border rows on both sides and 50 cm from either side. The net plot produce so obtained was tied in bundles and carefully labbeled. Ten spike from each plot from the marked plants were kept in labelled polythene bags. Bundles were weighed and transferred to threshing floor. The produce was threshed manually with the help of wooden sticks. Straw was removed by winnowing and grain produce so obtained was weighed.

Straw yield per plot was obtained by determining the difference between the bundle and net grain weight. Grain samples from produce of each plot was taken for test weight studies.

Table 3.5 Schedule of pre and post sowing operations

SN	Operations	Date of operations
1.	Field preparation	27 & 28.10.1984
2.	Sowing	19.11.1984
3.	Irrigation for germination due to dry soil sowing	20.11.1984
4.	Inter culture and mulching	04.12.1984
5.	Split application of urea and phosphorus	04.12.1984
6.	Ist irrigation	05.12.1984
7.	Split application of urea and phosphorus	18.12.1984
8.	2nd irrigation	26.12.1984
9.	3rd irrigation	17.01.1985
10.	Split application of urea and phosphorus	22.01.1985
11.	4th irrigation	02.02.1985
12.	5th irrigation	17.02.1985
13.	6th irrigation	04.03.1985
14.	Harvesting	25.03.1985
15.	Threshing and processing	26 to 28.03.1985

Treatment evaluation:

The details of observations recorded for statistical analysis during the course of investigation are given in Table 3.6.

Table 3.6 Observation recorded for statistical analysis

SN Observation	Size of sample/ net plot	Time of observation
1. Plant population	One running metre each in three random rows	10 days after sowing
2. Growth studies		
(a) Height of plant	10 tagged plants	At 40, 80, 120 days after sowing
(b) Total number of tillers	One running metre at three different tagged places	At 45, 75, 105 days after sowing
3. Post harvest studies		
(i) Length of spike	10 random spikes	At harvesting
ii) No. of spikelets per spike	10 random spikes	At harvesting
iii) No. of grains/ spike	10 random spikes	
iv) Weight of 1000 grains		
4. Yield studies in kg		
(i) Grain yield		
ii) Straw yield		

1. Plant population:

At the completion of germination i.e. 10 days after sowing plant population was recorded from the marked running metre.

2. Growth studies:

For growth studies height of the plants and number of tillers at 30 days interval till maturity of the crop were recorded.

2(a) Height of the plant:

Height of the ten tagged plants were recorded by measuring the plant from base of the stem to the base of the upper most fully opened leaf. In later stages, i.e. after ear emergence the height was measured from base of the stem up to the base of flag leaf.

2(b) Number of tillers per metre row:

Total number of tillers including main shoot were counted in one running metre each at three tagged places in each plot. In the later stages, i.e. after ear emergence number of ear bearing tillers (effective tillers) only were counted.

3. Post harvest studies:

For spike and 1000 grain weight studies observations were recorded as under:

3(i) Length of spike:

Length of spike was measured from the base of lower most spikelet to the tip in centimetres.

3(ii) Number of spikelets per spike:

Total number of spikelets were counted in each spike.

3(iii) Number of grain/spike:

Individual spike was threshed and total number of grains in it were counted.

3(iv) 1000 grain weight (in g):

Grain sample were taken from finally cleaned produce of each plot. 1000 grains from each plot were counted and weighed excluding broken grains and foreign material. But, shrivelled grains were taken in to account.

4. Yield studies:

4(i) Grain yield:

After threshing and winnowing the net plot produce of grain yield of each plot was recorded in grammes.

4(ii) Straw yield:

Grain yield of each plot was subtracted from the dry bundle weight of the plot to obtain straw yield.

All recorded data were subjected to statistical analysis by the technique of analysis of variance suggested by Yates (1937). The analysis of variance tables used for calculating the value of observed 'F' is given in Table 3.7.

Table 3.7 Skeleton of analysis of variance

Source of variance	d.f.	S.S.	M.S.	Observed 'F'	Table value of F at 5 %	1 %
Replication	3				2.748	4.096
Nitrogen levels (N)	3				2.748	4.096
Phosphorus levels (P)	1				3.988	7.040
Method of split application (M)	2				3.138	4.944
Int. (N x P)	3				2.748	4.096
Int. (N x M)	6				2.238	3.070
Int. (M x P)	2				3.138	4.944
Int. (N x M x P)	6				2.238	3.070
Error	69					
Total	95					

Calculation of S.Em. and C.D.values:

The standard error of mean (S.Em.) for different treatments and the values of critical difference (C.D.) calculated at 5 % and 1 % levels for judging the significance between different treatments by using the following formulae as given by Panse and Sukhatme (1957):

1. $S.Em.\ (N) = \pm \sqrt{\frac{E.MS}{r \times p \times m}}$

2. $S.Em.\ (P) = \pm \sqrt{\frac{EMS}{r \times n \times m}}$

3. S.Em. (M) $= \pm \sqrt{\frac{EMS}{r \times n \times p}}$

4. S.Em.Int.(N x P) $= \pm \sqrt{\frac{EMS}{r \times m}}$

5. S.Em.Int.(N x M) $= \pm \sqrt{\frac{EMS}{r \times p}}$

6. S.Em.Int.(M x P) $= \pm \sqrt{\frac{EMS}{r \times n}}$

7. S.Em.Int.(N x M x P) $= \pm \sqrt{\frac{EMS}{r}}$

8. C.D. for all treatments

(1) C.D. at 5 %, S.Em. x $\sqrt{2}$ x table value of 't' at 5 % level

(2) C.D. at 1 %, S.Em. x $\sqrt{2}$ x table value of 't' at 1 % level.

RESULTS

CHAPTER - IV

RESULTS

The different growth and yield contributing characters, grain and straw yield are presented in this chapter. This experiment was carried out to study the "Effect of split application of nitrogen and phosphorus doses related to crop requirement in irrigated wheat". Analysis of variance technique was used for finding out the significance and table of variance are given in appendix.

A. Pre harvest studies:

A.1 Plant population:

Plant population is an index of plant stand or population. Observation on plant population was recorded 12 days after sowing and analysed statistically.

The data in respect of plant population is presented in Table 4.1.

Table 4.1 Plant population per metre row

Nitrogen doses		Phosphorus doses		Method of split application	
N_0	51.2	P_1	51.3	M_1	51.2
N_1	51.3	P_2	51.2	M_2	51.2
N_2	51.4			M_3	51.3
N_3	51.2				
S.Em.(N) = ± 0.176		(P)	0.124	(M)	0.152
C.D. at 5 %	N.S.		N.S.		N.S.

Plant population is one of the major factors contributing yield. Above data show that the nitrogen and phosphorus doses or method did not affect plant population significantly. Plant population under different treatments as well as interaction was not affected which indicate that plant population stand was uniform in all the treatment plots. Thus experimental efficiency was maintained.

A.2 Plant height:

Plant height is a measure of relative difference in plant growth under different treatments due to agro-climatic condition with limitation of inherent varietal characters. This study was under taken keeping two aspects in view:

(a) Periodical height of plants

(b) Final height of plants

(a) Periodical height of plants:

The height of the plants was taken at 40 days interval starting from 40th day after sowing till maturity of the crop. Periodical increase in average plant height calculated by averaging 10 tagged plants from each plot as influenced by different treatments is shown in Table 4.2.

Table 4.2 Periodical height of plant in cm

Treatment	Days after sowing		
	40	80	120
N_0	14.88	41.41	53.58
N_1	16.25	52.33	71.85
N_2	16.27	54.53	73.64
N_3	16.57	55.85	74.35
P_1	15.94	50.79	68.38
P_2	16.04	51.27	68.34
M_1	16.10	51.43	69.10
M_2	15.93	50.91	68.03
M_3	15.87	50.92	67.95
S.Em. for (N) = ±	0.598	(P)± 0.423	(M)± 0.518
C.D. at 5 %	1.69	N.S.	N.S.

Study of the above table shows that plant height constantly increased upto last observation at 120 days but the rate of increase was rapid during vegetative growth (40 to 80 days) as compared to reproductive phase i.e. 80 to 120 days.

A.2 Final height of plants:

Table 4.2 shows that all the levels of N increased the height significantly over control. Maximum plant height of 74.35 cm was recorded under N_3 treatment and minimum by N_0 treatment. Phosphorus levels had no significant effect on plant height. Method of split application was not found significant.

Fig-1. AVERAGE HEIGHT OF PLANT AS AFFECTED BY NITROGEN AND PHOSPHORUS LEVELS AND METHOD OF SPLITS APPLICATION

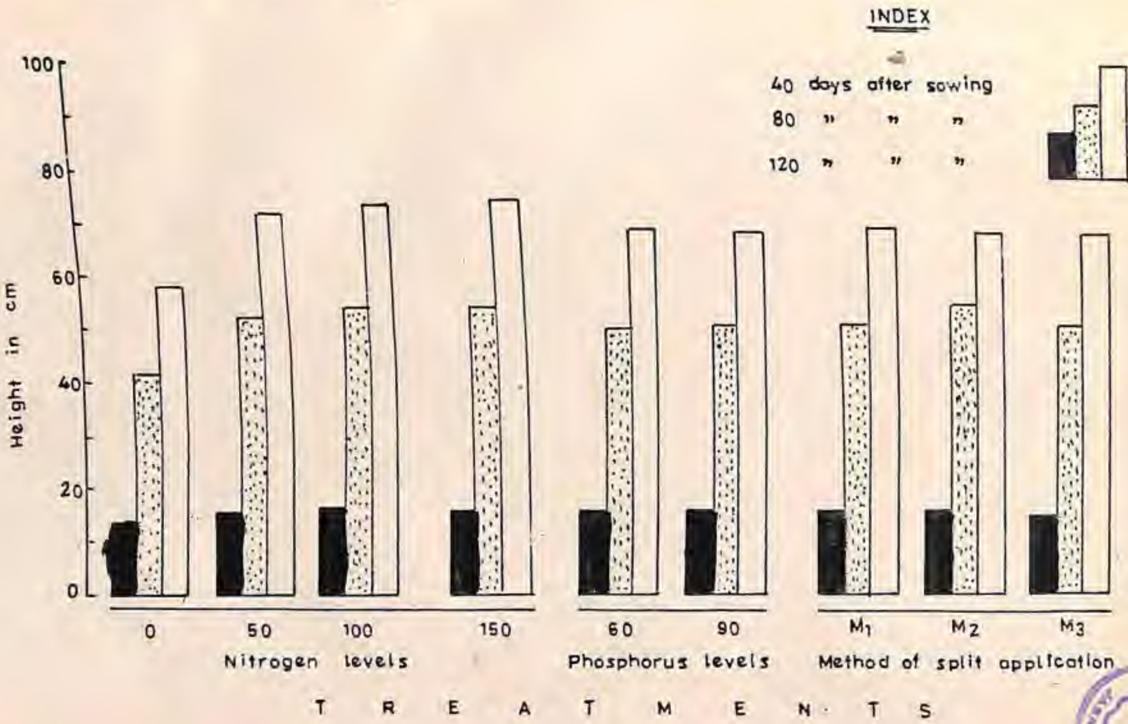
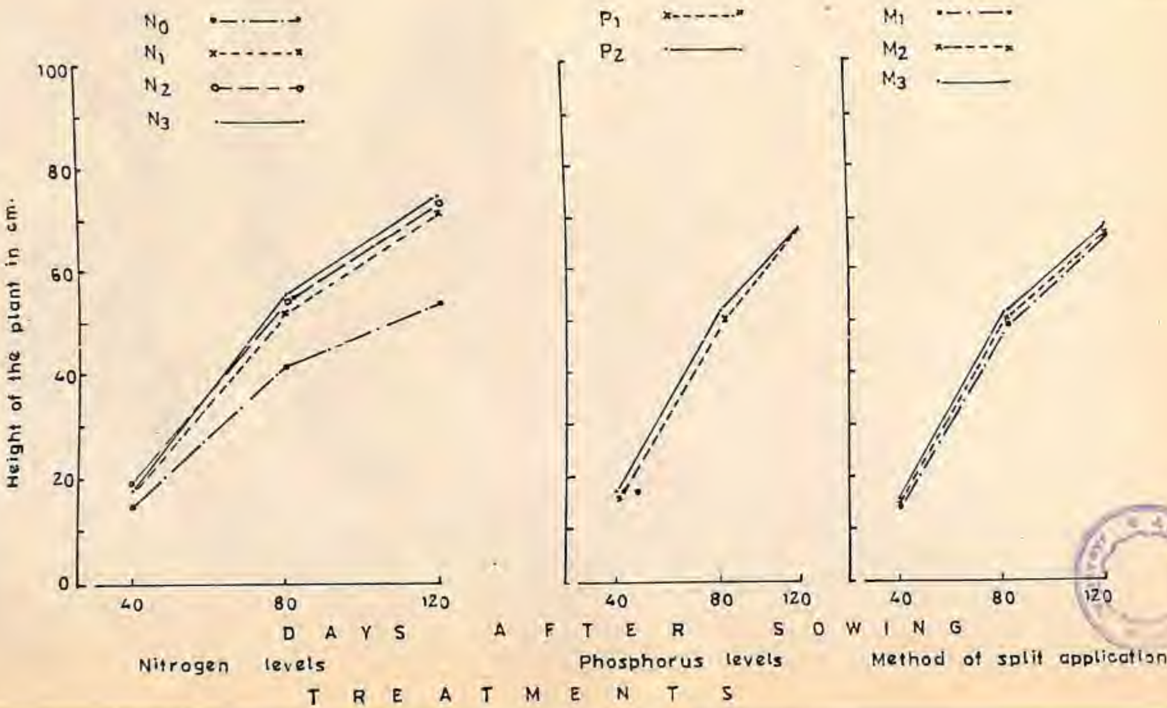


Fig_4.2 PERIODICAL HEIGHT OF PLANT IN cm AS AFFECTED BY DIFFERENT TREATMENT



interaction was found not significant in plant height.

A.3 Number of tillers per metre row:

The number of tillers is an important character of the plant which determine the grain yield. Two aspects of tillering were studied.

(a) Tiller mortality at different stages of plant growth

(b) Number of ear bearing tillers i.e. productive tillers at maturity.

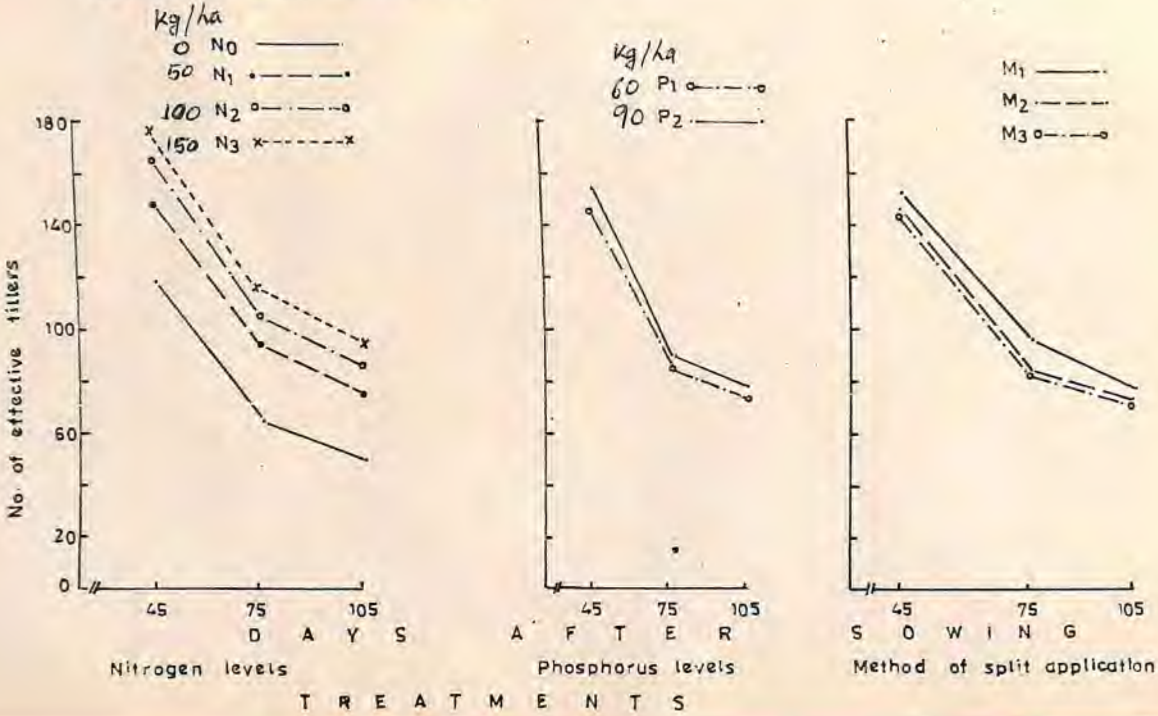
A.3(a) Tiller mortality at different stages of plant growth:

Total number of tillers per metre row at three tagged places in each plot were counted at 30 days interval starting from 45th day after sowing. Results obtained are depicted in Table 4.3.

Table 4.3 Number of tillers at different stages of crop growth and mortality percentage

Treatment	Days after sowing				
	45	75	%	105	%
N_0	116.17	65.15	43.94	58.83	21.99
N_1	143.83	92.25	35.86	75.00	18.70
N_2	164.38	105.26	35.17	87.25	17.12
N_3	175.21	115.33	34.18	94.83	16.17
P_1	146.60	86.77	41.16	75.00	13.57
P_2	153.19	90.14	40.80	78.96	12.41
M_1	152.59	97.19	36.30	79.63	18.07
M_2	148.69	84.60	36.38	76.06	19.60
M_3	148.41	83.16	37.23	75.25	19.23

Fig-2 No. OF EFFECTIVE TILLERS AS AFFECTED BY NITROGEN PHOSPHORUS LEVELS & METHOD OF SPLIT APPLICATION



Data in Table 4.3 reveal that number of tillers was maximum at 40 days i.e. maximum tillering stage after which the number reduced continuously up to final observation at 100 days when total number of spike were counted for effective tillers.

4.3(b) Final number of ear bearing tillers at maturity:

Final number of effective tillers were counted 100 days after sowing and results obtained were statistically analysed.

Table 4.4 Number of effective tillers per metre row

	P_1	P_2	Mean	Methods of split application
N_0	50.25	51.41	50.83	M_1 79.63
N_1	72.83	77.16	75.00	M_2 76.06
N_2	85.08	89.42	87.25	M_3 75.25
N_3	91.83	97.83	94.83	
Mean	75.00	78.96		Int.(N x P)
S.Em.(N)= ± 0.487	(P)± 0.345	(M)± 0.422		± 0.690
C.D. at 5 %=±1.37	± 0.97	± 1.19		± 1.95
C.D. at 1 %=±1.83	± 1.58	± 1.58		± 2.58

Study of the above table shows that all the levels of fertiliser N and P produced significantly more number of effective tillers. N_3 (150 kg/ha N) produced highest tiller number followed by N_2, and N_1. Lowest number of tillers was noticed in N_0 (0 kg N/ha). P_2 90 kg/ha, P_2O_5 produced more tillers followed by P_1 60 kg/ha P_2O_5. Method of split application were also found highly significant. M_1 (10 & 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) recorded highest tiller number followed by M_2 (50 % 21 days after germination + 50 % 56 days after germination) and M_3 (60 % 21 days after germination + 40 % 56 days after germination). Difference between M_1 and M_2 was also found significant. But difference between M_2 and M_3 was not significant.

Interaction between nitrogen and phosphorus levels was found significant but nitrogen x method and method x phosphorus was not found significant.

B. Post harvest studies:

Spike or ear of the plant was studied for its various components as some of these have direct influence of the yield. The components studied are as under:

1. Length of spike (in cm)
2. Number of spikelets per spike
3. Number of grain per spike
4. 1000 grains weight in gms.

B.1 Length of spike:

Ten spikes were randomly selected from each treatment plot at the time of harvesting and measured for length in cm and average worked out. Results obtained are mentioned in Table 4.5.

Table 4.5 Length of spike in cm

Nitrogen doses		Phosphorus doses		Method of application	
N_0	4.22	P_1	5.73	M_1	5.93
N_1	5.91	P_2	5.90	M_2	5.75
N_2	6.45			M_3	5.75
N_3	6.66				
S.Em.(N)= ± 0.094		(P)± 0.133		(M)± 0.081	
C.D. at 5%=±0.27		N.S.		N.S.	

Above table clearly indicate that nitrogen levels differ significantly. N_3 (150 kg/ha N) produced longest spike than N_2 (100 kg/ha N) and followed by N_1 (50 kg/ha N) when N_0 recorded the shortest spike.

Phosphorus doses and method of application are found not significant as regards length of spike.

Interaction of the treatments was not found significant for spike length.

B.2 Number of spikelets per spike:

Number of spikelets per spike is an important yield contributing character. Number of spikelets per spike for each treatment plot was calculated by averaging spikelet number of 10 randomly selected spikes in each plot. The data obtained are displayed in Table 4.6.

Fig-3. AVERAGE LENGTH OF SPIKE AS AFFECTED BY NITROGEN AND PHOSPHORUS LEVELS AND METHOD OF SPLIT APPLICATION.

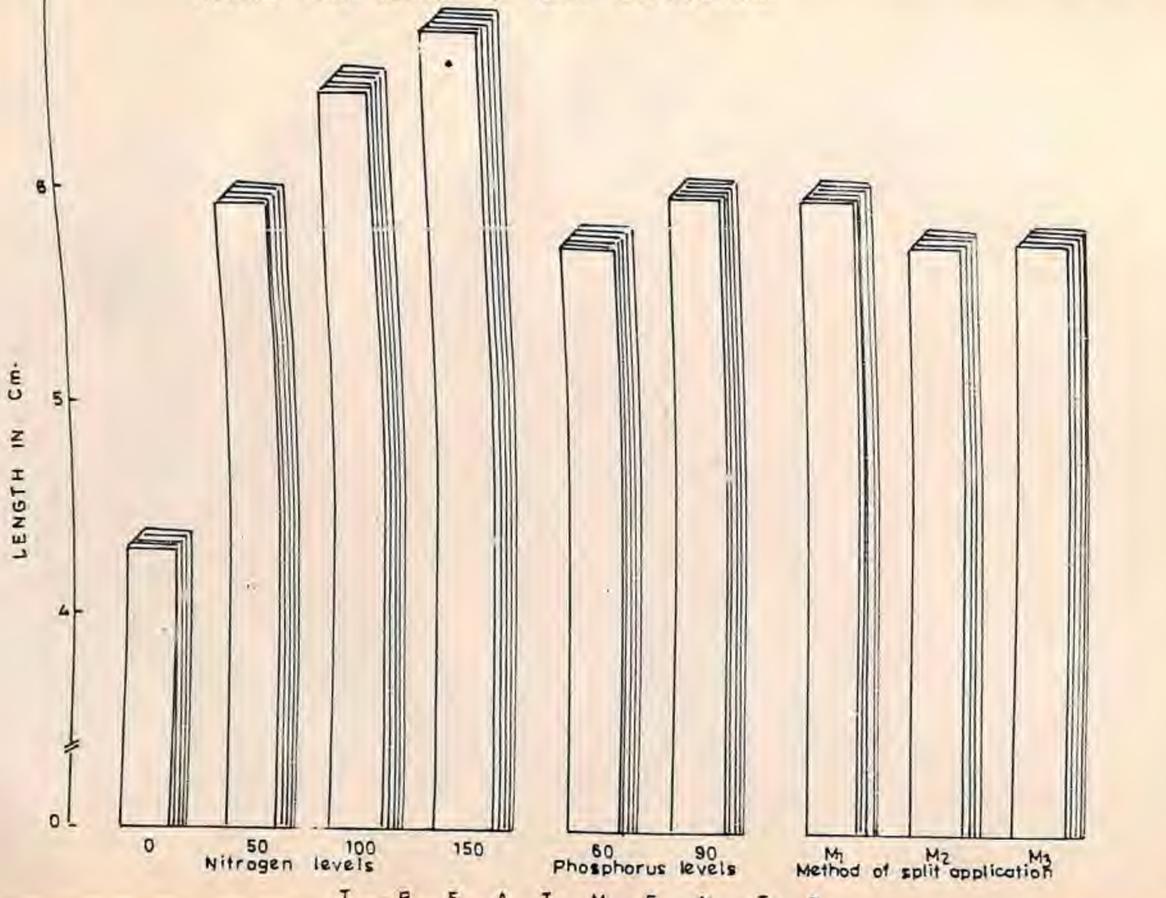


Table 4.6 Number of spikelets per spike

Nitrogen doses		Phosphorus doses		Method of application	
N_0	12.98	P_1	15.54	M_1	14.94
N_1	14.43	P_2	14.91	M_2	14.66
N_2	15.32			M_3	14.57
N_3	16.15				
S.Em.(N) =	± 0.057	(P)	± 0.040	(M)	± 0.049
C.D. at 5% =	±0.16		± 0.11		± 0.14

Study of Table 4.6 reveals that levels of nitrogen and phosphorus as well as methods were found to effect number of spikelets per spike significantly. The effect of doses of nitrogen and phosphorus was linear.

Interaction between the treatments was not found significant.

B.3 Number of grains/spike:

Total number of grains per spike is again an important yield component which in turn is dependent on number of spikelets/spike and number of grains/spikelet. Number of grains in 5 spikes was averaged and results are reproduced in Table 4.7 and analysis of variance is shown in appendix.

Fig.4. AVERAGE NUMBER OF SPIKELETS PER SPIKE AS AFFECTED BY NITROGEN AND PHOSPHORUS LEVELS AND METHOD OF SPLIT APPLICATION

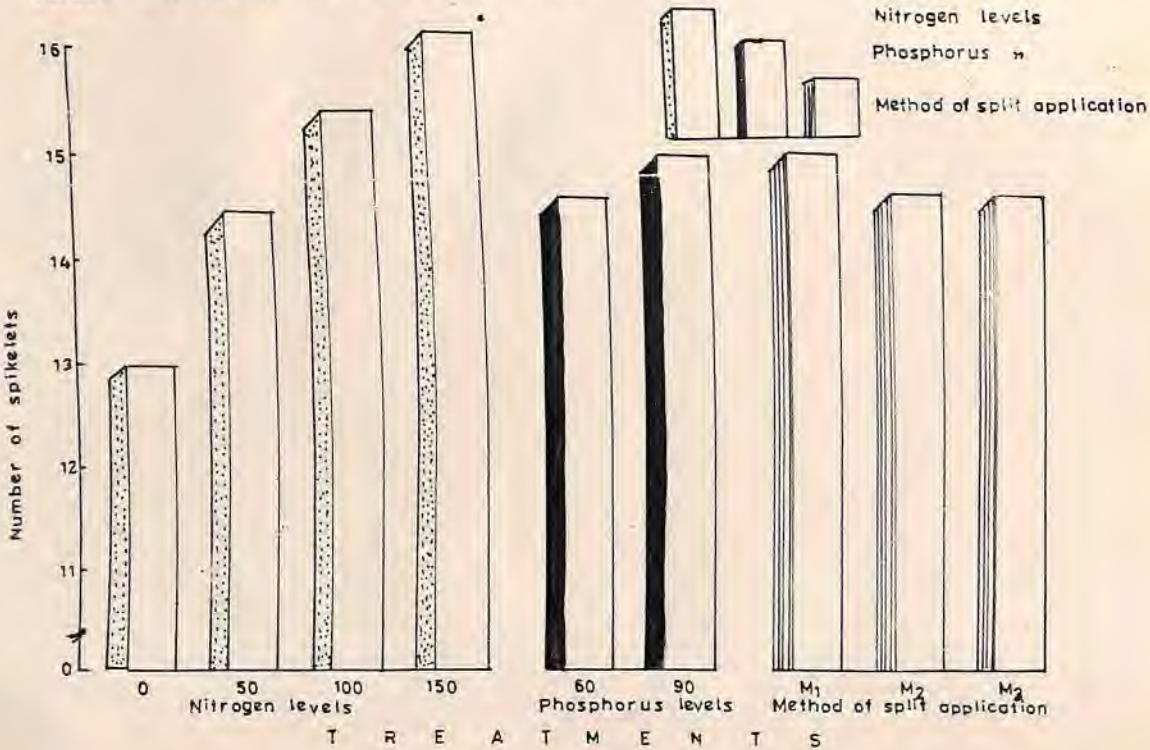


Table 4.7 Number of grain per spike

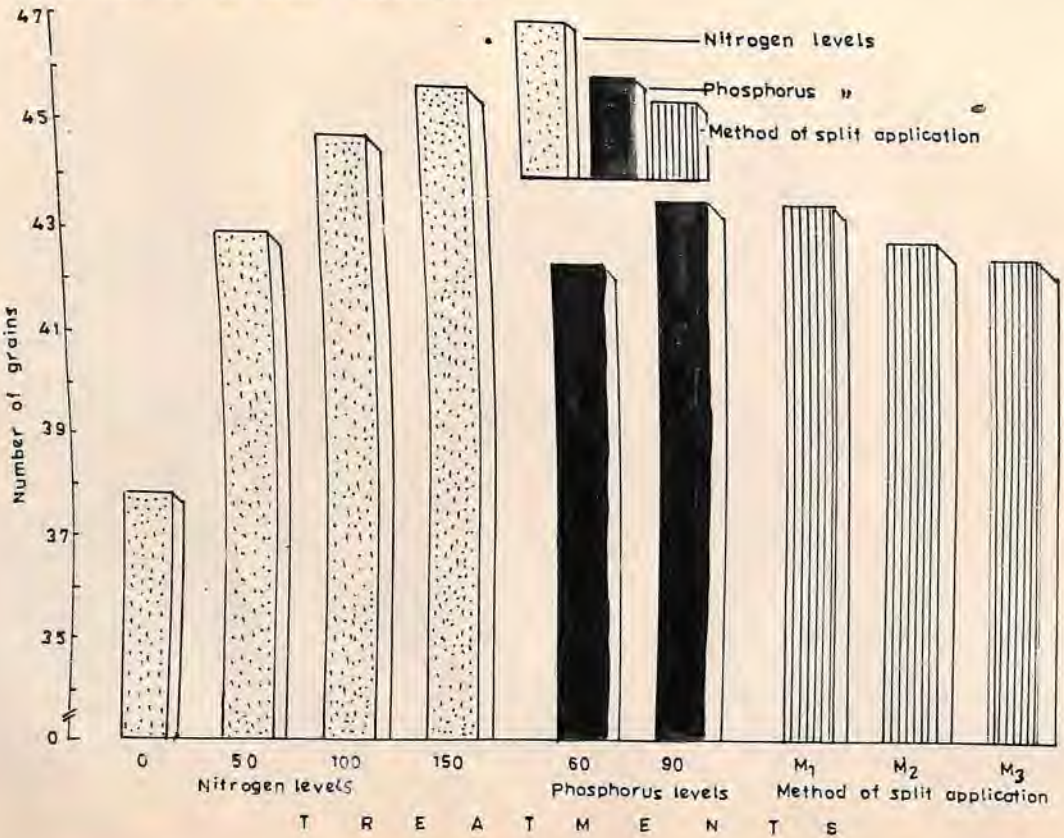
Nitrogen doses		Phosphorus doses		Method of application	
N_0	27.51	P_1	40.21	M_1	41.28
N_1	42.54	P_2	41.89	M_2	40.89
N_2	45.92			M_3	40.98
N_3	48.23				
S.Em.(N) = ±	0.094	(P)	± 0.067	(M)	± 0.082
C.D. at 5% =	±0.27		± 0.19		± 0.23
C.D. at 1% =	±0.35		± 0.25		± 0.31

Perusal of data in Table 4.7 indicate highly significant effect of nitrogen as well as phosphorus levels on number of grains per spike. The response to nitrogen and phosphorus doses was found linear. Again split method with low initial and higher subsequent doses recorded significant difference in number of grains.

Table 4.8 Interaction between nitrogen and phosphorus in number of grains per spike

	P_1	P_2	Mean
N_0	26.15	28.88	27.51
N_1	41.63	43.45	42.54
N_2	45.28	46.66	45.92
N_3	47.78	48.68	48.23
Mean	40.21	41.89	
S.Em.(N x P) = ±	0.133		
C.D. at 5 % = ±	0.38		
C.D. at 1 % = ±	0.50		

Fig.5. AVERAGE NUMBER OF GRAINS PER SPIKE AS AFFECTED BY NITROGEN AND PHOSPHORUS LEVELS AND METHOD OF SPLIT APPLICATION



Interaction between nitrogen and phosphorus levels was found highly significant. The above table shows that the maximum number of grains was produced by N_3P_2 followed by N_3P_1 and lowest in N_0P_1 and N_0P_2 respectively.

B.4 1000 grain weight in gms:

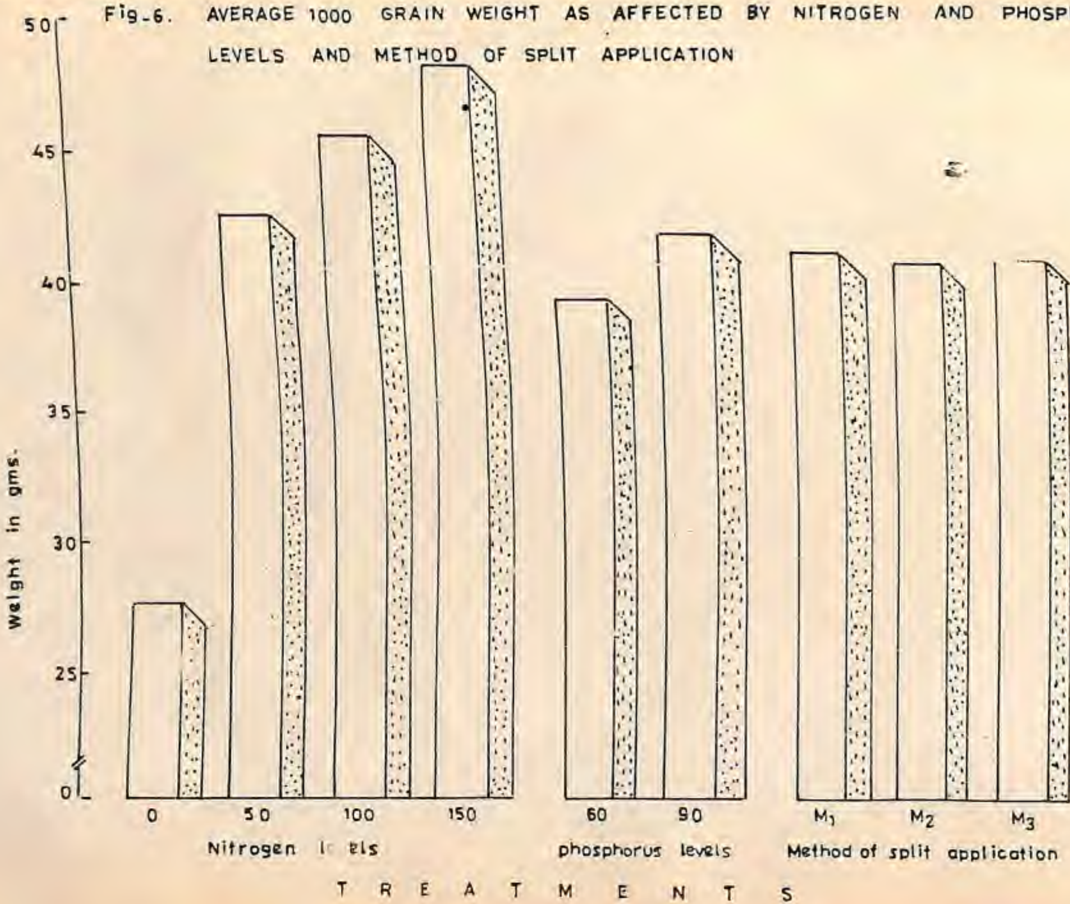
1000 grain weight is also one of the most important yield contributing character. 1000 grain weight in each treatment plot was recorded after due drying of produce. The data are reproduced in Table 4.9 and analysis of variance is given in appendix.

Table 4.9 1000 grain weight in grammes

Nitrogen doses		Phosphorus doses		Method of application	
N_0	37.77	P_1	42.29	M_1	43.44
N_1	42.85	P_2	43.35	M_2	42.77
N_2	44.73			M_3	42.41
N_3	46.13				
S.Em.(N) = ±	0.256	(P)	± 0.181	(M)	± 0.222
C.D. at 5% =	± 0.72		± 0.51		± 0.63
C.D. at 1% =	± 0.96		± 0.68		± 0.83

Perusal of data in Table 4.9 clearly shows that nitrogen and phosphorus levels had highly significant effect over 1000 grain weight. And method of split application was also highly significant over 1000 grain weight. Maximum 1000 grain weight was recorded by M_1 (10 % 7 days after germination + 60 % 21

Fig-6. AVERAGE 1000 GRAIN WEIGHT AS AFFECTED BY NITROGEN AND PHOSPHORUS LEVELS AND METHOD OF SPLIT APPLICATION



days after germination and 30 % 56 days after germination) followed by M_2 and M_3, respectively with all nitrogen and phosphorus levels.

Interaction between treatments was not found significant.

C. Yield studies:

(a) Grain yield (in kg/ha)

(b) Straw yield (in kg/ha)

C.1 Grain yield in kg/ha:

Grain yield is ultimate factor in an experiment to show that treatments had clear and marked effect.

Perusal of data in Table 4.10 will show that the grain yield was influenced significantly due to nitrogen and phosphorus levels and methods of split application.

Table 4.10 Grain yield in kg/ha

	Nitrogen doses	Phosphorus doses	Method of application
	N_0 2145.60	P_1 4163.25	M_1 4475.18
	N_1 3981.50	P_2 4334.79	M_2 4155.89
	N_2 5211.40		M_3 4115.98
	N_3 5657.80		
S.Em.(N) =	± 40.76	(P) ± 28.53	(M) ± 35.32
C.D.at 5%	±114.12	± 80.16	± 99.18
C.D.at 1%	±153.33	±108.97	±133.42

Data in Table 4.10 clearly indicate that nitrogen and phosphorus levels as well as method of split application recorded highly significant effect on grain yield. The effect of nitrogen doses was linear and highly significant similar linear trend was noticed in phosphorus. Maximum grain yield was noted in M_1 (10 % at 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) followed by M_2 (50 % 21 days after germination + 50 % 56 days after germination) and lowest yield was recorded in M_3 (60 % 21 days after germination + 40 % 56 days after germination).

Interaction effect for N x P and N x M is shown in Table 4.11.

Table 4.11 Combined effect of nitrogen and phosphorus and method of split application on grain yield

	P_1	P_2	M_1	M_2	M_3	Mean
N_0	2083.32	2207.87	2241.64	2197.68	1997.27	2145.59
N_1	3832.63	4130.41	4279.87	3777.16	3887.55	3981.52
N_2	5045.27	5377.01	5502.69	5125.66	5005.07	5211.4
N_3	5691.25	5623.79	5876.33	5523.07	5523.17	5657.81
Mean	4163.25	4334.79	4475.18	4155.89	4125.98	
S.Em.(NP) = ± 57.06			(NM) ± 70.65			
C.D. at 5% = ± 163.04			±203.80			
C.D. at 1% = ± 216.03			±266.30			

The interaction effect of nitrogen and phosphorus levels was found highly significant. Themaximum grain yield was produced by N_3P_1 (150 kg/ha N and 60 kg/ha P_2O_5). Nitrogen was also found to interact significantly with method of split application. The maximum grain yield was recorded in N_3M_1 (150 kg/ha dose of N @ 10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination). Whereas lowest yield was recorded from N_0M_3 (0 kg/ha dose of N @ 60 % 21 days after germination and 40 % 56 days after germination).

C.2 Straw yield in kg/ha:

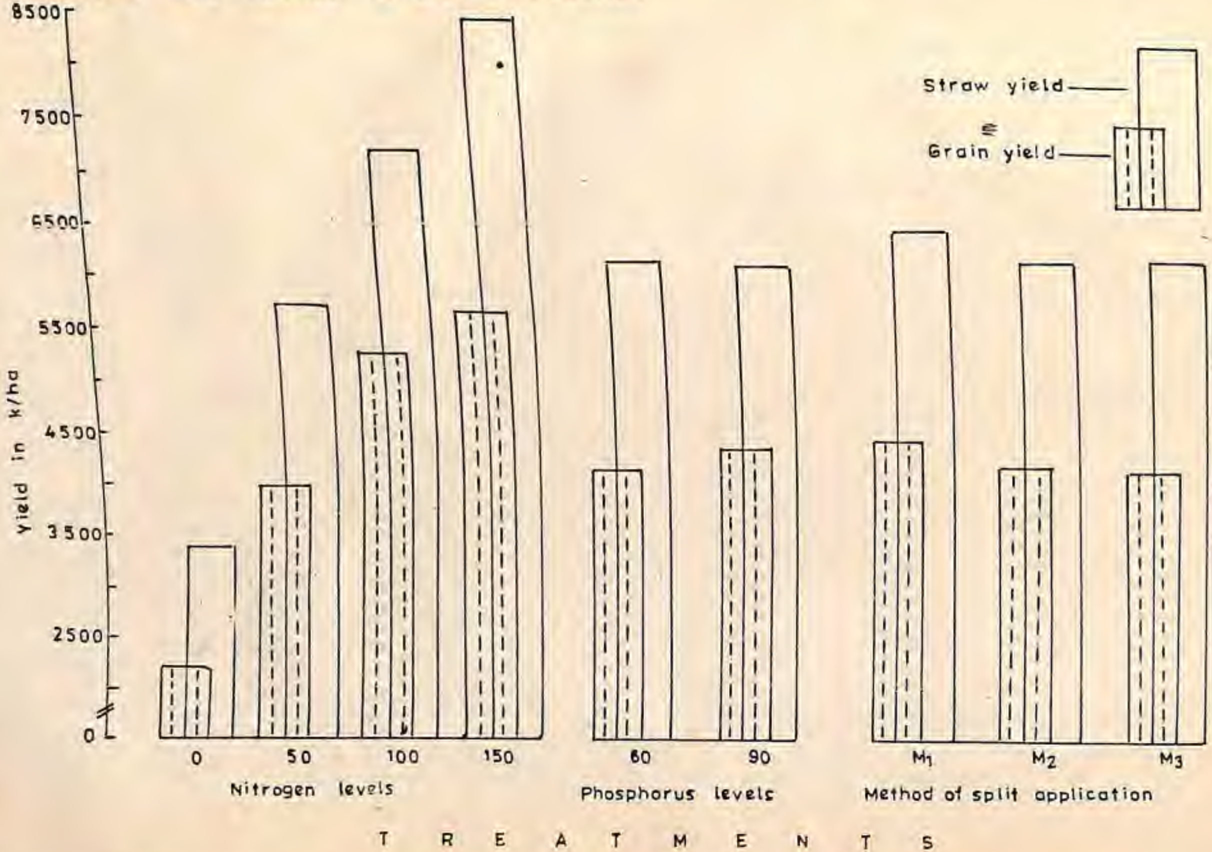
The straw yield per plot was converted into hectare and analysed. The result are exhibited in Table 4.12 and analysis of variance is shown as appendix.

Table 4.12 Straw yield in kg/ha

		P_1	P_2	Mean	Method of application	
	N_0	3268.78	3480.13	3364.45	M_1	6449.97
	N_1	5879.73	5624.98	5752.35	M_2	6131.94
	N_2	7113.87	7145.56	7129.71	M_3	6115.38
	N_3	8449.92	8383.12	8416.52		
Mean		6178.07	6153.45			
S.Em.(M) = ±		44.84 (P)	± 31.25 (M)	± 38.04 (MP)		± 62.50
C.D. at 5 % = ±		126.36	± N.S.	±107.34		±176.62

Result in Table 4.12 reveals that straw yield was linearly increased by nitrogen levels and differences were highly significant. Though phosphorus level exhibited increase in yield but were not significant. Method of split

Fig-7. AVERAGE GRAIN AND STRAW YIELD (Kg/ha) AS AFFECTED BY NITROGEN AND PHOSPHORUS LEVELS AND METHOD OF SPLIT APPLICATION



application was also found highly significant by causing increase in straw yield. Method M_1 produced more straw yield than M_2 and M_3 i.e. 318 kg/ha more straw which was highly significant.

The interaction between nitrogen and phosphorus levels were found significant with different treatment combinations. Highest straw yield was produced by N_3P_1 (150 kg/ha N and P_1 60 kg/ha P_2O_5) and lowest was recorded from N_0P_1 (0 kg/ha N and 60 kg P_2O_5/ha).

ECONOMICS OF THE EXPERIMENT

Cultivators are finally interest in term of monetary return. Hence any recommendation should be made keeping in view the net return from it. Table 4.13 out lines the net monetary return and cost benefit ratio of different treatments on grain and straw yield.

Table 4.13 Economics of the experiment

Treatment	Cost of prod./ha Rs	Income/ha Rs	Return/ha Rs	Net return per rupees investment
N_0	2710*	5328	2618	1:1.96
N_1	3102	9643	6541	1:3.10
N_2	3440	12422	8982	1:3.61
N_3	3635	13824	10189	1:3.80
P_1	3341	10086	6745	1:3.01
P_2	3411	10445	7034	1:3.06
M_1	3350	10832	7482	1:3.23
M_2	3210	10128	6918	1:3.18
M_3	3190	10052	6862	1:3.15

*

Above data show that net profit increased with increasing levels of fertilizers dose upto 150 kg/ha nitrogen and 90 kg/ha phosphorus.

Method of split application also gave highest net return. M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) then M_2 (50 % 21 days after germination + 50 % 56 days after germination).

Table 4.13 Individual interaction cost benefit ratio for grain yield

	P_1	P_2	M_1	M_2	M_3	Nitrogen mean
N_0	1.30:1	1.38:1	1.40:1	1.38:1	1.25:1	1.34:1
N_1	2.10:1	2.26:1	2.34:1	2.07:1	2.13:1	2.18:1
N_2	2.49:1	2.66:1	2.72:1	2.53:1	2.47:1	2.57:1
N_3	2.66:1	2.63:1	2.75:1	2.58:1	2.58:1	2.64:1
Phosphorus mean	2.14:1	2.23:1	2.30:1	2.14:1	2.11:1	

Above table clearly shows that nitrogen combined with phosphorus 2.66:1 and 2.75:1 methods of split application gave highest cost benefit ratio.

DISCUSSION

CHAPTER - V

DISCUSSION

Discussion of the results obtained in light of previous research findings is necessary to correlate the effect of every aspect of treatments on growth and yield of crop are shown herewith.

A.1 Pre harvest studies:

Preharvest studies like plant population, height and tillers are carried out to asses effect of different treatments which are directly or indirectly related to crop stand and growth.

(a) Plant population per metre row:

It is observed from Table 4.1 that the difference is due to doses of nitrogen, phosphorus and methods of split application were not significant. Which indicates uniformity in plant population. Which is a requisite for correct experimentation.

A.2 Plant height:

(a) Height of the plant:

Data in Table 4.2 indicated that active vegetative period of the crop was upto 80 days in which plant attained maximum height. After 80 days very little increase in height was noticed and there after height was almost constant as plant was in reproductive phase.

(b) Final height of the plant:

(i) Effect of fertilizer doses on plant height:

Plant height was increased with increase in the fertilizer doses. N_3 (150 kg/ha N gave significantly more height over N_0 fertilizer. Nitrogen is mainly responsible for vegetative growth of plant and its presence gave the expected results. These results are similar to those of Sharma et al. (1970) and Sandhu and Gill (1972).

(ii) Effect of method of split application:

Different methods of split application had no significant effect over plant height although maximum plant height of 69.10 cm was recorded by M_1 followed by 68.03 cm of M_2.

A.3 Number of tillers/effective tillers per metre row:

Study of data reveals that maximum tillering was found at 40 days stage followed by 70 and 100 days stage, respectively. This decrease in tiller number due to mortality of tillers with advance in growth stage is a normal phenomena. In fact tiller mortality is a response to internal and competative stresses and any one or all the components of the environment may be involved in the said process. Thus it is essential to study the pattern of tiller mortality under the present set of treatments.

Table 4.3 Mortality percentage of tillers at different stages of plant growth as affected by different treatments

No. of tiller

Treatments	Days after germination	
	75	105
N_0	43.94	21.99
N_1	35.86	18.70
N_2	35.17	17.12
N_3	34.18	16.17
P_1	41.16	13.57
P_2	40.80	12.41
M_1	36.30	18.07
M_2	36.38	19.60
M_3	37.23	19.23

It is evident from the table that nitrogen levels caused significant decrease in tiller mortality at both 75 and 105 days stage. Tiller mortality was also caused due to phosphorus and methods. But N_0 had greater mortality than N_1, N_2 and N_3 indicated lesser mortality.

In case of methods of split application M_3 (60 % 21 days after germination + 40 % 56 days after germination) experienced maximum mortality whereas other splits viz., M_2 and M_1 indicated lesser mortality but figures did not show much difference at both 75 and 105 days stage. By increased application of nitrogen in split at later growth stages, survival percentage of tillers was improved. Thus it emerges from the present data that late application of nitrogen increases the survival rate of tillers resulting in more number of effective tillers and ultimately causing more grain number as well as straw yield per unit area. All the factors viz., nitrogen, phosphorus and methods were found to increase the effective tiller number significantly. Indication of nitrogen and phosphorus was also found to increase the effective tillers and the differences were highly significant.

Different methods of split application had significant effect over number of effective tillers per metre row. M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) produced 79.63 i.e. highest number of effective tillers and minimum 75.25 under M_3 (60 % 21 days after germination + 40 % 56 days after germination) while M_2 (50 % 21 days after germination + 50 % 56 days after germination) produced 76.06 tillers. The increase in number of tillers per metre row in M_1 method was 5.82 and 4.69 % as compared to M_3 and M_2.

Interaction:

The combined effect of nitrogen and phosphorus doses was observed significant. Table 4.3 shows that all nitrogen and phosphorus doses responded by producing more number of effective tillers per metre row. In most of the cases all treatments (N x P) except N_0P_1, N_0P_2 and N_1P_1, N_2P_2 did not exhibit significant difference. Maximum number of effective tillers per metre row was recorded with the N_3P_2 while minimum with N_0P_1.

Post harvest studies:

Post harvest studies were made to find out the effect of various treatments on the yield components which are directly related to yield.

B.1 Length of spike:

Effect of fertilizer doses:

Nitrogen levels showed linear response in length of spike due to increase in levels but difference between 100 and 150 kg/ha was not found significant while phosphorus doses were not found to affect length of spike significantly.

The probable explanation is that balanced nutrition increased the length of spike and deficiency of these nutrients may lead to smaller spike, Nagar (1980) and Yadav (1981) also reported similar results.

The length of spike was not influenced by phosphorus doses and method of split application.

B.2 Number of spikelets per spike:

Effect of fertilizer doses:

It is revealed from Table 4.6 that nitrogen doses significantly influenced the number of spikelets per spike as the increase was linear. Similarly, 90 kg P_2O_5 per hectare recorded significant influence over 60 kg P_2O_5 per hectare. The percentage increase in number of spikelets per spike works out to 32.12, 11.22 and 5.41 % more than 0 kg, 50 kg and 100 kg N/ha is compared to 150 kg N/ha. Similarly, 90 kg P_2O_5/ha produced 2.54 % more spikelets/spike than 60 kg P_2O_5/ha. The increase may be due to availability of higher doses of nitrogen and phosphorus.

Methods of split application were also found significant. Maximum number of spikelets/spike were produced by M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination). Increase being 2.53 and 1.9 % over M_3 (60 % 21 days after germination + 40 % 56 days after germination) and M_2 (50 % 21 days after germination + 50 % 56 days after germination).

Interaction was not found significant in respect of number of spikelets/spike.

B.3 Number of grain per spike:

Effect of fertilizer doses:

Perusal of Table 4.7 indicates that number of grains increased with increasing levels of nitrogen and the differences were highly significant. 150 kg N/ha gave significantly (48.23) more number of grains per spike followed 0 kg (27.51), 50 kg (42.54) and 100 kg N (45.92) respectively. Similarly phosphorus levels were also found to increase number of grains per spike. The differences were highly significant.

Significant differences were also observed among different methods of split application. M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination), which produced highest number of grains per spike (41.28) followed by M_2 of 40.89 (50 % 21 days after germination + 50 % 56 days after germination) and 40.08 of M_3 (60 % 21 days after germination + 40 % 56 days after germination).

Interaction of nitrogen and phosphorus was also found significant on number of train per spike.

B.4 1000 grain weight:

Effect of fertilizer doses:

Table 4.8 reveals that levels of nitrogen showed linear increase in 1000 grain weight and the differences were highly significant. Phosphorus doses also recorded highly significant difference in 1000 grain weight.

The maximum test weight (46.13 gms) was recorded by N_3 (150 kg N/ha) followed by 0 kg N/ha (37.77 gms) the increase in terms of percentage of 150 kg N/ha works out to 22.13, 7.65 and 3.14 % over 0, 50 and 100 kg N, doses respectively. Similarly phosphorus level of 90 kg/ha recorded 2.5 % increase in test weight over 60 kg P_2O_5/ha.

Different methods of split application were also found significant in test weight. Maximum test weight of 43.44 gms was noted in M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) followed by 42.77 gms in M_2 (50 % 21 days after germination + 50 % 56 days after germination) and 42.11 gms in M_3 (60 % 21 days after germination + 40 % 56 days after germination). Difference between M_1 and M_2 were significant and M_1 and M_3 highly significant but M_2 and M_3 are not significant.

Interaction of all the treatments were not found significant.

C. Yield studies:

C.1 Grain yield in kg/ha:

It is revealed from Table 4.9 that increasing levels of fertiliser increased the grain yield. Maximum grain yield of 5657.8 kg/ha was obtained with 150 kg/ha N followed by 100 kg N/ha which were significantly superior to control and 50 kg N/ha. Phosphorus doses were also found significant in affecting grain weight. The difference between 90 kg P_2O_5/ha and 60 kg P_2O_5/ha was highly significant.

Increase in the grain weight due to fertilizer doses may be attributed to more number of effective tillers per metre row decrease in mortality percentage, length of spike, number of spikelets/spike and number of grains/spike. These are the important characters which influenced the yield directly. Pathak and Tiwari (1973), Agrawal and Singh (1976) and Prasad et al. (1979) also reported similar results.

Methods of split application also recorded significant differences in grain yield. M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination), registered highest grain yield of 4475 kg/ha which was 8.72 and 7.68 % more than M_3 and M_2, the existing recommendation respectively. The differences between the later two methods being not significant. The main factors responsible for higher grain yield in both M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) and M_3 (60 % 21 days after germination + 40 % 56 days after germination) is due to higher number of effective tiller, test weight, number of grains/spike and number of spikelets per spike, respectively as compared to M_2 (50 % 21 days after germination + 50 % 56 days after germination. Higher grain yield in M_1 can be attributed to the fact that [illegible] no quantity of nitrogen was applied as basal and full portion was applied at CRI and full vegetative stage i.e. late jointing stage. Hence desirable nutrient supply was available to the plant at maximum uptake stage which catered to the need of increased nutrient requirement of the crop thus reflected in yield increase.

Another factor responsible for lower grain yield may be enlisted as loss of nitrogen through leaching and volatilization as large amountof nitrogen was applied as basal and young plant seedlings having hardly any effective plant roots at that stage could not make effective use of available nutrients. On the other hand, smaller amount of nitrogen and phosphorus applied as basal in M_1, M_3 compared to M_2 i.e. The existing recommendation, which may not have suffered loss of nitrogen due to leaching and volatilization. Loss of nitrogen through leaching when applied in larger amount at initial stage has also been reported by Sandhu and Gill (1972). Thus the hypothesis of this experiment stands proved.

Interaction between nitrogen and phosphorus was found significant, and response was up to 150 kg N/ha was noticed 5691 kg/ha. Nitrogen and methods of split application were also found significant in grain yield. Highest grain yield of 5876 kg/ha was recorded by 150 kg N/ha with M_1 and lowest was 4125 kg/ha recorded by 0 kg N/ha with M_3. Methods of split application of phosphorus doses were not found significant in grain yield.

C.2 Straw yield:

Straw yield is indicative of the total vegetative growth of the plant. Obviously, straw yield is consist of two factors viz., height of the plant and number of tillers per unit area. Effect of nitrogen doses was found significant in straw yield. 150 kg N/ha recorded highest straw yield of 8449 kg/ha followed by 100 kg, 50 kg and 0 kg N/ha. Lowest straw yield produced by 0 kg N/ha 3268 kg/ha. Phosphorus levels did not influence the straw yield significantly.

Different methods of split application had significant effect on straw yield. Maximum straw yield of 6449 kg/ha was recorded in M_1 followed by M_2 and M_3.

Study of the results of individual treatments as well as combinations are complimentry, hence the findings may be considered confirmed particularly when similar results were obtained during the last three seasons.

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SUMMARY AND CONCLUSION

CHAPTER - VI

SUMMARY AND CONCLUSION

A field experiment entitled "Effect of split application of nitrogen and phosphorus doses related to crop requirement in irrigated wheat" was conducted during the rabi season of 1984-85 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture Farm, Indore.

The experiment consisted of 4 levels of nitrogen and 2 levels of phosphorus. The levels of nitrogen tried were 0,50, 100 and 150 kg/ha and levels of phosphorus 60 and 90 kg/ha and 3 methods of split application (10 % + 60 % + 30 %), (50 % + 50 %) and (60 % + 40 %). Nitrogen and phosphorus both were given in split application at different growth stages of the crop. Irrigation were given at the critical stages. All the combinations of nitrogen x phosphorus doses and method of split application were replicated four times in a randomized block design.

The result of the experiment are summarised below:

Fertilizer doses:

Increasing levels of N and P fertilisers increased the height of plant, number of effective tillers/metre row, length of spike, number of spikelets, number of grain/spike and 1000 grain weight.

Application of 150 and 90 kg/ha N and P gave 5657 kg/ha and 4334 kg/ha grain yield, respectively, ~~and significantly~~. ~~Superior to control 100 kg/ha and 60 kg/ha.~~

The fertilizer doses of 150 kg/ha N gave maximum net return of Rs.9616/- per hectare as against Rs.2618/- with 0 kg/ha N.

Methods of split application:

Different methods had no significant effect over height of plant and length of spike. While tillering, number of spikelets/spike, number of grain/spike and test weight were significantly effected by these treatment M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) produced maximum number of effective tillers followed by M_2 (50 % 21 days after germination + 50 % 56 days after germination) and M_3 (60 % 21 days after germination + 40 % 56 days after germination). From the present experiment it emerged that late application of nitrogen and phosphorus reduced the mortality percentage of tillers and increased survival of tillers per unit area which caused increase in grain production per unit area by 7.68 %.

Method of application M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) also proved superior to other treatments in number of spikelets/spike, number of grains/spike and test weight giving significantly more grain yield. M_1 gave an increase of 7.68 %, and 8.72 % over M_2, M_3.

Interaction:

Nitrogen x phosphorus interaction was found significant are number of effective tillers and number of grains/spike. N_3P_2 (150 kg N + 90 kg/ha P) combination produced maximum number of tillers and number of grains/spike.

In case of grain yield interaction of nitrogen x phosphorus and nitrogen x methods of split application were found significant. N_3P_2 (150 kg N + 90 kg/ha P) and N_3M_1 (150 kg N/ha, 10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination) produced highest grain yield.

Conclusion:

Application of nitrogen and phosphorus at the rate of 150 kg N + 60 kg/ha P were found superior than other combination of nitrogen and phosphorus. Maximum grain yield of 5691 kg/ha was recorded from N_3P_1 followed by 5045 kg/ha in N_2P_1 and 3832 kg/ha in N_1P_1, respectively.

Methods of split application M_1 (10 % 7 days after germination + 60 % 21 days after germination and 30 % 56 days after germination), proved superior than other method of split application M_2 and M_3, respectively. M_1 method gave maximum grain and straw yield. This treatment gave better results due to nutrients being available in soil at peak requirement.

The validity of hypothesis of lower initial input of nitrogen [illegible] as a starter is proved by the four years results now available. If possible various chemical studies may be made to attribute reasons for beneficial effect of this new split combination method in black cotton soil, particularly, with water infiltration and nutrient movement. Two tier plant maturity was also noticed the earlier tillers matured fully closely followed by secondary tillers which completed the life cycle but produced slightly smaller spikelets/spike, number of grains per spike but caused higher grain and straw yield due to availability of nutrient at later stages of crop growth.

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* Original not seen.

APPENDIX

APPENDIX

Table 1 Plant population per metre row

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	10.27	3.42	4.65**	2.748	4.096
Nitrogen (N)	3	0.71	0.236	0.315NS	2.748	-
Phosphorus (P)	1	0.465	0.465	0.620NS	-	-
Methods of split application (M)	2	0.0275	0.013	0.018NS	-	-
Int. (N x P)	3	1.066	0.355		-	-
Int. (N x M)	6	0.503	0.083	0.473NS	-	-
Int. (M x P)	2	0.173	0.087	0.11NS	-	-
Int. (N x M x P)	6	1.745	0.29	0.116NS	-	-
Error	69	51.699	0.749	0.387NS	-	-
Total	95	66.65				

** Significant at 1 % level.

NS Not significant.

Table 2 Height of plant in cm

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	1888.97	629.65	73.25**	2.748	4.096
Nitrogen (N)	3	14136.83	4712.28	548.57**	2.748	4.096
Phosphorus (P)	1	0.064	0.0604	0.007NS	3.988	4.988
Methods of split application (M)	2	53.018	26.50	3.08NS	3.138	7.04
Int. (N x P)	3	26.29	8.76	1.019NS	2.748	-
Int. (N x M)	6	15.72	2.62	0.30NS	-	-
Int. (M x P)	2	0.233	0.116	0.013NS	-	-
Int. (N x M x P)	6	10.93	1.82	0.211NS	-	-
Error	69	592.82	8.59	-	-	-
Total	95	16724.85	-	-	-	-

** Significant at 1 % level

NS Not significant

Table 3 Number of effective tillers per metre row

SV	DF	SS	MS	F.Cal.	Ftable value 5 %	Ftable value 1 %
Replication	3	312.54	104.18	18.2**	2.748	4.096
Nitrogen (N)	3	26682.79	8894.26	1554.94**	2.748	4.096
Phosphorus (P)	1	376.04	376.04	65.74**	3.988	7.04
Methods of split application (M)	2	346.58	173.29	30.30**	3.138	4.988
Int. (N x P)	3	73.46	24.87	4.34*	2.748	4.096
Int. (N x M)	6	53.33	8.89	1.35NS	2.338	3.07
Int. (M x P)	2	2.085	1.042	0.182NS	-	-
Int. (N x M x P)	6	8.165	1.36	0.237NS	-	-
Error	69	394.96	5.72	-	-	-
Total	95	28249.96	-	-	-	-

* Significant at 5 % level

** Significant at 1 % level

NS Not significant

Table 4 Length of spike in cm

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	1.034	0.334	1.55NS	2.748	4.096
Nitrogen (N)	3	88.164	29.38	136.68**	2.748	4.096
Phosphorus (P)	1	0.7	0.7	3.26NS	3.988	7.04
Methods of split application (M)	2	0.692	0.34	1.62NS	-	-
Int. (N x P)	3	0.241	0.08	0.373NS	-	-
Int. (N x M)	6	0.068	0.0114	0.053NS	-	-
Int. (M x P)	2	0.193	0.096	0.448NS	-	-
Int. (N x M x P)	6	0.172	0.028	0.13	-	-
Error	69	14.82	0.214	-	-	-
Total	95	106.091				

** Significant at 1 % level

NS Not significant

Table 5 Number of spikelets/spike

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	10.73	3.58	46.49**	2.748	4.096
Nitrogen (N)	3	132.91	44.30	575.32**	2.748	4.096
Phosphorus (P)	1	3.33	3.33	43.25**	3.988	7.04
Methods of split application (M)	2	2.38	1.19	15.45**	3.138	4.944
Int. (N x P)	3	0.579	0.193	2.51NS	2.748	4.096
Int. (N x M)	6	0.148	0.025	0.324NS	-	-
Int. (M x P)	2	0.011	0.005	0.064NS	-	-
Int. (N x M x P)	6	0.112	0.019	0.264NS	-	-
Error	69	5.29	0.077	-	-	-
Total	95	155.49	-	-	-	-

** Significant at 1 % level

NS Not significant

Table 6 Number of grains/spike

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	45.21	15.07	70.42**	2.748	4.096
Nitrogen (N)	3	6258.11	2086.04	9747.85**	2.748	4.096
Phosphorus (P)	1	67.84	67.84	317.00**	3.988	7.04
Methods of split application (M)	2	2.69	1.37	6.28**	3.138	4.944
Int. (N x P)	3	11.21	3.74	17.48**	2.748	4.096
Int. (N x M)	6	1.11	0.185	0.886NS	-	-
Int. (M x P)	2	0.044	0.022	0.102NS	-	-
Int. (N x M x P)	6	0.156	0.026	0.121NS	-	-
Error	69	14.74	0.214	-	-	-
Total	95	6401.1	-	-	-	-

** Significant at 1 % level

NS Not significant

Table 7 Test weight in gms/plot

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	112.57	37.52	23.87**	2.748	4.096
Nitrogen (N)	3	961.28	320.83	203.83**	2.748	4.096
Phosphorus (P)	1	32.08	32.08	20.41**	3.988	7.04
Methods of split application (M)	2	17.537	8.768	5.57**	3.138	4.944
Int. (N x P)	3	6.74	2.24	1.42NS	2.748	4.096
Int. (N x M)	6	0.713	0.1188	0.075NS	-	-
Int. (M x P)	2	0.140	0.703	0.044NS	-	-
Int. (N x M x P)	6	0.567	0.094	0.36NS	-	-
Error	69	108.49	1.572	0.094NS	-	-
Total	95	1240.12	-	-	-	-

** Significant at 1 % level

NS Not significant

Table 8 Grain yield in kg/plot

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	0.81	0.27	12.27**	2.748	4.096
Nitrogen (N)	3	96.288	32.096	1458.91**	2.748	4.096
Phosphorus (P)	1	0.382	0.382	17.36**	3.988	7.04
Methods of split application (M)	2	1.343	0.676	30.72**	3.138	4.944
Int. (N x P)	3	0.328	0.109	4.95**	2.748	4.096
Int. (N x M)	6	0.309	0.506	2.54*	2.238	3.07
Int. (M x P)	2	0.056	0.048	2.18NS	3.138	4.944
Int. (N x M x P)	6	0.114	0.020	0.09NS	-	-
Error	69	1.512	0.022	-	-	-
Total	95	101.142	-	-	-	-

* Significant at 5 % level

** Significant at 1 % level

NS Not significant

Table 9 Straw yield in kg/plot

SV	DF	SS	MS	F Cal.	F table value	
					5 %	1 %
Replication	3	0.0142	0.004	0.153NS	2.748	4.096
Nitrogen (N)	3	182.185	60.72	2291.66**	2.748	4.096
Phosphorus (P)	1	0.007	0.007	0.269NS	3.988	7.04
Methods of split application (M)	2	0.186	0.093	3.52*	3.138	4.944
Int. (N x P)	3	0.339	0.113	4.27**	2.748	4.096
Int. (N x M)	6	0.146	0.025	0.961NS	2.238	3.07
Int. (M x P)	2	0.069	0.034	1.306NS	3.138	4.944
Int. (N x M x P)	6	0.262	0.043	1.65NS	2.238	3.07
Error	69	1.825	0.026	-	-	-
Total	95	185.03	-	-	-	-

* Significant at 5 % level

** Significant at 1 % level

NS Not significant

VITA

VITA

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Educational institutions

Name of the Institution	Year of joining	Year of leaving
Govt. Primary School, Tarsman	1961	1966
Govt. Middle School , Konther Kalan	1966	1968
Higher Secondary School, Konther Kalan	1968	1970
Sindhia Junior College, Porsa	1970	1971
College of Agriculture, Gwalior	1971	1975
College of Agriculture, Indore	1983	1986

Educational qualifications

Name of Examination	Year of passing	Name of Board/ University	Division	% OGPA
H.S.S.C.	1971	M.P.Board of Secondary Education, Bhopal	FIRST	62.00
B.Sc.(Agri.)	1975	J.N.Krishi Vishwa Vidyalaya, Jabalpur	FIRST	3.17/4.00 (68.00)
M.Sc.(Agri.)	1986	J.N.Krishi Vishwa Vidyalaya, Jabalpur	FIRST	3.10/4.00 (66%)