

**RESPONSE OF COMPOSITE MAIZE
(Zea mays Linn.) TO LEVELS & TIME OF
APPLICATION OF NITROGEN IN MALWA**

THESIS

SUBMITTED IN FACULTY OF AGRICULTURE

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

AGRICULTURE

(AGRONOMY)



BY

ABDUL QADEER NAZRI

B. Sc. [Agr.]

DEPARTMENT OF AGRONOMY

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

COLLEGE OF AGRICULTURE, CAMPUS INDORE [M.P.]

1976

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S. S. PATHAK

COLLEGE OF AGRICULTURE
INDORE

Professor & Head of
Agronomy Section

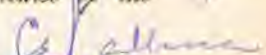
CERTIFICATE - I

*This is to certify that the thesis entitled "RESPONSE OF COMPOSITE MAIZE (Zea mays Linn.) TO LEVELS AND TIME OF APPLICATION OF NITROGEN IN MALWA," submitted in partial fulfilment of the requirements for the degree of Master of Science in Agriculture of the Jawaharlal Nehru Krishi Vishwa Vidyalyaya, Jabalpur, is a record of bonafied research work carried out by Shri **ABDUL GADEER NAZRI** I. D. No. AP/ID/8787/73, under my guidance & supervision. The subject of the thesis has been approved by the Students Advisory Committee & the Director of Post Graduate Studies.*

No part of the thesis has been submitted for any other degree or diploma. All the assistance and help received during the course of the investigation have been duly acknowledged by him.

INDORE

Date.....January 1976


CHAIRMAN OF THE
ADVISORY COMMITTEE

The is approved by the Students Advisory Committee.



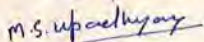
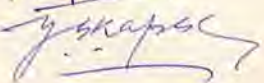
Chairman:- Shri S. S. Pathak

Members:- Dr. M. M. Rai

Dr. B. R. Chandrawanshi

Shri M. S. Upadhyaya

Shri Y. S. Kapse

CERTIFICATE - II

This is to certify that the thesis entitled "RESPONSE OF COMPOSITE MAIZE (Zea mays Linn.) TO LEVELS AND TIME OF APPLICATION OF NITROGEN IN MALWA", submitted by Shri Abdul Qadeer Nazri to Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfilment of the requirements of the degree of Master of Science in Agriculture in the Department of Agronomy has been approved by the Students Advisory Committee and External Examiner after an oral examination on the same.

R.R. Singh
External Examiner

Major Advisor:

S. S. Chakrabarti

Head of the Department:

S. S. Chakrabarti

Director of Post Graduate Studies:

May 10-3-76
DEAN,
College of Agriculture, Indore;

ACKNOWLEDGEMENT

I have no words to express my esteemed gratitude to Shri S.S.Pathak, Professor and Head of Agronomy, Section Guide and Chairman of my Advisory Committee, for his valuable suggestions, sincere criticism and his careful evaluation of the manuscript.

I remain greatly indebted to Dr. H.M.Rai, Professor and Head of the Section of Soil Science and Agricultural Chemistry and Dr. Chandravanshi Sorghum Agronomist for their kind help during the course of investigations.

I am deeply thankful to Shri H.S.Upadhyaya and Y.S.Kapse for their sincere consideration and help during the period of investigations.

I express my sincere gratitude to Dr.S.S.Baghel Sorghum Breeder, for advice and assistance in my statistical analysis and suggestions for interpretation.

I am thankful to Dr.S.C.Jethmalani Agronomist, W.M.S.S. Project, Shri R.A.Jain and Shri B.G.Apte, Assistant Professors, for their sincere consideration and help during the period of my stay in this institution.


My heart felt thanks are also to Sarvashri M.C. Chaurasia and B.G.Iyer, for their help and assistance which I received during the investigations.

I take the opportunity to thank the Colombo plan and Government of India for providing the facilities for my study in J.N.R.V.V. at its College of Agriculture Indore campus.

I am also grateful to Dr. D.K.Tiwari, Dean of the College for providing necessary technical facilities for the successful completion of this work.

Above all I am greatly indebted to Mr.A.A.Pianchi, R.G.Karale, P.C.Antony, H.S.Khasgiwala, T.M.Hedge, U.C.Tiwari, A.K.Ajmera, B.D.S.Katti, A.E.Kazan, M.A.Ardakani, J.A.Chaman, & A.A.Islami.

Indore:


(Abdul Qadeer Nazri)

Dated: 12 January 1976.

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INTRODUCTION

CHAPTER - I

INTRODUCTION

Maize (Zea mays Linn.) is one of the important food crops of the world. It ranks third after wheat and rice in the world production of cereal crops. In India it ranks fifth in acreage and fourth in production among the cereal crops. In 1973-74, the area under maize cultivation in India was about 6030.7 thousand hectare with an annual production of 5642.6 thousand tonnes. Madhya Pradesh is one of the leading states in maize production having an area of 83.8 thousand hectare and production of 84.6 thousand tonnes. It has a special significance, since it is the staple food crop of the tribal areas.

Its usefulness as a quick growing grain and fodder crop and its capacity to grow well in a variety of climatic conditions is well established. The green cobs are palatable and nourishing and favoured both by the rich and poor alike. It is also grown as fodder, which is sweet, succulent and fit for feeding green or for ensilage. Starch extracted from the grain has varied uses.

On account of its quick growth habits, maize is a highly exhaustive crop and it is absolutely essential that the necessary nutrients be supplied in appropriate proportions

to maintain soil fertility and to get higher yield. The rapid growth of maize in the early stages also necessitates the liberal dressing of readily available nutrients in the very beginning. It follows from this high nutrient requirement that maize is regarded as a good indicator of the nutrient status of the soil and it readily responds to the application of fertilizers.

Maize yield can be increased considerably by applying higher doses of fertilizers, this has been demonstrated by several experiments conducted in recent years, Galvez et al, 1956 in Phillippines; Lang et al, 1956 in Illinois; Thomas 1956 in Alabama; Raheja et al, 1957 in India; Galvez and Bruce 1958 in Phillippines; Wolfe and Kipps 1959 in New York; Relwani 1962 in Punjab and Anonymous 1963 in India. It has been established that nitrogen is the most important element limiting yield in most soils. Although adequate supply of other plant nutrients is also essential.

The timeliness of nitrogen application is of particular importance due to the fact that maize is sown in Kharif season, which receives frequent rains during its life cycle. Nitrogen fertilizers being highly soluble are susceptible to leaching losses. Obviously, the fertilizer applied at planting time may not be available to plants in later stages of growth when they starve for it. Under such conditions, supply of nitrogen in later stages of plant growth becomes inevitable.

Therefore, the best way of nitrogen application and the timeliness of application in relation to dosage still needs to be further investigated in order to obtain maximum efficiency of the nitrogen applied. Under critically needed intensive production of food grains, application of optimum dose of nitrogen by suitable methods at proper stage of plant growth is of prime importance. Efficient utilization of fertilizers is all the more essential in the existing high cost and shortage of fertilizers for meeting the food requirement of ever increasing population.

Keeping the above in view, the present experiment was conducted on a composite maize variety, "Chandan Makka - 3", with the following main objects:

1. To find out the optimum level of nitrogen with its proper time of application.
2. To schedule proper time of nitrogen application i.e. whether to apply full dose of nitrogen in a single application at planting or to split it into two or three doses and apply at different stages of growth.
3. To determine economic optimum level of nitrogen.

REVIEW OF LITERATURE

CHAPTER - II

REVIEW OF LITERATURE

2:1 - EFFECT OF NITROGEN

Nitrogen is essential for the growth and reproduction of plants. It plays a major role in the manufacture of protoplasm, being an essential constituent of all proteins. Maize has a high requirement of nitrogen and yield increases considerably with increase in dose of nitrogen fertilizer. This has been proved by several experiments conducted in recent years. The omission of no other element cause such a drastic decline in the yield and growth indicating that nitrogen is the most limiting factor in comparison to other elements. Keeping in view the above facts an experiment was conducted on nitrogen requirement and its time of application on maize. Work done in the past on the subject is reviewed under different heads:

2:1:1 - RESPONSE ON VEGETATIVE CHARACTERS

a) Effect on height of plant

Application of nitrogen increased the plant height considerably as reported by Crowther et al. 1937 in Egypt; Davide 1962 in Phillipines; El. Hindi 1965; Kharoche and Khuspe 1970; Tiwary et al. 1970 and Mandoli et al. (1970). Also Niopek(1965) in Germany observed that under nitrogen deficiency, the height of maize plant was reduced, but Nair (1962) found

that high fertility levels did not modify the height of maize plant in India. Similarly Handpuri (1963) reported that different rates of nitrogen did not appear to effect plant height in Oregon.

b) Effect on leaf growth

Rajput *et al* (1970) reported that with increasing levels of nitrogen the number of green leaves and plant survival increases. Similarly, Fivary *et al* (1970) observed that number of effective leaves at the tasselling stage increase with the application of nitrogen.

c) Effect on rate of development

Many workers studied the effect of nitrogen on the maturity of maize. Federico (1960) found that shortening of vegetative cycle of maize plant was achieved by increasing amount of applied nitrogen upto 200 kg/ha. in Itlay. Similarly, Rai (1961) observed accelerated early vegetative growth from 88 lb level of nitrogen per feddan, (feddan = 1.038 acres) as tasselling, silking, and maturity were hastened by 9-16 days in Toxi, Sudan. He further reported that higher nitrogen rates were necessary for the effect to persist to the end of growing season.

2:1 - RESPONSE ON REPRODUCTIVE CHARACTERISTICS AND YIELD

2:2:1. Effect on grain yield

Amongst the factors responsible for the growth of plant, nitrogen could be next only to moisture in limiting

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maize production on most soils. Long (1953) found that application of 170 kg N/ha. produced 67.5 q/ha. of maize and with each additional application the yield increased by 27 kg, which is considered to be optimum return. Krantz and Chandler (1954) in North Carolina, reported general range of nitrogen response to each kg of nitrogen producing 39.9 kg maize/ha. whereas the optimum economic dose was found to be 124.5 kg N/ha.

Laird et al (1954) from central Mexico reported that out of 177 fertilizer trials 73.4 per cent responded to nitrogen, 35.6 per cent to phosphate and only 2.3 per cent to potash, which indicate that nitrogen was most important factor in maize manuring. Viets et al (1954) observed that only the applied nitrogen increased grain yields significantly. Galvez et al (1958) in Philippines reported that optimum yields were obtained from 45-90 kg nitrogen per hectare in three locations. Verma & Sharma (1958) reviewing their experiments found significant increase in maize yield with increasing levels of nitrogen application upto a dose of 60 lb N/acre. Similarly Rai (1961) found that maize grain and straw yield increased with increasing nitrogen doses upto 88 lbs nitrogen per feddan at Tozi, Sudan. Federico (1960) reported that grain yield increased with increasing dose of nitrogen upto 300 kg N/ha. Anonymous (1963) reported that the results of experiments conducted under coordinated maize breeding scheme at different stations in India revealed that the highest yield performance could be achieved by using about 200 kg N/ha. However,

Caputa (1962) recommended a dose of 80-120 kg N/ha for higher yields of maize in Switzerland. Human (1963) in Pretoria, South Africa found that grain yields were increased by application of nitrogen and phosphorus.

Harrington (1965) in Queensland reported that the response to nitrogen was obtained upto 225 kg/ha. and the yields were 6.8 to 31.7 q/ha. Molani and Mukkeri (1965) found that 100 and 150 kg N/ha increased the grain yield by about 16 and 34 per cent over 50 kg N/ha. Singh et al (1965) reported highest yield of grain and stover were observed at 201.6 kg N/ha which was significantly superior over other treatments and gave an increase of 318 per cent over control. Satra (1968) found that nitrogen responded from 37 to 202 kg N/ha and increased the grain yield both of hybrid as well as of local varieties of maize. Goydani and Singh (1968) reported that grain yields increased from 25.53 to 35.21 q/ha. by increasing nitrogen levels from 100 to 200 kg/ha. Sharma and Gupta (1968) have shown average yields increased significantly as the rates of nitrogen increased from 0 to 100 kg N/ha but there was no significant increase at 150 to 200 kg N/ha. Sirbu et al (1968) found that application of nitrogen fertilizer resulted in mean increase yield by 9-11 per cent over the control.

Alvord (1969) reported that with the increase in nitrogen levels the grain yield also increases simultaneously. Gaur et al (1969) while studying the effects of nitrogen levels

on hybrid Gange 101 maize, found that application of 45 and 90 kg N/ha gave yields of 16.34 and 28.97 q/ha, respectively compared with 8.22 from control plots. There was however no further increase in yield by increasing the nitrogen dose to 135 kg/ha. Thitipoca and Firth (1970) found that 800-240 kg N/ha. gave higher grain yield, but the optimum economic dose was 50 kg N/ha. Singh and Saroha (1970) found that application of 80 kg N/ha gave significant higher yield of grain and stover over 40 kg N/ha. Verma and Singh (1970) found that grain yield was significantly increased with application of 150 kg N/ha. The maximum response to nitrogen (24.8 kg grain per kg N/ha) was obtained with first dose of nitrogen (50 kg N/ha). The response at 100 and 150 kg N/ha decreased to 19 and 14 kg grain per kg. of added nitrogen, respectively.

Bapna and Trivedi (1971) reported that increasing levels of nitrogen to 75, 150 & 225 kg/ha. increased the grain yield significantly over control. The per cent increase being 19.9, 23.2 and 22.6 (q/ha), and 23.6, 27.3, and 32.9 (gm/plant), respectively, over control. However difference between them were not significant. Hindayala et al (1971) reported that 50 lb N/ac. gave higher yields than control. There was no significant difference between 50 and 100 lb N/ac. Pathak et al (1971) reported that increasing levels of nitrogen fertilization has increased the yield and showed a significant

positive correlation. Gumball (1971) obtained significant increase in the yield of grain and stover due to application of nitrogen. Mandloi et al (1972) found that application of nitrogen at the rate of 240 kg/ha was economical and it gave a net profit of over ₹.2000/ha. Panwar and Singh (1972) studied the response of nitrogen on maize for two years and concluded that yield increases by increase in rate of applied nitrogen. Shukla (1972) reported that corn responded upto 180 kg/ha. Sinha and Umar (1972) indicated that the yield of 'Jaunpur' maize increased with nitrogen application upto 160 kg/ha. but decreased at 200 kg N/ha. Tivari et al (1973) reported that application of 160 kg N/ha was significantly superior to 75 kg N/ha. Singh et al (1973) found a linear response to application of nitrogen upto 120 kg N/ha in maize. Nitrogen application increased gross returns of ₹.486 from 40 kg N/ha to ₹.836 by the application of 120 kg N/ha.

3:3:2 - Effect on ear size and number

In maize more number of cobs per plant or their size are factors which determine higher grain production unlike other crops. Crowther et al (1937) found that manuring markedly increased the weight of grain per cob especially at close spacing in Egypt. Thomas (1956) indicated that the average weight of ear was not significantly affected by additional of nitrogen. El-Hindi (1965) found that each successive increase in nitrogen level increased the grain

yield per cob significantly upto 120 kg δ /ha. Alvord (1969) has shown that by increasing the nitrogen level grain per cob also increased. Rajput *et al* (1970) reported that increase in the rates of applied nitrogen were accompanied by linear increase in number of grain per cob. Tiwari *et al* (1970) found that with maize hybrid 'Ganga' 101, applied nitrogen increased the number of grains per cob.

In conclusion, Soubies and others 1956 in Toulouse France; Strang and Brone 1959 in Australia; Brensing and Harper 1960 in Oklahoma; Rai 1961 in Sudan, Bair 1962 in India and Tiwari *et al* 1970, have reported that the number of cobs per plant, average number of grains per cob, length and weight of cob were favourably affected by application of nitrogen in most soils.

EFFECT ON EFFICIENCY INDEX

Grain to stover ratio is the efficiency of plants in grain production. Crowther *et al* (1937) in Egypt also supported this view. They revealed that the grain to stover ratio i.e. the efficiency of the plants in grain production was increased by nitrogenous manuring. These results indicate that stover yields were increased by nitrogen fertilization, but the amount of the increase was lower than the increase in grain yield. Krantz and Chandler (1954) observed that the use of nitrogen increased grain yields three or four times as

such as stover weight at two locations. In both experiments the stover grain ratio was nearest at the highest nitrogen levels. Rai (1961) in Sudan observed that the application of 0 to 103 kg N/ha. widened the ratio from 0.435 to 0.757. El-Hindi (1965) found that application of nitrogen from 75 to 150 kg N/ha increased the efficiency index.

EFFECT ON TEST-WEIGHT OF GRAIN

Test weight is one of the components contributing directly to the final yield. Lang et al (1956) in Illinois found that the average weight per grain was mostly influenced by soil fertility level. Similarly Strang and Brome (1959) in Australia; Rai (1961) in Sudan; Sair (1962) in India reported that thousand grain weight was increased with increasing nitrogen application on the soil. Singh (1964) also recommended that nitrogen and phosphorus increased the test-weight. El-Hindi (1965) found that application of nitrogen upto 150 kg/ha significantly increased the test weight, but further increase in nitrogen level did not respond appreciably. Singh (1967) observed that with increase in levels of nitrogen from 0 to 134.5 kg N/ha, there was increase in grain weight. Rajpur et al (1970) and Tivari et al (1970) found that nitrogen application increased thousand grain weight.

3:2 - TIME OF NITROGEN APPLICATION

Nitrogen is a highly soluble major plant nutrients.

Full application of higher dose of nitrogen at a time may result in leaching and may also be utilized by plant as a luxury consumption in earlier stage of plant growth. Hence under intensive production of food grains application of optimum dose of nitrogen by suitable method at proper stages of plant growth is of prime importance in efficient utilization of fertilizers under present situation of fertilizer crisis and their higher cost.

2:2:1 - Effect on growth

Number of investigations have been directed towards determining the best time to apply nitrogen Pitts et al 1946; Lang, 1946; Robertson and Ohlorogge, 1952; Rhoades and Lavrey, 1954 reported that other than providing a few pounds of nitrogen positionally available to the small plant, the major applications should be made when the nitrogen requirement of the plant becomes high. Thus nitrogen applied as side dressing when the corn is 2-3 ft tall has generally proved more effective than either earlier or later applications. Nitrogen applied at tasselling was found to be late to meet the requirements of the plant during the period of rapid vegetative growth.

Pumphery and Harris (1956) reported that on low productivity soil, time of nitrogen application (at planting time or side dressed when maize was 20-36 inches high) had little influence on the yield of maize. Corby (1957) reported that most of the nitrogen should be applied 5 weeks after

planting and the rest at planting and tasselling. Tilo (1957) found it better to apply the fertilizer at sowing and 2 weeks after sowing as practiced in the wet season. Vasilin and Davidsen (1959) found that best time of applying nitrogen for irrigated maize was in three instalments viz. 1st during tillage, before sowing 2nd when the third leaf appeared; and 3rd when the male inflorescence appeared. Laird and Lisarranga (1959) in seven out of ten trials observed that applying half of the nitrogen at sowing and half as a side dressing at the time of last weeding was more effective than applying full dose at sowing. Gautam et al (1964) reported that higher efficiency of nitrogen fertilization to maize is achieved by applying the total quantity of nitrogen in three split i.e. at planting at knee high stage and at tasselling over single application of nitrogen at planting.

Stanisavljevic (1969) reported that nitrogen should be applied to maize at 40-60 kg N/ha at sowing and 40-50 kg N/ha subsequently in one or two top dressings. Gass (1972) studied that nitrogen fertilizers applied as a side dressing immediately before or during the period of optimum nitrogen uptake and leaf development (5-7 weeks after emergence), was generally more efficient than earlier or later applications. Tiwari et al (1973) found that the application of nitrogen in two splits i.e. 1/5 at planting + 4/5 at 30 days after planting at knee high stage was superior over the presently recommended practice

of two splits 1/3 + 2/3 or three splits, between 30 and 40 days after planting.

2:2:2 - Effect on yield

Geor (1953) could also obtain the highest yield of grain when application of ammonium sulphate was split (usually equal) into two dressings which were applied 0.3 weeks after sowing and again at 3-8 weeks after sowing. Shubeck and Caldwell (1955) reported that when plants were 8 feet high, one application of 15 lb. of side dressed nitrogen on silty clay loam soil was as effective in increasing yield and ear size as 30 lb. nitrogen split into two applications. Pronin and Afanas'ev (1960) showed that the nutrients supplied at 4th leaf stage produced the highest grain yield 3560 kg/ha and they suggested that if fertilizers are given at 7-8 leaf stage, they should be placed at a distance of 30 cm from the crop row.

Fayeni (1968) reported from a field trial at Njala, Sierra Leone, in which 80 lb N/ac. was given to maize (a) at sowing, (b) one month after sowing, (c) two month after sowing (d) as two equal split dressing at sowing and (e) 1,2 and 3 month after sowing. Yields of cobs and stover were higher with (b), (c), (d) and (e) than with single application at sowing (a) and control. Goydani and Singh (1968) obtained higher yields from applying nitrogen in 3 split dressing (at sowing, at knee high stage and at tasselling, than applying nitrogen in a single (at sowing) or two split dressing (at

sowing and at the knee high stage). Stoimenov (1968) reported that highest yields of grain were obtained when nitrogen fertilizer was applied at 5-6 leaf stage.

Alvord (1969) reported that the best results were obtained by applying two-thirds of the top-dressing at four weeks after planting and the remaining one-third at eight weeks, except where the total amount of applied nitrogen exceeded 190. lb N/ac. In the later case, significantly higher yields were obtained when the top-dressing was made in three equal amounts at four, eight and 12 weeks after planting. Gour *et al* (1969) observed that nitrogen applied in three dressing at sowing, at knee high stage and at tasselling gave higher yield (27.13 q/ha) than when applied in two dressing (23.44 q/ha) or in a single-dressing at sowing (18.69 q/ha). Shukla and Wassay (1970) reported higher grain yields (5.66 t/ha) resulted from the application of 112 kg N/ha in three-split dressing at sowing at knee high stage and at tasselling than two split dressing at sowing and at knee stage (4.5 t/ha) or in a single-dressing at sowing (4.5 t/ha). Hindayala *et al* (1971) found that all combination of 0.50 or 100 lb N/ac. applied in two split dose, 25% at sowing and 75% at 4 weeks after sowing. 50 kg N/ac. gave higher grain yield, over control but there was no significant difference between 50 and 100 lb N/ac rates. Glenn and Dhanyadee (1971) found that the highest yield was recorded by the split

application in two doses 50 lb at sowing and 150 lb N/ha as a side dressing gave (133-149 bu.grain/ha.) compared with (74 bu grain/ha.) when no nitrogen was applied. Griestava et al (1971) compared the different times of nitrogen application and found three equal split application of nitrogen yielded highest grain (30.44 g/ha).

Kashid (1972) found that nitrogen at the rate of 0, 100 and 200 kg/ha, 2/3 of which was applied at planting time and 1/3 when corn was about 30-40 days increased the yields of stover and grain significantly over control. Mandloi et al (1972) reported that split dressing, 33 per cent at sowing and 67 per cent as a top dressing, increased the grain yield. Miller et al (1975) found application of nitrogen from 4 to 6 weeks after sowing was nearly as good as or superior to those obtained from nitrogen applied at planting.

The findings of all the above workers indicate universal and consistent response of nitrogen on maize crop and on its different vegetative and reproductive characters including the final yield. Hence an experiment was conducted at the college of Agriculture farm Indore to collect more information on nutritional aspects using newly evolved composite 'Chandan Makka-3' on the medium black cotton soils of the Malwa Plateau.

MATERIALS & METHODS

CHAPTER - IIIMATERIALS AND METHODS

A experiment was conducted at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Agriculture College Farm, Indore "To study the response of composite Maize (*Zea mays* Linn.) to levels and time of application of nitrogen under the agroclimatic conditions of Malwa Plateau.

The experimental study was carried out with the following objects in view:

1. To find out the optimum level and time of application of nitrogen.
2. To schedule proper time of nitrogen application i.e. whether to apply full dose of nitrogen in a single application at planting or to split it into two or three doses and apply at different stages of growth.
3. To determine economic optimum level of nitrogen.

1. Experimental site:

The experiment was conducted in a typical medium heavy black cotton soil in field No.31 of 'B' block of

Agriculture college, farm Indore. The topography of the field was uniform.

2. Soil:

The soil of the experimental field is typical medium heavy black cotton soil of Malwa Plateau. Soil samples from 0-9 inches depth were taken from various spots randomly from the experimental area before laying out the experiment and a composite sample was made. The composite sample was analysed. The result of the analyses are as under:

Mechanical composition

<u>Constituent</u>	<u>Percentage</u>
Sand	22.84%
Silt	36.73%
Clay	40.36%

Chemical Composition

Available nitrogen	220.0 kg/ha.
Available phosphate	20.6 kg/ha.
Available potash	810.0 kg/ha.
Soil pH	7.0
Electrical conductivity	0.3 mm hos/cum
Organic carbon percentage	0.3

3. Cropping history of the field:

The cropping history of the experimental field

for the last four years is presented below:

<u>Year</u>	<u>Kharif</u>	<u>Rabi</u>
1971-72	Maize	wheat
1972-73	Soybean	wheat
1973-74	Mung & fodder Jowar	wheat
1974-75	Fallow	wheat
1975-76	Maize (experiments)	wheat

4. Climatic conditions:

Indore is situated in the south western Madhya Pradesh having a latitude of 22° - 43 N and longitude of 75° - 56 E with altitude of 585.7 meters above mean sea level in the Malwa Plateau, thus having a subtropical climate.

The meteorological data for the crop season showing monthly maximum and minimum temperature, rainfall, relative humidity percentage and hours of bright sunshine per day is presented below:

Meteorological data recorded at Indore farm during
the crop season of 1978

Period	Rainfall in mm	No. of rainy days	Temper- ature max.	CO ₂ Mini.	R.H.* %	Hrs. of sunshine per day
June 4-10	7.9	1	35.4	23.9	71	9.6
11-17	10.9	1	39.1	24.2	64	7.4
18-24	57.4	6	32.8	22.9	83	4.9
25-1 July	141.0	7	30.8	22.2	92	6.5
July 2-8	85.6	5	30.3	22.5	87	4.9
9-15	83.4	5	28.8	20.8	95	0.9
16-22	29.5	6	27.4	21.8	93	2.4
23-29	2.3	1	30.3	22.6	85	5.6
30-5 Aug.	28.1	6	29.8	22.7	91	2.4
Aug. 6-12	113.9	7	26.7	22.1	97	1.2
13-19	218.7	5	26.7	21.8	95	1.6
20-26	19.2	6	27.4	21.0	94	3.8
27-2 Sept.	146.9	6	29.4	21.8	96	3.9
Sept. 3-9	83.5	6	27.3	21.5	93	1.8
10-16	282.2	6	35.8	20.0	93	3.5
17-23	0.0	1	30.4	20.9	84	9.2
24-30	9.4	4	30.8	21.0	86	6.0
Oct. (1-7)	10.6	3	29.6	20.9	91	7.3
(8-14)	2.3	2	31.2	20.5	87	8.5
Total:	1301.9 mm					

* Relative Humidity.

It is clear from the above data that the temperature was almost normal, but the relative humidity was higher than normal and the rainfall was rather abnormal. It rained on 28 days out of 31 in August, which coincided with grand period of growth. The hours of sunshine were also much below standard requirement.

5. Plant material:

'Shandari Babka-3' a composite variety evolved by J.B.K.V.V. breeding station Chhindwara was selected for the experiment. It normally produces two cobs per plant. The grains are hard and orange in colour. It matures in 85-95 days, average grain yield is 40-45 q/ha.

6. Treatments:

The following two factors with all possible combinations were included as treatments in this experiment as mentioned below:

6:1. <u>Levels of nitrogen:</u>	<u>Symbol</u>
80 kg nitrogen per hectare	N ₁
120 kg nitrogen per hectare	N ₂
160 kg nitrogen per hectare	N ₃
6:2. <u>Time of nitrogen application:</u>	<u>Symbol</u>
Full dose at sowing.	S ₀
2/3 + 1/3 (2/3 at sowing+1/3 at knee high stage.	S ₁
1/3+2/3(1/3 at sowing+2/3 at knee high stage.	S ₂
1/3+1/3+1/3(1/3 at sowing+1/3 at knee high stage +1/3 at tasselling)	S ₃
1/5+4/5(1/5 at sowing+4/5 at knee high stage.	S ₄

Nitrogen was applied in the respective treatments in the form of ammonium sulphate. A uniform dose of phosphate in the form of single superphosphate @ of 80 kg/ha and potash @ of 50 kg/ha in the form of muriate of potash, respectively, was applied at the time of sowing to all the plots.

7. Lay out and statistical design:

The plan of lay out is given in Fig. (1).

Design: Factorial randomised block design.

No. of treatments: $3 \times 5 = 15 + 1$ (an absolute control) = 16

Replication: 4

No. of plots: $4 \times 16 = 64$

Plot size: Gross : $6 \times 4.80 = 28.80$ square metres.

Net : $4.80 \times 3.60 = 17.28$ square metres.

No. of rows: Gross plot = 6

Net plot = 6

Spacing: 60×30 centimeters

Variety: Chandan Makha - 3

8. Schedule of cultural operations:

Pre-sowing operation:

After receiving two three showers when the soil came into condition it was given one harrowing, followed by discing and a final planking to level it properly, before laying-out and marking the treatment plots.

9. Application of fertilizers:

Weighed quantity of the three fertilizers i.e.

Fig. 1.

PLAN OF LAYOUT



R II

N_3S_3	N_2S_2	N_1S_4	N_3S_4
N_1S_0	N_1S_2	N_2S_1	N_1S_3
N_2S_4	N_1S_1	N_2S_3	No N
N_3S_1	N_3S_2	N_3S_0	N_2S_0

R I

4.80 m

N_3S_0	N_2S_3	N_3S_2	N_2S_0
N_2S_1	N_1S_4	N_1S_3	N_2S_4
N_3S_4	N_2S_2	N_3S_1	N_1S_2
No N	N_3S_3	N_1S_1	N_1S_0

75 cm
6 m
75 cm

R III

N_1S_0	N_2S_1	N_1S_4	N_2S_3
N_1S_1	N_3S_0	N_2S_0	N_3S_3
No N	N_2S_4	N_3S_2	N_3S_4
N_1S_2	N_3S_1	N_1S_3	N_2S_2

R IV

N_1S_2	N_1S_3	N_3S_1	N_3S_2
N_3S_4	N_1S_0	No N	N_3S_0
N_2S_0	N_2S_2	N_3S_3	N_1S_1
N_2S_4	N_1S_4	N_2S_3	N_2S_1

2.50 m

ammonium sulphate, single superphosphate and muriate of potash were mixed and placed about 8 cm deep in rows 80 cms apart made by drill and covered.

10. Seed:

The 'Chandan Nakka-3' variety was selected for sowing.

10:1 - Seed treatment:

The seed were treated with Agrosan G.R., at the rate of 2.5 gm/kg of seed against seed borne diseases.

11. Sowing:

Seed was hand dibbled @ two seed per point 80 cms apart and covered, thus maintaining a uniform *plant population*.

11:1 - Sowing and post sowing operations:

The schedule of sowing and post sowing operations are given below:

Schedule of sowing and post sowing cultural operation

<u>Operation</u>	<u>Particulars</u>	<u>Dates</u>
<u>Sowing:</u>	Sowing was done by the dibbling method as stated above.	22-3-75
<u>Gap filling:</u>	It was done one week after sowing when ever regained.	4-7-75
<u>Weeding:</u>	Hand weeding was done as and when required to keep the crop free of weeds.	14-7-75
<u>Razing:</u>	It was done by bullock and rotary harrow.	15-7-75
<u>Thinning:</u>	It was done by pulling out extra seedlings.	17-7-75
<u>Control of insects:</u>	0.75% granules thiodan applied in whorl @ of two to three granules.	19-7-75
<u>Control of insects:</u>	0.75% spray thiodan @ 300 litres per hectare.	26-7-75
<u>Controls of insects:</u>	0.75% spray thiodan spray @ 300 litres per hectare.	17-8-75
<u>Top dressing of ammonium sulphate:</u>	On both sides of plant rows, it was placed by the help of hand, - At knee high stage - At tasselling stage	18-7-75 22-8-75
<u>Harvesting:</u>	It was done by sickle.	11-10-75 & 12-10-75
<u>Shelling:</u>	It was done by hand sheller.	16-10-75
<u>Weighting:</u>	It was done by beam balane	17-10-75

12. Methods:

Observations on growth, development and yield were recorded during the course of present investigation to study the various characters as under:

12:1 - Growth studies:

Field observations on growth were taken on five plants in each plot out of the different rows selected randomly and labelled. The growth studies were made by measuring the height, number of green leaves per plant at 15 days interval starting from 20 days after sowing.

12:1:1 - Plant population:

After gapfilling, weeding and thinning was done to keep uniform spacing 30 cm between the plants one initial population count and a final count was taken at harvest.

12:1:2 - Height:

Height of the five selected plants was measured in cm. from the base of the stem to the last leaf juncture (or to the base of the upper-most fully-opened leaf).

12:1:3 - Number of green leaves:

The number of green leaves on every tagged plant were counted and recorded at 15 days interval. The leaves having more than 50% green area to fully emerged leaf were taken as green leaves.

12:2 - Developmental studies:

12:2:1 - Grain to stover ratio:

It was worked out by dividing the total weight of

grains by the total weight of stover per plot.

12:3 - Yield studies:

12:3:1- Length of cob:

The length of cob was measure in cm. from the base of the cob to the tip of the cob.

12:3:2 - Girth of cob:

The girth of cob was measured in cm. from the centre of the cob.

12:3:3 - Number of rows per cob:

The number of rows per cob were counted and recorded.

12:3:4 - Grain yield per plant:

The five plants which were tagged for growth observations were harvested separately, by dividing their yields by five, per plant yield was worked out.

12:3:5 - stalk weight per plant:

After removing the cobs, the five tagged plants were harvested and weighed, by dividing their weight by five, per plant weight was worked out.

12:3:6 - Test weight of grain:

Thousand grains were counted from the five tagged plants of each plots and weighed.

12:3:7 - Grain yield per hectare:

After sun drying, the maize cobs were shelled with the help of hand sheller and the grains were cleaned free of chaff and weighed. From plot wise data, the grain yield in quintal per hectare was calculated. Stover were also weighed to work out the grain stover ratio.

12:3:8 - Stalk yield per hectare:

The stalks without cobs were cut from the ground surface with the help of sickles and the entire of net plot stalk was weighed by spring balance after complete sundrying. From plot wise-data the stalk yield in quintal per hectare was calculated.

13 - Methods of statistical analysis:

The data were put to the analysis of variance, as suggested by Yates (1935). The Tables for the analysis of variance of experimental data are presented in appendix.

Skeleton analysis of variance Table

S.No.	Source of variance.	Degrees of freedom	Sum of square	Meansum of square.	Observed F value	Table value
1.	Block	3				
2.	Treatments	15				
	a) Nitrogen	2				
	b) Time of N application	4				
	c) Nitrogen Vs no nitrogen	1				
	d) NMS combination	8				
2.	Error	45				
	Total:	63				

The interpretation of result is based on the (F) test. The critical difference was worked out by using equation given by Panse and Sukhatme (1967).

To compare the nitrogen levels with no nitrogen, treatments pooled least significant difference was worked out. To find out the least significant difference in this case standard error of difference was worked out as given below:

1. For N levels Vs no nitrogen:

$$S.E.d. = \pm \sqrt{\frac{\text{Error mean square}}{20} + \frac{MMS}{4}}$$

$$C.D. \text{ at } 5\% = S.E.d \times \text{Table value 't' at } 5\%$$

$$C.D. \text{ at } 1\% = S.E.d \times \text{Table value of 't' at } 1\%$$

2. For K level means:

$$S.E.m. = \pm \sqrt{\frac{\text{Error mean square}}{20}}$$

$$C.D. \text{ at } 5\% = S.E.m \times (t) \times \sqrt{2}$$

$$C.D. \text{ at } 1\% = S.E.m \times (t) \times \sqrt{2}$$

3. For time of application means:

$$S.E.m. = \pm \sqrt{\frac{\text{Error mean square}}{12}}$$

$$C.D. \text{ at } 5\% = S.E.m \times \sqrt{2} \times \text{Table value of } (t) \text{ at } 5\% (3)$$

$$C.D. \text{ at } 1\% = S.E.m \times \sqrt{2} \times \text{Table value of } 't' \text{ at } 1\%.$$

4. For R x T interaction means:

$$S.E.m = \pm \sqrt{\frac{\text{Error means square}}{4}}$$

$$C.D. \text{ at } 5\% = S.E.m \times (t) \times \sqrt{2}$$

$$C.D. \text{ at } 1\% = S.E.m \times (t) \times \sqrt{2}$$

RESULTS & DISCUSSION

CHAPTER - IVRESULT AND DISCUSSION

The present investigations were carried out at College of Agriculture farm, Indore during Kharif 1975 "To study the response of composite maize (Zea mays Linn.) to levels of nitrogen and time of application under the agroclimatic conditions of Malwa Plateau".

Analysis of variance technique was adopted for finding out the differences among various treatments. The findings are discussed below:

1. WEATHER AND THE CROP

Maize is known to be one of the sensitive crops to changes in environmental and soil conditions. The moisture supply, sunshine and temperature constitute the main limiting factors in its growth and production. The study of climatological data reported in previous chapter would indicate that distribution of rainfall was not uniform. Continuous rains in the early stages affected the normal growth and development of the crop and the rains during flowering resulted in poor grain setting because of washing of pollen grains which was ultimately reflected in the relatively low overall yield during this year.

The weather data indicates that in the month of June total rainfall was 202.1 mm. During July the total rainfall

was less than normal (185.7 mm). The weather condition during the month of August were rather extreme. Entire August remained cloudy and it rained for 28 days out of 31. The hours of bright sunshine were much less i.e. 2.8. There was heavy rain in the night of 4th August (176.8 mm) which resulted in temporary water-logging in the experimental field. During September on fourth night there was again heavy shower (185.8 mm) which caused temporary water-logging, and again on 2nd October it rained (71.1 mm), thus the crop suffered temporary sets back of water logging thrice.

Briefly, the weather conditions for the duration of the crop were not favourable for good growth and development of the maize crop, particularly in the month of August which coincided with the grand period of growth.

The weekly means of maximum and minimum temperatures, relative humidity, numbers of hours of bright sunshine and the total rainfall for the duration of the crop are presented graphically in fig. (2).

2. PLANT POPULATION

The plant population per plot was recorded at the time of harvesting of maize crop by counting the plants in each plot. Almost uniform stand was found in all the treatments. The data of the final plant population is presented in the Table - 1.

Fig. 2.

WEATHER CONDITIONS FOR CROP DURATION

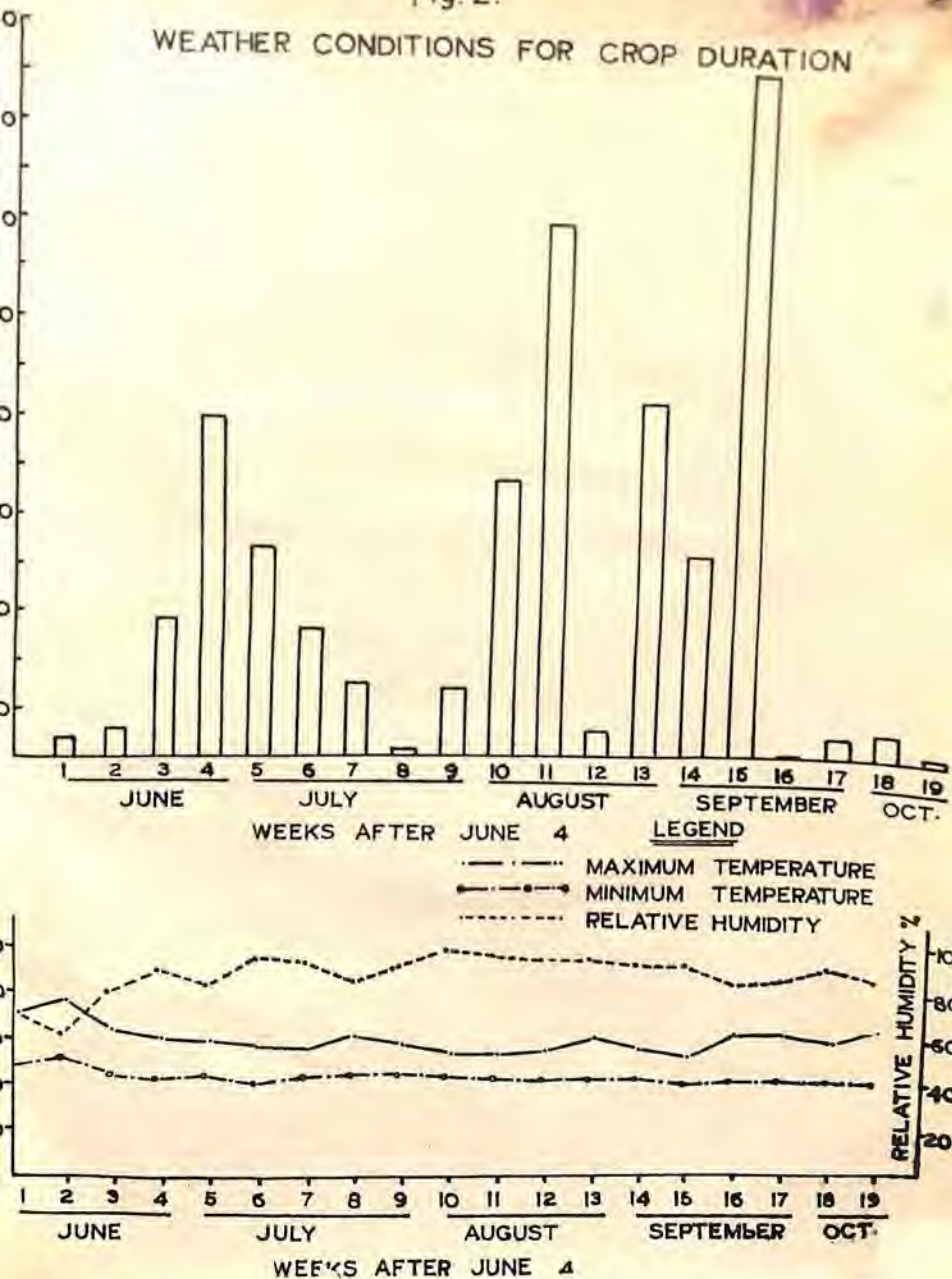


TABLE - 1

NxS combination summary Table

Treatments kg N/ha.	Time of N application (S)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	94.75	95.60	94.75	95.25	95.60	94.55
N ₂	94.50	94.50	95.25	95.00	94.75	94.90
N ₃	95.00	94.60	95.25	95.25	94.00	95.30
Control	-	-	-	-	-	94.75
Mean:	94.75	94.83	95.08	95.18	94.75	

<u>Nitrogen VS No N</u>	<u>Nitrogen levels</u>	<u>Time of N application</u>	<u>NxS combination</u>
S.E.d = \pm 2.05	S.E.M = \pm 0.58	\pm 0.75	S.E.M = \pm 0.13
C.D. at 5% N.S.	C.D. at 5% N.S.	N.S.	N.S.

The analysis of variance (Appendix Table 1) indicated that the treatments did not effect the plant population significantly indicating that the plant population was uniform in all the treatments.

3. GROWTH STUDIES:

3:1 - Height of the plant:

Plant height was recorded at various stages of growth. The first observation was taken 20 days after sowing and the subsequent observation were recorded at 15 days interval. The mean plant height at various stages is summarized in Table 2 and is presented in fig. 3.)

TABLE - 2

Mean heights in cm of plants at different stage of growth

S.No.	Treatment	20	35	50	65	80	95
1.	N ₁ S ₀	18.35	71.25	166.20	198.60	203.05	211.70
2.	N ₁ S ₁	18.10	71.00	172.15	205.15	208.00	210.50
3.	N ₁ S ₂	17.85	69.40	167.55	198.90	200.90	204.60
4.	N ₁ S ₃	16.60	55.90	154.65	193.45	195.05	200.20
5.	N ₁ S ₄	16.00	51.90	156.80	183.85	185.65	198.60
6.	N ₂ S ₀	18.65	80.25	183.75	203.55	207.35	213.35
7.	N ₂ S ₁	19.10	72.75	183.25	208.65	214.20	214.75
8.	N ₂ S ₂	18.05	69.35	176.80	203.85	209.40	215.00
9.	N ₂ S ₃	17.45	63.85	167.05	197.10	204.15	210.50
10.	N ₂ S ₄	17.45	56.15	161.60	192.35	200.10	205.80
11.	N ₃ S ₀	18.40	80.10	183.45	211.55	211.05	220.70
12.	N ₃ S ₁	18.55	76.45	182.85	208.90	211.05	215.20
13.	N ₃ S ₂	18.75	72.25	178.05	199.35	203.50	210.85
14.	N ₃ S ₃	17.65	67.40	171.00	197.90	204.20	205.40
15.	N ₃ S ₄	16.55	55.40	152.00	193.10	198.75	209.25
16.	Control	8.95	30.80	95.200	161.05	163.25	168.35

The increases in plant height was maximum between 35 to 65 days after sowing which represented the period of grand growth. The last observation of final height of plant at the time of harvesting was taken from base of the tassel in all the plots. The final plant height under different treatments is

given in Table 3.

TABLE - 3

N₂O combination summary table

Treatments kg N/ha.	Time of N application (31)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	211.70	210.50	204.60	200.30	188.60	203.12
N ₂	213.25	214.75	216.00	210.50	205.80	212.66
N ₃	220.70	215.20	210.85	205.40	209.25	212.68
Control	-	-	-	-	-	168.35
Mean	215.22	213.48	210.48	205.35	201.55	

<u>Nitrogen Va</u> <u>control</u>	<u>Nitrogen level</u>	<u>Time of N</u> <u>application</u>	<u>N₂O combination</u>
S.E.d = ± 6.6	S.E.m = ± 2.69	± 3.47	S.E.m. = ± 6.0
C.D. at 5% 13.3	C.D. at 5% = 7.68	9.90	N.S.
C.D. at 1% 17.6	-	-	-

3:1:1 - Effect of nitrogen levels:

The mean plant height shows a range from 168.35 to 220.70 cm in various treatments. The differences in plant height among different treatments at harvesting were found to be significant both for time of application and nitrogen levels (Appendix Table 2). The application of nitrogen in general resulted in increased plant height over control. Increasing levels of nitrogen increased plant height at all stages of crop growth. The maximum height of 220.70 cm and an increase of 52.35 over control was recorded from N₃S₀ (160 kg N/ha full at

sowing) treatment. 80 kg N/ha. gave an increase of above 35 cm as compared to control. Further increase of nitrogen levels upto 120 kg N/ha. resulted in a small increase 9.54 cm over 80 kg N/ha, but further increase from 120 to 160 kg N/ha did not result in any increase in height. The percentage increase at 80, 120 and 160 kg N/ha were 20.65, 25.91 and 26.92 per cent, respectively, over control. The result obtained is in conformity with that of Hair (1962).

3:1:2 - Effect of time of nitrogen application:

The analysis of variance indicated that the plant height varied significantly at different times of nitrogen application. Single application of nitrogen i.e. S₀ and S₁ ($\frac{2}{3} + \frac{1}{3}$) gave significantly more plant height as compared to S₄ ($\frac{1}{5} + \frac{4}{5}$) but do not differ with S₂ & S₃ and among themselves, though there was a gradual reduction in the height as the proportion of basal application was decreasing.

3:1:3 - Effect of combination:

The mean sum of squares due to N x S interaction were not significant which indicates that the effect of nitrogen on plant height was uniform for all the times of application.

3:2 - Number of green leaves per plant:

The number of green leaves were recorded at 15 days interval starting the first observation 20 days after sowing.

The data on the average number of leaves at different stages of plant growth are presented in Table 4 and Fig. (3)

TABLE - 4

Number of grass leaves at different stages of growth days after planting

Treatment	20	35	50	65	80
N ₁ S ₀	7.6	10.8	13.1	10.6	6.6
N ₁ S ₁	8.9	11.7	13.9	12.0	7.5
N ₁ S ₂	7.9	11.1	13.3	11.8	8.9
N ₁ S ₃	7.1	10.2	12.8	11.5	6.1
N ₁ S ₄	7.3	10.5	12.6	11.4	6.3
N ₂ S ₀	7.9	11.8	13.6	11.9	6.9
N ₂ S ₁	7.6	12.1	13.4	11.9	6.6
N ₂ S ₂	7.8	11.8	13.9	11.8	6.8
N ₂ S ₃	7.7	11.1	13.2	11.9	6.7
N ₂ S ₄	8.1	11.0	13.2	12.1	7.1
N ₃ S ₀	8.2	12.5	13.6	12.5	7.2
N ₃ S ₁	7.8	11.6	13.5	11.9	6.8
N ₃ S ₂	7.7	11.4	13.8	12.2	6.7
N ₃ S ₃	7.5	11.7	13.2	12.0	6.5
N ₃ S ₄	7.3	10.5	12.8	12.1	6.3
NO _N	6.2	9.1	9.9	8.9	5.2

The data indicated that the production of leaves started rapidly in the early stages of growth and 20 days after

sowing 6-8 leaves were produced. There was a linear increase in the number of leaves and it was maximum at 50 days after sowing when number of leaves per plant varied from 9.9 to 13.9. After 50 days the average number of green leaves started declining and at harvest (95 days after sowing) were completely dry.

The number of green leaves per plant at dough stage (80) days after sowing were statistically analysed and the mean number of leaves in various treatments are presented in Table 8. and Fig. (3)

TABLE - 8

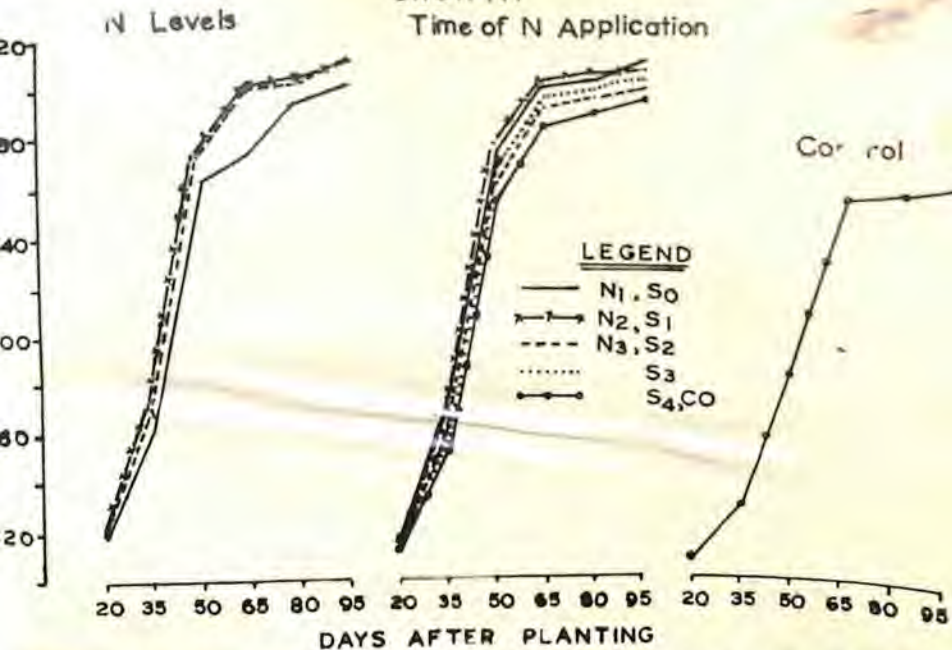
N₂O combination summary table

Treatments kg N/ha	Time of N application (a)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	6.6	7.5	6.9	6.1	6.5	6.66
N ₂	6.9	6.6	6.8	6.7	7.1	6.83
N ₃	7.2	6.8	6.7	6.5	6.3	6.72
Control	-	-	-	-	-	5.20
Mean	6.90	6.81	6.83	6.44	6.66	

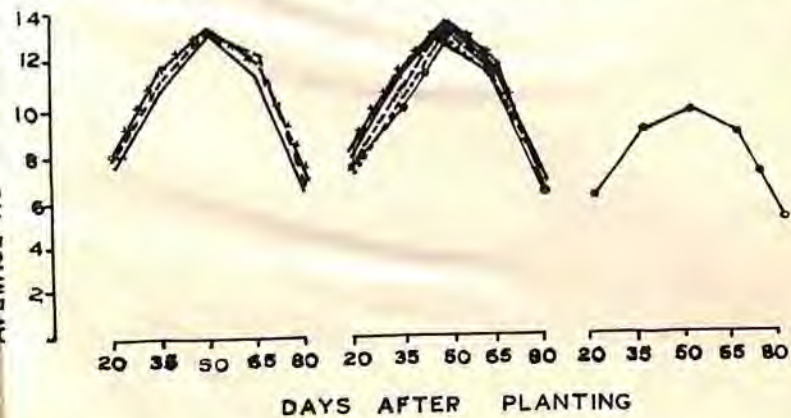
N Vs No nitrogen	Nitrogen levels	Time of N application	N ₂ O combination
S.E.d = ± 0.22	S.E.M = ± 0.14	± 0.39	± 0.67
C.D. at 5% = 0.44	N.S.	N.S.	N.S.

The analysis of variance revealed highly significant differences in the mean number of green leaves per plant between the plots having nitrogen and no nitrogen (appendix Table 3). It

MEAN HEIGHT OF PLANT AT DIFFERENT STAGES OF GROWTH



MEAN NO. OF LEAVES AT DIFFERENT STAGES OF GROWTH



could be attributed to the poor overall growth in control plots. However, among various levels of nitrogen and the time of application the average number of leaves per plant were not significantly different. It is understandable. Since, once the proper height is achieved the average number of leaves is a genetic character and could not be expected to be influenced by the agronomic treatments.

4. DEVELOPMENTAL STUDIES:

4:1 - Grain to stover ratio:

The data summarizing the grain to stover ratio under different treatments are presented in Table 5.

TABLE - 5

N₂ combination summary Table

Treatment kg N/ha.	Time of N application (a)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	3.93	3.99	4.31	3.77	3.75	3.93
N ₂	3.90	4.04	4.30	4.49	4.18	4.18
N ₃	3.98	4.49	4.43	4.19	4.16	4.25
Control	-	-	-	-	-	3.41
Mean	3.94	4.18	4.31	4.15	4.03	

<u>Nitrogen Vs control.</u>	<u>Nitrogen levels.</u>	<u>Time of N application</u>	<u>N₂ combination</u>
S.E.d = 0.26	S.E.m = ± 0.11	± 0.14	± 0.24
C.D. at 5% = 0.53	N.S.	N.S.	N.S.
C.D. at 1% = 0.70			

The ratio varied between 3.41 to 4.49 with an over all

average of 4.08.

4:1:1 - Effect of nitrogen levels:

The analysis of variance indicated that the application of nitrogen increased grain to stover ratio over control (appendix Table 4), however the increases among various nitrogen levels were not significant. The highest grain to stover ratio of 4.49 was given by the treatments N_2S_3 (120 kg N/ha $1/3 + 1/3 + 1/3$) and N_3S_1 (160 kg N/ha $2/3 + 1/3$), but these were not statistically superior over other treatments. Similar results with application of nitrogen have been reported earlier (Crowther *et al.* (1937).

4:1:2 - Effect of time of nitrogen application:

Although split application of nitrogen increased the grain to stover ratio linearly over the full dose of nitrogen application at sowing, however the differences between various time of application were not statistically significant.

4:1:3 - Effect of combination:

The combined effect of nitrogen levels and time of application was not found significant.

6. YIELD STUDIES

6:1 - Average length of cob:

The length was measured in centimeters from the base to the tip of the cob. The average length of cob are presented in Table 7. Fig. (4).

TABLE - 7

Ex:1 combination summary Table

Treatment kg N/ha	Time of nitrogen application(a)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	15.8	17.7	18.5	17.8	18.4	17.85
N ₂	18.6	18.7	19.7	18.3	19.5	18.98
N ₃	19.8	19.4	20.2	18.7	19.6	19.57
Control	-	-	-	-	-	12.55
Mean	18.41	18.64	19.51	18.26	19.18	

Nitrogen Vs control.	Nitrogen levels.	Time of N application.	N x S combination
S.E.d = ± 0.88	S.E.m = ± 0.36	± 0.46	± 0.80
C.D. at 5% = 1.77	± 1.03	F.S.	N.S.
C.D. at 1% = 2.35	± 1.36	-	-

S:1:1 - Effect of nitrogen levels.

From table 7 above and analysis of variance (Appendix Table 4) indicated that the difference due to levels of nitrogen Vs no nitrogen was highly significant, indicating that the application of nitrogen resulted in an appreciable increase in cob length. Among the nitrogen levels 120 and 160 kg N/ha. caused significant increase in length over 80 kg N/ha, however the differences between 120 & 160 kg N/ha were not significant. The increase at 80, 120 & 160 kg N/ha over control were, 42.8, 51.6 and 56.5 per cent, respectively. The above results are supported by Singh (1967) and Tiwary et al (1970).

5:1:3 - Effect of time of nitrogen application:

The time of application did not influence the length of the cob, since the variation due to time of fertilizer application were not significant. (Appendix Table 4).

5:1:3 - Effect of combination:

The interaction between nitrogen levels and time of its application was found to be not significant.

5:2 - Average girth per cob:

The measurement of the girth was made in cm. from the centre of the cob. The data on average girth of the cob are presented in Table 8. and Fig. (4).

TABLE - 8
N x S combination summary Table

Treatments kg N/ha.	Time of N application (s)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	13.7	14.2	14.4	12.8	14.1	13.87
N ₂	14.2	14.3	15.0	14.4	14.7	14.58
N ₃	14.5	14.5	15.1	14.8	14.8	14.75
Control	-	-	-	-	-	12.37
Mean	14.13	14.38	14.94	13.95	14.55	

Nitrogen Vs control.	Nitrogen levels.	Time of N application	N x S combination
S.E.d = 0.42	S.E.m = \pm 0.17	\pm 0.22	\pm 0.39
C.D. at 5% = 0.85	0.49	N.S.	N.S.
C.D. at 1% = 1.12	0.65	-	-

5:2:1 - Effect of nitrogen levels:

The analysis of variance indicates that the application of nitrogen significantly increased the girth of the cob (Appendix Table 6). Among nitrogen levels, the maximum girth was obtained from 160 kg N/ha. level, however, it was not significantly superior than the 120 kg N/ha. The girth of cob was significantly more at both these levels when compared with the girth of cob at 80 kg N/ha. The percentage increases in cob girth at three levels of nitrogen were 18.7, 18.9 and 19.8 over control, respectively.

5:2:2 - Effect of time of nitrogen application:

The analysis of variance revealed that the time of nitrogen application did not influence the cob girth, significantly, since the differences due to time of nitrogen application were not significant. The above results are in agreement with findings of Tiwary *et al* (1970).

5:2:3 - Effect of combination:

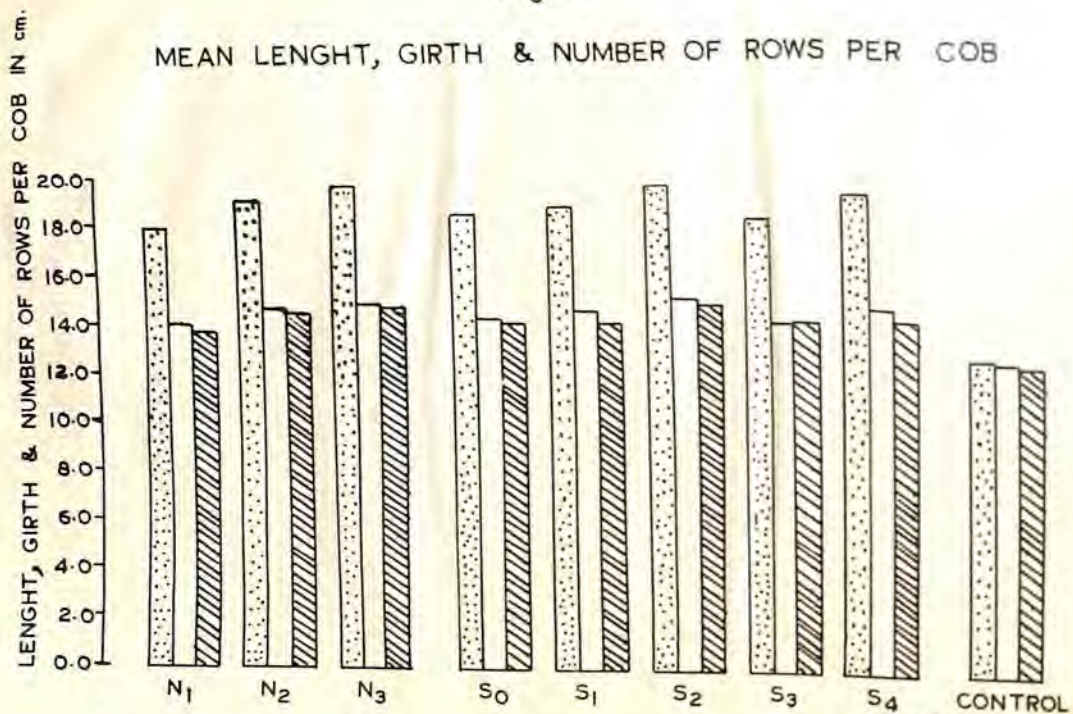
The interaction of levels of nitrogen with the time of application was also not significant.

5:3 - Average number of rows per cob:

The average number of grain rows per cob are presented in Table 9. and Fig. (4).

Fig. 4.

MEAN LENGTH, GIRTH & NUMBER OF ROWS PER COB



LEGEND

- ← Length of Cob in cm.
- ← Girth of Cob in cm.
- ← Number of ROWS / Cob.



TABLE - 9

N₂S combination summary Table

Treatments kg N/ha.	Time of N application(a)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	14.0	13.5	14.3	13.5	13.5	13.7
N ₂	14.5	14.2	14.7	14.2	14.5	14.4
N ₃	14.7	14.7	15.2	14.2	14.5	14.7
Control	-	-	-	-	-	12.2
Mean	14.4	14.1	14.7	14.0	14.2	

Nitrogen Vs control.	Nitrogen levels.	Time of N application	N ₂ S combination
S.E.d = ± 0.44	S.E.m = ± 0.17	± 0.22	± 0.38
C.D. at 5% = 0.88	0.48	N.S.	N.S.
C.D. at 1% = 1.17	0.64	-	-

5:3:1 - Effect of nitrogen levels:

The data presented in Table 9 indicated that the application of nitrogen significantly increased the number of rows per cob over control. The increase due to nitrogen doses from 30 to 120 kg N/ha significantly increased the number of rows, however further increase of nitrogen application from 120 to 180 kg N/ha did not result in any significant increase. The results are in conformity with Brensing and Harper (1960), Rai (1961), Nair (1962), Singh (1964), Singh (1967) and Tiwary et al (1970).

5:3:2 - Effect of time of nitrogen application:

The data presented in table 9 revealed that the time

of nitrogen application did not influence the number of rows per row.

5:3:3 - Effect of combination:

The nitrogen x time of its application interaction was not significant (Appendix Table 7).

5:4 - Grain yield in gm per plant:

The data on the yield of grain per plant are presented in Table 10 and are depicted in fig. (5)

TABLE - 10
Ex3 combination summary Table

Treatments kg N/ha.	Time of N application(s)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	83.9	93.6	107.8	89.0	98.1	94.48
N ₂	103.0	107.9	120.4	103.7	114.3	109.74
N ₃	105.1	114.2	124.8	106.5	118.1	113.74
Control	-	-	-	-	-	38.50
Mean	97.33	105.03	117.66	99.73	110.16	

Nitrogen Vs control.	Nitrogen levels.	Time of N application.	Ex3 combination
S.E.d = ± 3.75	S.E.m = ± 1.63	± 1.98	± 3.4
C.D.at 5% = 7.6	4.4	5.6	N.S.
C.D.at 1% = 10.00	5.9	7.5	

The overall average yield per plant was 101.79 gm and the yield per plant under different treatments varied from 38.5 to 124.8 gm.

5:4:1 - Effect of nitrogen levels:

From the above table it is evident that the application of nitrogen has appreciably increased grain weight per plant and the increase was highly significant over control. The rate of increase in per plant yield for every kg of added nitrogen was more from 0 to 80 kg N/ha, but it was considerably reduced when the dose was increased from 80 to 120 kg N/ha and from 120 to 160 kg N/ha. Among the levels of nitrogen the difference between 80 kg N/ha and 120 kg N/ha. were highly significant, however, the increase between 120 and 160 kg N/ha was statistically not significant. The percentage increase in grain at various nitrogen levels were 145.4, 185.0 and 195.4 over control. The results obtained are in conformity of Rai (1961), Singh (1967) and Rajput *et al* (1970).

5:4:2 - Effect of time of nitrogen application:

Highly significant differences in grain yield per plant was observed among various time of nitrogen application (Appendix Table 8). The highest grain yield per plant was obtained when nitrogen was applied in two splits (i.e. 1/3 as basal and 2/3 top dressing 30 days after sowing). Further reduction of dose at basal i.e. 2/3 + 1/3, 1/3 + 1/3 + 1/3 & 1/5 + 4/5 resulted in reduced yield. The increase in S_2 (1/3 + 2/3) was 20.9% over no splitting (S₀). From these results it could be inferred that for maximum grain yield from nitrogen it should be applied in two split doses i.e. 1/3 at planting and 2/3 as top dressing, 30 days after sowing.

5:4:3 - Effect of combination:

Interaction between nitrogen levels and time of application was not significant. However all doses applied in two splits gave more yield and 1/3 + 2/3 giving maximum yield.

5:5 - Stalk yield in gm per plant:

The average yield of stalk per plant is presented in Table 11. and Fig. (5)

TABLE - 11

N₂ combination SUMMARY Table

Treatment kg N/ha.	Time of N application (s)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	147.5	134.4	141.0	107.7	109.5	128.05
N ₂	152.0	144.7	147.5	117.5	117.5	135.90
N ₃	155.7	150.0	160.5	122.5	123.0	140.35
Control	-	-	-	-	-	61.25
Mean	151.75	143.0	145.33	115.91	115.75	

Nitrogen Vs control.	Nitrogen levels.	Time of N application	N ₂ combination
S.E.d = ± 3.88	S.E.m = 1.58	± 2.09	± 3.54
C.D. at 5% = 4.98	= 2.85	3.68	N.S.
C.D. at 1% = 6.60	= 3.78	4.87	-

The average weight of stalk per plant was 130.17 gm which varied from 61.25 to 155.7 gm in different treatments.

5:5:1 - Effect of nitrogen levels:

Analysis of variance revealed highly significant differences among various treatments for stalk yield (Appendix Table 9). The application of nitrogen resulted in significant increase in stalk yield. The highest stalk yield of 140.35 gm per plant was recorded at 160 kg N/ha dose. All nitrogen levels 80 - 120 and 160 kg N/ha resulted in significant increase in stalk yield at all the levels. The increases in stalk yield at 80, 120 and 160 kg N/ha were, 109.0, 121.8 and 129.1 per cent, respectively, over control. The above results are in agreement with Rai (1961); Singh (1967) and Rajput et al (1970).

5:5:2 - Effect of time of nitrogen application:

The split application of nitrogen resulted in significantly low stalk yield over the single application of nitrogen as basal. There was a gradual reduction as the proportion of basal was decreased in S₁, S₂ etc. The lowest stalk yield was recorded in S₃ (1/3 + 1/3 + 1/3) and S₄ (1/5 + 4/5) treatments.

5:5:3 - Effect of combination:

Interaction of nitrogen levels with time of application was not found significant.

5:6 - Test weight of grain in gm.

Test weight is an indication of size and density of maize grain. The average test weight of grain under various

treatments are presented in Table 12, and Fig. (5)

TABLE - 12

Exp combination summary Table

Treatments kg N/ha	Time of N application (g)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	236.0	234.2	250.5	231.0	241.2	238.58
N ₂	240.2	241.5	256.2	238.0	245.2	244.42
N ₃	244.5	248.2	253.5	241.5	249.5	249.44
Control	-	-	-	-	-	170.00
Mean	240.23	242.30	256.73	236.83	245.53	

Nitrogen Vs control.	Nitrogen levels.	Time of N application.	Exp combination
S.E.d = ± 6.5	S.E.M = ± 3.65	± 3.42	± 5.91
C.D. at 5% = 13.1	7.56	9.78	N.S.
C.D. at 1% = 17.4	10.01	12.93	-

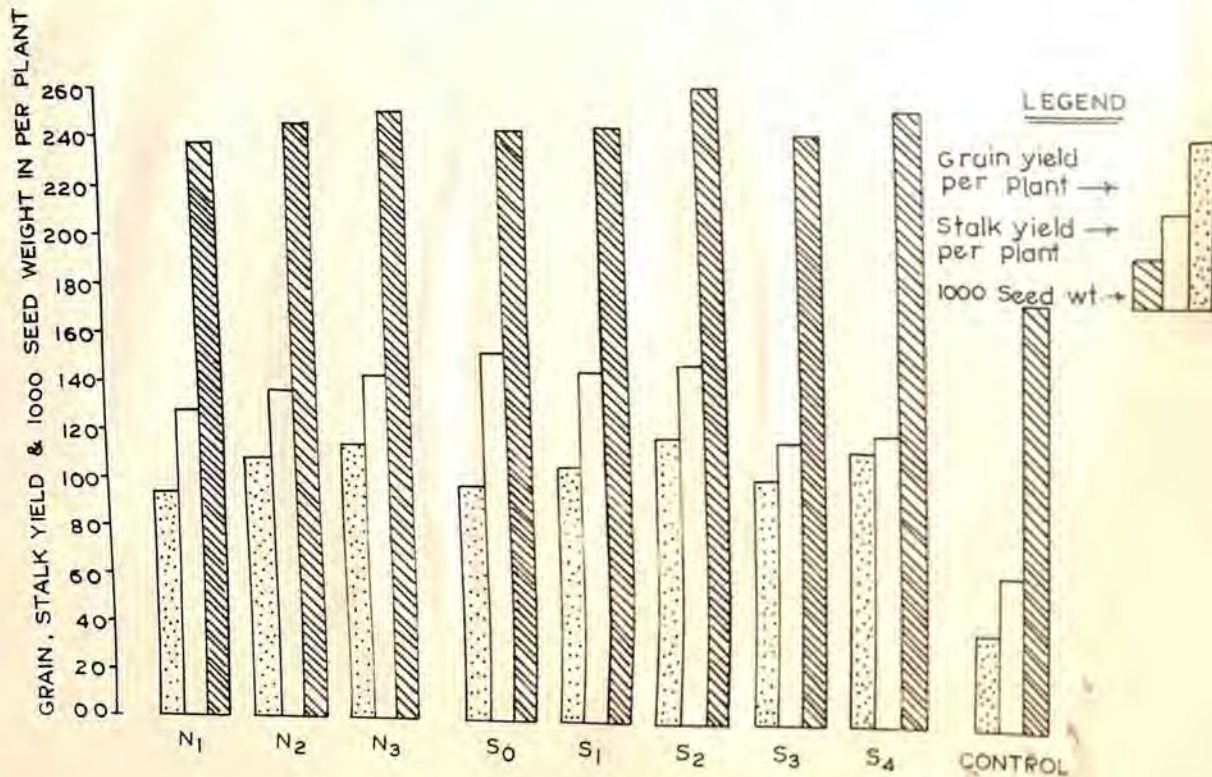
The average weight of thousand grain was 239.53 gm and it showed variation from 170.00 to 253.5 gm.

5:6:1 - Effect of nitrogen levels:

The analysis of variance revealed that the test weight varied significantly among different treatments (appendix Table 12). A perusal of Table 12 would reveal that the application of nitrogen at all the levels significantly increased the grain weight as compared to control. The highest grain weight was recorded at 160 kg N/ha. However it was not significantly superior over

Fig. 5

YIELD OF GRAIN, STALK PER PLANT & 1000 SEED WEIGHT IN Gm.



the 120 kg N/ha., similarly the test weight at 120 kg N/ha. was not significantly superior than at 80 kg N/ha. The results obtained are in conformity with those of EB-Hindi (1966); Singh (1967); Rajput *et al* (1970) and Tiwary *et al* (1970).

5:6:2 - Effect of time of nitrogen application:

The analysis of variance indicated that the test weight was significantly influenced by the time of nitrogen application (Appendix Table 12). The highest grain weight was obtained when 1/3 nitrogen was supplied as basal and two(2/3) third top dressed 30 days after sowing. The lowest test weight was obtained for S₃ (1/3 + 1/3 + 1/3). However, it was not significantly different than other treatments, except S₂. It is interesting to note that for yield also the treatments S₂ was best, indicating that test weight is an important yield component in composite maize.

6:1:3. Effect of combination:

The interaction between nitrogen levels and time of its application was found not significant.

5:7 - Grain yield in quintals per hectare:

From plot wise data, the grain yield/ha was computed to study the over all effects of different treatments. The mean yield in q/ha. for various treatments is presented in Table 13. and Fig. (6)

TABLE - 12

N:P combination summary Table

Treatments kg N/ha	Time of N application (g)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	33.1	35.5	39.2	34.7	37.0	35.03
N ₂	39.8	41.1	43.3	40.9	44.3	41.54
N ₃	41.2	44.2	45.9	42.6	44.3	43.82
Control	-	-	-	-	-	16.42
Mean	37.50	40.26	43.33	39.40	41.80	

Nitrogen Vs control.	Nitrogen levels.	Time of N application	N:P combination
S.E.d = ±0.775	S.E.m = ±0.308	±0.398	+0.217
C.D. at 5% = 1.50	0.88	1.14	N.S.
C.D. at 1% = 20.00	1.16	1.50	-

The average yield per hectare was 37.87 quintals per hectare and varied from 16.4 to 45.9 g/ha. for different treatments.

5:7:1 - Effect of nitrogen levels:

From analysis of variance it was observed that the differences among the treatments were highly significant (Appendix Table 10). Comparison between control (no nitrogen) and different levels of nitrogen revealed that there was a sudden jump in yield from 0 to 80 kg N/ha. Thereafter the response for every kg of added nitrogen was low even though statistically significant improvement in yield was recorded

upto 160 kg N/ha. This is in confirmity with the results obtained from grain yield per plant. The percentage increase over control at 80, 120 and 160 kg N/ha were 119.3, 152.9 and 166.8, respectively.

Similar significant yield increases with application of nitrogen have been reported earlier by (Sharma and Gupta (1968); Gaur et al (1969); Verma and Singh (1970); Bapna and Trivedi (1971); Pathak et al (1971); Srivastava et al (1971); Sunball (1971); Shukla (1972) and Tivari et al (1973).

5:7:2 - Effect of time of nitrogen application:

Time of nitrogen application resulted in significant differences in the grain yield. As in case of grain yield/plant, in this case also S₂ (1/3 + 2/3) gave significantly superior yield than others. All the treatments involving split application of nitrogen gave significantly superior yield than single application at planting. The superiority of all the treatments involving split application of nitrogen over single dose at planting clearly demonstrated that considerable amount of nitrogen is lost during rainy season by leaching, washing. etc. The results are in conformity with Goor (1953); Alvord (1969); Hindayala (1971); Glenn and Bhanyadee (1971); Kashird (1972); Mandloi et al (1972) and Miller et al (1975).

5:6:3 - Effect of combination:

The nitrogen \times time of application (N \times T) interaction was

not found significant, indicating that at all the levels of nitrogen split application is beneficial.

5:7 - Stalk yield in quintal per hectare:

Stalk yield in q/ha was computed from plot wise data. The results are summarized in Table 14. Fig. (6)

TABLE - 14
ExS combination summary Table.

Treatments kg N/ha.	Time of N application (a)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
S ₁	78.12	71.61	66.98	58.47	68.98	68.44
S ₂	67.75	79.14	76.35	69.59	70.31	76.63
S ₃	88.96	82.50	82.92	68.96	72.90	79.35
Control	-	-	-	-	-	46.74
Mean	84.94	77.75	75.42	65.67	72.80	

Nitrogen Vs control.	Nitrogen levels.	Time of N application.	ExS combination
S.E.d = ±2.47	S.E.M = ± 1.00	± 1.29	± 2.25
C.D. at 5% = 4.98	3.85	3.68	N.S.
C.D. at 1% = 5.60	3.78	4.87	-

The average yield of stalk was 73.02 q/ha. and varied from 46.74 to 88.96 q/ha. in different treatments.

5:7:1 - Effect of nitrogen levels:

Highly significant differences were observed in stalk

yield among various treatments (Appendix Table 11). The application of nitrogen significantly increased the stalk yield. A marked improvement of about 46.4% over control was observed with 60 kg N/ha. Further increase in nitrogen upto 120/kg N/ha resulted in significant improvement in yield. Subsequent increase of dose from 120 to 180 kg N/ha did not result in significant improvement in stalk yield. Percentage increases in stover yield at three levels of nitrogen application were 46.4, 63.9 and 69.5 over control. The above results are supported by findings of Rai (1961); Singh and Saroha (1970) and Sunball (1971).

5:7:2 - Effect of time of nitrogen application:

Single application of nitrogen 60 (full dose at the time of sowing) gave significantly higher yield of stalk over double and triple split application. The three splits of nitrogen application (S₃) gave the lowest yield of stalk when compared with other split applications. The differences among treatments involving two split (S₁, S₂, and S₄) were not significant.

5:7:3 - Effect of combination:

Interaction between nitrogen levels and time of application were not significant.

6. ECONOMICS:

The economics of different treatment has been

calculated at the following rates for different items.

6:1 - Cost of fertilizers:

- Ammonium sulphate @. 120 per quintal
- Single superphosphate @. 110.00 per quintal
- Muriate of potash @. 130.00 per quintal

6:2 - Labour charges for fertilizer application (per acre)

6:2:1 - Soil application:

6:2:1:1 - Placement of ammonium sulphate + single

superphosphate + Muriate of potash. Five labour per day (@ @.3 per day).

6:2:1:2 - Top dressing of ammonium sulphate:

Two labour for each dressing.

6:3 - Sale price of produce:

- Grain - @ @. 80.00 per quintal.
- Stalk - @ @. 5.50 per quintal.

Economics of different levels and time of application of nitrogen

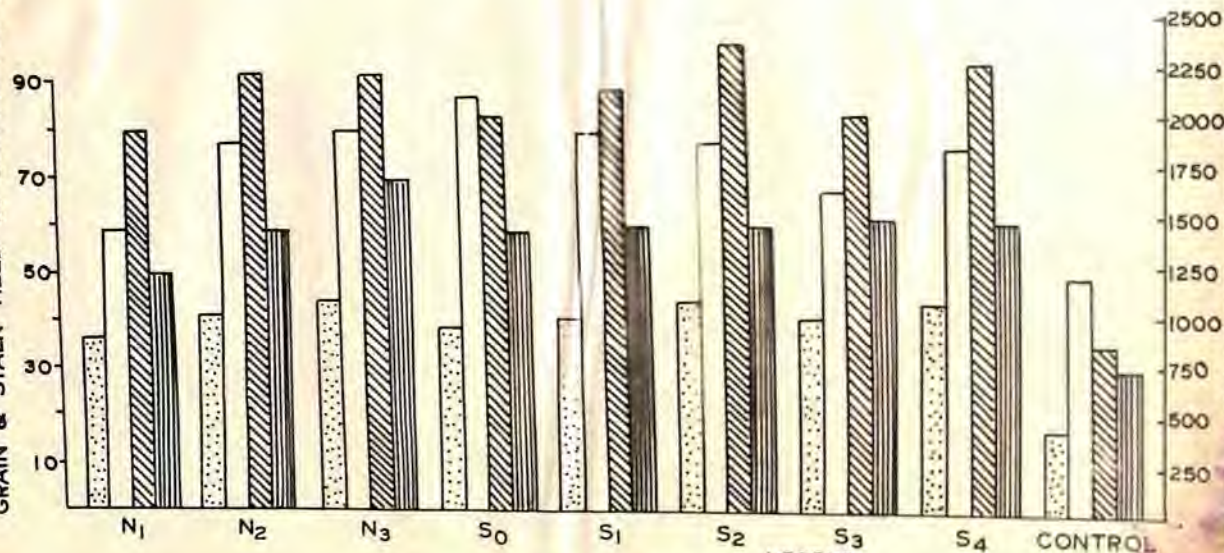
Treatments	Value of total produce ₹./ha	Extra expenditure ₹./ha	Income ₹/ha.
N ₁ S ₀ -(80 kg N/ha full at sowing)	3077.85	1194.40	1883.28
N ₁ S ₁ -(80 kg N/ha 2/3 at sowing + 1/3 at 30 days after sowing)	3333.85	1218.70	1937.32
N ₁ S ₂ -(80 kg N/ha 1/3 at sowing + 2/3 at 30 days after sowing)	3532.39	1218.70	2235.86
N ₁ S ₃ -(80 kg N/ha 1/3 at sowing + 1/3 at 30 days after sowing + 1/3 at tasselling)	3097.68	1943.00	1773.91
N ₁ S ₄ -(80 kg N/ha 1/5 at sowing + 4/5 at 30 days after sowing)	3338.39	1218.70	2031.85
N ₂ S ₀ -(120 kg N/ha full at sowing)	3538.82	1434.32	2104.29
N ₂ S ₁ -(120 kg N/ha 2/3 at sowing + 1/3 at 30 days after sowing)	3723.27	1458.63	2264.64
N ₂ S ₂ -(120 kg N/ha 1/3 at sowing + 2/3 at 30 days after sowing)	3883.92	1458.63	2425.29
N ₂ S ₃ -(120 kg N/ha 1/3 at sowing + 1/3 30 days after sowing + 1/3 at tasselling)	3554.74	1482.93	2171.81
N ₂ S ₄ -(120 kg N/ha 1/5 at sowing + 4/5 at 30 days after sowing)	3922.70	1458.63	2464.07
N ₃ S ₀ -(160 kg N/ha full at sowing)	3783.28	1674.26	2111.02
N ₃ S ₁ -(160 kg N/ha 2/3 at sowing + 1/3 at 30 days after sowing)	3989.75	1698.56	2291.19
N ₃ S ₂ -(160 kg N/ha 1/3 at sowing + 2/3 at 30 days after sowing)	4208.05	1698.56	2509.50
N ₃ S ₃ -(160 kg N/ha 1/3 at sowing + 1/3 at 30 days after sowing + 1/3 at tasselling)	3787.22	1722.86	2064.36
N ₃ S ₄ -(160 kg N/ha 1/5 at sowing + 4/5 at 30 days after sowing)	3936.95	1698.86	2237.39
Control	1569.07	714.82	854.85

The results are summarised in Table 15, Fig. (6).

Fig. 6.

YIELD OF GRAIN, STALK IN QUINTAL & ECONOMICS OF FERTILIZATION PER HECTARE

GRAIN & STALK YIELD IN QUINTAL PER HECTARE



LEGEND

GRAIN YIELD PER HECTARE

STALK " " "

COST OF FERTILIZATION IN RS/ha

NET PROFIT IN RS/ha

COST OF FERTILIZATION & NET PROFIT IN RS PER HECTARE

TABLE - 15

Best combination summary table

Treatment kg N/ha	Time of nitrogen application (s)					Mean
	S ₀	S ₁	S ₂	S ₃	S ₄	
N ₁	1883.28	1937.32	2235.86	1773.91	2031.86	1972.44
N ₂	2104.29	2264.64	2425.29	2171.81	2464.07	2286.02
N ₃	2111.02	2291.19	2509.50	2064.36	2237.39	2242.69
Mean	2032.86	2164.38	2390.21	2003.36	2244.44	

The economics presented in Table 15 indicated that the dose of 120 kg N/ha gave Rs. 2286.02 per hectare and the highest income as against 1972.44 and 2242.69 from 80 and 160 kg N/ha. The rate of income per kg of nitrogen was high with 80 kg N/ha (i.e. Rs. 123.27) than 120 (Rs. 95.25) and 160 kg N/ha (Rs. 70.08). Application of nitrogen into two split 1/3 at sowing + 2/3 at 30 days after sowing gave the highest income over single and other splits.

Results shows that dose of 120 kg N/ha and two split i.e. 1/3 at sowing + 2/3 at 30 days after sowing was best among different levels and time of application of nitrogen.

TABLE - 17

Yield Response and Economics of Nitrogen Application

Levels of N (kg/ha.)	Mean yield of grain of maize (kg/ha.)	Increased yield		Yield response per kg of N		Net value of additional produce after deducting the cost of fertiliser		
		Over the control (kg/ha.)	Over the preceding dose (kg/ha.)	Over No N (kg/ha.)	Over preceding of N (kg/ha.)	Over the control (%/ha.)	Over preceding of N (%/ha.)	Return per rupee of nitrogen
0	1642							
80	3602	1960	1960	24.50	24.50	2561.60	2561.60	7.53
120	4154	2512	552	30.93	13.80	3323.20	761.60	6.51
160	4382	2740	228	17.12	5.70	3505.60	182.40	5.15

Cost per kg N at ₹. 4.35 and per kg of maize ₹. 0.80 was taken to work out the economics of nitrogen application.

Application of 80, 120 and 160 kg N/ha. increased the yield of grain by 1960, 2512 and 2740 kg/ha., respectively, over control. The highest increase in yield was obtained from 80 kg N/ha. The magnitude of response decreased with further increase of 40 kg nitrogen levels, i.e. 552 and 228 kg for the second and third increases, respectively.

The response to one kg of nitrogen was 24.50, 30.93 and 17.12 kg with 80, 120 and 160 kg nitrogen respectively, indicating decreasing mean response with the increasing levels of nitrogen. For the successive additional increment of 80 kg for the first and 40 kg for second and third the response to one kg of nitrogen

was 24.50, 13.80 and 5.70 kg of maize grain. The additional produce valued at Rs. 2561.60, 3323.20 and 3505.60 with the application of 80, 120 and 160 kg N/ha respectively, over the control. Though the income of the additional produce of maize with first level of 80 kg nitrogen and increase of 40 kg for the second and third decreased which it was economical in relation to the nitrogen cost.

The first degree and the second degree polynomial relationship of nitrogen level and maize yield was studied, where x is the dose of nitrogen in kg per hectare, and y is the expected yield of maize grain in kg per hectare.

$$Y = 18.5380 + 0.1758 x$$

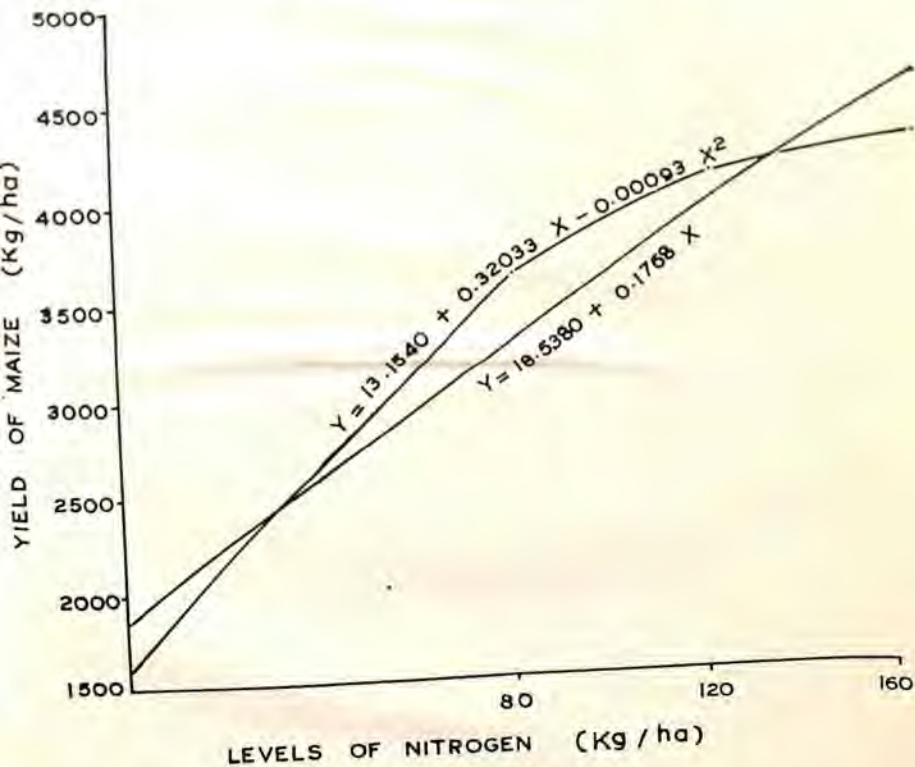
$$Y = 13.154 + 0.32033 x - 0.00093 x^2$$

Estimated yield response for 0, 80, 120 and 160 kg N/ha were 0, 3268.2, 3975.4 and 4582.6 linear and 0, 3282.8, 3820.2 and 4059.9 polynomial, respectively.

The ratio of fertilizer when price of maize is about Rs. 0.86, the response per kg of N is 24.50, 20.93 and 17.12 kg grain with an application of 80, 120 and 160 kg N/ha. Application of nitrogen at 80, 120 and 160 kg N/ha gave returns of Rs. 7.53, 6.51 and 5.15 per rupee of nitrogen cost, and the optimum dose of nitrogen was about 120 kg N/ha. Fig.7.

Fig. 7.

YIELD RESPONSE OF MAIZE TO LEVELS OF NITROGEN



SUMMARY & CONCLUSION

CHAPTER - VSUMMARY AND CONCLUSION

The experiment was laid out to study the response of composite maize variety 'Chandab Makra-3' to different levels of nitrogen and its time of application under the agro-climatic conditions of Malwa Plateau, during the Bharif season 1975 on the farm of College of Agriculture, Indore.

The objective of the experiment was to find out the optimum dose of nitrogen fertilizer and its proper time of application. The main finding of the present study are summarized below:

1. The plant height studies at different stages of plant growth showed that maximum plant height increase was between 35 to 65 days after sowing. The difference in plant height among different treatments at harvesting were found to be significant. The application of nitrogen, in general resulted in increased plant height over control. The plant height did not increase beyond 120 kg N/ha. The increase in plant height at 80, 120 and 160 kg N/ha were 20.65, 28.91 and 26.92 per cent, respectively, over control. The single application of nitrogen gave more plant height as compared to the split application.

2. There was linear increase in the number of leaves and it was maximum at 60 days after sowing. The analysis of variance revealed highly significant differences in the mean number of green leaves per plant between the plots having nitrogen and no nitrogen. Various levels of nitrogen and time of application did not affect the average number of leaves per plant significantly.
3. The analysis of variance indicated that the application of nitrogen increased grain to stover ratio over control. However, the grain to stover ratio at various levels and under various time of application of nitrogen was not significantly affected.
4. The application of nitrogen resulted in an appreciable increase in cob length. Among nitrogen levels 120 and 160 kg N/ha gave significant improvement over 80 kg N/ha. The increase at 80, 120 and 160 kg N/ha. over control was 42.8, 51.6 and 56.5, respectively.
5. The application of nitrogen significantly increased the number of rows per cob over control. The increase in nitrogen from 80 to 120 kg N/ha. significantly increased the number of rows. The increase in 80, 120 and 160 kg N/ha were 12.3, 18.0 and 20.5 per cent, respectively, over control.
6. The application of nitrogen significantly increased the girth of the cob. The increase at three levels of nitrogen

were 12.7, 18.2 and 19.9 per cent over control, respectively.

7. The over all average yield per plant was 101.79 gm and the yield per plant under different treatments varied from 38.5 to 134.8 gm. The increase in the grain yield due to nitrogen application was highly significant over control. The percentage increase in grain yield at various nitrogen levels were 145.4, 185.0 and 195.4 over control, respectively. The application of nitrogen above 120 kg N/ha did not result in significant improvement in per plant yield. However the significant improvement upto 180 kg N/ha was observed in terms of yield per hectare.

The highest grain yield per plant was obtained when nitrogen was applied in two split dose i.e. (1/3 basal at sowing and 2/3 as top dressing \pm 30 days after sowing. The increase from the said treatment was 20.9 per cent over full basal. From these results it could be inferred that for the maximum efficiency of nitrogen application it should be applied in two split dose i.e. 1/3 at planting and 2/3 as top dressing 30 days after sowing. Similar results are obtained when yield are converted to quintal per hectare.

Here again the application of nitrogen in two splits (1/3 + 2/3) gave significantly superior yield over single application or basal and the other time of application treatments.

8. The differences among the treatments were highly

significant in yield/ha. This is in confirmity with the results obtained for grain yield per plant (gm). The percentage increase over control at 80, 120 and 160 kg N/ha were 119.3, 152.9 and 166.8, respectively.

9. The application of nitrogen resulted in significant increase in stalk yield. The highest stalk yield of 140.35 gm per plant was recorded at 160 kg N/ha. The increase in yield at 80, 120 and 160 kg N/ha were 109.0, 121.3 and 129.1 per cent, respectively, over control. Split application of nitrogen resulted in significantly low stalk yield over the single basal application of nitrogen as basal (S₀).

10. Application of nitrogen at all the levels significantly increased the grain weight as compared with control. Highest grain weight was recorded at 160 kg N/ha.

Test weight was significantly influenced by the time of nitrogen application. The highest grain weight was obtained when 1/3 nitrogen was supplied as basal and 2/3 supplied as top dressing 30 days after sowing (S₂). It is interesting to note that in yield per hectare also treatment S₂ was best, indicating that the test weight is an important yield component for composite maize.

11. Application of nitrogen resulted in marked improvement in grain yield. The response per kg of nitrogen applied was high

upto 120 kg N/ha but dropped thereafter.

12. Application of nitrogen significantly increased the stalk yield per hectare. A marked improvement of about 46.6 per cent over control was observed with 80 kg N/ha. Single application of nitrogen i.e. full dose at the time of sowing gave significantly higher yield of stalk over split application.

Conclusion:

In levels though 150 kg nitrogen/hectare gave highest yield of maize however in response per kg of nitrogen 80 kg gave most encouraging results. Similarly time of application 1/3 + 2/3 (Basal at planting and top dressing at 30 days after sowing gave an increase of 5.83 quintals/ha. Over full basal when combined effect of the two factors is studied an increase of 10 q / ha. over basal was obtained. This finding in conformity with various workers.

The ratio of fertilizer: when price of maize is about Rs. 0.80, the response per kg of N is 24.50, 30.93 and 17.12 kg grain with an application of 80, 120 and 160 kg N/ha. Application of nitrogen at 80, 120 and 160 kg N/ha gave returns of Rs. 7.53, 6.51 and 5.15 per rupee of nitrogen cost, and the optimum dose of nitrogen was about 120 kg N/ha.

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* Original not seen.

APPENDIX

APPENDIX
ANALYSIS OF VARIANCE TABLES

TABLE - 1
Plant population per plot

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio of observed	Table value of F at 5%	at 1%
Blocks	3	9.06	3.02	0.44 NS	2.82	4.06
Treatments	15	10.44				
i) Nitrogen	2	5.64	2.82	0.41 NS	3.21	5.13
ii) Time of B application	4	1.84	0.46	0.07 NS	2.59	3.78
iii) NVs no nitrogen	1	0.10	0.10	0.01 NS	4.03	7.30
iv) ExS combination	8	2.86	0.36	0.05 NS	2.16	2.95
Error	45	307.94	6.84			
Total:	62	327.44				

TABLE - 2
Final height of plant in cm

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio of observed	Table value of F at 5%	at 1%
Blocks	3	257.75	85.92	0.59 NS	2.82	4.28
Treatments	15	9736.52				
i) Nitrogen	2	1184.50	592.25	4.09*	3.21	5.13
ii) Time of B application	4	1640.04	410.01	2.83*	2.59	3.78
iii) NVs no nitrogen	1	6318.11	6318.11	43.64**	4.03	7.30
iv) ExS combination	8	593.87	74.23	0.51**	2.16	2.95
Error	45	6514.55	144.77			
Total:	63	16508.82				

N.S. = Not significant
* = Significant at 5%
** = Significant at 1%

TABLE - 3

Number of green leaves per plant at dough stage

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio of observed	Table value of F at 5% at 1%
Blocks	3	0.69	0.23	1.28 NS	2.82 4.36
Treatments	15	11.04			
i) Nitrogen	2	0.29	0.14	0.77 NS	3.21 5.13
ii) Time of F application	4	1.44	0.36	2.00 NS	2.59 3.78
iii) Nvs no nitrogen	1	6.21	6.21	34.50 **	4.03 7.30
iv) N x S combination	8	3.10	0.38	2.11 NS	2.16 2.95
Error	45	8.31	0.18		
Total:	63	20.04			

TABLE - 4

Grain to stover ratio

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio of observed	Table value of F at 5% at 1%
Blocks	3	0.04	0.01	0.05 NS	2.82 4.36
Treatments	15	5.11			
i) Nitrogen	2	1.12	0.56	2.43 NS	3.21 5.13
ii) Time of N application	4	1.00	0.25	1.09 NS	2.59 3.78
iii) Nvs no nitrogen	1	1.89	1.89	8.22 **	4.03 7.30
iv) N x S combination	8	1.10	0.14	0.61 NS	2.16 2.95
Error	45	10.50	0.23		
Total:	63	15.65			

N.S. = Not significant
 ** = Significant at 1%

TABLE - 5

Length of cob in cm

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%
Blocks	3	0.83	0.28	0.11 NS	2.82 4.26
Treatments	15	196.34			
i) Nitrogen	2	30.40	15.20	5.89 **	3.21 5.13
ii) Time of N application	4	13.26	3.31	1.28 NS	2.59 3.78
iii) N Vs no nitrogen	1	146.64	146.64	55.84 **	4.03 7.30
iv) Rxs combination	8	6.04	0.75	0.29 NS	2.16 2.95
Error	45	116.14	2.58		
Total:	63	313.31			

TABLE - 6

Girth of cob in cm

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%
Blocks	3	1.88	0.62	1.03 NS	2.82 4.26
Treatments	15	94.40			
i) Nitrogen	2	8.83	4.41	7.35 **	3.21 5.13
ii) Time of N application	4	5.01	1.25	2.08 NS	2.59 3.78
iii) N Vs no nitrogen	1	16.15	16.15	26.92 **	4.03 7.30
iv) Rxs combination	8	4.41	0.55	0.92 NS	2.16 2.95
Error	45	27.24	0.60		
Total:	63	63.30			

NS = Not significant.

** = Significant at 1%

TABLE - 7

Number of row per cob

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%	
Block	3	2.42	0.81	1.39 NS	2.82	4.26
Treatments	15	30.36				
i) Nitrogen	2	9.60	4.80	8.27 **	3.21	5.13
ii) Time of N application	4	4.10	1.02	1.76 NS	3.59	3.78
iii) N Vs no nitrogen	1	15.76	15.76	27.17 **	4.03	7.30
iv) N x S combination	8	0.90	0.11	0.19 NS	2.16	2.95
Error	45	29.23	0.65			
Total:	63	59.11				

TABLE - 8

Grain yield per plant in 22-

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%	
Blocks	3	89.63	29.88	6.64 NS	2.82	4.26
Treatments	15	24518.40				
i) Nitrogen	2	4124.60	2062.25	43.93**	3.21	5.13
ii) Time of N application	4	3231.42	807.85	17.21**	3.59	3.78
iii) N Vs no nitrogen	1	17092.69	17092.69	354.14**	4.03	7.30
iv) N x S combination	8	69.70	8.72	0.18 NS	2.16	2.95
Error	45	2112.37	46.94			
Total:	63	25720.40				

NS = Not significant.

** = Significant at 1%

TABLE - 9

Stalk yield per plant in gm.

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%	
Blocks	3	88.87	19.56	0.39NS	2.82	4.25
Treatments	15	35066.36				
i) Nitrogen	2	1551.44	775.72	15.43**	3.21	5.13
ii) Time of N application	4	14055.74	3513.93	69.90**	2.59	3.78
iii) N Vs no nitrogen	1	20257.62	20257.62	403.17**	4.03	7.30
iv) NxS combination	8	91.85	11.44	0.23NS	2.16	2.95
Error	45	2252.06	50.27			
Total:	63	38287.11				

TABLE - 10

Test weight of 1000 grain in gm.

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%	
Blocks	3	502.45	167.48	1.19NS	2.82	4.25
Treatments	15	24626.50				
i) Nitrogen	2	1179.64	589.82	4.20**	3.21	5.13
ii) Time of application	4	2857.84	714.43	5.09**	2.59	3.78
iii) NVs no nitrogen	1	20600.66	20600.66	146.73**	4.03	7.30
iv) NxS combination	8	58.36	7.29	0.05NS	2.16	2.95
Error	45	6318.05	140.40			
Total:	63	31517.00				

NS = Not significant
 * = Significant at 5%
 ** = Significant at 1%

TABLE - 11

Grain yield in quintal per hectare

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%
Blocks	3	12.96	4.32	2.27NS	2.82 4.36
Treatments	15	3079.54			
i) Nitrogen	2	648.76	324.38	170.73**	3.21 5.13
ii) Time of N application	4	239.29	59.82	31.43**	2.59 3.78
iii) NVs no nitrogen	1	2167.60	2167.60	1140.73**	4.03 7.30
iv) N x S combination	8	23.98	2.99	1.57NS	2.16 2.95
Error	45	85.41	1.90		
Total:	63	3176.91			

TABLE - 12

Stalk yield in quintal per hectare

Source of variation	Degrees of freedom	Sum of squares	Means sum of squares	F ratio observed	Table value of F at 5% at 1%
Blocks	3	12.25	4.08	0.20NS	2.82 4.36
Treatments	15	6984.12			
i) Nitrogen	2	1272.45	636.16	31.26**	3.21 5.13
ii) Time of N application	4	2612.65	653.16	32.09**	2.59 3.78
iii) NVs no nitrogen	1	2945.67	2945.67	144.75**	4.03 7.30
iv) N x S combination	8	153.35	19.17	0.94NS	2.16 2.95
Error	45	915.94	20.35		
Total:	63	7939.79			

NS = Not significant.

** = Significant at 1%.