

RESPONSE OF LINSEED (Linum usitatissimum Linn.) TO NITROGEN AND PHOSPHORUS LEVELS

THESIS

Submitted to the
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE
IN
AGRICULTURE
(AGRONOMY)



BY

Uma Shankar Awasthi



DEPARTMENT OF AGRONOMY
JAWAHARLAL NEHRU KRISHI VISHWA VIDYALAYA
COLLEGE OF AGRICULTURE
REWA (M. P.)

1986

- 7.
- 17412
- crop

J. N. Krishi Vishwa Vidyalaya,	
LIBRARY, JABALPUR.	
Acc. No. 32682	Date 13-3-87
Initials	<i>MS</i>

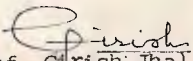
I Dedicated
this work to
My Parents
whose unflinching
affection and encouragement
always inspired me towards
Honesty and Hardworking.



C E R T I F I C A T E - I

This is to certify that the thesis entitled, "Response of linseed (Linum usitatissimum Linn.) to nitrogen and phosphorus levels" submitted in partial fulfilment of the requirements for the degree of "MASTER OF SCIENCE IN AGRICULTURE" of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by SHRI - UMA SHANKAR AWASTHI under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.

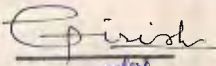
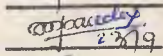
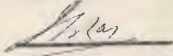
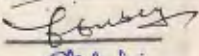
No part of the thesis has been submitted for any other degree or diploma (certificate awarded, etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

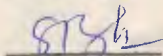

(Prof. Girish Jha)

Chairman of the Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman : Prof. Girish Jha
Member : Prof. S.N. Pandey
Member : Prof. J.P. Lal
Member : Prof. D.P. Dubey
Member : Dr. R. P. Tripathi
Member : Prof. P.M. Atri/Shri
Ranji Singh

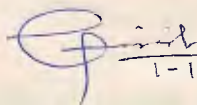


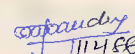
C E R T I F I C A T E - I I

This is to certify that the thesis entitled,
"Response of linseed (Linum usitatissimum Linn.)
to nitrogen and phosphorus levels" submitted by
SHRI UMA SHANKAR AWASTHI to the J.N. Krishi -
Vishwa Vidyalaya, Jabalpur in partial fulfilment of
the requirements for the degree of M.Sc. (Ag.) in the
Department of Agronomy, College of Agriculture, Rewa,
M.P., has been approved by the Student's Advisory
Committee and External Examiner after an oral examina-
tion on the same.


External Examiner

Major Advisor :


1-12-86

Head of Department/Section : 
11/4/86

Director of Instruction :



A C K N O W L E D G E M E N T S

It is my great pleasure and privilege to express my deepest sense of gratitude to Shri Girish Jha, Assistant Professor, Department of Agronomy, College of Agriculture, Rewa (M.P.) for his constant inspiration, valuable guidance and convincing suggestions during the course of investigation and preparation of this manuscript.

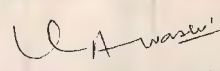
I am also indebted to Shri S. N. Pandey, Associate Professor and Head of the Section of Agronomy for his valuable guidance, generous help and profound interest during the course of present investigation.

I express my most affable and cordial thanks to Shri J. P. Lal, Associate Professor of Agronomy, Dr. R. P. Tripathi, Associate Professor of Agricultural Economics, Shri P.M. Atri, Assistant Professor, Maths and Statistics, Shri D. P. Dubey, Assistant Professor of Agronomy, members of my Advisory Committee and Shri J.S. Bhatia, Librarian, College of Agriculture, Rewa, for their valuable guidance during the conduct of the experiment and preparation of the thesis.

I acknowledge my sincere thanks to Dr. M. M. Rai, Dean, College of Agriculture, Rewa (M.P.) and Dr. S.N.Dubey, Director of Instruction, J.N.K.V.V., Jabalpur for providing necessary facilities in course of programme and the field research.

I express my humbly gratitude to my friends and colleagues S/Shri V.D.Dwivedi, L.D. Kushwaha, T.D. Pandey, K.P. Tiwari, B.P. Mishra, R.S. Patel, H.G. Sharma, M.K.Raile, V.K. Swarnkar, D.L. Patel and R.K. Jain and all other friends who helped me during thesis work.

College of Agriculture,
Rewa (M.P.)


(Uma Shankar Awasthi)

Dated, September , 1986

C O N T E N T S

Chapter			Page No.
I	INTRODUCTION		1 - 6
II	REVIEW OF LITERATURE	..	7 - 30
III	MATERIALS AND METHODS	..	31 - 42
IV	RESULTS		43 - 59
V	DISCUSSION		60 - 66
VI	SUMMARY, CONCLUSIONS AND SUGGESTIONS		67 - 71
	BIBLIOGRAPHY		72 - 80
	APPENDICES		81 - 85
	VITA		86

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page No.</u>
1	Weekly average of meteorological observations during crop season (October 1985 to February 1986)	32
2	Chemical analysis of the soil ..	33
3	Cropping sequence of experimental field	34
4	Analysis of variance	41
5	Plant population/m row length ..	43
6	Periodical height of plant (cm) ..	44
7	Height of the plant (cm.) at maturity	45
8	Periodical number of branches/plant	46
9	Number of branches per plant at maturity	47
10	Number of capsules per plant ..	48
11	Test weight of 1,000 grain (gm.).	49
12	Grain yield per plant (gm.) ..	50
13	Straw yield per plant (gm.) ..	51
14	Grain yield (q/ha)	52
15	Yield of straw (q/ha)	54
16	(a) Prevailing market rates (Rs.) ..	55
	(b) Cost of cultivation (Rs./ha.) excluding cost of nitrogen and phosphorus	56
	(c) Cost of cultivation under different treatment combination (Rs./ha.).	57
	(d) Net return under different treatment combination (Rs./ha.)	58
	(e) Net profit (Rs./ha.)	59

LIST OF FIGURES

<u>Fig. NO.</u>	<u>Title</u>
1	Weekly average of Meteorological observations during crop season, 1985-86.
2	Lay out
3	Plant population/m row length
4	Periodical height of plant (cm)
5	Periodical number of branches/plant
6	Number of capsules/plant
7	Test weight of 1000 grain (gm)
8	Grain and straw per plant (gm)
9	Grain and straw yield (q/ha)
10	Net profit (Rs./ha.)

LIST OF ABBREVIATIONS

Words		Abbreviations
Centimeter	..	cm.
At the rate of	..	@
Critical difference	..	C.D.
Degree of freedom	..	d. f.
Degree of Centigrade	..	°C
Gram ..	..	gm.
Figure ..	..	fig.
Metre(s) ..	..	m
Kilogram(s)	..	kg
Nitrogen ..	..	N
Nonsignificant	..	N.S.
Number ..	..	No.
Pound(s) ..	..	lbs.
Per hectare	..	/ha.
quintal ..	..	q.
Percent ..	..	%
Standard error of means	..	S. Em.

CHAPTER-I :

I_N_T_R_O_D_U_C_T_I_O_N

I N T R O D U C T I O N

If modern science is applied to increase the production with the same intensity as it was applied to produce the weapons during the war then within few years, a world of famine would be transformed into a world of plant (Sir John Boyd Orr.).

India is an agricultural country where majority of the population is engaged in agriculture which contributes nearly 50% of the national income. Besides this, near about 80 percent people directly or indirectly depend upon agriculture. Food grain problems can be solved by production of cereals and pulses, but the need for earning foreign exchange and improving the economic condition of the people of the country cannot be over looked.

Oilseed crops play a very vital role in the national economy, the oils not only form essential part of human diet but also serve as an important raw material for the agrobased industries and for manufacturing various other sophisticated products. The major oil seeds grown in the country are groundnut, rape seed, mustard, sesamum, safflower, sunflower, niger, soybean, castor and linseed. India is a largest producer of groundnut, rape, mustard and sesamum. It is second in respect of castor seed production, third in coconut production, fourth in cotton seed and fifth in linseed. Oilseeds oils and oil cakes contribute the most important items among agricultural commodities from the export point of view.

Linseed (Linum usitatissimum Linn.) popularly known as alsi, tissi etc., is one of the most important oil and fibre

producing crop grown in different countries of the world. In India, it is grown since time immemorial. It is one of the oldest crops cultivated by man for its seeds and fibre. The two products of its seed are linseed oil and linseed meal. The oil is considered as a quality drying oil due to its ability to form a durable film rapidly on exposure to air. Linseed oil has many industrial uses. Most of the oil is used in the form of paints and varnishes including new emulsion paints. It is used in the process of cementing of roads in U.S.A. and in antibiotics. It is also used for making linoleum, oil cloth, printers ink, patent leather and other products.

The fibre obtained from the stem is the most valuable fibre to spun into clout. The fibre is also used in making various other kinds of textiles. At present, the use of linseed as a textile has declined with the availability of improved cottons and man made fibre. The fibre extraction from its stem is of high quality and in India, it is mainly grown for seed purpose, except in a small pocket where it is grown for fibre also.

The residue left after the extraction of oil is called oil cake and is quite nutritive, particularly with reference to fats and protein. Oil cake is good in taste and contains 36 percent protein, 85 percent of which is digestible. It is fed to both milch and fattening animals. It is also used as

organic manure. It contains about 5 percent nitrogen, 1.4 percent phosphorus and 1.8 percent Potash.

Straw from seed varieties is used in the manufacture of upholstery tow, insulating materials, rugs, twine and paper.

India, though tops in the world with largest acreage under oilseeds, is much deficient in the field of production and meeting the annual demand of the country. This can very well be stressed with the facts that though total area in India under oilseed crops is 16,825 million hectares (1982-83) and with an annual production of about 9.011 million tonnes, it is not yet enough to meet the annual demand of about 3.8 million tonnes of edible oils. On the contrary, only 2.7 million tonnes are made available. Consequently, the country is forced to import over one million tonnes of oil costing Rs. 700 crores or so every year. This ultimately reflects on our national economy. To overcome the prevailing grave situation, boosting of oilseeds production is the only answer. To achieve it, policy to increase production of important oil - seeds has very rightly been advocated in the new 20-points programme of our country.

India with over two million hectares under linseed cultivation occupies 25 percent of the total world acreage and ranks first in area, fourth in production and eighth in productivity. During the last three decades, linseed area

increased from 1.4 to 2.02 million hectares (1982) but per unit productivity has gone down and is at the same level. The average production of linseed is 440.3 thousand tonnes which is much below the national average and other linseed growing states of the country (1983).

In Madhya Pradesh, linseed is grown on 584.7 thousand hectares with an annual production of 164.3 thousand tonnes and with an average yield 285 kg/ha. In Rewa, linseed is grown on 25.1 thousand hectares with an annual production of 5.3 thousand tonnes and with an average yield of 213 kg/hectare.

The reasons for low productivity of this oil seed crop are non availability of suitable high yielding varieties, heavy damage to the crop due to insect pests and diseases, poor management practices and use of most neglected and unfertile fields and use of insufficient fertilizers.

The countries which are producing maximum yields are using lots of artificial fertilizers. India is much behind in this respect. Experimental evidences indicate that nitrogen and phosphorus are the two most essential plant nutrients which are generally lacking in Indian soils. This is probably due to the fact that nitrogen is essential for building up of protoplasm and proteins which induce cell divisions and initiate the meristematic activity. It is present in many other compounds of great physiological

importance in plant metabolism, e.g., nucleotides, enzymes and imparts dark green colour of plants. Phosphorous is a constituent of nucleic acid, phytin and phospholipids. An adequate supply of P_2O_5 early in plant life is important in laying down the primordia for reproductive part of plant and is a constituent of majority of enzymes, importance in the transformation of energy in carbohydrate metabolism and respiration of plants. It is closely related to cell division.

There is a need to know the optimum doses of nitrogen and phosphorus required for getting maximum yields though many workers have conducted trials in this aspect but requirement of these nutrients to be supplied differ from soil to soil and place to place as the agroclimatic conditions have great influence on the nutrient requirement of a crop. It is, therefore, essential that optimum doses of nitrogen and phosphorus to be supplied should be worked out in agroclimatic condition of this tract.

In the light of above facts, an experiment entitled, "Response of linseed to nitrogen and phosphorus levels" was laid out at the Instructional Farm, J.N.K.V.V., College of Agriculture, Rewa during Rabi 1985-86 to study the response of linseed to nitrogen and phosphorus levels with the following objectives :-

1. To determine the optimum dose of nitrogen and phosphorus for maximum production of linseed.

2. To study the effect of nitrogen and phosphorus on the growth and yield characters of linseed crops.
3. To determine the most suitable combined dose of nitrogen and phosphorus for linseed crop.
4. To calculate the economics of various treatments for economical dose of nitrogen and phosphorus.

*Figures from Agricultural Statistics, M.P., 1984.

CHAPTER-II :

R E V I E W O F L I T E R A T U R E

REVIEW OF LITERATURE

The fertilization in linseed, an important oilseed crop of India, is most predominating and limiting factor in enhancing per hectare production. Lot of work has been done on this aspect in India and abroad. It is not possible here to summarise the entire literature. The representative references pertaining to the application of nitrogen and phosphorous are given in this chapter.

(A) Effect of Nitrogen on Linseed Crop

Effect of Nitrogen on Growth and Development of Plant :

Alimohammed (1930) reported a significant increase in height, number of basal branches and yield of seed by the application of nitrogen.

Tokuoka and Dyo (1938) reported that the height of the flax plant increased when nitrogen in the form of urea was applied.

Scharrer and Schreiber (1943) observed that the increasing dose of nitrogen also increased the number of capsules per plant.

Khedkar (1951) at I.A.R.I. during his studies on some Indian and foreign varieties of linseed found that 20 lbs. of nitrogen per acre increased the height and branches of all the varieties significantly. There was also a favourable effect on the number of capsules per plant and thousand seed weight while no effect was observed on number of seed per capsule.

Tiwari (1956) at I.A.R.I., New Delhi found an increased number of basal branches and number of capsules per plant by the application of nitrogen while, the height of the plant remained unaffected.

Khan and Gupta (1959) stated that nitrogen in the form of ammonium sulphate increased the yield of linseed by 22.6 % over the control. Application of phosphorus was helpful in increasing the oil content but not yield.

Singh (1964) concluded that application of nitrogen increased the height of the plant, number of capsules per plant, number of seeds per capsule significantly, whereas it did not show any significant effect on the number of basal branches per plant.

Hussain et al. (1970) observed that nitrogen significantly increased plant height, stem length and tip branches in linseed.

Pandey et al. (1970) working at J.N.K.V.V., Jabalpur reported that increasing levels of nitrogen enhanced the height of the plant, number of branches and number of capsules per plant significantly.

Kondratowicz (1971) observed that nitrogen had more effect on flax growth than phosphorus and potash. Stem length, number of branches and number of capsules were increased by nitrogen application.

Sahu (1976) reported that maximum flowers and productive capsules per plant and maximum days to maturity were recorded from moderate levels of fertility i.e., 30 kg N + 15 kg P_2O_5 / ha under rainfed condition.

Patel (1977) noted that application of 30 kg N/ha increased the plant height, tillers, number of flowers per plant and branches at sample area significantly. But plant population was non-significant by different levels of nitrogen and phosphorus.

Yayock and Quinn (1977), in Nigeria did not find any response of nitrogen to the number of capsules, plant height and number of branches per plant which were less affected by fertilization.

Jaiswal (1983) reported the height of plant, branches and capsules per plant increased significantly by nitrogen application, while working with linseed crop under agro - climatic condition of Sehore, M.P.

Effect of Nitrogen on Test Weight and Grain Yield :

Petterson (1929) in Iraq found increased yield by the application of nitrogen. There was no significant difference in different levels.

Ali Mohammad (1930) reported from Pusa, Bihar, the effect of fertilizer application on linseed crop and found

that sodium nitrate when applied at the rate of one mound (37 kg) per acre increased the yield by 6 per cent.

Robinson and Weidemann (1932) observed that by use of fertilizers seed yield was increased.

Optiz (1945) stated that the maximum yields were obtained at lower doses of nitrogen application.

Caldwell (1949) observed in his experiment that 20 lbs. nitrogen per acre gave highest seed yield of linseed.

Blackman and Bunting (1951) observed that 35 lbs. of nitrogen per acre increased the seed yield of linseed and by 10% over control.

Anonymous (1951) observed that yield increased progressively with the increase in the dose of nitrogen when applied through ammonium sulphate.

Khedkar (1951) while working at I.A.R.I., New Delhi, reported a significant increase in the seed yield and total produce by the nitrogen application under irrigated conditions.

Khan and Gupta (1959) from I.A.R.I., New Delhi reported that nitrogen as ammonium sulphate either alone or in combination with phosphorus increased the yield of linseed by 22.6 % over control.

Gupta et al. (1961), while studying at I.A.R.I., New Delhi reported that the nitrogenous fertilizers increased the seed yield significantly by applying 20 to 60 lbs nitrogen per acre. The response was linear.

Dybing (1964) concluded that nitrogen extended the flowering period and produced seed of lower weight under irrigated condition.

Pandey and Singh (1965) observed that the application of 20 lbs. nitrogen (22.6 kg/ha) and 20 lbs P_2O_5 (22.6 kg/ha) per acre increased the seed yield and favoured the 1000-seed weight of linseed.

Pandey et al. (1970) stated that increased levels of nitrogen enhanced the seed yield of linseed per hectare as well as seed yield per plant.

Shekhawat et al. (1971) at Govt. Agriculture Research Station, Kota reported that the application of nitrogen at the rate of 20 kg N/ha resulted in significantly higher yield of linseed.

Bhan and Singh (1973) found that 60 kg N/ha gave the highest seed yield of oilseed flax, but 30 kg N/ha was the optimum and economic dose of nitrogen for linseed crop in the central tract of Uttar Pradesh.

Tomar and Singh (1973) conducted experiments for three years and reported that application of nitrogen significantly increased the seed yield over control.

Singh et al. (1974) reported that 15.71% extra seed yield of linseed by application of 30 kg N/ha through ammonium sulphate.

Sahu (1976) observed maximum seed yield with highest level (60 kg/ha) of nitrogen under rainfed condition.

Woodhead and Neilson (1977) found that the application of nitrogen did not influence the test weight of linseed.

Anonymous (1978). ~~At B.H.U. Varanasi~~ found in All India Co-ordinated Trials and locational trials that the response of nitrogen was quadratic. The nitrogen application at the rate of 40 kg N/ha gave maximum seed yield.

Singh and Singh (1978) at B.H.U. Varanasi, worked out 35% increased yield of linseed over the control by the application of 40 kg N/ha.

Bhan (1980) at Kanpur, observed that the application of 30 kg N/ha is most beneficial for increasing the linseed yield, specially under rainfed condition.

Singh et al. (1982) reported from J.N.K.V.V., Jabalpur that the application of 50 kg N/ha enhanced the seed yield significantly over control.

Effect of Nitrogen On Straw Yield :

Robinson and Weidemann (1932) observed that the complete fertilizers increased the yield of unthreshed straw and threshed straw for fibre flax.

Granhall and Larsson (1946) found during the trial with fibre plants that the application of nitrogen to fibre flax increased the straw yield.

Friederich (1948) observed that heavy application of nitrogen resulted in a lower yield of straw of fibre flax.

Richharia (1950) was of the opinion that under black cotton soils of M.P. and in Gangetic alluviums of Bihar much better crop from the straw and seed point of view could be raised from plot manured with F.Y.M. and castor cake and ammonium sulphate.

Khedkar (1951) found that application of 20 lbs. (22.6 kg/ha) nitrogen per acre in the form of ammonium sulphate increased the straw yield of linseed significantly over control.

Denell (1952) mentioned in his results that application of ammonium sulphate significantly increased the straw yield.

Tiwari (1956) from I.C.A.R., New Delhi, reported that total produce and straw yield differed significantly by the application of nitrogen.

Singh (1964) revealed that nitrogen increased to some extent straw yield per acre. Maximum yield was observed at 20 lbs. per acre (22.6 kg/ha) of nitrogen.

Pandey and Singh (1965) noted that the application of nitrogen 20 lbs (22.6 kg/ha) per acre gave significantly higher straw yield under rainfed condition.

Pandey et al. (1970) found that increasing levels of nitrogen increased the straw yield per hectare.

Singh and Prasad (1975) reported that the highest straw yield was obtained under 20 kg N/ha over 0, 40, 60 and 80 kg N/ha, because at 20 kg level, there was maximum total uptake of nitrogen under rainfed condition.

Effect of Nitrogen on Oil Content

Mc.Gregor (1937), during his study on oilseed found that increasing rates of nitrogenous fertilizers application along with other effects have resulted in a considerable decrease in the iodine number and drying ability of oil.

Scharrer and Schreiber (1943) reported that the increasing doses of nitrogen application decreased the oil content of the seed but increased the yield of capsule.

Khedkar (1951) observed during his studies, that 1,000 seed weight has favourable effect to nitrogen application.

Blackman and Bunting (1954) reported that the oil content was depressed (of seeds slightly) by the application of nitrogen but the protein content was increased by a small amount.

Tiwari (1956) reported that by the application of nitrogen, the iodine value was significantly lowered.

Mathur (1958), while working at I.A.R.I., New Delhi, concluded that oil content decreased with the increasing dose of nitrogen application. The placement below soil level slightly increased the oil content.

Gupta et al. (1961) from I.A.R.I., New Delhi, reported that the oil content of the seed decreased with increasing doses of nitrogen.

Singh (1964) recorded an increase in the oil content due to the application of 40 lbs (45.2 kg/ha) nitrogen per acre, but the effect was non significant.

Abdul-kareem (1966) concluded that the application of nitrogen at the rate of 21 kg/ donum could slightly increase the percentage of oil in the seed of linseed.

Singh et al. (1968) stated that the application of 64.8 kg N/ha decreased the oil content in seed but increased the protein content.

Woodhead and Neilson (1977) reported that application of nitrogen decreased the oil content in the seed.

Yayock and Quinn (1977) found that the oil content was slightly depressed at a level above 33 kg N/ha.

Singh and Singh (1978), at B.H.U. Varanasi, found that the oil content was decreased when increasing levels of nitrogen were applied.

Jaiswal (1983) : The results of experiment conducted at J.N.K.V.V., College of Agriculture, Sehore, with four nitrogen levels 0, 20, 40 and 60 kg N/ha revealed that oil percentage increased by nitrogen application upto 40 kg/ha and it decreased slightly afterwards.

Effect of Phosphorus on Linseed Crop

Effect of Phosphorus on Growth and Development of Plant

Alimohammad (1930) reported that the application of two mounds of superphosphate per acre gave significantly negative effect on height of the crop causing 5% reduction. Early flowering was also noted in the treatment where superphosphate was applied.

Bogustawski (1940), while studying the effects of nitrogen, phosphorus and potash reported that phosphorus hastens the maturity and increases the oil content of seed flax.

Pike (1941) stated that the application of super-phosphate in higher doses showed no effect on seed yield of fibre.

Lewis (1943) reported that phosphorus content in plant was more marked than seeds, it means more requirement of P_2O_5 by stem at growth.

Muskett and Coldund (1947) also recorded that the lower leaves on such plant die prematured by the application of super phosphate.

Blackman and Bunting (1951) from U.K. reported that the phosphate application to linseed crop did not show any significant effect on the seed yield.

Millikan (1951) stated that plant becomes dwarf like as a result of phosphorus deficiency and acquired a dark green colour. The leaves become small and are pressed against the stem. The hypopotyle donary shoot formation was greatly reduced.

Blackman and Bunting (1954) reported that the phosphorus had no effect on branching and maturity.

Tiwari (1956) reported that there was no significant difference by the application of phosphorus on the growth and branching but maturity was hastened.

Sahay (1957) while working at I.A.R.I., New Delhi, found that the phosphorus had no effect on height, branches and number of capsules per plant.

Khan et al. (1963) reported that by the application of phosphorus, there was lesser flower formation and the growth was also found to be stunted.

Singh (1964) reported that application of phosphorus increased the height of plant and number of capsules per plant significantly over the control but it did not affect the number of branches per plant significantly.

Parashar et al. (1968) concluded that the application of phosphorus increased the height of main shoot of linseed plant and number of basal branches per plant.

/ Pandey et al. (1970) stated that application of phosphorus influenced the plant height, number of capsules per plant and number of seeds per capsule.

/ Sahu (1976) at Raipur, M.P., recorded maximum flowers and productive capsules per plant and maximum days to maturity of linseed at moderate levels of fertility, i.e., 15 kg P_2O_5 /ha under rainfed condition.

Effect of Phosphorus on Grain Yield

Alimohammad (1930), while working at Pusa, Bihar, found that super phosphate has a negative effect on the seed yield of linseed and by application of 2 mounds per acre of super phosphate reduction of 6% in seed yield was recorded.

Pike (1941) stated that the application of super - phosphate in higher doses showed no effect on seed yield of fibre flax.

Milthorpe (1943) while discussing the effect of nutrient on flax stated that under most of the Australian field conditions, best results were obtained by sowing the seeds at the rate of 70 to 80 lbs. along with the application of super phosphate per acre.

Froir and Denell (1948), while describing the cultivation and processing trials of fibre plant mentioned that phosphorus alone did not increase the yield.

Blackman and Bunting (1951) reported from U.K. that the phosphorus application to linseed crop did not show any significant effect on the seed yield.

Anonymous (1953) reported that during the manurial - cum-varietal trial of linseed on the three varieties of

linseed, the phosphorus did not show any beneficial effect on the yield of the crop.

Blackman and Bunting (1954) concluded that the application of phosphorus has no effect on the yield of linseed.

Tiwari (1956) reported from I.A.R.I., New Delhi, very little effect of phosphorus on the yield of linseed.

Sahay (1957) at I.A.R.I., New Delhi, observed that the phosphate had practically no effect on the yield of the seed.

Mathur (1958) reported from I.A.R.I., New Delhi that phosphorus in the form of super phosphate at 60 lbs./acre either alone or in combination with nitrogen did not appreciably increase the seed yield.

Khan and Gupta (1959) at I.A.R.I., New Delhi, found that phosphate when applied at the rate of 60 lbs per acre did not increase the seed yield but increased the oil content.

Khan et al. (1963), while studying the effect of N, P and K on yield and quality of linseed found that there is no effect of phosphorus and potash on the growth and yield of linseed.

Anonymous (1970) reported that the application of 30 kg P_2O_5 /ha increased the seed yield to an extent of 923 kg/ha over the control.

Pandey et al. (1970) observed that increasing levels of phosphorus increased the seed yield and test weight significantly over control.

Shekhawat et al. (1971) recorded significantly higher yield of linseed due to the application of 20 kg phosphorus per hectare.

Choudhary (1977) found that the application of 15 kg P_2O_5 /ha could increase the seed yield of linseed considerably.

Rai and Singh (1977) worked out fertilizer requirement of linseed and noted that good crop of linseed requires 40 kg phosphorus per hectare in combination with 50 kg N and 40 kg K_2O per hectare respectively.

Yayock and Quinn (1977) reported from Nigeria that the maximum seed yield was obtained by the application of 16 kg P_2O_5 /ha.

Singh and Singh (1978) at B.H.U. Varanasi, found 18 per cent increase in seed yield over control due to application of 9 kg P_2O_5 /ha.

Bhan (1980) at Kanpur, found that the application of 15 kg P_2O_5 /ha increased seed yield significantly over control.

Singh et al. (1982) observed the maximum production of linseed by the application of 30 kg P_2O_5 /ha at J.N.K.V.V., Research Farm, Jabalpur.

Lal and Singh (1982) stated that if recommended dose of fertilizer is given, substantial increase in seed yield can be achieved. Recommended dose of fertilizer for linseed included 30 kg P_2O_5 /ha if the crop is grown for seed production.

Jaiswal (1983) observed that the seed yield per hectare significantly increased with the increasing levels of phosphorus. Thus 30 kg P_2O_5 /ha produced the maximum seed yield.

Effect of Phosphorus on Straw Yield

Optiz (1941) reported that there was corresponding increase in the straw yield of linseed. Addition of small amount of phosphorus had more marked effect on yield of straw and seed while larger application of it showed little effect on straw.

Pike (1941) reported that application of superphosphate alone to the fibre crop in larger doses significantly increased

the yield of hand pulled flax.

Milthorpe (1943) found that the application of super - phosphate has increased the straw yield and showed an increase in weight per plant.

Prior and Denell (1948) found that the application of phosphorus did not give the increased yield of straw and grain in linseed.

Choudhary (1977) reported from Raipur, M.P., that the application of phosphorus did not influence the straw yield per hectare in linseed.

Jaiswal (1983) reported that straw yield was not influenced significantly by application of phosphorus.

Effect of Phosphorus on Oil Content :

Alimohammed (1930) reported that there was no remarkable effect of N, P and K separately and in combination, but the oil content of the seed from these plots raised from 0.53 to 1.24 per cent to that of control. Out of all the treatment, application of super phosphate had shown the maximum increase in the oil content over the control closely followed by fertilizer treatment.

Peive and Rodov (1939) reported that phosphorite was the best phosphatic fertilizer on ploughed virgin soil and

dark newly cultivated soil. Boron increased the yield of flax straw seed and fibre.

Bogustawski (1940) in a trial with different fertilizers of N, P and K reported greater difference in yield and small difference in quality, both of oil and fibre. The improvement in quality is due to fertilizer application as compared to the effect on yield.

Milthorpe (1946) reported that super-phosphate gave lower plant stand than no super-phosphate thus retarded the germination.

Blackman and Bunting (1951) reported that phosphorus diminishes the percentage of oil.

Blackman and Bunting (1954) reported that phosphorus decreased the yield of fibre and on the oil percentage, no constant results were obtained.

Tiwari (1956) reported that phosphorus increased significantly the yield of oil in the seed.

Sahay (1957) reported that application of phosphorus had no effect on oil content of the seed.

Mathur (1958) found that phosphorus when applied at the rate of 60 lbs. per acre (67.8 kg/ha), slightly increased the oil content of the seed.

Khan and Gupta (1959) at I.A.R.I., New Delhi, found that phosphate when applied at the rate of 60 lbs per acre (67.8 kg/ha) did not increase the seed yield but increased the oil content of the seed.

Singh et al. (1960) concluded that application of 40 lbs phosphorus per acre (45.2 kg/ha) increased the percentage of oil in oilseeds.

Khan et al. (1963) while working at I.A.R.I., New Delhi, reported in a factorial experiment that none of the treatment affected the oil content and iodine value.

Singh (1964) reported a slight increase in the percentage of oil as compared with control due to the application of phosphorus.

Abdul-Kareem (1966) mentioned that the percentage of oil in the seed was increased due to the application of phosphorus @ 22 kg/donum.

Singh and Singh (1978) found that the application of phosphorus at the rate of 9 kg/ha increased the oil content followed by 0, 18 and 27 kg P_2O_5 /ha.

Jaiswal (1983) observed that the oil content of linseed grain was influenced by higher doses of phosphorus to a considerable extent.

Effect of the Interaction (N x P) on Linseed Crop

Effect of Interaction (N x P) on Grain Yield:

Pike (1941) from Waite Agriculture Research Station reported that the experiment conducted during 1937-38 did not show any effect on seed yield from the application of ammonium sulphate in addition to super phosphate.

Mac Issac and Mc Gregor (1941) observed that the application of the 20 lbs. ammonium phosphate increased the yield of seed significantly. The interaction between the treatment was found to be significant.

Stewart (1947), reviewing the results of manurial experiment conducted in India on various important crops stated that linseed had shown little or no effect to N and P applied almost in combination. Stewart further observed that the lack of response to manure in linseed was exceptional and very difficult to explain.

John (1949) reviewing the research work on oilseed in India stated that in Bihar although no systematic manurial trial had been concluded but the preliminary manurial trial had shown the response to application of nitrogen or phosphorus.

Blackman and Bunting (1951) showed during the 25 field experiments in England that the addition of 35 lbs P_2O_5 /acre

alongwith 35 lbs. nitrogen per acre had given small but consistent results.

Anonymous (1951) showed that the combined effect of N and P in various levels gave significant increase in seed yield in Punjab.

Trepachev (1953) found that when nitrogen was incorporated with granules of super-phosphate, it decreased the yield of oil seed flax.

Tiwari (1956) reported from I.A.R.I., New Delhi, that the application of nitrogen and phosphorus significantly increased the yield of linseed. The combination of nitrogen and phosphorus was found most economical followed by nitrogen alone.

Mathur (1958) found that phosphorus when applied through super phosphate at the rate of 60 lbs P_2O_5 per acre either alone or in combination with nitrogen increased the yield of seed flax.

Gipson et al. (1961) did not find any interaction effect of nitrogen and phosphorus on seed yield of linseed.

Singh (1964) reported that there was no significant increase in seed yield due to the interaction of nitrogen and phosphorus.

Patel (1977) found that nitrogen and phosphorus interaction did not show any significant difference in yield of linseed.

Woodhead and Neilson (1977) cited that nitrogen and phosphorus interaction had no effect on seed yield.

Yayock and Quinn (1977) stated that seed yield did not differ significantly due to nitrogen and phosphorus interaction in case of linseed.

Effect of Interaction (N x P) on quality and composition of Linseed Crop and Straw Yield

Bogustawski (1940) while working with fertilizer nitrogen, P_2O_5 and K_2O reported greater differences in yield but only small difference in quality, both of oil and flax fibre. The improvement in quality due to fertilizers was small when compared to the effect on yield e.g. the increase of oil content is minor as compared to the greater increase in the oilseed.

Mac Issac and Mc Gregor (1941) stated that the use of ammonium phosphate appeared to have no effect on ether content or iodine value in relation to varieties or localities.

Tiwari (1956) reported that by the application of N and P, the percentage of oil in the seed was increased. The

combination effect of nitrogen and phosphorus resulted increased iodine value over the single application but did not differ with control.

Khan et al. (1963) reported that combination of N x P affected the oil content and iodine value.

Singh (1964) observed that there was no significant increase in straw yield due to the application of nitrogen and phosphorus in combined form.

Effect of Nitrogen and Phosphorus on Oil Content of Linseed Grain

Singh et al. (1960) reported that the application of 25 lbs. (28.25 kg/ha) nitrogen and 40 lbs (45.2 kg/ha) phosphorus gave highest out turn of oil per acre.

Singh (1964) observed increase in percentage of oil due to the application of nitrogen and phosphorus.

Abdul-Kareem (1966) showed that the combination of nitrogen and phosphorus slightly increased the percentage of oil in the seed.

Pandey et al. (1970) cited that nitrogen and phosphorus showed significant difference in oil content.

Singh and Singh (1978) found that application of nitrogen 40 kg/ha and phosphorus 9 kg/ha increased the oil content of linseed.

Jaiswal (1983) reported that interaction of nitrogen and phosphorus increased the maximum oil content in the seed and was noted i.e., 47.1 per cent. It is about 1.54 per cent more than the oil content of the control.

CHAPTER-III

M_A_T_E_R_I_A_L_S A_N_D M_E_T_H_O_D_S

CHAPTER-III

MATERIALS AND METHODS

MATERIALS AND METHODS

The manurial experiment was carried out with the object to determine the most suitable manurial dose i.e. the amount of fertilizers required by the crop for its maximised production and at the same time, the effects of different doses on oil content and yield of linseed.

This chapter deals with the details of the methods followed during the course of investigation and the materials used in the experiment.

Site of the Experiment :

The experiment was laid out in the field No. 31 of the old area of Instructional Farm, College of Agriculture, Rewa, M.P., during rain season of 1985-86.

Climate and Season :

Rewa is situated at 24° 30' north latitude, 81°15' east longitude and at an altitude of 365.7 metre above the mean sea level. It enjoys the sub tropical climate. Hot and dry summer and cold winters are the main characteristic features of the region. The average annual rainfall varies from 90 to 115 cm which is received mainly from July to mid September. The average monthly maximum and minimum temperature touches 43.4°C and 6.2°C respectively. It is well known that climate plays an important role in germination

and development of plants so it becomes necessary to know the details of the weather conditions during the period of experimentation.

The meteorological data during the crop period recorded at Kuthulia Farm is presented in table 1 and graphically depicted in fig. 1.

Table 1. Weekly averages of meteorological observation during crop season (October 1985 to February, 1986)

Months	Week No.	Temperature °C		Relative Humidity percentage		Rainfall in mm.
		Maximum	Minimum	High	Low	
October	40	31.6	24.8	93	62	32.2
	41	29.4	24.4	95	71	110.2
	42	29.5	20.1	94	64	00.0
	43	29.8	17.3	91	45	00.0
	44	30.1	16.0	92	48	00.0
November	45	29.9	13.6	91	31	00.0
	46	28.3	11.7	94	29	00.0
	47	27.7	11.6	93	29	00.0
	48	26.9	9.5	93	31	00.0
December	49	25.4	7.8	93	37	00.0
	50	28.1	12.1	89	38	00.0
	51	25.5	9.0	95	39	00.0
	52	25.3	8.9	93	47	00.0
January	1	21.1	2.1	93	51	00.0
	2	24.3	6.1	91	38	00.0
	3	24.0	10.5	94	42	00.0
	4	26.3	10.6	95	54	8.2
	5	23.6	10.2	95	51	00.0
February	6	24.1	12.5	94	61	24.6
	7	23.4	10.9	95	62	14.2
	8	26.2	11.0	92	42	00.0
	9	24.8	10.8	92	42	2.00

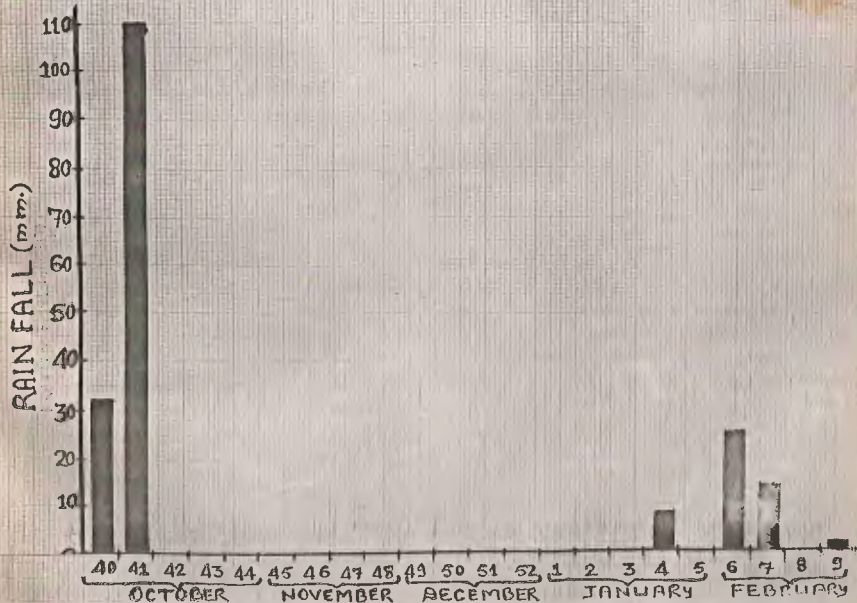
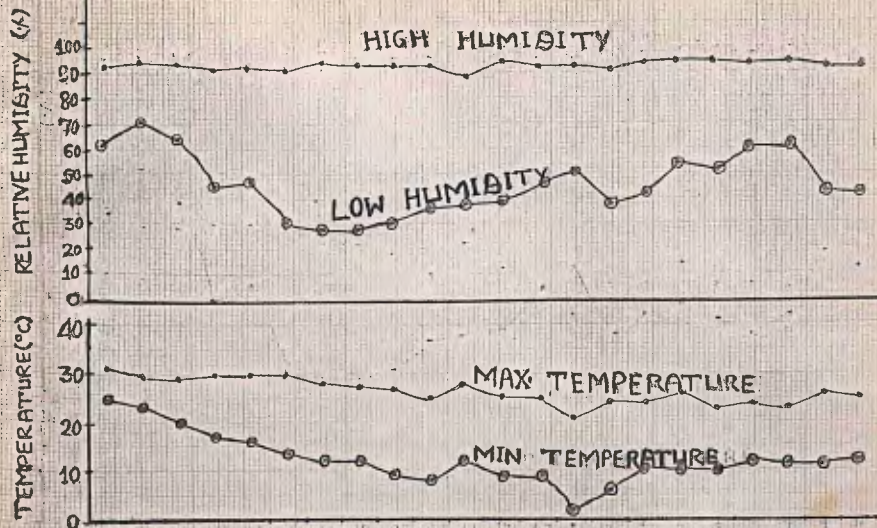


FIG: 1 METEOROLOGICAL WEEKS YEAR 1985-86

Soil :-

Soil of the experimental field was sandy clay loam in texture. The field had a gentle slope from north to south and also had a slight fertility variation. To determine the inherent fertility status of the soil, soil samples from 0-15 cm depth were taken randomly from each replication and plot with the help of soil auger. From these samples, a composite sample was prepared and analysed at the soil testing laboratory, Rewa. The results of the soil test are given in table 2.

Table 2 : Chemical analysis of the soil

Constituents	..	Value
Organic carbon (%)	..	0.68
Available N (kg/ha)	..	225.40
Available P (Kg/ha)	..	12.50
Available K (kg/ha)	..	237.12
pH ..	..	7.20

Previous history of the field :

The sequence of cropping followed in the experimental field during last five years is given in table-3.

Table 3 : Cropping sequence of experimental field

Years	Kharif	Rabi
1980-81	Paddy	Wheat
1981-82	Paddy	Wheat
1982-83	Paddy	Gram
1983-84	Paddy	Wheat
1984-85	Paddy	Wheat
1985-86	Fallow	Experimental crop of linseed

Details of the Experiment :

Treatments and symbols used are given below :

Levels of NitrogenSymbol

Control (no nitrogen)	..	N ₀
15 kg N/ha	..	N ₁
30 kg N/ha	..	N ₂
45 kg N/ha	..	N ₃

Levels of Phosphorus

Control (no phosphorus)	..	P ₀
10 kg P ₂ O ₅ / ha	..	P ₁
20 kg P ₂ O ₅ / ha	..	P ₂

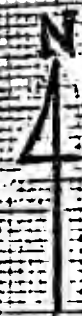
Treatment combinations :

N_0P_0	N_1P_0	N_2P_0	N_3P_0
N_0P_1	N_1P_1	N_2P_1	N_3P_1
N_0P_2	N_1P_2	N_2P_2	N_3P_2

Details of Layout :

The particulars about the experiment are given below and the plan of lay out is shown in fig. 2.

Experimental design	..	R.B.D.
Number of treatments	..	12
Number of replications	..	4
Number of plot in each replication	..	12
Total number of plots	..	48
Gross plot size	..	4.5 m x 3 m
Net plot size	..	3.90 m x 2.40 m
Replication border	..	1 m
Plot border	..	0.5 m
Seed rate	..	30 kg/ha
Spacing row to row	..	30 cm
Number of rows in gross plot.		10
Number of rows in net plot ..		8
Total experimental area	..	61 m x 13.5 m = 823.5 sq.m.
Date of sowing	..	17-10-1985.



Scale 1cm = 3m.

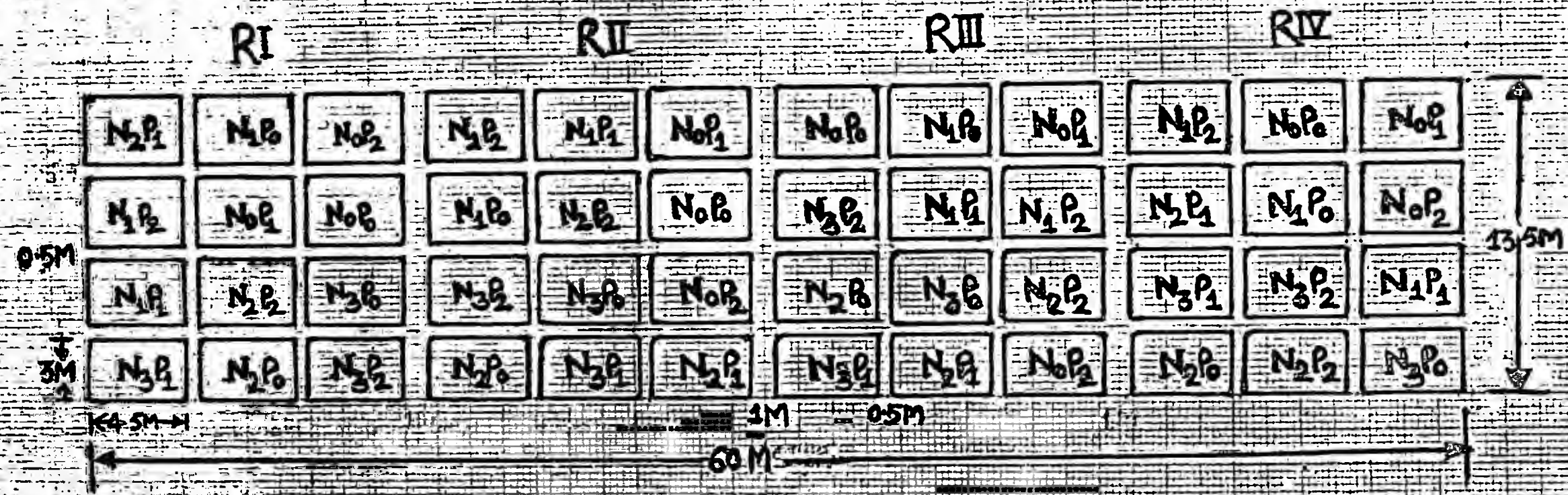


FIG-2

PLAN OF LAYOUT

Varietal character :

T-397 :

The variety was evolved in 1960 by hybridization and is recommended for cultivation in the Bundelkhand region of Uttar Pradesh. It matures in 130 to 135 days. Plants are medium, tall, leaves dark green; grain bold, brown; attractive, resistant to wilt and rust, Oil 42 to 44% and yield potential 900 kg to 1115 kg/ha.

Pre and Post Sowing OperationsField Preparation :

The crop being the oil crop with small sized seeds requires well pulverised and fine seed bed. The field was, therefore, prepared to a very fine seed bed giving 3-4 ploughings during rains and before sowing in the month of October. For good germination, sufficient moisture was ensured in soil at the time of sowing.

Fertilizers used :

Nitrogen was applied as urea and phosphorus as single super phosphate. The urea containing 46% nitrogen and single super phosphate containing 16% P_2O_5 were used.

The required amount of these fertilizers as per treatments were mixed and drilled in rows at the uniform

depth of 5 - 7 cm, just before sowing.

Sowing of Seed :

Sowing of seed was done by drilling method in rows 30 cm apart.

Irrigation :

One irrigation was given on 27th October, 1985, because germination was not uniform. Second irrigation was given on 29th November, 1985.

Weeding :

One weeding with khurpi was done in the third week of November to keep the crop weed free and second weeding with khurpi was done in the fourth week of December.

Plant Protection :

The crop was sprayed with Endosulphan @ 35 E.C. of 1,000 ml per hectare in order to prevent and check the attack of gall fly.

Harvesting :

The fully matured crop was harvested with the help of sickles. First of all, the plot borders were harvested, then the harvesting of the net plots was done. The harvested material was tied into bundles and kept in the threshing floor.

Threshing :

The threshing of each plot produce was done separately by the manual labours. Threshing of sample plant was also done separately. The cleaned seeds were weighed by the pan balance for determining the seed yield per plot.

Details Of Operations date wise :

S.No.	Field Operations	Date of operation	Days after sowing	Remarks
1.	Deep ploughing	2-10-85	-	By tractor
2.	Presowing irrigation	5-10-85	-	-
3.	Disking, harrowing	14-10-85	-	By tractor
4.	Lay out	16-10-85	-	-
5.	Fertilizer application	17-10-85	-	Application of N and P
6.	Sowing of seed	17-10-85	-	By manual labour
7.	Irrigation I	27-10-85	10	-
8.	Irrigation II	29-11-85	43	-
9.	Weeding I	19-11-85	33	Hand weeding
10.	Weeding II	25-12-85	69	Hand weeding
11.	Spray of Endosulphan	24-12-85	68	-
12.	Harvesting	24-2-'86	129	By labours
13.	Threshing and cleaning	5-3-'86	-	By labours

Characters Studied and Method of Sampling :

(A) Sampling technique :

In each net plot area, three plants were selected randomly and tagged for studies of plant height, branches per plant and capsules per plant. First observation was taken twenty five days after sowing and subsequent four observations were recorded at an interval of 25 days.

(B) Character studied :

A) Pre-harvest studies :

(i) Plant population : Plant counts were recorded in one metre row length at five places selected randomly in each plot and averages were worked out for statistical analysis.

(ii) Height of the plant : The main shoot of the plant was measured in cm from the base to the top of the shoot. Then the mean height was calculated.

(iii) Number of branches per plant : All the branches of the plant were counted which were arising from the base of the plant and then averages were calculated on per plant basis.

B) Post-harvest observation :

(i) Number of capsules per plant : The number of capsules in the tagged plants was counted and the mean was

calculated for the assessment of average number of capsules per plant in different treatments.

(ii) Test Weight of 1,000 Grains :

The samples of 1,000 grains were drawn from finally cleaned produce of the net plot and weight was taken by electrical balance.

(iii) Yield of grain per plant :

The yield of grain per plant was recorded by weighing the threshed grains of three plants and then averages were calculated on the per plant basis.

(iv) Yield of straw per plant :

The figure obtained after subtracting the weight of grain of three sample plant, from the gross weight of the three sample plant gave the weight of straw of three plants, and then average were calculated on the per plant basis.

(v) Yield of grain per plot and per hectare :

The yield of grain per plot was recorded by weighing the threshed grain per plot. These figures were then converted into per hectare yields.

(vi) Yield of straw per plot and per hectare :

The figure obtained after subtracting the weight of grains per plot from the gross weight of the bundle gave the

weight of straw per plot. Weight of straw per hectare was then calculated.

Economics of the treatment :

The cost of cultivation and income/ha for various treatments were calculated at prevailing market rates.

Statistical analysis :

The data were analysed by the method of analysis of variance as described by R.A. Fisher (1937). The skeleton of analysis of variance of the design is as follows :

Table 4 : Analysis of Variance

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' tabulated	
					5%	1%
Replication	3					
Nitrogen level (N)	3					
Phosphorus level (P)	2					
Interaction (NxP)	6					
Error	33					
Total	47					



The 'F' test was applied for testing the significance of the treatments. The significant differences between different means were judged by using critical differences at

5% and 1% levels of significance which were calculated by the following formulae :

$$\text{S.E.m. } \pm \text{ for level of nitrogen (N)} = \sqrt{\frac{\text{Error variance}}{r \times p}}$$

$$\text{S.Ed. for levels of nitrogen (N)} = \sqrt{\frac{\text{Error variance} \times 2}{r \times p}}$$

$$\text{C.D. for levels of nitrogen (N)} = \text{S.Ed.} \times \text{'t' value at 5\%}$$

$$\text{S.E.m. } \pm \text{ for level of Phosphorus (P)} = \sqrt{\frac{\text{Error variance}}{r \times N}}$$

$$\text{S.Ed. for levels of Phosphorus (P)} = \sqrt{\frac{\text{Error variance} \times 2}{r \times N}}$$

$$\text{C.D. for levels of Phosphorus (P)} = \text{S.Ed.} \times \text{'t' value at 5\%}$$

$$\text{S.E.m. } \pm \text{ for interaction (N} \times \text{P)} = \sqrt{\frac{\text{Error variance}}{r}}$$

$$\text{S.Ed. for interaction (N} \times \text{P)} = \sqrt{\frac{\text{Error variance} \times 2}{r}}$$

$$\text{C.D. for interaction (N} \times \text{P)} = \text{S.Ed.} \times \text{'t' value at 5\%}$$

CHAPTER-IV

R E S U L T S

R E S U L T S



The results obtained during the course of study are being presented in this chapter and tables of analysis of variance are given in the Appendices. The significant responses have been depicted by graph and histograms.

(A) Pre harvest studies

(1) Plant population

Table 5 : Plant population/m row length

N/P levels	P ₀	P ₁	P ₂	Mean
N ₀	22.40	22.51	22.92	22.61
N ₁	22.72	23.10	22.67	22.83
N ₂	22.87	22.77	23.25	22.96
N ₃	22.63	22.77	23.17	22.85
Mean	22.65	22.78	23.00	
	Nitrogen	Phosphorus	Interaction (N x P)	
S.Em. +	0.100	0.087	0.174	
C.D. at 5%	N.S.	0.250	N.S.	

The population count was recorded in each plot after 25 days of sowing. The results in table-5 and fig. 3 indicate

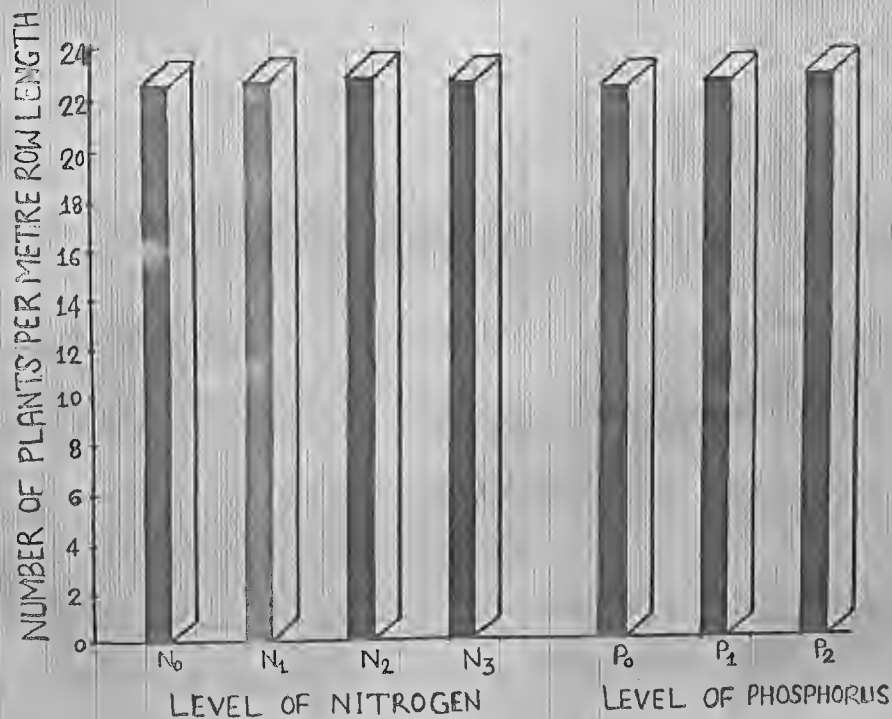


FIG:3-PLANT POPULATION PER METRE ROWLENGTH

that there were 22 to 23 plants per metre row length. The analysis of the variance table (Appendix I) indicates that the application of phosphorus significantly affected the plant population. But, neither Nitrogen nor their interaction affected the plant population significantly.

(2) Height of the plant :

The height of plant measured at different intervals showed that it increased steadily with the increase in duration of plant growth. The perusal of data in table-6 and fig. 4 indicates that the height of plant continuously increased upto 100th day after sowing thereafter it became constant under all treatments. The rate of increase in height of plant was rapid from 25 to 75 days after sowing.

Table 6 : Periodical height of plant (cm.)

Treatments	Days after sowing				
	25	50	75	100	125 (maturity)
Effect of N					
N ₀	17.45	33.06	47.96	52.03	52.03
N ₁	17.95	34.23	49.50	53.13	53.13
N ₂	18.36	35.10	51.26	55.40	55.40
N ₃	18.36	37.06	52.23	56.86	56.86
Effect of P					
P ₀	17.25	32.90	49.40	53.65	53.65
P ₁	18.33	35.02	50.25	54.47	54.47
P ₂	18.52	36.67	51.07	54.95	54.95

Whereas, it was slow from 75 to 100 days after sowing under all level of nitrogen and phosphorus.

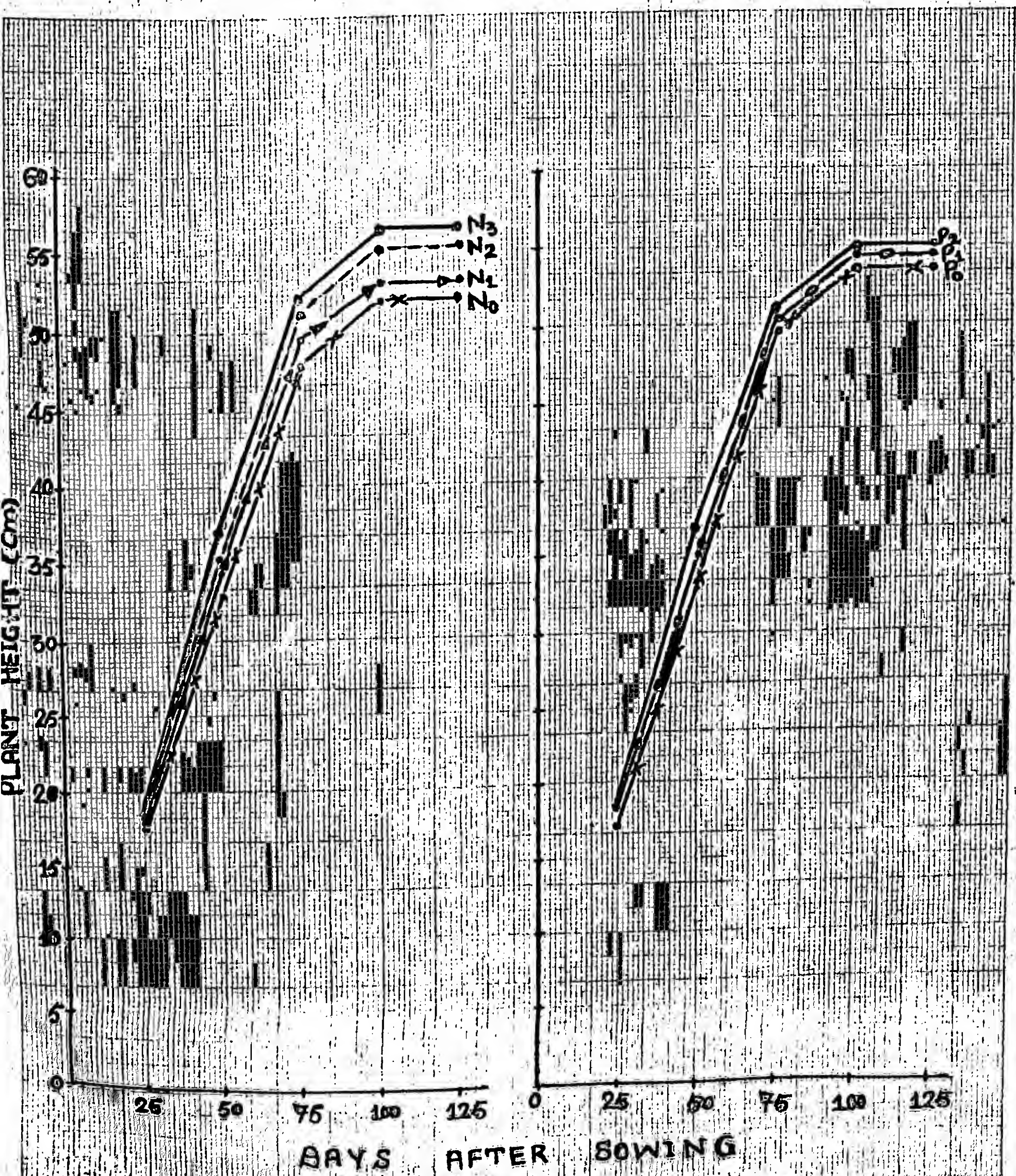


FIG. 4 - PLANT HEIGHT AT SUCCESSIVE STAGES

The data of plant height at maturity was analysed statistically (Appendix II). The results of main effects and the interaction are summarized in table 7.

The examination of data presented in table 7 indicates that highest level of N_3 gave significant maximum height of plant followed by N_2 . N_1 and N_0 , the differences among latter levels were also significant.

Table 7 : Height of the plant (cm.) at maturity

N/P levels	P_0	P_1	P_2	Mean
N_0	52.3	51.9	51.9	52.03
N_1	52.7	53.2	53.5	53.13
N_2	53.7	55.6	56.9	55.40
N_3	55.9	57.2	57.5	56.86
Mean	53.65	54.47	54.95	
	Nitrogen Phosphorus Interaction (N×P)			
S.Em. ±	0.204	0.176	0.353	
C.D. at 5%	0.587	0.506	1.015	

As regards P levels, P_2 produced significantly tallest plants as compared to P_0 . The difference between P_0 and P_1 was also found to be significant whereas the

difference among P_1 and P_2 was non-significant.

The interaction effect was also found to be significant. Interaction N_3P_1 and N_3P_2 produced tallest plants as compared to lower levels of nitrogen with all the levels of phosphorus.

(3) Number of branches/plant

The number of branches per plant was noted during the observation intervals of 25, 50, 75 and 100 days after sowing. The number of branches were found to be increased with the increase in growth.

It is clear from the table-8 and fig. 5 that number of branches per plant continued to increase upto 75 days after sowing and afterwards, it did not increase under all levels of N and P.

Table 8 : Periodical number of branches/plant

Treatments	Days after sowing			
	25	50	75	100
Effect of N				
N_0	1.73	2.50	2.96	2.96
N_1	2.23	2.96	3.53	3.53
N_2	2.56	3.16	3.76	3.76
N_3	2.96	3.43	4.21	4.21
Effect of P				
P_0	2.10	2.75	3.32	3.32
P_1	2.40	3.10	3.66	3.66
P_2	2.62	3.20	3.87	3.87

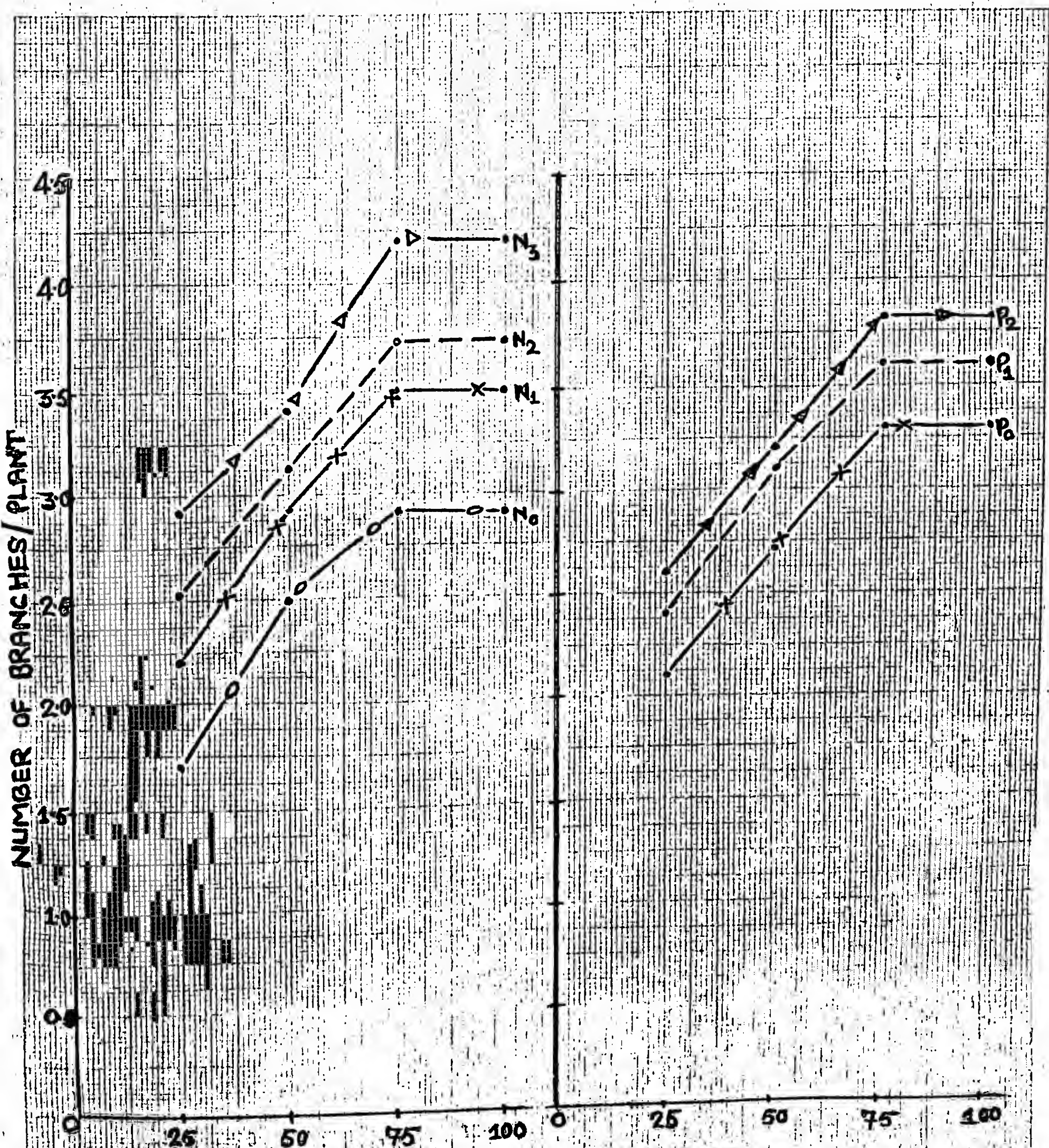


FIG 5: NUMBER OF BRANCHES PER PLANT AT SUCCESSIVE STAGES

The rate of branching was highest at 25 days after sowing and thereafter branching commenced at slow rate upto 75 days after sowing under all treatments. The data of number of branches/plant at maturity was analysed statistically (Appendix III). The results are summarized in table-9.

Table 9 : Number of branches per plant at maturity

N/P levels	P ₀	P ₁	P ₂	Mean
N ₀	2.9	2.9	3.1	2.96
N ₁	3.2	3.7	3.7	3.53
N ₂	3.3	3.8	4.2	3.76
N ₃	3.9	4.25	4.5	4.21
Mean	3.32	3.66	3.87	
	Nitrogen	Phosphorus	Interaction (N×P)	
S. Em. ±	0.082	0.071	0.142	
C.D. at 5%	0.235	0.204	N.S.	

The data further reveal that N₃ produced significant highest number of branches per plant followed by N₂, N₁ and N₀. N₂ and N₁ were also found significantly superior to control(N₀). The difference between N₂ and N₁ were found to be nonsignificant.

As regards P levels, P₂ produced significant highest number of branches/plant followed by P₁ and P₀. P₁ was also

significantly superior to P_0 . The difference between P_1 and P_0 was also found to be significant.

The interaction ($N \times P$) effect was found to be non significant.

(B) Post harvest studies :

(1) Number of capsule per plant

The analysis of variance table (Appendix-IV) indicates that main effects of N and P were found to be significant whereas their interaction ($N \times P$) was non significant.

Table 10 : Number of capsule/plant

N/P levels	P_0	P_1	P_2	Mean
N_0	18.75	24.00	28.00	23.58
N_1	24.25	28.75	31.25	28.08
N_2	28.50	30.75	34.25	31.16
N_3	30.00	33.50	36.25	33.25
Mean	25.37	29.25	32.43	
	Nitrogen	Phosphorus	Interaction ($N \times P$)	
S. Em. $\pm$	0.713	0.617	1.23	
C.D. at 5%	2.051	1.77	N.S.	

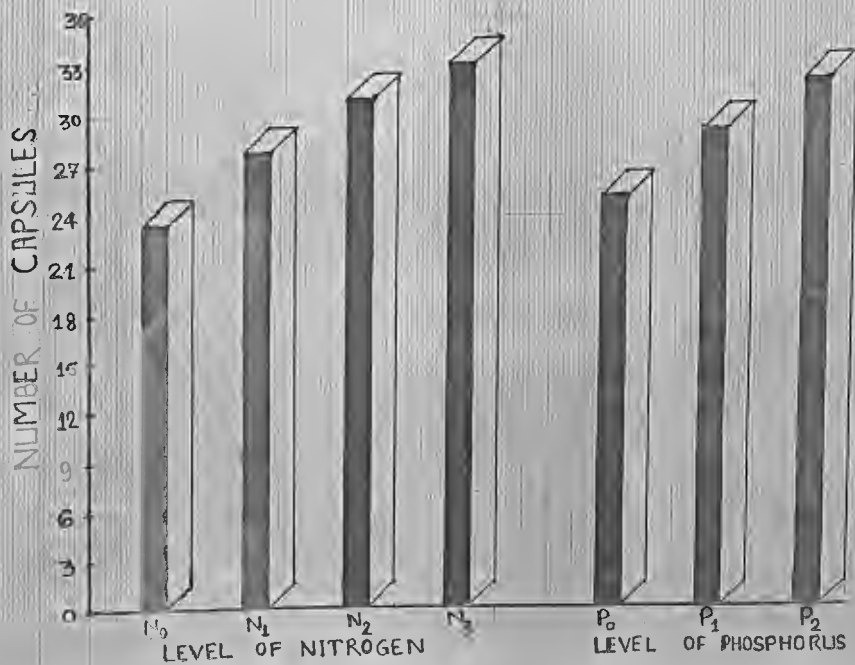


FIG:6- NUMBER OF CAPSULES PER PLANT

The data presented in table 10 and depicted in fig. 6 reveal that N_3 produced significantly highest number of capsules per plant as compared to N_2 , N_1 and N_0 . The difference between N_2 , N_1 and N_0 were also significant among themselves.

As regards P levels, P_2 produced significantly maximum number of capsules per plant as compared to P_1 and P_0 , the difference among latter two levels was also significant.

Test Weight :

The test weight of seed is one of the most important criterion to determine the seed size as well as the quality of seed produced and to some extent to judge the efficiency of fertilizer application.

Table 11 : Test weight of 1,000 grain (gm.)

N / P levels	P_0	P_1	P_2	Mean
N_0	7.50	7.75	8.00	7.75
N_1	7.75	8.25	8.50	8.16
N_2	8.25	8.50	8.50	8.41
N_3	8.25	8.75	8.75	8.58
Mean	7.93	8.31	8.43	
	Nitrogen	Phosphorus	Interaction (N x P)	
S. Em. $\pm$	0.19	0.165	0.33	
C.D. at 5%	0.54	N.S.	N.S.	

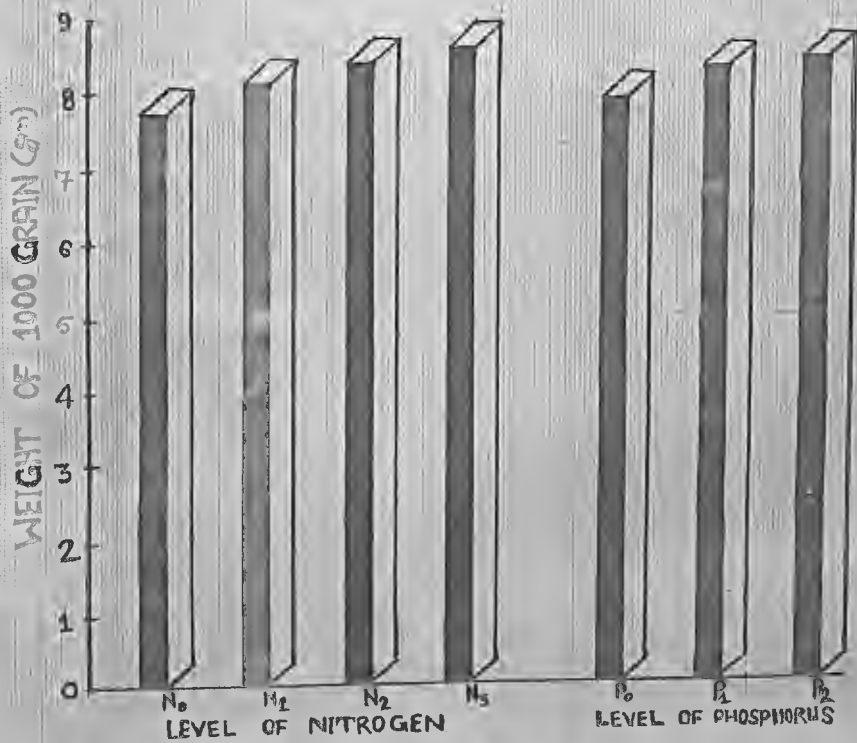


FIG: 7 TEST WEIGHT OF 1000 GRAIN

Analysis of variance vide Appendix-V reveals that effect of nitrogen on test-weight of linseed was significant. The effect of phosphorus and interaction effect of nitrogen and phosphorus (N x P), however, were absent.

The observation of data in table-11 and fig. 7 indicate that N_3 gave significantly heavier seeds as compared to N_0 , whereas it failed to prove its superiority over N_1 and N_2 . The differences between N_2 , N_1 and N_0 were not significant.

(3) Grain yield per plant (gm.) :

It is clear from the data in table-12 that the various level of nitrogen secured significant variation for grain yield per plant. The grain yield per plant was increased with the increase in levels of nitrogen and the maximum value of it was recorded under N_3 (45 kg N/ha) which was significantly superior to remaining levels of nitrogen under study.

Table-12 : Grain yield per plant (gm.)

N/P levels	P ₀	P ₁	P ₂	Mean
N_0	2.2	2.6	2.8	2.53
N_1	2.5	3.0	3.3	2.93
N_2	2.7	3.3	3.7	3.23
N_3	3.1	3.5	3.9	3.50
Mean	2.625	2.85	3.42	
	Nitrogen	Phosphorus	Interaction(NxP)	
S. Em. +	0.050	0.044	0.088	
C.D. at 5%	0.142	0.126	N.S.	

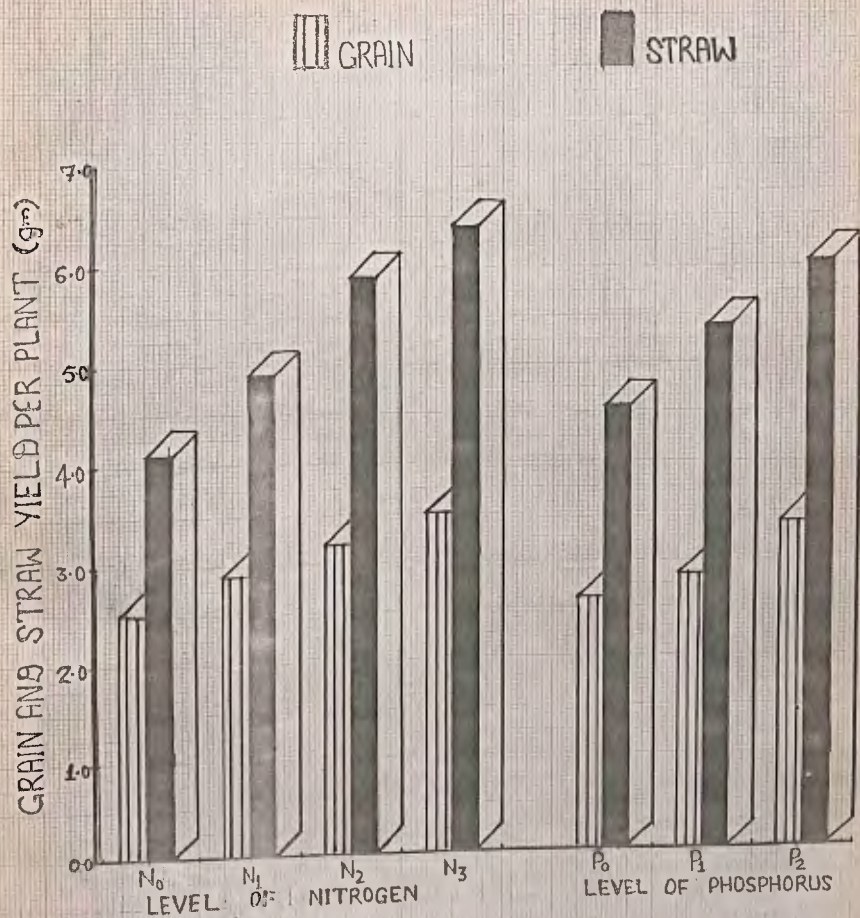


FIG:8- GRAIN AND STRAW YIELD PER PLANT (gm)



The data in table-12 and fig.8 also reveal that application of phosphorus enhanced the seed yield significantly. P_2 proved to be significantly superior, to P_1 and P_0 . P_1 and P_0 also differed significantly with each other, however, interaction of N x P was found to be non significant.

(4) Straw yield per plant (gm.)

It was observed from the analysis of variance table (Appendix VII) that straw yield per plant was significantly affected by application of nitrogen and phosphorus, however, interaction of N x P was found to be non significant.

Table 13 : Straw yield per plant (gm)

N/P levels	P_0	P_1	P_2	Mean
N_0	3.7	3.7	4.9	4.10
N_1	4.2	5.2	5.3	4.90
N_2	5.2	6.2	6.3	5.90
N_3	5.1	6.5	7.8	6.40
Mean	4.55	5.4	6.07	
	Nitrogen Phosphorus Interaction (NxP)			
S. Em. $\pm$	0.218	0.189	0.379	
C.D. at 5%	0.627	0.543	N.S.	

The study of data in table 13 and fig. 8 indicates that N_3 gave maximum straw yield per plant and was found significantly superior to N_1 and N_0 levels. The difference among N_3 and N_2 was found to be non significant.

As regards application of P, P_2 proved significantly superior than P_1 and P_0 . The difference between P_1 and P_0 was also found to be significant.

(5) Grain yield per hectare :

Yield per unit area is an important character which enables the investigator to ascertain or select superior treatment or treatment combination for future maximized production programme of a particular crop. In the present trial, it was observed vide Appendix VIII that nitrogen, phosphorus and their interaction had favourable impact on seed yield.

Table 14 : Grain yield (g/ha)

N/P levels	P_0	P_1	P_2	Mean
N_0	9.08	8.65	8.33	8.68
N_1	9.08	10.36	11.00	10.14
N_2	10.25	11.53	11.64	11.14
N_3	10.79	12.60	13.99	12.46
Mean	9.80	10.78	11.24	
	Nitrogen	Phosphorus	Interaction ($N \times P$)	
S. Em. $\pm$	0.0122	0.0108	0.021	
C.D. at 5%	0.035	0.030	0.060	

 GRAIN
  STRAW

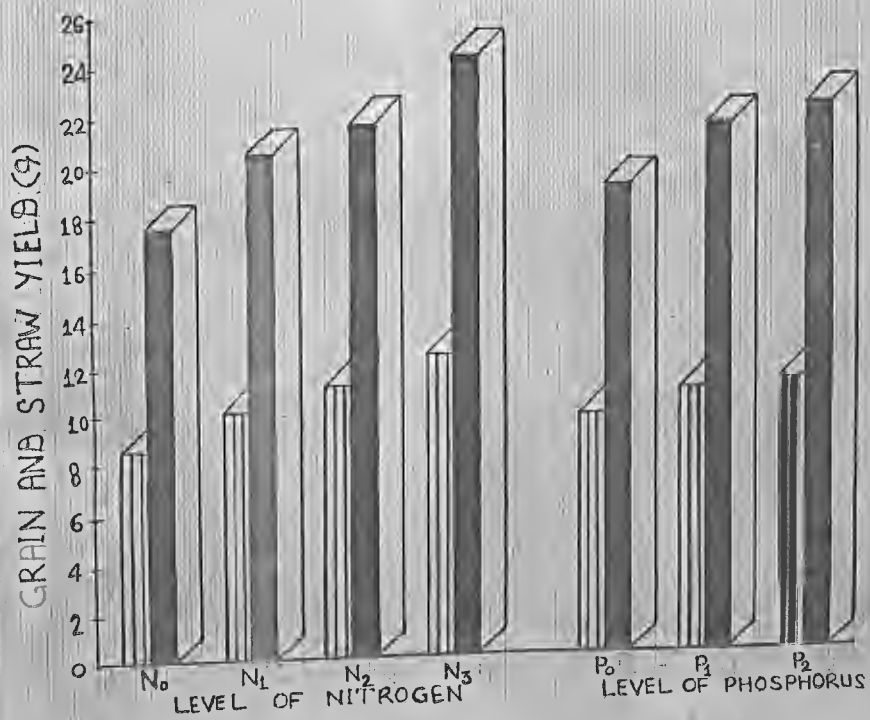


FIG. 9.- GRAIN AND STRAW YIELD (q/ha)

A critical study of the data in table 14 and fig. 9 shows that 45 kg N/ha (N_3) enhanced the seed yield significantly by 43.54, 22.87 and 11.84 per cent over N_0 , N_1 , N_2 levels respectively. Simultaneously, the yield difference between 30 and 45 kg N/ha levels was also significant.

The data further reveal that application of phosphorus enhanced the seed yield significantly. Phosphorus at the rate of 20 kg/ha increased the seed yield significantly by 14.69 and 4.26 per cent over P_0 and P_1 respectively.

The interaction N_3P_2 produced significantly maximum grain yield per hectare over other combinations. It enhanced the seed yield by 54.0% over N_0P_0 .

(6) Straw yield per hectare :

Analysis of variance (Appendix VIII) drawn on straw yield per hectare shows that 'F' test values for nitrogen and phosphorus levels were highly significant.

Interaction effect of nitrogen and phosphorus on straw yield was also significant.

.. table ..

Table 15 : Yield of straw (q/ha)

N/P levels	P ₀	P ₁	P ₂	Mean
N ₀	17.30	18.26	17.30	17.62
N ₁	19.01	21.36	21.68	20.68
N ₂	19.87	21.90	23.39	21.72
N ₃	20.83	24.78	27.56	24.39
Mean	19.25	21.57	22.48	

	Nitrogen	Phosphorus Interaction (N _x P)	
S.E.m. ±	0.022	0.019	0.039
C.D. at 5%	0.063	0.054	0.111

It is evident from table 15 and fig. 9 that increasing nitrogen levels increased the straw yield significantly. N₃ gave maximum straw yield per hectare and was significantly superior to rest of the N levels. Nitrogen level of 45 kg/ha (N₃) enhanced the straw yield by 38.42, 17.94 and 12.29 percent over N₀, N₁ and N₂ levels respectively.

Response of phosphorus on linseed straw yield per hectare was also significant (table 14). Phosphorus at the rate of 10 kg/ha increased the straw yield of linseed crop by 12.05% as compared to no phosphorus treatment (P₀).

however, addition in phosphorus level over 10 kg P_2O_5 /ha. increased the straw yield of linseed crop by 16.77 and 4.21 percent over P_0 and P_1 levels respectively.

The interaction N_3P_2 produced significantly maximum straw yield per hectare over other combination. It enhanced the straw yield by 59.30 percent over N_0P_0 .

Economics of the treatment :

In order to find out the best remunerative treatment combination, the economics of various treatment has been calculated at prevailing market rates which is presented in the table 16(a) to 16(e).

Table 16(a) : Prevailing market rates (Rs.)

S.No.	Particulars	Rs.
1.	One tractor ploughing	260.00/ha.
2.	Disc harrowing and planking	130.00/ha.
3.	Irrigation by electric pump	75.00/irrigation
4.	Labour charges -	
	(a) Male	9.33/day
	(b) Female	9.33/day
5.	Fertilizer	
	(a) Nitrogen (through urea @ Rs 225/qt.)	4.89/kg
	(b) P_2O_5 (through single super-phosphate @ 90.00/qt.)	5.62/kg
6.	Endosulphan (35 E.C.)	100.00/lit
7.	Seed of linseed	695.00/q.
8.	Linseed grain	485.00/q.

Table 16(b) : Cost of cultivation (Rs./ha) excluding cost of nitrogen and phosphorus

S.No.	Particulars of expenditure	Cost (Rs.)
1.	Land preparation :	
	(a) One deep ploughing (tractor)	260.00
	(b) Harrowing and planking (two)	260.00
	(c) Lay out	76.00
2.	Labour charges :	
	(a) Application charges of fertilizer	135.00
	(b) Sowing charges	135.00
3.	Cost of seed @ 30 kg/ha	208.50
4.	Irrigation charges (two irrigations)	150.00
5.	Weeding (one)	100.00
6.	Spraying of insecticide	50.00
7.	Harvesting	115.90
8.	Threshing	135.32
9.	Cleaning	40.10
10.	Interest on working capital	55.00
11.	Land revenue	25.00
	Total	1745.82

Table 16(c) : Cost of cultivation under different treatment combination (Rs./ha.)

Treatments	Cost of N	Cost of P	Cost of N+P	Cost of cultivation without fertilizer	Total cost
N_0P_0	-	-	-	1745.82	1745.82
N_0P_1	-	56.20	56.20	1745.82	1802.02 ✓
N_0P_2	-	112.40	112.40	1745.82	1858.22
N_1P_0	73.35	-	73.35	1745.82	1819.17
N_1P_1	73.35	56.20	129.55	1745.82	1875.37
N_1P_2	73.35	112.40	185.75	1745.82	1931.57
N_2P_0	146.7	-	146.70	1745.82	1892.52
N_2P_1	146.7	56.20	202.90	1745.82	1948.72
N_2P_2	146.7	112.40	259.10	1745.82	2004.92
N_3P_0	220.05	-	220.05	1745.82	1965.87
N_3P_1	220.05	56.20	276.25	1745.82	2022.07
N_3P_2	220.05	112.40	332.45	1745.82	2078.27

Table 16(d) : Net return under different treatment combination (Rs./ha.)

Treatment	Grain yield (g/ha)	Value of grain (Rs./ha.)	Cost of cultivation (Rs./ha.)	Net income (Rs./ha.)
N_0P_0	9.08	4403.80	1745.82	2657.98
N_0P_1	8.65	4195.25	1802.02	2393.23
N_0P_2	8.33	4040.05	1858.22	2181.83
N_1P_0	9.08	4403.80	1819.17	2584.63
N_1P_1	10.36	5024.60	1875.37	3149.23
N_1P_2	11.00	5335.00	1931.57	3403.43
N_2P_0	10.25	4971.25	1892.52	3078.73
N_2P_1	11.53	5592.05	1948.72	3643.33
N_2P_2	11.64	5645.40	2004.92	3640.48
N_3P_0	10.79	5223.15	1965.87	3267.28
N_3P_1	12.60	6111.00	2022.07	4088.93
N_3P_2	13.99	6785.15	2078.27	4706.88

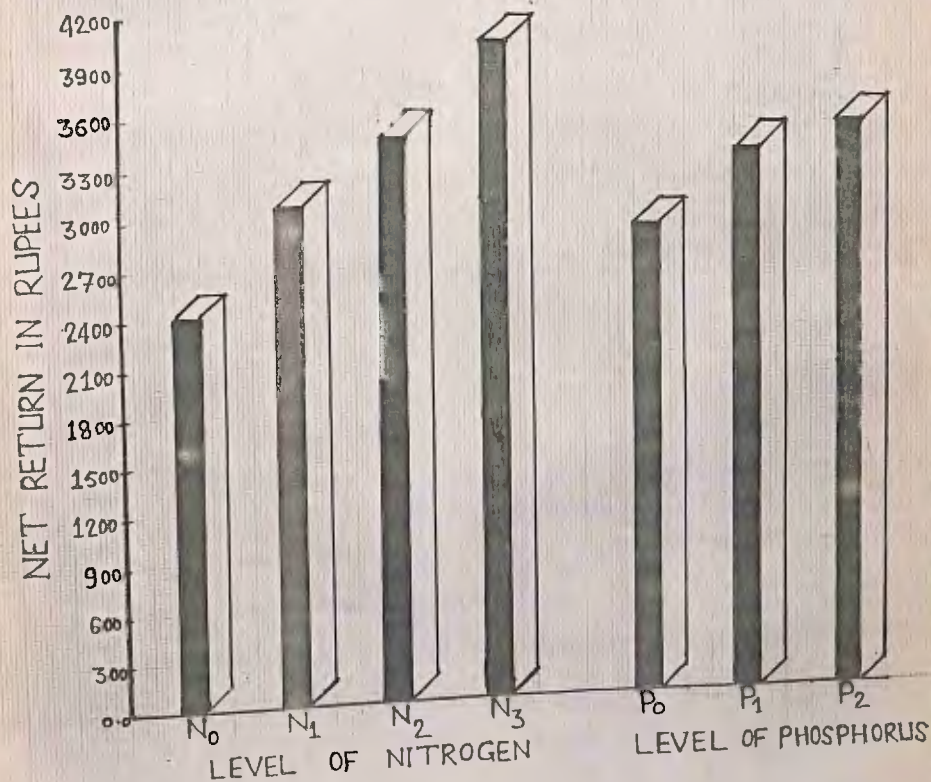


FIG:10 NET RETURN OF TREATMENT (Rs/ha)

Table 16(e) : Net profit (Rs./ha.)

N/P levels	P ₀	P ₁	P ₂	Mean
N ₀	2657.98	2393.23	2181.83	2411.01
N ₁	2584.63	3149.23	3403.43	3045.76
N ₂	3078.73	3643.83	3640.48	3454.18
N ₃	3267.28	4088.93	4706.88	4021.03
Mean	2897.15	3318.68	3483.15	

The perusal of the data in table 16 (d and e) and fig. 10 indicates that increasing levels of N and P increased the net profit per hectare. N₃ gave higher net return as compared to rest of the N levels. Similarly P₂ fetched highest net profit in comparison to P₁ and P₀. As regards interaction combinations, N₃P₂ gave maximum net profits per hectare followed in order by N₃P₁, N₂P₂, N₂P₁, N₃P₀, N₁P₂, N₁P₁, N₁P₂, N₂P₀, N₀P₁, N₁P₀, and N₀P₀.



CHAPTER-V

D_I_S_C_U_S_S_I_O_N

DISCUSSION

The experimental findings of present experiment entitled, "Response of linseed to nitrogen and phosphorus levels" discussed in the foregoing chapter, are elaborated here in order to find out possible interpretation for the variation obtained in the experimental findings.

The main object of the problem is to test the response of nitrogen and phosphorus in different combinations to linseed crop and to find out the economic combinations. In this connection, to study the various phases of linseed crop behaviour, the necessary visual morphological and finally agronomical observations were made from time to time as cited on the previous pages. Here, in this chapter, results are discussed as a whole in relation to the findings of the work in the field. Although, some results obtained are not statistically significant, yet they are discussed as they show definite effect of nitrogen and phosphorus.

It is well known that the plant considered as a whole reflected upon its yield of grain. The growth is generally represented by the increase in the plant height, number of branches per plant, therefore, it is important to study the influence of various treatments on these characters which have affected the yield. Like other crops, the linseed also responded to two most essential plant nutrients. The results obtained during investigation are discussed in the ensuing pages.

(A) Growth Character

Height of plant and number of branches/plant

The study reveals that the application of nitrogen significantly increased the height of plant and number of branches per plant. The reason for significant response of growth yield attributes may be beneficial effect of nitrogen. This is probably due to the fact that nitrogen is essential for building up of protoplasm and protein which induce cell division and initiate the meristematic activity. The results have been supported by the finding of Alimohammed (1930), Tokuoaka and dyo (1938), Singh (1964), Hussain et al. (1970), Pandey et al. (1970), Kondratowioz (1971), Patel (1977) and Jaiswal (1983).

The height of plant and number of branches/plant significantly increased with the application of increasing levels of nitrogen. This may be attributed to the beneficial effect of nitrogen. Auxin and carbohydrates are necessary for cell division and elongation and it is the nitrogen in the plants which favours the formation of these substances. The plants supplied with increasing amount of nitrogen elongated rapidly resulting in increased growth activity. Similar results were also reported by Khedkar (1951), Sahu (1976) and Jaiswal (1983).

The application of phosphorus significantly affected the height of plant and number of branches/plant. This may be explained on the basis of beneficial effect of phosphate to linseed crop. The increase in plant height may be due to the fact that phosphorus plays an important role as a structural component of the cell and metabolically active compounds. It is essential for cell division and development of meristemic tissues at growing points. The phosphate helps in better utilization of nitrogen. Thus, by addition of phosphate besides higher utilization of nitrogen, the absorption of nutrients from the soil is also increased the growth. Similar results were also obtained by Singh (1964), Parashar et al. (1968) and Pandey et al. (1970).

The height of plant significantly increased with the combination of nitrogen and phosphorus. The results are in close conformity with the findings of Mac Issac and McGregor (1941), Anonymous (1951), Blackman and Bunting (1951), Tiwari (1956) and Mathur (1958).

(B) Yield Characters

(1) Number of capsule/plant and test weight of 1,000 grains

The nitrogen significantly influenced the number of capsule/plant and test weight of 1,000 seeds. It is because of proper growth and development and increased photosynthetic and metabolic activities of the plant in presence of nitrogen.

which ultimately synthesized more food material for increasing yield attributes. The higher supply of food material in the presence of nitrogen resulted in responsive growth and yield characters. Similar results were also obtained by Scharrer and Schreiber (1943), Khedkar (1951), Tiwari (1956), Singh (1964), Pandey et al. (1970), Kondratowicz (1971), Sahu (1976) and Jaiswal (1983).

Number of capsule/plant was affected significantly by application of phosphorus. It may be due to the fact that phosphorus at later stage enhances primordia for the reproductive parts of the plant, flowers and seed formation. These findings collaborate with the findings of Singh (1964), Pandey et al. (1970) and Sahu (1976).

(ii) Grain yield/ha :

Grain yield/ha. was significantly increased by application of nitrogen. The possible reason for this may be that nitrogen significantly influenced the yield attributing characters viz. number of capsule/plant, test weight of 1,000 grain and grain yield/plant. By proper supply of nitrogen, the vegetative and reproductive activities of plant were increased. Consequently yield attributing characters were favourably affected which ultimately resulted in increased grain yield. The highest grain yield/plant/ha recorded under N_3 may be due to desired requirement of linseed crop for

nitrogen upto this level. This result is in full agreement with many workers like Khan and Gupta (1959), Pandey (1970), Tomar and Singh (1973), Singh et al. (1974), Sahu (1976), Anonymous (1978), Singh and Singh (1978), Bhan (1980) and Singh et al. (1982).

The application of phosphorus significantly influenced the grain yield/ha. It is because of the reason that yield attributing characters were increased significantly and so dependent yield also responded favourably to phosphorus application. The maximum response under highest level of phosphorus may be on account of fulfilment of optimum requirement of phosphate. This finding is in close conformity with the findings of Anonymous (1970), Pandey et al. (1970), Shekhawat et al. (1971), Choudhary (1977), Singh and Singh (1978), Bhan (1980), Singh et al. (1982) and Lal and Singh (1982).

The interaction N x P significantly influenced the grain yield/ha. This may be ascribed to the combined beneficial effect of nitrogen and phosphorus. Application of nitrogen in combination with phosphorus may have fulfilled the requirement of plant for two most essential nutrients. Nitrogen accelerated the growth and photosynthetic activities of the plant whereas phosphorus extended the root system for higher absorption of plant nutrients from the soil. Thus, nitrogen in combination with phosphorus increased the yield contributing characters.

The highest yield obtained under $N_3 \times P_2$ may be due to the increased reproductive phase and yield attributes. Beneficial effect of interaction has also been recorded by Anonymous (1951), Tiwari (1956) and Mathur (1958).

(iii) Straw yield/ha :

The significant response in the straw yield/ha under nitrogen application may be ascribed to the beneficial effect of nitrogen on growth attributes like height of plant and number of branches/plant. Since straw yield depends on growth and development of plant, hence, it increased with the increase of growth associate characters. Similar results were also obtained by Granhall and Larson (1946), Richharia (1950), Khedkar (1951), Denell (1952), Tiwari (1956), Singh (1964), Pandey and Singh (1965) and Pandey et al. (1970).

Increased straw yield/ha of linseed crop by application of phosphorus, may be due to favourable effect of phosphorus on growth characters as height of plant, number of branches/plant and, ultimately, on resultant straw yield. These findings are similar to those obtained by Optiz (1941), Pike (1941) and Milthorpe (1943).

The straw yield/ha significantly increased with the interaction effect of nitrogen and phosphorus. Nitrogen increased the growth and photosynthetic activities of the

plant whereas phosphorus increased the absorption of plant nutrient from the soil. Thus, interaction effect of nitrogen and phosphorus increased the straw yield.

Net profit/ha.:

The application of nitrogen and phosphorus alone and in combination proved beneficial from income point of view. Net profit/ha. continued to increase with increasing levels of nitrogen and phosphorus. This may be on account of increase in grain yield/ha. The combined application of nitrogen and phosphorus was also statistically beneficial to grain yield, however, it has substantially increased the net return/ha.

*** **

CHAPTER - V I :

S_U_M_M_A_R_Y, C_O_N_C_L_U_S_I_O_N_S
A_N_D S_U_G_G_E_S_T_I_O_N

SUMMARY, CONCLUSIONS AND SUGGESTIONS

Summary :

The experiment entitled, "Response of linseed (Linum usitatissimum Linn.) to nitrogen and phosphorus levels" was carried out at Instructional Farm, J.N.K.V.V., College of Agriculture, Rewa, M.P., during rabi 1985-86 with the following objectives :

1. To find out the suitable dose of nitrogen and phosphorus for maximum production of linseed.
2. To study the effect of nitrogen and phosphorus on the growth and yield characters of linseed crops.
3. To determine the most suitable combined dose of nitrogen and phosphorus for linseed crop.
4. To calculate the economics of various treatments for economical dose of nitrogen and phosphorus.

The experiment consisted of four levels of nitrogen (0, 15, 30 and 45 kg/ha.) and three levels of phosphorus (0, 10 and 20 kg/ha.) making twelve treatment combinations and were tried in a randomized block design with four replications.

The soil of the experimental site was sandy clay loam with uniform fertility. The seed of variety T. 397 was sown

@ 30 kg/ha. at a row to row distance of 30 cm. on 17-10-1985. The nitrogen and phosphorus were applied as per treatment at the time of sowing. First irrigation was given after 10 days of sowing for proper germination of seed and second after 43 days of sowing. The climatic conditions were favourable for proper growth and development of linseed crop. The other cultural operations were done as per usual requirement of the crop. The crop was harvested on 24-2-1986.

The results are summarized below :

Effect of nitrogen :

1. The nitrogen did not influence plant population significantly.
2. Increasing levels of nitrogen significantly increased the plant height. Maximum height (56.86 cm.) was obtained under 45 kg N/ha.
3. Increasing levels of nitrogen significantly influenced the number of branches/plant. Highest number (4.21) was noted under 45 kg N/ha.
4. Maximum number of capsules/plant (33.25) were produced by 45 kg N/ha. It was significantly superior to rest of the nitrogen levels.
5. Heaviest seeds (8.58 gm test weight) were produced by 45 kg N/ha but rest of the nitrogen levels did not differ significantly.

6. Maximum grain yield/ha. (12.46 q) was obtained under 45 kg N/ha. It was significantly superior to rest of the nitrogen levels.
7. Yield of straw/ha. increased significantly with increase in nitrogen levels, 45 kg N/ha. gave maximum yield of straw (24.39 q.).
8. Net profit/ha. increased with increase in levels of nitrogen and maximum was obtained under 45 kg N/ha. (Rs. 4021.03).

Effect of phosphorus :

1. Application of phosphorus significantly influenced the plant population. Maximum number of plants (23 per metre row length) was noted under 20 kg P_2O_5 /ha.
2. Application of phosphorus significantly influenced the plant height. Maximum height (54.95 cm.) was obtained under 20 kg P_2O_5 /ha. It was superior to rest of the phosphorus levels.
3. Increasing levels of phosphorus significantly influenced the number of branches/plant. Maximum number of branches (3.87) was noted under 20 kg P_2O_5 /ha.
4. Application of 20 kg P_2O_5 /ha proved better in number of capsule/plant (32.43). It was significantly superior to rest of the phosphorus levels.

5. The phosphorus did not influence significantly test weight of 1,000 seed. Highest test weight was noted under 20 kg P_2O_5 /ha (8.43 gm)
6. Increasing levels of phosphorus significantly increased the grain yield/ha., however, maximum was recorded under 20 kg P_2O_5 /ha. (11.24 q.).
7. Increasing levels of phosphorus significantly increased the straw yield/ha. Maximum straw yield/ha (22.489 q.) was obtained under 20 kg P_2O_5 /ha.
8. Net profit/ha. continued to increase with increasing levels of phosphorus and 20 kg P_2O_5 /ha proved to be most remunerative (Rs. 3483.15).

Effect of interaction (N x P) :

1. The interaction effects of nitrogen and phosphorus did not influence plant population, number of branches/plant, number of capsules/plant, test weight, grain yield/plant and straw yield/plant, significantly.
2. Interaction of 45 kg N/ha x 20 kg P_2O_5 /ha significantly influenced the plant height. Interaction N_3P_1 and N_3P_2 produced tallest plants as compared to lower levels of nitrogen with all the levels of phosphorus.

3. The interaction $N_3 \times P_2$ produced significantly maximum grain yield per hectare over other combinations. It enhanced the seed yield by 54.0 percent over N_0P_0 .
4. The interaction $N_3 \times P_2$ produced significantly straw yield per hectare over other combinations. It enhanced the straw yield by 59.30 percent over N_0P_0 .

Conclusion :

It may be concluded that under agroclimatic conditions prevailing at the time of experimentation, application of 45 kg N/ha and 20 kg P_2O_5 /ha singly or in combination proved better from yield point of view. However, maximum net income of Rs. 4706.88/ha. was obtained when 45 kg nitrogen/ha. was applied in combination with 20 kg P_2O_5 /ha.

Suggestions for further work :

It is suggested that this experiment may be repeated as such for further confirmation of the validity of the results, so that definite recommendation could be given to the cultivators.

B_I_B_L_I_O_G_R_A_P_H_Y

BIBLIOGRAPHY

- Abdul-Kareem, H. (1966). Effect of fertilizers on the yield of flax and on the oil and protein content of the seed. Field Crop Abstr. (1967), 20(3), 1903 : 336-339.
- Alimohammad, K.S. (1930). Some investigation into the effect of fertilizers on the growth and oil content of lin-seed. Agric. J. India 25 : 471-86.
- Anonymous (1951). Progress report of linseed breeding scheme, Punjab. Annual Report of I.C.O.C.
- _____ (1953). Scientific report, I.A.R.I., New Delhi.
- _____ (1970). Annual progress report. All India Coordinated Research Project on Oilseeds in M.P. J.N. Krishi Vishwa Vidyalaya, Jabalpur (Unpublished).
- _____ (1978). Locational trials (a) varieties x nitrogen at Pantnagar alone. Coordinated trials (b) Variety x fertility. Ann. Progr. Report, AICORP, I.C.A.R. : 36-38.
- Bhan, S. (1980). Linseed yield can be stepped up. Indian Eng. 30(5) : 19-20.
- Bhan, S. and Singh, A. (1973). Optimum fertilizer rates for linseed in the central tract of U.P. Bhartiya Krishi Anusandhan Patrika, 1(1) : 51-54.
- Blackman, G.E. and Bunting, E.S. (1951). Studies of oilseed crops, factors controlling seed production of linseed. J. Agric. Sci. 41 : 256-270.

- Blackman, G.E. and Bunting, E.S. (1954). Studies in oil crops, an assessment of the interrelationship between plant development and seed production in linseed. J. Agric. Sci. 45(1) : 3-9.
- Bogustawski E Von (1940). Manuring and quality of fibre plants for schung sdienst. Son-din-hrt.12. Fort-schrift eteder land wrirt. Schaft lidchemis chen Forschany 40. 82-92. Bio Abstr. 24(9), Sept., 1959.
- Caldwell, A.C. (1949). The effect of weed control on the efficiency of use of fertilizers for flax. Nation Joint. Comm. Fert. Appl. Proc. Ann. Meet. 24 : 92 Bio. Abstr. 23(4989), 1949.
- Choudhary, C.S. (1977). The response of different linseed varieties under various fertility levels. Thesis submitted for M.Sc. (Ag.), J.N.K.V.V., Jabalour, M.P. (Unpub.).
- Denell, N. (1952). Experiment with flax for fibre-production. Results of expt. respecting growth, cultivation weed and manuring in the year 1949, Station Jord br. Forsk. Medd. 39 : 57 (Soils Fertil.15,289).
- Dybing, C.D. (1964). Influence of nitrogen level on flax growth and oil production in varied environments. Crop Sci., 4(5) : 491-94.
- Friederich, J.C. (1948). Fibre flax, versl. cent. land bouw. Onderzoek 67.70 Neatherland. Field Crop Abstr. III, 98.

- Froier, K. and Denell, N. (1948). Cultivation and processing trial of fibre plants, Lantbruk shogak. Jordbr. Medd. 1944. No. 27, 1-36. Field Crop Abstr. 3:45
- Gipson, A.G., Cald, W. and Fisher, F.L. (1961). Flax fertilizer responses constant bend of taxes. Propr. Rept. Taxes, Agric. Expl. St. 22401-2, Bio.Abstr. (1962), 40 (31).
- Granhall, I. and Larsson, N.G. (1946). Cultivation and preparation investigation with fibre plants. Soil Sci. 2 : 226.
- Gupta, G.P., Mehta, R.P. and Khan, A.R. (1961). Effect of time of application of nitrogen on the yield and quality of linseed. Indian Oilseeds J. 5(1) : 63-68.
- Hussain, M.A., El-Shaer, M.H. and Mahoud, M.E.I.F. (1970). Studies on the effect of irrigation, nitrogen, fertilization and seedlings rate on fibre - quality and number of plant characters in flax (Linum usitatissimum L.). Field Crop Abstr., 1972, No. 2460.
- Jaiswal, I.K. (1983). Effect of different levels of nitrogen and phosphorus on the growth, quality and yield of linseed (Linum usitatissimum Linn.), under rainfed condition. Thesis submitted for M.Sc.(Ag.) JNKVV, Jabalpur (Unpublished).
- Johns, C.M. (1949). Report on research on oilseed crops in India published by I.C.O.C.

→ Khan, A.R. and Gupta, G.P. (1959). Effect of some nutrients on yield of linseed and quality of its products. Indian Oilseed J. 3(4) : 221-25.

→ Khan, A.R. and Gupta, G.P. RaRoot, M.A. and Mathur, B.P. (1963). Effect of N P and K on the yield and quality of linseed. Indian Oilseed J. 7(2) : 136-9.

Khedkar, P.K. (1951). Thesis submitted in I.A.R.I., New Delhi for Diploma course (Unpublished).

Kondratowioz, J. (1971). The effect of increasing nitrogen rates and different proportion of N P and K on yield and quality of fibre. Part I. Influence of different fertilizer rates on flax growth and yield. Soils Fertil. No. 5299.

Lal, S. and Singh, H.N. (1982). Linseed can supplement oilseed production in India. Farmer and Parliament, 17(6): 23-8.

Lewis, A.H. (1943). The uptake of nutrients by flax. J. Agric. Sci. 33 : 169-173.

Mac Issac, F.M. and Mc Gregor, W.G. (1941). The effect of ammonium sulphate on the yield and quality of linseed, flax in northern Saskatchewan and N.E. Alberta. Sci. Agric. 22 : 195-200.

→ Mathur, B.P. (1958). Differential response of linseed varieties to various doses of nitrogen and phosphate and their method of application. Indian Oilseed J. 2(2) : 89-93.

- McGregor, W.G. (1937). Inheritance of quality and quality of oil in flax in relation to other plant characters. Can. J. Res. 15(c) : 362-79.
- Milthorpe, F.L. (1943). The growth and fibre production of flax. J. Aust. Inst. Agric. 9 : 72-76.
- Millikan, C.R. (1951). Diseases of flax and linseed. Aust. Dept. Agric. Biol. Brand. Tech. Roy. Vict. 61, 25-42.
- Milthorpe, F.L. (1946). Studies on manuring nutrition of flax. Univ. Sydney. pub. Bot. Set. No. 1. (66), Soils Fertil. 9 : 330.
- Muskett, A. and Coldund, John (1947). The diseases of the flax plant W and G. Baird Ltd., Belfast.
- Optiz, K. (1941). The response of flax plant to mineral fertilizers. Phosphorus (10) : 185-95. Soils Fertil. 10 : 199.
- Optiz, K. (1945). The possibilities of increasing flax yield without reduction in quality. Planzenbau 20 : 61-95 (Bio.Abstr. 10381), 109-116.
- Pandey, R.C. and Singh, M. (1965). Manuring and irrigational requirements of linseed. Ferti. News 10(8) : 16-32.
- Pandey, R.C., Singh, M. Agrawal, S.K. and Khan, R.A. (1970). Effect of different levels of nitrogen and phosphorus on growth, yield and quality of linseed (Linum usitatissimum Linn.). Indian J. Agron. 15(2) : 125-30.

- Parashar, C.R.K., Sachan, P.L. and Bhel, N.K. (1968). The effect of different levels of nitrogen and phosphorus on growth and yield of linseed. Indian J. Sci., 12(1) : 49-54.
- Patel, A.P. (1977). Effect of placement of fertilizer on growth and crop yield of rainfed linseed. Thesis submitted for M.Sc. (Ag.), JNKVV, Jabalpur (Unpublished).
- Petterson, D.D. (1929). Linseed in Iraq. Department of A-gric. Iraq memoris No. 12-13.
- Peive, Ya. V. and Rodov, A.S. (1939). The effect of fertilizer on newly cultivated soil on the growth of linseed Gedroiz. Inst. Fert. Problems of Development of reclaimed soil, 88-104.
- Pike, K.A. (1941). Fibre flax. J. Dept. Agric. Aust. 44 : 491-507.
- Rai, B. and Singh, A. (1977). Seed production of linseed. Ind. Fmg. 27(5) : 19-20.
- Richharia, R.H. (1950). Wealth from waste. The Indian linseed plant for fibre point of view. The United Press Limited Bhagalpur, India.
- Robinson, B.B. and Weidemann, A.G. (1932). Fertilizer - experiment with seed and fibre flax. Oua. Bull. Agric. Expt. Stat. Michigan 14(3) : 158-161.
- Sahay, K.N. (1957). Thesis submitted for Assoc. I.A.R.I., New Delhi (unpublished).

- Sahu, D.R. (1976). To study the response of different linseed varieties under various fertility levels in rain-fed conditions. Thesis submitted for M.Sc.(Ag.) JNKVV, Jabalpur, M.P. (Unpublished).
- Scharrer and Schreiber, R. (1943). The nutrient requirements of clintorus as regard N and P_2O_5 . Bodenk V. Pflanzenrhahr 31 : 253-262. Biol. Abstr. (5985) 252 Feb., 1952.
- Shekhawat, G.S., Jain, M.M. and Sharma, D.C. (1971). Response of linseed (Linum usitatissimum L.) to micro - nutrients under varying fertility levels in barani condition. Indian J. Agron. 16(1) : 64-66.
- Singh, M. (1964). Effect of various levels of nitrogen and phosphorus with and without irrigation on the growth, yield and quality of linseed. Thesis, submitted for diploma course to Sagar Univ.
- Singh, G.B., Sandhu, R.S., Sethi, I.K. and Arora, S.K. (1968). Effect of graded dose of nitrogen on yield and quality of linseed in the Punjab hills. J. Res. P.A.U., 8(3) : 342-6.
- Singh, H., Gupta, M.L. and Anant Rao, N.K. (1960). Effect of N, P and K on the yield and oil content of sesame. Indian J. Agron. 4(3) : 174.
- Singh, P.P., Nema, V.P. and Singh, S. (1982). Response of fertility levels, row spacing and seed rate on the seed yield of linseed (Linum usitatissim Linn.) JNKVV Reg. J. Agric. Sci. 48(10) : 583-8

- Singh, P.P., Kaushal, P.K. and Sharma, Y.K. (1974). Effect of nitrogen and phosphorus rate on the seed yield and oil content of linseed. Indian J. Agron. 19(2) : 85-86.
- Singh, R.P. and Prasad, M. (1975). Fertilizer use in rainfed crops, grain yield and nitrogen uptake. Indian J. Agron. 20(2) : 106-12.
- Singh, R.A. and Singh, H.R. (1978). Effect of nitrogen and phosphorus on yield, quality and moisture and use, pattern of linseed grown on rainfed lands. Indian J. Agric. Sci. 48(10) : 583-88.
- Stewart, A.B. (1947). Report on soil fertility investigation in India.
- Tiwari, R.K. (1956). Response of linseed to the application of fertilizers in conjugation with Br. and Mn. Thesis submitted for Diploma Course, I.A.R.I., New Delhi.
- Tokuoka, M. and Dyo, S. (1938). Effect of nitrogenous fertilization of urea type. II. Flax J. Soc. Trop. Agron. Taihoku 10 : 204-9. Soils and Fertil. 2:237.
- Tomar, S.P. and Singh, U.B. (1973). Response of linseed levels of N P K and irrigations. Indian Oilseed J. 3(3) : 23-26.
- Trepachev, E.P. (1953). The rate of fertilizer in changing the oiliness of seed. Soil. Agron. No. 4. 7982 in Soils Fertil. 17/3/1954.

Woodhead, M. and Neilson, B.E. (1977). The fertilizer requirement of linseed for oilseed production. Soil Fertil. 40(12).

Yayock, J.Y. and Quinn, J.G. (1977). Agronomy of linseed oil cultivars (Linum usitatissimum Linn.) in northern Nigeria, Exol. Agric. 13(1) : 93-100.

APPENDICES

Appendix I

Analysis of variance table for plant population/m
row length

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	4.820	1.606			
Nitrogen (N)	3	0.790	0.263	2.155	2.89	4.45
Phosphorus(P)	2	0.991	0.495	4.057*	3.29	5.32
Interaction (N x P)	6	1.179	0.196	1.606	2.39	3.41
Error	33	4.030	0.122			
Total	47	11.810				

*Significant at 5%

Appendix II

Analysis of variance table for height of the plant (cm)

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	7.105	2.368	-		
Nitrogen (N)	3	171.390	57.130	113.578**	2.89	4.45
Phosphorus(P)	2	14.123	7.061	14.037**	3.29	5.32
Interaction (N x P)	6	14.427	2.404	4.779**	2.39	3.41
Error	33	16.615	0.503			
Total	47	223.660				

**Significant at 1%

Appendix III

Analysis of variance table for number of branches per plant

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	0.755	0.251	-		
Nitrogen (N)	3	9.415	3.138	38.740**	2.89	4.45
Phosphorus(P)	2	2.352	1.176	14.518**	3.29	5.32
Interaction (NxP)	6	0.483	0.080	0.987	2.39	3.41
Error	33	2.675	0.081			
Total	47	15.680				

**Significant at 1%

Appendix IV

Analysis of variance table for number of capsules/plant

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	23.560	7.853			
Nitrogen (N)	3	635.230	211.743	34.649**	2.89	4.45
Phosphorus(P)	2	400.290	200.145	32.751**	3.29	5.32
Interaction (NxP)	6	18.210	3.035	0.496	2.39	3.41
Error	33	201.690	6.111			
Total	47	1278.980				

** Significant at 1%.

Appendix V

Analysis of variance table for test weight of 1,000 grain (gm.)

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	0.563	0.187			
Nitrogen(N)	3	4.730	1.576	3.568*	2.89	4.45
Phosphorus(P)	2	2.167	1.083	2.439	3.29	5.32
Interaction (NxP)	6	0.333	0.055	0.125	2.39	3.41
Error	33	14.680	0.444			
Total	47	22.473				

*Significant at 5%

Appendix VI

Analysis of variance table for grain yield per plant (gm)

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	1.048	0.349	-		
Nitrogen (N)	3	6.754	2.251	72.610**	2.89	4.45
Phosphorus(P)	2	5.199	2.599	83.837**	3.29	5.32
Interaction (NxP)	6	0.280	0.046	1.483	2.39	3.41
Error	33	1.031	0.031			
Total	47	14.312				

**Significant at 1%

Appendix VII

Analysis of variance table for straw yield per plant (gm.)

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	1.603	0.534	-		
Nitrogen (N)	3	39.888	13.269	23.076**	2.89	4.45
Phosphorus(P)	2	19.018	9.509	16.537**	3.29	5.32
Interaction (N x P)	6	5.529	0.921	1.601	2.39	3.41
Error	33	18.981	0.575			
Total	47	35.019				

**Significant at 1%

Appendix VIII

Analysis of variance table for grain yield (q./ha.)

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	0.075	0.025			
Nitrogen (N)	3	0.870	0.290	152.635**	2.89	4.45
Phosphorus(P)	2	0.130	0.065	34.210**	3.29	5.32
Interaction (N x P)	6	0.190	0.031	16.315**	2.39	3.41
Error	33	0.065	0.001			
Total	47	1.330				

** Significant at 1%

Appendix IX

Analysis of variance table for straw yield (q/ha)

Source of variation	d.f.	S.S.	M.S.S.	'F' Cal	'F' ratio	
					5%	1%
Replication	3	0.234	0.078			
Nitrogen(N)	3	2.435	0.811	130.806**	2.89	4.45
Phosphorus(P)	2	0.714	0.357	57.580**	3.29	5.32
Interaction (NxP)	6	0.500	0.083	13.387**	2.39	3.41
Error	33	0.206	0.006			
Total	47	4.089				

** Significant at 1%

V I T A

V I T A

The author of the thesis, Shri Uma Shankar Awasthi was born on 1st February, 1960 in Village Khajwa, Tehsil-Rajnagar, Distt. Chhatarpur, M.P.

He passed his Higher Secondary School Certificate Examination in First division with 68.6 percent marks from Govt. Higher Secondary School, Rajnagar in the year 1978.

He was admitted in B.Sc. (Ag.) in J.N.K.V.V., College of Agriculture, Rewa and obtained the Bachelor's degree in Agriculture with an O.C.G.A. 3.58 out of 4.00 Scale in 1984.

He joined the same College in 1984 for his Post-graduate studies leading to M.Sc. (Agr.) degree in Agronomy and completed the course work of M.Sc. (Agri.) with an O.C.G.A. 3.60 out of 4.00 scale.

He has a deep interest in augmenting linseed - production through the results of present investigation as well as other improved cultivation practices.