RESPONSE OF GRAM VARIETIES TO DATES OF PLANTING AND ROW SPACING

By

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B. Sc (Ag.)

THESIS

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R A K COLLEGE OF AGRICULTURE, SEHORE, M P.

CERTIFICATE

This is to certify that the thesis entitled "Response of Gram Varieties to Dates of planting and Row spacing submitted by Prafulla Raibagkar in partial fulfilment of the requirements for the award of the degree of Master of Science in Agriculture in Agronomy, Faculty of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, M P. is a faithful record of the bonafide research work carried out under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma.

Dated : 9-8-74

(C. P. S. Yadav)
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Dated 31/12/74

We hereby recommend that the thesis entitled Response of Gram Varieties to Dates of planting and Row spacing submitted by Prafulla Raibagkar be accepted in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE IN AGRICULTURE IN AGRONOMY.

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August 9 , 1974
Sehore , M.P.

P.S Raibagkar

(P . S . RAIBAGKAR)

CONTENTS

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INTRODUCTION

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

Starvation , want and adequate supply of food are problems as old as the world . Many things have changed since the dawn of civilization but the problem of malnutrition and hunger remains still unsolved and it will hardly be solved in future too because the world population is increasing at a fast rate . However , temporary relief has been achieved in food supply with the evolution of high yielding varieties of cereals coupled with advanced methods of their cultivation . But the problem of protein deficiency has created an alarming situation , particularly in under developed countries where millions of people are suffering due to malnutrition.

At present the entire world is facing protein shortage due to population explosion . According to U.N. Statistics the world population was 3.6 billions in the year 1968 , which is expected to rise to 6.0 billions in the year 2000 A.D. According to Colvin (1968), F.A.O. estimates , that by the year 2000 A.D. we must triple our present food production and increase the level of protein production by a factor of 40 to feed the growing population . This challenge can be met by increasing protein rich food from animal sources or by increasing production of pulses . The use of formers in daily diet of Indians is restricted because of two reasons ; firstly low production of animal protein and its high cost per unit. According to Divitt and Mudambi (1969) , the cost of animal protein varies from Rs. 0.18 to 0.47 per 10 grams where as that of vegetable protein ranges from Rs. 0.05 to 0.11 . Secondly majority of Indians

are vegetarian . Hence , increasing the production of pulses is the only alternative to tackle this problem .

Gram commands premier place amongst the pulse crops in India . It covers 7.85 million hectares under its cultivation with an annual production of 4.97 million tons , which accounts 50% of the total acreage and production under pulse crops in India . Madhya Pradesh ranks second in production as well as in acreage under this crop in India .

Gram , besides a rich source of protein also buildsup soil fertility and thrive well under unirrigated conditions where most of the rabi crops do not fairwell . The crop is so much important and common in Indian dietary that it is used in several ways and various forms through out the country , It is used as dal, besan , flour , crushed or whole gram , boiled or parched , roasted or cooked , salted or sweet preparations and green foliage as vegetables . Germinated seed is recommended against scurvy . Malic and oxalic acids extracted from green leaves of gram are used to cure intestinal disorders . It is also a rich source of calcium , phosphorous , iron and vitamin 'C' .

Unfortunately , gram crop in India have never traditionally yielded per hectare as much as crops grown in other countries of the world . For increasing the total production of gram in India , the per uit area yield is needed to be pushed up because no extra land is available which can be brought under plough for its cultivation. Hence , the only alternative is to increase yield per hectare by evolving new varieties of high yielding potentials with new

techniques of cultivation , such as optimum date of planting , suitable row spacing and judicious manuring .

Poor yield performance can be attributed to the lack of sufficient knowledge about optimum time of sowing . Crop sown at proper time gives more yield per hectare while a little early or late sowing may make a great difference in yield . Late sowing reduces growth period which ultimately affect grain yield . Early sowing ensures better utilization of moisture for growth particularly when moisture is a limiting factor . Time of sowing depends on several factors such as soil fertility , climatic conditions (rainfall , humidity and temperature) and characteristics of the variety .

Row spacing is the most important factor in the cultivation of gram crop . It has been observed that yield of gram is greatly affected by spacing . Therefore , to obtain maximum production of grain optimum row spacing must be provided to the crop . Proper spacing ensures uniform supply of moisture , nutrients and sunlight to the growing crop .

Varieties play an important role in the production of grain . Selection of proper variety for a set of agro-climatic conditions is very important to achieve maximum potential . It has also been observed that varieties interact with dates of sowing and row spacing .

Soil and climatic conditions vary from place to place in India . These varying problems , which are rarely identical from one place to another , demand individual indigenous investigation

before solutions for them can be found . Keeping in view the above facts a trial entitled " Response of gram varieties to dates of planting and row spacing" was conducted on gram crop during the Rabi season 1973-74 at Rafi Ahmad Kidwai Agriculture College Farm , Sehore (M. P.) to find out the answers of the following problems :

(i) Suitable date of sowing for Sehore region .

(ii) Optimum row spacing .

(iii) A variety which can prove highest yielder for this tract.

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

Though gram is an important pulse crop of the country but there is a great paucity of research work . However , an attempt has been made here to summarise the work already done on dates of sowing , spacing and variety aspects on this crop . A brief review of the same is presented below under the following heads :

EFFECT OF DATE OF SOWING ON :

Yield :- Singh (1959) , reported that end of September to mid October as normal sowing time of gram in U. P.

Sen, et-al. (1964) , stated that gram yield decreased when the crop was sown later than the last week of October .

Gandhi and Mathur (1964) , found at Delhi that yield of gram did not differ significantly when crop was sown from the first day to the last day of October under unirrigated conditions.

Sur , Sengupta and Sen (1966) , concluded that the grain yield was maximum when the crop was sown on October 28 , and there was reduction in yield in earlier or later sowings .

Sen , Sengupta and Mukherjee (1966) , reported , at Berhampore Farm , West Bengal , that highest yield of gram was obtained from early sowing (October) .

Sawhney (1967) , concluded from the experiments conducted at Punjab on gram , that the sowings carried out in the first fortnight of October proved conducive to higher grain yield than late plantings .

Sen (1967) , confirmed that late October sowing is best

for gram crop , but fair out turn could be obtained when sown up to the second week of November . Sowing in November gave poor yields and very early sown crop also did not yield high .

Eshel (1968) , stated that October sowing produces more grain yield per plant .

Mathur and Tomar (1968) , at Regional Agril. Research Station , Shriganganagar (Rajasthan) found that the optimum sowing time for all varieties of gram was from mid October to the first week of November .

Sharma , Batra and Vaidya (1968) , reported from the experiment on gram varieties , at Ferozpur Punjab , that higher grain yields were obtained from the sowings done on 21st October and 4th November than on 18th November .

Choudhary , Bhatia , Sharma and Singh (1971) , observed that planting on 2nd November gave maximum average yield of 36.48 qt/ha. The other two dates yielded significantly less . The reduction in yield was smaller in early plantings than in the late plantings.

Saxena , Yadav and Singh (1971) , reported the results of an investigation carried out on the different dates of sowing , row spacing and varieties at Pantnagar . They found that the sowing on 25th November gave higher yields than late sowing .

Maheshwari and Singh (1972), concluded from the experiments carried out at Jabalpur and Indore , that yield differences due to different sowing dates were significant at both the locations . The highest mean grain yield (22.34 qt/ha.) was recorded

at Jabalpur when the crop was sown on 5th November while at Indore the optimum sowing time was 20th October , which produced highest mean grain yield (18.58 Qt/ha.) .

Singh and Mishra (1972) , reported significant differences in the yield due to different dates of sowing . The crop planted on 30th October gave highest grain yield of 27.05 Qt/ha. They further stated on the basis of past results that 15th October sowing gave the highest yield . There was decrease in yield of gram varieties when planted after 30th October .

Khedkar (1972) , observed that the yield differences due to various dates of planting were significant . Sowing done on 1st October gave the highest yield . The yield was significantly reduced as the sowing was delayed .

Saxena , Yadav and Singh (1972) , concluded that the effect of dates of planting was highly significant . Yield decreased significantly as the date of sowing was delayed beyond October , 30.

Khedkar (1972-73) , found that out of different dates of sowing viz 1st October , 15th November and 30th November . First two dates of sowing (1st & 15th Oct.) were significantly superior in yield.

Nema (1973) , conducted an experiment at the Agriculture College Farm , Sehore on gram and found that the effect of dates of planting was highly significant . He concluded that yield declined with late sowing beyond October , 30 .

Saxena and Yadav (1973) , found that date of sowing i.e. 30th November gave the highest yield of gram over other dates of

sowing . They concluded that yield differences between different dates of sowing were not statistically significant .

Panwar and Singh (1973) , reported from Kanpur , that the yield of grain was consistent up to 30th October at Kalyanpur , Etawah and Azamgarh centres . Drastic reduction in yield were recorded at all centres for 15th November and 30th November sowings.

Results of the coordinated trials conducted at different centres under I.A.R.I. Pulse Project during 1972-73 , indicate that the difference in yield due to dates of sowing were significant . 30th October , 1st October , 15th October and 15th October were found significantly superior in yield at Ludhiana (Punjab), Sehore (M.P.) Bandnapur and Chanduli (M.S.) respectively .

Plant height:- Singh and Alam (1944) , reported that the rate of increase in stem height was greater in late sowing than early ones.

Mahanta (1967) , reported that the wheat crop sown on 1st December recorded significantly more height than other dates of sowing . The plant height decreased when sown earlier or later than optimum time of sowing .

Indoria (1968) , found that the height of wheat plant mostly increases from 1st to last date of sowing .

Maturity:-Singh and Alam (1944) , stated that as the sowing were delayed in wheat crop the number of days from sowing to ripening went on decreasing .

Pal and Bhutani (1947) , observed progressive decrease in the number of days taken from sowing to maturity , in delayed sowing of wheat crop .

Test weight :- Singh and Alam (1944) , found that there was a definite reduction in test weight with late sowing .

Pal , et - al (1947) , found that early sowing in wheat crop recorded more test weight of 1000 grains as compared to late sowing . This is also confirmed by Garg (1959) , Indoria (1968) .

Protein content :- Viljoen (1937) , from South Africa reported that delayed planting of Soyabean results in slight increase in protein content .

Maley (1968) , concluded from experiment done at Sehore Agriculture College that the increase in protein percentage was associated with delayed planting of soyabean crop .

EFFECT OF ROW SPACING ON :

Yield :- Anonymous (1953-54) , at Arnej in Ahmedabad observed that 30 cm. spacing between two rows gave significantly higher yield than either 38 cm. or 46 cm. spacings .

Anonymous (1955-56) , from Niphad in Nasik (M.S.) concluded that 25 cm. spacing gave higher yield than 37 cm. in both the years , but the difference in yield was significant only in one year .

Anonymous (1957-58) , from Waghai in the Dangs , found that 25 cm. spacing between two adjacent rows gave significantly higher yield than 38 cm. spacing with chafa variety in two out of three years .

Nirad , Sen and Jana (1960) , stated that number of pods and yield per plant increased with wider row spacing .

Sawhney (1967) , stated that 30 cm. spacing between the rows produced higher yields under Hissar conditions .

Davis , et - al (1969), found that narrow row spacing of

25 cm. gave maximum yield (2735 Kg/ha.) as compared to wider row spacing of 50 cm. (2135 Kg/ha.) .

Choudhary , et - al (1971) , observed that row spacing of 30 cm. gave the highest grain yield (36.34 qt/ha.) . Increasing the row spacing to 45 cm. reduced in a significant loss of yield (3.0 qt/ha.) . At 60 cm. spacing the yield reduction was maximum (0 to 15 qt/ha.) .

Saxena , et - al (1971) , reported from Agriculture University , Pantnagar that row spacing failed to show any significant effect on the yield of gram crop . However , they reported higher yield in 30 cm. spacing than the 45 cm. and 60 cm. spacings.

Maheshwari , et - al (1972) , found in a three years trial that 20 cm. row spacing gave highest grain yield at Jabalpur while at Indore the highest grain yield was recorded under 30 cm. spacing. Similar results were obtained by Sen and Jana (1960) and Horner , et - al (1967) .

Saraf (1972) , found that row spacings affected grain yield significantly . A closer spacing of 30 cm. row to row gave 207 Kg/ha. more yield over wider spacing of 45 cm.

Singh and Mishra (1972) , reported from Hissar that row spacing failed to show any significant effect on the yield of gram .

Khedkar (1972) , found that row spacing influenced the yield significantly . The yield was decreased significantly as the row spacing increased from 30 cm. to 60 cm.

Saxena , et - al (1972) , observed that the differences between three row spacings were not significant . But the row spacing of 30 cm was best for variety C.235 .

Khedkar (1972) , in his studies on the effect of irriga - tion and row spacing on yield of gram noted that the spacing of 30 cm. x 15 cm. gave significantly higher yield than 45 x 10 cm. spacing .

Nema (1973) , found in his studies at Sehore Agriculture College Farm that the variety G.62-404 sown with 30 cm. row spacing gave significantly higher yield than other treatments.

Yadav , et - al (1973) , found that difference due to row spacing was highly significant . Sowing at 45 cm. apart was found superior over 30 cm.

Panwar and Singh (1973) , concluded from the results of two research centres , (Etawah & Azamgarh) that the 30 cm. row spacing was significantly superior to 45 cm. spacing .

Sinha (1973) , found that the crop planted with the row spacing of 30 cm. produced maximum grain yield .

Kaul and Sekhon (1973) , reported from Punjab Agriculture University Ludhiana , that the row spacing did not influence the grain yield significantly . However , the trend was in favour of 30 cm. row spacing .

Results of the coordinated trials conducted at different centres during 1972-73 indicate that the differences in yield due to row spacings were significant . Row spacing of 30 cm. proved superior than 45 cm. row spacing at Sehore , Ludhiana and Chanduli centres . Under irrigated conditions , at Badnapur (M.S.) row spacing of 45 cm. was found superior in yield over 30 cm. row spacing .

Plant population :- Pickett and Fredericks (1960) , reported that very high yield of jowar and more number of plants with closer spacing as compared to wider spacing .

Yadav (1963) , found that the spacing of 30 cm. between rows of jowar crop gave highest number of plants per plot than the wider spacing .

Paliwal (1965) , recorded more number of jowar plants with closer spacing of 30 cm. as compared to wider spacing .

Plant height :- Paliwal (1965) , found that different spacings have not influenced the height of jowar plants considerably . However , maximum height of plants was recorded in wider spacing than the closer spacing .

Test weight :- Nirad , et - al (1960) , reported that the test weight of 1000 grains was more or less the same in 25 cm. and 45 cm. spacings.

EFFECT OF VARIETIES ON :

Yield :- Mathur and Tomar (1968) , reported that variety R.S.-10 and local proved superior over kabuli gram .

Choudhary , et - al (1971) , found superiority of variety C.235 over G.24 in respect of grain yield .

Saxena , et - al (1971) , concluded from the trials carried out at Pantnagar with three selected varieties viz. C.235 , G.130 and T.3 that variety C.235 and G.130 were best yielders and were significantly superior to T.3 .

Saraf (1972) , reported that out of three selected varieties of gram viz. C.235 , C.104 and G.130 , variety C.235 was superior to all other varieties .

Trials carried out at Hissar in the year 1971-72 with two selected varieties , C.235 and C.214 showed that differences due to varieties were non significant .

Khedkar (1972) , found superiority of variety chafa over variety C.235 .

Results of coordinated trials during 1972-73 , indicate that the variety G.62-404 was statistically superior in yield to C.235 at Sehore and Badnapur centres . At Sehore T.3 recorded higher yield than C.235 but was inferior to G.62-404 .

Saxena and Yadav (1973) , reported that out of three varieties , variety C.130 produced highest yield followed by T.3 and H.355 .

Sinha (1973) , reported that out of two varieties viz. C.235 and S.T.4 , the variety Ex. C.235 proved better than S.T.4 in respect of grain yield .

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation was conducted during the rabi season of 1973-74 at Rafi Ahmad Kidwai Agriculture College Farm , Sehore (M.P.) in order to study the effect of five dates of planting and two row spacings on the yield of different varieties of gram . The varieties taken for the experiment were T.3 , C.235 and G.32-404.

EXPERIMENTAL SITE :

The experiment was conducted in field No.15 of the College Farm with an area of 0.34 hectare . The topography of the experimental field was fairly uniform .

SOIL :

The farm has medium black soil with average fertility . Soil samples (0 - 25 cm. depth) from experimental field were collected from different places at-randomly before sowing the crop . The composite sample was subjected to mechanical and chemical analysis and the results are given in Table 1 .

TABLE 1 : Showing Mechanical and Chemical Composition of Soil .

S.No.	Particulars	Contents	Methods of determination
A.	Mechanical		
1.	Sand	33.2 %	By International
2.	Silt	27.4 %	pipette method .
3.	Clay	39.2 %	(Piper , 1950)
B.	Chemical		
1.	Available nitrogen (kg/ha)	205.0	Alkaline Permanganate method (Motiramani, 1964).

Table 1 continued

S.No.	Particulars	Contents	Methods of determination
2.	Available phosphorous (Kg/ha.)	13.6	Sodium bi-carbonate extractant. (Olsen , 1954)
3.	Available potash (Kg/ha.)	335.0	Morgan's extractant . (Motiramani , 1964)
4.	Soil pH	8.1	Beckman's pH meter .

The analysis shows that the soil is clayey in texture and is low in nitrogen , medium in phosphorous and high in potash .

CLIMATE AND SEASON :

Sehore is situated at Latitude (22° 33' and 23° 54' north) and Longitude (76° 11' and 78° 02' east) and lies in the Eastern tract of Malwa plateau of Madhya Pradesh , and enjoys sub-tropical climate with maximum temperature of 48.7°C. (110°F.) in the month of May-June and minimum temperature of 4,4°C. (40°F.) in the month of December - January . The average annual rainfall is 101 cm. (40") which is mostly received in the months of June to September . Occasionally winter showers are received which proved very useful for rabi crops . This year frost occured in the months of January and February . Occurance of severe frost is rare but mild damage to crops on account of cold waves is occasionally experienced from the mid of December to the mid of February .

The daily meteorological observations were recorded during the course of experiment . The fortnightly weather data recorded are depicted in the figure 1 and summary table of the data is given in Table 2 .

FIG. 1

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FORTNIGHTLY METEOROLOGICAL OBSERVATIONS - 1973-74

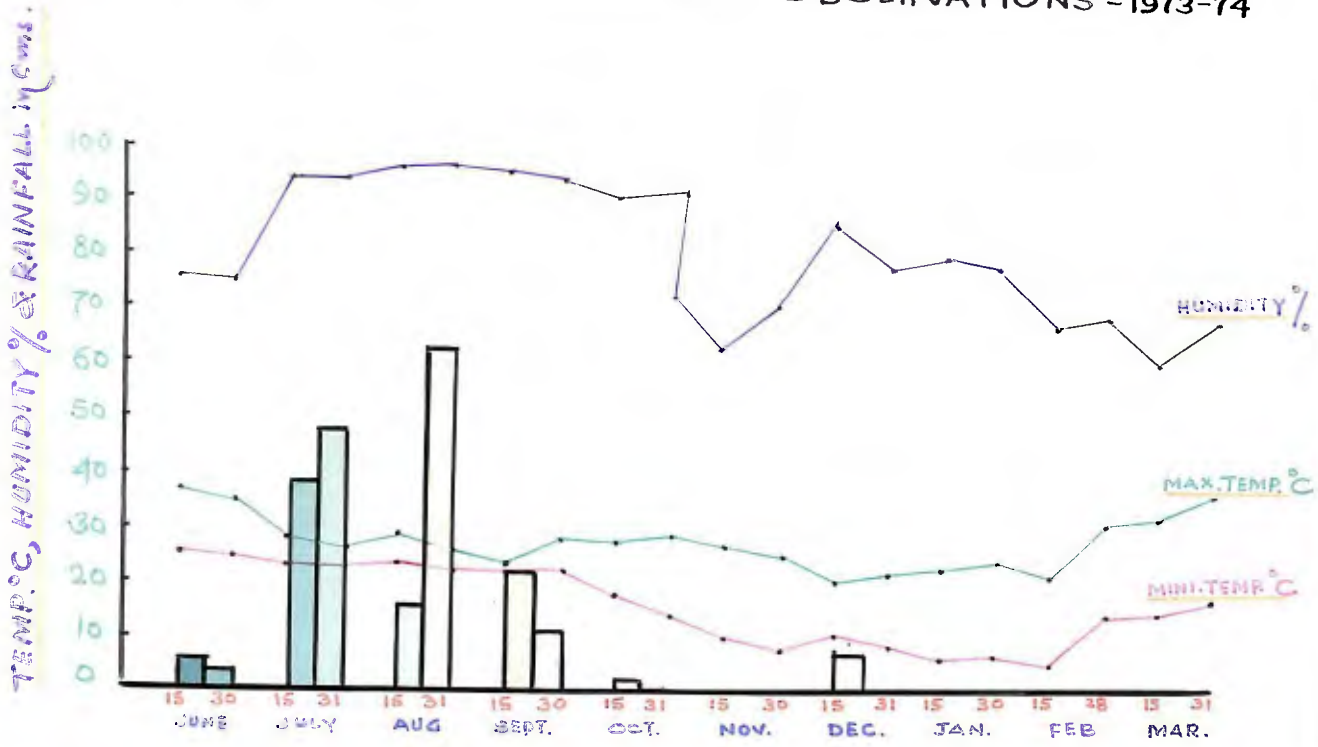


TABLE 8 : Meteorological Observations from 1st June 1973 to 31st March , 1974 .

S.No.	Date From	Date To	Temperature Max. °C	Temperature Min. °C	Humidity percentage .	Rainfall in Cms.
1.	1 -	15 June	36.6	24.6	76	5.46
2.	16 -	30 "	34.8	24.7	75	3.15
3.	1 -	15 July	27.7	22.5	94	33.19
4.	16 -	31 "	25.8	22.0	94	48.21
5.	1 -	15 August	28.4	23.0	96	15.62
6.	16 -	31 "	25.5	21.6	97	63.06
7.	1 -	15 September	28.9	20.6	96	20.91
8.	16 -	30 "	27.1	21.2	95	10.12
9.	1 -	15 October	27.2	17.2	91	0.74
10.	16 -	31 "	28.3	13.3	73	Nil
11.	1 -	15 November	26.4	9.6	64	"
12.	16 -	30 "	25.5	7.1	72	"
13.	1 -	15 December	20.3	9.4	87	6.09
14.	16 -	31 "	21.3	7.5	79	Nil
15.	1 -	15 January	22.2	4.2	81	"
16.	16 -	31 "	23.9	5.4	80	"
17.	1 -	15 February	20.4	3.8	68	"
18.	16 -	28 "	30.3	13.4	70	"
19.	1 -	15 March	31.7	13.7	61	"
20.	16 -	31 "	35.2	15.7	69	"

The total rainfall during the year 1973-74 was recorded

to 211.55 cm. which was almost double than the normal year . During the months of October and November temperature was 28°C and 26°C respectively, which favoured good germination . During this year monsoon started from last week of September . Rainfall was intense and maximum in the months of July and August .

Rainfall from the first week of July to middle of August and last week of August to second week of September was moderately distributed . Nominal rains intraces were received in the month of October and the atmosphere was clear till the end of November . Winter showers during the month of December amounted to 6.0 cm. which proved very useful to the crop.

PREVIOUS CROPPING HISTORY OF THE FIELD :

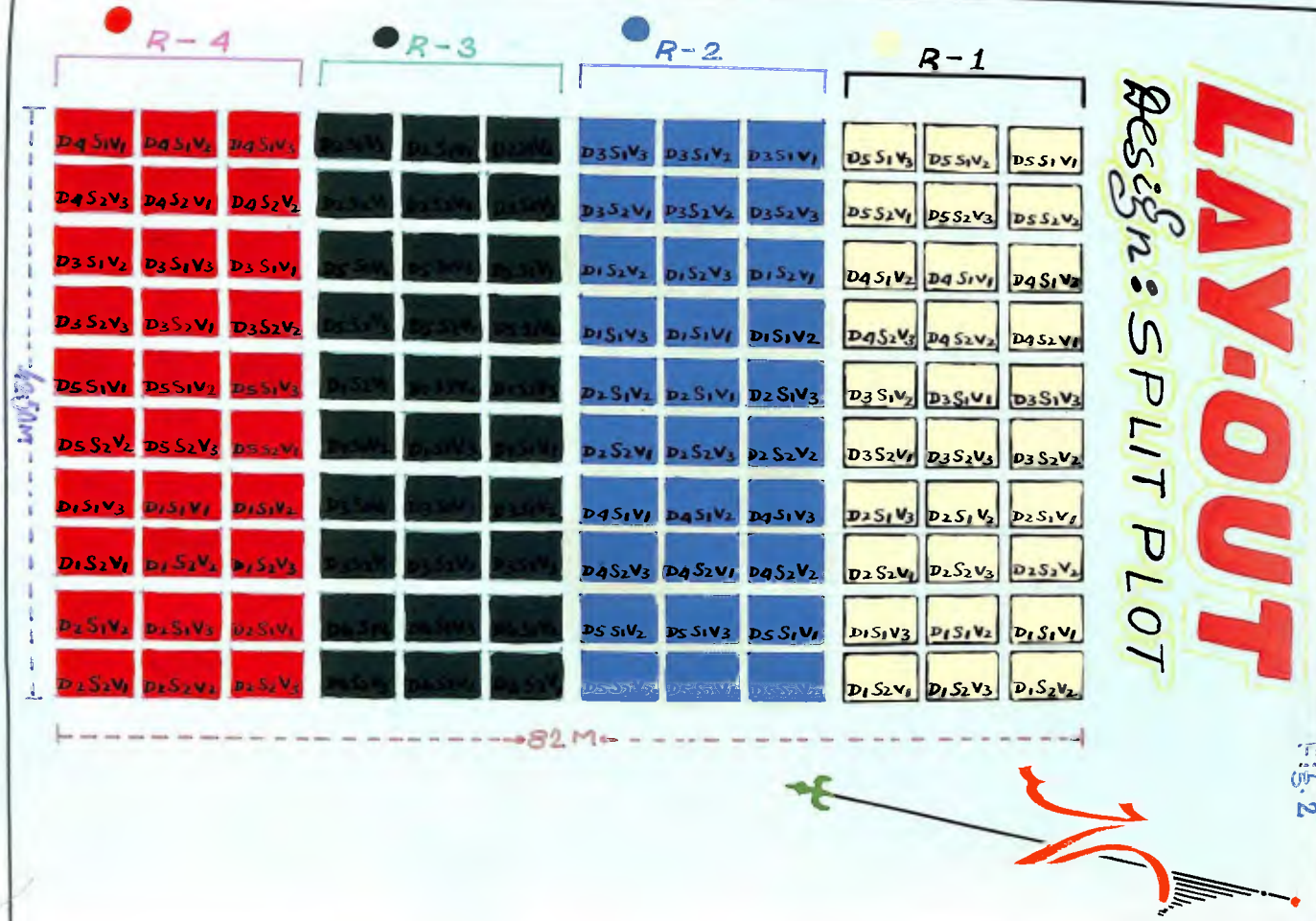
The cropping sequence of the field in which present investigation was carried out was in the following order -

Year	Season	Crop
1971-72	Kharif	Arhar
	Rabi	-
1972-73	Kharif	Urd & Moong
	Rabi	Gram
1973-74	Kharif	Fallow
	Rabi	Gram

EXPERIMENTAL DETAILS :

Particulars of the experiment are given below and the plan of lay-out is given in Fig. 2 .

1. Design - Single split plot .
2. Replications - 4 (Four)


LAY-OUT
design: SPLIT PLOT
R-4
R-3
R-2
R-1
82 M
Fig. 2

3. Gross plot size - 3.0 x 3.6 metre or 21.6 sq. metre.

4. Net plot size - 3.0 x 3.0 " or 15.0 sq. " (S_1)

5.0 x 2.7 " or 13.5 sq. " (S_2)

5. Dimension of the field - 82.0 x 42.5 metre .

6. Total experimental area - 3485 sq. metres.

7. Spacing - row to row - 30.0 cm. (S_1)

45.0 cm. (S_2)

8. Rows in gross plot - 12 (S_1)

8 (S_2)

9. Rows in net plot - 10 (S_1)

6 (S_2)

Treatments and Symbols used :-

Main treatments - Dates of sowing .

1st October 1973 (D_1)

15th October 1973 (D_2)

30th October 1973 (D_3)

15th November 1973 (D_4)

30th November 1973 (D_5)

Sub treatments - Spacing cum Variety

30 cms. (S_1)
45 cms. (S_2)
x
T. 3 (V_1)
C.235 (V_2)
G.62-404 (V_3)

Treatment combinations - 30 .

APPLICATION OF FERTILIZER :

Recommended doses of N and P for gram crop viz. 25 kg N and 50 kg P per hectare were given , just before the sowing .

DiAmmonium Phosphate (250 gms/plot) was applied in rows by manual labour at the time of sowing 4 cm. below the seed .

CULTURAL OPERATIONS :

Pre sowing Operations :-

Before sowing the seed bed was prepared by carrying out following operations :-

a. Disc ploughing	-	1
b. Bukharing	-	3
c. Planking	-	1

After bukharing the weeds were collected and destroyed .

Seed Treatments :-

Prior to sowing germination percentage of all the three varieties was tested . Representative samples of hundred seeds of each variety were taken and the germination percentage was tested , which was 98 % , 94 % and 92 % for varieties T.3 , C.235 and G.62-404 respectively .

Before sowing seed was treated with Thiram at the rate of 3.0 gms. per kilogram of seed .

Sowing :-

First sowing was done on 1st October 1973 . Treated seeds were dibbled at a depth of about 3-4 cm. in rows . The seed rate used was 80 kg./ha.

Irrigation :-

One pre sowing irrigation was given before each date of planting . One more irrigation was given to the crop to protect it from frost damage .

Post sowing Operations :-

No interculture operations were done except one hand weeding.

Plant Protection Measures :-

Severe attack of gram caterpillar (Heliothis armigera) was noticed after three months of sowing . These were effectively controlled by spraying Nuvacron 40 EC on 8th February 1974. Spraying of Dimecron 50 WP was done on 28th February 1974 as a precautionary measure for insect pests .

Harvesting and Threshing :-

Both operations ; harvesting and threshing were done from 21st March 1974 to 26th March 1974 . The border rows were left as such at the time of harvesting . Varietywise harvesting was done by manual labour with the help of sickles . The harvested material of each net plot was threshed separately by hand beating . The threshed material was then cleaned by the help of local hand fan (Soopa) and the final weight of grain was recorded .

VARIETAL CHARACTERS :

Varietal characters are given below for general reference.

1. T.3 - T.3 variety is characterised by the medium to late maturing variety (165 days) . Plants are spreaded type . Flowers are pink and the seeds are round , smooth and very bold having light gray colour . Average height is 33 to 35 cm.

2. C.235 - It is an outstanding variety which is less affected in years of severe epiphytics of gram blight . This is the medium to late maturing variety (160 to 165 days). Plants are tall and well spreaded type . Flowers are pink in colour and the seeds are medium in size having yellowish gray colour .

3. G.62-404 - The variety is double podded , with wide adoptability Average height is 37 - 38 cm. and it matures in 120 to 125 days . Seed colour is light yellowish brown and thousand grain weight is 150 gms.

COLLECTION OF DATA :

Atrandom five plants in each net plot area were taken for study . The first observation was taken after 15 days of sowing and subsequent observations were recorded fortnightly .

Methods and details of observations recorded during the course of investigation are given below :

Methods and Details of Observations :-

1. GROWTH STUDIES :

(A) Plant population :

Total number of plants in each plot were recorded .

(B) Final Growth :

Final height of the plant in Cms - The final plant height was measured in cms after 90 days of sowing . The main shoot was taken to reoresent the height of the plant . The height was recorded from the ground surface to the topmost leaf lamina .

(C) Progressive Growth :

a. Height of the plant at successive stages - Plant height was measured in cms at different successive stages of growth . Fortnightly height observations were recorded till the pod - formation .

b. Number of branches per plant - The total number of main branches were counted alongwith main shoot .

c. Number of days for flower initiation and flowering (50 %) - Visual observations were taken to know the average number of days for flowering . Total number of days from sowing to initiation of flowers and flowering were recorded for different treatments.

d. Number of days for pod initiation and pod setting (50 %) - Visual study was done to observe the average number of days for pod initiation and pod setting . This was recorded daily from initiation of pods till the pod formation did not complete in each main and sub treatments .

e. Number of days required for maturity (95 %) - Visual observations were taken to know the number of days required for maturity (95 %) in different treatments . This was recorded daily from initiation of maturity of pods till the 95 % pods did not mature in all the treatments .

2. YIELD STUDIES :

a. Number of effective pods per plant - After pressing the pods gently by hand , the presence or absence of grain inside the pod was known . The pod containing the grain was counted as effective pod .

b. Grain yield - The yield of grain per plot was recorded with the help of Pan Balance in kilograms . Since the net plot size varied in different spacing treatments , the yield per hectare in quintals was calculated by the appropriate conversion factor to bring out uniformity per plot .

c. Test weight of 1000 grains - Samples were drawn from finally cleaned grain of each plot to record test weight of 1000 grains . The broken shrivelled and unmatured seeds were discarded .

3. QUALITY STUDY :

Protein content of the grain - Composite samples of completely matured seeds of each variety at different dates of sowing were collected and taken for analysis . Samples were dried and powdered. For determining the protein content , the nitrogen content was estimated by the Kjeldahl's Method (Piper 1950) and it was calculated by using the conversion factor of 6.25 .

STATISTICAL ANALYSIS :

Split plot Design was adopted for the present investigation , and the statistical analysis of data by the technique of analysis of variance as described by R.A. Fisher , in order to study the significant differences amongst the different dates of sowing , rowspacings and varieties . The 'F' test was performed for judging the significance of the treatment mean squares .

In the case where the test proved the significance of treatment effect , critical differences at 5 % probability level were worked out to judge the difference between the two treatment means . The analysis of variance of following characters were studied .

a. Plant population per plot .
b. Average height of the plant in cms.
c. Average number of branches per plant .
d. Average number of effective pods per plant.
e. Grain yield in quintals per hectare .
f. Test weight of 1000 grains .

SKELETON OF ANALYSIS OF VARIANCE TABLE:

S.No.	Source of Variance	D.F.	S.S.	M.S.	F.c.	F.t.5%-1%
1.	Replication	3				
2.	Date of sowing	4				
3.	Error (a)	12				
4.	Spacing x Varieties	5				
5.	Interaction	20				
6.	Error (b)	75				
	TOTAL	119				

In case , the 'F' test has given significant result , standard effor and critical difference was calculated by the following formulas :

1. For Main Treatment -

$$S.Em. = \sqrt{\frac{E(a)\ M.S.}{Rep. \times Sub\text{-}treat.}}$$

$$C.D. = S.Em. \times t\ 5\% \times \sqrt{2}$$

2. For Sub Treatment -

$$S.Em. = \sqrt{\frac{E(b)\ M.S.}{Rep. \times Main\ treat.}}$$

$$C.D. = S.Em. \times t\ 5\% \times \sqrt{2}$$

3. Interaction - (D x SV) -

$$S.Em. = \sqrt{\frac{(\text{Sub treat.} - 1)\,(E_{(b)}\ M.S. + E_{(a)}\ M.S.)}{\text{Rep. x Sub treatment}}}$$

$$C.D. = S.Em. \times t\ 5\% \times \sqrt{2}$$

$E_{(a)}$ - $E_{(a)}$ denotes the error due to main factor .

$E_{(b)}$ - $E_{(b)}$ denotes the error due to sub factor .

EXPERIMENTAL FINDINGS

..... ?

EXPERIMENTAL FINDINGS

The text of this chapter deals with the results of the experiment . The data relating to growth characters , yield and its attributory characters have beeb analysed statistically (Appendix I and II) . The results of main effects and those of the significant interactions have been summarised in appropriate tables and have also been depicted by bar diagrams and figures .

GROWTH CHARACTERS :

(A) PLANT POPULATION PER PLOT -

As per analysis of variance table vide appendix I , the effect of spacing was highly significant and those of varieties , dates of sowing and interactions were non significant . The summary tables of treatment averages are presented below :

TABLE 3 : PLANT POPULATION PER PLOT - S x V

Treatments	S_1	S_2	Mean averages
V_1	400.8	344.1	372.4
V_2	408.0	311.0	359.5
V_3	389.3	332.1	360.8
Mean averages	399.3	329.1	

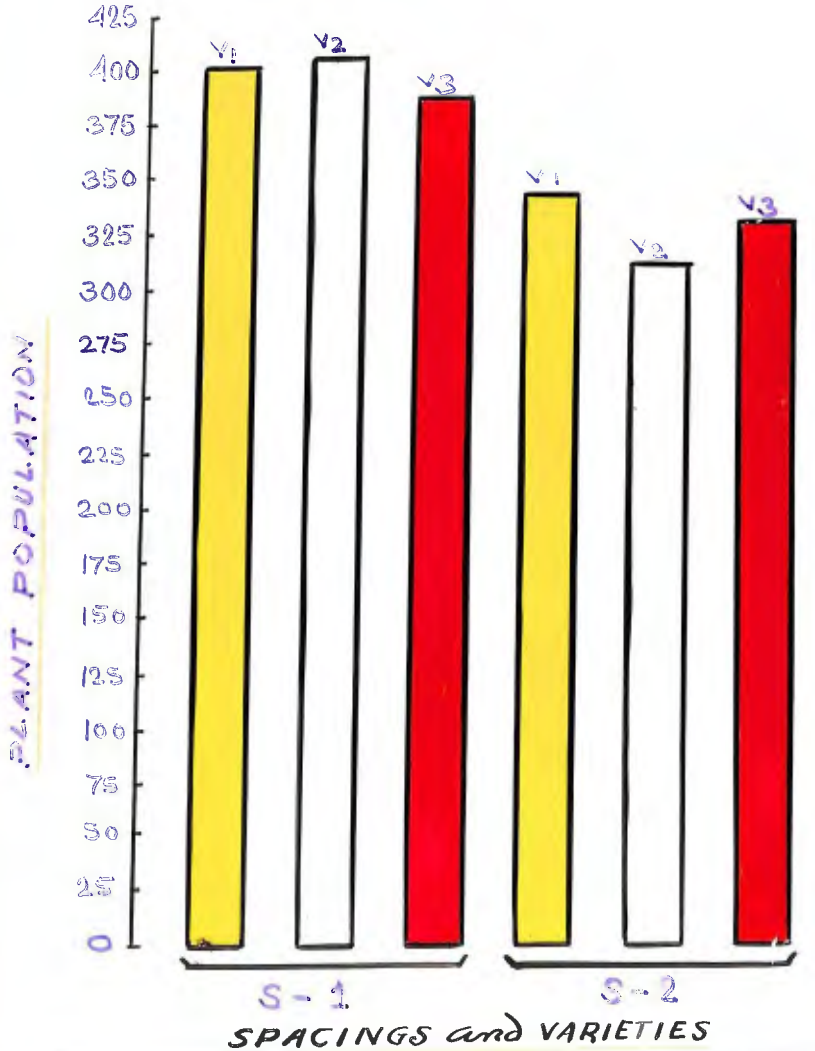
S.Em. ± 9.8

C.D. at 5% 27.24

Table 3 , reveals that spacing differed in giving the

Fig-3

EFFECT OF DIFFERENT TREATMENTS ON PLANT POPULATION/PLOT



final stand of the crop . Spacing of 30 cm. recorded significantly more plant population as compared to 45 cm. spacing . Variety T.3 had more plant population than other varieties (C.235 and G.62-404 However , the differences were non significant . The results have also been depicted graphically in Fig.3 .

TABLE 4 : PLANT POPULATION PER PLOT - D x V

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
V_1	364.8	358.7	380.7	390.1	367.7	372.4
V_2	345.6	323.0	353.5	392.6	382.8	359.5
V_3	331.3	354.5	367.2	365.5	385.6	360.8
Mean averages	347.2	345.2	367.1	382.7	378.7	

Main factor - Non significant .

Amongst different dates of sowing D_4 (15th Nov.) recorded more number of plants per plot followed by D_5 , D_3 , D_1 and D_2 , but the differences were non significant statistically .

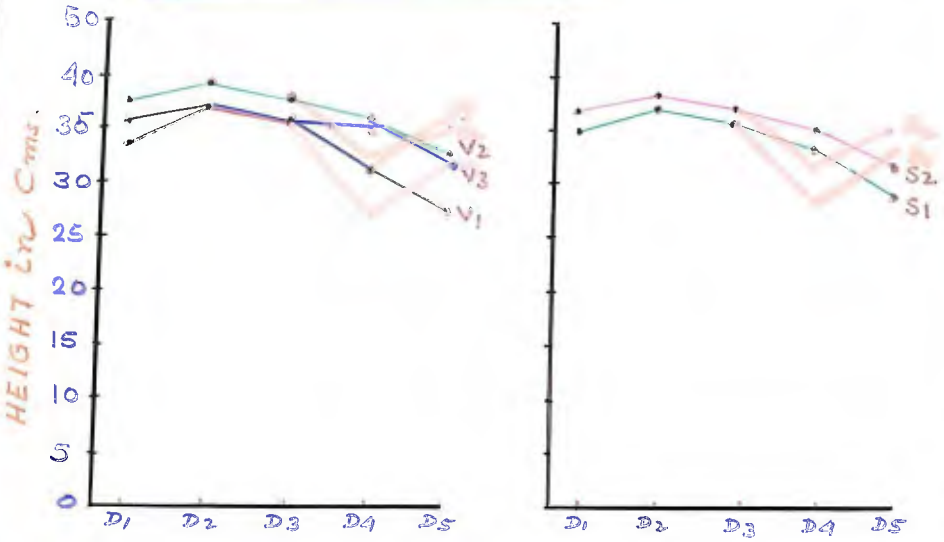
(B) FINAL HEIGHT OF THE PLANT IN CMS -

Height of the plant is an important character of plant growth which ultimately reflects the yield of the crop .

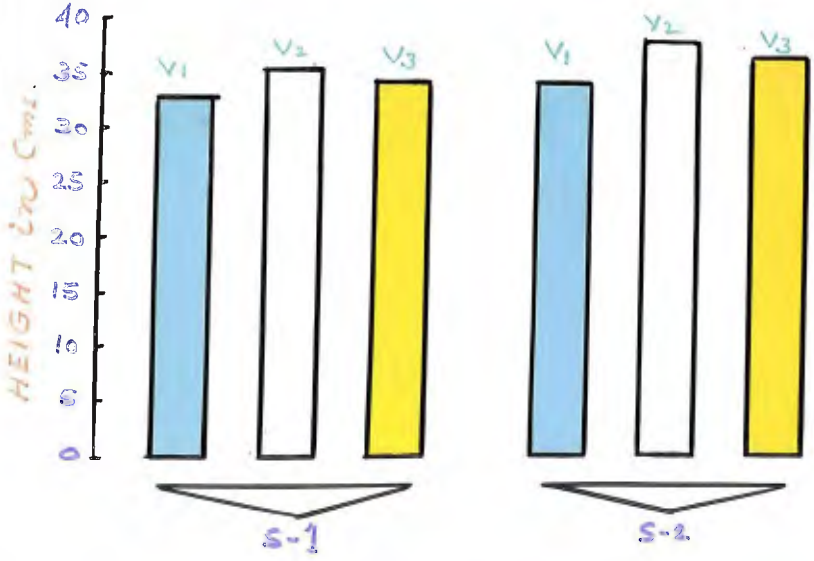
It is obvious from the analysis of variance table vide appendix I , that the different dates of sowing , varieties and spacings affected final plant height significently but interactions of main factor and sub factor failed to reach to the level of significance .

EFFECT OF DIFFERENT TREATMENTS ON average

HEIGHT OF PLANTS. (in Cms.)



DATES OF SOWING



SPACINGS and VARIETIES

MAIN EFFECTS :

DATES OF SOWING -

TABLE 5 : FINAL HEIGHT OF THE PLANT IN CMS - D x V

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
V_1	33.9	37.2	35.7	31.6	27.2	33.1
V_2	37.5	39.1	38.0	35.5	32.4	36.5
V_3	35.8	37.3	35.9	35.8	31.4	35.2
Mean averages	35.7	37.8	36.5	34.3	30.3	

S.Em. ± 0.64

C.D. at 5% 1.99

It is clear from the Table 5 and Fig. 4 , that the dates of sowing affected the plant height significantly . Tallest plants were observed in D_2 (15th Oct. sowing) followed by D_3 , D_1, D_4 and D_5 . Plant height was recorded significantly superior in D_2 plots over D_1 , D_4 and D_5 . Differences in plant height between D_2 and D_3 were statistically non significant . Minimum height of crop plants was recorded in D_5 plots which was found significantly inferior to all other dates of sowing .

VARIETIES :

TABLE 6 : HEIGHT OF THE PLANT IN CMS - S x V

Treatments	S_1	S_2	Mean averages
V_1	32.6	33.6	33.1
V_2	35.1	37.8	36.5
V_3	34.4	36.1	35.2
Mean averages	34.0	35.8	

S.Em. ± 0.53

C.D. at 5% 1.47

The above table shows that variety T.3 (V_1) produced less height of the plants and was found significantly inferior to C.235 (V_2) and G.62-404 (V_3) , Fig.4 . Maximum height of the plant was recorded in variety C.235 (V_2) followed by G.62-404 (V_3) , however differences between these two were not significant .

SPACINGS :

As regards spacing S_2 was found significantly superior to S_1 . Data recorded are illustrated vide Fig. 4 and Table 6 .

PROGRESSIVE GROWTH :

(A) AVERAGE HEIGHT OF PLANT AT SUCCESSIVE STAGES OF GROWTH -

The average height of the plants as affected by different treatments at the successive stages of growth is presented in the Table 7 and have also been depicted graphically in Fig. 5 .

Fig. 5

EFFECT OF DIFFERENT TREATMENTS ON AVERAGE HEIGHT OF PLANTS AT SUCCESSIVE STAGES OF GROWTH.

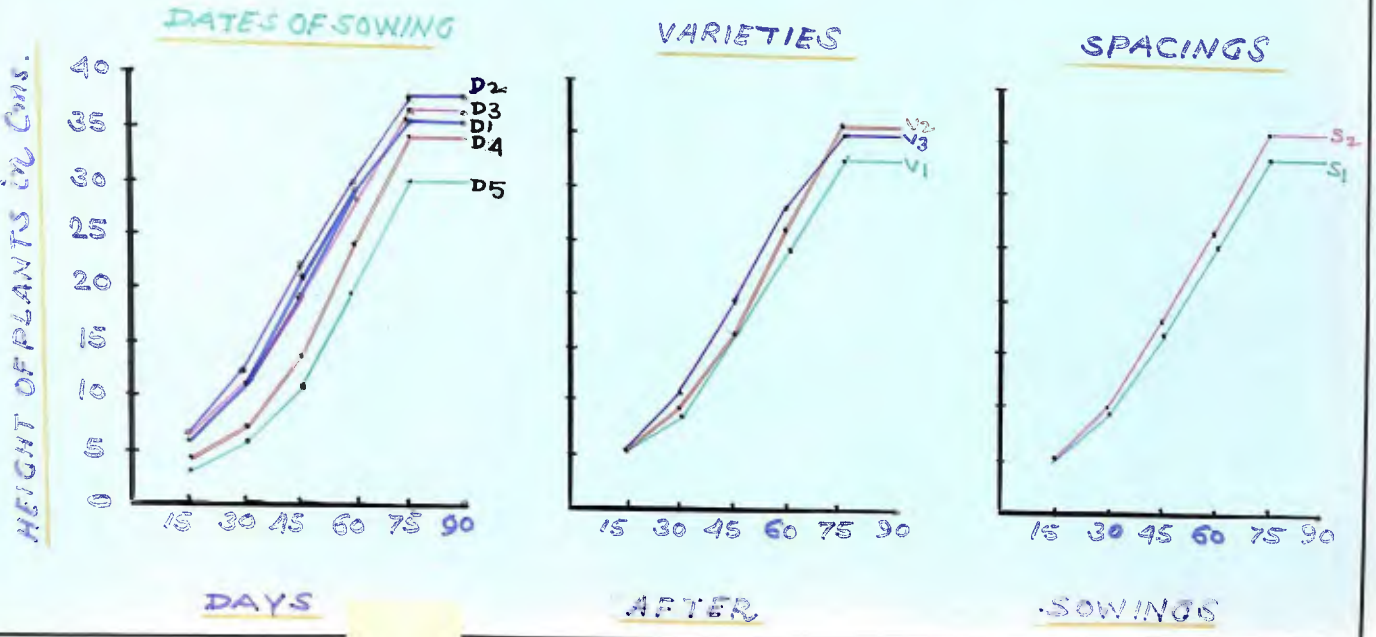


TABLE 7 : AVERAGE HEIGHT OF PLANT (CMS) AT DIFFERENT SUCCESSIVE STAGES OF GROWTH .

Treatments	Days After Sowing					
	15	30	45	60	75	90
Dates of sowing						
D_1	5.5	11.1	21.4	29.2	35.7	35.7
D_2	5.7	12.3	22.2	29.5	37.8	37.8
D_3	5.7	11.1	19.4	28.5	36.5	36.5
D_4	4.0	7.2	13.8	24.3	34.3	34.3
D_5	3.0	5.8	10.6	19.8	30.3	30.3
Row spacings						
S_1	5.3	9.4	16.9	25.6	34.0	34.0
S_2	5.2	9.6	18.0	27.0	36.3	36.3
Varieties						
V_1	5.1	8.9	16.4	24.1	33.1	33.1
V_2	5.1	9.0	16.5	26.3	36.4	36.4
V_3	5.4	10.6	19.5	28.4	35.2	35.2

It is evident from the Table 7 and Fig.5 , that the maximum rate of growth started from 30th day of sowing and it continued almost in the same pattern up to 75 days after sowing . After this no increase in plant height was observed and the trend of growth curve was maintained in straight line till maturity of the crop .

(B) NUMBER OF BRANCHES PER PLANT -

The number of branches is also a measure of growth and

has direct bearing on the yield of crop . It is seen from the variance table vide appendix I , that the effect of dates of sowing and varieties was significant statistically . The summary tables of treatment averages are presented below .

MAIN EFFECTS :

DATES OF SOWING -

TABLE 8 : NUMBER OF BRANCHES PER PLANT - D x V

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
V_1	3.7	3.7	3.7	3.3	3.3	3.6
V_2	3.5	3.3	3.2	3.0	3.0	3.2
V_3	4.1	4.3	3.6	3.5	3.1	3.7
Mean averages	3.7	3.8	3.5	3.2	3.1	

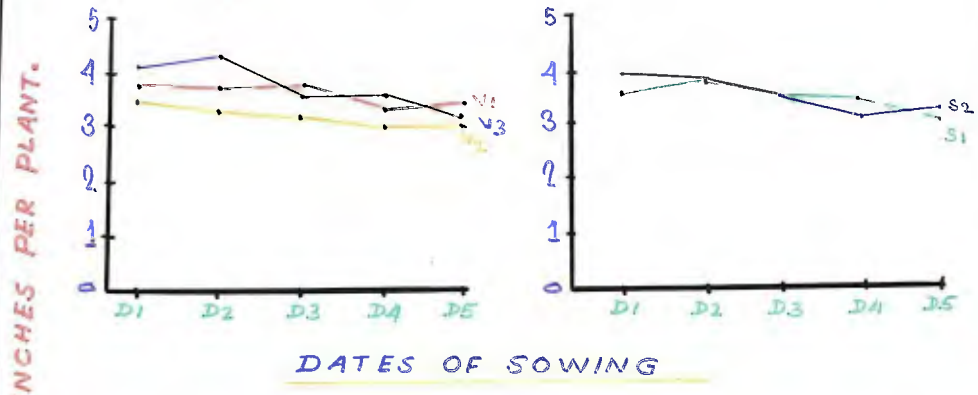
S.Em. ± 0.144

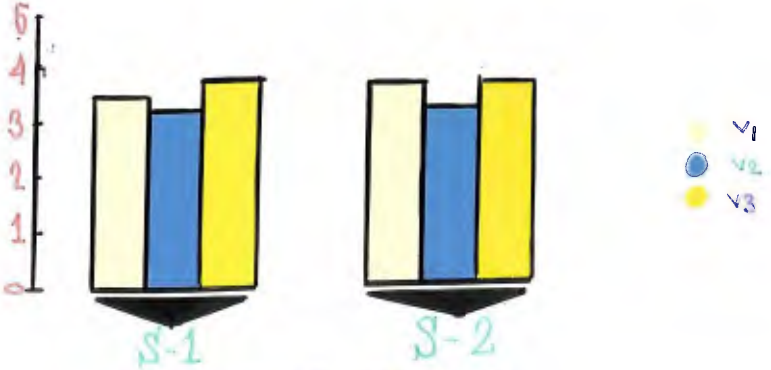
C.D. at 5% 0.446

Data vide Table 8 and Fig. 6 , shows that the dates of sowing affected the number of branches per plant significantly . D_2 produced more number of branches per plant and was significantly superior to other dates of sowing except D_1 and D_3 . Sowing on first date was also found significantly superior to D_4 and D_5 . Minimum branches were observed in fifth date of sowing .

Fig. 6

EFFECT OF DIFFERENT TREATMENTS ON AVERAGE NO. BRANCHES PER PLANT.





VARIETIES AND SPACINGS -

TABLE 9 : NUMBER OF BRANCHES PER PLANT - S x V

Treatments	S_1	S_2	Mean averages
V_1	3.5	3.7	3.6
V_2	3.2	3.2	3.2
V_3	3.8	3.7	3.7
Mean averages	3.5	3.5	

S.Em. ± 0.141

C.D. at 5% 0.276

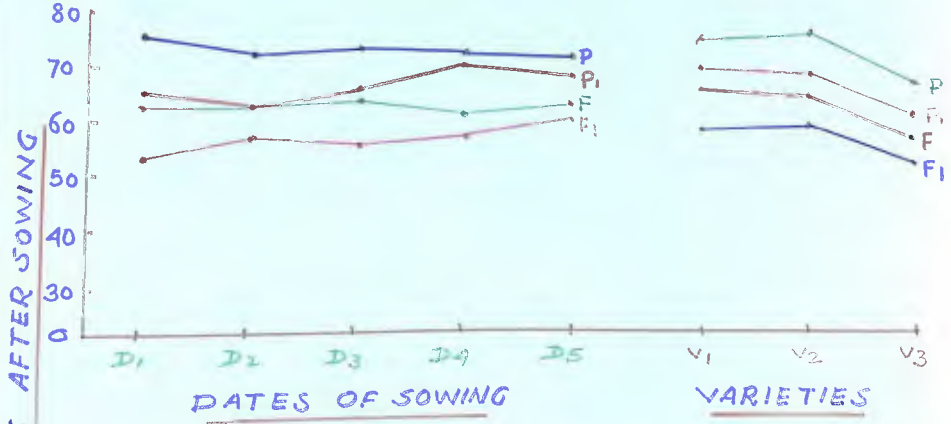
It is obvious from the Table 9 , that varieties differed in producing the number of branches , the order of number of branches per plant was $V_3 > V_1 > V_2$. Variety G.32-404 and T.3 were found significantly superior to C.235 . The difference between V_1 and V_3 was not significant . Effect of spacing on number of branches per plant was not observed . Data recorded have also been presented graphically in Fig. 6 .

(C) NUMBER OF DAYS REQUIRED FOR FLOWERING , POD FORMATION AND MATURITY -

Flowering and pod setting are important characters which have direct bearing on the maturity and yield of crop . In the present investigation the dates of flower and pod , initiation , flowering and pod formation (50 %) were recorded separately . The dates were converted in to number of days after sowing and are summarised in Table 10 .

Fig. 7

EFFECT OF DIFFERENT TREATMENTS ON - NO. OF DAYS FOR FLOWER & PODS INITIATION, (50%) FLOWERING and PODS SETTING.



EFFECT OF DATES OF SOWING and VARIETIES ON - MATURITY PERIOD OF CROP (95%).

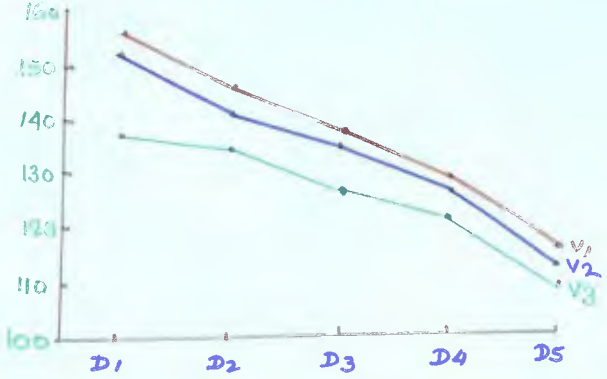


TABLE 10 : SHOWING AVERAGE NUMBER OF DAYS REQUIRED FOR FLOWERING AND POD FORMATION .

Treatments	Flowering		Pod formation	
	Initiation	50%	Initiation	50%
Dates of sowing				
D_1	53.3	63.0	64.0	75.3
D_2	56.3	62.3	62.3	72.0
D_3	55.3	64.0	66.0	73.6
D_4	56.6	61.0	70.0	73.3
D_5	60.0	63.0	68.6	72.6
Varieties				
V_1	58.0	66.0	69.4	75.6
V_2	59.2	65.2	68.2	76.6
V_3	51.8	56.8	61.4	67.8

Not analysed statistically .

An examination of data presented in Table 10 and Fig.7 , shows that there was almost no effect of dates of sowing on flowering and pod setting .

Flowering and pod setting are varietal characters . Variety G.62-404 recorded flowering and pod setting about 9 days earlier than T.3 and C.235 .

TABLE 11 : SHOWING AVERAGE NUMBER OF DAYS REQUIRED FOR MATURITY 95 PERCENT .

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
V_1	155	144	136	127	115	135.4
V_2	151	140	133	126	112	132.4
V_3	136	134	125	121	108	124.8
Mean averages	147.3	139.3	131.3	124.6	111.6	

Not analysed statistically .

As regards maturity (95 %) , all the varieties required more number of days for first date of sowing . The maturity was hastened in all the varieties as sowing was delayed as evident from Table 11 and Fig. 7 .

YIELD AND ITS ATTRIBUTORY CHARACTERS :

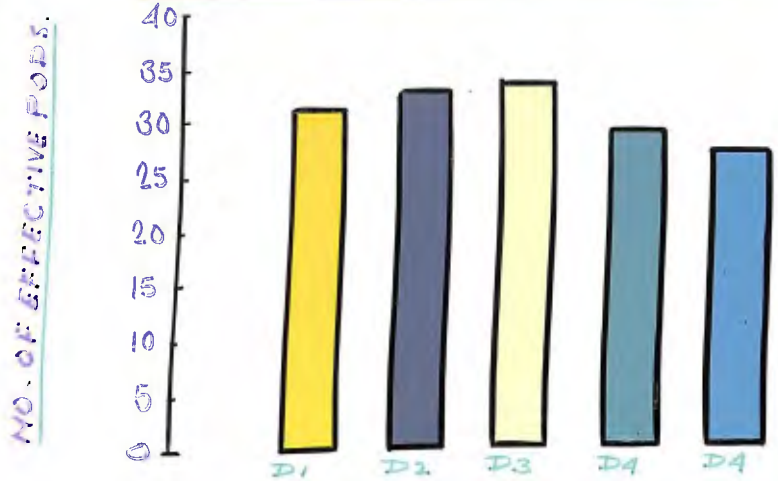
(A) NUMBER OF EFFECTIVE PODS PER PLANT -

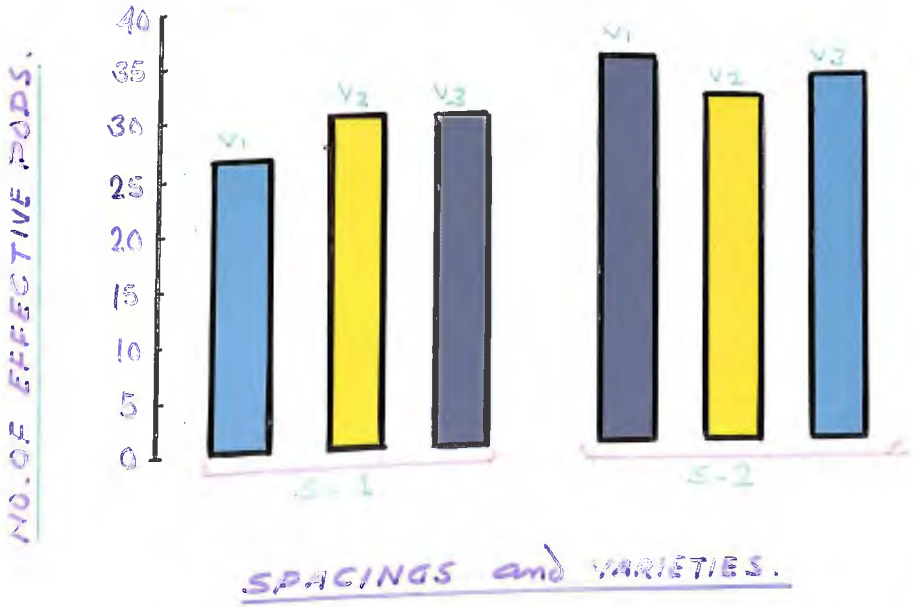
The number of effective pods per plant has direct co-relation with the crop yield . The average number of effective pods per plant were influenced by the dates of sowing , spacing and varieties as depicted graphically in Fig. 8 .

Analysis of variance (Appendix II) shows that the main and sub treatments are statistically significant . However , the interactions between main and sub treatments were found non - significant . The treatment averages are summarised in Table 12 & 13 and illustrated in Fig. 8 .

Fig-8

EFFECT OF DIFFERENT TREATMENTS ON AVERAGE NO. OF EFFECTIVE PODS/PLANT.





MAIN EFFECTS :

DATES OF SOWING -

TABLE 12 : NUMBER OF EFFECTIVE PODS PER PLANT - D x SV

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
S_1V_1	24.5	33.2	24.0	34.0	25.5	26.2
S_1V_2	31.5	33.2	33.2	27.7	32.0	29.5
S_1V_3	28.5	24.5	30.5	34.2	27.5	29.0
S_2V_1	35.0	38.5	38.7	29.5	34.7	35.3
S_2V_2	32.5	35.2	37.2	27.7	24.7	31.5
S_2V_3	34.2	32.0	38.2	31.7	30.5	33.3
Mean averages	31.0	32.7	33.6	29.1	27.5	

S.Em. ± 1.13

C.D. at 5% 3.48

It is evident from the Table 12 , that all the dates of sowing affected the number of effective pods per plant . Sowing on third date produced maximum number of effective pods per plant . D_2 and D_3 were significantly superior to D_4 and D_5 . The order of effective pods per plant was $D_3 > D_2 > D_1 > D_4 > D_5$, but the differences between D_1 , D_4 and D_5 were non significant .

SPACING AND VARIETIES -

It is clear from the Table 12 , that the treatment S_2V_1 gave significantly higher number of effective pods per plant than all the other treatments except S_2V_3 .

TABLE 13 : NUMBER OF EFFECTIVE PODS PER PLANT - S x V

Treatments	S_1	S_2	Mean averages
V_1	26.2	35.3	30.7
V_2	29.5	31.5	30.5
V_3	29.0	33.3	31.2
Mean averages	28.2	33.3	

S.Em. ± 1.60

C.D. at 5% 4.52

Data vide Table 13 and graphically depicted Fig. 8 , shows that varieties ~~and xxxxxxxx~~ did not differ statistically in producing the number of effective pods per plant , however V_3 was found slightly superior to V_1 and V_2 .

Spacing S_2 recorded significantly more number of effective pods per plant as compared to spacing S_1 .

(B) GRAIN YIELD IN QUINTALS PER HECTARE -

All the factors viz. dates of sowing , spacings and varieties affected grain yield significantly . The results are given in appendix II . The main effect of dates of sowing and varieties & spacings on grain yield are presented in Table 14 - 17 and graphically depicted in Fig. 9 .

MAIN EFFECTS :

DATES OF SOWING -

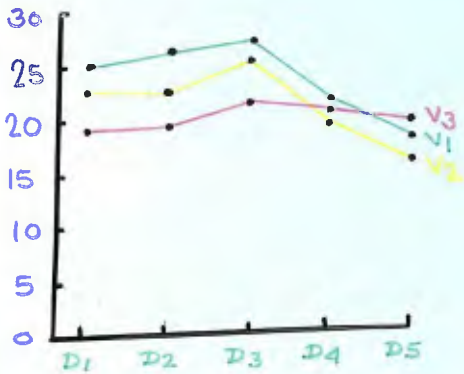
TABLE 14 : YIELD OF GRAIN IN QUINTALS PER HECTARE - D x V.

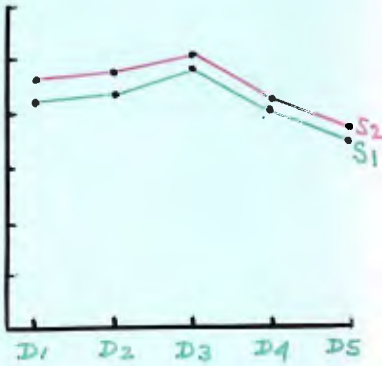
Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
V_1	25.0	26.1	27.0	21.4	18.2	23.5
V_2	22.8	22.9	25.5	19.8	16.1	21.4
V_3	19.1	19.3	21.5	21.0	19.5	20.0
Mean averages	22.3	22.7	24.6	20.7	17.9	
S.Em. ±	1.17					
C.D. at 5%	3.61					

Dates of sowing greatly influenced the grain yield per hectare as evident from the Table 14 and Fig.9 . The grain yield increased gradually up to third date of sowing and after which it decreased as the sowings were delayed . Highest yield was obtained in D_3 and was found significantly superior to D_4 and D_5 . But yield differences amongst D_1 , D_2 and D_3 were non significant . The order of increase in grain yield was $D_3 > D_2 > D_1 > D_4 > D_5$. The increase in grain yield in D_3 as compared to D_1 , D_2 , D_4 and D_5 was 10.8 % , 8.3 % , 18.8 % and 37.4 % respectively .

Fig. 9

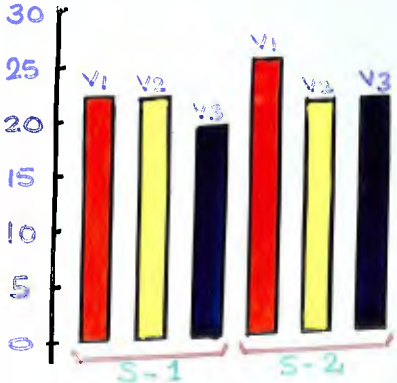
EFFECT OF DIFFERENT TREATMENTS ON YIELD OF GRAIN (IN QNTLS./HECTARE)



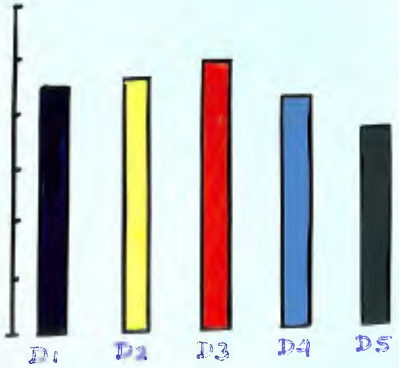


DATES OF SOWING

YIELD IN QNTLS./HECTARE



SPACING & VARIETIES



DATES OF SOWING

VARIETIES -

TABLE 15 : YIELD OF GRAIN IN QUINTALS PER HECTARE - S x V

Treatments	S_1	S_2	Mean averages
V_1	22.2	24.8	23.5
V_2	21.9	20.9	21.4
V_3	19.0	21.1	20.0
Mean averages	21.0	22.2	
S.Em. ±	0.61		
C.D. at 5%	1.71		

It is seen from the Table 15 and Fig.9 , that varieties under trial affected the grain yield significantly . Variety T.3 produced highest grain yield and was significantly superior to G.62-404 and C.235 .

The data in Table 14 , shows that all the varieties gave highest grain yield in the third date of sowing and delayed sowing reduced the grain yield in general .

SPACINGS -

TABLE 16 : YIELD OF GRAIN IN QUINTALS PER HECTARE - D x S

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
S_1	21.2	21.8	24.2	20.4	17.5	21.0
S_2	23.3	23.7	25.1	21.0	18.3	22.2
Mean averages	22.2	22.7	24.6	20.7	17.9	
S.Em. ±	0.61		C.D. at 5%		1.71	

The effect of row spacings on grain yield have been presented in Table 16 and graphically depicted in Fig.9 . The results of above table indicate that highest grain yield was obtained with row spacing of 45 cm. (S_2) , but it failed to reach to the level of significance over 30 cm. spacing (S_1) .

All the varieties except V_2 recorded higher grain yield in S_2 as compared to S_1 (Table 15 & Fig. 9) . Both the spacings gave highest grain yield at D_3 , and lowest yield was recorded at fifth date of sowing .

INTERACTIONS D x SV -

TABLE 17 : YIELD OF GRAIN IN QUINTALS PER HECTARE - D x SV

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
S_1V_1	23.7	25.0	26.0	20.6	16.0	22.2
S_1V_2	23.2	22.1	26.1	20.7	17.5	21.9
S_1V_3	16.8	18.5	20.5	20.0	19.2	19.0
S_2V_1	26.2	27.3	28.0	22.2	20.5	24.8
S_2V_2	22.3	23.7	25.0	18.8	14.7	20.8
S_2V_3	21.3	20.1	22.5	22.0	19.8	21.1
Mean averages	22.2	22.7	24.6	20.7	17.8	
S.Em. ±	2.01					
C.D. at 5%	2.08					

It is clear from the Table 17 , that all the varieties at both the spacings gave maximum response at third date of sowing

and were found significantly superior over last date of sowing except in treatments S_1V_3 , S_2V_1 and S_2V_3 .

The combination of 45 cm. spacing (S_2) and variety T.3 (V_1) with sowing on 30th October (D_3) gave maximum yield of grain .

(C) TEST WEIGHT OF 1000 GRAINS IN GRAMS -

As per analysis of variance table vide appendix II , the effect of main treatments i.e. dates of sowing , sub treatments i.e. spacings and varieties and interactions of main and sub treatments are highly significant . The summary table of treatment averages are presented below :

MAIN EFFECTS :

DATES OF SOWING -

TABLE 18 : TEST WEIGHT OF GRAINS - D x V

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
V_1	204.3	198.7	191.7	191.1	177.5	192.7
V_2	121.5	114.6	107.8	119.3	116.0	115.8
V_3	142.8	152.0	141.6	132.2	134.0	140.7
Mean averages	156.5	156.1	147.6	147.6	142.4	

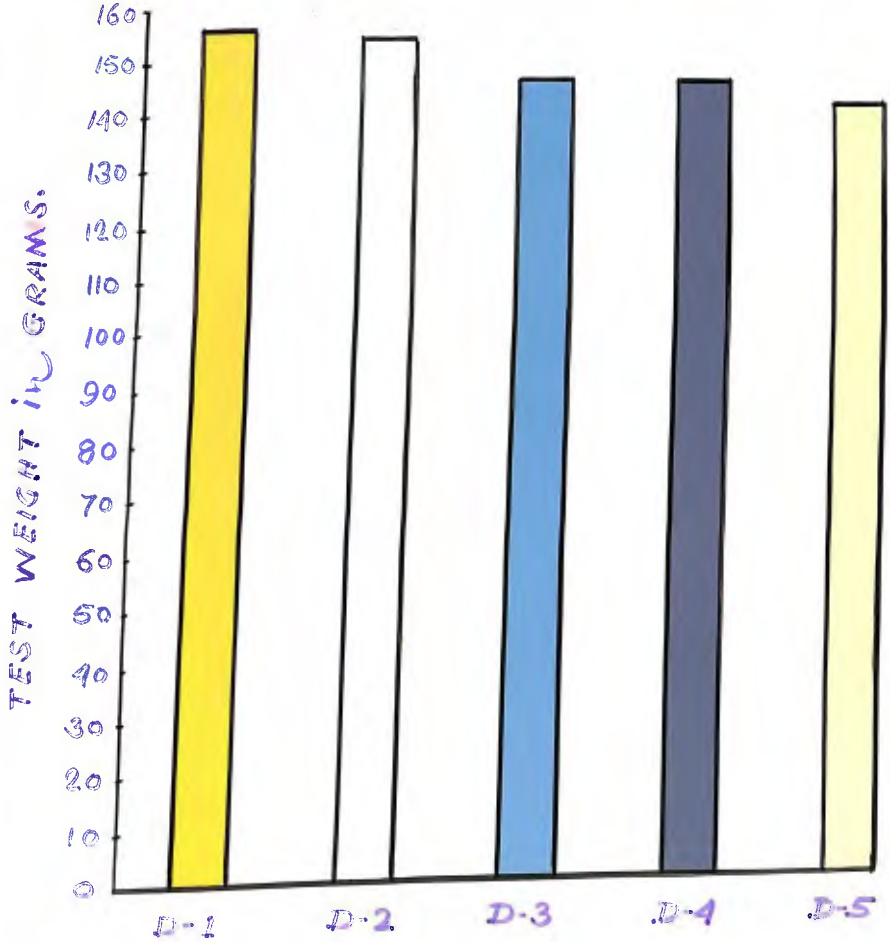
S.Em. ± 1.57

C.D. at 5% 4.88

Data in Table 18 and Fig. 10 , indicates that the test weight of grains was decreased with each delayed sowing . Sowing at first and second date (D_1 and D_2) recorded higher test weight

Fig.10

EFFECT OF DIFFERENT DATES OF SOWING ON TEST WEIGHT OF 1000 GRAINS.



of seed and were significantly superior to other dates of sowing . However , difference between D_1 and D_2 was not significant . Smaller seeds were observed at D_5 .

VARIETIES -

TABLE 19 : TEST WEIGHT OF GRAINS - S x V

Treatments	S_1	S_2	Mean averages
V_1	195.5	189.9	192.7
V_2	115.6	116.1	115.8
V_3	141.2	140.2	140.7
Mean averages	150.7	148.7	

S.Em. ± 1.73

C.D. at 5% 4.80

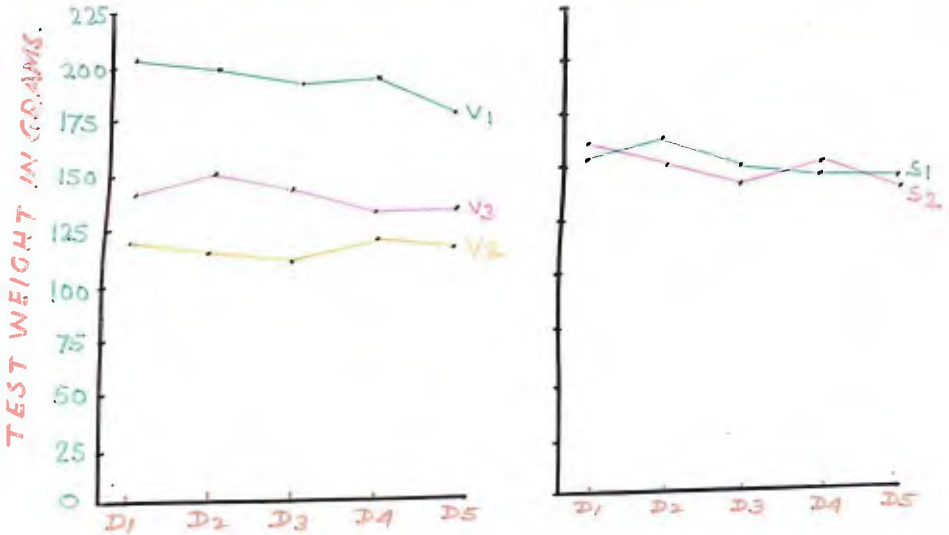
It is obvious from the Table 19 and Fig.11 , that the variation in test weight of different varieties was affected significantly . Heaviest seeds were produced by variety T.3 (V_1) which was found significantly superior to C.235 (V_2) and G.62-404 (V_3) . Variety G.62-404 (V_3) also produced heavier seeds significantly as compared to C.235 .

It is clear from Table 18 and Fig. 11 , that all the varieties in general recorded more test weight in first date of sowing . After second date of sowing seed weight of all the varieties decreased considerably with subsequent delayed sowing .

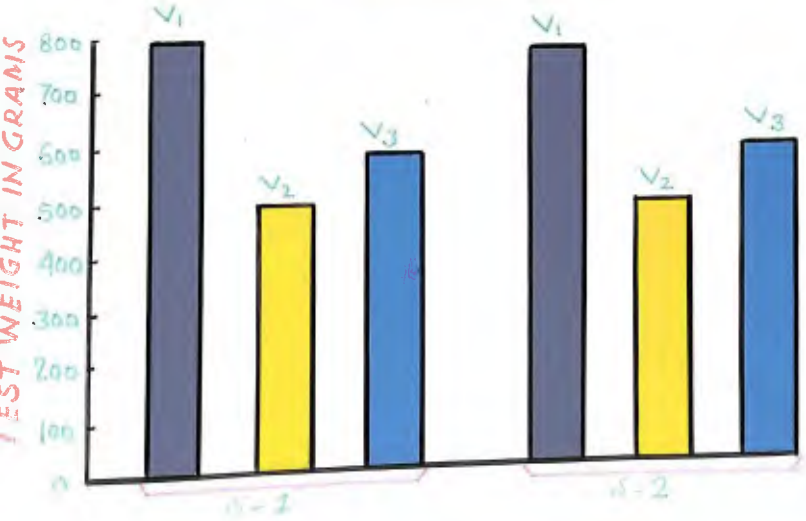
EFFECT OF DIFFERENT TREATMENTS ON

Fig-11

TEST WEIGHT OF 1000 GRAINS IN GRAMS



DATES OF SOWING



SPACING & VARIETIES

SPACINGS -

TABLE 20 : TEST WEIGHT OF GRAINS - D x S

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
S_1	154.5	161.4	148.7	146.1	148.0	150.7
S_2	158.5	148.8	145.4	149.0	141.9	148.7
Mean averages	156.5	155.1	147.6	147.5	142.4	
S.Em. ±	1.78					
C.D. at 5%	4.80					

As regards spacing S_1 produced heavier seeds than S_2 . The difference between S_1 and S_2 was not significant . As per Table 20 and Fig. 11 , it is observed that seeds of treatment S_1 in D_2 were heavier where as S_2 treatment produced more test weight in D_1 . Test weight of grains of both S_1 and S_2 treatments decreased with delayed sowing .

INTERACTIONS D x SV -

TABLE 21 : TEST WEIGHT OF GRAINS - D x SV

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
S_1V_1	207.2	207.0	193.5	189.5	180.2	195.4
S_1V_2	114.7	120.5	109.0	118.2	115.7	115.6
S_1V_3	141.7	156.7	143.7	130.7	133.2	141.2
S_2V_1	201.5	190.5	190.0	192.7	174.7	189.8
S_2V_2	128.2	108.7	106.7	120.5	116.2	116.0

Table No. 21 continued -

Treatments	D_1	D_2	D_3	D_4	D_5	Mean averages
S_2V_3	146.0	147.2	130.5	133.7	134.7	140.2
Mean averages	156.5	155.1	147.6	147.5	142.4	
S.Em. ±	4.98					
C.D. at 5%	13.58					

It is evident from the data in Table 21 , that all the three varieties with 30 cm. spacing and 45 cm. spacing gave more test weight at early sowing as compared to late sowing . Variety T.3 (V_1) with both the spacings at first (D_1) and second dates of sowing recorded significantly more weight of 1000 grains as compared to last date of sowing (D_5) .

The combination D_1 S_1 V_1 proved to be the best in recording the maximum weight of 1000 grains .

QUALITY CHARACTER :

PROTEIN CONTENT OF THE GRAIN -

As the protein content of the grain is constant varietal character , the composite samples from each treatment were chemically analysed . The summary table of mean averages is presented below :

TABLE 22 : PROTEIN CONTENT OF THE GRAIN IN PERCENTAGE .

Treatments	D_1	D_2	D_3	D_4	D5	Mean averages
V_1	18.15	18.23	18.41	18.42	18.58	18.35
V_2	17.31	17.33	17.46	17.50	17.51	17.42
V_3	17.62	17.63	17.63	17.68	17.70	17.66
Mean averages	17.69	17.73	17.85	17.86	17.93	

Not analysed statistically .

The data recorded in Table 22 reveal that the highest yielder variety T.3 also maintained its supremacy in containing protein percentage . Variety C.235 had the lowest protein percentage It recorded 5.0 % less protein than T.3 . Delayed sowing was associated with increase in protein percent . The increase in protein percentage from D_1 to D6 was about 1.3 percent .

DISCUSSION

D I S C U S S I O N

Results obtained in the present investigation , are briefly discussed here in the light of review of literature cited for different characters under study . Possible explanations have been given wherever necessary , in support of the results obtained . The discussion has been presented in three different heads , viz. , influence of dates of sowing , row spacings and varieties on the yield , quality and growth of gram crop .

DATES OF SOWING -

As regards to date of sowing , highest grain yield was obtained by sowing on 30th October (24.6 qt/ha.) followed in order D_2 (22.7 qt/ha) > D_1 (22.2 qt/ha.) > D_4 (20.7 qt/ha.) > D_5 (17.9 qt/ha.) . The yield obtained under first three dates of sowing viz. 1st Oct. , 15th Oct. and 30th Oct. showed no significant difference , however D_3 produced significantly higher grain yield over D_4 and D_5 . The higher grain yield in 30th October sowing may be attributed to the favourable climatic conditions prevailed at grand growth and grain setting stages . Such finding has also been confirmed by Sen , et - al . (1964) , Sur , et - al . (1966) , Sen , et - al . (1966) , Sen (1967) , Bshel (1968) , Mathur and Tomar (1968) , Sharma , et - al . (1968), Maheshwari and Singh (1972) , Singh and Mishra (1972) , Saxena , et - al .(1972) Nema (1973) , Panwar and Singh (1973) , and Kaul , et - al. (1973) .

Maximum number of effective pods per plant were recorded under third date of sowing (33.6 pods / plant). D_2 and D_3 proved

significant over D_4 and D_5 planting . The possible reason may be attributed to more vegetative growth and favourable weather conditions at pod setting and filling of grains .

The test weight of 1000 grains showed a definite downward trend from first to last date of sowing . D_1 gave maximum test weight . The reason for fall in test weight from D_1 to D_5 may be due to decrease in ripening period especially in late sowings . Similar results have been reported by several research workers on wheat crop . Singh and Alam (1944) , Pal , et - al . (1947) , Garg (1959) and Indoria (1968) .

The dates of sowing also influenced the protein content of grain . The increase in protein percentage was found to be associated with delayed sowing , as it was minimum (17.69 %) and maximum (17.93 %) in first and last date of sowing respectively . These results are supported by the findings of Viljoen (1937) and Maley (1968) on soybean crop .

Maximum number of plants per plot was recorded in 15th Nov. (D_4) sowing but it failed to establish its supremacy statistically . Where as early sowing (D_1 and D_2) , favoured in increasing the height of the crop plants . Maximum height of plants was recorded in 15th October sowing . All the dates proved significantly superior over D_5 . This may be attributed to prolonged growing season and favourable temperature during the initial stage of growth . These findings coincide with the findings of Singh and Alam (1944) , Mahanta (1967), and Indoria (1968) on wheat crop . In case of number of branches per plant , 15th October planting

produced highest number of branches per plant and proved significantly superior over other dates of sowing except D_1 and D_3 (1st October and 30th October) . The possible explanation may be attributed to long growing period and slightly higher temperature at the early stages of growth which indicated increase in over all growth of the crop plants .

With regards to flowering and pod formation , dates of sowing could not affect it . Number of days required for flowering and pod formation under different dates of sowing were almost identical . As far maturity was concerned the number of days from sowing to ripening went on decreasing as the sowings were delayed . This may be due to the fact that plants under late sowing could not get desired temperature and photoperiod . This result is in close confirmity with the finding of Singh and Alam (1944) on wheat crop.

ROW SPACINGS -

It is well known fact that the response of a crop variety may be obtained when the crop plants are spaced properly . In the present investigation wider spacing produced higher yield (22.2 q/ha) However , it failed to establish its supremacy significantly over closer spacing . Higher grain production under wider spacing may be attributed to more availability of plant nutrients and moisture from soil to the crop plant and also less competition for solar energy which might have resulted in increased photosynthesis . These findings are supported with the results obtained by Nirad , et - al . (1960) , Saxena , et - al. (1971) , Singh and Mishra(1972), Saxena and Yadav (1972) , Yadav , et - al. (1973) , Kaul and Sekhon

(1973) and Report of All India Coordinated Experiment from Badnapur (1972-73) .

Maximum number of effective pods per plant were recorded under 45 cm. spacing and it was significantly superior to 30 cm. spacing, which ultimately resulted in higher grain yield . This result has also been confirmed by Mirad , et - al. (1960) .

Average weight of 1000 grains was recorded more or less the same for both the spacings . However , slightly higher test weight was observed with closer spacing as compared with wider spacing . Similar result was obtained by Mirad , et - al. (1960) .

Different row spacing treatments led to a conspicuous variation in plant population per plot . Closer spacing of 30 cm. recorded significantly more number of plants per plot as compared to wider spacing of 45 cm. . Similar results were reported by Pickett and Fredericks (1960) , Yadav (1964) and Paliwal (1965) on jowar crop .

Wider spacing of 45 cm. increased plant height signific - antly . This increase might be due to optimum availability of moisture , plant nutrients and solar energy . Similar results were reported by Paliwal (1965) on jowar crop . In case of number of branches per plant , different spacings failed to establish any significant difference . Where as flowering , pod formation and maturity were also not effected by different spacings .

VARIETIES -

It is well known fact that the yield is directly co-related with vegetative and yield attributory characters. Varieties

differed in producing the grain yield . Highest grain yield (23.5 qt/ha.) was produced by variety T.3 which was significantly superior over C.235 (21.4 qt/ha.) and G.62-404 (20.0 qt/ha.) .

As regards to number of effective pods per plant , no difference was found in different varieties . Where as the test weight of 1000 grains was significantly affected by different varieties . The maximum test weight was recorded by variety T.3 (132.7 gms) followed in order of G.62-404 (140.7 gms) > C.235 (115.8 gms.) .

Different varieties showed marked difference in protein percentage . The variation was associated with varietal character . Variety T.3 recorded maximum percentage of protein .

Maximum number of plants per plot were recorded in variety T.3 , which ultimately proved its supremacy in producing grain yield also over other varieties as evident from Table 15 and Fig. 9 . This is due to higher germination percentage (98 %) as already mentioned in chapter III .

Maximum height of the crop plants was recorded in variety C.235 followed in order by G.62-404 and T.3 . This change in plant height is due to varietal character . Varieties differed in producing the number of branches per plant . Highest number of branches per plant were produced in variety G.62-404 . Variety G.62-404 was also found early in flowering , pod formation and maturity as compared to other varieties .

INTERACTIONS -

A combination of treatments interaction D_3 (30th Oct.) x

S_2 (45 cm.) x V_1 (T.3) gave maximum yield of grain than all the other combinations . In general D_3 planting proved superior than all other dates of planting in producing highest grain yield for all the varieties .

As regards to test weight of 1000 grains a combination of treatments of D_1 (1st October) x S_1 (30 cm.) x V_1 (T.3) proved its supremacy in recording higher test weight of grains than all other treatments combinations .

SUMMARY AND CONCLUSION

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SUMMARY AND CONCLUSION

SUMMARY :

A field experiment with 30 treatments combinations comprising of five dates of sowing (1st October , 15th October , 30th October , 15th November and 30th November) , two row spacings (30 cm. and 45 cm.) and three varieties (T.3 , J.235 and G.32-104) was conducted at the Farm of R.A.K. College of Agriculture , Sehore (M.P.) during the Rabi season of the year 1973-74 . Split plot design with dates of sowing in main plots and row spacings cum varieties in sub plots with four replications was adopted . The study aimed to evaluate the " Response of gram varieties to dates of planting and row spacing " . The results of the investigation are summarised in this chapter .

EFFECT OF DATES OF SOWING -

(i) Different dates of planting affected the grain yield . Among the different dates D1 , D2 , D3 , D4 and D5 the third date (30th October) turned out to be the most suitable for obtaining the higher grain yield . It gave significantly higher grain yield (24.6 qt/ha.) over D4 and D5 . The percentage increase in grain yield over D1 , D2 , D4 and D5 was recorded as 10.8 % , 8.2 % , 18.8 % and 37.4 % respectively .

(ii) In case of yield attributory characters ; number of effective pods per plant were affected by different dates of sowing . Sowing on second and third date , produced maximum number of effective pods per plant and proved superiority over D4 and D5 .

However , differences between D_1 , D_4 and D_5 were nonsignificant.

As regards to the test weight of 1000 grains , it decreased in decreasing order with each delayed sowing . First and second date of planting recorded marked difference in test weight of grains , as compared to other dates of sowing .

(iii) The increase in protein content was associated with subsequent delayed sowing .

(iv) The growth characters viz. plant height and number of branches per plant were affected favourably by different dates of sowing . Maximum height of the crop plants was recorded in D_2 plots which was significantly superior over D_1 , D_4 and D_5 . There was no marked difference in D_2 and D_3 plots . Similarly D_2 plots also maintained their supremacy in producing maximum number of branches per plant .

EFFECT OF ROW SPACINGS -

(i) Both the spacings (S_1 and S_2) failed to show any marked effect on grain yield per hectare of the crop .

(ii) As regards yield attributory characters , number of effective pods per plant were significantly affected by row spacing. Wider spacing i.e. 45 cm. proved its superiority over 30 cm. spacing Whereas test weight of grain was not affected favourably by row spacing .

(iii) Amongst the growth characters , only the plant height was affected significantly . Wider spacing (S_2) proved its supremacy over closer spacing (S_1) .

EFFECT OF VARIETIES -

(i) Variety T.3 produced highest grain yield (23.5 qt/ha.) followed by C.235 (21.4 qt/ha.) . The increase in grain yield by variety T.3 over C.235 and G.62-404 was 9.8 % and 17.5 % respectively

(ii) In case of yield attributory characters number of effective pods were not affected by none of the varieties tried . However , 1000 grain weight was favourably affected . Maximum test weight was recorded by variety T.3 (192.7 gms.) which was significantly higher than other two varieties .

(iii) Variety C.235 produced taller plants than other two varieties (T.3 and G.62-404) .

(iv) Protein content in the seeds of variety T.3 was recorded highest with 18.35 % followed by G.62-404 with 17.66 % and C.235 with 17.42 % .

CONCLUSION :

1. A sowing date of 30th October proved more conducive for getting higher grain yield of gram crop for this region .

2. A row spacing of 45 cm. proved optimum for gram crop under Sehore conditions .

3. Variety T.3 proved to be high yielder for agro-climatic conditions of this place.

4. Variety T.3 sown in last week of October i.e. 30th October with 45 cm. row spacing turned out to be the most suitable combination for obtaining maximum grain yield .

ABSTRACT

A B S T R A C T

Response of gram varieties to dates of planting and row spacing .

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The present investigation was carried out at R.A.K. College of Agriculture Farm , Sehore in the Rabi season 1973-74 to study the response of three gram varieties to dates of planting and row spacing under soils and agro-climatic conditions of Sehore .

The experiment was laid out in split plot design with four replications and 30 treatments combinations viz. five dates of sowing , two row spacings and three varieties . The details of the treatments are as under :

Dates of sowing	Row spacings	Varieties
1st October 1973	30 cm.	T. 3
15th October "	45 cm.	C. 235
30th October "		G. 62-404
15th November "		
30th November "		

Biometric observations were recorded on plant population,

plant height in cms , number of branches per plant , number of effective pods per plant , test weight of 1000 grains in gms , grain yield in quintals per hectare and protein content in percentage . The results were statistically analysed and accordingly results were interpreted .

Amongst the dates of sowing 30th October planting increased grain yield as compared to other dates of sowing . Similarly plant height and number of effective pods per plant were also affected favourably . The increase in protein percent was recorded in ascending order with the delayed sowing .

Both the row spacings i.e. 30 cm. and 45 cm. failed to show any significant effect on grain yield , number of branches per plant and test weight . However , wider spacing of 45 cm. proved its supremacy over 30 cm. spacing in respect of number of effective pods per plant and plant height .

Out of three varieties under trial variety T.3 turned out to be the most suitable for this tract by stablishing its supremacy in grain yield over variety C.235 and G.82-404 by 3.8 % and 17.5 % respectively . As regards yield attributing characters , variety T.3 gave significantly more test weight of grain than G.82-404 and C.235 , but it did not differ significantly in producing number of effective pods per plant . Variety T.3 also recorded highest protein content i.e. 13.35 % than others .

Variety T.3 sown in last week of October i.e. 30th October with wider row spacing of 45 cm. proved to be the most suitable combination for obtaining maximum grain yield .

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APPENDIX

APPENDIX

APPENDIX I : MEAN SQUARES OF FINAL PLANT POPULATION AND GROWTH ATTRIBUTES OF GRAM

S.No.	Source of Variance	D.F.	Number of plants per plot	Plant height in Cms.	Number of branches per plant
1.	Replication	3	327.17	2.9334	0.430
2.	Date of sowing	4	7210.70	230.1300**	2.385*
3.	Error (a)	12	3853.34	10.0505	0.507
4.	Spacing and Varieties.	5	32651.48**	38.0726**	1.272*
5.	Interaction D x SV	20	1387.24	5.4163	0.271
6.	Error (b)	75	1035.48	5.7107	0.404
	TOTAL	119			

** Significant at 1 % level .

* Significant at 5 % level .