RESPONSE OF MUSTARD GENOTYPES TO DIFFERENT SOWING DATES

THESIS

Submitted to

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

in partial fulfilment of the requirements

for the Degree of

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IN

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By

UIKEY MRINALINI CHANDANSINGH

SECTION OF AGRONOMY

COLLEGE OF AGRICULTURE, NAGPUR

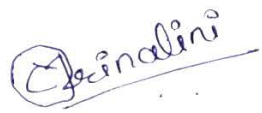
DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
KRISHINAGAR PO, AKOLA (MS) 444104

Enrolment Number - DD-1282 **2011**

DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled **"Response of mustard genotypes to different sowing dates"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data had been derived from any thesis /publication of any University or Scientific Organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place : Nagpur
Date : 31/05/2011



(UIKEY MRINALINI CHANDANSINGH)

Enrolment No. DD/1282

CERTIFICATE

This is to certify that the thesis entitled **"Response of mustard genotypes to different sowing dates"** submitted in partial fulfillment of the requirement for the degree of **"Master of Science in Agriculture (Agronomy)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Uikey Mrinalini Chandansingh** under my guidance and supervision.

The subject of the thesis has been approved by the Student's Advisory Committee.

Place : Nagpur
Date : 31/05/2011

(S. M. Nawlakhe)
Chairman
Advisory Committee

Countersigned

Associate Dean,
College of Agriculture, Nagpur
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

THESIS APPROVED BY THE STUDENT'S ADVISERY COMMITTEE INCLUDING EXTERNAL EXAMINER (AFTER VIVA-VOICE)

1. Chairman	Dr. S.M. Nawlakhe	.....
2. Member	Dr. R. M. Deshpande	.....
3. Member	Dr. P.C. Pagar	.....
4. Member	Smt. Beena Nair	.....
5. External Member	(Shri I.M. Nagarare)	.....

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Place : Nagpur
Date : 31/05/2011

Mrinalini

(UIKEY MRINALINI CHANDANSINGH)

Enrolment No. DD/1282

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(A) List of Tables

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(C) Abbreviations

%	:	Per cent
^0C	:	Degree Celsius
Agril	:	Agricultural
C.D	:	Critical Difference
cm	:	Centimeter
m	:	Meter
D ^0C	:	Days degree Celsius
DAS	:	Days after sowing
et. al.	:	Et alia (and his associates)]
Fig.	:	Figure
g	:	Gram
GDD	:	Growing degree days
ha^{-1}	:	Per hectare
i.e.	:	That is
Kg	:	Kilogram
K	:	Potassium
Max.	:	Maximum
Min.	:	Minimum
Mt.	:	Metric tones
Mm	:	Millimeter
MW	:	Meteorological week
N	:	Nitrogen

No./no.	:	Number
q.	:	Quintal
R.H.	:	Relative humidity
S.E. (m) $\pm$	:	Standard error of mean
Sig.	:	Significant
t^{-1}	:	Per tonne
T_{max}	:	Maximum temperature
T_{min}	:	Minimum temperature
T_b	:	Lowest temperature
viz.	:	Namely

(D) **THESIS ABSTRACT**

a) **Title of the thesis**	:	"RESPONSE OF MUSTARD GENOTYPES TO DIFFERENT SOWING DATES"
b) **Full Name of student**	:	**Uikey Mrinalini Chandansingh**
c) **Name and Address of Major Advisor**	:	**Dr. S.M. Nawlakhe** Professor of Agronomy, College of Agriculture, Nagpur.
d) **Degree to be awarded**	:	M.Sc. (Agriculture)
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i) **Signature of Student**	:	Mrinalini
j) **Signature, Name and address of forwarding authority**		

Professor of Agronomy,
College of Agriculture, Nagpur.

ABSTRACT

A field experiment entitled "Response of mustard genotypes to different sowing dates" was conducted at Agronomy farm, College of Agriculture, Nagpur during *rabi* 2010-2011.

Mustard crop was grown on clay soil, low in nitrogen, medium in phosphorous and high in potassium content with pH 7.8. The experiment was laid out in spilt plot design with sixteen treatment combinations, four sowing dates and four different varieties replicated thrice.

Sowing on S_2 (43rd MW) found to be superior on various growth characters *viz.,* plant height, number of branches plant^{-1}, number of leaves plant^{-1}, dry matter accumulation plant^{-1}. But, in respect of dry matter accumulation plant^{-1} S_1 (42nd MW) found statistically at par with S_2 (43rd MW).

The yield contributing characters *viz.,* number of siliqua plant^{-1}, number of seeds siliquae^{-1}, test weight, seed yield plant^{-1} were recorded maximum in S_2 (43rd MW) over sowing on S_1 (42nd MW), S_3 (45th MW) and S_4 (45th MW). In respect of oil yield ha^{-1} and oil content S_2 (43rd MW) proved to be superior over rest of the sowing dates. Seed yield (q ha^{-1}) recorded maximum in S_2 (43rd MW) found significantly superior over S_3 (45th MW) and S_4 (45th MW) but, S_1 (42nd MW) found to be at par with S_2 (43rd MW).

Variety V_2 (Pusa bold) was found to be taller than V_1 (ACN-9), V_3 (Urwashi), V_4 (JD-6). Moreover, variety V_2 (Pusa bold) produced significantly higher number of branches plant^{-1}, number of leaves plant^{-1}, dry matter accumulation plant^{-1}, number of siliqua plant^{-1}, number of seeds siliquae^{-1}, test weight, seed yield plant^{-1}, as well as ha^{-1} . V_2 (Pusa bold) required more number of days for to attained physiological maturity than V_1 (ACN-9), V_3 (Urwashi), V_4 (JD-6).

Variety V_2 (Pusa bold) was found more profitable than V_1 (ACN-9), V_3 (Urwashi), V_4 (JD-6) as it yielded 11257 Rs ha^{-1} net monetary return than the other. Similarly, gross monetary return and benefit cost ratio was found higher in V_2 (Pusa bold).

It could be concluded that, variety V_2 (Pusa bold) could be sown on S_2 (43^{rd} MW). As S_1 (42^{nd} MW) and V_1 (ACN-9) found at par with combination V_2 (Pusa bold) and S_2 (43^{rd} MW) in respect of some growth and yield parameters they also preferred for practice.

Chapter I

INTRODUCTION

1.1 Background information :

India is one of the largest oilseed producing country that covers one-fifth of the entire area under this group of crops and also yields one-fifth of the total oilseed production in the world. In India, oilseeds are the second largest agricultural commodity after cereals, which occupy about 13.5 per cent of the gross cropped area in the country, and account for 5 per cent of gross national product and 10 per cent of the value of all agricultural products (Rai *et. al.,* 2002).

Among oilseeds, rapeseed-mustard occupies a prestigious position and ranks second after groundnut in area and production, contributing 23 per cent of the total oilseed production. It is estimated that 58 million tonnes of oilseed will be required by the year 2020, wherein the share of rapeseed-mustard will be around 24.2 million tonnes (Bartarial *et. al.,* 2001).

Mustard commonly called as "Sarson" or "Rai" is an important major *rabi* oilseed crop of our country. Indian mustard and has become an integral part of cropping system and being raised after rice, maize, pearl millet, urd bean, mug bean, cow pea, groundnut and sunflower in various states. Low cost of production and high yield potential hold promise for its large scale cultivation in the country (Chidda Singh, 1998).

The oilseeds productivity of India is only 988 kg ha^{-1} as compared to the world productively of 1012.7 kg ha^{-1}. Low productivity of oilseeds, exceptional increase in population and augmenting demand for edible oil leads to increase in oil prices, which is beyond reach of the common people. Among the major countries producing mustard, India ranks 3rd in the world in terms of area, Canada being the 1st followed by China (Anonymous, 2003).

Among the oilseed crops grown in India mustard defenses second in terms of area and production and contribute 90 per cent of oil of the country. In India it occupies second position after groundnut with an area of 6.70 million ha with production of 5.95 million tonnes and average productivity is 888 kg ha^{-1}. It contributes about 25 per cent of total oil production. It is grown traditionally in the states of Rajasthan Uttar Pradesh, Madhya Pradesh, Haryana and Punjab. Now a day, it is spreading to non-traditional areas like Maharashtra, Andhra Pradesh, Tamilnadu and Karnataka. In Maharashatra, it is grown on an area of 1200 ha with production of 3000 tonnes (Anonymous, 2003).

Indian contribution to global rapeseed-mustard production being 49.48 million tonnes, acreage 30.23 million hectares and yield 1636 kg ha^{-1} which was 21.7% ,14.3% and 66.7% respectively, during 2007 (FAO, 2009).

Rapeseed-mustard constitutes an important source of edible oil next to soybean and groundnut in India contributing 19.6% and 21.1% to the total oilseeds production and acre in 2007-08 (Anonymous, 2009).

1.2 Importance of study :

Indian mustard is the most important winter season (*rabi*) oilseed crop, which thrives best in light to heavy loam soil in areas having 25-40 cm of rainfall Mustard is nutritionally very rich and its oil content varies from 37-49 per cent. The seed and oil are used as a condiment in the preparation of pickles, flavoring curries and vegetables as well as for cooking and frying purposes. Its oil is used for many industrial products, cake as a cattle feed and manure and green leaves for vegetables and green fodder (Banga *et. al.*, 2007).

Some of the constraints behind the low productivity of mustard are its cultivation on residual moisture and non-availability of improved crop husbandry. Sowing time remains to be the prominent factor to decide the seed as well as oil yield of mustard.

If optimum sowing time is not observed, drastic yield reduction seems imminent. Proper sowing time, if managed, can help to enhance seed yield. Sowing of mustard at inappropriate time reduce seed yield and yield attributes (Prasad *et. al*, 1999).

Another reason of yield reduction is non-availability of suitable variety for a particular agro-climate. Local variety of mustard, which is being sold as rai or toria, its seed size is very small. Only improved variety currently available with the farmer is Pusa bold. Pusa bold has been identified for its higher yield performance and recommended for cultivation in Vidarbha region.

ACN-9 (Shatabdi) mustard variety has the better features. It is early in duration than Pusa bold, have less height and hence tolerant to lodging. It has given more seed and oil yield over Pusa bold. In Vidarbha region, seed yield of ACN-9 produced to the extent of 16.98 q ha^{-1} (Anonymous, 1999).

Urwashi, a mustard variety released in 1999 found suitable for irrigated condition and having an average yield of 2200 to 2500 kg ha^{-1}. JD-6, a mustard variety, early maturing, released in 2004 is having the average yield variation ranges from 597 to 1049 kg ha^{-1}.

1.3 Objectives of study :

Adoption of improved variety and suitable crop management practices are important factors for improving crop productivity. Sowing dates as non-monetary inputs can be manipulated to increase the seed yield of mustard. However, the individual factor and their interaction effects need to be studied. In mustard production, use of improved variety and sowing the crop at optimum date are the important production factors.

In vision of importance of mustard cultivation, the experiment "Response of mustard genotypes to different sowing dates" is planned during *rabi* season of 2010-2011 at College of Agriculture, Nagpur with following objectives:

1. To find out the optimum sowing time for mustard genotypes.
2. To study the effect of sowing time on growth and yield of mustard.

1.4 Hypothesis :

To study the effect of response of mustard genotypes and different sowing dates, number of experiments was conducted.

Optimum sowing dates for mustard were found between October 31st to November 20th to achieve maximum yield. The latter was positively correlated with total dry matter production. Late sowing of mustard retarded yield by adversely affecting reproductive growth in Varanasi, Uttar Pradesh (Shrivastava, 2003).

Panda, (2004), in an experiment at Indian Agricultural Research Institute, New Delhi, determined the sowing on 16th October, 31st October and 15th November for successive increase in leaf area index , total dry matter accumulation, crop growth rate, net assimilation rate, biological yield, seed yield, harvest index. Each delayed sowing after 16th October progressively and significantly decreased leaf area index, total dry matter accumulation, crop growth rate, net assimilation rate, days to 50 % flowering and maturity, biological yield, seed yield, and harvest index. A significantly genotypic variation was also observed for these parameters. Pusa bold was superior than SEJ-2 in terms of crop physiological characters and yield.

Mustard cultivars ACN-9 and Pusa bold under clay alkaline soils of Vidarbha, Maharashtra, recorded that sowing on 15th November significantly increased protein yield (39.2%), nitrogen and phosphorous uptake through seed and stover due to higher seed yield. Late sowing on 30th November increased

the protein content in seed, as well as nitrogen and phosphorous contents both in seed and stover (Ghanbahadur, 2002).

At College of Agriculture, Nagpur sowing during 22nd to 29th October proved superior in all growth characters and yield contributing characters viz; plant height, number of leaves, leaf area, leaf area index, number of branches, dry matter accumulation etc. over 12th November and 6th October (Sharma , 2006).

Growth characters, yield attributes and yield of mustard were significantly influenced by different sowing dates and two varieties 'Vaibhav" and "Urwashi" at Kanpur, Uttar Pradesh. Higher values of plant height, length of siliqua, seed siliqua^{-1} and seed and stover yield were obtained when the crop were sown on 15th October than when it was sown on 30th October and variety Vaibhav excelled over Urwashi. (Awasthi, 2007).

1.5 Scope and limitations :

Mustard (*Brassica juncea* L.) has very wide uses. All parts of plant have extensive uses. The oil is utilized for human consumption through out India in cooking and frying purpose. It is also used in the preparation of hair oil, soap, medicine and lubricants. Mustard cake is used as best cattle feed and manures. The leaves of young mustard plant are used as green vegetables as they provide enough sulphur minerals in the diet. In tanning industry, oil is used for softening leather (Chidda Singh, 1998).

Mustard has a good medicinal value as the considerable health benefits of mustard oil. Mustard has beneficial effect on prevention of cancer, coronary heart disease, hypertension etc. It helps is reducing cholesterol level.

Since Mustard crop is taken in the study area, the knowledge of cost, returns and its profitability will be useful for the farmers who want to substitute this crop for the traditional crops grown in the area. The results of the study will be useful in making suggestion for farmers and overcome the constraints in the

production of mustard. The findings of the study will help to increase the productivity and area under mustard by knowing the profitability of crop and also help for motivate farmers in the adoption of improved practices of the cultivation of this crop in the region.

Adoption of suitable crop management practices are important factors for improving crop productivity. Due to limitations and other recourses, the study was restricted to limited aspects; hence the findings can not be generalized beyond the limits of the area of study. However, the findings may become applicable in the areas where similar conditions exits.

In last 3-4 years mustard faced the problems due to necrosis and abiotic stresses in Vidarbha zone and the yield were poor. Hence, there is a need to popularize contingent oilseed crop such as mustard in this zone. Though mustard is known crop to this area, it need to be exploited better, both agronomically and genetically for high yielding nature and high oil content. Hence, a study was undertaken to standardize the date of sowing of mustard and suitability of mustard genotypes to this region.

Chapter II

REVIEW OF LITERTURE

Several workers have undertaken studies on sowing time and mustard genotypes. In this chapter, an attempt has been made to present a review of the available research work on effect of sowing dates and different genotypes of mustard pertaining to growth, yield and yield attributes, quality and their economics. Available literature is reviewed under appropriate headings in this chapter.

2.1 Response of mustard to sowing dates:

2.1.1 Effect of sowing dates on growth and growth attributes:

Rohan Singh *et. al.*, (1976) reported that, number of branches, plant height were reduced when sowing of mustard was done beyond 18th October.

Singh *et. al.*, (1980) recorded maximum plant height, number of branches plant^{-1} and number of siliquae plant^{-1} of mustard from 27th September sowing followed by 7th October sowing.

Singh *et.al.*, (1984) conducted the field experiment under different sowing dates during winter season and observed that the dry matter accumulation was decreased by later sowing but not significantly affected by plant density.

Diwan Singh *et.al.*, (1993) in a field experiment conducted at Hissar with three seeding dates, reported that the accumulated heat units and the number of days of reaching the various growth stages, like vegetative, bolting and termination of flowering on the main shoot decreased with successive delay in seeding.

Pramanic *et.al.*, (1996) reported that, plant height and biomass decreased when sowing was delayed beyond 30th October.

Surekha and Reddy (1996) observed that, sowing on 5th October resulted in higher growth of mustard.

Tyagi *et.al.,* (1996) conducted a field experiment at the Haryana Agriculture University, Hissar with three sowing dates and three varieties. They reported that, early sowing resulted in early flowering, longer seed filling period, a longer reproductive phase and ultimately a higher seed yield per unit area. Days taken to the first four stages increased significantly as sowing were delayed. However, days taken to maturity were reduced following delayed sowing due to high temperature at maturity, which resulted in forced maturity.

Belgamwar (1998) in a research trial at Dr. P.D.K.V., Akola noticed that there was significant influence of late sowing on plant height, number of branches and number of leaves of Indian mustard. He observed significant reduction in growth parameters with delay in sowing by each successive metrological week. He further reported that duration of flower and siliquae initiation was progressively delayed due to late seeding and the crop took more days to flower initiation in late or advanced sowing after branching. He also observed considerable reduction in crop maturity period in respect of late sowing.

Saini and Sidhu (1998) studied the effect of sowing dates of sarson at Amritsar in winter season. They reported that the time to emergence increased, but the time for 50 per cent flowering, siliqua formation and maturity decreased, as sowing was delayed from 1st October to 15th November.

Shivani and Sanjiv Kumar (2002) conducted the field experiment during *Rabi* season in Sikkim to study the response of Indian mustard to sowing date. Crop sown on 25th September and 5th October, produced taller heights of 158.1 cm and 161.4 cm which were at par with each other but significantly taller than 15th October, 25th October and 4th November later sown crops. Plant height decreased progressively with delay in sowing from 5th October to 4th November. Number of secondary branches plant^{-1} also showed the same trend due to variation in sowing dates.

Rajendra Kumar *et.al.,* (2002) carried out the field experiment during winter (*rabi*) season of two years at Ludhiana to study the response of *Brassica* species under three sowing dates and found that plant height, leaf area index of *Brassica* species were significantly higher in 21st October and 15th November as compared to 10th December sown crop by 18.6 and 20.0 per cent. The crop sown on 21st October and 15th November were found to be similar as compared to 10th December for primary branches plant^{-1}. They also observed that the crop sown on 21st October produced significantly higher dry matter plant^{-1} than that on 15th November and 10th December. The increase in dry matter accumulation of 21st October sown crop over 15th November and 10th December sown crops was 9.1 and 80.1 per cent and 6.1, 66.1 per cent during 1998- 99 and 1999–2000 respectively.

Singh and Singh (2002) in Uttar Pradesh, observed that growth characters viz; plant height, leaf area index, primary and secondary branches plant^{-1} were found to be more with 14th October sowing as compared to 29th October, 13th November and 28th November sowing dates during two years.

Ghanbahadur and Lanjewar (2004) conducted the field trial at Akola, with two sowing dates and found that plant height of Indian mustard were significantly influenced by sowing dates. The crop sown on 15th November shows increase in plant height of 145.7 and 160.5 cm in two seasons as compared to 30th November 137.4 and 150.4 cm respectively. Dry matter production of Indian mustard were significantly influenced by sowing dates. The crop sown on 15th November produced higher dry matter plant^{-1} (38.4 and 42.14 g) than crop sown on 30th November (30.07 and 32.62 g) in two years.

Patel *et.al.,* (2004) revealed from the studies of three years at Rajasthan that duration for emergence and 50 per cent flowering of mustard was delayed due to delay in sowing from 8th November to 18th December. The duration for physiological maturity was shortened by 17 days. The higher plant height and

branches plant^{-1} recorded higher on 8th November as compared to 18th and 28th November and 8th and 18th December.

Thakare *et.al.,* (2004) in an experiment at Akola on mustard crop reported increase in plant height, number of branches plant^{-1} up to 157.89 cm, 5.59 branches respectively due to early sowing on 25th September as compared to 10th October., 25th October, 10th and 25th November

Sharma (2006) conducted the experiment at Nagpur and concluded that sowing during 22nd, 29th October proved superior in growth characters viz; plant height, number of leaves, leaf area index, number of branches, as compared to sowing on 2nd week of November and 1st week of October. There was 2.75 , 25.46, 57.43 per cent increase in dry matter accumulation plant^{-1} in 29th October and 22nd October sowing over 12th November and 6th October.

Awasthi *et.al.,* (2007), reported that sowing of mustard crop on 15th October has achieved highest value of plant height up to 151.8 cm as compared to 30th October sowing which was 143.8 cm respectively at Kanpur, Uttar Pradesh.

Bhuiyan *et.al.,* (2008) conducted the field experiment at Rangpur, Bangladesh during *Rabi* season and observed that the highest plant height of 115 cm was recorded from the mustard plants of third planting (10th November) and it was significantly different from sowing in October and December. The highest number of primary branches plant^{-1} (6.85) was found from 20th October, 30th October and 20th November The lowest primary branches plant^{-1} recorded from 30th November sowing (6.20).

Shah and Rahman (2009) at Pakistan revealed that, plant height was reduced as sowing was delayed from 15th October. The plots sown on 15th September matured earlier than sowing on 25th September, 5th , 15th, 25th October and 5th , 14th November.

2.1.2. Effect of sowing dates on yield and yield attributes:

Shastry and Arvind Kumar (1981) in an experiment at New Delhi revealed that mustard sown on 1st October resulted in the higher seed yield over 11th October, 21st October and 31st October sowings. They further stated that successive 10 days delay in planting reduced the yield by 19.7, 33.0 and 47.7 per cent, correspondingly. Increase in number of siliquae, 1000 seed weight and number of siliquae plant^{-1} reflected in higher seed yield from the crop planted on 1st October. Flowering was found delayed due to late sowing, however crop attained early maturity in late sowing done on 31st October.

Chavan *et.al*, (1989) conducted an experiment during *Rabi* season of two years and observed that sowing of mustard during third week of November produced significantly more seed yield than sowing in the first week of November.

Jain *et.al*, (1989) reported that, normal sowing of mustard (19th October) resulted in 28.8, 70.3 and 17.1 per cent increase in seed yield over 29th October, 8th and 18th November sowing, respectively. They further reported that, late sowing adversely affected the seed yield and yield attributes.

Sharma *et.al*, (1991) studied the effect of sowing dates on yield at Gwalior and reported that there was significant reduction in yield of mustard due to late sowing (after 5th November).

Bali *et.al*, (1992) in an experiment at Jammu and Kashmir reported significant reduction in seed yield of mustard with delay in sowing from 25th September to 11th November.

Chandrakar and Urkurkar (1993) studied the effect of three sowing dates and observed that, delay in sowing by each week reduced the yield of mustard by 6.29 and 47 per cent, respectively as compared to sowing on 23rd November

Khande *et.al*, (1993) reported significant reduction in seed yield of mustard when sowing was done later than 25th September.

Chaudhary and Thakaria (1994) in an experiment under rainfed condition of Karimganj with four sowing dates observed significant reduction in mustard seed yield when sown after 15th November

Mehar Chand *et.al*, (1995) in Haryana reported the higher seed yield of mustard with sowing from 22nd September to 17th October and the seed yield reduced gradually with successive delay in sowing.

Dudhade *et.al*, (1996) reported the highest seed yields when the crop was sown on 15th October. Subsequent sowing at an interval of 15 days resulted in the significant reduction in seed yield of mustard. They further recorded significant reduction in straw yield and biological yield due to delay sowing and there was progressive reduction in harvest index when the Indian mustard was sown late.

Surekha and Reddy (1996) in an experiment at Rajendranagar, Hydrabad, during *Rabi* season, observed that sowing on 5th October resulted in higher growth and yield components followed by 20th October, 5th and 20th November. The reduction in seed yield was 34.6, 67.6 and 88.4 per cent with the respective dates of sowing.

Tuteja *et.al*, (1996) reported the highest seed yield when the mustard crop was sown on 12th October and subsequently decreased due to delayed sowing.

Thakur and Singh (1998) with four sowing dates viz; 5th, 20th October, 4th and 19th November reported that the delayed sowing resulted in reduction of crop yield because of abnormal mean temperature at sowing and at different growth stages that resulted in heavy diseases and pest infestation.

Yadav *et.al*, (1999) in a field experiment in Madhya Pradesh while working on Indian mustard variety Pusa bold reported delay in sowing caused significant reduction in seed yield.

Zora Sing *et.al*, (1998) at Ludhiyana reported that among the four sowing dates viz; 30th October, 15th and 30th November and 15th December, more seed yield was reported under 30th October. Delayed sowing resulted in significant reduction in seed yield. Maximum seed yield was produced in 15th October which was at par with 15th November sowing. They also observed that the straw yield decreased significantly with each delay in sowing which was might be due to completion of vegetative phase in unfavorable climatic condition in late sown crop that ultimately started flower initiation and siliquae formation.

Shivani and Sanjeev Kumar (2002) during *Rabi* season at Sikkim studied the response of Indian mustard to different sowing dates. Crop sown on 25th September produced yield attributes similar to that sown on 5th October, but further delay in sowing adversely affected the yield attributes. Crop sown on 25th September and 5th October gives more seed yield of 1882 kg ha^{-1} and 1800 kg ha^{-1} as compared to 15th and 25th October, 4th November sowing.

Rajendra Kumar (2002) conducted the experiment at Ludhiyana during winter season, and reported that the crop sown on 21st October recorded 1000 seed weight increased by 17.9 per cent as compared to 10th December. They further noticed that crop sown on 15th November produced 14.61 and 17.53 q ha^{-1} seed yield in two season respectively, which was significantly higher than 10th December sown crop. Similarly, the crop sown on 15th November produced 15 and 8 per cent more seeds $siliqua^{-1}$ and 11 and 15 per cent higher seed weight than 10th December sown crop.

Ghanbahadur and Lanjewar (2004) conducted the field trial in clay soils at Akola, with the object to compare performance of Indian mustard on 15th and 30th November. Number of siliquae and 1000 seed weight found to be significantly higher in 15th November (412.9 and 3.65 g) over succeeding date in two years, respectively. Also similar pattern was found in seed yield. The 15th November gives 24.34 q ha^{-1} to 13th November 17.06 q ha^{-1}.

Gupta *et.al*, (2004) in an experiment at Pantnagar observed the effect of sowing dates and revealed that, sowing on 21st October gave the highest mean yield of 1585.7 kg ha^{-1}. Further delay in sowing significantly reduced the yield of mustard.

Patel *et.al*, (2004) found that crop sown on 8th November produced 1409 kg ha^{-1} seed yield in protected environmental condition and in unprotected environmental condition 279 kg ha^{-1} which is higher than 8th and 18th December in their both environmental conditions at Rajasthan.

Thakare *et. al.*, (2004) in an experiment at Akola observed that, crop sown on 25th September gives highest yield of 4.33 q ha^{-1} as compared to 10th and 25th October; 10th and 25th November respectively.

Awasthi *et.al.*, (2007), at Kanpur, Uttar Pradesh observed that, mustard crop sown on 15th October gives highest 1000 seed weight (4.25 g), highest seed yield (1.43 t ha^{-1}), highest stover yield (4.28 t ha^{-1}) as compared to 30th October planting.

Bhuiyan *et.al.*, (2008) conducted an experiment at Rangpur, Bangladesh. The results showed that the highest 1000 seed weight was recorded in 30th October (3.80 g) which was statistically similar to those of 20th October (3.68 g) and 10th November (3.68 g) as compared to 10th November (3.68 g) as compared to 20th and 30th November (3.28, 3.24 g). Similar pattern was observed in seed yield plant^{-1} and seed yield ha^{-1} which was highest (3.78 g and 1.86 t) in 30th October. Wide variation was found in the stover yield. The highest value was recorded in 20th October (6.06 t) and delay in sowing reduced stover yield significantly.

Shah and Rahman , (2009) reported that significantly highest yield was obtained from plot sown on 25th September and 5th October (3657.4 and 2856.5 kg ha^{-1}) as compared to the crop sown on 15th October to 14th November. The lowest yield were obtained from sowing on 14th November.

Sharma (2006) in an experiment at Nagpur noticed that crop sown on 44th metrological week i.e. last week of October recorded higher seed yield of 14.09 q ha^{-1} followed by sowing on 40th, 42nd and 46th meteorological weeks.

2.1.3. Effect of sowing dates to mustard on oil yield, oil content and protein content :

Bishnoi and Kanwar Singh (1979) studied the effect of three sowing dates on mustard at Hissar and observed that, significant increase in protein content was observed in delayed sowing.

Singh *et. al.,* (1980) reported significant reduction in oil percentage due to sowing onwards from 7th October.

Ghosh and Chatterjee (1988) conducted an experiment with three sowing dates and revealed that, delay in sowing after first fortnight of November reduced oil content by 2.9 per cent. Further 1.9 per cent reduction was due to another 15 days delay in sowing i.e. first to third week of November.

Rajput *et.al.,* (1991) observed that consecutive delayed sowing from 10th to 30th October increased the seed protein content but reduced the oil content.

Channawar and Nagre (1992) in a field experiment with two varieties, three sowing dates and four levels of nitrogen reported that, the non-significant effect of sowing dates on protein content of mustard seed, when the crop was sown on three sowing dates i.e. 28th September and 13th and 28th October.

Chaudhary *et.al.,*(1993) at Nagpur (M.S.) revealed that, sowing on 29th October increased the oil content in seeds as compared with delayed sowing from 29th October to 19th November

Jadhav and Singh (1993) at Water Technology Center, New Delhi, with four sowing dates for mustard crop reported that, the oil content was highest when the crop was sown on 18th and 28th October. The oil content decreased

significantly when the sowing was delayed upto 17th November. The probable reasons for this may be due to improper seed development and oil synthesis in seed under delayed condition of sowing and also due to restricted growth of plants and size during the seed development phase.

Yadav *et.al.,* (1996) studied the effect of sowing dates at Morena, Madhya Pradesh and observed that, nitrogen and phosphorous percentage of plant increased significantly with the delay in sowing. The heighest seed protein content was reported in 16th November sowing.

Dhingra *et.al.,* (2002) conducted the field experiment at Ludhiana, Punjab on different *Brassica* species on different sowing dates viz; 20th October, 15th November and 10th December. They further observed that, mustard crop sown on 20th October recorded the highest oil content of 42.30 per cent and oil yield of 7.80 q ha^{-1} and decreased significantly with the delay in sowing.

Shivani and Sanjeev Kumar (2002) studied the response of Indian mustard to different sowing dates in Sikkim and concluded that, oil yield and oil content of 25th September and 5th October sown crop gives higher values of 33.0 and 32.6 per cent oil content and 619 and 583 kg ha^{-1} oil yield as compared to crop sown on 5th, 25th October and 4th November. They further revealed that, the delay in sowing of mustard crop from third week of October to first week of November reduced the oil content by 2.9 per cent.

Rajendra Kumar (2002) at Ludhiyana, observed that, delayed sowing on 10th December recorded 16.7 and 14.4 per cent less yield than the early sowing on 21st October and 15th November respectively. They also found that, oil yield of *Brassica* species during individual seasons was significantly higher under early sowing of 15th November as compared to late sowing of 10th December. Values of 20.4 and 59.0 per cent higher oil yield was recorded over 10th December sowing.

Patel *et.al*, (2004) in a field experiment at Rajasthan noticed that, highest oil content was recorded with 8th November sowing as compared to 28th November and 8th or 18th December sowing, respectively.

Parminder Kaur and Sidhu (2006) in an experiment at Ludhiyana, Punjab during the *Rabi* seasons studied the response of *Brassica carinata* to various sowing dates and concluded that, the oil and protein content significantly decreased as sowing was delayed from 15th October to 15th December in both years (1999 - 2000 and 2000 - 01). The highest oil and protein content (35.3 per cent) was recorded for the crop sown in 15th October.

2.2 Response of different genotypes of mustard :

2.2.1 Effect on growth and growth attributes of different genotypes :

Mehrotra *et.al*, (1976) observed considerable variation in respect of primary and the secondary branches among different mustard varieties.

Lad *et.al*, (1993) at Nagpur revealed that, variety Pusa bold had higher leaf area, dry matter that attributed to higher straw yield.

Bhalerao (1997) reported significantly higher growth attributes like leaf area, leaf area index, dry matter, average growth rate, net assimilation rate in Pusa bold over Varuna variety of mustard. More number of days were required for 50 per cent flowering for Pusa bold.

Anonymous (1999_a) concluded that, ACN-9 the pre-released variety of Indian mustard is shorter in height (142 cm) than Pusa bold (166 cm) and hence can tolerate lodging. They further reported that, 50 per cent flowering (43 days) and maturity (98 days) was observed early in ACN-9 as compared to Pusa bold (50 per cent flowering in 52 days and maturity in 110 days).

Anonymous (2003) reported that, Pusa bold variety of Indian mustard flowers in 35 to 40 days and matures in 110 to 115 days. They further reported

that the prereleased variety of mustard ACN-9 flowers in 35 to 38 days and mature early within 95 to 105 days.

Hundal *et.al*, (2004) in Ludhiyana, Punjab revealed that different crop growth intervals registered a peak crop growth rate of 33.7 and 30.4 g $m^{-1}day^{-1}$ for Bio – 902 and Pusa bold, respectively.

Ghanbahadur and Lanjewar (2004) conducted the field experiment at Akola, during *rabi* season on two mustard varieties. Pusa bold and ACN-9 and found that Pusa bold recorded higher plant height of 146.5 and 158.4 cm in 1999 - 2000 and 2000 – 01 as compared to ACN-9 (136.5 and 152.5 cm) in both years respectively. The dry matter production in variety Pusa bold was significantly higher than ACN-9 in both the years at all growth stages. The Pusa bold variety produced 7.2 and 5.04 per cent more dry matter over variety ACN-9 at harvest during first and second year, respectively.

Sharma (2006) conducted the field experiment at Nagpur during *Rabi* season under irrigated condition on variety Pusa bold and recorded values of plant height 160.58 cm, number of leaves $plant^{-1}$ 35.72, 1.334 leaf area index, number of branches $plant^{-1}$ 10.42 respectively. The dry matter accumulation by Pusa bold is heighest (32.72 g).

Awasthi *et.al.,* (2007), performed an experiment during winter season at Kanpur, Uttar Pradesh on two mustard varieties, Vaibhav and Urwashi in terms of plant height, number of siliquae, length of siliquae. Urwashi recorded 141.7 cm plant height, 284.9 number of siliquae, 4.2 cm length of siliquae.

2.2.2 Effect on yield and yield attributes of different genotypes:

Mehrotra *et.al*, (1976) observed considerable variation in respect of siliquae $plant^{-1}$ and 1000 seed weight among different mustard varieties. They further reported that, cultivar Pusa bold gave higher 1000 seed weight than Varuna and Kranti owing to bold seed size.

Anonymous (1999_b) reported significant increase in seed yield of mustard variety ACN-9 (16.98 q ha^{-1}) over Pusa bold (15.01 q ha^{-1}) under multi varietals trails of University. They further recorded 6 to 13 per cent increase in seed yield of mustard variety ACN-9 over Pusa bold. Lower test weight (3.2 g) was recorded in ACN-9 than Pusa bold (3.7 g) owing to small seed size of ACN-9.

Pooran Chand *et.al.,* (2000) conducted the field trial in Regional Agricultural Research Station, Palem, India on six Indian mustard varieties, viz; Vardhan, Varuna, Sita, GM-1, Pusa bold and Kranti. They observed that, among mustard cultivars, GM-1 gave the highest seed yield (1050 kg ha^{-1}), followed by Kranti (790 kg ha^{-1}) and Pusa bold (760 kg ha^{-1}), respectively.

Shivani and Sanjeev Kumar (2002) in an experiment at Sikkim observed that Pusa bold recorded seed yield upto 1882 kg ha^{-1}, 1000 seed weight upto 5.3 g in interaction with sowing dates.

Singh and Singh (2002) showed that, genotype Pusa bold significantly produced highest test weight than other genotypes.

Ghanbahadur and Lanjewar (2004) in an experiment at Akola found that seed yield of mustard variety ACN-9 (14.76 and 22.14 q ha^{-1}) in two years was higher as compared to Pusa bold which recorded 12.25 and 19.27 q ha^{-1} respectively. The 1000 seed weight of ACN-9 was lower (3.11 g) as compared to Pusa bold (3.82 g).

Panda *et.al.,* (2004) conducted the field experiment at ICAR, New Delhi during winter season under irrigated condition. Results revealed that Pusa bold was superior than SEJ-2 in terms of yield. Pusa bold recorded 1527 kg ha^{-1} grain yield.

Sharma (2006) in field trial under irrigated condition at Nagpur revealed that Pusa bold recorded average seed yield ha^{-1} of 10.26 q ha^{-1} and average straw yield of 27.71 q ha^{-1}.

Awasthi *et.al.*, (2007) in an experiment at Kanpur, Uttar Pradesh, concluded that variety Vaibhav was superior than Urwashi in terms of seed yield and stover yield. Urwashi recorded 1.23 t ha^{-1} seed yield and 3.85 t ha^{-1} stover yield which was lower as compared with Vaibhav.

Pati and Acharya (2009) performed the field experiment during *rabi* season at Central Research Station, Bhubaneshwar and revealed that among four varieties tested in two seasons, JD-6 recorded heighest seed yield followed by PT-303 which was 12 per cent more than the rest of varieties.

2.2.3 Effect on oil yield, oil content and protein content of different genotypes:

Bhalerao (1997) reported 35.18 per cent and 3.11 q ha^{-1} oil yield in Indian mustard variety Pusa bold.

The oil content in ACN-9 (36.37%) and Pusa Bold (36.11%) was at par but variety ACN-9 exhibited 7.0 per cent increase oil yield over Pusa bold in University trials due to higher seed yield of the former (Anonymous (1999_a).

Ghanbahadur and Lanjewar (2004) at Akola, observed that, ACN-9 recorded highest oil content and oil yield as compared to Pusa bold. ACN-9 recorded 5.19 and 7.76 q ha^{-1} oil yield and 34.74 and 34.83 per cent oil content over Pusa bold which recorded 4.25 and 6.67 q ha^{-1} oil yield and 34.35 and 34.48 per cent oil content, respectively in two seasons.

Sharma (2006) in an experiment at Nagpur observed that Pusa bold recorded 38.76 per cent oil content, 4 q ha^{-1} oil yield, 23.33 per cent mean protein content.

Anonymous (2009) revealed that, the oil content (38 to 40 per cent) in mustard variety Pusa bold and ACN-9 was at par.

Chapter III

MATERIAL AND METHODS

A field experiment entitled "Response of mustard genotypes to different sowing dates" was carried out during *rabi* season of 2010-2011. The details of material used and method adopted during the course of present investigation are presented in this chapter under appropriate headings.

3.1 Basic resource information :

3.1.1 Experimental site :

The present experiment was conducted at Agronomy Farm, College of Agriculture, Nagpur, during *rabi* season of 2010-2011. The experimental field No. 9 was fairly uniform and leveled.

3.1.2 Soil :

The soil of the experimental plot was vertisol. The soil samples were drawn randomly at five places from 0 – 30 cm depth before sowing with the help of soil auger. A composite sample was then prepared and used to study the availability of major elements and some phisico-chemical properties. The methods adopted and the results of the analysis are presented in Table 1.

Table 1: Physico-chemical properties of experimental soil

Sr.No.	Particulars	Value	Analytical method adopted
A. Mechanical composition			
1.	Coarse sand (%)	8.01	Standard International Pipette method (Piper, 1966)
2.	Fine sand (%)	10.9	
3.	Silt (%)	35.5	
4.	Clay (%)	53.6	
B. Chemical composition			
1.	Organic Carbon (%)	0.58	Walkley and Black Rapid titration method (Jackson, 1967)
2.	Available Nitrogen (kg ha^{-1})	175.6	Alkaline permanganate method (Subbiah and Asija, 1956)
3.	Available P_2O_5 (kg ha^{-1})	24.4	Olsen's method (Jackson, 1967)
4.	Available K_2O (kg ha^{-1})	237.5	Flame emission spectrometer (Jackson, 1967)
C. Soil reaction			
1.	Soil pH	7.8	Beckman's Glass Electrode pH meter (Jackson, 1967)
2.	Electrical Conductivity (d Sm^{-1})	0.9437	Conductivity Bridge method (Jackson, 1967)

It would be observed from the data presented in Table 1, that the soil of the experimental field was clayey in texture, medium in nitrogen content, medium in phosphorus rich in potash. Organic carbon content was medium and soil reaction was slightly alkaline in nature.

3.1.3. Cropping history of the experimental site :

The cropping history of the experimental field during the preceding three years is given in Table 2.

Table 2 : Cropping history of the experimental field.

Year	Crop		
	Kharif	Rabi	Summer
2008-2009	Soybean, Mung	Gram	-
2009-2010	Soybean	Linseed	-
2010-2011	Soybean	Mustard (Present Investigation)	-

3.2 Climate and weather condition :

Nagpur is part of Central Vidarbha Zone of Maharashtra, which falls under eco- unit VIII of ninth rainfall zone of Maharashtra State. Nagpur is situated at 321 meters above mean sea level at $21^0 10^1$ N latitatude and $79^0 19^1$ E longitude having a subtropical climate with assured but variable rainfall in *kharif* season associated with hot and dry summer, white *rabi* is normally cool.

Weekly weather data in respect of maximum and minimum temperature, rainfall, number of rainy days and evaporation during the *rabi* season of 2010-2011 recorded at meteorological observatory, College of Agriculture, Nagpur along with its normal values are presented in Table 3 and depicted in Fig.1, that mean weekly maximum and minimum temperature for the last 10 years (2000-2010) during the crop growth period of 2010-2011 was ranged in between 27.5 °C to 32.8 °C and 10.4 °C to 20.1 °C.

Table 3: Monthly meteorological data for 10 years and for rabi, 2010-2011

Mon.	Max. temp. °C		Min. temp. °C		Rainfall (mm)		Rainy days		Relative humidity (%)	
	A	B	A	B	A	B	A	B	A	B
Oct.	32.7	32.8	19.6	20.1	71.9	66.2	4.5	4	58.1	57.7
Nov.	30.4	29.5	15.3	17.1	10.6	34.4	1.4	4	82.3	56.8
Dec.	28.1	28.2	10.6	13.6	4.6	3.2	1.0	1	67.1	51.5
Jan.	28.0	27.5	11.1	10.4	15.0	13.4	1.4	1	68.9	54.7
Feb.	31.0	30.8	14.5	15.2	12.7	1.8	2.6	1	67.3	41.8

A = 10 years average (2000-2010), **B** = present monthly average (2010-11)

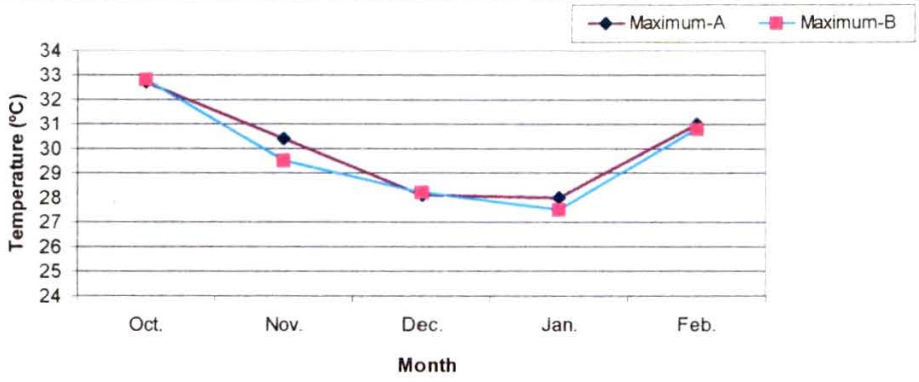


Fig. 1 (a) Monthly maximum temperature (°C) during the year 2010-2011 at Nagpur

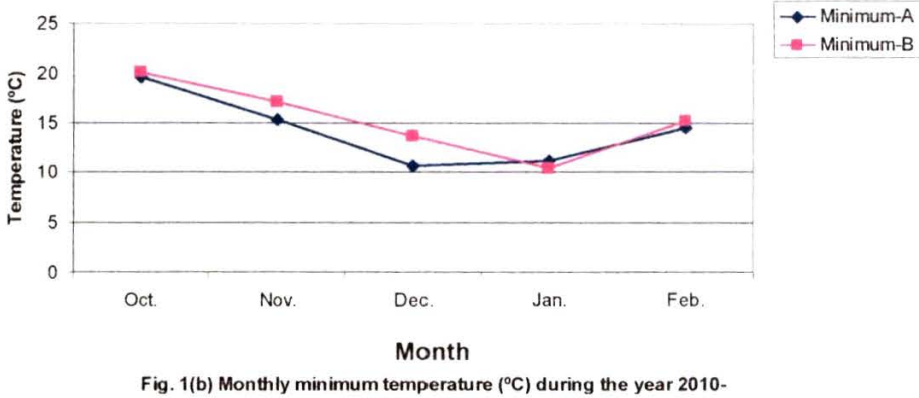


Fig. 1(b) Monthly minimum temperature (°C) during the year 2010-2011 at Nagpur

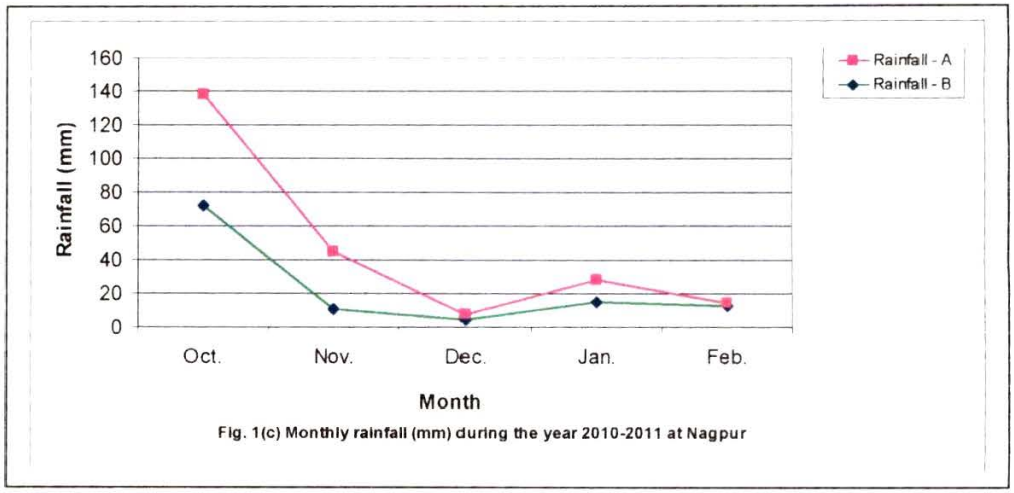


Fig. 1(c) Monthly rainfall (mm) during the year 2010-2011 at Nagpur

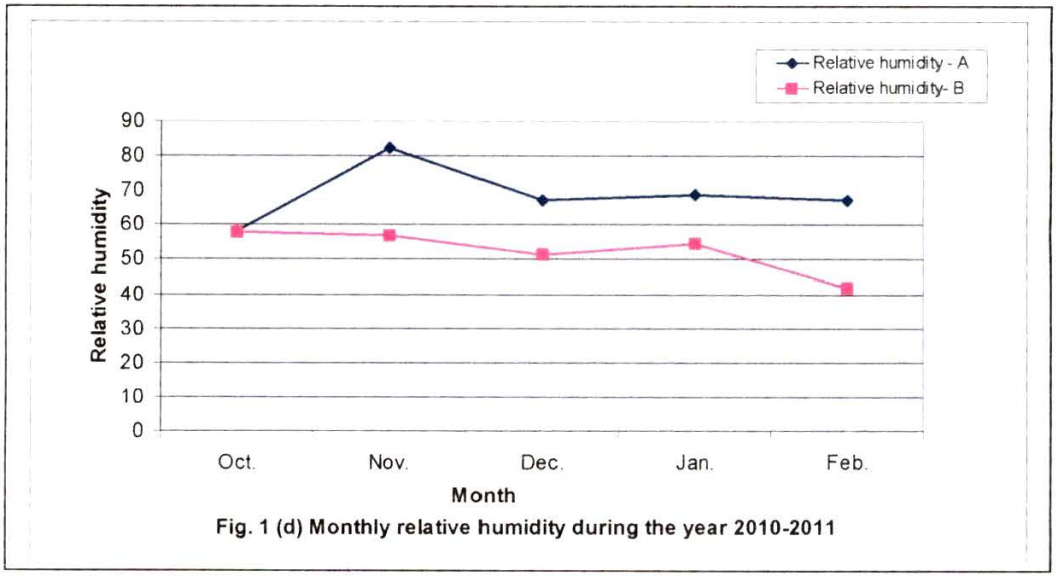


Fig. 1 (d) Monthly relative humidity during the year 2010-2011

Table 4 : Weekly data for the year 2010-11 (Period with Oct 2010 to Feb 2011) recorded at meteorological observatory, College of Agriculture, Nagpur.

Date		Met Week	Temp °C		R.H. %		Total Rainfall (mm)	No.of Rainy days	Bright sunshine hours	Wind speed (km/hr.)	Evaporation (mm)
			Max	Min	Mor	Eve					
01-07	Oct.10	40	32.6	22.2	73	55	-	-	6.9	3.1	3.0
08-14		41	33.9	22.7	69	46	-	-	7.3	3.1	3.2
15-21		42	31.3	23.1	76	66	00.8	-	3.6	4.2	3.0
22-28		43	32.0	19.9	78	49	20.8	1	5.0	2.6	3.0
29-04	Nov 10	44	29.4	19.0	73	57	-	-	4.3	3.5	2.3
05-11		45	31.2	19.5	72	56	1.6	-	6.7	3.2	2.2
12-18		46	31.7	20.5	77	63	20.4	1	-	2.0	2.2
19-25		47	30.9	18.8	69	53	38.0	2	-	2.4	2.6
26-02	Dec 10	48	31.7	19.1	74	47	-	-	-	1.5	2.5
03-09		49	28.7	16.5	67	46	-	-	-	4.3	2.9
10-16		50	28.4	13.9	61	37	-	-	-	2.8	2.8
17-23		51	26.7	07.7	57	29	-	-	-	2.0	2.2
24-31		52	28.3	11.9	70	38	-	-	-	1.7	2.2
01-07	Jan.11	1	26.2	08.0	44	26				3.5	1.8
08-14		2	27.6	07.6	48	26				2.0	2.8
15-21		3	29.4	10.1	54	31				2.4	2.7
22-28		4	30.7	12.5	66	27				2.0	2.9
29-04	Feb.11	5	31.0	14.7	58	30				3.0	3.4
05-11		6	32.3	13.5	55	24				2.2	3.9
12-18		7	33.2	16.3	55	25				2.8	4.4
19-25		8	28.6	15.3	63	44	18.4	2		4.4	3.5

OCT 2010 TO FEB 2011

Total Rainfall = 81. 6 mm
No. of Rainy Days = 6

3.3 Experimental details :

The experiment was laid out in split plot design with four treatment of sowing dates (S_1,S_2,S_3,S_4) under main plot treatments and four various (V_1, V_2, V_3, V_4) as sub plot treatment forming 16 treatment combinations and replicated three times. The treatment details with symbols used for each treatment are given as followed.

3.3.1 Details of treatment combinations :

Main plot treatments	:	S1	42nd	MW (15-21 October)
(Sowing Dates)		S2	43rd	MW (22-28 October)
		S3	44th	MW (29-04 November)
		S4	45th	MW (05-11 November)
Sub plot treatments	:	V1	ACN-9	
(Varieties)		V2	Pusa bold	
		V3	Urwashi	
		V4	JD-6	

3.3.2 Other experimental details :

The other details of experiment are :

1. Experimental design	:	Split plot
2. Number of replications	:	3
3. Number of treatment combination	:	16
4. Crop	:	Mustard
5. Number of plots	:	48
6. Gross plot size	:	4.0 m x 3.6 m
7. Net plot size	:	3.6 m x 2.7 m
8. Spacing	:	45 cm x 20 cm
9. Inter space between replication	:	1.0 m
10. Inter space between two plots	:	0.5 m
11. Seed rate	:	5 kg ha^{-1}
12. Recommended dose of fertilizer	:	50 : 40 : 00 NPK kg ha^{-1}

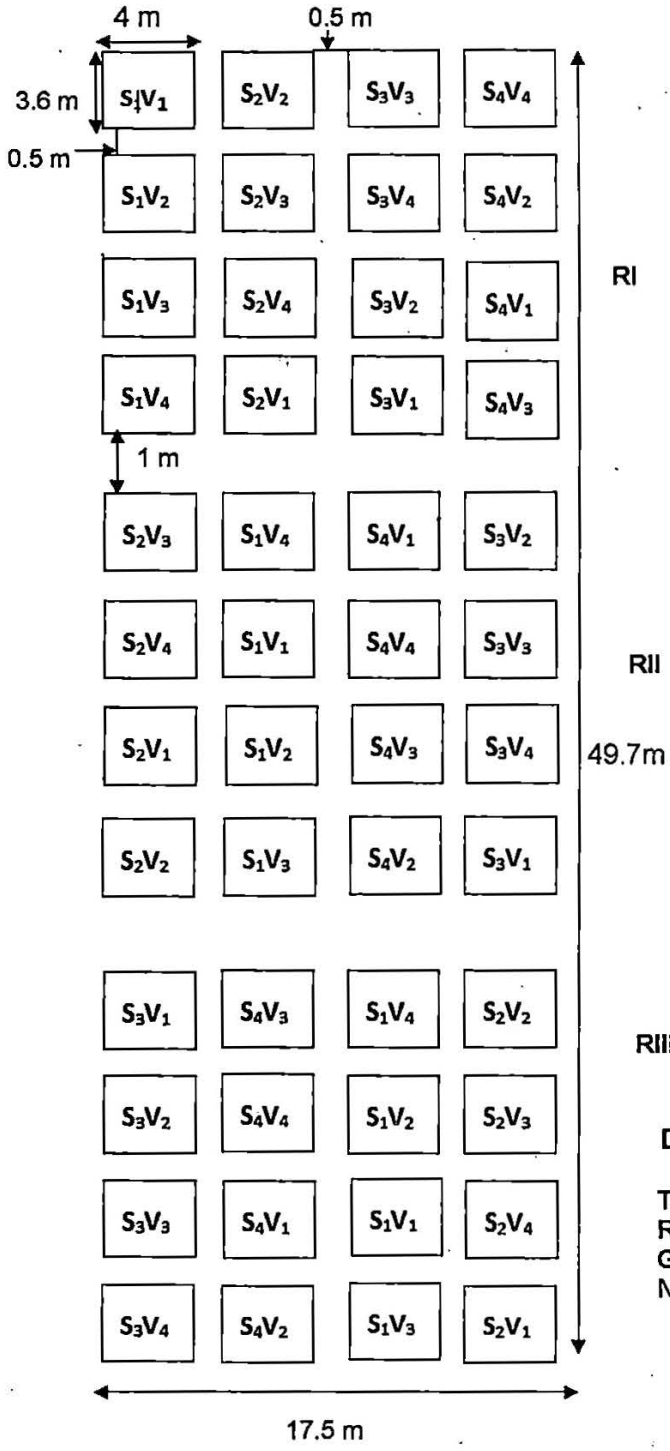
13. Method of sowing	:	Drilling
14. Date of sowing	:	22/10/10 28/10/10 04/11/10 11/11/10

3.3.3 Experimental layout :

The experimental field was laid out as per plan after preparatory tillage operation. There were 16 treatment combinations laid out in split plot design with three replications. The plan of layout for the present investigation is depicted in Fig. 2.

The distance between two replications was 1 m and 0.5 m between two plots. The gross and net plot size were 4.00 m x 3.6 m and 3.6 m x 2.7 m respectively.

Fig 2: PLAN OF LAYOUT :



S_1V_1	S_2V_2	S_3V_3	S_4V_4
S_1V_2	S_2V_3	S_3V_4	S_4V_2
S_1V_3	S_2V_4	S_3V_2	S_4V_1
S_1V_4	S_2V_1	S_3V_1	S_4V_3
S_2V_3	S_1V_4	S_4V_1	S_3V_2
S_2V_4	S_1V_1	S_4V_4	S_3V_3
S_2V_1	S_1V_2	S_4V_3	S_3V_4
S_2V_2	S_1V_3	S_4V_2	S_3V_1
S_3V_1	S_4V_3	S_1V_4	S_2V_2
S_3V_2	S_4V_4	S_1V_2	S_2V_3
S_3V_3	S_4V_1	S_1V_1	S_2V_4
S_3V_4	S_4V_2	S_1V_3	S_2V_1

Design: Split Plot Design

Treatments : 16
Replication : 3
Gross plot size : 4.00 m x 3.6 m
Net plot size : 3.6 m x 2.7 m

3.4 Cultivation details :

The schedule of various cultural operations undertaken in the experimental field during the course of investigation are presented in Table 5.

Table 5 : Schedule of cultural operations carried out in the experimental plot

Sr. No.	Particulars	Frequ-ency	Date of operation			
			S_1	S_2	S_3	S_4
1	**Pre-sowing operations**					
a	Ploughing	1	14/10/10	14/10/10	14/10/10	14/10/10
b	Harrowing cross wise	2	20/10/10	20/10/10	20/10/10	20/10/10
c	Cleaning	1	20/10/10	20/10/10	20/10/10	20/10/10
d	Planking	1	20/10/10	20/10/10	20/10/10	20/10/10
e	Layout	1	21/10/10	21/10/10	21/10/10	21/10/10
2	**Sowing and marking**	1	22/10/10	28/10/10	04/10/10	11/11/10
3	**Thinning and gap filling**	1	30/10/10	07/11/10	14/11/10	20/11/10
4	**Fertilizer applications**					
a	Basal	1	22/10/10	28/10/10	04/11/10	11/11/10
b	Top dressing	1	21/11/10	29/11/10	05/12/10	10/12/10
5	**Intercultural operations**					
a	Opening of furrows	1	07/11/10	13/11/10	18/11/10	26/11/10
b	Hand weeding	2	27/11/10	03/12/10	07/12/10	14/12/10
c	Hoeing	1	17/11/10	22/11/10	29/11/10	05/12/10
6	**Plant protection**	1	29/12/10	07/01/10	15/10/10	20/01/10
7	**Harvesting**	1	15/01/11	20/01/11	30/01/11	10/02/11
8	**Threshing**	1	21/01/11	01/02/11	11/02/11	15/02/11

3.4.1 Preparatory tillage :

The land was prepared after the harvest of previous crop with ploughing and subsequent cross wise harrowing and stubble picking. The field was laid out in plots as per plan of layout and kept ready for sowing.

3.4.2 Seed and sowing :

The seed of mustard varieties, ACN-9, Pusa bold, Urwashi, JD-6 was used in the present investigation. The seed was obtained from section of Agronomy, College of Agriculture, Nagpur. The seed was treated with thirum @ 3.0 g kg^{-1} seeds prior to sowing.

The seed was drilled at the spacing of 45 cm between rows and 20 cm within plants. Seed rate used was 5 kg ha^{-1}. The seed was covered with light planker immediately after sowing.

3.4.3 Fertilizer application :

The required quantity of chemical fertilizers were measured and applied as per the recommended dose of fertilizer for Mustard by mixing in the soil. Nitrogen and phosphorous were supplied through urea and single super phosphate.

Recommended full dose of P_2O_5 (40 kg ha^{-1}) and half dose of nitrogen (25 kg ha^{-1}) was applied as besal at the time of sowing and remaining half dose of nitrogen (25 kg ha^{-1}) was given prior to first irrigation.

3.4.4 Plant protection measures :

There was some infestation of powdery mildew, aphids and leaf minor found during crop growth period and hence spray of malathion @ 100 ml ha^{-1} was used against the diseases and pests obsevered in the experimental plot.

3.4.5 Harvesting and threshing :

The crop was harvested when it was completely matured. The observation plants were harvested first and then border rows and plants on either sides of gross plot were removed and then plants from net plot area were harvested. The harvesting was done with the help of sickle. The produce was tied in bundles plot wise and carried to threshing yard for sun drying. After complete drying the produce from each net plot area was threshed, winnowed, cleaned separately and grain weight was recorded for each net plot. The details of biometric observations recorded in the field are given in Table 6.

Table 6 : Scheduled of biometric observation:

Sr.No	Observations	Frequ-ency	Stages of Observations
A	**Pre-harvest observations**		
1	Plant stand (Initial and Final)	2	20 DAS and at harvest
2	Plant height (cm)	4	30,60,90 DAS and at harvest
3	No. of functional leaves plant^{-1}	4	30,60,90 DAS and at harvest
4	No. of branches plant^{-1}	4	30,60,90 DAS and at harvest
5	Total dry matter (g plant^{-1})	4	30,60,90 DAS and at harvest
B	**Post- harvest observations**		
1	No. of siliqua plant^{-1}	1	At harvest
2	No. of seeds siliquae^{-1}	1	At harvest
3	1000 seed weight (g)	1	At harvest
5	Seed yield (q ha^{-1})	1	At harvest
6	Stover yield (q ha^{-1})	1	At harvest
7	Oil content (%)	1	At harvest

C	**Chemical studies**		
1	Soil analysis	2	Before sowing and after harvest
D	**Derivative Observation**		
1	Harvest index (%)	1	After harvest
2	GDD (D ^{0}C)		
E	**Economics**		

3.5 Details of observations :

A) Pre-harvest observations :

3.5.1 Sampling technique :

Within each net plot area, five representative plants were selected randomly and labeled properly. Various biometric observations were recorded at 30,60,90 days after sowing and at harvest from these five representative plants.

3.5.2 Plant stand :

Total number of seedlings emerged per net plot area were counted twenty days after sowing. Similarly, the final plant population was recorded at the time of harvest and plant stand $ha^{-1}$was recorded at the time of harvest and plant stand per hectare was calculated.

3.5.3 Plant height :

The height of the plant was measured from the base of the plant at ground surfaces to the tip of the main shoot. The observations were recorded at a fixed interval of 30 days from the five randomly selected observation plants. The average height per plant was then calculated and expressed in cm.

3.5.4 Number of branches plant^{-1} :

The number of branches arising from the main stem were counted at a fixed interval of 30 days from five randomly selected observation plants and average number of branches per plant was calculated.

3.5.5 Number of functional leaves plant^{-1} :

Green leaves are the photosynthetic organs of the plant. Vigour of the plant is judged by the number of green leaves. The number of functional leaves were counted at an interval of 30 days and average was worked out to know the number of functional leaves per plant.

3.5.6 Dry matter accumulation plant^{-1} :

The dry matter production studies were made by taking one plant from each net plot area periodically. Sample plants were cut from ground level and aril portion of the plant was dried in shade for 48 hours and then placed in separate brown paper bag and kept in an oven at 65°C for 24 hours for drying till it attains constant weight. The dried weight was expressed as dry matter in g plant^{-1}.

B) Post- harvest observations :

3.6.7 Number of siliquae plant^{-1} :

The number of siliquae from the five observation plants were counted. The average was calculated and was expressed as mean number siliquae per plant.

3.6.8 Number of seeds siliquae^{-1} :

Five siliquae from randomly selected plant were taken, threshed separately and number of grains counted and means were calculated.

3.6.9 Test weight :

After threshing 1000 seeds from each treatment were counted, weighted with the help of electronic balance and this weight was expressed as the test weight in gram.

3.6.10 Seed yield :

After harvesting, produce from every net plot was sun dried, weighted and then threshed. After cleaning, seed yield per net plot was recorded and seed yield ha^{-1} was calculated.

3.6.11 Stover yield :

The weight of straw was recorded for each treatment. This was done by deducting the weight of grains from the total weight of plant harvested and the weight was expressed as straw yield (kg ha^{-1}) after complete drying.

3.6.12 Oil content (%) and oil yield ha^{-1} :

The oil per cent in seed was calculated by extraction method. Oil percentage was calculated by using the following formula.

$$\text{Oil (\%)} = \frac{\text{Weight of oil}}{\text{Weight of sample}} \times 100$$

Oil yield was calculated as per following formula.

$$\text{Oil Yield (kg ha}^{-1}\text{)} = \frac{\text{Oil (\%)} \times \text{Seed yield (kg ha}^{-1}\text{)}}{100}$$

C) Chemical analysis :

3.6.13 Soil analysis :

Soil samples from 0-30 cm depth were collected randomly from the experimental site before sowing and after harvest of crop. Plot wise soil samples were collected and analyzed separately for available nitrogen, available phosphorous, available potassium. It was determined by alkaline permanganate method, Olsen's method and flame photometer respectively.

D) Derivative observations :

3.6.14 Harvest index :

To calculate the harvest index, the economic yield (seed yield) was divided by the biological yield (total produce). It is expressed by using following formula.

$$\text{Harvest index} = \frac{\text{Seed yield per unit area}}{\text{Biological yield of same area}} \times 100$$

3.6.15 Growing degree days :

A growing degree-day or a heat unit is the mean temperature above base temperature. Mathematically, it can be expressed as follow.

$$\text{Growing degree-days} = \sum_{I=1}^{n} \left\{ \left(\frac{T_{max} + T_{min}}{2} \right) - T_b \right\}$$

E) Economics :

3.6.16 Cost of cultivation (Rs.ha^{-1}) :

The total cost of cultivation was calculated considering the inputs used in each treatment with prevailing market rates.

3.6.17 Gross monetary return (Rs.ha^{-1}) :

The total value of produce i.e. grain and straw was estimated treatment wise as per prevailing market rates gross monetary return was calculated.

3.6.18 Net monetary return (Rs.ha^{-1}) :

Net monetary returns were calculated by subtracting the cost of cultivation from gross monetary returns treatment wise. This represent the actual income to the farmer.

3.6.19 Benefit : cost ratio :

The benefit cost ratio was worked out by dividing gross monetary return (Rs. ha^{-1}) with total cost of cultivation (Rs.ha^{-1}). This was calculated with the following formula.

$$\text{Benefit : cost ratio} = \frac{\text{Gross monetary returns (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

3.7 Statistical analysis :

The experimental data collected during the course of investigation were statistically analyzed by adopting standard statistical techniques known as "Analysis of variance " (Panse and Sukhatme, 1971). Whenever, the results were found significant, critical difference (CD) were worked out at 5 per cent level of probability for comparison of treatment means. The treatment effects were presented by making table of means with appropriate standard error (S.E.) and C.D. value.

Chapter IV

RESULTS AND DISCUSSION

A field experiment entitled "Response of mustard genotypes to different sowing dates" was conducted during *rabi* season of 2010-2011 at Agronomy Farm, College of Agriculture, Nagpur. During the course of investigation, an attempt was made to study the various aspects of growth, such as plant height, branches, dry matter, number of siliqua plant^{-1}, number of seeds per siliquae^{-1}, 1000 seed weight (g), seed and stover yield, oil content as influenced by different sowing dates and varieties. The results obtained are presented and discussed in this chapter. An attempt is made to provide logical reasoning for the results. The literature cited evidence has also been considered for conforming the trends of results.

4.1 Soil, season and growth

The experimental site was fairly uniform and leveled. The soil was clayey in texture, medium in nitrogen content, medium in phosphorous and rich in potash. Organic carbon content was medium and soil reaction was slightly alkaline in nature.

The meteorological data presented in Table 3 indicated that, there was slightly variation in the mean maximum temperature during 2010–2011 as compared to their averages. The mean maximum temperature ranged from 32.8 ^{0}C to 27.5 ^{0}C and minimum temperature ranges from 20.1 ^{0}C to 10.4 ^{0}C during the growth period of crop. The total rainfall during cropping season was 81.6 mm. There was no major incidence of any insect pest during the crop life period. Over all season was quite favourable which resulted in better crop growth and yield. Crop sown on 43 MW and 42 MW experienced favourable temperature conditions and showed better germination and crop growth. However, crop sown later on

44 MW and 45 MW badly affected due to low temperature showing poor germination and stunted growth. As the temperature rise during reproductive phase of the crop growth sown on 44 MW and 45 MW, it affects flowering, siliqua formation and grain filling resulting into low yields. The temperature conditions for the crop sown on 43 MW and 42 MW were most favourable throughout the cropping period and thus shows better growth and yield.

4.2 Pre-harvest studies

4.2.1 Emergence count and final plant stand

The data regarding emergence count at 20 DAS and at harvest of mustard crop as affected by various treatments are presented in Table 7.

Average initial plant stand was 115876 ha^{-1}. At harvest stage the plant population averaged was 115049 ha^{-1}.

Effect of sowing dates

It is evident from the Table 7 that, mean number of emerged plants and at harvest, did not differ significantly due to sowing dates.

Effect of varieties

Different varieties tried neither affected the emergence count nor the final plant population significantly.

Interaction

Interaction effect of sowing dates and different varieties were found to be non-significant.

Table 7 : Mean plant population ha^{-1} at emergence and at harvest as influenced by various treatments

Treatments	Plant stand at emergence (ha^{-1})	Plant stand at harvest (ha^{-1})
Sowing Dates		
S_1 - 42nd MW	116120	115266
S_2 - 43rd MW	116188	115342
S_3 - 44th MW	115625	114820
S_4 - 45th MW	115570	114766
SE(m)±	341.50	297.33
CD at 5 %	N.S.	N.S.
Varieties		
V_1 - ACN-9	116120	115060
V_2 - Pusa bold	116314	115104
V_3 - Urwashi	115629	115030
V_4 - JD-6	115440	115000
SE(m)±	358.69	277.17
CD at 5 %	N.S.	N.S.
Interaction		
SE(m)±	643.59	414.34
CD at 5 %	N.S.	N.S.
G.M.	115876	115049

4.2.2 Mean plant height

The data pertaining to mean plant height as influenced periodically at 30 days interval by various treatments are presented in Table 8 and graphically depicted in Fig. 3.

A glance of data would indicate that mean height of plant increased with successive stages of crop growth from 9.11 cm at 30 DAS to 156.58 cm at harvest stages. Mean height was increase in between 30 to 60 DAS. Thereafter it slowed down towards maturity.

Effect of sowing dates

The data indicated that sowing date showed significant variation on plant height at all stages of growth. All observations S_2 (43 MW) recorded significantly more plant height at 30, 60 and 90 DAS and at harvest than rest of sowing dates. At 30 DAS S_2 (43 MW) was found statistically at par with S_1 (42 MW) while S_3 (44 MW) and S_4 (45 MW) were at par with each other.

The accumulated heat units and the number of days of reaching maximum plant height decreased due to successive delay in sowing. Similarly results were reported by Diwan Singh *et.al.*, (1993), Shivani and Sanjiv Kumar (2002) and Ghanbahadur and Lanjewar (2004).

Effect of varieties

The data revealed that plant height was significant at 30^{th}, 60^{th}, 90^{th} and at harvest. The plant height was significantly maximum in V_2 (Pusa bold) over V_3 (Urwashi) and V_4 (JD-6) but it was found to be at par with V_1(ACN-9) at 60 DAS. However, at 30 DAS and 60 DAS V_3 (Urwashi) and V_4 (JD-6) found at par with each other.

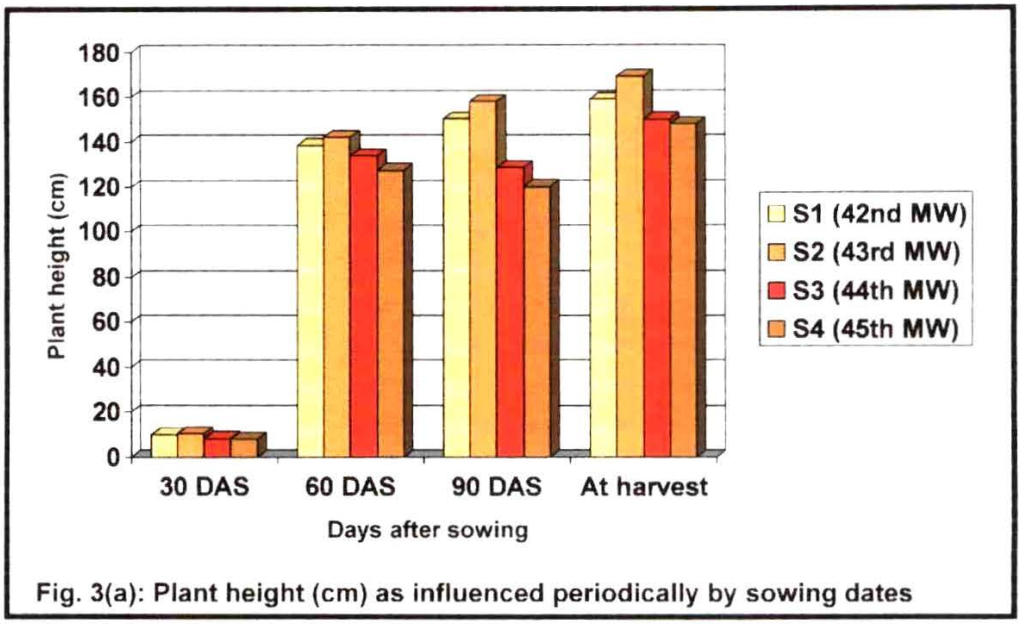


Fig. 3(a): Plant height (cm) as influenced periodically by sowing dates

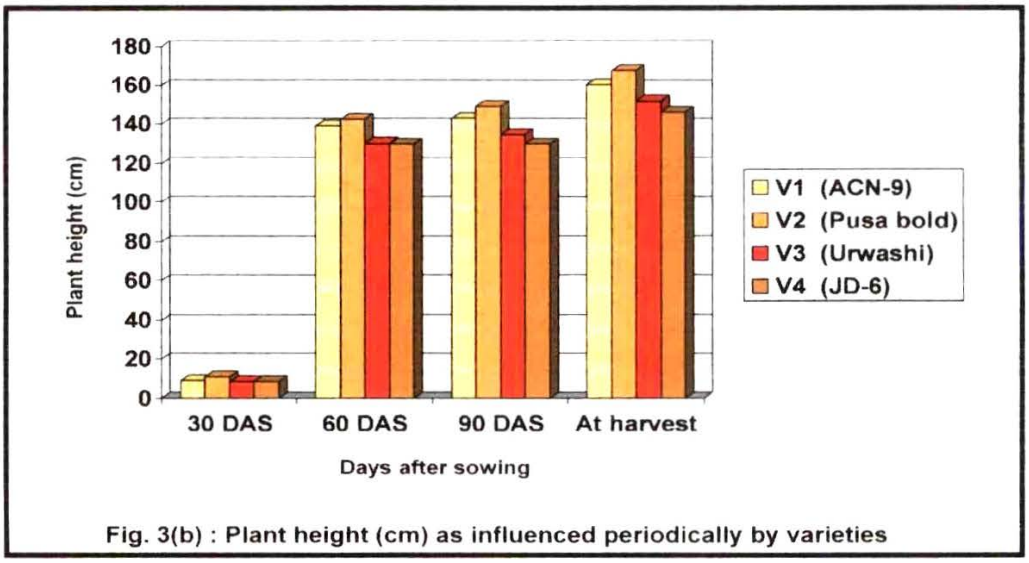


Fig. 3(b) : Plant height (cm) as influenced periodically by varieties

Reduction in plant height may be due to shorter life span of variety resulted forced maturity. Similar, results were reported by Sharma (2006) and Awasthi *et.al.*, (2007).

Interaction

Interaction among the various treatments were non-significant.

Table 8 : Mean plant height (cm) as influenced periodically by various treatments

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
Sowing dates				
S_1 - 42nd MW	10.00	138.50	150.34	159.11
S_2 - 43rd MW	10.25	142.11	158.27	169.08
S_3 - 44th MW	8.20	134.09	128.60	150.10
S_4 - 45th MW	8.01	127.40	120.21	148.03
SE(m)±	0.14	0.84	0.90	1.12
CD at 5 %	0.41	2.44	2.65	3.24
Varieties				
V_1 - ACN-9	9.09	139.40	143.20	160.40
V_2 - Pusa bold	10.68	142.40	149.20	167.60
V_3 - Urwashi	8.37	130.30	135.20	152.03
V_4 - JD-6	8.32	130.00	130.10	146.29
SE(m)±	0.16	0.82	0.95	1.58
CD at 5 %	0.46	2.43	2.75	4.60
Interaction				
SE(m)±	0.28	1.86	2.21	2.10
CD at 5 %	N.S.	N.S.	N.S.	N.S.
GM	9.11	135.52	139.35	156.58

4.2.3 Mean number of branches plant^{-1}

The data respect of mean number of branches plant^{-1} as influenced periodically by different treatments are presented in Table 9 and depicted graphically in Fig. 4.

The data indicate that, the number of branches plant^{-1} were increased progressively with enhancement in crop age. The mean number of branches plant^{-1} were 9.11 at harvest.

Effect of sowing dates

Effect of sowing dates dose not show significant influence on number of branches plant^{-1} at 30 DAS and 60 DAS. Sowing date S_2 (43 MW) recorded significantly higher number of branches per plant over S_3 (44 MW) and S_4 (45 MW) but, was at par with S_1 (42 MW). Treatments S_3 (44 MW) and S_4 (45 MW) found to be at par with each other at 90 DAS and at harvest.

However, it was observed that significant reduction in number of branches plant^{-1} with delay in sowing by each successive meterological week due to high temperature. These findings are close accordance with Belgamwar (1998), Ghanbahadur and Lanjewar (2004).

Effect of varieties

Varieties showed significant influence on number of branches plant^{-1} at all growth stages. V_2 (Pusa bold) found significantly superior over rest of the varieties at all periodic interval.

Reduction in number of branches plant^{-1} due to genetic variation in variety. These results are in conformity with the finding of Ghanbahadur (2002).

Interaction

Interaction effect was found non-significant at all stages.

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Table 9 : Mean number of branches plant^{-1} as influenced periodically by various treatments

Treatments	Number of branches plant^{-1}			
	30 DAS	60 DAS	90 DAS	At harvest
Sowing dates				
S_1 - 42nd MW	2.50	5.30	8.52	9.10
S_2 - 43rd MW	3.09	5.90	9.47	10.50
S_3 - 44th MW	2.09	4.50	7.50	8.50
S_4 - 45th MW	1.51	4.20	7.10	8.34
SE(m)±	0.53	0.40	0.33	0.24
CD at 5 %	N.S.	N.S.	0.90	0.70
Varieties				
V_1 - ACN-9	2.50	5.50	8.37	9.40
V_2 - Pusa bold	3.08	5.80	9.58	10.04
V_3 - Urwashi	2.11	4.50	7.54	9.00
V_4 - JD-6	1.50	4.10	7.10	8.00
SE(m)±	0.14	0.08	0.27	0.19
CD at 5 %	0.41	0.23	0.79	0.54
Interaction				
SE(m)±	0.64	0.55	0.48	0.44
CD at 5 %	N.S.	N.S.	N.S.	N.S.
GM	2.29	4.97	8.14	9.11

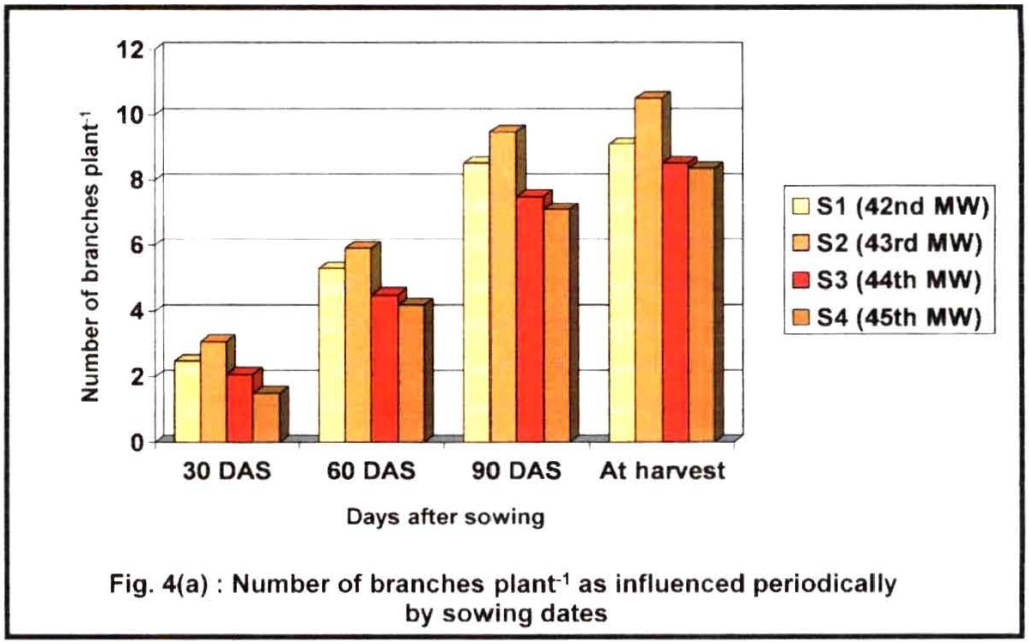

Fig. 4(a) : Number of branches plant^{-1} as influenced periodically by sowing dates

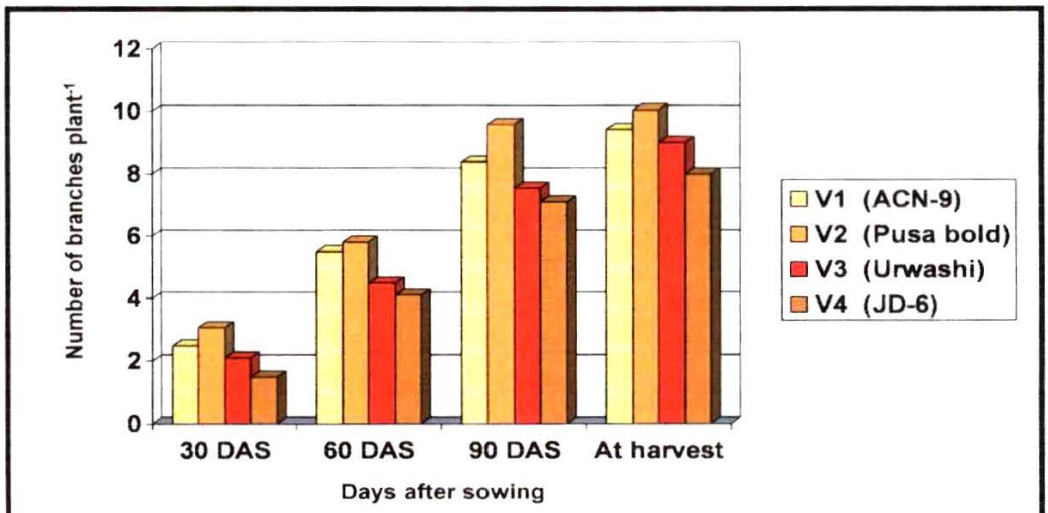

Fig .4(b) : Number of branches plant^{-1} as influenced periodically by varieties

4.2.4 Number functional of leaves plant^{-1}

The data in respect of mean number of functional leaves plant^{-1} are presented in Table 10 and illustrated graphically in Fig. 5.

The data revealed that, the mean number of functional leaves plant^{-1} increased progressively from 22.25 (90 DAS) to 31.00 (at harvest) which was of the order of 8.75. In general, the rate of increase declined, which was only 3.11 between 60 and 90 DAS. The mean number of functional leaves plant^{-1} were 31.00.

Effect of sowing dates

The data indicated non-significant influence of sowing time on number of functional leaves plant^{-1} at 30 DAS. At 60 DAS, 90 DAS and at harvest, it shows significant influence. S_2 (43 MW) produced maximum number of leaves plant^{-1} throughout the experimentation but was found to be at par with S_1 (42 MW) at 60 DAS. Treatment S_2 was also significantly superior over S_3 (44 MW) and S_4 (45 MW) at all observation stages. S_3 (44 MW) and S_4 (45 MW) are comparable with each other at 90 DAS.

Reduction in number of functional leaves plant^{-1} might be observed due to successive delay in sowing. This result was in conformation with the finding reported by Sharma (2006) and Ghanbahadur and Lanjewar (2004).

Effect of varieties

Different varieties showed significant influence on number of functional leaves plant^{-1} at 30, 60 and 90 DAS and, at harvest. Variety V_2 (Pusa bold) found consistently superior over rest of the mustard varieties. At 60 DAS V_3 (Urwashi) and V_4 (JD-6) found statistically at par with each other.

These are in accordance with the finding reported by Bhalerao (1997).

Interaction

None of the interaction effect was found to be significant in respect of number of functional leaves plant^{-1}.

Table 10 : Mean number of leaves plant^{-1} as influenced periodically by various treatments

Treatments	Number of leaves plant^{-1}			
	30 DAS	60 DAS	90 DAS	At harvest
Sowing dates				
S_1 - 42nd MW	14.50	19.80	23.62	34.03
S_2 - 43rd MW	15.93	20.40	25.47	35.07
S_3 - 44th MW	14.02	18.82	20.56	29.50
S_4 - 45th MW	13.12	17.54	19.38	25.42
SE(m)±	0.98	0.39	0.60	0.36
CD at 5 %	N.S.	1.14	1.74	1.08
Varieties				
V_1 - ACN-9	14.50	19.62	23.38	32.50
V_2 - Pusa bold	15.77	20.68	24.85	34.50
V_3 - Urwashi	14.14	18.50	21.00	29.00
V_4 - JD-6	13.30	17.76	19.80	28.00
SE(m)±	0.60	0.34	0.42	0.44
CD at 5 %	1.62	1.03	1.23	1.26
Interaction				
SE(m)±	1.77	0.80	1.25	0.85
CD at 5 %	N.S.	N.S.	N.S.	N.S.
GM	14.39	19.14	22.25	31.00

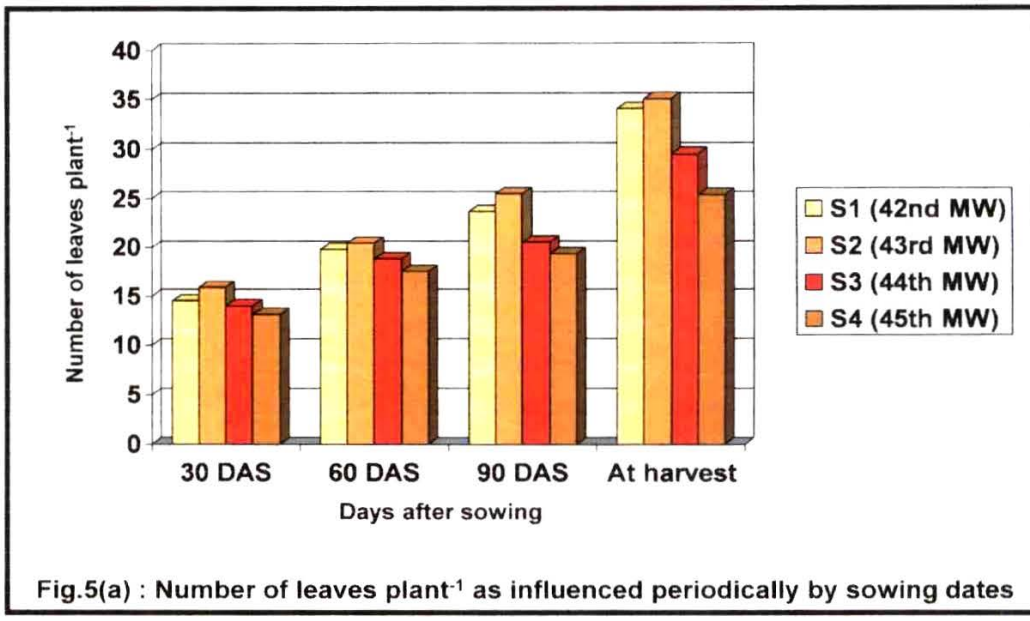

Fig.5(a) : Number of leaves plant^{-1} as influenced periodically by sowing dates

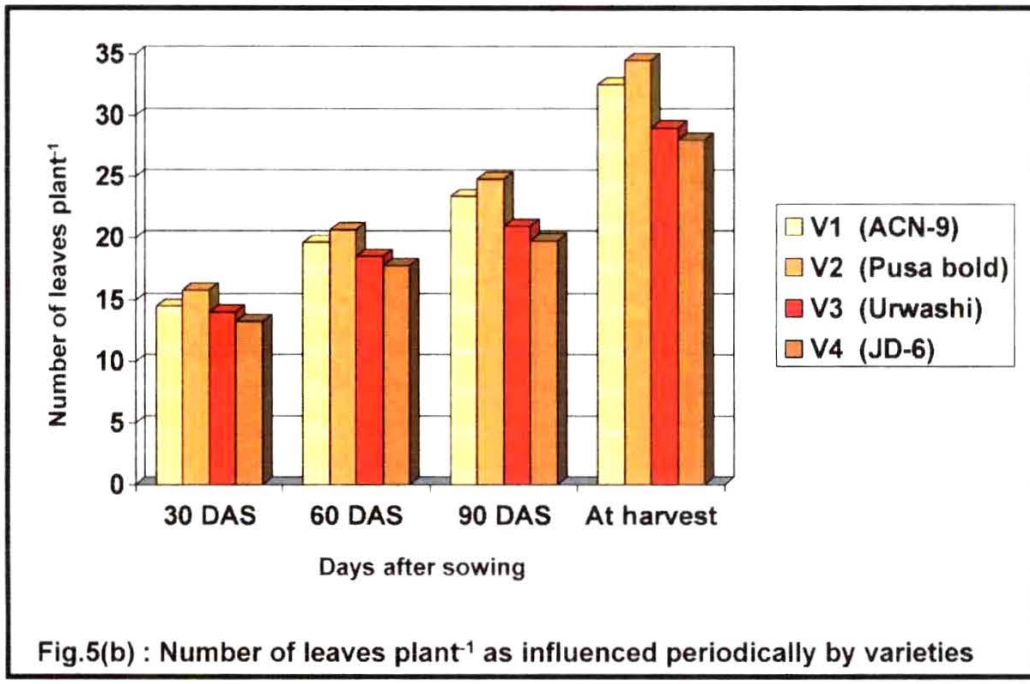

Fig.5(b) : Number of leaves plant^{-1} as influenced periodically by varieties

4.2.5 Total dry matter accumulation plant^{-1}

Accumulation dry matter plant^{-1} is considered as the best index of crop growth put forth by crop. The data regarding mean dry matter accumulation plant^{-1} as influenced by different treatments are presented in Table 10 and depicted graphically in Fig. 5.

It would be observed that the rate of dry matter accumulation plant^{-1} was found progressively increased with physiological maturity of crop. The crop was slow in dry matter accumulation up to 30 DAS and produced only 6.67 g mean dry matter plant^{-1}. The mean maximum accumulation of dry matter plant^{-1} was 28.08 g at harvest.

Effect of sowing dates

Effect of sowing dates on dry matter accumulation plant^{-1} was significant at all observations stages. At 30 DAS, 60 DAS, 90 DAS and at harvest, dry matter accumulation plant^{-1} was significantly maximum in S_2 (43 MW). At 60 and 90 DAS, S_2 (43 MW) was found at par with S_1 (42 MW) whereas S_3 (44 MW) and S_4 (45 MW) found similar with each other.

Dry matter accumulation plant^{-1} was decreased due to late sowing. Optimum sowing period facilitate luxurious crop growth resulting in maximum dry matter accumulation. These results are in confirmation with the finding reported by Singh *et.al.,* (1980), Rajendra Kumar *et.al.,* (2002) , Ghanbahadur (2002) and Sharma (2006).

Effect of varieties

Dry matter accumulation plant^{-1} due to the influence of varieties significant at 30 DAS, 60 DAS, 90 DAS and at harvest. However, with passage of time dry matter accumulation plant^{-1} found significant increased. It was recorded 32.40 g significantly maximum at harvest in V_2 (Pusa bold). V_2 (Pusa bold) found to be superior over rest of the treatment

and at par with V_1 (ACN-9) at harvest. At 60 DAS, 90 DAS and at harvest V_3 (Urwashi) and V4 (JD-6) found to be at par with each other.

Dry matter net assimilation rate was higher in V_2 (Pusa bold) due to more number of days were required for 50 per cent flowering. These are in accordance with the finding reported by Bhalerao (1997).

Interaction

Interaction effect found to be non-significant.

Table 11 : Mean dry matter accumulation plant^{-1} (g) as influenced periodically by various treatments

Treatments	Dry matter accumulation plant^{-1}(g)			
	30 DAS	60 DAS	90 DAS	At harvest
Sowing dates				
S_1 - 42nd MW	6.90	15.80	21.63	31.80
S_2 - 43rd MW	7.60	16.25	22.50	33.72
S_3 - 44th MW	6.28	14.25	18.50	25.93
S_4 - 45th MW	5.90	13.10	17.03	20.89
SE(m)±	0.12	0.37	0.51	0.60
CD at 5 %	0.35	1.10	1.48	1.72
Varieties				
V_1 - ACN-9	7.20	16.10	21.50	30.39
V_2 - Pusa bold	7.68	16.50	23.82	32.40
V_3 - Urwashi	6.40	13.63	17.33	25.56
V_4 - JD-6	5.40	13.17	17.01	23.99
SE(m)±	0.11	0.40	0.43	0.72
CD at 5 %	0.30	1.56	1.26	2.21
Interaction				
SE(m)±	0.20	0.65	1.10	1.44
CD at 5 %	N.S.	N.S.	N.S.	N.S.
GM	6.67	14.85	19.91	28.08

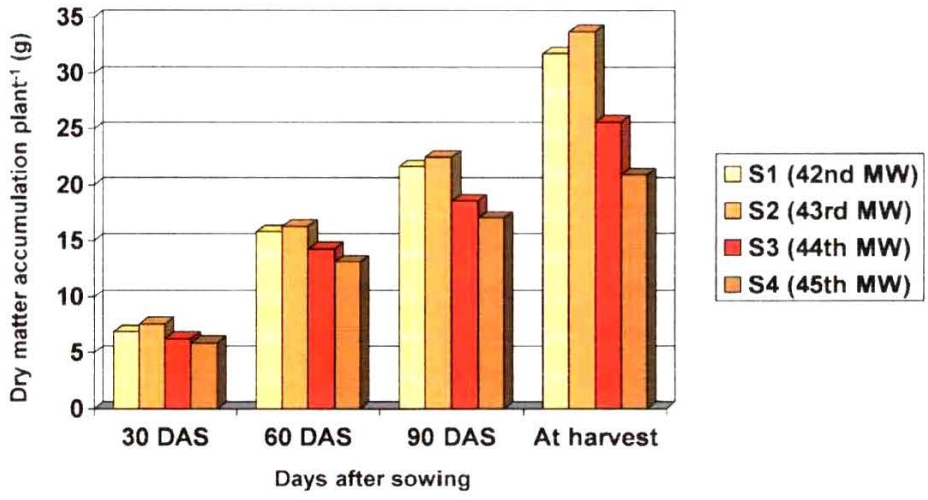

Fig.6(a) : Dry matter accumulation plant^{-1} (g) as influenced periodically by sowing dates

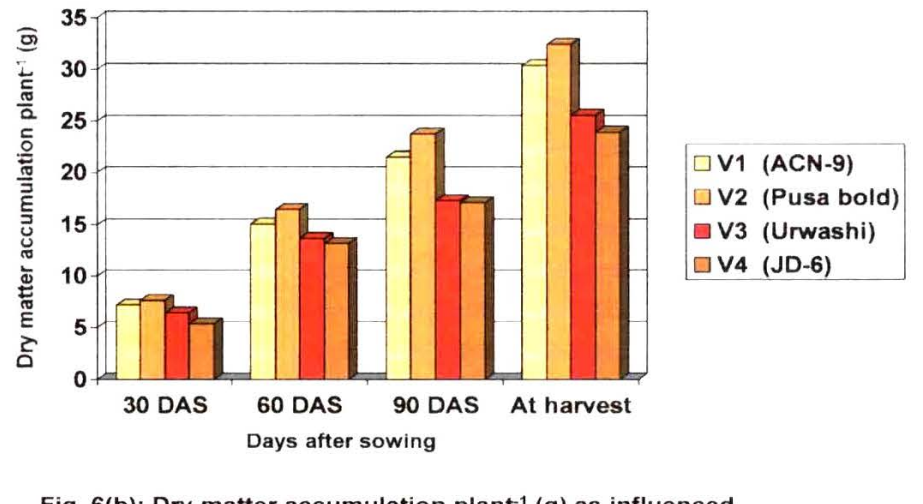

Fig. 6(b): Dry matter accumulation plant^{-1} (g) as influenced periodically by varieties

4.3 Post-harvest studies

Important yield contributing characters were included under post harvest studies.

4.3.1 Number of siliqua plant^{-1}

Data regarding mean number of siliqua plant^{-1} as influenced by various treatments are presented in Table12 and graphically depicted in Fig. 7. From the data it would be noticed that various treatments showed significant influence on the number of siliqua plant^{-1}. Mean number of siliqua plant^{-1} was 122.96.

Effect of sowing dates

Data indicated that, sowing time showed significant influence on number of siliqua plant^{-1}. S_2 (43 MW) produced more number of siliqua plant^{-1} over S_3 (44 MW) and S_4 (45 MW) but found to be at par with S_1 (42 MW). As the sowing time delayed further after 43rd MW number of siliqua plant^{-1} were decreased.

Siliqua initiation was progressively delayed due to late sowing as the crop took more days to flower initiation in late or advanced sowing after branching. These findings are closed accordance with Belgamwar (1998), Shashtry and Arvind Kumar (1981).

Effect of varieties

Among varieties, V_2 (Pusa bold) found to be significantly superior over V_1 (ACN-9), V_3 (Urwashi) and V_4 (JD-6). However, V_3 (Urwashi) and V_4 (JD-6) were found to be statistically similar with each other.

It seems due to variation in respect of number of siliqua plant^{-1} among different mustard varieties. These results are in conformation with the finding reported by Mehrotra *et.al.*, (1976).

Interaction

Interaction effects were not found significant.

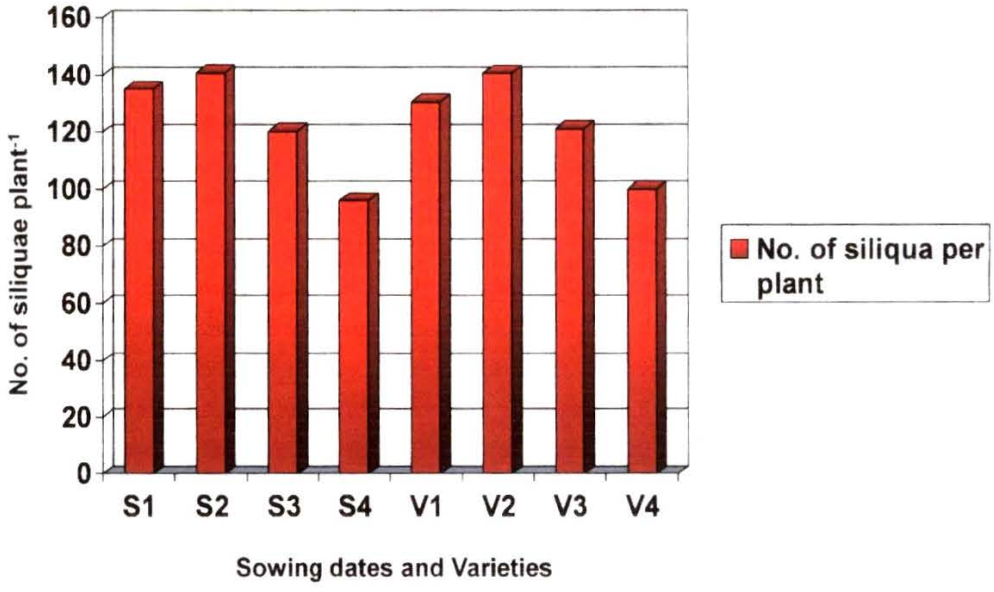

Fig. 7: Number of siliqua plant^{-1} as influenced by sowing dates and varieties

Table 12 : Mean number of siliqua plant^{-1}, number of seeds siliquae^{-1}, seed yield plant^{-1} (g) and test weight (g) and as influenced periodically by various treatments

Treatments	No. of siliqua plant^{-1}	No. of seeds siliquae^{-1}	Seed yield plant^{-1} (g)	Test weight (g)
Sowing dates				
S_1 – 42nd MW	135.09	13.68	7.76	4.20
S_2 – 43rd MW	140.80	14.20	8.49	4.25
S_3 – 44th MW	120.13	12.08	6.06	4.16
S_4 – 45th MW	95.85	9.90	3.93	4.15
SE(m)±	6.15	0.25	0.20	0.26
CD at 5 %	17.90	0.72	0.64	N.S.
Varieties				
V_1 - ACN-9	130.47	13.95	7.66	4.22
V_2 - Pusa bold	140.55	14.05	9.09	4.30
V_3 - Urwashi	120.95	11.94	5.41	4.19
V_4 - JD-6	99.90	9.92	3.48	4.07
SE(m)±	5.42	0.35	0.51	0.20
CD at 5 %	15.82	1.02	1.50	N.S.
Interaction				
SE(m)±	9.84	0.56	0.76	0.41
CD at 5 %	N.S.	N.S.	N.S.	N.S.
GM	122.96	12.46	26.24	4.19

4.3.2 Number of seeds siliquae^{-1}

The data in respect of regarding mean number of seed siliqua^{-1} as influenced by different treatments are presented in Table 12 and depicted in Fig. 8. The various treatments showed significant influenced on the number of seed siliqua^{-1}. The average number of seed siliqua^{-1} were 12.46.

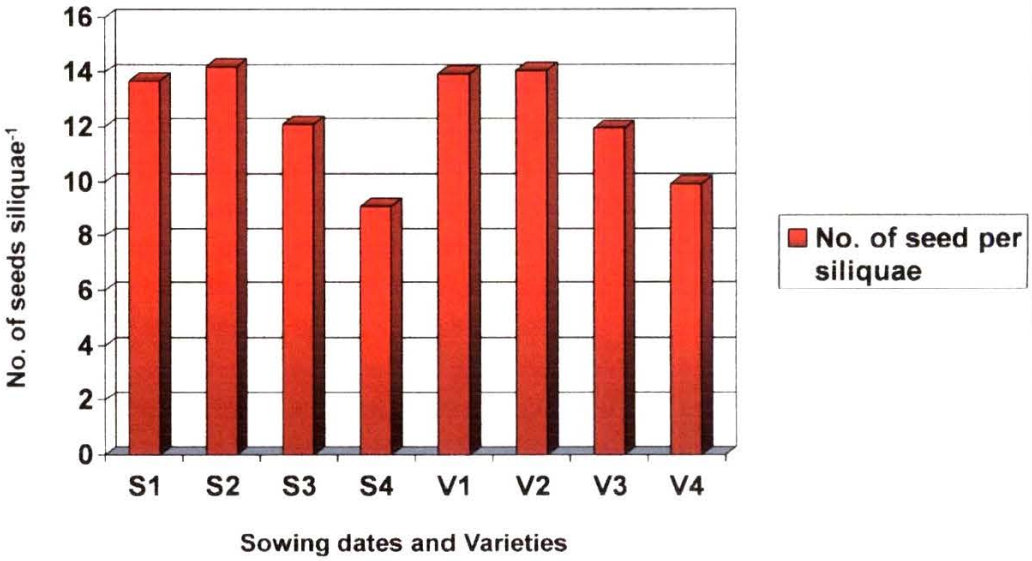

Fig. 8: Number seeds siliquae^{-1} as influenced by sowing dates and varieties

Effect of sowing dates

The number of seed siliqua^{-1} were significantly influenced due to sowing dates. Number of seeds siliqua^{-1} were significantly maximum in S_2 (43 MW) over but S_3 (44 MW) and S_4 (45 MW) but at par with S_1 (42 MW).

The reduction might be occurred in number of seed siliqua^{-1} due to successive delay in sowing. These results are in conformation with the findings of Ghanbahadur and Lanjewar (2004).

Effect of varieties

The number of seed siliqua^{-1} showed significant influenced on varieties. Variety V_2 (Pusa bold) recorded significantly higher number of seed siliqua^{-1} over rest of the varieties, but found statistically at par with V_1 (ACN-9). It might be due to potential strength among different genotypes. The results are in conformation with the findings of Ghanbahadur and Lanjewar (2004).

Interaction

Interaction effect found to be non-significant.

4.3.3 Test weight

The data regarding mean test weight are presented in Table 12 and depicted in Fig. 9. The mean test weight was observed to be 4.19 g.

Effect of sowing dates

It is evident from the Table11 that test weight did not significantly differed due to different sowing dates. The results are in conformation with the findings of Ghanbahadur and Lanjewar (2004), Bhalerao (1997).

Effect of varieties

Different varieties treatment no significant influence on the test weight of mustard crop. The results are in conformation with the findings of Ghanbahadur and Lanjewar (2004), Bhalerao (1997).

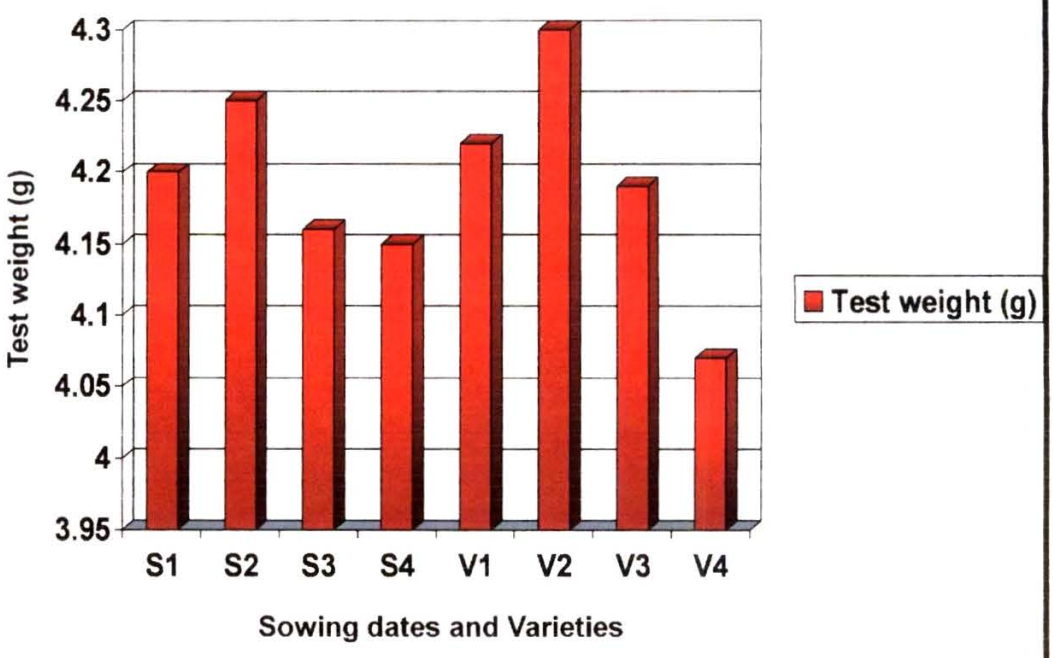

Fig. 9: Test weight (g) as influenced by sowing dates and varieties

Interaction

Interaction effect between sowing dates and different varieties were found to be non-significant.

4.3.4 Seed yield plant^{-1} (g)

The data in respect of seed yield plant^{-1} as influenced by different treatments are given in Table 12 and depicted graphically in Fig. 10. Data revealed that seed yield plant^{-1} was influenced significantly due to various treatments. On an average, the mean seed yield plant^{-1} of 26.24 g was recorded.

Effect of sowing dates

Among sowing dates, sowing on S_2 (43 MW) recorded slightly higher seed yield plant^{-1} (8.49 g) than S_3 (44 MW) and S_4 (45 MW) but it was at par with S_1 (42 MW). Delay in sowing might be reduced the seed yield plant^{-1} due to environmental conditions. The results are in close accordance with the findings of Ghanbahadur and Lanjewar (2004).

Effect of varieties

Different varieties had significant influence on the seed yield plant^{-1}. The variety V_2 (Pusa bold) registered higher seed yield plant^{-1} (9.09 g) than other varieties. Lowest seed yield was recorded by V_4 (JD-6).

This result is due to the variety to variety variation between their potential to produce seeds plant^{-1}. These are in accordance with the finding reported by Bhalerao (1997).

4.3.5 Oil content (%)

The relevant data on oil content (%) in seed under different treatments are presented in Table 13.The average oil content was observed to be 37.37 %.

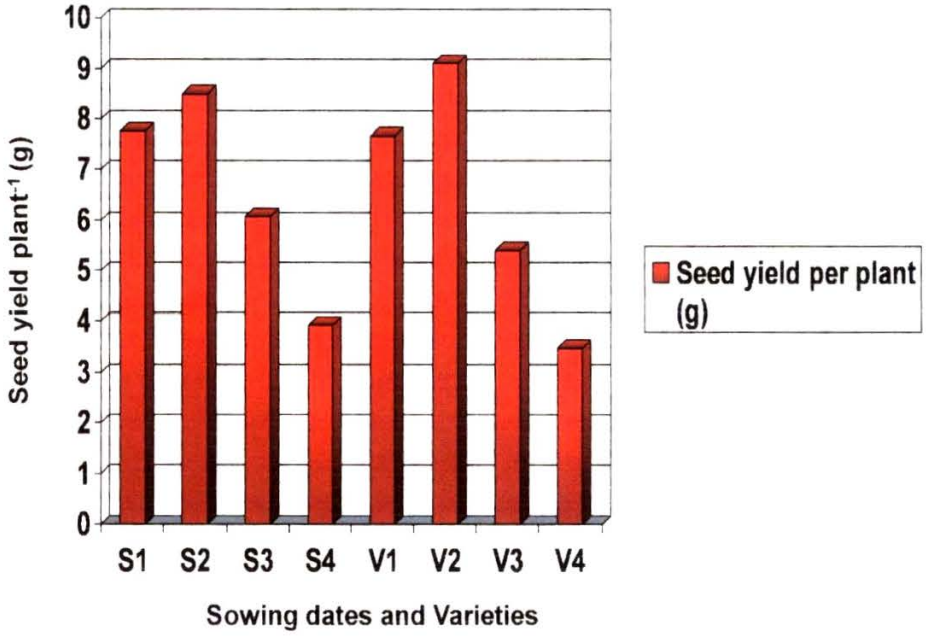

Fig. 10: Seed yield plant^{-1} (g) as influenced by sowing dates and varieties

Effect of sowing dates

Sowing treatments showed non-significant influence on oil content (%). S_2 (43 MW) recorded maximum oil content (38.25 %) over rest of the sowing dates. Delayed sowing recorded less oil content. The results are in conformation with the findings of Sharma (2006).

Effect of varieties

Oil content showed significant influence on variety. Variety V_2 (Pusa bold) recorded highest value of oil content (38.25 %) and found to be at par with V_1 (ACN-9) (38.05 %).

It is due to the genetic variation between variety and favourable environmental conditions. These results are in conformation with the findings of Ghanbahadur (2002).

Interaction

Interaction effect was found to be non-significant.

4.3.6 Oil yield (q ha^{-1})

The data regarding the oil yield (q ha^{-1}) in seed are presented in Table 13 and illustrated graphically depicted in fig. 11. The average oil yield was recorded to be 2.83 (q ha^{-1}).

Effect of sowing dates

Oil yield showed significant influenced on sowing dates. S_2 (43^{rd} MW) recorded highest value of oil yield (3.33 q ha^{-1}) and found to be at par with S_1 (42^{nd} MW).

The successive delayed planting reduced the oil yield. The findings are close accordance with Shashtry and Arvind Kumar (1981), Anonymous (2003).

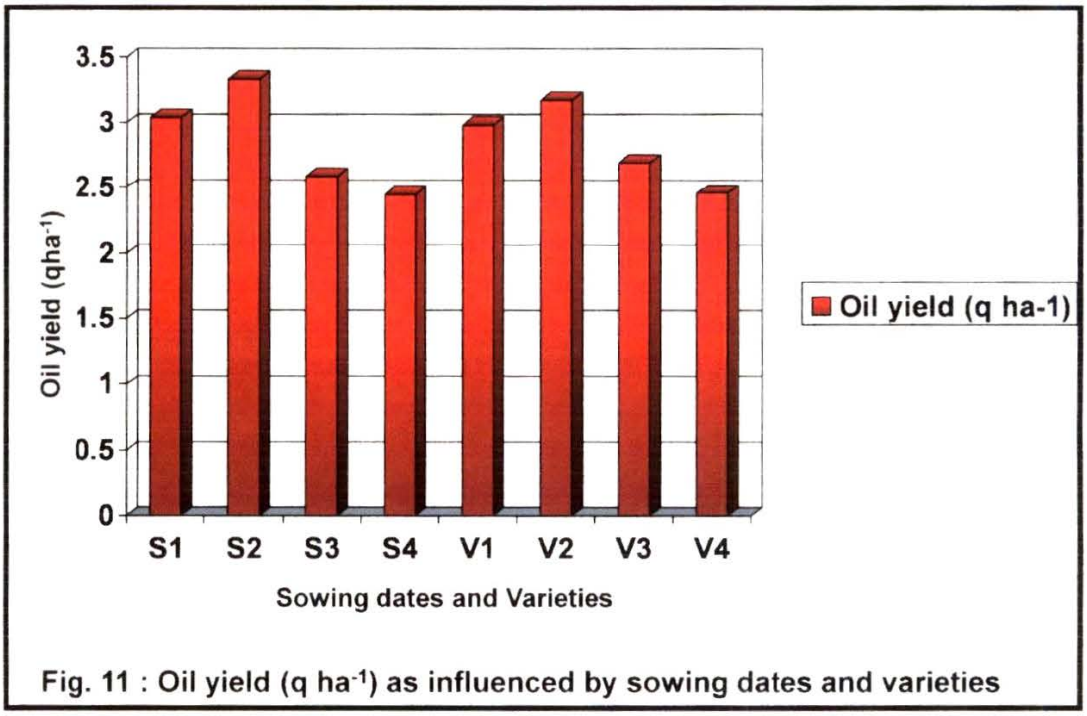

Fig. 11 : Oil yield (q ha^{-1}) as influenced by sowing dates and varieties

Effect of varieties

Oil yield was not significant influence by varieties. Variety V_2 (Pusa bold) recorded highest oil yield (3.33 q ha^{-1}).

Due to the seed combination the oil yield among different varieties varies. The findings are close accordance with Bhalerao (1997)

Interaction

Interaction effect was found to be non-significant.

4.3.7 Growing degree days (D ^{0}C)

The data in respect of growing degree days are presented in Table 13. The average growing degree days of 4979.28 was observed.

Effect of sowing dates

Sowing on S_2 (43rd MW) recorded higher heat units (5300.4) where as minimum heat unit were observed in S_1 (42nd MW). As the crop sown on S_2 (43rd MW) required more days to attained maturity, so it takes more number of days for seed filling. These results are close accordance with Tyagi *et.al.,* (1996)

Effect of varieties

Variety V_2 (Pusa bold) recorded numerically maximum heat units (3880) whereas minimum heat units were recorded in V_1 (ACN-9).

It is due to the genetic variation between variety and favorable environmental conditions. These results are in conformation with the findings of Ghanbahadur (2002).

Table 13 : Mean number of seed yield (q ha^{-1}), oil content (%), oil yield (q ha^{-1}) and growing degree days as influenced by various treatments

Treatments	Seed yield (q ha^{-1})	Oil content (%)	Oil yield (q ha^{-1})	GDD (D ^0C)
Sowing dates				
S_1 - 42nd MW	8.22	38.05	3.04	4709.9
S_2 - 43rd MW	8.75	38.35	3.33	5300.4
S_3 - 44th MW	7.00	37.05	2.59	5268.9
S_4 - 45th MW	6.27	36.05	2.45	4638.2
SE(m)±	0.27	0.07	0.29	-
CD at 5 %	0.78	N.S.	0.78	-
Varieties				
V_1 - ACN-9	7.85	38.05	2.98	4979.36
V_2 - Pusa bold	8.25	38.25	3.17	5637.17
V_3 - Urwashi	7.29	37.15	2.69	4700.03
V_4 - JD-6	6.85	36.05	2.46	4600.29
SE(m)±	0.29	0.10	0.42	-
CD at 5 %	0.86	0.29	1.20	-
Interaction				
SE(m)±	0.58	0.41	0.54	-
CD at 5 %	1.72	N.S.	N.S.	-
GM	7.56	37.37	2.83	4979.28

Table 14 : Mean seed yield (q ha^{-1}) , stover yield (q ha^{-1}) and harvest index(%) as influenced by various treatments

Treatments	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
Sowing dates			
S_1 - 42nd MW	8.22	32.12	20.48
S_2 - 43rd MW	8.75	34.20	20.41
S_3 - 44th MW	7.00	24.50	22.22
S_4 - 45th MW	6.27	19.20	24.08
SE(m)±	0.27	0.76	0.05
CD at 5 %	0.78	2.40	0.13
Varieties			
V_1 - ACN-9	7.85	31.26	20.10
V_2 - Pusa bold	8.25	32.50	20.24
V_3 - Urwashi	7.29	25.52	23.00
V_4 - JD-6	6.85	24.40	23.85
SE(m)±	0.29	0.72	0.04
CD at 5 %	0.86	2.18	0.11
Interaction			
SE(m)±	0.58	2.02	0.29
CD at 5 %	1.72	N.S.	N.S.
GM	7.56	27.50	21.79

4.3.8 Seed yield (q ha^{-1})

The data regarding mean seed yield ha^{-1} are presented in Table 13 and depicted graphically in Fig. 12. The mean seed yield was observed to be 7.56 (q ha^{-1}).

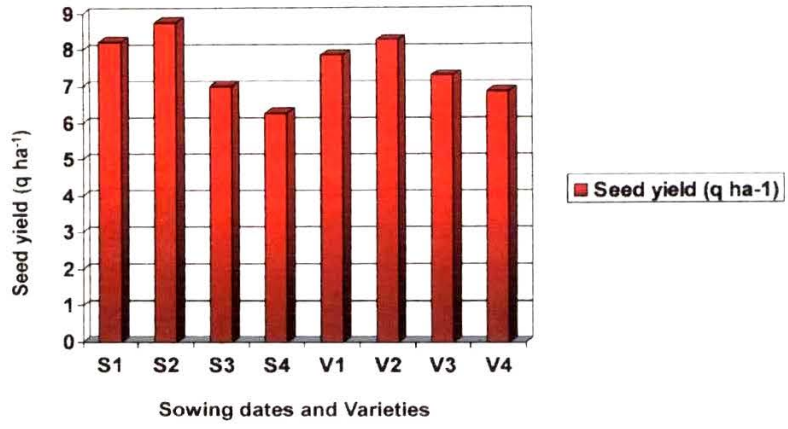

Fig. 12(a) : Seed yield (q ha^{-1}) as influenced by sowing dates and varieties

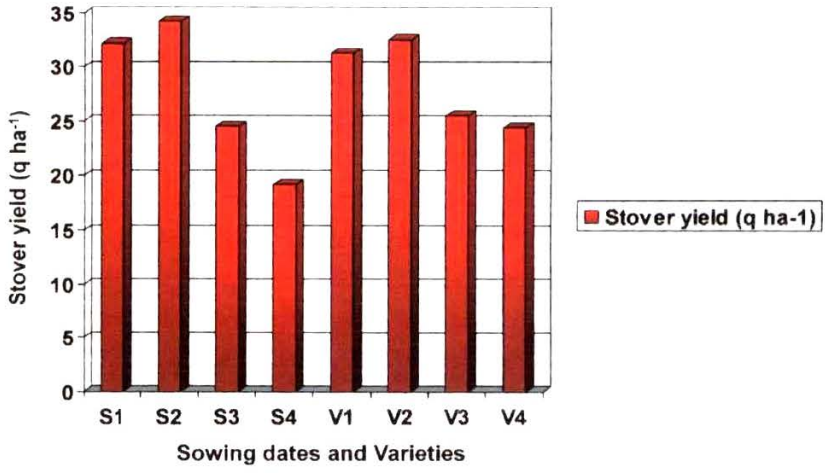

Fig. 12(b) : Stover yield (q ha^{-1}) as influenced by sowing dates and varieties

Effect of sowing dates

Seed yield showed significant influence on variety. Sowing date S_2 (43 MW) recorded highest value of seed yield (8.75 q ha^{-1}) and it was found to be at par with S_1 (42^{nd} MW) (8.22 q ha^{-1}). Minimum seed yield was recorded in S_4 (45 MW) was at par with S_3 (44^{th} MW).

Sowing in 42^{nd} MW resulted in early flowering, longer seed filling period, a longer5 reproductive phase and ultimately a higher seed yield per unit area. Increased in yield contributing characters reflected in high seed yield. These results are in conformation with the findings of Shashtry and Arvind Kumar (1981), Jain *et.al*, (1989), Tyagi *et.al*, (1996), Zora Sing *et.al*, (1998) and Ghanbahadur and Lanjewar (2004).

Effect of varieties

Seed yield showed significant influenced on variety. Varieties V_2 (Pusa bold) recorded highest value of seed yield (8.35 q ha^{-1}) than other varieties except V_1 (ACN-9) which was at par. Lowest seed yield was recorded in V_4 (JD-6) and has comparable with V_3 (Urwashi).

Higher seed yield from V_2 (Pusa bold) due to longer seed filling period and longer reproductive phase resulted in higher yield. These findings are closed accordance with Shashtry and Arvind Kumar (1981) and Gupta *et.al*, (2004).

Interaction

Significant influence of sowing dates × varieties was observed on seed yield (q ha^{-1}). S_2 (43^{rd} MW) sowing with combination with V_2 (Pusa bold) in every row proved significantly superior over rest of the treatment combination.

Table 15 : Mean Seed yield (q ha^{-1}) as influenced by interaction of sowing dates × varieties

Treatment	V_1 - ACN-9	V_2 - Pusa bold	V_3 - Urwashi	V_4 - JD-6	Mean
S_1 - 42nd MW	8.60	8.89	7.90	7.50	8.22
S_2 - 43rd MW	8.70	9.11	8.69	8.50	8.75
S_3 - 44th MW	7.20	7.90	6.90	6.00	7.00
S_4 - 45th MW	6.90	7.12	5.68	5.41	6.27
Mean	7.85	8.25	7.29	6.85	

S.E(m). ± : 1.71
CD at 5 % : 7.56

4.3.9 Stover yield (q ha^{-1})

Data pertaining to stover yield as influenced by various treatments are presented in Table 14 and depicted in Fig. 12. The average stover yield was found to be 27.50 (q ha^{-1}).

Effect of sowing dates

Sowing treatments showed significantly influenced on straw yield S_2 (43 MW) found superior to all treatments. Delayed sowing onwards S_3 (44 MW) decreased stover yield. Higher growth attributing characters resulted in higher stover yield. These results are in conformation with the findings of Ghanbahadur and Lanjewar (2004).

Effect of different varieties

Different varieties significantly influenced the straw yield V_2 (Pusa bold) found superior to all treatments but was at par with V_1 (ACN-9). V_3 (Urwashi) and V_4 (JD-6) were found similar with each other.

These findings are closed accordance with Bhalerao (1997).

Interaction

Interaction in respect of stover yield was found to be significant.

4.3.10 Harvest index (%)

The data regarding mean seed yield are presented in Table 14. The mean harvest index was observed to be 21.79 %. Harvest index was slightly affected by the treatments.

Effect of sowing dates

Sowing treatment showed significant influence on harvest index. S_4 (45^{th} MW) recorded maximum harvest index (24.85 %) than other sowing dates. S_1 (42^{nd} MW) and S_2 (43 MW) were at par with each other. These findings are closed accordance with Ghanbahadur (2002).

Effect of different varieties

Varieties showed significant influenced on harvest index. Variety V_4 (JD-6) recorded heighest harvest index (23.85 %) than remaining varieties.

The findings are close accordance with Sharma (2006).

Interaction

Interaction between sowing dates and varieties did not exhibit significant influence on harvest index.

4.7 Economics studies

Data in respect of gross monetary returns, net monetary returns and B:C ratio are presented in Table 17 and graphically depicted in fig. 13.

4.7.1 Gross monetary returns (GMR)

Data presented in Table 16 indicated that, the gross monetary returns were significantly influenced by various treatments. The mean gross monetary returns were found to be Rs. 22680 ha^{-1}.

Effect of sowing dates

Among the sowing dates, the gross monetary returns was found significantly higher in S_2 (43 MW) Rs. 26250 ha^{-1} than other sowing dates but it was at par with S_1 (42^{nd} MW).

Effect of different varieties

Different varieties also significantly influenced the gross monetary returns. Variety V_2 (Pusa bold) recorded maximum gross monetary returns Rs. 24750 ha^{-1} and was at par with V_1 (ACN-9).

Interaction

Interaction effect was statistically non-significant.

Table 16 : Cost of cultivation (Rs. ha^{-1}), gross-monetary returns, net monetary returns and benefit: cost ratio as influenced by different treatments.

Treatments	Cost of cultivation (Rs.ha^{-1})	GMR (Rs.ha^{-1})	NMR (Rs.ha^{-1})	B:C ratio
Sowing dates				
S_1 - 42nd MW	13493	24660	11167	1.82
S_2 - 43rd MW	13493	26250	12757	1.94
S_3 - 44th MW	13493	21000	7507	1.55
S_4 - 45th MW	13493	18810	5317	1.39
SE(m)±	-	560	560	-
CD at 5 %	-	1687	1687	-
Varieties				
V_1 - ACN-9	13493	23550	10057	1.74
V_2 - Pusa bold	13493	24750	11257	1.83
V_3 - Urwashi	13493	21870	8377	1.62
V_4 - JD-6	13493	20550	7057	1.52
SE(m)±	-	456	456	-
CD at 5 %	-	1380	1380	-
Interaction				
SE(m)±	-			-
CD at 5 %	-	N.S.	N.S.	-
GM	13493	22680	9187	1.67

4.7.2 Net monetary returns (NMR)

Data presented in Table 16 and depicted in Fig. 13 indicated that, net monetary returns were slightly influenced by various treatments. The mean net monetary returns found to be Rs. 9187 ha^{-1}.

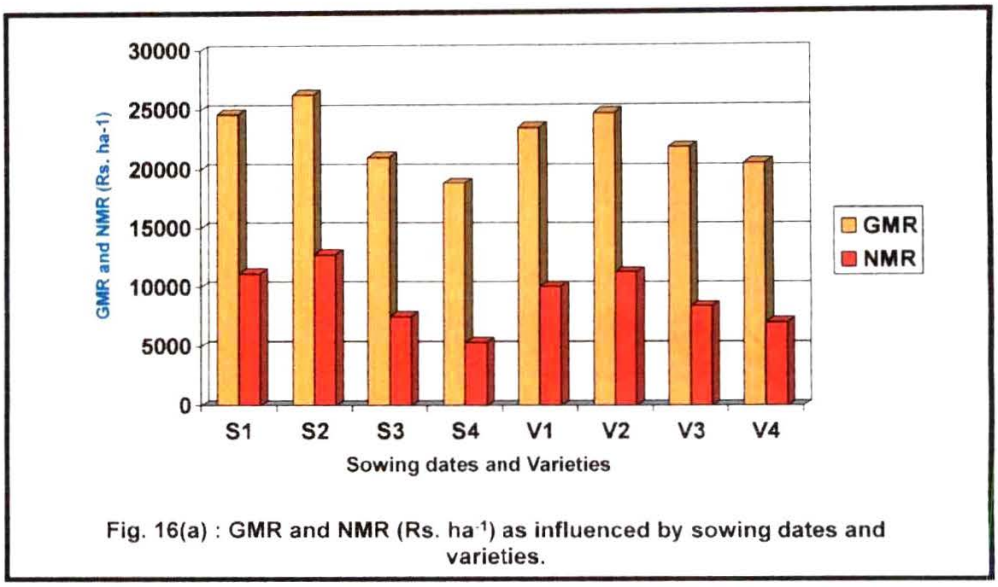

Fig. 16(a) : GMR and NMR (Rs. ha^{-1}) as influenced by sowing dates and varieties.

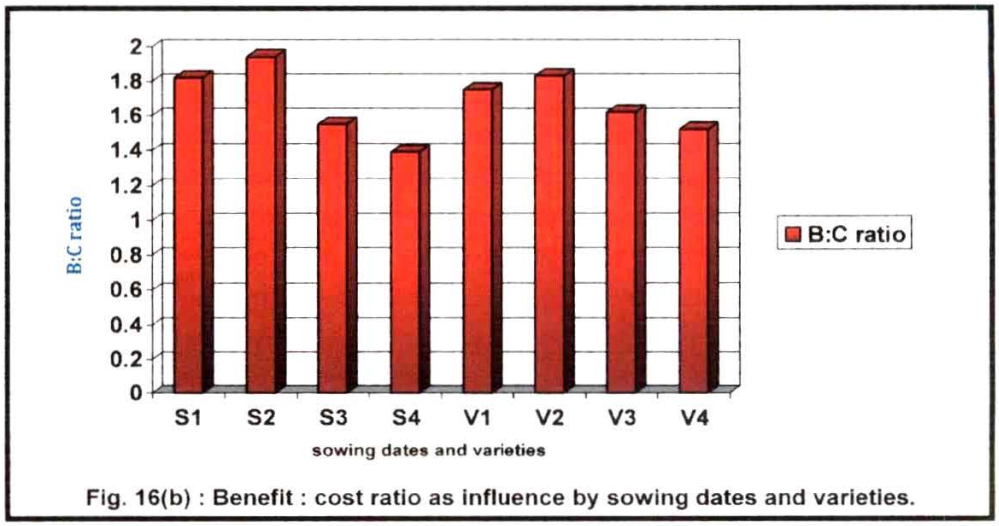

Fig. 16(b) : Benefit : cost ratio as influence by sowing dates and varieties.

Effect of sowing dates

Heighest net monetary returns (Rs. 12757 ha^{-1}) was recorded by S_2 (43^{rd} MW) and was at par with S_1 (42^{nd} MW) (Rs. 11167 ha^{-1}) and both recorded significant net monetary returns than S_3 (44 MW) and S_4 (45 MW) sowing dates.

Effect of different varieties

Variety V_2 (Pusa bold) recorded maximum net monetary returns (Rs. 11257 ha^{-1}) which was statistically at par with V_1 (ACN-9) (Rs. 10057 ha^{-1}).

Interaction

Interaction effects were found to be statistically non-significant.

4.7.3 Benefit : Cost ratio

Data on benefit : cost ratio presented in Table 16 and depicted Fig. 13. The mean benefit : cost ratio found to be 1.68.

Effect of sowing dates

Among sowing dates, S_2 (43^{rd} MW) recorded higher benefit : cost ratio 0f 1.94 and was followed by S_1 (42^{nd} MW). Lowest benefit : cost ratio of 1.39 was recorded by S_4 (45 MW) sowing dates.

Effect of different varieties

Among varieties V_2 (Pusa bold) recorded higher benefit : cost ratio of 1.83 followed by V_1 (ACN-9). Minimum benefit : cost ratio of 1.52 was noticed by in Variety V_4 (JD-6).

Chapter V

SUMMARY AND CONCLUSIONS

5.1 Summary

An agronomic investigation entitled "Response of mustard genotypes to different sowing dates" was carried out at Agronomy Farm, College of Agriculture, Nagpur during *rabi* season of 2010–2011. The experiment was laid out in split plot design consisting four main treatments of sowing dates *viz.*, S_1 (42^{nd} MW), S_2 (43^{rd} MW), S_3 (45^{th} MW) and S_4 (45^{th} MW) and four sub-treatments of varieties *viz.*, V_1 (ACN-9), V_2 (Pusa bold), V_3 (Urwashi), V_4 (JD-6). There were sixteen treatment combinations replicated thrice.

The soil was clayey in texture with pH 7.8 indicating slightly alkaline in reaction. The total precipitation received during cropping seasons was 81.6 mm in 6 rainy days. The periodical observations on growth parameters and yield contributing characters were recorded at specific periodic interval to evaluate the treatment effects. Some of the important findings emerged from this investigation are summarized below.

5.1.1 Sowing dates :

The emergence count and final plant population at harvest was not significantly influenced due to sowing dates. Plant height, number of branches plant^{-1}, number of leaves plant^{-1} and mean dry matter accumulation plant^{-1} was highest on S_2 (43^{rd} MW). But, dry matter accumulation plant^{-1} found statistically at par with S_1 (42^{nd} MW).

Yield contributing characters *viz.*, number of siliqua plant^{-1}, number of seeds siliquae^{-1} had also recorded highest value in treatment S_2 (43^{rd} MW) which was at par with the sowing on S_1 (42^{nd} MW). Similarly, test weight and seed yield plant^{-1} was recorded maximum in S_2 (43^{rd} MW).

Highest seed yield ha^{-1} (8.75 q) and stover yield ha^{-1} (34.20 q) was recorded in the treatment S_2 (43^{rd} MW) and it was statistically at par with the treatment S_1 (42^{nd} MW). The oil content was not influenced by sowing dates significantly and oil yield ha^{-1} (3.33 q) was also recorded maximum in the sowing date S_2 (43^{rd} MW) which was at par with S_1 (42^{nd} MW).

S_2 (43^{rd} MW) required the heighest growing degree days to attained physiological maturity of crop, as compared to it in S_1 (42^{nd} MW) which required less period to mature.

Gross monetary returns and net monetary returns and benefit cost ratio was highest in sowing on S_2 (43^{rd} MW). In respect of Gross and net monetary returns S_1 (42^{nd} MW) found statistically at par with S_2 (43^{rd} MW) respectively.

5.1.2 Varieties :

The emergence count and final plant population was not influenced due to varieties.

Plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and mean dry matter accumulation $plant^{-1}$ were significantly influenced on all growth stages. Variety V_2 (Pusa bold) found significantly superior over rest of the varieties. At 30 DAS and 60 DAS, V_3 (Urwashi) and V_4 (JD-6) found statistically at par with each other. Also, V_3 (Urwashi) and V_4 (JD-6) number of leaves $plant^{-1}$found to be at par with each other at 60 DAS in respect of number of leaves $plant^{-1}$.

The dry matter accumulation $plant^{-1}$ in V_3 (Urwashi) and V_4 (JD-6) varieties found to be at par with each other at 60 DAS, 90 DAS and at harvest.

Yield contributing characters *viz.*, number of siliqua $plant^{-1}$, number of seeds $siliquae^{-1}$, seed yield $plant^{-1}$, seed yield ha^{-1}, stover yield ha^{-1}, oil content and oil yield ha^{-1} was found to be significant and recorded

maximum value in variety V_2 (Pusa bold) which was at par with V_1 (ACN-9). The test weight was found to be non-significant statistically.

The gross and net monetary returns was more in V_2 (Pusa bold) variety which was statistically at par with V_1 (ACN-9). Also, benefit cost ratio was recorded highest with V_2 (Pusa bold).

5.1.2 Interaction :

Interaction effects of sowing dates and varieties were found to be non-significant in respect of growth, yield attributes, quality parameters and economics of mustard crop, except seed yield. Seed yield interaction between sowing dates and varieties found to be significant. Heighest seed yield were recorded (9.11 q ha-1) between S_2 (43^{rd} MW) and V_2 (Pusa bold) combination.

5.2 Conclusion :

On the basis of results obtained during the course of present experimentation, following conclusions are drawn.

1. Crop sown on S_2 (43^{rd} MW) as well as S_1 (42^{nd} MW) gives higher growth rate, yield and yield attributes, oil content and oil yield and net monetary returns. Therefore, sowing during S_1 (42nd MW) and S_2 (43rd MW) is optimum for mustard.

2. Crop sown with variety V_2 (Pusa bold) gives higher values of growth rate, seed and oil yield and yield attributes and net monetary returns. So, variety V_2 (Pusa bold) found to be superior for sowing.

3. S_2 (43rd MW) sowing in combination with V_2 (Pusa bold) variety produced higher seed yield than other treatment combinations but it was at par with S_1 (42^{nd} MW) sowing in combination with variety V_1 (ACN-9).

The above findings are basted on only one year data and need further conformation for recommendation to farmer.

LITERATURE CITED

Anonymous, 1999_a. Pre-released proposal for mustard ACN-9, submitted to research review committee, Dr. P.D.K.V.Akola, PP 1-2.

Anonymous, 1999_b. 'Agriculture situation in India' published by the Directorate of Economics and Statistics, New Delhi.

Anonymous, 2003. Indian economic data research center, Ministry of Agriculture, New Delhi, .PP 118-120.

Anonymous, 2009. Directorate of Oilseed Development, Hyderabad. http://www.dacnet.nic.in/oilseeds/gapy (February, 2009).

Awasthi, U.D., R.B. Singh and S.D. Dubey 2007. Effect of sowing dates and moisture conservation practices on growth and yield of Indian mustard (*Brassica juncea*) varieties. Indian J. of Agronomy 52(2): PP 151-153.

Bali, A.S., T. Singh, M.H. Shah, K.N. Singh and F.A. Negvi, 1992. Response of Indian mustard to sowing dates and fertilizer application. Indian J. of Agric. Sci. 62(10): PP 690-691.

Banga, R.S., R.S. Bisht and Ashok Yadav, 2007. Variation in growth rate and seed yield of Mustard (*Brassica juncea*) genotypes as affected by nitrogen levels. Paper presented in 12th International Rapeseed Congress held at WUHAN, China March. Proc. III. PP 246-247.

Bartarial, A.M., A.K. Shukla, C.D. Kaushik, P.R. Kumar and N.B. Singh, 2001. Major diseases of Rapeseed-Mustard and their management. NRC on Rapeseed-Mustard, ICAR, Sewer, Bharatpur (Rajasthan).

Belgamwar, M.M., 1998. Crop weather relations as influenced by dates of sowing in mustard (*Brassica juncea*) M.Sc. Thesis Dr. P.D.K.V.Akola (M.S.).

Bhalerao, P.D., 1997. Response of mustard (*Brassica juncea*) varieties to nitrogen levels under varied moisture regime. Ph.D. Thesis, Dr. P.D.K.V.Akola (M.S.).

Bhuyian, M.S., M.R.I. Mondol, M.A. Rahman, M.S. Alam and A.H.M.A. Faisal., 2008. Yield and yield attributes of rapeseed as influenced by date of planting. Int. J. Sustain. Crop Prod. 3(3) : PP 25-29.

Bishnoi, K.C. and Kanwar Singh, 1979. Effect of sowing dates, varieties and nitrogen levels on yield and yield attributes of raya. Indian J. of Agronomy 242(2): PP 123-129.

Chandrakar, B.L.and J.S. Urkurkar, 1993. Performance of mustard (*Brassica juncea*) varieties to dates of sowing in rice fallow. Indian J. of Agronomy 38(1): PP 143-144.

Channawar, A.G. and K.T. Nagre, 1992. Effect of various sowing dates and nitrogen levels on the growth, yield and quality of mustard varieties under irrigation, Thesis Abstn Dr. P.D.K.V.Akola (M.S.) PP: 8.

Chavan, S.A., V.M. Khande, P.P. Shinde and S.A. Khanvikar, 1989. Effect of date of sowing plant density and levels of nitrogen on mustard. J. Mah. Agric. Uni. 14 (1) : PP 198-200.

Chaudhary, C.S., S.R. Had and P.P. Gaurai, 1993. Effect of sowing dates on growth and yield of different varieties of mustard. J. Soils and Crops. 3(2) : PP 94-96.

Chaudhary, J.K. and R.K. Thakaria, 1994. Response of Indian mustard and toria to sowing date under rainfed condition. Indian J. of Agronomy 39(4): PP 687-688.

Chidda Singh, 1997. Modern techniques of raising field crops, Oxford and IBH publishing Com. Pvt. ltd. Kolkata : PP 301.

Dhingra, K.K., Jagrup Singh, M.P. Singh and B.S. Malhi, 2002. Performance of different genotypes of the *Brassica species* under different sowing dates. J. of Res. Punjab Agril. Univ. 39(3) : PP 328-333.

Diwan Singh, V. Umamaheshwar Rao and O.P. Bishnoi, 1993. Thermal requirement of *Brassica species* under three dates of seeding. Indian J. of Agronomy 4(3): PP 445-447.

Dudhade, D.D., B.N. Gare, K.K. Khade and D.G. Ramshe, 1996. Effect of sowing dates on growth, yield attributes and yield of Indian mustard. Indian J. of Agronomy 47 (3): PP 405-410.

FAO, 2009; FAOSTAT-2007. http://www.fao.org. (June 3, 2009).

Ghanbahadur, M.R., 2002. Response of mustard genotypes to sowing dates and water management, Ph.D. Thesis, Dr. P.D.K.V.Akola (M.S.).

Ghanbahadur, M.R. and B.K. Lanjewar, 2004. Performance of Indian mustard (*Brassica juncea*) varieties with respect to sowing dates, irrigation levels and mulching. PKV. Res. J. 28 (2) : PP 186-187.

Ghosh, R.K. and B.N. Chatarjee, 1988. Effect of dates of sowing on oil content and fatty acid profiles of indian mustard. J. Oil. Seed. Res. 5(2) : PP 144-149.

Gupta, T.S. and J.S. Saini, 2004. Effect of sowing dates and rate and application of nitrogen on seed and oil yield of toria. Indian J. of Agronomy 27 (4): PP 326-329.

Hundal, S.S., Prabhjyot Kaur and S.D.S. Malikpuri, 2004. Radiation use efficiency of mustard cultivars under different sowing dates. J. of Agromet. 6(1): PP 70-75.

Jadhav, S.N. and N.P.Singh, 1993. Effect of sowing dates, insect pest control measures and irrigation on oil content, seed and oil yields in mustard (*Brassica juncea*) Indian J. of Agronomy 38(1): PP 139-141.

Jain, V.K., V.S. Chauhan, M.P. Khandekar and P.C. Jain, 1989. Effect of sowing dates and genotypes on yield and yield attributing traits in Indian mustard. Madras Agric. J. 76 (5) : PP 241-246.

Jackson, M.L., 1967. Soil Chemical Analysis. Preventic Hall Inc. Faglewood, giffs, USA India Edu. 1962. Asian publishing house.

Khande, B.A., M.H. Shah, A.S. Bali and K.N. Singh, 1993. Variation in yield and its attributes in Indian mustard in relation to planting time, fertilizers and plant population. Indian J. Agric. Sci. 63 (3) : PP 175-176.

Lad, S.R., C.S, Chaudhary and P.P. Gawai, 1993. Effect of sowing dates on growth and yield of different varieties of mustard J. Soils and crops 3(2) : PP 94-96.

Mehar, Chand, A.S. Bangarna, Sandeep P. Kumar and R.K. Pannu, 1995. Crop weather relationship in *Brassica species* Agric. Sci. Digest, 15 (4): PP 197-200.

Mehrotra, O.N., H.K. Saxena and M. Moosa, 1976. Physiological Analysis of varietal differences in seed yield of Indian mustard Indian J. Plant Physiology. 19 (2) : PP 139-146.

Panse, V.G. and P.V. Sukhatme,1971. Statistical method for agricultural workers, IARI, New Delhi.

Patel, S.R., A.K. Awasthi and R.K.S. Tomar, 2004. Assesssment of yield losses in mustard (*Brassica juncea*) due to mustrd aphid under different thermal environments in eastern central India. Applied Eco. and Env. Res. 2(1) : 1-15. http:// www.ecology.kee.hu.

Pati, P. and N.N. Acharya, 2009. Response of toria varieties to fertilizer levels. Agric. Sci. Digest. 29 (2). http://www.agri.sci.diest.in.

Parmindar kaur and M.S. Sidhu, 2006. Effect of sowing date, nitrogen level and row spacing on oil quality of Ethiopian mustard. Env. and Eco. 24(4) : PP 1112-1114.

Pramanic, S.C., N.P. Singh, Subedar Singh, S.K. Bandopadhyay, L.M. Garnayak and S.Singh, 1996. Productivity and water use efficiency by Ethiopian mustard (*Brassica carinata A. Br.*) as influenced by time of sowing and irrigation. Annals of Agric. Res. 17 (1) : PP 1-8.

Panda, B.B., S.K. Batopadhyay and Y.S. Shivay, 2004. Effect of irrigation level, sowing dates and varieties on yield attributes, yield, consumptive water use and water use efficiency of Indian mustard(*Brassica juncea*). Indian J. Agril. Sci. 74(6): PP 339-342.

Piper, C.S., 1966. Soil and Plant analysis. Inter science publishers Inc. New York, PP 367.

Pooran Chand, M. Govardhan and M. Sujatha, 2000. Effect of dates of sowing on performance of mustard varieties. Res. on Crops. 1(2) : PP 153-155.

Prasad, S.N., Singh Ratan, D.H. Rao and R. Singh, 1999. Effect of pre sowing irrigation and soil mulch on yield attributes, yield and water use of chick-pea (*Cicer arietinum*) linseed (*Linium usitatisimum*) and Indian mustard (*Brassica juncea*) , Indian J. of Agric. Sci. 69(6): PP 424-426.

Rai, Mangala, Harvir Singh and D.M. Hegde, 2002. Oilseeds and Oils, Research and Development and Needs. Indian Society of oilseed Research, Hyderabad.

Rajender Kumar, 2002. Effect of nitrogen and sowing dates on productivity of *Brassica spp.*, Indian J. of Agronomy 47(3): PP 411-417.

Rajput, R.L., M.M. Sharma, D.V.S. Chauhan and O.P. Verma, 1991. Response of mustard (*Brassica napus*) and mustard (*Brassica juncea L.*) to date of sowing. Indian J. of Agronomy. 36.: PP 153-155.

Rohan Singh and S.R. Pal, 1976. Effect of time of sowing on the yield of different varieties of *Brassica spp.* in west Bengal. Indian Agriculturist. 17 (4) : PP 323-326.

Saini, K.S. and J.S. Sidhu, 1998. Crop phonology of gobhi sarson (*Brassica napus*) as influenced by different sowing dates, row spacing and nitrogen levels. Annals of Biology, Ludhiana 14 (1) : PP 71-72.

Sharma, M.L., G.S. Bhardwaj and Y.S. Chauhan, 1991. Response of Raya cultivars to sowing dates under irrigated conditions. Haryana J. Agronomy. 7(2) : PP 103-105.

Sharma, S.K., 2006. Effect of sowing and irrigation management on growth and yield of mustard (*Brassica juncea*). M.Sc. Thesis, Dr. P.D.K.V.Akola, College of Agriculture, Nagpur.

Shah, Sayad Anwar and K. Rahman, 2009. Yield and growth response of rapeseed (*Brassica napus L.*) mutants to different sowing rates and sowing dates. Pak. J. Bot. 41 (6) : PP 2711-2716.

Shastry, A.B.and Arvind Kumar, 1981. Variation in yield and quality of Indian mustard in relation to planting time and levels of plant population. Indian J. Agric. Sci. 51(1) : PP 27-32.

Shivani Kumar and Sanjeev Kumar, 2002. Response of Indian mustard (*Brassica juncea*) to sowing date and rows of spacing in mid-hills of Sikkim under rainfed conditions. Indian J. of Agronomy 47 (3): PP 405-410.

Singh, Dildagh, S.S. Gill, Jasbir Singh and Hari Singh, 1980. Effect of dates of sowing on the incidence of pea leaf minor in *Brassica spp.* Indian. J. Agric. Res. 18 (1) : PP 45-48.

Singh, G.R., P. Jangir and G.L. Keshwa, 1984. Studies on growth and yield of mustard varieties as affected by sowing time in semi-arid areas. Madras Agric. J. 71 (9) : PP 620-622.

Singh, S.K. and Ghanshyam Singh, 2002. Response of Indian mustard (*Brassica juncea*) varieties to nitrogen under sowing dates in eastern Uttar Pradesh. Indian J. of Agronomy. 47(2) : PP 242-248.

Subbiah, B.V. and G.L. Asija, 1956. A rapid procedure for the estimation of available nitrogen in soil. Curr. Sci., 25 : PP 259-269.

Surekha, E. and G. Ramasuba Reddy, 1996. Performance of mustard varieties under different dates of sowing. J. Oilseed Res. 13 (1) : PP 70-73.

Thkare, A.Y., U.B. Men, S.D. Deshmukh and M.N. Nachane, 2004. Effect of sowing dates on aphid incidence and its effect on yield of mustard. PKV Res. J. 28 (2) : PP 235-236.

Thakur, K.S. and C.M. Singh, 1998. Performance of *Brassica spp* under different dates of sowing in mid hills of Himachal Pradesh, Indian J. of Agronomy. 43 (3) : PP 464-468.

Tuteja, S.S., R. Lakpale and R.S. Tripathi, 1996. Effect of dates of sowing, nitrogen levels and nitrogen splitting on mustard. Advances in Pl. Sci. 9 (1) : PP 167-168.

Tyagi, P.K., D. Singh, V.U.M. Rao and A. Kumar, 1996. Effect of sowing dates on phonological development of Indian mustard(*Brassica juncea*) varieties. Crop Res. Hissar 11 (2) : PP 151-155.

Yadav, K.S., R.L. Rajput and M.S. Agarkar, 1999. Effect of sowing dates and irrigation schedules on yield and water use efficiency of Indian mustard (*Brassica juncea*). Indian J. of Agronomy. 44 (1) : PP 148-150.

Yadav, K.S., R.L Rajput, O.P.Verma and R.D.Yadav, 1996. Effect of sowing dates on productivity of *Brassica spp* . Indian J. of Agronomy 41 (2): PP 275-278.

Zora Singh, Brar, Daljit Singh Bal and Anupam Singh Johl, 1998. Influence of sowing dates, nitrogen and planting geometry on the performance of gobhi Sarson(*Brassica napus spp.oleifera var. annua*)., Indian J. of Agronomy 43(1): PP 133-137.

APPENDIX-I

Common cost of cultivation

Sr. No.	Particulars	Frequency	Bullock Pair	Male	Female	Tractor	Total (Rs. ha^{-1})
1.	Ploughing	1	-	-	-	900	900
2.	Harrowing	2	-	-	-	500	1000
3.	Clod crushing	1	1	1	-	-	350
4.	Cleaning	1	-	-	7	-	1050
5.	Planking	1	1	1	-	-	350
6.	Cost of seed	1	-	-	-	-	120
7.	Sowing	1	2	2	5	-	1450
8.	Gap filling	1	-	-	4	-	600
9.	Hoeing	1	1	2	-	-	500
10.	Weeding	1	-	-	20	-	3000
11.	Harvesting	1	-	-	10	-	1500
12.	Threshing and cleaning	1	-	-	10	-	1500
13.	Market	1	-	2	-	-	500
14.	Octri	1	-	-	-	200	200
15.	Seed treatment	1	-	-	-	-	10
16.	Fertilizer Urea SSP	 1 1	 - -	 - -	 4 	 90 85.0	 463.0
Total cost of Cultivation							13493

APPENDIX-II

Prevalent rates of different operational input and materials

Labour charges	:	Rs. day^{-1}
Male	:	120
Female	:	120
Bullock pair	:	200
Tractor drown implement	:	$900ha^{-1}$
Harrowing by tractor	:	$500ha^{-1}$

Input charges:

Seed of Mustard	:	Rs. 30 kg^{-1}
Urea	:	Rs. 5 kg^{-1}
SSP	:	Rs. 3.75 kg^{-1}
Thirum	:	Rs. 500 kg^{-1}

Yield of Mustard was converted in money value (Rs. ha^{-1}) @ recommended by price fixing committee, Dr. PDKV, Akola for the year 2010-11.

Mustard Seed	:	Rs. 3000 q^{-1}

APPENDIX-III (a)

Statement showing daily Met. data at College of Agriculture, Nagpur for the period of October- 2010

Date	Temp °C		Humidity		Total rainfall (mm)	No. of rainy days	B.S.H.	Wind speed Km/hr	Evaporation (mm)
	max	min	Mor.	Eve					
1	32.3	20.1	65	53	-	-	10.0	3.3	03.8
2	31.8	21.5	75	57	-	-	09.0	2.8	03.0
3	32.7	22.7	78	63	-	-	07.0	2.4	02.1
4	32.7	23.7	81	66	-	-	03.2	2.1	01.9
5	32.1	23.5	77	51	-	-	02.9	3.4	02.0
6	33.1	21.5	68	41	-	-	08.7	3.6	04.7
7	33.7	23.0	71	59	-	-	08.1	4.4	03.5
8	32.5	23.2	73	56	-	-	07.6	5.5	03.3
9	33.1	23.5	79	53	-	-	08.0	3.5	03.5
10	34.3	23.1	75	45	-	-	07.4	2.2	03.2
11	34.7	22.7	72	49	-	-	07.4	1.9	02.9
12	34.3	23.6	63	41	-	-	07.1	3.0	02.8
13	34.3	21.9	67	43	-	-	05.9	2.9	04.0
14	34.3	21.1	60	35	-	-	07.8	3.3	02.9
15	34.1	20.6	60	46	-	-	08.6	4.0	05.2
16	32.8	24.0	71	68	-	-	03.8	6.1	03.2
17	30.1	24.6	75	76	-	-	00.00	6.2	03.0
18	29.5	23.1	84	78	-	-	00.0	5.6	02.6
19	28.3	24.0	80	65	0.8	-	00.6	3.7	02.2
20	31.5	22.6	80	66	-	-	06.5	2.2	02.0
21	32.8	23.1	82	65	-	-	05.9	1.8	03.2
22	34.1	21.6	90	72	20.8	-	04.5	3.0	02.6
23	29.3	21.6	84	64	-	-	00.0	2.4	02.0
24	31.3	20.3	85	57	-	-	01.0	1.7	02.1
25	32.8	20.6	70	48	-	-	08.0	3.2	03.6
26	32.8	18.6	66	38	-	-	07.0	2.7	03.5
27	32.1	16.9	78	35	-	-	07.5	3.0	04.4
28	32.1	20.1	75	34	-	-	07.4	2.2	03.1
29	32.3	17.5	67	56	-	-	07.2	1.8	02.1
30	31.3	17.4	70	48	-	-	07.5	2.8	02.8
31	30.1	21.9	78	59	-	-	00.0	3.4	01.8

APPENDIX-III (b)

Statement showing daily Met. data at College of Agriculture, Nagpur for the period of November- 2010

Date	Temp °C		Humidity		Total rainfall (mm)	No. of rainy days	B.S.H.	Wind speed Km/hr	Evaporation (mm)
	max	min	Mor.	Eve					
1	25.8	15.4	72	47	-	-	00.0	3.1	01.1
2	29.3	19.1	78	65	-	-	09.3	5.6	02.8
3	28.6	21.7	79	69	-	-	03.6	5.0	02.8
4	29.0	20.6	79	57	-	-	03.1	3.4	03.3
5	31.7	17.9	59	46	-	-	07.2	2.7	01.8
6	32.1	15.6	62	55	-	-	09.3	2.1	02.9
7	30.1	15.6	67	42	-	-	06.4	2.4	02.0
8	31.1	22.6	68	60	-	-	07.5	6.4	03.2
9	30.1	22.2	91	65	-	-	01.7	5.6	01.6
10	30.1	20.9	79	50	-	-	06.2	1.6	01.6
11	33.3	22.0	80	77	-	-	08.8	1.6	02.5
12	33.3	21.1	90	63	20.4	-	-	2.9	02.4
13	30.8	21.3	78	65	-	-	-	1.6	03.2
14	32.1	21.1	82	69	-	-	-	1.9	02.0
15	29.9	20.3	76	57	-	-	-	1.8	01.0
16	31.7	19.3	74	43	-	-	-	2.0	02.6
17	32.3	17.5	67	47	-	-	-	2.1	02.3
18	32.3	23.1	78	98	-	-	-	1.8	02.5
19	32.1	21.0	89	73	34.2	-	-	4.1	02.5
20	30.3	21.5	88	57	3.8	-	-	1.9	01.6
21	30.8	18.1	47	39	-	-	-	2.5	02.9
22	29.9	16.0	60	55	-	-	-	2.2	03.4
23	30.5	17.1	54	54	-	-	-	2.2	02.8
24	31.1	19.2	71	51	-	-	-	2.1	02.2
25	31.9	19.1	80	46	-	-	-	1.8	03.0
26	32.8	19.9	73	44	-	-	-	1.8	04.0
27	32.8	19.9	83	51	-	-	-	1.1	02.4
28	30.8	19.6	75	48	-	-	-	1.2	01.9
29	32.3	19.1	81	46	-	-	-	1.5	02.2
30	31.7	19.1	72	47	-	-	-	1.5	02.7

APPENDIX-III (c)

Statement showing daily Met. data at College of Agriculture, Nagpur for the period of December- 2010

Date	Temp °C		Humidity		Total rainfall (mm)	No. of rainy days	B.S.H	Wind speed Km/hr	Evaporation (mm)
	max	min	Mor.	Eve					
1	30.7	18.0	67	51	–	–	–	1.9	2.9
2	31.3	18.1	72	45	–	–	–	1.8	2.0
3	31.3	18.6	69	51	–	–	–	3.6	2.9
4	29.3	16.1	57	32	–	–	–	3.9	3.8
5	28.8	12.6	49	36	–	–	–	3.4	3.4
6	27.8	12.6	53	26	–	–	–	3.1	3.6
7	27.3	15.6	71	45	–	–	–	4.4	3.2
8	29.3	19.6	84	75	–	–	–	7.1	2.6
9	27.3	20.6	86	63	–	–	–	4.7	2.4
10	28.8	18.6	77	47	–	–	–	3.6	2.4
11	29.3	17.1	74	42	–	–	–	1.5	2.8
12	30.8	18.1	57	42	–	–	–	3.8	3.2
13	30.8	13.6	69	41	–	–	–	2.9	3.4
14	27.5	12.7	52	39	–	–	–	2.9	2.4
15	26.3	9.7	45	28	–	–	–	2.8	3.0
16	25.8	8.1	59	26	–	–	–	2.6	2.5
17	25.8	7.3	56	29	–	–	–	2.4	2.1
18	26.3	7.6	59	24	–	–	–	1.9	3.0
19	26.3	7.6	53	28	–	–	–	2.3	2.4
20	26.8	7.6	51	30	–	–	–	2.8	3.4
21	26.3	6.6	52	28	–	–	–	1.8	2.0
22	26.8	7.6	63	33	–	–	–	1.8	1.8
23	28.8	9.6	66	31	–	–	–	1.5	1.2
24	28.9	10.6	70	40	–	–	–	1.6	2.2
25	29.8	12.6	71	43	–	–	–	1.2	2.1
26	28.8	11.6	71	35	–	–	–	1.2	1.8
27	28.8	12.6	71	37	–	–	–	1.6	2.3
28	27.3	11.1	62	34	–	–	–	2.1	3.0
29	27.3	10.6	66	32	–	–	–	2.4	2.5
30	27.8	11.6	78	38	–	–	–	2.3	2.8
31	27.8	15.6	75	52	–	–	–	1.5	1.2

APPENDIX-III (d)

Statement showing daily Met. data at College of Agriculture, Nagpur for the period of January-11

Date	Temp °C		Humidity		Total rainfall (mm)	No. of rainy days	B.S.H.	Wind speed Km/hr	Evaporation (mm)
	max	min	Mor.	Eve					
1	27.8	10.6	53	28	-	-	-	5.1	1.6
2	27.8	11.6	41	28	-	-	-	4.8	2.0
3	27.3	8.8	39	21	-	-	-	4.8	2.2
4	27.1	8.1	43	31	-	-	-	1.5	1.8
5	25.6	7.1	49	35	-	-	-	2.8	1.6
6	23.3	4.6	46	21	-	-	-	2.7	1.6
7	25.1	5.6	37	19	-	-	-	3.4	2.4
8	26.8	6.1	45	24	-	-	-	2.5	5.0
9	26.9	8.1	46	27	-	-	-	2.1	2.4
10	27.1	7.0	41	22	-	-	-	2.4	2.2
11	26.3	6.1	53	23	-	-	-	2.3	2.4
12	26.3	7.6	49	25	-	-	-	2.1	2.8
13	29.3	8.6	52	31	-	-	-	1.3	2.6
14	31.0	10.2	51	34	-	-	-	1.4	2.7
15	31.7	11.3	65	43	-	-	-	1.7	2.8
16	30.5	13.9	57	55	-	-	-	3.1	2.4
17	27.1	6.5	45	36	-	-	-	3.8	4.8
18	28.3	7.6	55	12	-	-	-	1.3	2.0
19	31.1	10.5	50	26	-	-	-	1.8	1.4
20	29.7	11.0	58	30	-	-	-	2.2	2.8
21	27.9	10.1	49	19	-	-	-	2.9	2.7
22	28.1	8.6	50	21	-	-	-	2.2	3.2
23	29.8	10.1	64	24	-	-	-	2.0	3.0
24	31.1	11.7	67	26	-	-	-	1.6	2.7
25	31.7	13.2	75	34	-	-	-	1.7	3.0
26	31.3	15.4	75	30	-	-	-	1.8	2.0
27	32.1	14.8	65	29	-	-	-	2.8	2.8
28	30.7	13.7	68	28	-	-	-	2.2	3.8
29	31.9	15.7	65	29	-	-	-	2.3	2.7
30	32.0	14.6	65	30	-	-	-	3.1	4.8
31	31.8	16.3	68	40	-	-	-	3.5	3.0

VITA

1. Name of the Student : Uikey Mrinalini Chandansingh
2. Date of birth : 21st February 1988
3. Name of the College : College of Agriculture Nagpur
4. Residential address along with phone no. : Uikey Mrinalini Chandansingh
   'Aplona',
   Plot No. 23,
   Mitranagar, Manewada Road,
   Nagpur-440027
   Mobile No. 08087285204
5. Academic Qualification:

Sr. No.	Name of Degree awarded	Year in which obtained	Class	CGPA	Name of the awarding University	Subject
1	B.Sc. (Agri.)	2009	Second	7.16	Dr. P.D.K.V., Akola	Agriculture

6. Field of Interest : Research in Agronomy.

Place: Nagpur

Date: 31/05/2011

Mrinalini

Signature of Student