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Original Research Article

Effect of Different Sowing Dates on Growth, Yield and Quality of Various Indian Mustard (*Brassica juncea* L.) Varieties

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Keywords

Mustard, sowing dates, LAI, oil yield, quality, protein

A B S T R A C T

A field experiment was conducted during *Rabi* season of 2015–16 at Agronomy research farm of N. D. University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India to assess the effect of different dates of sowing on the growth yield and quality of various Indian mustard (*Brassica juncea* L.) varieties. The experiment was conducted with split plot design replicated four times. Treatments consisted of four dates of sowing viz., 15th October, 30th October, 14th November and 29th November was kept as main plot and three varieties viz., Varuna, Narendra Rai-1 and Kranti was kept as sub plot. The growth characters like plant height, leaf area index, dry matter accumulation, seed and stover yield was influenced significantly due to different sowing dates and varieties. Highest plant height (164.6 cm), leaf area index (4.5), dry matter accumulation (41.0 g plant^{-1}), seed yield (1873.5 kg ha^{-1}), stover yield (6472.3 kg ha^{-1}) and oil yield (838.2 kg ha^{-1}) was recorded when the crop was shown on 14th November. Among the various varieties taken under investigation, Varuna proves better with respect to growth and yield which gave highest plant height (170.22 cm), leaf area index (4.7), dry matter accumulation (42.7 g plant^{-1}), seed yield (1877.0 kg ha^{-1}), stover yield (6533.8 kg ha^{-1}) and oil yield (841.1 kg ha^{-1}). Whereas quality parameters like oil, nitrogen and protein content were not influenced significantly due to different dates of sowing as well as varieties.

Introduction

Oilseeds, the raw material for vegetable oils, occupy a significant position in India's national economy, next to food grains, accounting for about 10% of the cultivated area and value of all agricultural produce. The requirements for vegetable oil seed have been projected to be around 34 mt by 2020 AD. Out of which 14 mt is to be contributed by rapeseed-mustard to meet the annual domestic demand based on present level of consumption of fats and oils (8.5 kg Capita^{-1} year^{-1}) and the subsequent growth.

Rapeseed-Mustard is the third important oilseed crop in the world after soybean (*Glycine max*) and palm oil (*Elaeis guineensis jacq.*) which contributes 28.6% in the production of oilseeds. The global production of rapeseed-mustard and its oil is around 38–42 and 12–14 mt respectively. India contributes 8.3% and 19.8% of world acreage and production respectively. The seeds are highly nutritive containing 38–57% erucic acid, 5–13% linoleic acid and 27% oleic acid.

Among the different agronomic practices, sowing time plays an important role to fully exploit the genetic potentiality of a variety as it provides conductive condition for growth and development; delayed sowing influences both the productivity of seed and oil yield to a great extent. Rapeseed-mustard is usually sown by the end of September to second fortnight of October in north India when grown as a sole crop or on dates of the main crop when sown as mixed or intercrop. But, with the development of new varieties of crops and adoption of multiple cropping systems under irrigated condition, it has become essential to extend their sowing from October to mid of November or even later. Delayed sowing would influence adversely the crop performance owing to change in abiotic and biotic environmental conditions (Singh *et al.*, 2011). It necessitates developing suitable agro techniques to augment the productivity of the crop.

Materials and Methods

A field experiment was conducted during *Rabi* season of 2015–16 at Agronomy research farm of N. D. University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India. Soil of that particular field was Silt loam, with pH 8.2, lower in organic carbon content (0.37) and low in available nitrogen (194.25 kg ha^{-1}) and medium in phosphorous (18.3 kg ha^{-1}) and potash (250.25 kg ha^{-1}). Three varieties viz. Varuna (V_1), Narendra Rai-1 (V_2) and Kranti (V_3) were used to assess their performance fewer than four dates of sowing viz., 15th October, 2015 (D_1), 30th October, 2015 (D_2), 14th November, 2015 (D_3) and 29th November, 2015 (D_4). The experiment was conducted under Split plot design with four replications in which date of sowing was taken as main plot treatments and varieties were allocated in sub plots. The experimental crop was fertilized with a uniform dose of nitrogen, phosphorus and potassium @ 120 kg ha^{-1}, 60 kg ha^{-1} and 50 kg ha^{-1} respectively and Urea, DAP and Muriate of potash were used as the source of nitrogen, phosphorus and potassium respectively. Crop was sown at different dates with 5 kg seed ha^{-1} of each variety and sowing was done manually. Two irrigations, 1st irrigation at 30 DAS and 2nd at flowering stage of the crop were provided along with manual intercultural operation at 45 DAS. Observations regarding growth like plant height (cm), dry matter accumulation were recorded at 30, 60, 90 DAS and at harvest stage while observations regarding Leaf Area Index (LAI) were taken at 30, 60 and 90 DAS interval. Plant height was recorded by selecting 5 random plants from each net plot and tagged and height of plant was measured with the help of meter scale from soil surface to apex of the plant at 30, 60, 90 DAS and at harvest of the crop and mean value from all the recorded data was worked out. Similarly the leaf area of five plants was measured by automatic leaf area meter at 30, 60 and 90 DAS of the crop and Leaf area index was calculated by the following formula:

Leaf Area Index (LAI) = leaf area/ground area

For dry matter accumulation, plants falling within the quadrate (0.25×0.25 m^2) from the area marked were cut close to the ground surface and dried in a hot air oven maintained at 70±2°C till constant dry weight. Dry matter of plants was recorded and expressed in gram m^{-2}. Harvesting of individual plot was done at physiological maturity when siliquae turned brownish. Mainly mustard crop was harvested as soon as 75% pods turned yellowish brown and bundles of harvested plants were sun dried for few days at threshing floor after proper tagging. The bundle weight of net plot was recorded individually. Whole biomass was

weighted just before the threshing. Threshing was done by wooden sticks and cleaned separately for taking the seed weight from the net plots. Stover yield was recorded by subtracting seed weight from total biomass yield. All the data were recorded in kg plot^{-1} which was finally converted into kg ha^{-1}.

To calculate the oil content**,** seed samples were kept in the electric oven at 65°C for removal of moisture thereafter, the seeds were ground in a pestle mortar for extraction of oil. The conventional soxelet method was used for estimation of oil (AOAC, 1970). The oil content was also estimated by Oxford Analytical Newport 4000 NMR using following formula:

$$\text{Oil content (\%)} = \frac{\text{Weight of oil flask + ether extract - Weight of flask oil}}{\text{Substances taken}} \text{x100}$$

Total oil yield was computed by multiplying the seed yield with oil content. Oil yield was computed by using following formula:

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

Nitrogen content in seeds was determined by Micro-Kjeldahl's method (Subbiah and Asija, 1956). For determination of protein content, seed samples of different treatment were analyzed for nitrogen content in seeds by multiplying with a constant factor 6.25 and expressed in percentage. The protein yield was calculated by multiplying the seed yield with protein content in seeds.

Results and Discussion

Growth attributes of plants

Plant height (cm)

It is evident from the data that plant height (Table 1) increased successively till 90 DAS under different dates of sowing. Different dates of sowing had no significant influence on plant height at 30 DAS which might be due to similar growth pattern at initial growth period. Whereas at 60 DAS, 90 DAS and at harvest, plant height was found to be highest with crop shown on 14th November which was at par with 30th October and significantly higher over 15th October and 29th November. The varieties had no significant influence on plant height at 30 DAS which might be due to similar growth pattern at initial growth period whereas at 60, 90 DAS and at harvest the variety Varuna recorded significantly higher plant height at as compared to Narendra Rai-1 and Kranti this might be due to their own genetic characteristics and similar findings were reported by (Singh, 1989; Kurmi, 2002 and Singh and Singh, 2002).

Leaf Area Index (LAI)

Different dates of sowing had no significant influence on the leaf area index (Table 2) at 30 DAS which might be due to similar and slower growth rate at initial crop age. It is quite evident from the data that leaf area index increased successively till 60 DAS under different dates of sowing. Crop sown on 14th November recorded significantly higher leaf area index over 15th October and 29th November and at par with 30th October at 60 DAS. Similar trends were recorded at successive stages. Delayed, sowing by one month achieved lower leaf area index at all the stages of mustard crop which might be due to less vegetative growth because of less favorable environmental conditions when crop was sown too early and late sowing conditions. Different varieties have no significant influence on the leaf area index at 30 DAS. Among the varieties Varuna recorded significantly higher leaf area index at 60 DAS, 90 DAS and at harvest as compared to Narendra Rai-1 and Kranti.

Table.1 Plant height as influenced by different date of sowing and varieties

Treatments	plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
Date of sowing				
15th Oct 2015	21.9	65.8	126.3	153.1
30th Oct 2015	22.3	67.2	132.5	160.3
14th Nov 2015	22.8	71.2	136.2	164.6
29th Nov 2015	21.6	64.4	123.8	150.2
SEm±	0.40	1.35	2.43	3.22
CD (*p*=0.05)	NS	4.69	8.43	11.17
Varieties				
Varuna	22.64	75.16	141.94	170.22
Narendra Rai-1	22.15	67.68	128.42	154.48
Kranti	21.64	60.09	118.69	146.49
SEm±	0.44	1.48	3.11	3.75
CD (*p*=0.05)	NS	4.39	9.25	11.14

Table.2 Leaf area index as influenced by different date of sowing and varieties

Treatments	Leaf area index		
	30 DAS	60 DAS	90 DAS
Date of sowing			
15th Oct 2015	1.6	4.2	3.2
30th Oct 2015	1.7	4.4	3.3
14th Nov 2015	1.7	4.5	3.4
29th Nov 2015	1.6	3.9	2.9
SEm±	0.047	0.09	0.06
CD (*p*=0.05)	NS	0.33	0.23
Varieties			
Varuna	1.7	4.7	3.6
Narendra Rai-1	1.6	4.2	3.2
Kranti	1.6	3.8	2.8
SEm±	0.03	0.08	0.07
CD (*p*=0.05)	NS	0.25	0.22

Table.3 Dry matter accumulation as influenced by different date of sowing and varieties

Treatments	Dry matter accumulation (g plant^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest
Date of sowing				
15th Oct 2015	1.7	14.7	32.7	37.9
30th Oct 2015	1.8	15.4	34.4	39.8
14th Nov 2015	1.8	15.9	35.4	41.0
29th Nov 2015	1.7	13.6	30.3	35.2
SEm±	0.05	0.43	0.79	0.80
CD (*p*=0.05)	NS	1.5	2.74	2.79
Varieties				
Varuna	1.8	16.5	36.9	42.7
Narendra Rai-1	1.7	14.9	33.2	38.5
Kranti	1.7	13.2	29.5	34.2
SEm±	0.03	0.33	0.59	0.88
CD (*p*=0.05)	NS	1.00	1.77	2.64

Table.4 Seed and stover yield as influenced by different date of sowing and varieties

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
15th Oct 2015	1630.3	5627.8
30th Oct 2015	1750.7	6057.9
14th Nov 2015	1873.5	6472.3
29th Nov 2015	1547.3	5478.4
SEm±	53.97	151.68
CD (*p*=0.05)	186.8	524.89
Varuna	1877.0	6533.8
Narendra Rai-1	1778.8	6185.7
Kranti	1521.5	5271.1
SEm±	42.32	150.84
CD (*p*=0.05)	125.75	448.18

Table.5 Oil content, oil yield, nitrogen content and protein content as influenced by different date of sowing and varieties

Treatments	Oil content (%)	Oil yield (kg)	Nitrogen content (%)	Protein content (%)
Date of sowing				
15th Oct 2015	39.5	723.3	3.4	21.8
30th Oct 2015	40.1	782.4	3.5	22.0
14th Nov 2015	40.4	838.2	3.5	22.1
29th Nov 2015	38.5	660.2	3.4	21.3
SEm±	0.78	20.92	0.06	0.67
CD (*p*=0.05)	NS	72.40	NS	NS
Varieties				
Varuna	40.5	841.1	3.5	21.8
Narendra Rai-1	39.5	781.0	3.5	21.8
Kranti	37.6	608.4	3.4	21.4
SEm±	0.83	18.38	0.49	0.58
CD (*p*=0.05)	NS	54.61	NS	NS

Dry matter accumulation

Perusals of the data obviously reveal that the dry matter accumulation (Table 3) increased successively with age of the crop till the harvest. It is obvious from the data revealed that dry matter accumulation was significantly influenced by different dates of sowing. Different dates of sowing have no significant effect on dry matter accumulation plant^{-1} at 30 DAS. Higher dry matter accumulation was recorded under 14th November sowing over 29th November and at par with 15th October and 30th October at 60 DAS and 90 DAS. Whereas at harvest dry matter accumulation was at par with 30th October and significantly higher over 15th October and 29th November sowing. Accumulation of dry matter in the plant is directly related to plant height, leaf area index and number of branches plant^{-1} which were appreciably reduced as sowing delayed. Drastic decrease in dry matter accumulation of mustard was also observed by Panda *et al.*, (2004) and Khushu and Singh (2005). Among the varieties Varuna recorded significantly higher dry matter accumulation at 60, 90 DAS and at harvest as compared to Narendra Rai-1 and Kranti respectively and its probable reason might be attributed to genetic characters of Varuna which has higher capacity to utilized the photosynthates more efficiently for maximum leaf area index, number of branches plant^{-1} and ultimately the dry matter production. Similar findings have been reported by (Kumar *et al.*, 2000 and Chaplot *et al.*, 2012).

It might be probably due to their genetic characters of varieties and Leaf area index was decreased after 90 days after sowing due to decreasing growth rate and senescence stage which showed drying and shattering of the leaves. Similar findings were reported by Thakur and Singh 1988.

Yield

Seed and stover yield

The data reveal that date of sowing and varieties significantly influenced the seed yield (Table 4) of mustard. Different dates of sowing under investigation brought significant influence on the seed yield. Crop sown on 14th November recorded significantly higher seed yield over 15th October and 29th November sowing while at par with 30th October sowing. The seed yield was recorded lowest under 29th November sowing of mustard. Seed yield was significantly influenced due to varieties. Among the varieties Varuna recorded significantly higher seed yield as compared to Kranti and at par with Narendra Rai-1. The data reveal that date of sowing and varieties had significantly influenced the stover yield (Table 4) of mustard. Different dates of sowing under investigation brought significant influence on the stover yield. Crop sown on14th November recorded significantly higher stover yield over 15th October and 29th November sowing while at par with 30th October sowing, stover yield was recorded lowest under with 29th November sowing of mustard. Stover yield was significantly influenced due to varieties.

Among the varieties Varuna recorded significantly higher stover yield as compared to Kranti and at par with Narendra Rai-1. All the growth and yield attributes which determined the seed and stover yield of mustard crop, were adversely influenced when the sowing were done on too early and late sowing, which might be resulted to poor growth and translocation of photosynthates from source to sink and ultimately lower yield was recorded. Significant reduction in seed and stover yield of mustard in too early and late sown have also been reported by (Panwar *et al.*, 2000; Singh *et al.*, 2001 and Panda *et al.*, 2004). The variety Varuna produced higher value of seed and stover yield as compared to Narendra Rai-1 and Kranti which might be due to aggressive growth characters and better source and sink relationship which ultimately results in low yield and similar findings were reported by Bharadwaj 1991 and Kumar *et al.*, (2000).

Quality

Dates of sowing had significantly influenced the oil yield (Table 5) of mustard. A critical examination over data obviously reveal that the crop sown on 14th November produced significantly higher oil yield as compared to 15th October and 29th sowing and at par with 30th October sowing. Oil yield and oil content was significantly influenced due to varieties. Among the varieties, Varuna recorded significantly higher amount of oil yield as compared to Narendra Rai-1 and Kranti. Nitrogen content and protein content (Table 5) of mustard was not influenced significantly due to dates of sowing and varieties (Kumar *et al.*, 2015).

Form the results discussed above it can be concluded that 14th November date of sowing of mustard with Varuna variety was found to be most suitable and realize better growth as well as yield and quality of oil.

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