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Influence of diffirenet sowing dates and varieties on entire shrivelled substance and its seperation in disntict plant parts and yield of Indian mustard

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Abstract

The field experiment entitled " Influence of different sowing dates and varieties on entire shrivelled substance and its sepration in distinct plants parts and yield of Indian mustard (Brassica juncea L.)" was conducted during *Rabi* season of 2018-19 at Agricultural Research farm of faculty of Agricultural sciences and Allied Industries, Rama University, Mandhana, Kanpur (U.P.). The experiment was laid out in split-plot design with three replications consisted three sowing dates (October 25, November 10, 5 December) and three varieties (Varuna, Kranti, Pusa Bold,) as main plot and sub-plot treatments. October 25 sown crop resulted into significantly higher total plant biomass and its partitioning into different parts (leaves, stem and siliquae) at all growth stages, yield attributes (siliquae plant-1, 1000-seeds weight), yields (seed and stover), harvest index and oil content as compared to November 10 and December 5 sown crops. Consecutive 20 days delay in sowing from October 25 to November 15 and December 5 caused a loss in seed yield by 22.7 and 36.5%., respectively. Among varieties, Kranti led to record higher total biomass and its partitioning at all growth stages and resulted into higher yield attributes, yield and harvest index followed by cvs. Varuna and Pusa Bold. Kranti exhibited 30.2 and 7.15% higher seed yield over cvs. Varuna and Pusa bold, respectively. However, Kranti exhibited significantly higher oil content (43.5 %) followed by cvs. Pusa Bold (38.7 %) and Varuna (36.5 %).

Keywords: shrivelled substance, Indian mustard, oil content, sowing dates, varieties

Introduction

Rapeseed and mustard are the major oilseed crops, traditionally grown everywhere in the country due to their high adaptability in conventional farming systems. Oilseeds, the second largest agricultural commodity after cereals in India, play a significant role in India's agrarian economy, sharing 14% of the gross cropped area and accounting for nearly 1.5% of the gross national production and 8% of the value of all agricultural products. Indian mustard (*Brassica juncea* L.) belongs to the family Cruciferae is one of the most important winter oilseed crop. The Main growing state are Rajasthan, Gujarat, M.P., Uttarakhand, Uttar Pradesh, Bihar, West Bengal and Assam. India occupies third position in rapeseed-mustard production in the world after China and Canada (Anonymous, 2017) [2].

The important mustard growing countries of the world are India, Canada, China, Pakistan, Poland, Bangladesh and Sweden. In India, its cultivation is mainly confined in the states viz., Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Assam, Bihar, Gujarat and West Bengal. Among states, Uttar Pradesh alone produces about 20 percent of total mustard production in India. It is also grown in certain tropical and subtropical regions as a cold weather crop. Indian mustard is reported to tolerate annual precipitation of 500 to 1200 mm, annual temperature of 6 to 27^{0}C, and soil pH of 6.5 to 8.3. Rapeseed - mustard follows C_3 pathway for carbon assimilation. Therefore, it has efficient photosynthetic response at 15 to 20^{0}C temperature. At this temperature the plant achieves maximum CO_2 exchange range which declines thereafter. Mustard requires well drained sandy loam soil. Rapeseed - mustard has a low water requirement (240 - 400 mm) which fits well in the rain fed cropping system. Nearly 20% these crops are rainfed.

Sowing time is one of the most important factors affecting crop yield and other agronomic traits like dry matter production, oil content, the optimization of sowing time for mustard is essential. Sowing either too early or too late has been reported to be unfavourable (Uzun *et al*., 2009) [13]. Islam and Choudhary (2002) [4] also mentioned that mustard plants under later sowings more rapidly ful fill the low temperature requirement to initiate earlier inflorescence and flowering. But early inflorescence restricts leaf production resulting in small plant, fewer pods bearing branches and finally low dry matter yield. As the level of dry matter in plants decide the yield potential and seed yields from late sown crops are greatly affected. It is also a fact that specified genotypes does not exhibit the same phenotypic characteristics in all environmental conditions. Improved cultivar is an important tool, which have geared production of mustard in many countries of the world. In addition to many other factors responsible for achieving higher yields, cultivars with higher yield potential and a wide range of adaptability to adaphic and climatic conditions is essential for increasing yield per unit area, ultimately boosting up total production. Panda *et al.* (2004) [9] has also reported that the yield potential of different mustard varieties may differ under different agro-climatic conditions because of their inherent capacity. The mustard genotypes differ in their yielding ability, this calls for a need to generate more information on the response of mustard genotypes to the dates of sowing for greater yields in a given agroclimatic conditions. The present study was therefore, undertaken to determine the effects of sowing dates and varieties on pattern of total biomass accumulation, its partitioning into different parts and yield of Indian mustard.

Material and Method

Experimental details and site description: The field experiment entitled, "Effect of integrated nutrient management on growth, yield and quality of Indian mustard (*Brassica juncea* L.)" was conducted during *Rabi* season of 2017-18 at Agricultural research farm of faculty of Agricultural sciences and Allied Industries, Rama University, Mandhana, Kanpur (U.P.). Geographically, Kanpur is situated in the central part of U.P. and subtropical tract of North India between latitude ranging from 25^0 56' to 28^0 58' North and longitude 79^0 31' to 80^0 34' East and is located at an elevation of about 125.9 meters above mean sea level in gangetic plain. The seasonal rainfall of about 629.5 mm received mostly from IInd Fortnight of June or first Fortnight of July to mid-October with a few showers in winter season. The maximum and minimum temperature in the *Rabi* season usually occurs 35˚C and 10˚C, respectively The soil of experimental field was slightly alkaline in reaction with 7.8 pH, low in organic carbon (0.31%) and low in available nitrogen (181.4 kg ha-1), phosphorus (18.4 kg ha-1), medium in potassium (290 kg/ha), available sulphur 7.3 (ppm) and available Zinc 0.59 (ppm). The experiment consist of in Split Plot Design with three replications.

Data Collection: The various observations on growth attributes (plant height and dry weight) and yield attributes (Number of siliqua plant-1 and Length of siliqua) were recorded as per standard procedure at 90 DAS and at harvest. Moreover, yields viz., grain, straw and harvest index of mustard (q/ha) was worked out in different plot of the experimental field. The mean weather data such as weekly average temperature, relative humidity (R.H.), wind speed, evaporation rate and total rainfall etc. were recorded during crop season from meteorological observatory located at student Instructional Farm of the university.

The main plot treatments consisted of three sowing dates (October 25, November 10 and December 5) and the sub-plot treatments consisted of three varieties (Varuna, Kranti, Pusa Bold). The soil of experimental field was clay to clay loam with pH 6.7, low in available nitrogen (262 kgha-1), rich in available P2O5 (23.9 kg ha-1), medium in available K2O (260 kg ha-1) and organic carbon (5.5.0 g kg-1). The recommended doses of nitrogen (80 kg N ha-1), phosphorus (60 kg P2O5 ha-1) and potassium (40 kg k2O ha-1) along with sulphur (20 kg S ha-1) were applied. The mustard crop was sown in lines 30 cm apart drawn by *kudali* using a seed rate of 5 kg ha-1. All other agronomic and plant protection measures were applied as per recommendations. Five plants from each plot were uprooted at fifth true leaf exposed, first flower opened, lowest pod more than 2 cm long, most seeds green and fully ripened seeds (maturity) avoiding border effects. The plants were divided into different parts *viz*., leaves, stem and siliquae (if present). The samples were then allowed to sundry for 2-3 days. Thereafter, the samples were oven dried at 60 °C for 72 hours and weighed by electronic balance. The biomass partitioning among different parts was then converted to gram per plant (g plant-1). Based on biomass of different plant parts, the total biomass accumulation was obtained. Yield attributes were recorded from the five plants sample collected at the time of harvest. The crop harvested from net plot area was threshed after 4-5 days of sun drying and the seed yield of net plot was then converted into kg ha-1. Before threshing of the crop harvested from net plot, the sun dried whole plant samples (biological yield) were weighed and stover yield was obtained by subtracting seed yield from biological yield. The seed oil content of all samples was determined by nuclear magnetic resonance spectrometer (NMR) (Robertson and Morrison, 1979) [10].

Results and Discussion

Entire Biomass and its sepration: Irrespective of treatments, the biomass partitioning towards leaves was higher as compared to stem at Six leaf exposed and first flower opened growth stages because the crop developed vegetatively during these stages and partitioning into siliqaue in the later growth stages when the crop entered the reproductive phase. Leaves and stem weight increased till end of reproductive phase and declined towards maturity. The decreased weight of vegetative organs after anthesis might be due to contribution of vegetative reserve to final grain yield. The allocation of biomass towards reproductive plant part/sink (siliquae) kept on increasing throughout life cycle of the plant and reached maximum at fully ripened stage (maturity).

Table 1: Effect of different treatments on total biomass and its partitioning (g plant^{-1}) at various growth stages:

Treatments	**Six true leaf exposed**			**First flower opened**		
Sowing Dates	Leaf	Stem	Total	Leaf	Stem	Total
20 Oct.	0.26	0.03	0.29	2.02	0.42	2.46
10 Nov.	0.28	0.05	0.33	2.35	0.49	2.84
5 Dec.	0.18	0.02	0.20	1.63	0.30	1.93
S.Em+	0.02	0.01	0.03	0.06	0.01	0.07
CD(P=0.05)	0.04	0.05	0.02	0.25	0.06	0.31
Varieties						
Varuna	0.19	0.04	0.21	1.60	0.31	2.03
Kranti	0.26	0.06	0.28	2.33	0.47	2.80
Pusa Bold	0.22	0.03	0.25	2.08	0.40	2.81
S.Em+	0.01	0.03	0.01	0.12	0.11	0.12
CD (P=0.05)	0.03	0.07	0.02	0.36	0.04	0.38

Sowing dates affected distinctly the total biomass as well as its partitioning into different plantparts. At all growth stages, the crop sown on November 10 resulted into significantly higher total plant biomass as well as its partitioning into different parts as compared to Octover 25 and December 5 sown crops. At Six true leaf exposed and first flower opened growth stages, November 10 sown crop resulted into significantly higher total biomass as well as its partitioning into leaves and stem followed by October 25 and December 5 sown crops. However, biomass partitioning into stem was found nonsignificant between October 25 and December 5; and between Octover 25 and December 5 sown crops (Tables 1). Similarly, at lowest pod more than 2 cm long and most seeds green growth stages, November 10 sown crop also exhibited significantly higher total biomass and its partitioning into leaves, stem and siliquae followed by Octover 25 and December 5 sown crops, except biomass partitioning into stem at lowest pod more than 2.2 cm long growth stage where October 25 and December 5 sown crops did not differ significantly (Table 2). At fully ripened growth stage, November 10 sown crop also recorded significantly higher total biomass (48.1 g plant-1) and its partitioning into stem (23.2 g plant^{-1}) and siliquae (25.9 g plant-1) followed by Octover 25 and December 5 sown crops. However, biomass partitioning into siliquae between October 25 and December 5; and between Octover 25 and December 5 sown crops did not differ significantly (Table 2). The reduction in total dry matter accumulation and its partitioning to various plant parts under delayed sowing could be attributed to unfavourable temperature and sunshine hours during crop growing season. The increased temperatures during late reproductive phase under delayed sowings hastened the maturity and therefore, the crop duration was shortened and resulted into reduced dry matter production as well as lesser partitioning into different plant parts. Similarly, the sharp rise in temperature towards maturity resulted into transpiration losses and reduced growth rate, and consequently, reduction in the dry matter accumulation. Similar results were also reported by Singh and Singh (2002) [11] and Lallu *et al.* (2010) [7]. Correspondingly, low temperature during early and grand growth period resulted into reduced plant growth in terms of plant height, number of branches and leaf area index which ultimately affected the total dry matter production and its partitioning (Tobe *et al*., 2013) [12].

Table 2: Effect of different treatments on total biomass and its partitioning (g plant-1) at various growth stages.

Treatments	**Lowest Pod more than 2 cm Long**				**Max. green seed**			**Fully Ripened seed**			
Sowing Dates	Leaf	stem	Silique	Total	Leaf	Stem	Total	Leaf	Stem	Silique	Total
25 Oct.	3.36	5.40	0.23	8.50	3.36	20.3	18.5	40.5	19.2	21.4	43.1
10 Nov.	3.80	5.41	0.26	9.50	3.86	21.4	19.1	42.5	22.2	23.4	45.1
5 Dec.	2.71	4.54	0.15	0.15	2.17	18.5	16.5	36.5	18.3	19.4	36.8
S.Em+	0.03	0.14	0.01	0.15	0.02	0.2	0.3	0.4	0.3	0.7	0.6
CD(P=0.05)	0.15	0.61	0.01	0.63	0.12	0.5	1.2	1.5	1.3	3.2	2.4
Varieti.											
Varuna	2.36	4.80	0.16	7.55	2.50	17.9	15.7	39.8	17.8	20.5	39.1
Kranti	3.36	4.97	0.21	8.55	2.91	18.9	16.7	40.3	18.8	21.3	40.1
P. Bold	2.71	4.44	0.17	7.46	2.16	17.4	15.9	36.4	18.2	19.4	37.7
S.Em+	0.03	0.14	0.01	0.16	0.02	0.3	0.4	0.5	0.3	0.7	0.8
CD(P=0.05)	0.15	0.61	0.01	0.63	0.12	0.05	1.3	1.6	NS	NS	2.6

In general, *cv*. Kranti led to record higher total biomass and it's partitioning into different plant parts *viz*., leaves, stem and siliquae followed by *cvs*. Varuna and Pusa Bold at all growth stages (Tables 1 and 2). At six leaf exposed growth stage, produced significantly higher total biomass as well as its partitioning into leaves and stem followed by *cvs*. Varuna and Pusa Bold. However, biomass partitioning into stem between *cvs*. Pusa Bold and Varuna did not differ significantly. Similar trend was also observed at first flower opened growth stage except total biomass and its partitioning into leaves between *cvs*. Pusa Bold and Varuna did not differ significantly. At lowest pod more than 2 cm long and most seeds green growth stages, *cv*. Kranti produced significantly higher total biomass and its partitioning into leaves, stem and siliquae followed by *cvs*. Varuna and Pusa Bold. However, biomass partitioning into stem between *cvs*. Pusa Bold and Varuna was found non-significant. Similarly, biomass partitioning into siliquae between *cvs*. Pusa Bold and Varuna; and Kranti at most seeds green stage was also found non-significant. At fully ripened growth stage, *cv*. Kranti exhibited significantly higher total biomass followed by *cvs*. Varuna and Pusa Bold. However, biomass partitioning into stem and siliquae did not differ significantly among different varieties. Similarly, total biomass production between *cvs*. Pusa Bold and Varuna also did not differ significantly. The differences in dry matter production among varieties could mainly be attributed in their genetic constitutions (Kumar *et al.*, 2008) [6].

Table 3: Effect of different treatments on yield attributes, yield and oil content of Indian mustard

Sowing Dates	**No. of silique (Plant^{-1})**	**No Of seeds (siliquae^{-1})**	**1000 seed weight (g)**	**Seed Yield (Kg^{-1})**	**Stover Yield (Kg^{-1})**	**Biological Yield**	**Harvest Index**	**Oil content (%)**
25 Oct.	185.4	12.3	5.73	1595	4362	5960	27.2	40.1
10 Nov.	198.8	13.1	6.17	2009	4889	6893	29.5	42.5
5 Dec.	153.6	11.3	5.41	1225	4061	5285	23.1	38.2
S.Em+	5.4	0.4	0.07	73	129	186	0.31	0.31
CD(P=0.05)	22.0	NS	0.31	293	516	753	1.13	1.14
Varieti.								
Varuna	163.3	11.2	4.95	1387	4344	5753	38.5	38.6
Kranti	196.4	13.6	6.39	1805	4827	6629	40.5	40.2
P. Bold	178.1	12.3	6.00	1635	4137	5776	42.0	41.0
S.Em+	5.3	0.3	0.07	88	271	332	0.35	0.35
CD(P=0.05)	16.7	1.0	0.28	276	NSS	NS	1.12	1.12

Data (Table 3) reveal that seed (2009 kg ha-1), stover (4889 kg ha-1), biological yield (6893 kg ha-1) and harvest index (29.5%) were recorded significantly higher under November 15 sown crop followed by Octover 25 and December 5 sown crops.

Consecutive 20 days delay in sowing from October 25 to November 10 and December 5 caused a loss in seed yield by 20.5 and 39.1%., respectively. The higher seed yield under November 10 sowing might be attributed to improved yield attributing characters *viz*., number of siliqua plant-1 and 1000-seeds weight. The favourable effect of early sowing (October 25) on sink component could be attributed to better development of the plants leading to increased bearing capacity due to optimum growth on account of favourable environmental conditions (Kumari *et al*., 2012) [5]. The reduction in seed yield under delayed sowing could be due to less translocation of current photosynthates towards reproductive parts, rapid initiation of inflorescence, flowering, fruiting and maturity, less number of siliquae and less siliqua filling duration because of non-fulfilment of Temperature demands under late sowings. High temperatures and long days accelerated rapid maturity and lower the seed yield (Mondal *et al*., 2011) [8]. Islamand Choudhary (2002) [4] also mentioned that mustard plants under later sowings more rapidly fulfill the low temperature requirement to initiate earlier inflorescence and flowering. But early inflorescence restricts leaf production resulting in small plant, fewer pods bearing branches and finally low dry matter yield. As the level of dry matter in plants decide the yield potential and seed yields from late sown crops are greatly affected. Similarly, reduction in stover and biological yields under delayed sowing also occurred primarily due to the decreased in growth characters in terms of plant height, LAI and lower biomass buildup plant-1 (data not given). The slower growth on account of lower temperature during early vegetative growth phase and the overall shorter life span of crop caused reduction biomass production (Tobe *et al*., 2013) [12]. The significantly higher harvest index under early sowing of November 15 was due to proper vegetative growth and better and faster transfer of photosynthetic substances from source to the sink, and it consequently causes an increase in the yield and harvest index in early planting dates which was in accordance with the research of Kumari *et al*. (2012) [5]. Among different varieties, Kranti produced significantly higher seed yield (1805 kg ha- 1) followed by *cvs*. Varuna (1635 kg ha-1) and Pusa Bold (1387 kg ha-1). However, *cvs*. Kranti and Varuna were found non-significant. Cultivar Kranti recorded 29.5% and 8.26% higher seed yield over Pusa Bold and Varuna, respectively. The higher seed yield in *cv*. Kranti was ascribed due to improved yield attributes *viz*., more number of siliqua plant-1, more number of seeds (siliqua-1) and 1000- seeds weight. The varietal differences in seed yield had also been reported by Adak *et al.* (2011) [1] and Kumari *et al.* (2012) [5]. Varieties were failed to affect stover yield and biological yield significantly. The cultivar Kranti recorded significantly higher harvest index followed by *cvs*. Pusa Bold and Varuna. However, *cvs*. Kranti and Pusa Bold were at par. The varietal differences in harvest index had also been reported by Kumari *et al.* (2012) [5].

Oil content: November 15 sown crop exhibited significantly higher content of oil (42.5%) followed by Octover 20 (40.5%) and December 5 (38.1%). The longer duration of reproductive phase under October 20 sowing had a positive influence on the development of seed and therefore, increased oil content (Tobe *et al*., 2013). Among different varieties, Varuna recorded significantly higher oil content (42.0%) followed by *cvs*. varuna (40.1%) and Pusa Bold (38.5%). The differences in oil content among different varieties could be attributed to their genetic constitution (Fasi *et al*., 2012) [3]. It may be concluded from the study that the planting date of October 20 as compared to Octover 25 and December 15 enjoyed a significantly higher yield. Likewise, oil content was also higher under 10 November sown mustard crop. Among varieties, Kranti was found to be most suitable for agro-climatic condition of Kanpur U.P. and exhibited 29.8 and 8.2% higher seed yield over *cvs*. Pusa Bold and Varuna, respectively.

Conclusion

The above research finding shows that the overall growth stages, the crop sown on November 10 resulted into significantly higher total plant biomass as well as its partitioning into different parts as compared to Octover 25 and December 5 sown crops. At Six true leaf exposed and first flower opened growth stages, November 10 sown crop resulted into significantly higher total biomass as well as its partitioning into leaves and stem followed by October 25 and December 5 sown crops. However, biomass partitioning into stem was found nonsignificant between October 25 and December 5; and between Octover 25 and December 5 sown crops (Tables 1). Similarly, at lowest pod more than 2 cm long and most seeds green growth stages, November 10 sown crop also exhibited significantly higher total biomass and its partitioning into leaves, stem and siliquae followed by Octover 25 and December 5 sown crops, except biomass partitioning into stem at lowest pod more than 2.2 cm long growth stage where October 25 and December 5 sown crops did not differ significantly (Table 2). At fully ripened growth stage, November 10 sown crop also recorded significantly higher total biomass (48.1 g plant-1) and its partitioning into stem (23.2 g plant^{-1}) and siliquae (25.9 g plant-1) followed by Octover 25 and December 5 sown crops. However, biomass partitioning into siliquae between October 25 and December 5; and between Octover 25 and December 5 sown crops did not differ significantly. The significantly higher harvest index under early sowing of November 15 was due to proper vegetative growth and better and faster transfer of photosynthetic substances from source to the sink, and it consequently causes an increase in the yield and harvest index in early planting dates which was in accordance with the research of Kumari *et al*. (2012) [5]. Among different varieties, Kranti produced significantly higher seed yield (1805 kg ha- 1) followed by *cvs*. Varuna (1635 kg ha-1) and Pusa Bold (1387 kg ha-1). However, *cvs*. Kranti and Varuna were found non-significant.

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