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Research Article

Effect of Sowing Dates and Crop Geometry on Total Plant Dry Matter, Oil Content and Yield of Indian Mustard

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ABSTRACT

Field experiment was conducted at Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture, Tikamgarh (Madhya Pradesh), India during rabi season of 2015-16 to study the effect of sowing dates and planting geometry on growth, yield attributes and yield of Indian mustard var. RGN-73. The experiment was carried out in split plot design with 3 sowing dates viz., 20 October, 2015, 30 October, 2015 and 09 November, 2015, and 5 planting geometry viz., 45 cm x 30 cm, 45cm x 15 cm, 30 cm x 30 cm, 30 cm x 20 cm and 30 cm x 10 cm as main plot and sub-plot treatments, respectively. Among different sowing dates, crop sown on October 20 resulted into significantly greater plant height (cm), more number of branches(plant-1), higher leaf area index and higher total plant dry biomass (g plant-1) followed October 30 and November 09 sown crops. Similarly number of siliquae (plant-1), 1000-seed weight (g), seed yield (kg ha-1), stover yield (kg ha-1), biological yield (kg ha-) and harvest index were also significantly higher under October 20 followed by October 30 and November 09 sown crops. Consecutive 10 days deley in sowing from October 20 to October 30 and November 09 caused a loss in seed yield by 27.8 % and 40.7%., respectively. Among different planting geometries ,45cm x 30cm showed significantly more number of branches (plant-1) higher leaf area index and more total dry biomass (g plant-1) and the lowest with 30cm x 10cm.However, significantly greater plant height (cm) was recorded with planting geometry of 30cm x 10cm. Similarly, number of siliquae plant (plant-1), number of seeds (siliqua-1) and 1000 –seed weight (g) were also observed higher with 45cm x 30cm. However, seed yield (kg ha-1), biological yield (kg ha-1) and harvest index were recorded significantly higher with 30cm x 10cm as compared to other planting geometries.

Key words: *Planting geometries, Harvest index, Rapeseed-mustard*

INTRODUCTION

Rapeseed-mustard is the second most important edible oilseed in India after groundnut sharing 27.8% in the India's oilseed economy. Madhya Pradesh, occupying 0.75 million hectare area with 0.86 million tonnes production accounting 11 % and 10 % of the national rapeseed and mustard area and production, respectively during 2009–10.

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The average productivity of rapeseed and mustard in the Madhya Pradesh is 1147 kg ha-1[2]. Production potentiality of Indian mustard in Madhya Pradesh can be fully exploited with suitable agronomic practices and varieties. Among different agronomic practices, research findings have shown that sowing date is one of the most important agronomic factor and non-monetary input which pave the way for better-use of time and play an important role to fully exploit the genetic potentiality of a variety as it provides optimum growth conditions such as temperature, light, humidity and rainfall. Since the temperature and solar radiation play an important role in partitioning of biomass between various organs of plant which is related to, and often governed by phenological phase of the plant and the way in which a crop develops can affect the yield and this therefore an aspect with which agronomists are much concerned. Sowing at proper time allows sufficient growth and development of a crop to obtain a satisfactory yield and different sowing dates provide variable environmental conditions within the same location for growth and development of crop and yield stability. As 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[13]. Islam and Choudhary[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. 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.*[9] has also reported that the yield potential of different mustard varieties may differ under different NANDLAL PATEL, P.K. TYAGI *and* K.C. SHUKLA 414 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 METHODS

The field experiment was conducted at Research Farm, J.N.K.V.V., College of Agriculture, Tikamgarh (24° 43’ N latitude and 78° 49’ E longitude at an altitude of 358m above mean sea level), Madhya Pradesh during *rabi* 2015-16. The experiment was laid out in split-plot design with three replications. The main plot treatments consisted of three sowing dates (October 20, October 30 and November 09) and the sub-plot treatments consisted of five crop geometry (45 cm x 30 cm, 45cm x 15 cm, 30 cm x 30 cm, 30 cm x 20 cm and 30 cm x 10 cm). The soil of experimental field was clay to clay loam with pH 6.9, low in available nitrogen (266kgha-1), rich in available P2O5 (25.9 kg ha-1), medium in available K2O (255 kg ha-1) and organic carbon (5.0 g kg-1). The recommended doses of nitrogen (80 kg N ha-1), phosphorus (40 kg P2O5 ha-1) and potassium (20 kg k2O ha-1) along with sulphur (20 kg S ha-1) were applied. The mustard crop was sown in lines 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)[10].

RESULTS AND DISCUSSION

Total biomass

Irrespective of treatments, the biomass partitioning towards leaves was higher as compared to stem at fifth 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 (g plant-1) at various growth stages

Treatments	Fifth true leaf	First flower opened	Lowest pod more than 2 cm long	Most seeds green	physiological maturity
20 October	0.45	3.10	10.9	46.0	55.3
30 October	0.24	2.72	9.32	43.0	53.4
09November	0.20	2.30	8.33	40.0	49.0
S.Em±	0.04	0.20	0.11	0.86	0.16
CD(P=0.05)	0.10	0.58	0.32	2.45	0.45
45x30	0.34	3.62	11.1	50.6	62.7
30x30	0.32	3.37	10.6	44.9	58.8
45x15	0.31	2.75	9.05	42.6	53.7
30x20	0.28	2.01	8.65	40.4	46.1
30x10	0.24	1.77	8.15	36.5	41.6
S.Em±	0.02	0.33	0.18	0.79	0.42
CD(P=0.05	0.05	0.69	0.52	2.32	1.23

Sowing dates affected distinctly the total biomass At all growth stages, the crop sown on October 20 resulted into significantly higher total plant biomass as compared to October 30 and November 09 sown crops. At fifth true leaf exposed and first flower opened growth stages, October 20 sown crop resulted into significantly higher total biomass followed by October 30 and November 09 sown crops. Between October 30 and November 09 sown crops (Tables 1). Similarly, at lowest pod more than 2 cm long and most seeds green growth stages, October 20 sown crop also exhibited significantly higher total biomass followed by October 30 and November 09 sown crops. At fully ripened growth stage, October 20 sown crop also recorded significantly higher total biomass (67.0 g plant-1) and followed by October 30 and November 09 sown crops. 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[11] and Lallu *et al*.[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[12] in general, *cv*. 45cm x 30 cm led to record higher total biomass and followed by *cvs*.30cm x 30 cm and 45cm x 15cm at all growth stages (Tables 1). At fifth leaf exposed growth stage, 45cm x 30 cm produced significantly higher total biomass followed by *cvs*. 30cm x 30 cm and 45 cm x 15 cm Similar trend was also observed at first flower opened growth stage except total bioma. At lowest pod more than 2 cm long and most seeds green growth stages, *cv*. 45cm x 30 cm produced significantly higher total biomass followed by *cvs*.30cm x 30 cm and 45 cm x15cm. However, biomass partitioning into stem between *cvs*. 45cm x 30cm and 30cm x 30 cm was found non-significant. Similarly, biomass partitioning into siliquae between *cvs*. 45cm x 30cm and 30cm x 30 cm; and 45 cm x 15 cm and 30cm x 20 cm at most seeds green stage was also found non-significant. At fully ripened growth stage, *cv*. 45cm x 30cm exhibited significantly higher total biomass followed by *cvs*. 30cm x 30 cm and 45 cm x 15 cm. However, biomass partitioning into stem and siliquae did not differ significantly among different geometries. Similarly, total biomass production between *cvs*. 45cm x 30 cm and 30cm x 30 cm also did not differ significantly. The differences in dry matter production among geometries could mainly be attributed in their genetic constitutions[6].

Yield attributes and yield

Crop sown on October 20 resulted into significantly higher siliquae plant-1 (272.1) and 1000-seeds weight (5.04 g) followed by October 30 (190.4 and 4.79 g, respectively) and November 09 (142.6 and 4.74g, respectively) sown crops (Table 2). These may be attributed to favourable environmental effect on plant growth and development. However, all sowing dates were failed to show significant differences for number of seeds siliqua-1. Among different varieties, 45cm x 30cm produced significantly more number of siliquae (142.6 plant-1), number of seeds siliqua-1 (12.8) and 1000 seed weight (5.03 g) followed by *cvs*.30cm x 30 cm (212.3, 12.5 and 4.95 g, respectively) and 45cm x 15 cm (193.3, 12.1 and 4.95g, respectively). However, number of seeds siliqua-1 between *cvs*. 45cm x 30 cm and 30cm x 30cm; and between *cvs*. 45cm x 15cm and 30cm x 20cm were found non-significant. The geometrical differences in yield attributes among different geometries of *Brassica* species had also been reported by Kumar *et al*.[6].

Table 2: Effect of different treatments on yield attributes, yield and oil content of Indian mustard

Treatments	No. of siliqua (plant-1)	No.of seeds(siliquae-1)	1000-seed weight (g)	Seed yield (kg ha-1)	Stover yield (kg ha-1)	Biological yield (kg ha-1)	Harvest index (%)	Oil content (%)
20 October	272.1	12.5	5.04	1866	6695	8561	21.8	39.9
30 October	190.4	12.4	4.79	1347	4886	6233	21.6	38.4
09November	142.6	12.3	4.74	1107	4731	5837	19.1	37.2
S.Em±	7.07	0.25	0.07	49.2	162.3	244.0	0.56	0.44
CD(P=0.05)	20.1	NS	0.19	140.4	462.7	695.8	1.70	1.26
45x30	269.7	12.8	5.03	1266	4997	6262	20.1	40.8
30x30	212.3	12.5	4.95	1285	5050	6335	20.3	39.1
45x15	193.3	12.1	4.95	1456	5647	7103	20.6	38.5
30x20	183.9	12.2	4.81	1532	5773	7305	21.0	38.1
30x10	149.3	12.3	4.54	1660	5719	7380	22.2	36.0
S.Em±	7.96	0.28	0.06	57.4	271.0	322.6	0.52	0.66
CD(P=0.05	23.4	NS	0.17	168.6	NS	947.2	1.50	1.93

data (Table 3) reveal that seed (1866 kg ha-1), stover (6695 kg ha-1), biological yield (8561 kg ha-1) and harvest index (21.8%) were recorded significantly higher under October 20 sown crop followed by October 30 and November 09 sown crops. Consecutive 10 days delay in sowing from October 20 to October 30 and November 09 caused a loss in seed yield by 27.8% and 40.7%., respectively. The higher seed yield under October 20 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 20) 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[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-fulfillment of temperature demands under late sowings. High temperatures and long days accelerated rapid maturity and lower the seed yield[8]. Islam and Choudhary[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[12]. The significantly higher harvest index under early sowing of October 20 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*.[5]. 417

Oil content

October 20 sown crop exhibited significantly higher content of oil (39.9%) followed by October 30 (38.4%) and November 09 (37.2%). The longer duration of reproductive phase under October 20 sowing had a positive influence on the development of seed and therefore, increased oil content[12]. Among different geometries, 45cm x30cm recorded significantly higher oil content (40.8%) followed by *cvs*. 30cm x 30cm (39.1%) and 45cm x 15cm (38.5%). It may be concluded from the study that the planting date of October 20 as compared to October 30 and November 09 enjoyed a significantly higher yield. Likewise, oil content was also higher under October 20 sown mustard crop. Among geometries, 30cm x 10cm was found to be most suitable for agro-climatic condition of Tikamgarh (M.P.) and exhibited 27.8% and 40.7% higher seed yield over *cvs*.45cm x 30cm and 30cm x 30cm respectively.

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