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Anita Arya
Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar, U. S. Nagar, Uttarakhand, India

Anil Shukla
Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar, U. S. Nagar, Uttarakhand, India

Aaradhana Chilwal
Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar, U. S. Nagar, Uttarakhand, India

Correspondence
Anita Arya
Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar, U. S. Nagar, Uttarakhand, India

Effect of planting date and plant geometries on growth and yield of Indian mustard RH-749, under *tarai* conditions of Uttarakhand

Anita Arya, Anil Shukla and Aaradhana Chilwal

Abstract
A field experiment was conducted during the *rabi* season of 2016-17 at N.E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar (29^0 N, $79^0$29 E and at an altitude of 243.83 m) to study the effect of planting time and geometry on the growth, yield attributes, yield quality, and the economics of Indian mustard RH 749. The experiment consisting of 15 treatments, having three levels of planting date (14 Oct, 24 Oct and 03 Nov) in main plots and five planting geometries (30×10, 30×20, 30×30, 45×15 and 45×30 cm) in sub plot were studied in split plot design (SPD) with three replication. The growth parameters *viz*. plant population, plant height, dry matter accumulation, 50 per cent flowering and maturity ultimately yield influenced significantly by planting time and geometries. The crop sown on 14th October performed significantly better as compared to 24th October and 3rd November. Crop geometry of 30×10 cm recorded significantly higher seed yield (1925kg/ha) with better utilization of space, nutrients, water and sunshine resulting in higher dry matter translocation to yield components as compared to 30×20, 30×30, 45×15, 45×30 crop geometry.

Keywords: Planting geometry, date of sowing, mustard, growth, seed yield

Introduction
Plant based edible oils are indispensable in human diet, and also an important ingredient of several industrial products. India is one of the largest oilseeds producing countries in the world. Oilseeds are among the major crops that are grown in the country apart from cereals. In terms of acreage, production and economic value these crops are second only to food grains. India's vegetable economy is the fourth largest in the world, next to US, China and Brazil, accounting for about 14% of oilseeds area and 8.5% of world's oilseeds production. The oilseeds sector occupies a distinct position in the agriculture sector after cereal's sharing for 14% of the country's gross cropped area, accounting for 3% of the gross national product and 10% of the value of agriculture product. Rapeseed–mustard is a member of the *Brassicaceae* family, being the first in terms of oil production and second most important oilseed crop in India after soybean in terms of seed production, accounting for nearly 20-22% of total oilseeds produced in the country. Commonly known as *rai*, *raya* or *laha*, the plants of Indian mustard are tall (130-180 cm), erect and branched. Branching starts from axil of the fourth or fifth leaf with an angle varying from 10-40°. The plant normally bears long and tapering roots. The leaves are not dilated at the base and clasping as in case of rape, but are stalked, broad and pinnatified. The fruits (siliquae) are slender and 2.0-6.5 cm long strongly ascending or erect with short and stout beaks. It is a self-pollinated crop but cross-pollination may also take place upto some extent. Indian mustard (*Brassica juncea* L.) is predominantly cultivated in the states of Rajasthan, UP, Haryana, Madhya Pradesh, West Bengal, Gujarat, Asom and Bihar. It is also grown in some non-traditional areas of South India including Karnataka, Tamil Nadu and Andhra Pradesh.

The optimum sowing time of R&M in Northern India is the first fortnight of October but sowing of these crops gets delayed to November- first week of December particularly after cotton, maize, soybean and rice. Sowing of R&M either too early or too late has been reported to be unfavourable as the productivity gets reduced due to reduction in vegetative and reproductive phases (Hocking and Stapper, 2001; Robertson *et al*., 2004) [1, 2]. The detrimental effects of insects and diseases on canola yields, as well as the effect of delayed sowing on production cost, have been reported (Yousaf *et al*., 2002) [3]. Late sowings not only reduce the seed yield, but also decrease the oil levels in winter rapeseed (Pritchard *et al*., 2000) [4].

Besides this the competitive ability of rapeseed-mustard plant depends greatly upon the density of plants per unit area and the soil fertility status. The optimum plant population density/unit area varies with the environment, the genotype, the seeding time and the season. In oilseed rape, row spacing or plant density varies considerably worldwide, depending on the environment, production system and cultivar. Plant density in rapeseed governs the components of yield, and thus the yield of individual plants. A uniform distribution of plants per unit area is a prerequisite for yield stability (Diepenbrock, 2000) [5]. Hence, finding out the optimum planting time, it is also essential to select an appropriate plant geometry for obtaining the higher productivity to a great extent.

Material and Methods

The field experiment was conducted during *rabi* season of 2016-17 in the E_5 Block (Oilseed Agronomy Block) at Norman E. Borlaug Crop Research Centre (CRC) of G. B. Pant University of Agriculture & Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. The climate of Pantnagar is humid subtropical, which is a typical feature of *tarai* region. The climate is basically associated with hot summers, heavy rains in monsoon periods and cold winters. Winter extends from November to mid March. Usually the monsoon arrives in third week of June and continues until the end of September. The soils of *tarai* have been developed from calcareous, medium to coarse textured materials under predominant influence of tall vegetation and moderately to well drain conditions. The experimental plot had silty clay loam soil and is classed as mollisol. The field experiment was laid out in Split Plot Design with three replications taking three planting dates (October 14, October 24 and November 3) as main plot treatment and five planting geometries (30×10, 30×20, 30×30, 45×15 and 45×30 cm) as sub-plot treatment. In totality there were 45 experimental plots of different treatment combinations.

Results and Discussion

Plant height and days taken to 50% flowering and maturity

Planting date and geometries significantly influenced the growth parameters and yield of Indian mustard RH-749.Plant population, at both the stages, was non-significant under different planting times. The crop sown on 14 Oct resulted in maximum plant population followed by 24 Oct and 03 Nov sown crop. Among the planting geometries, the plant population under 30×10 cm was significantly more over rest of the planting geometries at initial stage as well as maturity. At initial stage of crop growth, 30 cm × 10 cm plant geometry resulted in a maximum plant population (333209) followed by 30 cm × 20 cm (166370) and 45 cm × 15 cm (147950) while the wider spacing of 30 cm × 30 cm and 45 cm × 30 cm resulted in a lower plant population of 110987 and 73913, respectively.

Crop planted on 14 Oct took significantly more number of days to attain 50% flowering than the crop planted on 03 Nov, and did not differ significantly with the crop sown on October 24. For the first planting date the growing period was longer and weather conditions were also favourable as per the crop requirement, which deteriorated thereafter. Consequently the first sown crop attained a good vigour and growth characters as compared to that of the other planting dates.

Table 1: Effect of planting date and geometries on plant population and days taken to 50% flowering and maturity.

Treatment	Plant population (per hectare)		Days taken to	
Planting date	**Initial stage**	**At maturity**	**50% flowering**	**maturity**
14 October	162963	148889	78.1	143.8
24 October	155555	141481	74.2	138.2
03 November	138518	129629	69.2	129.9
S.Em±	4309	3313	1.2	2.7
CD (P=0.05)	16847	12952	4.6	10.5
Plant geometry (cm)				
30× 10	207407	188889	70.0	130.8
30× 20	188889	174074	71.8	134.0
30× 30	170370	155555	75.8	140.3
45× 15	103703	96296	73.9	137.3
45× 30	91357	81481	77.8	144.0
S.Em±	5317	4805	0.4	8.1
CD(P=0.05)	15520	14026	1.1	NS

Plant height

Significantly taller plants were produced in case of timely sown crop (14 Oct) at all the stages of crop growth. The differences, however, were not significant between the crops planted on 14 Oct and 24 Oct at 60 days and maturity stages. Delayed sowing (03 Nov) resulted in significantly shortest plant at all the stages of plant growth. Significant reduction in plant height with delay in sowing has also been reported by Khan and Tak (2002), Goyal *et al*. (2006) [6, 7]. Among the planting geometries, maximum plant height was recorded at 30 cm × 20 cm plant geometry which was significantly superior over wider geometries. The wider planting geometries of 45 cm × 15 cm and 45 cm × 30 cm resulted in lower plant height because of having more area between the plant rows showing more lateral expansion than the vertical one.

Dry matter accumulation

The dry matter accumulation, in general increased with advancement of crop age and attained its maximum at maturity. Planting dates and geometries had a significant influence on dry matter accumulation. The crop sown on 14 Oct, accumulated good amount of dry matter (66.7 g) being significantly more at all the stages of crop growth as compared to that under the other planting dates, while the crop sown on 03 Nov accumulated significantly lower dry matter (40.7 g) among all the planting dates. It might be because of higher uptake of N and a longer duration of crop growth, which is truly indicative to the total photosynthate production. Similar results have been reported by Sihag *et al*. (2003) and Dehghani *et al*. (2008) [8, 9]. Among all the planting geometries, 30 cm × 30 cm geometry accumulated the highest dry matter at all the stages of crop growth being significantly superior over that of 45 cm × 15 cm & 30 cm × 10 cm geometries at maturity but did not differ significantly with that of 45×30 cm geometry.

Tertiary branches

Sowing on the first planting date (14 Oct) produced significantly more number of tertiary branches over rest of the planting dates. The planting geometries had a significant influence over the number of tertiary branches too. The 45 cm × 30 cm geometry resulted in the maximum number of the tertiary branches which was significantly superior over the

other planting geometries. The more number of branches in case of 45 cm × 30 cm geometry could be attributed to more space available for individual plants.

Test weight (1000- seed weight)

The highest value of test weight (4.67) was recorded in 14 Oct sown crop being significantly superior over the delayed sowing. The crop sown on 14 Oct had a longer crop duration and produced more dry matter. Similar findings have also been reported by Singh *et al*. (2001) and Bhuiyan *et al*. (2000) [10, 11]. Among the various planting geometries, 45 cm × 30 cm utilized all the resources to its maximum owing to more area available for the growth and produced more weight of 1000-seeds. The geometry of 45 cm × 30 cm (4.76 g) outplayed significantly over rest of the other geometries except 30 cm × 30 cm. Kumari *et al.* (2012) [12] also reported similar results.

Biological Yield

The effect of sowing time was found significant on the biological yield. Biological yield reduced as the planting date got delayed from 14 Oct to 03 Nov. The crop sown on 14 Oct produced the highest biological yield of 7750 kg/ha which was significantly superior over the other planting date *i.e.* 24 Oct (6755 kg/ha) & 03 Nov (5678 kg/ha). At 30 cm × 10 cm plant geometry, the biological yield (7289 kg/ha) was significantly superior over that of the other planting geometries. The lowest biological yield was recorded at 45 cm × 30 cm (6062 kg/ha) plant geometry.

Table 2: Effect of planting date and geometries on growth and yield of Indian mustard RH-749.

Planting date	Plant ht (cm)	Dry matter (g)	Tertiary branches	1000 seed weight (g)	Biological yield(kg/ha)
14 October	197.8	66.73	4.7	4.67	7750
24 October	185.8	53.60	3.3	4.03	6755
03 November	148.6	40.67	2.7	3.38	5678
S.Em±	6.0	1.49	0.1	0.07	75
CD (P=0.05)	23.5	5.17	0.3	0.25	293
Plant geometry (cm)					
30× 10	179.8	54.11	2.8	3.37	7289
30× 20	188.5	60.22	3.2	3.50	7064
30× 30	180.7	57.33	4.0	4.45	6845
45× 15	172.0	51.56	3.7	4.07	6375
45× 30	166.0	45.11	4.3	4.77	6062
S.Em±	5.7	2.60	0.1	0.12	71
CD(P=0.05)	NS	7.61	0.4	0.35	208

Table 3: Interactive effect between planting time and geometry on biological yield of mustard, RH 749

Planting geometry (G) / Planting date (D)	30 × 10	30 × 20	30 × 30	45 × 15	45 × 30
14 October	7892	7967	8209	7500	7180
24 October	7037	7324	6918	6408	6085
03 November	6939	5902	5408	5215	4921
					CD(P=0.05)
To compare two levels of G at same level of D					361
To compare two levels of D at same or different levels of G					432

Interaction between the planting time and geometry was found to be significant on the biological yield of Indian mustard showed n table3. The crop sown on 14 Oct produced the highest biological yield with the plant geometry of 30 cm × 30 cm which was significantly superior over that of the wider geometries of 45 cm × 15 cm and 45 cm × 30 cm. With delay in sowing time, the closer plant geometries of 30 cm × 20 cm and 30 cm ×10 cm compensated for the reduction in biomass production on per plant basis and came up with more biological yields under 24 Oct and 03 Nov sown crops, respectively. The combination of 14 Oct sowing with 30 cm × 30 cm plant geometry recorded the maximum biological yield which was significantly superior the other combinations except 30 cm × 10 cm and 30 cm × 20 cm under 24 Oct sowing which did not differ significantly.

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