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Research Communication

Influence of sowing date and nitrogen schedule on growth and productivity of canola oilseed rape (*Brassica napus*)

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ABSTRACT

A field study was carried out at Ludhiana, Punjab during the winter (*rabi*) season of 2016–17, to ascertain the effect of dose and time of application of nitrogen on productivity of canola oilseed rape (*Brassica napus* L.) sown on different dates. The experiment was conducted on loamy sand soil low in organic carbon and available nitrogen, in a split-plot design in 3 replications with 3 sowing dates (15 October, 30 October and 15 November) in the main plots and 7 treatments of dose (100 and 125 kg/ha) and time of application of nitrogen (2 or 3 splits) in sub-plots. Variety 'GSC 7' was sown at row spacing of 45 cm, with plant spacing within row of 10–12 cm. Crop sown on 15 October required conspicuously lesser number of days for emergence, experienced longer crop duration, attained significantly better growth, showed increased number of yield attributes, seed and stover yields than that sown on 30 October which in turn significantly outperformed the crop sown on 15 November for various growth and yield traits and yields. The 15 October-sown crop gave (2.48 t/ha) 4.1% and 41.6% higher seed yield than 30 October- and 15 November-sown crop respectively. Application of 125 kg N/ha resulted in 11.9% higher seed yield (2.13 t/ha) than 100 kg N/ha through significant improvement in number of siliquae/plant and 1,000-seed weight. Effect of N application time on different growth and yield attributes was variable. Mean maximum seed (2.40 t/ha) and stover (7.92 t/ha) yields obtained with 125 kg/ha of N applied in 3 splits as 50 kg at sowing + 50 kg at initiation of stem elongation + 25 kg at initiation of flowering were at par with application of 125 kg/ha of N in 2 equal splits at sowing and initiation of stem elongation (2.36, 7.84 t/ha). Seed yield produced by the crop sown on 15 October (2.68 t/ha), 30 October (2.51 t/ha) and 15 November (2.02 t/ha) with 125 kg/ha of N applied in 3 splits (50 kg at sowing + 50 kg at initiation of stem elongation + 25 kg at initiation of flowering) was at par with its yield in respective sowing dates with application of 125 kg/ha of N (2.60, 2.46, 2.02 t/ha respectively) and 100 kg/ha of N (2.57, 2.46, 1.94 t/ha respectively) in 2 equal splits at sowing and at initiation of stem elongation.

Key words **:** Growth, Nitrogen dose, Oil, Oilseed rape, Sowing dates, Split application, Yield

Among different oils used for cooking, rapeseed–mustard oil is the major vegetable oil in India and the third major source in the world after soybean and oil palm. Seed meal after oil extraction is a rich source of protein for livestock including poultry. However, traditional cultivars of rapeseed–mustard contain high levels of erucic acid (>40%) in oil and glucosinolates (100–130 μM per g) in de-oiled seed meal which pose health-related risks in human being (thickening of arteries) and livestock (reduced appetite and reproductively, and affect thyroid activity leading to thyroid associated health problems (Van Etten *et al*., 1976). Canola cultivars of rapeseed–mustard, besides having similar low levels of saturated fatty acids (7–10%) and moderate levels of poly-unsaturated essential fatty acids (18–22% linoleic acid and 8–12% linolenic acid) in oil as that of non-canola cultivars, posses extremely low level of erucic acid (<2%), high level of mono unsaturated (oleic acid 60–65%) fatty acid in oil and low level of glucosinolates (< 30 μmoles per gram) in the seed meal as compared to non-canola cultivars (Stefansson *et al*., 1961; Downey, 1964). Thus, canola cultivars of rapeseed–mustard offer nutritionally superior oil and seed meal than non-canola cultivars. In India, high-yielding canola cultivars of oilseed rape have been developed very recently and are becoming popular owing to their superior quality of oil and meal, white-rust immunity and frost tolerance.

Knowledge of optimum sowing time of a cultivar is

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essential for better harmony between plant and prevailing weather conditions for efficient use of resources and to harness potential productivity. Amount and time of application of nitrogen (N) have signicant impact on yield, quality, and the N economy of oilseed crops. Plant N-use efficiency can be improved by matching application rate and timing with plant demands and its split application may ensure its availability during different developmental stages of plant (Grant *et al.,* 2012; Ma *et al.,* 2015). In India, N to rapeseed–mustard is applied in 2 equal splits at sowing and after first irrigation, i.e. before stem-elongation stage. The aim of the present investigation was to study the effect of dose and time of application of nitrogen on growth and yield of canola oilseed rape sown on different dates.

The field experiment was conducted at the research farm of the Punjab Agricultural University, Ludhiana, during the winter (*rabi*) season of 2016–17. Loamy sand soil of the experimental field was free from salts (electrical conductivity 0.55 dS/m) and neutral in reaction (*p*H 6.9), low in organic carbon content (0.28%) and potassium permanganate available N (171 kg/ha), rich in sodium bicarbonate-extractable available phosphorus (24.1 kg/ha) and low in ammonium acetate-extractable available potassium (75 kg/ha) at the depth of 0–15 cm. Treatments comprised 3 sowing dates (15 October, 30 October and 15 November) in the main plots and 7 treatments of dose (100 and 125 kg/ha) and time of application of N (2 or 3 splits) in subplots which were replicated thrice as per split-plot design. Variety 'GSC 7' was sown at row spacing of 45 cm with plant spacing within row of 10–12 cm maintained by thinning. Nitrogen as per treatments was applied through urea. Phosphorus @ 30 kg P_2O_5 and potassium @ 15 kg K_2O were applied at sowing in the form of single superphosphate and muriate of potash respectively. Gross plot size was 20.25 m^2. Plant height, number of branches/plant and siliquae/plant were recorded from 10 randomly selected plants at maturity. For dry-matter accumulation (DMA), plants from 0.5 m row length from second outermost row on either side of each plot were cut at the base, dried first under shade and later in oven at 65^cC till constant weight. At maturity, 25 siliquae/plant were collected at random, hand-threshed and total number of seeds in them were counted and averaged to give number of seeds/siliqua.

Delay in sowing from 15 October to 30 October and further to 15 November took significantly more number of days for emergence but significantly lesser number of days for physiological maturity (Table 1). Early-sown crop experienced more favourable temperature and longer day length for emergence and subsequent growth as compared to delayed sowing which experienced lower maximum and minimum temperatures and reduced number of sunshine hours which slowed down the process of emergence and growth. The mean temperature during the week following 30 October sowing was 3.4°C lower than 15 October-sown crop (25.3°C). Similarly, mean temperature during the week following 15 November sowing was 2.7°C lower than 30 October sowing date. In a earlier study, at the same location, Ethiopian mustard (*Brassica carinata*) sown on 10 October and 30 October took lesser number of days for completion of emergence than 20 November and 10 December sown crop (Singh and Dhingra, 2003). Crop sown on 15 October took 3.8 more days than 30 October-sown crop which took 5.8 days more than 15 November-sown crop to attain physiological maturity. Increase in temperature and sunshine hours and reduction in relative humidity from mid-February onwards reduced the reproductive period and overall crop duration of late-sown crop in comparison to early-sown crop. Dry matter accumulation (DMA) at 80 days after sowing (DAS) by crop sown on 15 October (5.33 t/ha) was significantly more than 30 October (4.32 t/ha) and 15 November - (3.86 t/ha) sown crop. Similarly, 15 October-sown crop attained significantly more plant height at maturity, number of primary and secondary branches/plant than the crop sown on 30 October (12.1%, 9.1%, 35.0% respectively) and 15 November (19.7%, 15.4%, 44.6% respectively) except in number of primary branches/plant in 30 October-sown crop over 15 November-sown crop (Table 1). Optimum weather conditions during early sowing prolonged the vegetative growth phase and might have led to more meristematic cell-division. The reduction in plant height and branching under late-sown conditions could be due to slow pace of growth throughout growth period.

Crop sown on 15 October gave significantly more siliquae/plant, seeds/siliqua, 1,000-seed weight, seed and stover yields than the crop sown on later dates (Table 1). Siliqua directly contributes to seed yield. The number of siliquae per plant produced by 15 October (529) and 30 October - (507) sown crop was significantly (36.4% and 30.7% respectively) more than 15 November-sown crop. Seeds/siliqua (22.3) and 1,000-seed weight (4.77 g) produced by the crop sown on 15 October were significantly more than that on 30 October and 15 November. Extended growth period under early sowing contributed to better development of siliqua to accommodate more number of seeds than late-sown crop.

Crop sown on 15 October gave 4.1% more seed yield (2.48 t/ha) and 27.3% more stover yield (9.46 t/ha) than that on 30 October, whereas the crop sown on 15 October and 30 October outyielded 15 November-sown crop for seed yield by margin of 41.6% and 36.1% respectively and for stover yield by margin of 73.7% and 36.4% respec-

Table 1. Effect of sowing dates and nitrogen scheduling on growth and yield attributes, seed yield, stover yield and oil content of canola oilseed rape

Treatment	Days to		Dry-matter accumulation (t/ha) at 80 DAS	Plant height (cm) at maturity	Branches/plant		Siliquae/ plant	Seeds/ siliqua	1,000-seed weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Oil (%)
	Emergence	Maturity			Primary	Secondary						
Date of sowing												
15 October	7.7	141.4	5.33	187.0	6.0	8.1	529	22.3	4.77	2.48	9.46	39.1
30 October	8.9	137.6	4.32	166.8	5.5	6.0	507	20.7	4.10	2.38	7.43	39.6
15 November	10.2	131.8	3.86	156.2	5.2	5.6	388	19.5	3.78	1.75	5.44	38.1
SEm±	0.1	0.3	0.16	6.4	0.3	0.5	21	0.8	0.05	0.04	0.12	0.2
CD (P=0.05)	0.2	0.7	0.33	12.8	0.6	0.9	42	1.5	0.09	0.08	0.23	0.4
Dose (kg/ha) and time of application of nitrogen												
50* + 50**	8.8	135.2	4.46	173.7	5.8	6.6	475	20.4	3.94	2.32	6.94	39.5
25* + 75**	9.7	137.0	4.53	171.7	5.6	7.1	455	20.2	4.00	2.05	7.15	39.0
50* + 25** + 25***	8.8	136.0	4.35	166.8	5.3	6.1	463	21.5	4.13	2.01	7.40	38.7
25* + 50* + 25***	9.6	133.9	4.32	163.7	5.3	7.2	461	20.3	4.17	2.04	7.61	38.9
34* + 33** + 33***	8.9	136.8	4.36	173.9	5.3	6.0	444	22.4	3.97	2.22	7.31	38.9
62.5* + 62.5**	8.0	140.6	4.77	170.3	5.5	6.2	519	21.3	3.97	2.36	7.84	38.6
50* + 50** + 25***	8.8	139.1	4.72	170.2	5.9	6.9	506	20.0	4.17	2.40	7.92	39.1
SEm±	–	0.08	0.034	1.0	–	0.1	–	0.3	–	0.02	0.08	–
CD (P=0.05)	NS	0.5	0.210	6.0	NS	0.7	NS	1.6	NS	0.12	0.48	NS

*Sowing; **initiation of stem elongation; ***initiation of flowering

tively. This increase in seed yield in early-sown crop accrued from better growth, more number of siliquae/plant, seeds/siliqua and 1,000-seed weight as compared to delayed sowing. Early-sown (15 October) crop resulted in synchronous, faster and earlier flowering (61.1 DAS) and took lesser number of days for initiation to completion of flowering (14.6 days) in comparison to 30 October (72.3 DAS and 20.3 days respectively) and 15 November (78.6 DAS and 24.4 days respectively) sowing dates. On the other hand, the crop sown on 15 October had the longer reproductive phase (80.3 days) for utilization of assimilates, seed set and its development than 30 October (65.3 days) and 15 November (53.2 days) sowing dates. Prolonged duration of crop and congenial weather conditions for plant growth and development resulting in more dry-matter accumulation than the crop sown on later dates where growth duration was curtailed. Oil content in the crop sown on 30 October was significantly higher than that sown on 15 October and 15 November (Table 1) which may be attributed to reduced reproductive period of crop concomitant with higher temperature during oil synthesis in case of delayed sowing.

Number of days required for completion of emergence did not differ with dose (100 and 125 kg) and time of application (2 or 3 splits) of N (Table 1). Application of 125 kg N/ha (mean of its time of application) took 140 days and significantly delayed the physiological maturity by about 4 days in comparison to N application of 100 kg/ha (Table 1). Application of 125 kg N/ha in 2 equal splits– at sowing and initiation of stem elongation-significantly delayed the physiological maturity (140.6) than all the other treatments. Nitrogen application is known to promote cell-division and thus prolongs vegetative growth period and delays the maturity of plants.

The DMA with application of 125 kg N/ha in 2 equal splits–(4.77 t/ha) was at par with 125 kg N/ha applied in 3 splits – 50 kg at sowing, 50 kg at initiation of stem elongation and 25 kg at flowering initiation (4.72 t/ha) and significantly higher than all other treatments of N application (Table 1). Plant height attained by crop at maturity with application of N in 3 splits (100 kg/ha as 34 + 33 + 33 kg/ha or 125 kg/ha as 50 + 50 + 25) or in 2 splits (100 kg/ha as 50 + 50 or 25 + 75 kg/ha or 125 kg/ha as 62.5 + 62.5) at sowing and initiation of stem elongation was similar (170.3–173.9 cm). Application of one-fourth of the 100 kg/ha of N at flowering initiation resulted in significantly lower plant height (163.7 cm) than all the treatments of N scheduling indicating that the part of

N applied at flowering initiation was not utilized by the plant for its infrastructure build up, as the vegetative growth ceased with on set of flowering.

Nitrogen scheduling did not influence of primary branches, and siliquae/plant and 1,000-seed weight (Table 1). However, application of 100 kg N/ha applied as 25 kg at sowing + 50 kg at initiation of stem elongation + 25 kg at flowering initiation resulted in the highest number of secondary branches/plant (7.2). Mohapatra (1993) obtained highest number of branches/plant in *Brassica juncea* with 52.5 kg/ha N application in 2 splits as 25% at sowing + 75% at 21 DAS. Application of 125 kg N/ha in 2 equal splits resulted in the highest number of siliquae/plant (518.8), being 9.1–16.8% higher than application of 100 kg N/ha in 2 or 3 splits. Similarly, the number of seeds/siliqua increased with N dose (Table 1) probably due to better seed filling. The number of seeds/siliqua obtained with 100 kg N/ha applied in 3 splits (34 + 33 + 33 or 50 + 25 + 25 kg/ha at sowing, at initiation of stem elongation and initiation of flowering) or 125 kg/ha of N in 2 equal splits was statistically at par with each other. Increased dose and application of N at flowering initiation probably improved the assimilate availability to seeds for its better development.

Application of 125 kg N/ha resulted in 7.7, 11.5, 11.9 and 8.3% higher DM at 80 DAS, number of siliquae/plant, seed yield and stover yield (mean over N application) than that obtained with 100 kg N/ha (4.40, 460, 2.13, 7.28 t/ha, respectively). The maximum seed (2.40 t/ha) and stover (7.92 t/ha) yields obtained with 125 kg N/ha applied in 3 splits as 50 + 50 + 25 kg N/ha at sowing, initiation of stem elongation and initiation of flowering were at par with application of 125 kg N/ha of N in 2 equal splits (2.36, 7.84 t/ha). The seed yields obtained with above treatments was also at par with 100 kg N/ha of N in 2 equal splits at sowing and initiation of stem elongation (2.32 t/ha) and that of stover yields were at par with 100 kg N/ha in 3 splits as 50 + 25 + 25 (7.61 t/ha) or 25 + 50 + 25 kg (7.40 t/ha) at sowing, initiation of stem elongation and initiation of flowering and significantly higher than all other treatments of N application. Increased dose of N or its application at higher dose at early stage contributed to better growth, development and accumulation of more amount of assimilates for supply to sink at later stages for improvement in yield attributes and yields. Application of 125 kg N/ha when applied in 3 splits resulted in 6.5% higher seed yield than its application in 2 equal splits which might be owing to better seed development with increased number of splits of N. In general, N applied at sowing and initiation of stem elongation stage resulted in higher yield, whereas its application at flowering initiation did not benefit seed yield much. Reager *et al.* (2006) obtained the highest number of seeds/siliqua and seed yield of Indian mustard with application of 100 kg N/ha in 3 equal splits at sowing, 30 DAS and 60 DAS than application of its full dose at sowing or in 2 equal splits at sowing and 30 DAS. Earlier Jadhav *et al.* (1995) obtained higher seed yield of Indian mustard with application of 90 kg/ha of N as 25 kg at sowing + 75 kg at 30 DAS than its full dose at sowing or in 2 equal splits at sowing and 30 DAS. Mohapatra (1993) also reported similar beneficial effect of split application of N on seed yield of Indian mustard. The effect of N scheduling on oil content was non-significant (Table 1).

The interaction between dates of sowing and doses and time of application of N on seed yield was significant (Fig. 1). Crop sown on 15 October and 30 October gave significantly higher seed yield than 15 November-sown crop at all the treatments of N scheduling. Crop sown on 15 October gave higher but statistically similar seed yield with 30 October-sown crop except with application of 100 kg/ha of N as 25 kg at sowing + 75 kg at initiation of stem elongation when differences in seed yield were significant in favour of early sowing. Seed yield given by the crop sown on 15 October (2.68 t/ha), 30 October (2.51 t/ha) and 15 November (2.02 t/ha) with 125 kg N/ha applied in 3 splits (50 kg at sowing + 50 kg at initiation of stem elongation + 25 kg at initiation of flowering) was at par with its yield in respective sowing dates with application of 125 kg N/ha (2.60, 2.46, 2.02 t/ha respectively) and 100 kg N/ha of N (2.57, 2.46, 1.94 t/ha, respectively) in 2 equal splits at sowing and at initiation of stem elongation. In 15 November-sown crop, seed yields with 100 kg/ha in 2 equal splits at sowing and initiation of stem elongation or in 3 splits as 34 + 33 + 33 at sowing, initiation of stem elongation and flowering initiation and 125 kg/ha in 2 equal splits or in 3 splits as 50 + 50 + 25 were at par and significantly higher than all other treatments of N application time under this sowing date.

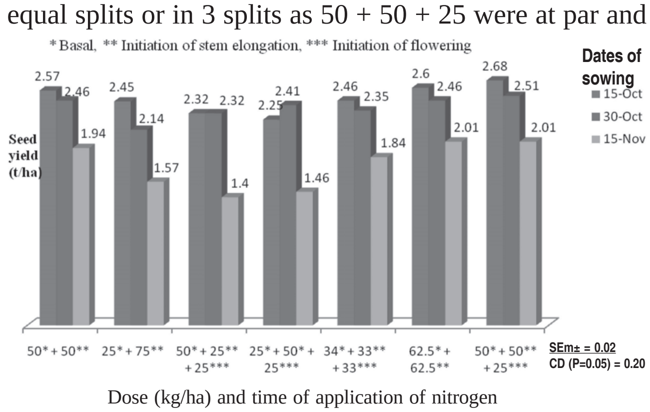

Fig. 1. Interaction effect of dates of sowing and dose (kg/ha) and time of applicaiton of nitrogen on seed yield (t/ha) of oilseed rape

This study revealed significant reduction in growth, duration, yield attributes and yield of canola oilseed rape with each fortnightly delay in sowing from 15 October to 15 November. Irrespective of sowing dates, application of 125 kg N/ha resulted in 11.9% higher seed yield (2.13 t/ha) than 100 kg/ha of N through significant improvement in number of siliquae/plant and 1,000-seed weight. Seed yields with application of 100 or 125 kg/ha of N in 3 splits at sowing, initiation of stem elongation and initiation of flowering (50 + 50 + 25 or 34 + 33 + 33) or in 2 equal splits at sowing and initiation of stem elongation 62.5+ 62.5 or 50 + 50) were at par.

REFERENCES

Downey, R.K. 1964. A selection of *Brassica campestris* L. Containing no erucic acid in its seed oil. *Canadian Journal of Plant Science* **44**: 295.

Grant, C., Wu, R., Selles, F., Harker, K.N., Clayton, G.W., Bittman, S., Zebarth, B.J. and Lupwayi, N.Z. 2012. Crop yield and nitrogen concentration with controlled release urea and split applications of nitrogen as compared to non-coated urea applied at seeding. *Field Crops Research* **127**(2): 170–180.

Jadhav, N.D., Jadhav, S.N. and Gangawane, S.B. 1995. Influence of irrigation, method and time of nitrogen application on growth, seed yield and water use of Indian mustard (*Brassica juncea*). *Indian Journal of Agronomy* **40**(1): 120–122.

Ma, B.L., Biswas, D.K., Herath, A.W., Whalen, J.K., Ruan, S.Q., Caldwell, C., Earl, H., Vanasse, A., Scott, P. and Smith, D.L. 2015 Growth, yield and yield components of canola as affected by nitrogen, sulphur and boron fertilization. *Journal of Plant Nutrition and Soil Science* **178**(4): 658–670.

Mohapatra, A.K. 1993. Response of late sown irrigated mustard (*Brassica juncea*) to levels of nitrogen and time of application in coastal Orissa. *Indian Journal of Agronomy* **38**(3): 496–497.

Reager, M.L., Sharma, S.K. and Yadav, R.S. 2006. Yield attributes, yield and nutrient uptake of Indian mustard (*Brassica juncea*) as influenced by nitrogen levels and its split application in arid western Rajasthan. *Indian Journal of Agronomy* **51**(3): 213–216.

Singh, A. and Dhingra, K.K. 2003. Effect of sowing time and planting density on phenology and growth of African sarson (*Brassica carinata* A. Braun). *Agricultural Science Digest* **23**(1): 157–161.

Stefansson, B.R., Hougen, F.W. and Downey, R.K. 1961. Note on the isolation of rape plants with seed oil free from erucic acid. *Canadian Journal of Plant Science* **44**(2): 218–219.

Van Etten, C.H., Daxenbichler, M.E., Williams, P.H. and Kwolek. W.F. 1976. Glucosinolates and derived products in cruciferous vegetables. Analysis of the edible part from twenty-two varieties of cabbage. *Journal of Agricultural Food and Chemistry* **24:** 452–455.