Journal Crop and Weed, 11(1):204-207(2015)

Performance of promising hybrids of Indian mustard (*Brassica juncea* L. Czern & Coss) under varying levels of nitrogen and row spacing

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Received: 28-01-2015, Revised:01-04-2015, Accepted:10-04-2015

ABSTRACT

A field experiment was conducted during the winter (rabi) season at the research farm of Punjab Agricultural University. Treatments consisted of two hybrids (PMH 128 and 145) and one variety RLC1 (check), three nitrogen levels (N_{100}, N_{125}, N_{150} kg ha^{-1}) and two row spacings (30 and 45 cm) evaluated in a split plot design. RLC 1 (check) registered significantly higher seed yield (17.68 q ha^{-1}) than PMH 145 (14.70 q ha^{-1}) and was statistically at par with PMH 128 (16.60 q ha^{-1}). Among the three doses of nitrogen, 150 kg ha^{-1} of N application produced highest seed yield (17.09 q ha^{-1}) which was statistically at par with 125 kg ha^{-1} of N (16.74 q ha^{-1}), however, significantly higher than 100 kg ha^{-1} of N (15.14 q ha^{-1}). Among the two row spacing, seed yield was significantly higher in 30 cm 17.01 q ha^{-1} as compared to 45 cm. Quality parameters (palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid) were found to be highest in RLC1 (check). Higher erucic acid content was observed in PMH 128 and PMH 145 as compared to RLC1 (check).

Keywords : Glucosinolate, nitrogen levels, oil content, siliquae

In India, rapeseed-mustard group of crops is grown in about 6.51 m ha with total production of about 7.67 million tones with an average productivity of 1,179 kg ha^{-1} (Kumawat *et al.*, 2014). Rapeseed-mustard is grown in about 29 states in country with the largest area under Rajasthan. In Punjab rapeseed-mustard is grown on an area of about 29 thousand hectares with a production of 37 thousand tones during 2013-14 with a productivity of 1,293 kg ha^{-1} (Anon., 2014). Among different *brassica* species, Indian mustard (*Brassica juncea* L. Czern & Coss) occupies a prominent position and is cultivated under diverse climatic and agro-ecological conditions in the country. The productivity is quite lower than developed countries mainly due to sub-optimal application of fertilizers and due to lack of high yielding hybrids (Tripathi *et al*., 2010). One of the major constraints is low productivity of this crop due to non adoption of recommended package of practices and situation specific improved varieties by most of the growers (Dutta, 2014). Indian mustard required high fertilizer requirements, therefore there is need to study the optimum dose of nitrogen for new hybrids and various agronomic practices are need to be studied to have maximum productivity and profitability. Variety RLC 1, which contains less than 2% erucic acid in the oil, is the first quality Indian mustard variety recently released in the state and is believed to gain popularity due to its heart friendly fatty acid composition. Different genotypes may differ in their response to different input factors, so present study was conducted to evaluate the effect of different nitrogen levels and spacing on the productivity and quality of Indian mustard hybrids.

The experiment was carried out at the research farm of oilseeds section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana during *rabi* 2009-10. The soil was loamy sand in texture, slightly alkaline, low in organic carbon, low in available nitrogen and medium in phosphorous and potassium. The study was conducted in split plot design with 2 hybrids (PMH 128 and PMH 145) and 1 variety (RLC1) as check in main plot and three doses of nitrogen (N_{100}, N_{125} and N_{150} kg ha^{-1}) and two row spacings (30 and 45 cm) as sub-plot treatments with three replications. Crop was sown on October 28 with a plot size of 5.0 x 4.5 m. Nitrogen was applied in two equal splits, first at the time of sowing and second after first irrigation and optimum plant population was also maintained by thinning and gap filling at 3 weeks after sowing by keeping plant to plant spacing of about 15 cm within rows. The oil content in seed was determined with Nuclear Magnetic Resonance (NMR) spectroscope (Newport Analyzer Model MK IIIA) by using non-destructive method of oil estimation as suggested by Alexander *et al.* (1967). Fatty acids in oil were trans-esterified and analyzed by Gas Liquid Chromatography using standard method of trans-esterification developed by Appleqvist (1968). Glucosinolates were estimated non-destructively on Foss NIR spectrophotometer 6500. Total glucosinolate content was expressed in micromole^{-1}g defatted seed meal.

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Yield attributes and yield

The yield attributes *viz.,* number of secondary branches plant^{-1}, number of siliquae plant^{-1}, number of seeds siliquae^{-1} and 1000-seed weight was significantly influenced by different treatments (Table1). Secondary branches plant^{-1} and siliquae plant^{-1} were found to be highest in RLC1 (check) and were statistically *at par* with PMH 128 and were significantly higher than PMH 145 but number of seeds siliquae^{-1} in the hybrids and RLC1 (check) was statistically similar. RLC1 (check) produced significantly higher 1000-seed weight (4.0 g) compared to PMH 128 (3.4 g) and PMH 145 (3.4 g) but PMH 128 and PMH 145 were found to be statistically similar in terms of 1000-seed weight. RLC 1 (check) produced higher seed yield (1768 kg ha^{-1}) which was statistically *at par* with PMH 128 (1660 kg ha^{-1}) but significantly better than PMH 145 (1470 kg ha^{-1}). The yield increase over PMH 128 by RLC 1 (check) was 6.5% and was statistically *at par* with it and 20.3% increase was there over PMH 145 and RLC 1 (check) was significantly better than PMH 145. However, increase in seed yield of 12.9% in PMH 128 over PMH 145 was inconspicuous. Higher seed yield recorded in RLC 1 (check) was due to various yield attributing

Table 1: Yield attributes, seed and stover yield and harvest index of Indian mustard as influenced by hybrids, doses of nitrogen and row spacing

Treatment	Number of secondary branches plant^{-1}	Number of siliquae plant^{-1}	Number of seeds siliquae^{-1}	1000-seed weight (g)	Yield (kg ha^{-1})		Harvest index (%)
					Seed	Stover	
Hybrids							
PMH 128	14.3	497.8	12.1	3.4	1660	6247	21.0
PMH 145	12.4	412.0	11.2	3.4	1470	6164	18.9
RLC 1 (check)	15.0	510.3	12.4	4.0	1768	6315	22.3
LSD (0.05)	**2.0**	**73.6**	**NS**	**0.4**	**2.19**	**NS**	**2.1**
Doses of nitrogen (kg ha^{-1})							
100	12.9	453.7	11.7	3.6	1514	5805	20.7
125	14.1	459.8	11.9	3.6	1674	6390	20.8
150	14.7	506.6	12.0	3.7	1709	6532	20.8
LSD (0.05)	**1.3**	**NS**	**NS**	**NS**	**1.05**	**3.39**	**NS**
Row spacing (cm)							
30	13.6	452.3	11.8	3.7	1701	6510	20.8
45	14.2	494.4	12.0	3.6	1564	5974	20.7
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**0.86**	**2.77**	**NS**

Table 2: Oil content, oil yield and glucosinolate content of Indian mustard as influenced by hybrids, doses of nitrogen and row spacing

Treatment	Oil content (%)	Oil yield (kg ha^{-1})	Glucosinolate content (mole.g^{-1} defatted meal)
Hybrids			
PMH 128	41.4	686	78.7
PMH 145	40.7	599	80.9
RLC 1 (check)	37.7	667	73.8
LSD (0.05)	**1.8**	**NS**	**5.1**
Doses of nitrogen (kg ha^{-1})			
100	40.5	612	74.4
125	40.0	668	78.0
150	39.4	672	81.0
LSD (0.05)	**NS**	**0.46**	**4.4**
Row spacing (cm)			
30	40.2	681	76.3
45	39.7	621	79.3
LSD (0.05)	**NS**	**0.37**	**NS**

characters like more number of branches plant^{-1} and siliquae plant^{-1} as compared to PMH 128 and PMH 145. Harvest index gives an indication about the amount of assimilates partitioned towards the developing reproductive and the vegetative parts. One of the most fundamental factors affecting this is the capacity to mobilize photosynthates to the plant organs having economic value. Harvest index of hybrids followed the pattern of seed yield. The highest harvest index was registered in RLC 1 (check) (22.3%) followed by PMH 128 (21.0%) and both these registered significantly higher harvest index than PMH 145 (18.9%).

Application of 150 kg ha^{-1} N resulted in significantly higher secondary branches plant^{-1} as compared to 100 kg ha^{-1} N but were found statistically similar with 125 kg ha^{-1} of N. Application of 150 kg ha^{-1} of N produced more number of siliquae plant^{-1} compared to 125 kg ha^{-1} and 100 kg ha^{-1} of N, however, such differences were non-significant. Similarly, number of seeds siliquae^{-1} and 1000-seed weight do not differ significantly for different doses of N application. The seed yield increased with increase in nitrogen levels up to 150 kg ha^{-1}. Highest seed yield (1709 kg ha^{-1}) was obtained with the application of 150 kg ha^{-1} of N, which was significantly superior over 100 kg ha^{-1} of N application (1514 kg ha^{-1}), however, it was statistically *at par* with 125 kg ha^{-1} N (1674 kg ha^{-1}). The increase in seed yield may be due to more number of branches plant^{-1}, siliquae plant^{-1} and 1000-seed weight with increase in doses of nitrogen. Similar increase in seed yield with an increase in N doses was also reported by other research workers (Yadav *et al*., 2007, Thakur *et al*., 2005).

The two row spacings 30 and 45 cm showed non-significant results for secondary branches plant^{-1}. Number of siliquae plant^{-1} were found to be highest in case of 45 cm as compared to 30 cm row spacing but the differences were found to be non-significant. Number of seeds siliquae^{-1} and 1000-seed weight also showed non-significant results for different row spacings. There was significant differences in seed yield with different row spacings. Higher seed yield was obtained with 30 cm (1701 kg ha^{-1}) row spacing as compared to 45 cm (1564 kg ha^{-1}) row spacing and seed yield at 30 cm row spacing was 8.8% higher than 45 cm row spacing. Inter row spacing of 30 cm produced significantly higher seed yield as compared with 45 cm because of higher population of plants m^{-2} in case of 30 cm row spacing than 45 cm row spacing. These results are in agreement with the findings of Gurjar and Chauhan (1997). Among the different row spacings (30 and 45 cm) results were found to be non-significant for harvest index.

Oil content and oil yield

Data presented in table 2 revealed significantly higher oil content in PMH 128 (41.4%) as compared to RLC 1 (check) (37.7 %) and was statistically *at par* with PMH 145 (40.75%). Hybrids and RLC 1 (check) do not differ significantly in oil yield but the highest oil yield was obtained in PMH 128 followed by RLC 1 (check) and PMH 145. With the increase in nitrogen doses, there was decrease in oil content but the differences was non significant with respect to different N doses. Highest oil content (40.5%) was obtained at 100 kg ha^{-1} of N and the lowest value was (39.4%) at 150 kg ha^{-1}. The oil content decreased by 2.79% from 100 kg ha^{-1} of N to 150 kg ha^{-1}

Table 3: Fatty acid composition of Indian mustard as influenced by hybrids, doses of nitrogen and row spacing

Treatment	Fatty acid composition (%)						
	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid	Eicosenoic acid	Erucic acid
	16:0	18:0	18:1	18:2	18:3	20:1	22:1
Hybrids							
PMH 128	3.2	1.9	20.7	20.3	11.9	8.9	33.2
PMH 145	3.8	1.8	23.9	21.3	12.3	10.1	27.5
RLC 1 (check)	4.6	4.1	42.6	26.0	15.4	4.5	2.6
LSD (0.05)	**1.0**	**0.6**	**3.8**	**4.3**	**2.8**	**0.5**	**8.4**
Doses of nitrogen (kg ha^{-1})							
100	4.1	2.8	29.5	21.5	12.9	8.4	20.6
125	3.8	2.5	28.9	22.3	14.0	7.4	21.5
150	3.6	2.4	28.8	23.9	12.8	7.6	21.2
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Row spacing (cm)							
30	3.7	2.5	28.8	22.5	13.1	8.2	21.2
45	3.9	2.7	29.3	22.6	13.3	7.5	21.0
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

of N application. Decrease in oil content with the increase in doses of nitrogen was also reported by Singh *et al.* (2008). With the increase in N doses, there was increase in the oil yield. Highest oil yield was obtained with the application of 150 kg ha^{-1} of N, but it was statistically *at par* with 125 kg ha^{-1} of N and was significantly better than 100 kg ha^{-1} of N application. Among the row spacings of 30 and 45 cm, differences were found to be non-significant for oil content but the significantly highest oil yield was obtained with 30 cm row spacing as compared to 45 cm row spacing.

Quality

Glucosinolate content presented in table 2 indicates that highest glucosinolate content was obtained in PMH 145 (80.9 m mole g^{-1} defatted meal) and which was statistically *at par* with PMH 128 (78.7 m mole g^{-1} defatted meal) and was significantly higher than RLC 1 (check) (73.8 m mole g^{-1} defatted meal). Among the different nitrogen doses, with the increase in N doses there was increase in glucosinolate content. Highest glucosinolate content was (81.0 m mole g^{-1} defatted meal) obtained with the application of 150 kg ha^{-1} of N and it was statistically *at par* with 125 kg ha^{-1} of N (78.0 m mole g^{-1} defatted meal) and was significantly higher than 100 kg ha^{-1} of N (74.4 m mole g^{-1} defatted meal). The glucosinolate content was increased by 8.9% with the increase in N doses from 100 to 150 kg ha^{-1}. Glucosinolate content showed non-significant differences with different row spacings (30 and 45 cm) but at 45 cm row spacing glucosinolate content was found to be slightly higher over 30 cm row spacing.

Palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid were found to be highest in RLC 1 (check) (Table 3), which was statistically *at par* with PMH 145 and significantly better than PMH 128 for palmitic acid. Stearic acid, oleic acid, linoleic acid and linolenic acid were significantly higher in RLC 1 (check) as compared to PMH 128 and PMH 145. Eicosenoic acid was significantly higher in PMH 145 as compared to PMH 128 and RLC 1 (check), whereas, erucic acid was higher in PMH 128 and it was statistically *at par* with PMH 145 and was significantly higher than RLC 1 (check). Results were found to be non-significant among the various doses of nitrogen and different row spacing for fatty acid composition.

The highest seed yield in hybrids PMH 128, PMH 145 and RLC 1 (check) was obtained at 150 kg ha^{-1} of nitrogen which was statistically *at par* with 125 kg ha^{-1} of nitrogen and significantly higher than 100 kg ha^{-1} of nitrogen. Eicosenoic acid was significantly higher in PMH 145 but erucic acid was significantly higher in PMH 128 as compared to RLC 1 (check). Highest glucosinolate content was obtained in PMH 145 and it was statistically *at par* with PMH 128 and was significantly higher than RLC 1 (check).

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