Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 8 [2] January 2019 : 82-87

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Impact of varying fertilizer doses and crop geometry on yield attributes and economics of late sown Indian mustard (*Brassica juncea* L.) under Southern-Western Haryana conditions

Naveen Rathi*, Bikram Singh, V.S. Hooda, Harender and Mohammed Mohsin[1]
Department of Agronomy, CCS Haryana Agricultural University, Hisar-125004
[1]Department of Agronomy, MPUAT, Udaipur-313001
**Author for correspondence*- rathi.naveen93@gmail.com

ABSTRACT
A field experiment was conducted at Regional research station, Bawal (CCSHAU, Hisar) during 2015-16 to study the response of late sown Indian mustard (Brassica juncea L.) to varying fertilizer doses and crop geometry under Southern-Western Haryana conditions. Results revealed that application of 85% RDF, 100% and 115% RDF recorded significantly higher values of yield attributes like number of siliquae/plant, number of seeds/siliqua and 1000 seed weight over 70% RDF. Whereas wider crop geometry (25 cm x 25 cm) produced significantly higher number of siliquae/plant, number of seeds/siliqua and 1000 seed weight and seed yield/plant over narrow crop geometry (30 cm X 10 cm). Fertilizer doses (70%, 85%, 100% and 115% RDF) application in late sown Indian mustard significantly enhanced the seed, stover and biological yields but the difference was significant up to 85% RDF. While narrow crop geometry (25 cm x 15 cm) produced significantly higher seed, stover and biological yields over other crop geometry. Sowing of late sown Indian mustard at a crop geometry of 25 cm x 15 cm with fertilizer application of 85% RDF (68 kg N + 23.5 kg P_2O_5 + 17 kg K_2O + 34 kg S per hectare) fetched highest net monetary return and B-C ratio (Rs. 38518/ha and 2.18) followed by 25 cm x 15 cm with 100% RDF (Rs. 37802/ha and 2.14).
Keywords: Crop Geometry, RDF, Oilseeds

Received 21.09.2018 Revised 29.11.2018 Accepted 11.12.2018

INTRODUCTION

Oilseeds crops are the most important determinant of agricultural economy, next to cereals. India is the world's second largest edible oil consumer after china, meeting more than 50 percent of its annual requirements through imports. Rapeseed-mustard (*Brassica spp.*) is one of the most valuable oilseed crops of the world as well as India. Among the seven edible oilseeds cultivated in India, rapeseed-mustard contributes 28.6% in the total oilseeds production and ranks second after groundnut sharing 27.8% in the India's oilseed economy [11].

Rapeseed-mustard in the world is grown on an area of 33.64 million ha with a production and productivity of 62.84 million tones and 1856 kg/ha, respectively (FAO STAT, 2017). There was considerable increase in productivity of rapeseed- mustard from 405 kg/ha in 1966-67 to 1856 kg/ha in 2016-17. In India, rapeseed-mustard occupy 5.99 million ha area with production of 6.31 million tones and productivity of rapeseed-mustard in India1053 kg/ha is very less as compared to world's productivity 1856 kg/ha [2]. Rapeseed-mustard spared over India mainly distributed in states of Rajasthan, Haryana, Uttar Pradesh, and Madhya Pradesh. The current annual production of edible oilseeds in the country fulfils only about 50% of the domestic requirement and the deficit is bridged through massive imports costing huge amount of foreign exchange. With increasing population and improving purchasing power of people, the demand of edible oil in the country is increasing at the rate of 4-6% per annum [10]. Thus, there is need to boost the oilseed production in India as well as Haryana.

Indian mustard (*Brassica juncea* L.) is an important *rabi* oilseed crop of Haryana. Indian mustard (*Brassica juncea* L. Czern) belongs to family Cruciferae, genus *Brassica* and species *juncea* popularly known as rai and cultivated as a cold weather crop. Its seed contains 37 to 49 per cent edible oil [12]. Under late sown condition, productivity declines primarily due to the shortening of vegetative and reproductive phase. Late sown Indian mustard is exposed to high temperature coupled with high evaporative demand of the atmosphere during the reproductive phase (ripening and grain filling) which consequently results in forced maturity and ultimately low productivity. High temperature in *Brassica* caused flower abortion with appreciable loss in seed yield [1]. Higher doses of fertilizer coupled with narrow crop geometry (inter and intra plant spacing) depleted more soil moisture as compared to lower doses of fertilizer in association with wider plant spacing. Temperature can't be manipulated easily under field conditions but by modifying fertilizer doses and crop geometry of late sown Indian mustard, soil moisture loss may be adjusted to meet out the evaporative demand of the atmosphere during reproductive phase.

The competitive ability of a rapeseed-mustard plant depends greatly upon the density of plants per unit area and soil fertility status [11]. Uniform distribution of crop plants over an area results in efficient use of nutrients, moisture, and suppression of weeds leading to high yield. In wider row spacing, solar radiation falling within the rows gets wasted particularly during the early stages of crop growth, whereas in closer row spacing upper part of the crop canopy may be well above the light saturation capacity but the lower leaves remain starved of light and contribute negatively towards yield. The dense plant population reduces the yield due to reduction in the photo- synthetically active leaf area caused by mutual shading [11]. The productivity of individual plant is limited under late sown conditions owing to poor growth and development. Hence, higher plant population may compensate for reduction in seed yield [5]. Late planted crop has low productivity due to restricted vegetative growth therefore, selection of appropriate spacing and management of fertilizer doses under late sown condition play an important role in enhancing mustard productivity [14].

MATERIAL AND METHODS

A field experiment was conducted at Regional Research Station of Chaudhary Charan Singh Haryana Agricultural University, Bawal in r*abi* (winter) season of 2015-16 located at 28º4' N latitude and 76º35' E longitude at an altitude of 266 meters above mean sea level. The average rainfall varies from 300-500 mm and the total rains as well as its distribution are subjected to great variations. The soil of experimental field was loamy sand in texture, slightly alkaline in reaction pH (7.5), low in organic carbon (0.46%), low in available N (105.16 kg/ha) and medium available P_2O_5 (10 kg/ha), K_2O (205 kg/ha). The experimental site had been used over the years for continuous Clusterbean- Indian mustard cropping. The field experiment comprising of 24 treatment combinations viz. four fertilizer dose F1: 80 % RDF, F2: 85 % RDF, F3: RDF (Recommended dose of fertilizer *i.e.* 80 kg N + 30 kg P_2O_5 + 20 kg K_2O + 40 kg S per hectare), F4: 115 % RDF as main plots and six crop geometry as sub plots viz. C1: 30 cm x 10 cm, C2: 25 cm x 15 cm, C3: 30 cm x 15 cm, C4: 25 cm x 20 cm, C5: 30 cm x 20 cm and C6: 25 cm x 25 cm as sub plot treatments was laid out in split plot design with three replications. In experiment gross plot size was 6.0 m x 3.0 m with net plot size 4.5 m x 2.0 m. Sowing of Indian mustard variety RH 9801 was done by using seed rates of 5.0, 4.0, 3.3, 3.0, 2.5 and 2.4 kg per ha in flat beds with the help of hand plough in rows as per treatments *i.e.* 30 cm x 10 cm, 25 cm x 15 cm, 30 cm x 15 cm, 25 cm x 20 cm, 30 cm x 20 cm and 25 cm x 25 cm (inter- row and intra-row plant spacing). Indian mustard variety RH 9801 was sown on 12 th November 2015 at the depth of 4 to 5 cm. The recommended dose of fertilizers as per CCSHAU package of practices were applied at the rate of 80 kg N/ha in the form of urea, 30 kg P2O5/ ha in the form of Diammonium phosphate, 20 kg K2O /ha in the form of Muriate of potash and 40 kg S/ha in the form of gypsum were applied to the crop. Half doses of nitrogen and full basal dose of phosphorus, potassium and sulphur as per treatments were applied at sowing. The remaining half dose of nitrogen was applied after first irrigation. Thinning was done at 21 days after sowing in order to maintain required spacing of plants within the row as per treatment (30 cm x 10 cm, 25 cm x 15 cm, 30 cm x 15 cm, 25 cm x 20 cm, 30 cm x 20 cm and 25 cm x 25 cm) to established plant population of 3.33, 2.66, 2.22, 2.00, 1.66 and 1.60 lakh plants/hectare, respectively. Total number of siliqua per plant was recorded from five tagged plant at harvest. Mean of five plants was recorded as the number of siliqua produced per plant. Seeds of five siliqua per plant from randomly five tagged plant from were recorded at harvest. Mean number of seeds of five siliqua per plant of five tagged plant was recorded as number of seeds per siliqua. The weights of thousands grains (g) was recorded from the grain sample drawn from the produced obtained from each of the net plot. Seed yield of five selected plants at harvest were calculated and their average as seed yield per plant (g). The entire produce from net plot was threshed, weighed and expressed as kg/ha. After proper drying and prior to threshing of harvested crop, the biomass yield comprising seed and straw per net plot under each treatment was recorded and expressed in kg/ha. Straw yield was worked out by deducting the seed yield from the total bundle weight from each plot. The harvest index for each plot was calculated by dividing the economic (seed) yield by the biological yield (seed + stover yield) of the same net plot and multiplied by 100. Total cost of cultivation for Indian mustard was calculated by taking into account the recommended package and practices and adding additional cost of treatment to each treatment. For calculating gross returns, seed and stover yield of individual/combination of treatment was taken into consideration. Net returns were calculated by subtracting cost of cultivation from gross returns. B-C ratio was calculated using following formula:

$$B : C = \frac{\text{Gross returns}}{\text{Cost of cultivation}}$$

Recommended package of practices was followed for all other operations. The data collected from the experiment subjected to statistically analyzed by the method of analysis of variance (ANOVA) as described by Panse and Sukhatme [8].

RESULTS AND DISCUSSION

Yield attributes and yields

Results of experiment revealed that all yield attributes like number of siliquae/plant, number of seeds/siliqua and 1000 seed weight were found to be successively increased for fertilizer doses (70%, 85%, 100% and 115% RDF). This might be also to the adequate supply of major plant nutrient under successive increased in fertilizer doses corroborative findings was Meena *et al.* [7] and Kumawat *et al.* [6]. However, application of 85% RDF, 100% and 115% RDF recorded significantly higher values for all of yield attributes over 70% RDF, but the difference among 85%, 100% and 115% RDF were found to be non-significant. Varying crop geometries had significant effect on 1000 seed weight. Wider crop geometry 25 cm x 25 cm *i.e.* 1.60 lakh plants/ha resulted into significantly higher 1000 seed weight over narrow spacing (30 cm x 10 cm *i.e.* 3.33 lakh plants/ha). Though, the differences in among different crop geometries of 25 cm x 15 cm, 30 cm x 15 cm, 25 cm x 20 cm, 30 cm x 20 cm and 25 cm x25cm were found to be non-significant with respect to 1,000- seed weight. Increasing plant spacing successively from closer crop geometries 30 cm x 10 cm (3.33 lakh plants/ha), 25 cm x 15 cm (2.66 lakh plants/ha), 30 cm x 15 cm (2.22 lakh plants/ha), 25 cm x 20 cm (2.00 lakh plants/ha), 30 cm x 20 cm (1.66 lakh plants/ha) to wider spacing 25 cm x 25cm (1.60 lakh plants/ha) caused significant increase in seed yield per plant of late sown Indian mustard. However, the differences between 30cm x 15 cm and 25 cm x 20 cm; and 30 cm x 20 cm and 25 cm x 25 cm were found to be non-significant in respect to the seed yield per plant. Wider crop geometry of 25 cm x 25 cm *i.e.* 1.60 lakh plants/ha resulted into significantly higher number of siliquae/plant, number of seeds/siliqua and seed yield/plant over narrow spacing (30 cm x 10 cm). This is presumably on account of more availability of nutrients, light, higher plant water and lesser competition among sinks (seeds) for source (photosynthates), which result better yield attributes. These findings are in accordance with those of Pyare *et al.* [9] and Kumari *et al.* [5].

Table 1: Effect of various treatments on yield attributes of late sown Indian mustard

Treatments	No. of sliquae/ Plant	No. of seeds/ Siliqua	1,000 seed weight (g)	Seed yield/ plant (g)
Fertilizer doses				
70% RDF	166.5	8.77	4.32	6.58
85% RDF	168.3	9.06	4.66	7.08
100% RDF	168.5	9.10	4.69	7.17
115% RDF	168.8	9.14	4.71	7.24
SEm	0.46	0.07	0.07	0.12
CD at 5%	1.64	0.24	0.23	0.41
Crop geometry				
30 cm x 10 cm	125.7	8.68	4.37	4.77
25 cm x 15 cm	158.7	9.03	4.49	6.44
30 cm x 15 cm	171.7	9.06	4.60	7.20
25 cm x 20 cm	174.6	9.07	4.68	7.40
30cm x 20 cm	186.4	9.12	4.71	8.01
25 cm x 25 cm	190.9	9.14	4.72	8.26
SEm	1.16	0.06	0.08	0.20
CD at 5%	3.34	0.16	0.25	0.59

Increasing levels of fertilizer doses increased the seed yield/plant (Table 2). Though, significant increase in seed yield per plant was observed up to 85% RDF over 70% RDF. Seed yield/plant increased from 70% to 115% RDF *i.e.* 6.58 to 7.24 g.

Application of 115%, 100% and 85% RDF increased in the seed yield to the tune of 10.5%, 9.8% and 7.6% respectively over 70% RDF. This can be attributed to increase in fertilizer doses which improved LAI and might have resulted in higher production of photosynthates and their translocation to sink (yield attributes), which results to the better yield attributes *viz.* number of siliquae/plant, number of seeds/siliqua, 1000 seed weight and seed yield/plant. The increase in seed yield and its attributes with increase in fertilizer doses have also been observed by Singh *et al.* [13] and Singh *et al.* [15]. Seed yield differed significantly under varying crop geometries (25 cm x 15 cm, 30 cm x 15 cm, 25 cm x 20 cm, 30 cm x 20 cm and 25 cm x25cm) respectively. Crop geometry (25 cm x 15 cm *i.e.* 2.66 lakh plants/ha) resulted into significantly higher seed yield over all other crop geometries under study. It produced 5.4%, 8.4%, 10.8%, 17.5% and 21.4% higher seed yield over crop geometry of 30 cm x 15 cm (2.22 lakh plants/ha), 30 cm x 10 cm (3.33 lakh plants/ha), 25 cm x 20 cm (2.00 lakh plants/ha), 30 cm x 20 cm (1.66 lakh plants/ha) and 25 cm x 25 cm (1.60 lakh plants/ha) respectively. Although the yield attributes per plant were better in case of wider spacing 25 cm x 25 cm but the yield per unit area was less because yield could not be compensated by loss in plant population as reported by Kumari *et al.* [5]. Application of 85% RDF recorded significantly higher stover and biological yields over 70% RDF, while the differences among 85%, 100% and 115% RDF were found to be non significant. This is due to fact that increased in fertilizer doses resulted in an increase in plant height, number of primary branches, dry matter accumulation per plant and LAI, respectively which ultimately resulted into increase in stover and biological yield. Harvest index was not significantly influenced by different fertilizer doses. Stover and biological yields under varying crop geometry differed significantly. Crop geometry (25 cm x 15 cm *i.e.*, 2.66 lakh plants/ha) resulted into significantly higher stover and biological yields over all other crop geometries under study. Closer spacing because of much higher number of plants per unit area resulted in higher stover as well as biological yield. Harvest index don't differ significantly under varying crop geometry.

Table 2: Effect of various treatments on Seed, Stover, biological yield and harvest index of late sown Indian mustard

Treatments	**Seed yield (Kg/ha)**	**Stover yield (Kg/ha)**	**Biological yield (Kg/ha)**	**Harvest Index (%)**
Fertilizer doses				
70% RDF	1240	3831	5071	24.4
85% RDF	1334	3936	5270	25.3
100% RDF	1362	4059	5421	25.1
115% RDF	1370	4071	5451	25.1
SEm	20	20	39	0.18
CD at 5%	70	69	139	NS
Crop geometry				
30 cm x 10 cm	1348	4128	5477	24.5
25 cm x 15 cm	1461	4326	5787	25.2
30 cm x 15 cm	1386	4146	5533	25.0
25 cm x 20 cm	1318	3928	5246	25.1
30cm x 20 cm	1243	3752	4995	24.8
25 cm x 25 cm	1203	3582	4785	25.0
SEm	21	23	44	0.21
CD at 5%	61	65	126	NS

Economics

It is evident from the data given in Table 3 that the net profitability (Rs./ha) and benefit-cost ratio (B-C ratio) from all the cop geometries (30 cm x 10 cm, 25 cm x 15 cm, 30 cm x 15 cm, 25 cm x 20 cm, 30cm x 20 cm and 25 cm x 25cm) under different fertilizer doses increased progressively from 70% RDF < 115% RDF < 100% RDF < 85% RDF, respectively.

Among various treatment combination, sowing of late sown Indian mustard at a crop geometry of 25 cm x 15 cm with fertilizer application of 85% RDF (68 kg N + 23.5 kg P_2O_5 + 17 kg K_2O + 34 kg S per hectare) fetched highest net monetary return and B-C ratio (Rs. 38518/ha and 2.18) followed by 30 cm x 15 cm with 85% RDF (Rs. 34551/ha and 2.06), 30 cm x 10 cm with 85% RDF (Rs. 32174/ha and 1.98), 25 cm x 20 cm with 85% RDF (Rs. 29934/ha and 1.92), 30 cm x 20 cm with 85% RDF (Rs. 29934/ha and 1.90) and 25 cm x 25 cm with 85% RDF (Rs. 27370/ha and 1.84) in diminishing order, respectively. It is obvious because of higher grain and stover yields under crop geometry of 25 cm x 15 cm along with application of 85% RDF as compared to other treatments combination which consequently resulted in higher net returns and benefit cost ratio.

Table 3: Economics of various treatment combinations

Treatments (Fertilizer doses x Crop geometry)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C
70% RDF with 30 x 10 cm	32260	61752	29492	1.91
70% RDF with 25 x 15 cm	32188	68710	36522	2.13
70% RDF with 30 x 15 cm	32141	65407	33266	2.04
70% RDF with 25 x 20 cm	32116	58730	26614	1.83
70% RDF with 30 x 20 cm	32081	57987	25907	1.81
70% RDF with 25 x 25 cm	32073	56104	24031	1.75
85% RDF with 30 x 10 cm	32819	64992	32174	1.98
85% RDF with 25 x 15 cm	32747	71264	38517	2.18
85% RDF with 30 x 15 cm	32699	67250	34551	2.06
85% RDF with 25 x 20 cm	32675	62609	29934	1.92
85% RDF with 30 x 20 cm	32639	62169	29530	1.90
85% RDF with 25 x 25 cm	32632	60002	27370	1.84
100% RDF with 30 x 10 cm	33377	65405	32028	1.96
100% RDF with 25 x 15 cm	33305	71107	37802	2.14
100% RDF with 30 x 15 cm	33258	66924	33666	2.01
100% RDF with 25 x 20 cm	33234	62811	29578	1.89
100% RDF with 30 x 20 cm	33198	62440	29242	1.88
100% RDF with 25 x 25 cm	33191	60413	27222	1.82
115% RDF with 30 x 10 cm	33936	65736	31800	1.94
115% RDF with 25 x 15 cm	33864	70798	36934	2.09
115% RDF with 30 x 15 cm	33817	67144	33327	1.99
115% RDF with 25 x 20 cm	33792	63044	29252	1.87
115% RDF with 30 x 20 cm	33756	62507	28750	1.85
115% RDF with 25 x 25 cm	33749	60357	26608	1.79

CONCLUSION

Thus it is concluded from the above finding that application of 85% RDF, 100% and 115% RDF recorded significantly higher values for all of yield attributes (number of siliquae/plant, number of seeds/siliqua and 1000 seed weight) over 70% RDF. Crop geometry of 25 cm x 15 cm (2.66 lakh plants/ha) with 85 % RDF was found optimum for late sown Indian mustard in order to gain higher net returns and benefit : cost ratio under southern-western Haryana conditions.

REFERENCES

1. Alam, M.M., Begum, F. and Roy, P. (2014). Yield and yield attributes of rapeseed- mustard (*Brassica*) genotypes under late sown condition. *Bangladesh Journal Agrcultural Research,* 3**9(2)**: 311-336.
2. Anonymous. 2016. http,//www.indiastat.com/agriculture/2.
3. DRMR. (2017). Vision 2050. Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan.,2. http,//www.icar.org.in/vision%202050 %20DRMR% 20Rajasthan.pdf
4. FAO STAT. 2017. Prospects for Food, Nutrition, Agriculture and Major Commodity Groups. www.fao.org/ docrep/009/a0607e/a0607e00.htm
5. Kumari, A., Singh, R.P. and Yashpal. (2012). Productivity, nutrient uptake and economics of mustard hybrid (*Brassica juncea*) under different planting time and row spacing. *Indian Journal Agroonomy* **57:** 61-67.
6. Kumawat, A., Pareek, B.L., Yadav, R.S. and Rathore, P.S. (2014). Effect of integrated nutrient management on growth, yield, quality and nutrient uptake of Indian mustard (B*rassica juncea*) in arid zone of Rajasthan. *Indian Journal of Agronomy,* **59(1)**: 119-123.
7. Meena, D.S., Meena, V.R. and Meena, A.K. (2013). Fertilizer management studies on growth and productivity of hybrid Indian mustard *Brassica juncea* (L.). *Journal of Oilseed Brassica,* **4(1)**: 39-42.
8. Panse, U. G. and Sukhatme, P. V. 1978. Statistical methods for Agricultural Workers, ICAR, New Delhi.
9. Paraye, P., Kashyap, T.L. and Chaubey, A.K. 2009. Effect of nutrient management practices and row spacing on growth yield attributes and yield of Indian mustard (*Brassica juncea* L.). *Environment and Ecology,* **27(2)**: 589-591.
10. Rao M V (2009) Ways and means to reduce the supply demand gap of vegetable oil in India. Key note address delivered in the national symposium on "Vegetable oils scenario: approaches to meet the growing demand". Indian Society of Oilseeds Research, Directorate of Oilseed Research, Hyderabad. January 29-31, 2009. 8.
11. Shekhawat, K., Rathore, S. S., Premi, O.P., Kandpal, B. K. and Chauhan, J. S. 2012. Advances in agronomic management of Indian mustard (*Brassica juncea* L.), An overview.*International Journal of Agronomy*.

12. Singh, C., Singh, P. and Singh, R. (2009). Modern techniques of raising field crops. 2nd edition. Oxford and IBH publishing company private limited, New Delhi, 337.
13. Singh, Y., Singh, T., Singh, U.N and Rajput, P.K. (2010). Effect of nutrient management on yield, quality and economics of irrigated Indian mustard (*Brassica juncea*). *Indian Journal of Agricultural Sciences,* **80(8)**: 691-694.
14. Singh, S.K and Singh, G. 2002. Response of Indian mustard *(Brassica juncea*) varieties to nitrogen under varying sowing dates in eastern Uttar Pradesh. *Indian Journal of Agronomy,* **47**: 242-248.
15. Singh, R. Kumar, A. and Kumar, P. (2014). Performance of Indian mustard (*Brassica juncea* L.) in response to integrated nutrient management. *Journal of Agrisearch,* **1(1)**: 9-12.

CITATION OF THIS ARTICLE

Naveen Rathi, Bikram Singh, V.S. Hooda, Harender and Mohammed Mohsin. Impact of varying fertilizer doses and crop geometry on yield attributes and economics of late sown Indian mustard (*Brassica juncea* L.) under Southern-Western Haryana conditions. Bull. Env. Pharmacol. Life Sci., Vol 8 [2] January 2019: 82-87