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Effect of Nitrogen and Phosphorus Fertilization on the Growth and Yield of Mustard Under Irrigated Conditions in Agra District

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ABSTRACT

The present field experiment was conducted at Agricultural Research Farm of RBS College, Bichpuri Agra, during Rabi season of 2018-19. The soil of the experimental site is Gangetic alluvial. The experimental was laid out in RBD factorial having 3 main treatment (N level) and 4 sub treatments (P_2O_5 level) with 3 replications. All growth and yield attributing character increase with application of N @ 120 Kg^{-1} and P_2O_5 @ 60 kg^{-1}. All the yield components i.e., number of siliquae plant^{-1}, length of siliqua and number of seeds siliqua^{-1} improved with the increase in the level of nitrogen. Higher value of harvest index was associated with the application of 60 kg P_2O_5 ha^{-1}. Seed yield increased appreciably with every additional increase in the level of nitrogen. Respectively 26.85 and 40.05 per cent higher seed yield ha^{-1} was obtained with the application of 80 and 120 kg ha^{-1} nitrogen as compared to 40 kg ha^{-1}.

Key words: *Rapeseed/Mustard; NWPZ; Harvest index; Sustainable; Yield; Cropping.*

Rapeseed/Mustard growing countries in the world, occupying the first position in area and second position in production after China. The world production of rapeseed/mustard has been increasing at a rapid rate in several countries largely in response to the continuing increase in demand for edible oils and its products. Rapeseed/mustard crops in India are grown in diverse agro climatic conditions ranging from North-Eastern / North -Western hills to down south under irrigated/ rainfed, timely/late sown, saline soils and mixed cropping. The nutrient requirement of oilseed crops, in general, is very high for almost all the essential mineral nutrients which are to be supplied in adequate quantities (*Jat, et al., 2017*). The most important role of N in the plant is its presence in the structure of protein, the most important building substances from which the living material or protoplasm of every cell is made. In addition, nitrogen is also found in chlorophyll, the green colouring matter of leaves. Chlorophyll enables the plant to transfer energy from sunlight by photosynthesis. Therefore, the nitrogen supply to the plant will influence the amount of protein, protoplasm and chlorophyll formed. In turn, this influences cell size and leaf area, and photosynthetic activity (*Bhat, et al., 2006*). Mustard is very sensitive to insufficient nitrogen and very responsive to nitrogen fertilization. The production of mustard is not being fully exploited because of the lack of proper information of nutritional and water requirement. The important constraints to crop growth are those caused by shortage of plant nutrients. The nutrient requirement of oilseed crops, in general, is very high for almost all the essential mineral nutrients which are to be supplied in adequate quantities Plants need phosphorus for growth, utilization of sugar and starch, photosynthesis, nucleus formation and cell division. Phosphorus compounds are involved in the transfer and storage of energy within plants. To optimize crop nutrition, phosphorus must be available to the crop in adequate amounts during the growing season. Plants need phosphorus throughout their life cycle, especially during early growth stages for cell division and during maturity stage for seed formation and increase in seed weight. Phosphorus is mobile in the plant, so it is absorbed during early growth and is later Introduction 7 redirected for use in seed formation. Higher phosphorus levels increased the yield and N use efficiency (*Yaping, et al. 2015*).

METHODOLOGY

The present field experiment was conducted at Agricultural Research Farm of RBS College, Bichpuri Agra, during Rabi season of 2018-19. The soil of the experimental site is Gangetic alluvial in origin with calcareous layer at the depth of about 1.5-2.0 meters and is well drained. The soil has ph 7.84, organic carbon 0.34 % available N 174.40Kg ha^{-1}, P_2O_5 25.80Kg ha^{-1}, K_2O 220.70% Kg ha^{-1}. The experimental was laidout in RBD factorial having 3 main treatment and 4 sub treatments with 3 replications as given below.

Nitrogen levels, (kg ha^{-1})	Phosphorus levels, (kg ha^{-1})
40 : N_1	0 : P_0
80 : N_2	20 : P_1
120 : N_3	40 : P_2
-	60 : P_3

Pre-sowing irrigation applied for good initial moisture level in soil for better germination. The quality seed of variety was sown @ 5 kg ha^{-1} at the row-to-row distance of 45 cm. Full amount of nitrogen and P_2O_5 as per treatment through urea (46%N) and SSP (16% P_20_5) along with 30 kg K_2O ha^{-1} through MOP (60% K_2O) were applied at the time of sowing as basal dressing.

RESULTS AND DISCUSSION

Progressive data in Table 1.0 on growth characters of Indian mustard in terms of plant stand, plant height, number of primary and secondary branches plant^{-1} , number of green leaves plant^{-1} and dry matter accumulation and the main yield attributing characters are number of siliquae plant^{-1} , length of siliquae, number of seeds siliquae^{-1} and 1000 seed weight. maximum crop stands metre^{-1} row length was recorded with 120 kg N ha^{-1} and application of 60 kg P_2O_5 ha^{-1}showed maximum crop stand. At harvest, the increase in plant height with the application of 120 kg N ha^{-1} was to the tune of 2.89 and 18.03%. At harvest, the increase in plant height with the application of 60 kg P_2O_5 ha^{-1}was to the tune of 3.00, 5.10 and 8.34 %. The number of green leaves plant^{-1} increased significantly with the application of 120 kg N ha^{-1} At 90 DAS, the magnitude of increase in number of green leaves plant^{-1} with the 60 kg P_2O_5 ha^{-1}. At harvest the magnitude of increase in number of primary branches with 120 kg N ha^{-1}. At harvest, the increase in number of primary branches plant^{-1} 60 kg P_2O_5 ha^{-1} was to the tune of 15.87 and 19.76 %. At harvest experimental findings the increase in secondary branches plant^{-1} was to the tune 024.75 per cent, respectively with the application of 120 ha^{-1}. At harvest,

Table 1. Growth and Yield contributing characters of mustard as influenced by various treatments

Treatments		1	2	3	4	5	6	7	8	9	10
Nitrogen level (kg ha^{-1})											
40	N1	9.80	148.64	3.14	4.84	13.21	39.25	175.73	4.85	11.41	4.44
80	N2	9.85	170.52	4.44	5.62	15.04	55.23	189.15	5.14	12.36	5.06
120	N3	10.17	175.44	4.65	6.28	16.48	58.50	208.50	5.36	13.04	5.62
SEm±		0.20	1.18	0.26	0.213	0.472	1.030	4.01	0.070	0.210	0.140
CD at 5%		NS	3.46	0.76	0.62	1.38	3.02	11.75	0.21	0.62	0.41
Phosphorus level (kg ha^{-1})											
0	P0	9.58	158.30	3.57	5.06	13.38	43.10	172.90	4.72	11.38	4.42
20	P 1	9.82	163.17	3.65	5.23	13.94	46.40	185.13	5.00	11.98	4.82
40	P 2	10.04	166.51	4.35	5.97	16.02	55.78	198.12	5.28	12.54	5.28
60	P 3	10.30	171.50	4.74	6.06	16.30	58.68	208.38	5.48	13.17	5.65
SEm±		0.17	1.02	0.22	0.184	0.409	0.892	3.47	0.061	0.182	0.121
CD at 5%		NS	2.99	0.65	0.54	1.20	2.61	10.18	0.18	0.53	0.36

1=Crop stand, 2=Plant height, 3=No. of green leaves plant^{-1}, 4=No. of primary branch plant^{-1}, 5=No. of secondary branch plant^{-1}, 6=Dry matter (g),7=No. of siliquae plant^{-1}, 8=Length of siliqua (cm), 9=No. of seeds siliqua^{-1}, 10=1000 seed weight(g)

Table 2. Biological Yield, seed and stalk yield of mustard as influenced by various treatments

Treatments		Biological yield (qha^{-1})	Seed (qha^{-1})	Stalk (qha^{-1})	Harvest index (%)
Nitrogen level (kg ha^{-1})					
40	N1	40.24	11.21	29.03	27.86
80	N2	47.48	14.22	33.26	29.95
120	N3	50.54	15.70	34.84	31.06
SEm±		1.02	0.42	0.48	0.98
CD at 5%		2.99	1.23	1.41^{NS}	
Phosphorus level (kg ha^{-1})					
0	P0	40.06	11.28	28.78	28.16
20	P 1	45.03	13.05	31.98	28.98
40	P 2	48.30	14.48	33.82	29.98
60	P 3	50.97	15.63	35.34	30.67
SEm±		0.88	0.364	0.416	0.849
CD at 5%		2.59	1.07	1.22^{NS}	

Table 3. Economics of mustard crop (Rs ha^{-1}) as influenced by levels of nitrogen and phosphorus.

Treatments	GI	CC	CoC	NI	BCR
N_1P_0	53010	19450	20015	32995	2.65
N_1P_1	57047	19450	21065	35982	2.71
N_1P_2	60234	19450	22115	38119	2.72
N_1P_3	62801	19450	23165	39636	2.71
N_2P_0	59754	19450	20580	39174	2.90
N_2P_1	63791	19450	21630	42161	2.95
N_2P_2	66978	19450	22680	44298	2.95
N_2P_3	69545	19450	23730	45815	2.93
N_3P_0	63020	19450	21146	41874	2.98
N_3P_1	67057	19450	22196	44861	3.02
N_3P_2	70244	19450	23246	46998	3.02
N_3P_3	72811	19450	24296	48515	3.00

GI=Gross income(Rs ha^{-1}), CC=Common cost(Rs ha^{-1})
CoC=Cost of cultivation (Rs ha^{-1}), NI=Net-income (Rs ha^{-1})
BCR=B: C Ratio

and 60 kg P_2O_5 ha^{-1} was to the tune of 16.93 and 21.82 per cent. At harvest the increase in dry matter accumulation in plant with the application 120 kg N ha^{-1} was to the tune of dry matter accumulation in plant was to the tune 49.04 per cent. At harvest, the magnitude of increase in dry matter accumulation in plant with the 60 kg P_2O_5 ha^{-1} was to the tune of 36.15 per cent. Application of nitrogen @ 120 kg N ha^{-1} increased siliquae $plant^{-1}$ 18.65 per cent than that of 40 kg N ha^{-1}. increase in the level of phosphorus significantly increase number of siliquae $plant^{-1}$ upto 60 kg P_2O_5 ha^{-1} 20.52%. Length of siliqua increased appreciably with increase in level of nitrogen up to 120 kg N ha^{-1}. Effect of Phosphorus Every increase in the level of phosphorus increased length of siliqua significantly up to 60 kg P_2O_5 ha^{-1} 16.10% (*Mishra, et al., 2010*). Effect of Nitrogen Every increasing level of nitrogen application increased number of seeds $siliqua^{-1}$ significantly and the variation in number of seeds $siliqua^{-1}$ with the application of 120 kg N ha^{-1} and 14.28 per cent. Effect of Phosphorus the number of seeds siliqua-[1] with the application of kg P_2O_5 ha^{-1} was to the tune 15.73 per cent over control (no phosphorus). Effect of Nitrogen The examination of data concluded that the 1000-seed weight increased significantly with every increase in levels of nitrogen up to 120 kg N ha^{-1} (N3) which registered 11.07 and 26.58 per cent higher 1000- seed. All the yield components i.e., number of siliquae $plant^{-1}$, length of siliqua and number of seeds $siliqua^{-1}$ improved with the increase in the level of nitrogen. These yields contributing characters influenced the seed yield $plant^{-1}$, which, in turn, was responsible for higher seed yield per hectare with increasing levels of nitrogen. Similar results were obtained by *Rajput, R.K. (2017)*. The plant growth Discussion 55 attributes such as plant height, number of green leaves per plant, number of primary and secondary branches $plant^{-1}$ also appreciably improved with the application of phosphorus upto 60 kg P_2O_5 ha^{-1}.

Yield : Table 2 shows that the yield of any crop is generally based on two major factors, yield $plant^{-1}$ and plant population unit-1 area. Further the yield $plant^{-1}$ is affected by several characters namely number of siliquae $plant^{-1}$, length of siliquae, number of seeds siliqua-1 and 1000 seed weight. Reference to shows that total biological yield qha^{-1} appreciably increased with every increase in the level of phosphorus application up-to 60 kg P_2O_5 ha^{-1}. The increase in biological yield with 20, 40 and 60 kg P_2O_5 ha-1significantly Biological yield ha^{-1} by 17.99 and 25.60 per cent was obtained with the application of 80 and 120 kg N ha^{-1} when compared with 40 kg N ha^{-1}, respectively. Application of 20, 40 and 60 kg P_2O_5 ha^{-1} significantly produced 12.41, 20.57 and 27.23 per cent higher biological yield than that of recorded with control, respectively. Effect of Nitrogen The application of various nitrogen levels influenced seed yield significantly. Seed yield increased appreciably with every additional increase in the level of nitrogen. Respectively 26.85 and 40.05 per cent higher seed yield ha^{-1} was obtained with the application of 80 and 120 kg ha^{-1} nitrogen as compared to 40 kg ha^{-1} increase in seed yield ha^{-1} with the application of 20, 40 and 60 kg P_2O_5 ha^{-1} was to the tune of 15.69, 28.37 and 38.56 per cent over control, respectively *Singh, et al. (2010)*.

Table 3 reveals that nitrogen levels nitrogen levels had no appreciable effect on harvest index. However, the maximum harvest index was recorded with the application of 120 kg N ha^{-1} followed by 80 kg N ha^{-1} Different levels of phosphorus levels had no significant effect on harvest index, however, the highest harvest index (30.67%) was recorded with the application of 60 kg P_2O_5 ha^{-1}. Harvest index did not modify significantly due to application of different levels of phosphorus. However, higher value of harvest index and Economics of the crop was associated with the application of 60 kg P_2O_5 ha^{-1} *Panotra, et al. (2016)*.

CONCLUSION

The present study could be concluded that the seed yield of mustard (*Brassica juncea L.*) can be increased significantly under the agro-climatic condition of Agra region in U.P. with the application of 120 Kg N ha-^{1} and 60 Kg P_2O_5 ha^{-1}. The highest B:C ratio obtained with the application of 120 kg N ha^{-1} and 60 Kg P_2O_5 ha^{-1}.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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