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Priyanka Bankoti
Department of Agronomy, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India

Krishna Kumar
ICAR-Central Potato Research Institute, Modipuram, Meerut, Uttar Pradesh, India

Arvind Kumar
Barkatullah University, Bhopal, Madhya Pradesh, India

Corresponding Author:
Priyanka Bankoti
Department of Agronomy, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India

Effect of nitrogen rates on performance of mustard (*Brassica juncea* L.)

Priyanka Bankoti, Krishna Kumar and Arvind Kumar

Abstract
A field trial was conducted in *Rabi* season 20016-17 at research form of SGRR, Dehradun to study nitrogen rates on growth, yield and quality of Indian mustard. The experimental results revealed that application of 100 kg N/ha recorded significantly maximum growth attributes *viz.*, plant height (cm), number of total branches/plant, dry weight at harvest stage, yield attributes (no of siliquae per plant, length of siliquae per plant, number of seed per siliquae, seed weight per siliquae, 1000 seed weight, seed weight per plant) and yield and harvest index, besides achieved better quality. Thus, the nitrogen @ 100 kg/ha has appeared to be more promising to boost the productivity of *B. juncea* on one hand and to improve its quality on the other.

Keywords: Nitrogen rate, performance and mustard

Introduction
The Indian soils have generally been reported to be low in nitrogen, phosphorus and sulphur because of the multiple cropping and introduction of high yielding varieties, and the deficiency of these nutrients in soil becoming wider. Fertilizer plays an important role in plant growth and shows a significant increase in yield (Singh *et al*., 2017) [1, 4, 8].

Crop production largely depends on cultivation of high yielding cultivars and need based application of nutrients. Nitrogen (N) is the most important nutrient, and being a constituent of protoplasm and protein, it is involved in several metabolic processes that strongly influence growth, productivity and quality of crops. The N fertilizer application accounts for significant crop production cost. Rapeseed-mustard group of crops have relatively high demand for N than many other crops owing to larger N content in seeds and plant tissues (Malagoli *et al.* 2005) [5]. Yield increases in Indian mustard at various locations in India have been reported with application of N as high as 150 kg/ha or more (Singh *et al* 2010) [1, 4, 8]. Brassicas are known to remove higher amount of N until flowering with relatively lower amount taken up during reproductive growth phase (Rathke *et al.* 2006) [7]. Poor translocation of N from vegetative parts to seed during reproductive growth results in low nitrogen use efficiency. A significant part of the unused N is lost to environment causing pollution and contamination of water bodies (Malagoli *et al.* 2005) [5]. or gets converted to greenhouse gases such as oxides of N. Furthermore, N efficiency decreases with increase in N application (Chamoro *et al.* 2002) [6]. Increasing N application also reduces oil content (Singh *et al.* 2008) [1, 4, 8]. Since N fertilizers are costly, poor NUE is of great concern and therefore, attempts are needed to improve the contribution of applied N to production of grain and this approach will reduce the environmental and production costs in agriculture.

Considering that the information on yield dynamics of mustard with respect to nitrogen is still not available in India, the present study aims to generate more information concerning the effect of different nitrogen levels on the agronomic traits, yield and oil quality of Indian mustard under the irrigated conditions.

Materials and Methods
Site description
The field experiment was conducted at Research Farm of SGRR Dehradun. The soil of experimental site was sandy loam in texture, low in organic carbon (0.32%) and available nitrogen (170.0 kg/ha), medium in available phosphorus (14.4 kg/ha) and high in available potassium (250.0 kg/ha) with saline in reaction. The treatment comprises 6 levels of nitrogen doses as factor A (0, 20, 40, 60, 80, 100 and 120 kg/ha). The experiment was planted on October 30, 2016. The sowing was performed with the help of small plough, keeping row to row spacing of 30 cm. The thinning operation was done two weeks after sowing in order to

maintain inter-row spacing of 15 cm. A uniform basal application of phosphorous @ 40 kg P_2O_5/ha as single super phosphate, sulphur @ 20 kg S/ha, borex @ 1 kg B/ha was made along with full dose of zinc as zinc sulphate and half dose of nitrogen through urea as per the treatment. Remaining half quantity of nitrogen was top dressed after first irrigation.

Data collection

Observations on various growth parameters *viz.*, plant height, braches/plant and total dry matter accumulation/plant, were recorded, yield attributes were recorded at harvest stage. The yield was estimated by the produce obtained from net plot area, treatment wise.

Qualities

Seed samples from all branches were collected and analysed for oil content (%) in seeds with the help of NMR. The oil content was expressed in per cent. Oil yield (kg/ha) was calculated by multiplying seed yield and oil content in the seeds. Moreover, seed samples from all branches were collected and analysed for crude protein content in seeds with the help of NMR and expressed in per cent. The crude protein yield (kg/ha) was calculated by multiplying seed yield with protein content in seeds.

Statistical analysis

The data on growth, yield attributes, yield, oil content and protein content as well as their yield were recorded as per the standard procedure. The data obtained were subjected to statistical analysis as outlined by Gomez and Gomez (1984). The treatment differences were tested by using "F" test and critical differences (at 5 per cent probability).

Results and Discussion

Growth attributes

At 30 DAS significantly maximum height was attained with application of 80 kg N/ha but remain at par with rest of the treatment except 40 kg N/ha. At 60 DAS and at harvest application of N fertilizer did not influence plant height significantly. At 90 DAS significantly maximum height was attained with application of 100 kg N/ha but remain at par with application of 60, 80 and 120kg N/ha. It is mainly due to the increasing nitrogen levels. The normal effect of nitrogen on growth is to increase the height and vigour of the crop. Similar observations on the growth have also been reported by Allen and Morgen (1972) [2] and Singh *et al*. (1997) [1, 4, 8]. Moreover, The pattern of dry matter accumulation in different plant parts *viz*. husk, stem and total straw at harvest is presented in Table 2 revealed that Successive increase in nitrogen fertilizer rates shown its superiority to increased husk, stem and total straw weight per plant and maximum husk, stem and total straw weight was recorded at 100 kg N/ha. Successive increase in nitrogen application rate enhanced number of primary branches per plant and maximum primary branches were recorded at 100 kg N/ha. However, this value remained at par with application of 80 and 120 kg N/ha. Similar trend was recorded in number of secondary and total branches per plant.

Yield attributes

The data presented in Table 3 revealed that average no of siliquae per plant, length of siliquae per plant, number of seed per siliquae, seed weight per siliquae 1000 seed weight, seed weight per plant were recorded higher with the application of 100 kg N/ha. However, among the various treatments significant difference was seen only to no of siliquae per plant and seed weight per plant which also remained statistically on par with application of nitrogen at 80 and 120 kg/ha. Although, control plot noticed lower average yield attributes. Crude protein formation is the principal use to which the plant puts the inorganic nitrogen that it takes up. Increasing the nitrogen supply increases the amount of protein formed and therefore the amount of protoplasm. This increase in turn results in greater cell size, more cell division, larger leaf area and thus, in greater photosynthetic activity. It ultimately provide larger frame (dry matter and number of branches) on which more flowers and eventually more siliquae-can develop. Since siliquae themselves are the site of most of the photosynthetic activity responsible for the seed dry matter production, the link between large N supplies and high yield is clear which is confirmed by the positive correlation of seed yield with total dry matter per plant, number of branches per plant, number of siliquae per plant and 1000 seed weight (Malagoli *et al.* 2005) [5].

Yield

Different rates of nitrogen and zinc fertilizer application significantly influenced the grain and biological yield (Table), whereas harvest index was not significant Application of successive doses of nitrogen increase yields. Maximum grain and biological yield was recorded at 80 kg N/ha level but remained at par with 100 and 120 kg N/ha. Further yields was significantly lowered when no nitrogen (control) was applied. Application of 100 kg N/ha increased the grain and biological yield of Indian mustard crop over control and 60 kg N/ha, respectively. Although, harvest index follow a similar trends as followed in grain and biological yield. The yield of *Brassica* species is a function of yield attributes like (i) number of plant per unit area, (ii) number of branches per plant, (iii) number of siliquae per branches (iv) number of seeds per siliquae, and (v) 1000-seed weight. Assuming that there is no important effect of different treatments on plant number the most meaningful yield components are number of branches per plant. Number of siliqua per unit area, siliquae size and the 1000-seed weight. For these again a good R&M crop is required, which in turn depends upon optimum growth of photosynthetic organs, translocation of nutrients and photosynthates to developing plant parts and finally larger frame to accommodate more number of yield attributes. These results are in line with the findings of Malagoli *et al.* (2005) and Holmes (1995) [5].

Quality attributes

At harvest significantly maximum oil content was attained with application of 40 kg N/ha but remain at par with application 0, 60 and 80 kg N/ha. Whereas, oil yield was significantly maximum with the application of 100 kg N/ha but it remained at par with application of 60 and 120 kg N/ha. Application of 100 kg N/ha increased seed oil yield over control (0) and 60 kg N/ha, respectively. This may be due to the fact that more availability of nitrogen increased the proportion of protein substances in the seed. However, a penalty from an excessive nitrogen supply results into unduly high proportion of photosynthate diverted to protein formation leaving a potential deficiency of carbohydrates to be degraded to actyl co-A for the synthesis of fatty acids. These results are in close conformity with the findings of Malagoli *et al.* (2005) [5]. Furthermore, significantly maximum protein content and yield was recorded when 100 kg N/ha was applied. However this protein content and yield remained at par with nitrogen fertilizer rates of 60 and 80 kg N/ha. Higher protein content in grains was might be due to the more nitrogen content in grains and higher grain yield which inturn improved the protein yield.

Table 1: Effect of N fertilizer rate on dry matter and number of branches on primary and secondary part

Treatment	Dry matter g/plant						Number of branches/plant at harvest			Plant height (cm)	Total dry matter accumulation (g/plant)
	Husk	Stem	Total	Seed	Straw	Total	Primary	Secondary	Total		
Nitrogen (kg/ha)											
0	10.5	29.1	39.6	10.6	39.6	50.2	4.5	6.7	11.2	199.6	50.2
40	12.1	32.0	44.1	12.8	44.1	56.9	4.9	8.4	13.4	203.8	56.9
60	11.5	34.1	45.6	13.2	45.6	58.9	5.1	9.5	14.6	204.7	58.9
80	14.5	37.6	52.1	14.3	52.1	66.4	6.0	12.6	18.6	205.2	66.4
100	16.7	41.5	58.2	18.4	58.2	76.5	6.3	15.9	22.2	205.5	76.5
120	15.6	39.5	55.1	17.5	55.1	72.6	5.7	13.3	19.0	206.0	72.6
S.Em±	1.2	2.6	4.0	1.1	4.0	4.8	0.4	1.7	2.0	2.6	4.8
CD at 5%	3.3	7.4	11.6	3.1	11.6	13.7	1.1	5.0	5.8	NS	13.7
Zinc (kg/ha)											
0	12.1	31.4	43.5	13.2	43.5	56.7	4.3	8.6	13.9	202.8	56.7
5	14.9	39.9	54.8	15.7	54.8	70.5	6.6	13.6	19.1	205.4	70.5
S.Em±	0.7	2.0	2.3	0.6	2.3	2.7	0.2	1.0	1.2	1.5	2.7
CD at 5%	1.9	5.7	6.7	1.8	6.7	7.9	0.7	2.9	3.3	4.4	7.9

Table 2: Effect of N fertilizer rate on yield attributes

Treatment	No. of siliqua/plant	Siliquae length (cm)	No. of seeds/siliquae	Seed weight/siliquae	1000-seed weight (g)	Seed weight g/plant
Nitrogen (kg/ha)						
0	111.6	5.2	16.5	0.79	4.50	10.56
40	128.6	5.0	16.4	0.83	4.56	12.78
60	138.1	5.0	16.2	0.78	4.69	13.24
80	148.9	4.9	16.6	0.76	4.73	14.27
100	172.3	5.2	17.2	0.82	4.76	18.35
120	166.5	5.1	16.1	0.75	4.61	17.52
S.Em±	10.1	0.2	1.0	0.05	0.10	1.07
CD at 5%	29.2	NS	NS	NS	NS	3.08
Zinc (kg/ha)						
0	131.7	4.8	15.1	0.73	4.45	12.94
5	156.9	5.3	17.9	0.85	4.84	15.96
S.Em±	5.9	0.1	0.6	0.03	0.06	0.62
CD at 5%	16.8	0.3	1.7	0.07	0.17	1.78

Table 3: Effect of N fertilizer rate on yields, oil and protein quality

Treatment	Biological yield (kg/ha)	Seed yield (kg/ha)	Harvest index (%)	Oil content (%)	Oil yield (kg/ha)	Protein content (%)	Protein yield (kg/ha)
Nitrogen (kg/ha)							
0	7010	1431	20.4	42.3	606	19.5	278
40	7521	1517	20.2	42.5	645	19.6	297
60	7865	1627	20.7	42.1	685	19.9	324
80	8490	1692	20.1	42.0	711	19.7	333
100	8406	1804	21.6	41.7	752	20.0	360
120	8312	1777	21.5	41.5	737	20.3	316
S.Em±	355	44	0.7	0.2	23	0.2	14
CD at 5%	1021	125	NS	0.5	67	NS	41
Zinc (kg/ha)							
0	7585	1497	19.9	41.7	625	19.8	297
5	8283	1886	22.9	42.3	799	19.8	374
S.Em±	205	37	0.43	0.1	15	0.1	8
CD at 5%	590	107	1.2	0.3	44	NS	24

Conclusion

It may therefore, be concluded that the expression of growth and productivity parameters *Brassica juncea* is enhanced by nitrogen fertilizer levels. Thus, the nitrogen @ 100 kg/ha appeared to be more promising to boost the productivity of *B. juncea* on one hand and to improve its quality on the other.

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