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Effect of organic and inorganic sources of nitrogen on productivity, profitability and soil fertility status after harvest of mustard (*Brassica juncea* L)

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Abstract

The field experiment was conducted from 2018-19 to 2020-21 to study the effect of organic and inorganic sources of nitrogen on growth, yield and soil fertility status after harvest of Indian mustard (*Brassica juncea* L.). The experiment encompassed six treatments *viz.,* 100% recommended dose of nitrogen (RDN) through inorganic fertilizers, 75% RDN through inorganic fertilizers + 25% RDN through FYM, 75% RDN through inorganic fertilizers + 25% RDN through mustard cake, 75% RDN through inorganic fertilizers + 25% RDN through vermicompost, 50% RDN through FYM + 50% RDN through vermicompost and 50% RDN through FYM + 50% RDN through mustard cake. The experiment was laid out in randomized complete block design with four replications. The experimental results revealed that improved growth parameters (plant height, branches/plant), yield attributes (length of siliqua, no. of siliquae/plant, no. of seeds/siliqua and test weight), yield (grain and stover) and quality parameter (oil content) of mustard were recorded significantly higher with the application of 50% RDN through FYM + 50% RDN through mustard cake or vermicompost. Maximum gross returns and net returns were recorded with the application of 50% RDN through FYM + 50% RDN through mustard cake, however B: C ratio was higher with the application of 75% RDN through inorganic fertilizers + 25% RDN through mustard cake. Whereas, application of RDN through FYM and vermicompost improved the organic carbon content and decreased the electrical conductivity substantially.

***Keywords*:** *Indian mustard*, *organic and inorganic sources of N, productivity, profitability*

Introduction

Indian mustard (*Brassica juncea* L.) belongs to *Cruciferae* family and genus *Brassica* (Rafiei *et al.,* 2011). It is introduced as an oily herb (38 to 40% oil content) which is appropriate for zones with short seasons and less rainfall (Burton *et al.,* 1999). India is the fourth largest vegetable oil economy in the world next to USA, China and Brazil. Oilseeds are the second largest contributor in Indian agricultural economy after the cereals (Choudhary *et al*., 2023). Mustard productivity has improved significantly in India over the last ten years, from 1,185 kg/ha in 2008-09 to 1,524 kg/ha in 2020-21, and production has increased from 7.20 million tonnes in 2008-09 to 10.21 million tonnes in 2020-21 (Anonymous, 2021). Currently the area, production and productivity of rapeseed-mustard in Gujarat is 3.07 lakh ha, 6.03 lakh tonnes and 1966 kg/ha, respectively (Anonymous, 2022-23). Nitrogen increases yield by influencing different growth parameters and by producing more vigorous growth and development as reflected *via* increasing plant height, number of branches, total plant weight, leaf area index and number and weight of siliqua and seeds per plant (Alien and Morgan, 1972). Nitrogen is a major nutrient element that provides lush green color in crop due to increase in chlorophyll and its deficiency in arid and semi-arid regions is considerable because the amount of organic matters, which are the main nitrogen reserves, is very low in these regions and even if they were found, they would be quickly decomposed (Bani-saeedi, 2001). Almost all investigations showed that nitrogen fertilizers gave substantial seed yield increase even in diverse and contradicting conditions (Siadat *et al.,* 2010). However, nitrogen fertilizers requirements can differ very much according to soil type, climate, management practice, timing of nitrogen application and cultivars *etc.* (Holmes and Ainsley, 1977).

Bani-saeedi (2001) stated that nitrogen by reducing flower abscission and consequently affecting test weight, increasing the number of siliquae per unit area caused

produce more seed yield per hectare. Singh and Rathi (1985) reported that increase in nitrogen significantly increased the crop yield, they observed the highest yield with 160 kg N/ha. Notwithstanding, Mirzashahi *et al.* (2000) noticed that increasing rates of N up to 180 kg/ha progressively increased the growth and yield components. Reddy and Sinha (1989) showed that seed yield has increased linearly by increasing nitrogen consumption, comparing with no nitrogen consumption, the amounts of 40 and 80 kg N/ha increased the seed yield by 49.5% and 96.5% respectively. Mobasser *et al.* (2008) showed that maximum number of siliquae per plant were produced with use of 138 kg N/ha. The number of seeds per siliqua and test weight was significantly increased with increasing levels of nitrogen fertilizer application (Chauhan *et al.,* 1995; Cheema *et al.,* 2001). Considering that the information on yield dynamics of mustard with respect to different organic and inorganic sources of nitrogen is still not sufficient, the present study aims to find out suitable sources of nitrogen either inorganic or organic inputs.

Materials and Methods

A field experiment was conducted during three consecutive *Rabi* seasons of 2018-19, 2019-20 and 2020-21 at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Adiya, Gujarat. The soil of the experimental field was loamy sand in texture and it had alkaline in reaction and soluble salt content under unsafe limit. It was low in organic carbon, medium in available P_2O_5 and medium to high in available K_2O (Table 1).

Table 1: Initial physico-chemical properties of soil at experimental site

Parameters	2017-18	Method and references
$pH_{1:2.5}$	6.91	Potentiometry, Jackson (1973)
$EC_{1:2.5}$ (dS/m)	1.34	Conductometry, Jackson (1973)
OC (%)	0.22	Modified Walkley and Black method, Walkley and Black (1934)
Available P_2O_5 (kg/ha)	37.9	Olsen's method (0.5 M $NaHCO_3$, pH 8.5, Olsen *et al.* (1954)
Available K_2O (kg/ha)	225	Neutral 1N NH_4OAc Flame photometry method, Jackson (1973)

The experiment was consisted six treatments *viz.* T_1: 100% recommended dose of nitrogen (RDN) through inorganic fertilizers, T_2: 75% RDN through inorganic fertilizers + 25% RDN through FYM, T_3: 75% RDN through inorganic fertilizers + 25% RDN through mustard cake, T_4: 75% RDN through inorganic fertilizers + 25% RDN through vermicompost, T_5: 50% RDN FYM + 50% RDN through vermicompost and T_6: 50% through RDN through FYM + 50% RDN through mustard cake. The experiment was laid out in randomized complete block design with four replications. The mustard variety 'GDM-4' was sown with kept spacing of 45 cm × 15 cm by using 3.5 kg/ha seed rate. The crop was raised with adopting standard package of practices. The recommended dose of fertilizer for mustard crop was 50:50:0:40 (N:P:K:S) kg/ha. Full dose of phosphorus, sulphur and half dose of nitrogen fertilizers were drilled just before the sowing as a basal application in the form of urea, DAP and elemental sulphur and remaining half dose of nitrogen was applied at 30-40 DAS as per treatments in earmarked plots. The thinning and manual weeding of experimental plot was done during 20-25 DAS. Uniformly four irrigations were applied during crop period. Various growth parameters, yield attributes and yield were recorded at harvest. The cost of cultivation and net returns were calculated by taking into account the prevailing market price of inputs and minimum support price of produce. Soil samples were collected from 0-15 cm depth from each plot. These samples were processed and analyzed for various physico-chemical properties in the laboratory of Department of Soil Science, CP College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. Soil available phosphorus was determined by Olsen's method (0.5 M $NaHCO_3$, pH 8.5) as suggested by Olsen *et al.* (1954). Available K_2O in the soil was determined by neutral 1N NH_4OAc flame photometry method (Jackson, 1973). Organic carbon content, soil pH and electrical conductivity were measured by using standard methods of analysis (Table 1). The standard analysis of variance (ANOVA) technique prescribed for the randomized complete block design was performed to compare the treatment means for each year separately and was pooled. Treatment means were compared at the 5% level of significance (P=0.05) using least significant difference (LSD) and hence results based on pooled analysis are presented here to draw logical inferences.

Results and Discussion

Growth and yield attributes

Data revealed that number of branches/plant, number of siliquae/plant, number of seeds/siliqua and lengths of siliqua were significantly affected by different treatments and the maximum values of these parameters were recorded with the application of 50% RDN through FYM + 50% RDN through mustard cake and it was

tended to increase to the tune of 16.9, 14.8, 13.3 and 12.2 % higher over application of 100% RDN through inorganic fertilizers (Table 2). Increase in plant growth parameters with combined application of organic and inorganic sources might be due to higher nutrient supply, rapid conversion of carbohydrates in to protein which in turn elaborated in to protoplasm. The yield is a function of yield attributes like length of siliqua, number of siliquae/plant, number of seeds/siliqua, 1000-seed weight, which in turn depends upon optimum growth of photosynthetic organs, translocation of nutrients and photosynthesis to developing plant parts and finally larger frame to accommodate a greater number of yield attributes in unit areas (Jat *et al*., 2017).

Table 2: Effect of different organic and inorganic sources of nitrogen on growth and yield attributes of mustard (3 years mean)

Treatment	Plant height (cm)	Branches/ plant	Siliquae/ plant	Seeds/ siliqua	Siliqua length	Test weight (g)
100% RDN through inorganic fertilizers	175	7.1	351	13.5	4.9	5.2
75% RDN through inorganic fertilizers + 25% RDN through FYM	178	7.3	360	14.3	5.0	5.3
75% RDN through inorganic fertilizers + 25% RDN through mustard cake	179	7.3	368	14.2	5.3	5.3
75% RDN through inorganic fertilizers + 25% RDN through vermicompost	181	7.5	366	14.8	5.2	5.3
50% RDN FYM + 50% RDN through vermicompost	182	8.2	395	15.0	5.5	5.4
50% RDN through FYM + 50% RDN through mustard cake	185	8.3	4031	5.3	5.5	5.4
SEm±	5.7	0.2	10.0	0.4	0.2	0.04
CD (*P*=0.05)	NS	0.44	27.0	1.18	0.41	NS

Oil content, yield and economics

The balanced nutrient management practices contributed to a great extent influencing the seed yield of mustard. The higher oil content (40.2%), seed yield (2.57 t/ha) and stover yield (5.27 t/ha) were recorded with the application of 50% RDN through FYM + 50% RDN through mustard cake (Table 3). However, the minimum yield was obtained with the application of 100% RDN through inorganic fertilizers, which was significantly lower than remaining treatments. Maximum gross returns and net returns were recorded with the application of 50% RDN through FYM + 50% RDN through mustard cake, however, B: C ratio was higher with the application of 75% RDN through inorganic fertilizers + 25% RDN through mustard cake (Table 3). The application of 50% RDN through FYM + 50% RDN through mustard cake can helpful in preventing flower and siliqua abscission and favorable in increasing the number of siliquae with produce bold size seed and affecting thousand seed weight which ultimately led to recorded higher seed yield. Higher seed yield with increasing the different organic sources of nitrogen was also reported by Siadat *et al.* (2010), Singh *et al.* (2022) and Singh *et al.* (2023).

Soil fertility status after harvest of mustard

Application of different organic sources of nitrogen significantly influenced the soil physico-chemical properties after harvest of crop at the end of three years cycle (Table 4). Application of 50% RDN through inorganic fertilizers + 50% RDN through mustard cake significantly reduced the EC of soil (0.99 dSm^{-1}) after harvest of mustard, but it was remained statistically at par with 50% RDN through FYM + 50% RDN through vermicompost. While, higher organic carbon content (0.39%) in soil after harvest of mustard was observed under 50% RDN through FYM + 50% RDN through mustard cake but it was remained statistically at par with 50% RDN through FYM + 50% RDN through vermicompost. Effect of different organic sources on mustard did not show any significant effect on soil pH, available P_2O_5 and K_2O status in soil after harvest of mustard (Table 4). The percentage of soil organic matter was increased due to the application of different organic materials like FYM, press mud, compost, poultry manure and sesbania green manure (Pareek and Yadav, 2011).

Conclusion

Based on three years mean data it can be concluded that application of 50% recommended dose of nitrogen (25 kg/ha) through farmyard manure (5.0 t/ha) and

Table 3: Effect of different organic and inorganic sources of nitrogen on oil content, yield and economics of mustard (3 years mean)

Treatment	Oil content (%)	Seed yield (t/ha)	Stover yield (t/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B.C. ratio
100% RDN through inorganic fertilizers	39.2	2.15	4.28	27809	90300	62491	3.25
75% RDN through inorganic fertilizers + 25% RDN through FYM	39.5	2.26	4.49	31402	94794	63392	3.02
75% RDN through inorganic fertilizers + 25% RDN through mustard cake	39.7	2.32	4.62	29597	97524	67927	3.30
75% RDN through inorganic fertilizers + 25% RDN through vermicompost	39.9	2.30	4.60	34527	96558	62031	2.80
50% RDN FYM + 50% RDN through vermicompost	40.1	2.48	5.03	48432	103992	55560	2.15
50% RDN through FYM + 50% RDN through mustard cake	40.2	2.57	5.27	38571	10806	669495	2.80
SEm±	0.44	0.05	0.11	-	-	-	-
CD (*P*=0.05)	NS	0.14	0.32	-	-	-	-

Table 4: Effect of different organic and inorganic sources of nitrogen on soil properties after harvest of mustard at the end of sequence

Treatment	pH	EC (dS/m)	OC (%)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
100% RDN through inorganic fertilizers	7.8	1.39	0.23	37.2	269
75% RDN through inorganic fertilizers + 25% RDN through FYM	7.8	1.33	0.28	37.0	284
75% RDN through inorganic fertilizers + 25% RDN through mustard cake	7.8	1.35	0.27	37.4	283
75% RDN through inorganic fertilizers + 25% RDN through vermicompost	7.8	1.22	0.29	40.5	286
50% RDN FYM + 50% RDN through vermicompost	7.8	1.08	0.37	42.8	293
50% RDN through FYM + 50% RDN through mustard cake	7.8	0.99	0.39	41.7	286
SEm±	0.08	0.04	0.02	2.64	8.25
CD (*P*=0.05)	NS	0.13	0.05	NS	NS

remaining 50% recommended dose of nitrogen (25 kg/ha) through either mustard cake (0.5 t/ha) or vermicompost (2.5 t/ha) along with recommended dose of phosphorus and sulphur (50 and 40 kg/ha) improved the seed yield and net returns of Indian mustard.

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