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Effect of integrated nutrient management on yield and quality of Indian mustard (*Brassica juncea*) and properties of soil*

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Application of chemical fertilizers not only affects the physical, chemical and microbial conditions of soil but also yield and quality of the produce to a great extent. Available evidence indicates that even balanced use of chemical fertilizers alone cannot improve the soil productivity under continuous cropping, whereas inclusion of farmyard manure, biofertilizers as well as secondary and micro-nutrients regulate quality, improve crop yield and physical status of soil (Kabeerathumma *et al.* 1993). Therefore an attempt was made to study the effect of integrated nutrient management on seed yield, oil and protein content of indian mustard [*Brassica juncea* (L.) Czernj & Cosson] and properties of soil.

A field experiment was carried out during the winter (*rabi*) season 1999–2000 taking 'Varuna' indian mustard on an Inceptisol having silt-loam texture. The surface soil of the experimental site had *p*H 8.4, organic carbon 0.32% available N 130 kg/ha, available P 9.79 kg/ha, available K 181 kg/ha, available S 8.5 ppm, available Zn 0.5 ppm, and available B 0.25 ppm. The experiment compared 13 treatments, viz T_1 (control), T_2 (100% NPK), T_3 (T_2+ 1.0 tonnes FYM/ha), T_4 (T_3 + 40 kg S/ha), T_5 (T_3 + 25 kg $ZnSO_4$/ha), T_6 (T_3 + 1.0 kg B/ha), T_7 (T_3 + *Azotobacter*), T_8 (75% NPK), T_9 (T_8 + 10 tonnes FYM/ha), T_{10} (T_9 40 kg S/ha), T_{11} (T_9 + 25 kg $ZnSO_4$/ha), T_{12} (T_9 + 1.0 kg B/ha) and T_{13} (T_9 + *Azotobacter*). Randomized block design was followed. Oil and protein content as described by AOAC (1970). Surface soil samples (0–15 cm) collected from each plot after harvest of indian mustard crop, were analysed for organic carbon by Walkley and Black (1934), available N by Subbiah and Asiza (1956), available P by Olsen *et al.* (1954) available K by Hanway and Heidel (1952) and cation-excahnge capacity and bulk density by Chopra and Kanwar (1976) methods.

The highest seed yield was recorded under treatment having 100% NPK along with 10 tonnes FYM/ha and *Azotobacter* inoculation (Table 1). Full recommended dose of NPK alone was found to be significantly superior with

Table 1 Yield and quality of indian mustard as influenced by nutrient management

Treatment	Seed yield (tonnes/ha)	Stover yield (tonnes/ha)	Oil content in seeds (%)	Protein content in seeds (%)
T_1, Control	4.13	18.90	37.6	22.3
T_2, 100% NPK	10.63	43.91	39.8	23.0
T_3, T_2 + 10 tonnes FYM/ha	12.66	47.80	40.4	23.4
T_4, T_3 + 40 kg S/ha	14.63	21.10	40.7	24.6
T_5,T_3 + kg $ZnSO_4$/ha	15.63	55.07	40.6	24.7
T_6,T_3 + 1.0 kg B/ha	16.05	56.32	40.5	24.7
T_7,T_3 + *Azotobacter*	16.69	57.86	40.2	24.1
T_8, 75% NPK	9.28	30.17	39.5	22.9
T_9,T_8 + 10 tonnes FYM/ha	10.17	31.08	40.1	23.5
T_{10},T_8 + 40 kg S/ha	11.60	37.29	40.6	24.5
T_{11},T_8 + 25 kg $ZnSO_4$ /ha	12.86	40.31	40.5	24.5
T_{12},T_8 + 1.0 kg B/ha	13.46	42.17	40.3	24.6
T_{13},T_8 + *Azotobacter*	14.05	43.34	40.2	24.6
CD (P = 0.05)	0.90	1.40	0.41	0.43

11.0% additional yield of seeds over 75% dose. Farmyard manure @ 10 tonnes/ha increased the seed yield significantly at 100% NPK dose with a tune of 0.203 m tonnes/ha but at 75% NPK level farmyard manure could not significantly increase yield. However, sulphur, zinc boron and *Azotobacter* enhanced the seed yield by 15.6, 23, 5, 26.8 and 31.8% at 100% dose of NPK; and 14.1, 26.5, 32.4 and 38.2% at 75% dose of NPK respectively. Combined application of FYM @ 10 tonnes/ha with 75% NPK was found at par with 100% NPK alone. These results corroborate the findings of Tomer *et al.* (1992). Similar trend was noticed for stover yield.

All the treatments were significantly increased the oil content of mustard seed of indian mustared over the control. Use of farmyard manure and sulphur significantly increased the oil content, however, zinc, boron and

* Short note

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Table 2 Properties of soil as affected by integrated nutrient management in indian mustard crop

Treatment	Bulk density (mg/m^3)	Organic carbon (%)	Cation exchange capcity C Mol (P+) kg^{-1}	Available nutrient (kg/ha) N	P	K
T_1, Control	1.58	0.30	15.06	74.2	8.2	182.2
T_2, 100% NPK	1.56	0.34	15.90	114.5	9.1	189.3
T_3, T_2 + 10 tonnes FYM/ha	1.44	0.45	16.85	120.8	10.2	191.1
T_4, T_3 + 40 kg S/ha	1.40	0.44	16.80	122.0	10.2	191.2
T_5,T_3 + kg $ZnSO_4$/ha	1.43	0.45	16.50	121.0	9.6	189.7
T_6,T_3 + 1.0 kg B/ha	1.40	0.43	16.95	120.2	10.2	190.5
T_7,T_3 + *Azotobacter*	1.42	0.46	17.15	123.5	9.9	190.8
T_8, 75% NPK	1.55	0.33	15.62	101.2	8.8	184.6
T_9,T_8 + 10 tonnes FYM/ha	1.50	0.40	16.55	108.4	9.7	187.8
T_{10},T_8 + 40 kg S/ha	1.51	0.39	16.40	109.6	9.7	188.6
T_{11},T_8 + 25 kg $ZnSO_4$/ha	1.48	0.41	16.35	107.9	9.3	187.8
T_{12},T_8 + 1.0 kg B/ha	1.52	0.40	16.50	107.1	9.4	188.2
T_{13},T_8 + *Azotobacter*	1.45	0.42	16.90	110.3	9.7	188.9
CD (P=0.05)	0.07	0.05	1.62	5.24	0.99	4.48

Azotobacter did not improve the oil content up to the level of significance. In general, the oil content in mustard seeds was less in 75% NPK plots than 100% NPK plots. The increase in oil content with application of farmyard manure may be attributed to the synthesis of more glycosides which increases the oil content (Singh 1984). Application of farmyard manure, S, Zn, B and *Azotobacter* significantly enhanced the protein content in seeds at both levels (100% and 75% dose).

The bulk density of soil decreased significantly over its initial value under all treatments except in T_1, T_2 and T_8 treatments. Maximum increase in organic carbon content of soil was found in the treatment having 100% NPK + FYM + *Azotobacter* (T_7). Overall treatments containing 75% NPK were found inferior in increasing the organic matter content compared with 100% NPK treatment. However, there is not much difference in organic carbon between T_2 and T_8 because of no supply of farmyard manure in both treatments. Increase in organic carbon content of the soil in farmyard manure-treated plots may be ascribed to additive effect of partially decomposed organic matter. Except in the control plots, cation-exchange capacity (CEC) of the soil enhanced under all treatments over initial value but significant increase was recorded only in treatments T_3, T_6, T_7 and T_{13} which ay be attributed to the considerable build-up of organic carbon in these treatments. The results confirm the findings of Kumar (2002).

Status of available N reduced under all treatments against initial value but lowest depletion was noticed in the treatment having *Azotobacter* inoculation of both 100% and 75% NPK levels. Phosphorus availability declined only in the control and the treatment receiving 75% NPK alone while rest treatments were effective in increasing the available P status of soil which may be attributed to increased solubility of native and applied phosphrus. Although available K content of the soil increased over initial status in all the treatments except T_1 and T_8, significant build-up was noticed only in T_3, T_4, T_6 and T_7 treatments. These results are in agreemnet with those of More (1994).

On the basis of the results obtained in this investigation, it may be concluded that appliction of farmyard manure along with inorganic fertilizers improved physical and chemical properties of soil.

SUMMARY

Field investigation carried out on effect of integrated nutrient management on yield and quality of mustard and properties of soil revealed that highest seed yield was recorded with 100% recommended NPK along with 10 tonnes farmyard manure/ha and *Azotobacter* inoculation. Use of farmyard manure and sulphur increased the oil and protein content in mustard seeds significantly. Application of farmyard manure along with inorganic fertilizers improved the physico-chemical properties of the soil.

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