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Effect of integrated nutrient management on growth, yield, oil content and nutrient uptake of Indian mustard (*Brassica juncea*) in foothills soils of eastern India

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ABSTRACT

A field experiment was carried out during the winter (*rabi*) seasons of 1994–95 to 1996–97 on sandy-loam acidic soil, to study the growth, yield, seed oil content and nutrient uptake by Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] as influenced by different integrated nutrient-management treatments. The plant height, branches/plant, siliquae/plant, seeds/siliqua, 1,000-seed weight, seed and oil yields of Indian mustard were improved at 100% recommended dose of N:P:K (80:17.2:33.2) + FYM @ 10 tonnes/ha compared with 100% NPK alone. It was at par with 100% NPK + borax @ 10 kg/ha + $ZnSO_4$ @ 20 kg/ha and 50% NPK + FYM @ 10 tonnes/ha + borax @ 10 kg/ha + $ZnSO_4$ @ 20 kg/ha. Seed yield increased by 27, 26 and 25% at 100% NPK + FYM, 100% NPK + borax + $ZnSO_4$ and 50% NPK + FYM + borax + $ZnSO_4$, respectively, over 100% NPK; and 134, 132 and 130% in the corresponding treatments over the control. Significant improvement owing to appropriate combination of NPK, FYM, borax and $ZnSO_4$ was observed for uptake of nutrients.

Key words : Integrated nutrient management, Indian mustard, Growth, Yield attributes, Yield, Oil content, Uptake of nutrients

The foothills region of eastern India is characterized by high rainfall (2,000 to 3,500 mm) and high relative humidity during the rainy season and low temperature in winter. Soils in this region are mostly sandy to sandy loam, porous and sometimes is of raw humus type. Soil reaction is acidic as a consequence of leaching of bases due to heavy rainfall causing deficiency of nutrients particularly Ca, Mg and some of the micronutrients like B and Zn. Indian mustard is the principal edible oilseed crop grown in the rice fallow areas with no or marginal use of fertilizers. Consequently the yield of this crop is low.

As nutrients are the major contributing

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factors their appropriate management practices is essential to achieve the optimum yield of Indian mustard. Thus the present investigation was undertaken to develop appropriate integrated nutrient-management package for sustainable productivity of Indian mustard and to study the nutrient uptake in the foothills region of the eastern part of the country.

MATERIALS AND METHODS

The field experiment was conducted at the experimental farm (26°19′86″ N and 89°23′53″ E), North Bengal Campus of Bidhan Chandra Krishi Viswavidyalaya, Coochbehar, West Bengal, during the winter season of 1994–95 to 1996–97. The soil was well-drained sandy loam, acidic (pH 6.4), having 0.82% organic C, 0.09% total N, 9.6 kg/ha available P, 127 kg/ha available K, 0.42 ppm available B. Ten treatments, comprising different combinations of organic (FYM @ 10 tonnes/ha) and inorganic (100% and 50% of recommended dose of NPK and micronutrients, viz. borax and $ZnSO_4$ @ 10 and 20 kg/ha, respectively) including 1 unfertilized control, were laid out in randomized block design with 3 replications.

The treatment were T_1, control; T_2, 100% NPK (80, 17.2 and 33.2 kg/ha); T_3, 100% NPK + FYM (10 tonnes/ha); T_4, 100% NPK + borax (10 kg/ha); T_5, 100% NPK + $ZnSO_4$ (20 kg/ha); T_6, 100% NPK + borax (10 kg/ha) + $ZnSO_4$ (20 kg/ha); T_7, 50% NPK + FYM (10 tonnes/ha); T_8, 50%NPK + FYM (10 tonnes/ha) + borax (10 kg/ha); T_9, 50% NPK + FYM (10 tonnes/ha) + $ZnSO_4$ (20 kg/ha); and T_{10}, 50% NPK + FYM (10 tonnes/ha) + Borax (10 kg/ha) + $ZnSO_4$ (20 kg/ha).

'RW 351' ('Bhagirathi') yellow, flower cultivar of Indian mustard, was sown at 30 cm row-to-row spacing in mid-November with optimum soil-moisture condition. The crop was thinned 15 days after sowing to maintain plant-to-plant spacing of 10 cm and to get desired plant population of 0.3 million/ha. Recommended dose of N (80 kg/ha) and K (40 kg K_2O/ha) was applied uniformly. Potassium in the form of muriate of potash was applied at sowing, but the crop received N in 2 splits; half basal and half at 30 days after sowing (DAS) through urea. Phosphorus and boron in the form of single superphosphate and borax, respectively, were applied as per the treatments. Two irrigations were given, 1 at 30 DAS (rosette stage) and another at 75 DAS (pod development stage). The growth and yield were recorded as per the standard methods. The crop was harvested in the first fortnight of March. Observations were recorded on various growth parameters, yield components and yield. The N, P and K contents in plant samples were analysed following the procedures of Jackson (1973) and concentration in the acid extracts were determined turbidimetrically following the procedure of Williams and Steinbergs (1959). Oil content was estimated through Soxhlet apparatus oil extraction using petroleum ether (40–60 °C) (AOAC, 1970) and oil yield was obtained by multiplying oil content with the seed yield of respective treatments. Data were analysed following the standard methods (Gomez and Gomez, 1984). Since error variances for yield of

respective treatments during years of experimentation were found homogenous, pooling of data was done.

RESULTS AND DISCUSSION

Growth parameters

The growth parameters, viz. plant height, number of primary and secondary branches/plant, were significantly influenced due to integrated nutrient-management treatments (Table 1). The plant height increased with increasing rate up to 60 DAS and then it increased with decreasing rate. The lowest values of these parameters were recorded in the control treatment. Significantly higher plant height and number of primary and secondary branches/plant were observed under T_3, though at par with T_6 and T_{10}. Application of FYM and or borax + $ZnSO_4$ in combination with 100% and 50% of NPK significantly influenced the growth of the plants. Boron favourably enhanced crop growth by cell-division in the meristematic region and by acting at the growing tips of the crop. The $ZnSO_4$ as a source of Zn and S enhanced plant height probably by maintaining higher levels of auxins in the plant tissues and by synthesizing more food in the leaves with the help of S, which usually participate in the synthesis of proteins, vitamins etc. The results are in conformity with the findings of Sinha *et al.* (1990).

Yield attributes and yield

The yield components, viz. siliquae/plant, seeds/siliqua and 1,000-seed weight, were significantly influenced due to integrated nutrient-management treatments. All these attributes were higher under T_3, T_6 and T_{10} compared with the control and other treatments. These 3 treatments were at par and superior to the control and other treatments. This was perhaps owing to more primary and secondary branches/

Table 1. Growth, yield attributes, yield and oil content of Indian mustard as influenced by integrated nutrient management treatments (pooled)

Treatment	Total branches/ plant	Siliquae/ plant	Seeds/ siliqua	1,000-seed weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Oil content (%)	Oil, yield (q/ha)
T_1	11.8	127.0	8.5	3.01	7.23	36.44	34.90	2.52
T_2	20.9	188.2	11.9	3.85	13.32	49.66	36.90	4.91
T_3	31.0	254.9	14.1	4.42	16.92	59.61	41.30	6.99
T_4	25.8	203.8	12.9	4.39	15.56	53.99	39.69	6.23
T_5	23.6	201.4	12.4	4.24	14.62	51.36	37.64	5.50
T_6	30.5	241.0	14.3	4.66	16.83	58.95	40.60	6.83
T_7	23.3	197.4	12.2	3.93	14.78	51.41	38.04	5.62
T_8	26.1	205.0	12.9	4.34	15.63	54.17	38.43	6.01
T_9	26.0	208.9	12.9	4.27	15.49	54.01	39.00	6.04
T_{10}	30.3	253.4	14.1	4.58	16.68	58.02	41.07	6.85
CD (P=0.05)	1.8	24.7	1.0	0.63	0.37	2.68	1.12	0.26

Details of treatments are given under Materials and Methods

plant. Thus it was observed that better yield attributes were recorded when FYM, or borax, or $ZnSO_4$ or borax + $ZnSO_4$ was combined with 100% NPK + FYM. Thus it was an indicative of their role in various physiological functions like movement of growth regulators within the plant, germination and growth of pollen-grains and pollen tubes (Sakal and Singh, 1995). The length of siliqua, though a varietal character, was also varied with the differences in nutrient status and availability of multiple nutrients in the soil. The average maximum length was observed under T_6 which was on a par with T_3 and T_{10}.

Both seed and stover yields were influenced significantly due to different integrated nutrient-management practices. The highest seed yield of Indian mustard was recorded under T_3 and it was statistically on a par with T_6 and T_{10} compared with the control (Table 1). There was increase in seed yield of 27.03, 16.81, 9.76 and 26.35% with the application of FYM, broax, $ZnSO_4$ and borax + $ZnSO_4$, respectively, along with 100% recommended dose and increased by 5.75, 4.80 and 12.85% with borax, $ZnSO_4$ and borax + $ZnSO_4$, respectively, along with 50% recommended dose + FYM over only 50% recommended dose + FYM. It indicated that application of 100% recommended dose of N, P_2O_5 and K_2O @ 80, 40 and 40 kg/ha in combination with FYM @ 10 tonnes/ha or borax @ 10 kg/ha + $ZnSO_4$ @ 20 kg/ha or 50% of the recommended dose in combination with FYM, borax and $ZnSO_4$ at the same rate ensured better yield than the other treatments. As yield is the resultant outcome of the effect of various growth factors and yield parameters, its expression was observed with their integrated influence. With the increment in supply of essential elements to Indian mustard, their availability, acquisition, mobilization and influx into the plant tissues increased and thus improved growth attributes, gas-exchange traits, yield components, harvest index and finally the yield. The results corroborated the findings of Tomer *et al.* (1996).

Oil content and oil yield

The seed oil content was significantly influenced by different levels of integrated nutrient-management treatments (Table 1). However, variations in oil content due to different treatments were not much. Higher seed oil content was recorded under T_3, T_6 and T_{10} treatments which were at par. The wider variations in oil yield was largely due to the differences in seed yield because oil yield is the resultant of seed yield and oil content. Significant difference in oil yield is perhaps due to the significant differences in seed yield. The essential elements like sulphur, boron and zinc contained in FYM, $ZnSO_4$ and borax probably promotes the synthesis of oils. The results are in conformity with the findings of Sinha *et al.* (1990).

Uptake of nutrients

Integrated application of nutrients like 100% NPK + FYM (T_3), 100% NPK + borax + $ZnSO_4$ (T_6) and 50 % NPK + FYM + borax + $ZnSO_4$ (T_{10}) increased the uptake of N, P, K and S both by seed and stover (Table 2), consequently increasing the total uptake (seed +.stover). The higher amount

Table 2. Total uptake (kg/ha) of nutrients by Indian mustard as influenced by the integrated nutrient-management treatments (pooled)

Treatment	Nitrogen	Phosphorus	Potassium	Sulphur
T_1	62.84	20.75	58.25	6.95
T_2	113.19	33.15	103.41	11.78
T_3	162.72	41.28	134.23	16.04
T_4	133.03	37.05	116.26	13.79
T_5	123.58	34.89	109.93	14.35
T_6	151.81	40.84	131.54	16.99
T_7	122.38	33.92	94.98	12.80
T_8	136.06	36.09	102.79	13.61
T_9	137.08	36.00	104.27	14.43
T_{10}	158.26	39.09	114.30	15.96

Details of treatments are given under Materials and Metheds

of uptake of these nutrient elements are closely correlated with their increased availability in soil by the higher levels of fertilizer nutrients compared with those of the reduced levels of nutrients. This was mainly due to the fact that better nutrient utilization by more healthy and vigorous plants under recommended and balanced level and resulting in more biomass production and yield, which ultimately increased the total uptake of nutrients/ha. The observations are in agreement with those of Tomer *et al.* (1996).

Thus, either borax @ 10 kg/ha + $ZnSO_4$ @ 20 kg/ha or organic manure (FYM @ 10 tonnes/ha) should be coupled with 100% recommended dose of N, P and K @ 80, 17.2 and 33.2 kg/ha. Application of 50% of the recommended dose may be advocated if it is supplemented with FYM @ 10 tonnes/ha along with borax @ 10 kg/ha and $ZnSO_4$ @ 20 kg/ha to meet the demand of multiple nutrients for mustard and to sustain the higher productivity of Indian mustard in the foot-hills region of eastern India.

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