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Effect of nutrient management practices on yield and quality of Indian mustard (*Brassica juncea*) under late sown condition

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Abstract

A field experiment was conducted during *rabi* season of 2004-05 as well as 2005-06 to assess the effect of nutrient management practices on yield and quality of Indian mustard [*Brassica juncea* (L.) czern coss] under late sown conditions. Integrated use of 100% recommended fertilizer dose along with organic sources of nutrients resulted in significantly higher number of branches/plant, siliqua/branch, seeds/siliquae and seed yield of mustard in comparison to application of 100% recommended dose of NPK alone. The protein content and protein yield were showed considerable improvement in response to the combined application of organic and inorganic sources of nutrients. Integrated nutrient management practices lead to higher content of Palmitic acid, Oleic acid, Linoleic acid, Linolenic acid Eicosenoic acid and Erucic acid and lower content of Glucosinolate in comparison to the application of chemical fertilizer alone

Key words: Indian mustard, organic manure, seed yield, oil yield

Indian mustard occupies more than 70 per cent of the area under rapeseed-mustard group of crops grown in India. It is preferred by the farmers of rainfed and dryland areas because of its capability to yield satisfactorily under sub-optimal level of resources. Inherited yield potentials of the crop, however, can only be realized by providing plant nutrients in balanced proportions alongwith suitable agronomic practices. Imbalanced nutrient application is one of the most important constraints for mustard productivity.

Intensification of agriculture coupled with the use of high analysis fertilizers; deprived of secondary/micronutrients, has lead to wide-spread deficiency of several nutrients. Restricted or no application of organic manures has further aggravated the situation. The deficiency of micro nutrients *i.e.* sulphur, zinc and boron are common in many states of the country. In Uttar Pradesh and Uttarakhand, 54 per cent of the soils are deficient in sulphur, 62 per cent deficient in zinc and 10 per cent deficient in boron (Anonymous, 1999). Nutrient indexing work on soils and crops done at the Pantnagar university revealed that negative balance of sulphur, zinc and boron is becoming evident in *Tarai* region (Srivastava *et al.*, 2006). Rapeseed-mustard requires relatively large amount of these nutrients for realization of yield potential but inadequate supply often leads to low productivity. Hence, it becomes imperative to increase crop productivity by providing balanced and adequate nutrition through organic and inorganic sources. Exclusive use of either organic or inorganic nutrient sources has few limitations. Therefore, judicious use of organic and inorganic fertilizers is needed for enhancing productivity of rapeseed-mustard. Integrated use of organic and inorganic fertilizers not only ensures availability of all the essential plant nutrients but also maintains better soil health (Thakur, *et al*, 2009). Use of farm yard manure (FYM), vermicompost and bio-fertilizers

like *Azotobacter* in judicious combination with fertilizers can facilitate profitable and sustainable production and are found to improve physical, chemical and biological soil properties (Shroff and Devasthali, 1992). In *Tarai* region of Uttarakhand and western UP the mustard crop is mainly sown late after harvest of rice under rice-mustard-sugarcane cropping system but the yield levels are low under late sown condition. Under timely sown condition, lot of information on nutrient management practices are available, however, information on this aspect, *i.e.* under late sown condition in mustard is lacking. In order to enhance the productivity of late sown mustard, it is important to develop suitable nutrient management practices for mustard to boost its growth and quality. Keeping in view the above facts, and to exploit the highest potential of the mustard crop, present investigation was carried out to study the effect of nutrient management practices on growth, yield and quality of Indian mustard (*B. juncea* L.) under late sown condition.

Materials and Methods

The field experiment was conducted at the Crop Research Centre of the G.B. Pant University of Agriculture and Technology, Pantnagar during rabi seasons of 2004-05 and 2005-06. The experimental soil showed an estimated amount of about 0.89 per cent organic carbon, 224 kg/ha available N, 12.2 kg/ha available P and 309 kg/ha available K. The field experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication comprised of sixteen treatment combinations. Full amount of P_2O_5, K_2O, FYM and vermicompost alongwith 50 per cent of nitrogen was applied as basal and remaining 50 per cent of N was top dressed after first irrigation. *Azotobacter* culture was used @ 10 g/kg seed. Mustard cv. 'Kranti' was grown during November-April, sown at a spacing of 30 cm × 15 cm. All the cultural practices were followed as per the schedule. Oil content (%) in seed was analyzed with the help of Soxhlet's extraction method taking petroleum ether as solvent (ISI, 1975). Oil yield was calculated by multiplying seed yield and oil content in the seeds. The protein content in the seeds was estimated by multiplying N content with a constant factor of 6.25 and expressed in per cent. The protein yield was calculated by multiplying seed yield with protein content in seeds. The fatty acid composition of oil was carried out by Gas-Liquid Chromatography (GLC) of methyl esters prepared from oil after extraction from the seed as per the AOAC protocol (AOAC method 965.49) (AOAC, 1975). Different components of fatty acids viz. palmitic acid, oleic acid, linoleic acid, linolenic acid, eicosenoic acid and erucic acid etc. were expressed in per cent of the oil content in the seed. The total glucosinolate content was estimated by determining the glucose released by myrosinase hydrolysis (Wang and McGregor, 1991). The total glucosinolate content was expressed in μ moles/g seed.

Results and Discussion

Effect of nutrient management practices on yield and yield attributes

The number of branches/plant was significantly affected by different nutrient management practices. The highest number of branches/plant were recorded with the application of 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + Vermicompost 2.5 t/ha + *Azotobacter* which was significantly higher than all other treatments. Application of 50% RDF or 75% RDF or 100% RDF with integration of FYM 10 t/ha, vermicompost 5 t/ha and FYM 5 t/ha + vermicompost 2.5 t/ha with or without *Azotobacter* resulted in more number of branches than chemical fertilizer alone, however integration of vermicompost proved to be slightly superior over FYM. These results are in close conformity with those of Singh and Kumar (1999), and Prasad (2000). It is mainly due to the increasing N levels. The normal effect of nitrogen on growth is to increase the height and vigour of the crop that results in increased branching and total dry matter production, while P and K application directly or indirectly results in increase in nitrogen use efficiency (Holmes, 1980).

The highest number of siliqua/branch was recorded with the integration of 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + Vermicompost 2.5 t/ha + *Azotobacter*,

which was significantly higher than control, chemical fertilizers alone, integration of FYM or/and vermicompost with 50% RDF and integration of FYM or vermicompost with 75% RDF (Table 1). The highest number of seeds/ siliquae was found with the application of 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + Vermicompost 2.5 t/ha + Azotobacter which was significantly higher than all the treatments except 100% RDF + Vermicompost 5 t/ha and 100% RDF + FYM 5 t/ha + Vermicompost 2.5 t/ha (Table 1). This indicates that supplementing the 100% inorganic fertilizers with organic sources like FYM, vermicompost and seed treatment with *Azotobacter* improves the general soil environment, physico-chemical and biological conditions which helps to improve the mustard growth and yield contributing characters. The positive response of application of FYM, vermicompost and *Azotobacter* has also been reported by Mir *et al*. (2003) and Premi *et al.* (2004).

All the nutrient management treatments (chemical fertilizer alone and integrated nutrient management treatments) resulted in significantly higher seed yield than the control. The highest seed yield was recorded with 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + Vermicompost 2.5 t/ha + *Azotobacter,* which was significantly higher than all the treatments except 100% RDF + FYM 5 t/ha + Vermicompost 2.5 t/ha (Table 2). Application of 100% RDF + FYM 5 t/ha + vermicompost + Azotobacter recorded 10.6 and 23.2 per cent higher seed yield over 75% and 50% RDF alongwith FYM 5 t/ha + vermicompost + *Azotobacter*, respectively. The positive response of supplementary ingredients on seed yield of mustard was also reported by Mir *et al.* (2003), Premi *et al*. (2004), Gudadhe *et al*. (2005), Singh and Sinsinwar (2006) with different combinations of supplementary nutrients applied.

Effect of nutrient management practices on oil content and oil yield

The oil content was decreased with increase in fertilizer levels while further increase was recorded with addition of organic sources of nutrient supply in addition to ferilizers. These results are in close conformity with the findings of Prasad (2000) and Kandpal (2001). Wither (1992) and Tomar *et al.* (1992) observed increase in protein content and decrease in oil content with successive increase in NPK fertilization. This may be due to the fact that the availability of nitrogen increases the proportion of protein substances in the seed leaving a potential deficiency of carbohydrates to be degraded to acetyl Co-A for the synthesis of fatty acids. The differences in oil content due to plant nutrient management practices were non-significant (Table 1). Though the highest oil content was obtained in control but the highest oil yield was observed with 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost 2.5 t/ha + Azotobacter, which was statistically at par with 100% RDF + FYM 5 t/ha + Vermicompost 2.5 t/ha, 100% RDF + Vermicompost 5 t/ha and 75% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost 2.5 t/ha + *Azotobacter*. Significant increase in oil content of Indian mustard in response to application of farm yard manure (5 t/ha) along with *Azotobacter* and *Azospirillum* over control was observed by Singh and Sinsinwar (2006).

Effect of nutrient management practices on protein content and protein yield

The protein content and protein yield were significantly affected by nutrient management practices. The highest protein content was observed with 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost 2.5 t/ha + *Azotobacter*, which was significantly higher than all the treatments except control and 50% RDF. Also the highest protein yield was observed with 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost 2.5 t/ha + *Azotobacter*, which was statistically at par with 100% RDF + FYM 5 t/ha + Vermicompost 2.5 t/ha, 100% RDF + Vermicompost 5 t/ha and 75% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost 2.5 t/ha + *Azotobacter*. Thanki *et al.* (2004) reported that an application of FYM enhanced the oil content and protein yield of mustard

Effect of nutrient management practices on fatty acid composition

The nutrient management practices had non-

Table 1. Yield attributes, yield, oil content, oil yield, protein content and protein yield as influenced by nutrient management practices (Pooled mean of two years)

Treatment		Branches/ plant	No. of siliquae/ plant	Seeds/ siliqua	1000-seed weight (g)	Seed yield (qt/ha)	Oil content (%)	Oil yield (kg/ha)	Protein content (%)	Protein yield (kg/ha)
T_1	Control	15.5	193	13.0	3.60	5.30	39.7	210.5	20.0	106.0
T_2	RDF 50%	16.5	198	13.3	3.62	6.96	39.6	275.5	21.0	172.5
T_3	RDF 75%	16.5	202	13.6	3.63	8.22	38.4	316.0	21.1	172.5
T_4	RDF 100%	16.7	207	13.9	3.63	8.99	38.4	349.0	21.4	192.0
T_5	RDF 50% + FYM 10 t/ha	17.3	209	14.1	3.64	8.92	39.2	349.5	21.6	192.5
T_6	RDF 50% + VC 5 t/ha	17.3	211	14.3	3.65	9.36	39.6	370.5	21.3	199.0
T_7	RDF 50% + FYM 5 t/ha + VC 2.5 t/ha	17.7	216	14.5	3.66	10.01	38.8	388.5	21.3	213.5
T_8	RDF 50%+ FYM 5 t/ha + VC 2.5 t/ha + *Azotobacter*	18.5	220	14.7	3.68	11.09	38.9	431.5	21.4	237.0
T_9	RDF 75% + FYM 10 t/ha	17.5	221	14.7	3.68	10.61	39.3	417.0	21.4	227.5
T_{10}	RDF 75% + VC 5 t/ha	17.8	225	15.0	3.70	10.93	39.3	430.0	21.5	234.5
T_{11}	RDF 75% + FYM 5 t/ha + VC 2.5 t/ha	18.8	229	15.1	3.74	11.82	39.0	460.5	22.0	260.0
T_{12}	RDF 75%+ FYM 5 t/ha + VC 2.5 t/ha + *Azotobacter*	19.2	232	15.4	3.76	12.34	39.1	483.0	21.6	267.0
T_{13}	RDF 100% + FYM 10 t/ha	18.5	231	15.5	3.77	11.72	38.6	452.0	21.7	254.0
T_{14}	RDF 100% + VC 5 t/ha	19.0	235	15.8	3.80	12.23	38.6	472.0	21.7	266.0
T_{15}	RDF 100% + FYM 5 t/ha + VC 2.5 t/ha	20.3	237	16.0	3.83	13.13	38.5	505.0	21.9	288.0
T_{16}	RDF 100%+ FYM 5 t/ha + VC 2.5 t/ha + *Azotobacter*	21.8	240	16.3	3.85	13.64	38.3	523.0	22.0	299.5
	S.Em.±	0.47	5	0.19	0.04	0.41	0.7	18.7	0.3	12.1
	C.D. at 5%	1.33	14	0.54	0.12	1.18	NS	56.2	0.9	34.3

RDF = Recommended dose of fertilizers (120N : 40P : 20K); FYM = Farmyard manure; VC = Vermicompost; *Azoto.* = *Azotobacter*

Table 2. Fatty acid composition and glucosinolate content of seed as influenced by nutrient management practices (Pooled mean of two years)

Treatment		Fatty acid composition (%) of seed						Glucosinolate content (μ mol/g seed)
		Palmitic acid	Oleic acid	Linoleic acid	Linolenic acid	Eicosenoic acid	Erucic acid	
T_1	Control	2.43	6.23	15.80	13.59	1.09	43.98	99.1
T_2	RDF 50%	2.43	6.26	15.80	13.60	1.10	44.35	98.8
T_3	RDF 75%	2.43	6.27	15.82	13.62	1.10	44.70	98.5
T_4	RDF 100%	2.44	6.28	15.86	13.63	1.10	45.27	98.3
T_5	RDF 50% + FYM 10 t/ha	2.44	6.29	15.90	13.65	1.10	45.77	97.5
T_6	RDF 50% + VC 5 t/ha	2.53	6.30	15.91	13.63	1.10	45.77	97.2
T_7	RDF 50% + FYM 5 t/ha + VC 2.5 t/ha	2.44	6.34	15.93	13.68	1.12	46.40	97.6
T_8	RDF 50%+ FYM 5 t/ha + VC 2.5 t/ha + *Azotobacter*	2.45	6.36	15.95	13.71	1.13	47.05	97.5
T_9	RDF 75% + FYM 10 t/ha	2.54	6.36	15.97	13.75	1.13	46.88	97.3
T_{10}	RDF 75% + VC 5 t/ha	2.45	6.37	15.98	13.78	1.13	47.02	96.8
T_{11}	RDF 75% + FYM 5 t/ha + VC 2.5 t/ha	2.45	6.39	16.01	13.85	1.14	47.74	96.3
T_{12}	RDF 75%+ FYM 5 t/ha + VC 2.5 t/ha + *Azotobacter*	2.46	6.41	16.05	13.89	1.14	48.27	96.1
T_{13}	RDF 100% + FYM 10 t/ha	2.47	6.43	16.06	13.93	1.14	48.84	95.6
T_{14}	RDF 100% + VC 5 t/ha	2.48	6.45	16.09	13.98	1.14	49.20	95.1
T_{15}	RDF 100% + FYM 5 t/ha + VC 2.5 t/ha	2.49	6.49	16.13	14.04	1.15	49.65	94.6
T_{16}	RDF 100%+ FYM 5 t/ha + VC 2.5 t/ha + *Azotobacter*	2.49	6.50	16.15	14.08	1.15	50.09	94.0
	S.Em.±	0.04	0.09	0.15	0.22	0.02	2.08	1.1
	C.D. at 5%	NS	NS	NS	NS	NS	5.76	3.0

RDF = Recommended dose of fertilizers (120N : 40P : 20K); FYM = Farmyard manure; VC = Vermicompost; *Azoto.* = *Azotobacter*

significant effect on fatty acid composition *i.e.* Palmitic acid, Oleic acid, Linoleic acid, Linolenic acid and Eicosenoic acid but Erucic acid content was significantly affected by nutrient management practices. The higher content of Palmitic acid, Oleic acid, Linoleic acid, Linolenic acid and Eicosenoic acid were recorded in response to application of 75% or 100% RDF coupled with FYM and/or vermicompost than chemical fertilizers alone. The highest Erucic content was observed with 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost 2.5 t/ha + Azotobacter, which was significantly higher than control. The fatty acid composition of rape oil is mainly under genetic control. Although, nitrogen fertilizer can affect it slightly, no effect could be detected in many investigations (Holmes and Bennett, 1979; Lammerink and Morice, 1970). Appelquist (1968) suggested that an adequate level of nitrogen nutrition can promote elongation of the fatty acid carbon chain and desaturation; high nitrogen increases the proportion of erucic acid (22:1) at the expense of eicosenoic (20:1) and oleic (18:1) and also slightly increased the proportion of the less saturated 18 carbon acids. Significant effect of S nutrient had been observed by Chakraborty *et al.*, (1994) and Rotkeiwicz *et al.*, (1996).

Effect of nutrient management practices on Glucosinolate content

The nutrient management practices had significant effect on Glucosinolate content. The lowest Glucosinolate content was recorded with 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost 2.5 t/ha + *Azotobacter*, which was significantly lower than control and application of chemical fertilizers alone. The highest Glucosinolate content was observed in control. Most of the rapeseed-mustard varieties grown in India contain high glucosinolates (4.0-13.0%) which adversely affect palatability due to its pungent smell (Tripathi and Singhal, 1995). The usual effect of nitrogen fertilizer on the glucosinolate content of rapeseed is to depress it (Zhao *et al.*, 1993 and Wetter *et al.*, 1970).

In summary, integrated use of 100% recommended fertilizer dose with organic sources of nutrient gives higher number of branches/plant, number of siliquae/branch, seeds/siliqua and seed yield of mustard, beside higher content of Palmitic acid, Oleic acid, Linoleic acid, Linolenic acid, Eicosenoic acid and Erucic acid and lower content of Glucosinolate than the application of chemical fertilizers alone.

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