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Response of Integrated Nutrient Management on Growth, Yield and Economics of Indian mustard (*Brassica juncea* L.) in Chhattisgarh Plains

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A B S T R A C T

The field experiments were conducted at the Instructional Farm, Krishi Vigyan Kendra, Raigarh (C.G.). During rabi 2016-17on *Inceptisol* to study the response of integrated nutrient management (INM) on growth, yield and economics of mustard (*Brassica juncea L.*). The experiment was laid out in randomized block design (RBD) comprising nine treatments with three applications. The results revealed that significantly better growth and yield attributes i.e. plant height (141.33 cm), no. siliqua plant^{-1} (249.67) and seed yield (1545.30 kg ha^{-1}) was obtained with combined application of T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] with all the treatments over control. The application of T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] was also found significantly higher gross cost (30750.00 Rs ha^{-1}) and gross return (57176.00 Rs ha^{-1}) over rest of the treatments. While, net return (29856.00 Rs ha^{-1}) was significantly higher with application of T_9 [75 % RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} +Azotobactor + PSB] over rest of the treatments except at par with T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB]. The highest benefit cost ratio (B: C ratio) was observed of mustard (3.93) with the application of T_6 [75 % RDF (75: 60:30: 22.5 ha^{-1} NPKS)].

Introduction

Rapeseed-mustard is the third important oilseed crop in the world. Indian mustard is important oilseed crop and determinant of agricultural economy of the country. Among the seven edible oilseed cultivated in India, rapeseed-mustard (*Brassica spp*.) contributes 28.6 per cent in the total production of oilseeds. In India, it is the second most important edible oilseed after groundnut sharing 27.8 per cent in India's oilseed economy. The share of oilseeds is 14.1 per cent out of the total cropped area, rapeseed-mustard accounts for 3 per cent to the Gross National Product and 10 per cent to the total value of all Agricultural commodities. In India rapeseed-mustard is grown on an area of 25.6 m ha with production and productivity of 27.5 m t and 1075 kg ha^{-1}, respectively (Anonymous, 2016). The global production of rapeseed-mustard and its oil is around 38–42 and 12–14 m t, respectively. India contributes 28.3 per cent and 19.8 per cent in world acreage and production. Due to intensive cultivation and imbalanced and inadequate

supply of fertilizers accompanied by restricted use of organic manures have made the soils not only deficient in the nutrients, but also deteriorated the soil health resulting in decline in crop response. In order to bring the soil well supplied with all the essential plant nutrients, the organic manures being cheaper and eco-friendly could be the alternative to fertilizers for improving both crop productivity and sustainability of the systems. Integrated use of vermicompost with fertilizers, not only supplies macronutrients but also meet the requirement of micronutrients and maintains physico-chemical properties of soil. Integrated use of nutrient is very essential approach, which not only sustains high crop production over the years but also improves soil health and ensures safer environment. Sulphur is also important element which increases yield attributes resultantly the yield of Indian mustard (Kumar *et al.,* 2011) and also enhanced S uptake as well as oil content (Singh and Pal, 2011 and Kumar and Trivedi, 2012). Biofertilizers can prove to be an effective low cost technology for the farmers. Thus, there is a need to improve the nutrient supply systems in terms of integrated nutrient management involving the use of fertilizers in conjunction with organic manures and fertilizers.

Materials and Methods

The field experiments was conducted on mustard during rabi 2016-17 for evaluating the growth and yield response under integrated nutrient management (INM) at the Instructional Farm of Krishi Vigyan Kendra, Raigarh (C.G.). The experimental site is located on the Northern part of Chhattisgarh and lies at 21°54'N latitude and 83°24' E longitude with an altitude of 215 m above the mean sea level (MSL). The soil of the experimental fields was an Inceptisol of silty clay loam texture with pH 6.50, EC 0.13 dSm^{-1}, organic carbon (OC) 5.0 g kg^{-1}, available nitrogen 210 kg ha^{-1}, available phosphorus 20.83 kg ha^{-1}, available potash 295 kg ha^{-1} and available sulphur 20.53 kg ha^{-1}. The experiment was laid out in randomized block design comprising nine treatments *i.e.* T_1- Control, T_2 -RDF (100:80:40:30 kg ha^{-1} NPKS), T_3 -RDF + Vermicompost 3 t ha^{-1}, T_4 - RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1}, T_5 - RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB, T_6 -75 % RDF (75: 60:30:22.5 ha^{-1} NPKS), T_7 -75 % RDF + Vermicompost 3 t ha^{-1}, T_8-75 % RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1}, T_9 -75 % RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB with replicated three times. Well decomposed FYM and vermicompost is properly incorporate in soil of experimental site. The 50% of N and full dose of P_2O_5, K_2O and sulphur was applied as basal dose. Remaining 50% dose of N is applied as top dressing. The crop variety was Chhattisgarh Sarson used as a test crop. Five plants were selected randomly from each plot for sampling purposes and observations were recorded. The data regarding growth characters, yield attributes and yield were analysed with statistical tools applied as and when required for the study. Economics of experiment was worked out, net return is the product of gross cost subtracted from gross return while, benefit cost ratio (B: C) was obtained when gross return divided by gross cost.

Results and Discussion

Growth and yield attributes

The data revealed that significant differences were observed in growth and yield attributes with all treatments depicted in table 1. The maximum plant height (141.33 cm) and no. siliqua $plant^{-1}$ (249.67) was recorded with T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] which was significantly superior with all the treatments over control,

where treatments were integrated with organics and bio fertilizers. Similar finding was also reported by Tripathi *et al.,* (2010) and Chandan *et al.,* (2018). The no. of seeds siliqua^{-1} had no significant response to different treatments. The results indicate that the highest plant height (141.33 cm) was recorded with T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] followed by T_9 [75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} +Azotobactor + PSB] (139.99 cm) and T_4 [RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1}] (136.55 cm).

The results showed that the use of 25% reduced quantity of NPK with organics and bio-fertilizers proved better combination in terms of seeds siliqua-1. The similar finding was also reported by Singh and Singh (2006), Rundala *et al.,* (2013) and Thaneshwar *et al.,* (2017). The maximum no. of siliqua plant^{-1} (249.67) was recorded with T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] followed by T_9 [75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} +Azotobactor + PSB] (238.33) and T_4 [RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1}] (238.33), where treatments were integrated with organics and biofertilizers. Similar finding was also reported by Pal *et al.,* (2008) and Swarup (2010). Data showed that the highest no. of seeds siliqua^{-1} (11.30) was recorded with T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] followed by T_9 [75 % RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} +Azotobactor + PSB] (11.10) and T_4 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1}] (10.80). The results showed that the use of 25% reduced quantity of NPK with organics and bio-fertilizers proved better combination in terms of no. seeds siliqua^{-1}. The similar finding was also reported by Ramesh *et al.,* (2009) and Pal and Pathak (2016). The seed yield of mustard increased significantly with all the treatments over control. The maximum (1545.30 kg ha^{-1}) and minimum seed yield (765.25 kg ha^{-1}) were recorded with T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] and control treatment, respectively.

Table.1 Effect of integrated nutrient management on growth and yield of mustard

Treatments	Plant height at maturity (cm)	No. of siliqua plant^{-1}	No. of seeds siliqua^{-1}	Seed yield (kg ha^{-1})
T_1 [Control]	118.22	158.67	8.90	765.25
T_2 [RDF (100:80:40:30 kg ha^{-1}NPKS)]	126.10	213.33	10.20	1255.50
T_3 [RDF + Vermicompost 3 t ha^{-1}]	131.67	227.67	10.60	1375.25
T_4 [RDF + Vermicompost 3 t ha^{-1} + FYM 5t ha^{-1}]	136.55	238.33	10.80	1450.65
T_5 [RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} + Azotobactor + PSB]	141.33	249.67	11.30	1545.30
T_6 [75 % RDF (75: 60:30:22.5 ha^{-1}NPKS)]	123.26	207.00	9.80	1075.60
T_7 [75 % RDF + Vermicompost 3t ha^{-1}]	128.22	218.33	10.50	1240.35
T_8[75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1}]	134.42	229.67	10.70	1325.75
T_9 [75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} +Azotobactor + PSB]	139.99	238.33	11.10	1430.25
SE(m) ±	0.19	0.03	0.51	0.35
C.D. (P=0.05)	0.58	0.11	NS	1.06

Table.2 Effect of integrated nutrient management on economics of mustard

Treatments	Gross cost (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
T_1 [Control]	8750.00	28314.00	19564.00	3.23
T_2 [RDF (100:80:40:30 kg ha^{-1}NPKS)]	13500.00	46454.00	32954.00	3.44
T_3 [RDF + Vermicompost 3t ha^{-1}]	28500.00	50885.00	22385.00	1.78
T_4 [RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1}]	30500.00	53674.00	23174.00	1.76
T_5 [RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} + Azotobactor + PSB]	30750.00	57176.00	26426.00	1.86
T_6 [75 % RDF (75: 60:30:22.5 ha^{-1}NPKS)]	10125.00	39797.00	29672.00	3.93
T_7 [75 % RDF +Vermicompost 3t ha^{-1}]	21375.00	45893.00	24518.00	2.15
T_8[75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1}]	22875.00	49053.00	26178.00	2.14
T_9 [75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} +Azotobactor + PSB]	23063.00	52919.00	29856.00	2.29
SE(m) ±	0.19	17.68	0.17	0.018
C.D. (P=0.05)	0.57	53.48	0.50	0.053

The variation in seed yield was observed due to variation in treatment combinations. The increment in seed yield might be due to improvement in soil quality with the application of vermicompost, farm yard manures, bio fertilizers and instant availability of nutrients from inorganic fertilizers. These finding are also reported by Chandra and Ram (2007) and Saha *et al.*, (2010). The application of reduced quantity of chemical fertilizers along with organics and microbial inoculants gave better results in terms of yield and yield attributing traits and prove better sustainable integrated nutrients management option for farmers.

Economic analysis

The result indicated that effect of integrated nutrient management (INM) on economics of mustard with various treatments presented in table 2. The maximum gross cost (30750.00 Rs ha^{-1}) and maximum gross return (57176.00 Rs ha^{-1}) of mustard was recorded with the application of T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB]. The maximum net return (29856.00 Rs ha^{-1}) of mustard was noted with the application of T_9 [75 % RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} +Azotobactor + PSB]. The highest benefit cost ratio (B: C ratio) was observed of mustard (3.93) with the application of T_6 [75 % RDF (75: 60:30: 22.5 ha^{-1} NPKS)]. In any case the treatments were highly remunerative and treatments had economic viability in absolute term. There are two considerations in the economic implications, the yield maximization against lower profit and economic maximization at the cost of productivity. The higher productivity means the higher food availability with a marginal sacrifice of monetary return. The findings are in close conformity of Chaurasia *et al.*, (2009) and Singh *et al.*, (2014).

The present study revealed that integrated nutrients management on the basis of above findings it can be concluded that treatment T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB] shows the best results with respect to significant growth and yield

attributes. From the economical point of view, the T_9 [75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} +Azotobactor + PSB] treatment gave higher net return (29856.00 Rs ha^{-1}) over rest of the treatments. While benefit: cost ratio (B: C) was significantly higher (3.93) with application of T_6 [75 % RDF (75: 60:30:22.5 ha^{-1}NPKS)] over rest of the treatments except being at par with T_5 [RDF + Vermicompost 3 t ha^{-1} + FYM 5 t ha^{-1} + Azotobactor + PSB]. Therefore treatment T_9 [75 % RDF + Vermicompost 3t ha^{-1} + FYM 5t ha^{-1} +Azotobactor + PSB] is recommended for higher net return in mustard cultivation. The application of reduced quantity of chemical fertilizers along with organics and microbial inoculants gave better results in terms of yield and yield attributing traits and prove better sustainable integrated nutrients management option for farmers.

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