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Effect of integrated nutrient management on performance and production economics in mustard [*Brassica juncea* (L.) Czerny & Cosson]

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Abstract
An experiment was conducted during *Rabi* season 2015-16 at Students' Instructional Farm (SIF), C.S.A.U.A&T Kanpur. Twelve treatments were tested in three replicated Randomized Block Design. Result found that significantly higher number of primary and secondary branches plant^{-1} and yield (24.30 q/ha) was obtained with combined application of RDN 50% + 25% FYM + 25% vermicompost + 30 kg S + azotobacter over rest of the treatments. The minimum grain yield (20.15 q/ha) and biological yield was received in treatment 100% RDN. The application of RDN 50% + 25% FYM + 25% vermicompost + 30 kg S + azotobacter was also found significantly higher gross income (Rs. 107210/ha) and net profit (Rs. 69798/ha) over rest of the treatments. Benefit: Cost ratio was also significantly higher (1.87) with application of RDN 50% + 25% FYM + 25% vermicompost + 30 kg S + azotobacter over rest of the treatments. The minimum gross income (Rs. 88889/ha), net income (Rs.54796/ha) and B: C ratio was received in treatment of 100% RDN. Thus, mustard fertilized with RDN 50% + 25% FYM+25% vermicompost+30 kg S +azotobacter have to be more remunerative in terms of economic and yields.

Keywords: INM, yield, production economics, performance and mustard

Introduction

Mustard is cultivated over an area of about 65.17 lakh hectares with production of 57.4 lakh tonnes of seed in India. The average yield of mustard is 1234 kg ha^{-1} in 2014-15 and it is cultivated over an area of about 5.8 million hectare with production 6.3 million tons in 2014-2015. In India, Rajasthan ranks first both in area and production and Bihar state has the highest productivity of mustard. In Uttar Pradesh, mustard is grown on 0.82 million hectare area with production of 0.90 million tonnes and productivity of 1141 kg ha^{-1}, which is more than the national average (Anonymous, 2017) [1].

Continuous and sole application of artificial or inorganic fertilizer induces the soil sickness and disturb the soil environment, to result in low productivity and unsustainability. Randhawa (1992) [17] stated that continuous application of chemical fertilizer create acidity resulting in phyto toxicity in crops. On other hand organic sources are ecofriendly, improve productivity and sustainability.

Nitrogen is an important constituent of protein. Higher the nitrogen greater would be the protein and protoplasm which would increase, in turn greater cell size, leaf area index resulting into greater photosynthetic activity. Phosphorus fertilization improves growth of rapeseed crops. Besides growth, phosphorus reduces the adverse effects of excess nitrogen fertilization. The role of potash in rapeseed mustard is to activate a wide range of enzyme systems. Although, vermicompost is a good organic source of plant nutrient supply. It is a rich source of nitrogen (3%), phosphorus (1%), potassium (1.50%), calcium (0.44%), Magnesium (0.15%), sulphur (0.45%), zinc (24.43ppm), iron (175.2ppm) vitamins and growth hormones which enhance plant growth and microbial population. In contrary to synthetic fertilizers, vermicompost reduce soil toxicity by buffering action, prevent soil degradation and enhance soil fertility status. Similarly, Farm Yard Manure (FYM) occupies important position among the organic manures. It supplies N, P and K in available form to the plant through biological decomposition, it contains 0.5-1.5, 0.4-0.8 and 0.5-1.9 percent of N, P and K respectively Sulphur is an important secondary plant nutrient which is essential for proper growth and functioning of the plant.

It is observed as divalent-sulphate ion. It is metabolized by roots only to the extent that they review it and most of the observed sulphate is translocated unchanged to the shoots. However, its deficiency causes general yellowing throughout the affected leaves and the deficiencies are usually noted first in younger leaves. Sulphur also results in a considerable amount of increase in growth and yield of mustard along with an increase in the oil content of mustard varieties. Moreover, significant response of oilseed to the tune of 30-40% was recorded due to the use of secondary major nutrients and micronutrients and with significant residual effect in cropping system (Hegde and Babu, 2016) [4]. Therefore, existing study was deliberate to assess the effect of integrated nutrient management on performance and production economics in mustard.

Materials and methods

Experimental details and site description

The present investigation was carried out at students Instruction Farm, Chandra Shekhar Azad university of Agriculture & Technology, Kanpur (U.P.). The present experiment was carried out during *Rabi* 2015-2016 in field at Students' Instructional Farm (SIF).The field was well leveled and irrigated by tubewell the farm is situated in west northern part of Kanpur city under subtropical zone in 5^{th} agro-climatic zone (central plain zone).Farm is falling in alluvial belt of gangetic plain of U.P. between $25^0 56$'N to $28^0 58$'N latitude and $79^0 31$' to 80^0 E longitudes and at an elevation of 125.9 meter from mean sea level. The average weekly maximum and minimum temperatures during the crop growth period ranged from 33.90^0C and 17.3 ^{0}C and 16.9 ^{0}C to 9.2 ^{0}C respectively. The relative humidity ranged between 42.1 to 85.5%, wind speed between 1.9 to 6.00 km/hr. Total evaporation ranged from 1.3 to 3.5 mm. The total rainfall received during the crop period was 23.3 mm. The soil of experimental field was slightly alkaline in reaction with 7.9 pH, low in organic carbon (0.32%) and low in available nitrogen (180.4 kg ha^{-1}), phosphorus (18.4 kg ha^{-1}), medium in potassium (290 kg/ha), available sulphur 7.3 (ppm) and available Zinc 0.59 (ppm). All the soil properties were analyzed as per the standard procedures adopted by Page (1982) [7]. The experiment consist of 12 treatments combinations which were laid out in Randomized Block Design with three replications.

Data Collection

The various observations on number of primary and secondary branches were counted from five randomly selected plant at 90 DAS and at harvest, yield attributes (number of seeds $siliqua^{-1}$and 1000-seed weight) were recorded as per standard procedure. Moreover, yields viz., grain and biological yield of mustard (q/ha) was worked out in different plot of the experimental field.

Production Economics

Economics of different treatment was worked out by taking into account the cost of cultivation and existing sale price of produce. Gross income was worked out by multiplying seed and stover yield obtained under various treatments with the prevailing market selling price. Net income in (Rs. ha^{-1}) was worked out by substracting the total cost of cultivation from gross income. The gross return and net return as well as the net return $rupee^{-1}$ invested were worked out as follows for each treatment.

Statistical analysis

The data on various parameters were exposed to statistically analyze as drew by Gomez and Gomez (1984) [3]. The treatment variances were tested by using "F" test and critical differences (at 5 percent probability).

Results and Discussion

The maximum primary branches and secondary branches at initial flowering and maturity stage, number of secondry branching at initial flowering and maturity stage of crop were recorded in RDN 50% + 25% FYM + 25% vermicompost + 30 kg S + Azotobacter followed by the RDN 50% + 25% FYM+25% vermicompost + 30 kg. RDN 50% + 25% FYM + 25% vermicompost. RDN 75% + 12.5%VC +12.5% FYM + 30kg S+ azotobacter. RDN 75% + 12.5%VC + 12.5% FYM + 30kg S, RDN 50% + 50% Vermicompost, RDN 50% + 50% FYM.and RDN 100% + 30 kg S. RDN 75% + 12.5% FYM + 12.5% vermicompost. RDN 75% + 25% VC. RDN 75% + 25% FYM and in RDN 100% minimum branches was recorded respectively This may be due to the better establishment of plants under this treatment compared to other remaining treatments and it might be also due to improvement in nutrient availability particularly those of vermicompost and NPKS by same reported by Singh *et al.* (2011) [10].

Yield attributes

Significantly highest number of seeds $siliqua^{-1}$and 1000-seed weight was noted in treatment RDN 50% + 25% FYM + 25% vermicompost + 30kg S +Azotobacter followed by the RDN 50% + 25% FYM + 25% vermicompost + 30kg. RDN 50% + 25% FYM + 25% vermicompost. RDN 75% + 12.5%VC + 12.5% FYM + 30kg S + azotobacter. RDN 75% + 12.5%VC + 12.5% FYM + 30kg S, RDN 50% + 50% Vermicompost, RDN 50% + 50% FYM.and RDN 100% + 30 kg S. RDN 75% + 12.5% FYM + 12.5% vermicompost. RDN 75% + 25% VC. RDN 75% + 25% FYM and in RDN 100%. Since the plant had larger vegetative growth on account of better root development and congenial moisture situations the seed size must have been increased due to more carbohydrates, synthesis process etc. under integrated nutrient supply by Mandal and Sinha (2004) and Kashved *et al.* (2010) [5, 6].

Yields

Maximum produce of grain yield and biological yield q/ha of mustard were recorded in RDN 50% + 25% FYM + 25% vermicompost + 30kg S + azotobacter, followed by rest, RDN 75% + 12.5%VC + 12.5% FYM + 30kg S, RDN 50% + 50% Vermicompost, RDN 50% + 50% FYM.and RDN 100% + 30 kg S. RDN 75% + 12.5% FYM + 12.5% vermicompost. RDN 75% + 25% VC. RDN 75% + 25% FYM and in RDN 100% in respect to grain yield and biological yield. The most probable reason for this phenomenon may be longer plant and increased dry matter, more vegetative growth under organic and inorganic nutrient supply. This might had resulted to increase straw yield, grain yield and consequently total biomass production by Tripathi *et al.* (2010) [11] and Premi *et al.* (2005) [8] reported similar result as yields.

Production economics

The highest gross income of mustard Rs 107210 /ha, net income of Rs 69798/ha were received with the application of RDN 50% + 25% FYM + 25% vermicompost +30kg S+ azotobacter, followed by other used treatment but B: C ratio was maximum recorded in mustard 1.87 with the use of of RDN 50% + 25% FYM + 25% vermicompost + 30kg S +

azotobacter, over other remaining treatments respectively. Organic and inorganic combined nutrient supply will have favourable effect on development of photosynthetic organ and rate of accumulation of growth characters, yield characters and yields. The findings are in close conformity of Tripathi *et al.* (2010) [11] and Premi *et al.* (2005) [8].

Table 1: Effect of integrated nutrient management on different parameters of mustard

Treatment	Number of primary branches plant^{-1}		Number of secondary branches plant^{-1}		Number of seeds siliqua^{-1}	1000-seed weight (g)
	90(DAS)	At harvesting	90(DAS)	At harvesting		
T_1-100% RDN	5.77	5.79	5.55	5.57	10.44	4.30
T_2-75% RDN+ 25% FYM	5.84	5.86	5.66	5.99	10.59	4.52
T_3-75%RDN +25% N VC	5.99	6.01	5.79	5.81	10.41	4.49
T_4-75% RDN + 12.5% FYM + 12.5% VC	6.17	6.19	5.88	5.90	10.77	4.53
T_5-75% RDN + 12.5% FYM + 12.5% VC + 30 kg S	7.92	7.04	7.01	7.03	11.66	4.82
T_6- 75% RDN + 12.5% FYM + 12.5% VC + 30 kAzotobactor	8.01	8.03	7.24	7.26	11.80	4.87
T_7-50% RDN + 50% N FYM	6.94	6.96	6.88	6.90	11.02	4.70
T_8-50% RDN + 50% VC	7.14	7.16	6.94	6.96	11.44	4.77
T_9-50% RDN +25% FYM + 25% VC	8.72	8.74	7.94	7.96	12.03	4.94
T_{10}-50% RDN + 25% FYM + 25% VC + 30 kg S	9.04	9.06	8.21	8.23	12.06	4.96
T_{11}- 50% RDN + 25% FYM + 25% VC + 30 kg S Azotobacter	9.20	9.22	8.98	9.00	12.08	4.98
T_{12}-100% RDN + 30 kg S	6.24	6.24	5.96	6.00	10.91	4.64
SE(d)±w	0.351	0.281	0.415	0.473	0.454	0.187
CD at 5%	0.728	0.584	1.219	1.389	0.943	0.389

Table 2: Effect of integrated nutrient management on different parameters of mustard

Treatment	Biological yield (q ha^{-1})	Seed yield (q ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. Ha$^{)}$	B-C ratio
T_1-100% RDN	92.82	20.15	88689	54596	1.60
T_2-75% RDN+ 25% FYM	98.30	21.20	93660	58020	1.62
T_3-75%RDN +25% N VC	99.70	21.50	94990	60734	1.77
T_4-75% RDN + 12.5% FYM + 12.5% VC	100.95	21.80	95090	59936	1.64
T_5-75% RDN + 12.5% FYM + 12.5% VC + 30 kg S	104.20	22.10	97990	61113	1.65
T_6- 75% RDN + 12.5% FYM + 12.5% VC + 30 kg S + Azotobactor	105.15	22.75	100455	63578	1.72
T_7-50% RDN + 50% N FYM	103.20	21.90	97089	61884	1.75
T_8-50% RDN + 50% VC	103.85	22.15	98095	63998	1.82
T_9-50% RDN +25% FYM + 25% VC	106.70	23.10	101990	66348	1.83
T_{10}-50% RDN + 25% FYM + 25% VC + 30 kg S	108.75	23.60	104150	66758	1.80
T_{11}- 50% RDN + 25% FYM + 25% VC + 30 kg S + Azotobacter	111.80	24.30	107210	69798	1.87
T_{12}-100% RDN + 30 kg S	101.35	21.75	96295	60452	1.68
SE(d)±	3.2513	0.9388	728.978	202.24	0.073
CD at 5%	6.744	1.947	1512.421	1258.78	0.153

Conclusion

Result from experiment revealed that significantly higher number of primary and secondary branches plant^{-1} and grain yield (24.30 q/ha) was obtained with combined application of RDN 50% + 25% FYM+25% vermicompost+30 kg S +Azotobacter over rest of the treatments. The application of RDN 50% + 25% FYM+25% vermicompost+30 kg S +azotobacter was also found higher in gross income, net profit and Benefit: Cost ratio over rest of the treatments. Thus, mustard fertilized with RDN 50% + 25% FYM+25% vermicompost+30 kg S +azotobacter have to be more remunerative in terms of economic and yields.

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