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Original Research Article

Integrated Nutrient Management in Mustard (*Brassica juncea* L.)

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Keywords

Farmyard manure, Azotobacter, Yield, Quality, Mustard, Nutrient uptake, Zinc

A B S T R A C T

A field experiment was carried out at the instructional Farm, Rajasthan College of Agriculture, Udaipur during *rabi* season 2011-12 to study the effect of integrated nutrient management on yield, quality and nutrient uptake of mustard (*Brassica juncea* L.). Significantly maximum seed and stover yield was recorded under treatment 75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_6). The seed and stover yield of mustard significantly increased by 68.44 and 36.46 per cent, respectively over control. The highest total uptake of N, P, K, S and Zn were recorded with 75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_6) which were 89.08, 65.35, 80.25, 94.11 and 77.78 per cent higher over control. The highest oil content and oil yield were registered with 50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_9) which was at par with T_6.

Introduction

Mustard is the second most important *rabi* oilseed crops in India occupying 6.51 mha acreage, 7.67 mt production and 1179 kg ha^{-1} productivity (Anonymous, 2010). The productivity is quite lower than other developed countries mainly due to sub-optimal application of fertilizers and cultivation on marginal lands. Further the quality of mustard oil and its cake is an important aspect affected greatly by mineral nutrition (Tripathi *et al.*, 2010). The gap between production and demand of oilseeds is progressively widening, therefore, the production of oilseed is to be increased for self-sufficiency. Mustard is a major oilseed crop and its oil is consumed mainly in North India. It is mainly grown in *rabi* season under poor management with imbalanced fertilization. The cost of production is increasing due to high prices of inorganic fertilizers.

Therefore, the alternatives of chemical fertilizers are to be looked into just to reduce the cost of cultivation. The organic manures being cheaper and eco-friendly, like FYM, compost and also biofertilizers are available and could be the alternatives of chemical fertilizers for improving both crop productivity and sustainability of the systems. Therefore, the present study was carried out with objective to study the effect of integrated nutrient management on seed yield, seed quality and nutrient uptake of mustard in agro climatic zone IV A of Rajasthan.

Materials and Methods

The experiment was conducted at the Instructional Farm, Rajasthan College of Agriculture, Udaipur during *Rabi* 2011-2012. The site is situated at South-Eastern part of Rajasthan at an altitude of 579.5 m above mean sea level, at 24°35' N latitude and 74°42' E longitude. The mean annual rainfall of the region is 637 mm, most of which is contributed by south west monsoon from July to September. Maximum and minimum temperatures ranged between 21.6 to 32.4 ºC and 4.2 to 15.7 ºC, respectively during *Rabi* 2011-2012. Before conducting the experiment, initial characteristics of the soil was determined by standards procedure as described by Jackson (1973). The soil of experimental site was sandy clay loam in texture, slightly alkaline in reaction (pH 8.11). The soil was medium in available nitrogen (264.24 kg ha^{-1}), phosphorus (18.36 kg ha^{-1}) and Sulphur (7.12 mg kg^{-1}), while high in potassium (356.59 kg ha^{-1}), and medium in DTPA extractable Fe (5.10 mg kg^{-1}), Mn (8.92 mg kg^{-1}), Zn (1.03 mg kg^{-1}) and Cu (2.05 mg kg^{-1}). The field experiment consisted of 10 treatments, i e. [T_1: Control, T_2: 100 % STR, T_3: 100 % STR + Zn @ 5 kg ha^{-1}, T_4: 75 % STR + FYM @ 5 t ha^{-1}, T_5: 75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1}, T_6: 75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*, T_7: 50 % STR + FYM @ 5 t ha^{-1}, T_8: 50% STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1}, T_9: 50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*, T_{10}: FYM @ 5 t ha^{-1}]. These treatments were replicated three times in RBD with mustard variety BIO-902. The field was prepared by cross cultivator followed by planking to obtain well pulverized soil tilth. Fertilizer will be applied as per treatments. Seed and stover yield were recorded $plot^{-1}$ and converted in to kg ha^{-1} and oil content in mustard seed determined by Soxhlet's Ether Extractation Method (A.O.A.C.1965). Nutrient content in seed and stover samples were determined as Nitrogen by Colorimetric method (Snell and Snell, 1959). P by Vandomolybdo phosphoric acid yellow colour method and K by Flame Photometer method (Jackson, 1973), S by Turbidi-metric method (Tabatabai & Bremner (1970)) and Zn estimation on AAS (Lindsay and Norvell, 1978).

Results and Discussion

Yield and Quality Parameters

The perusal of data in Table 1 revealed that the maximum seed (2139.37 kg ha^{-1}) and stover yield (4993.83 kg ha^{-1}) was recorded under 75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_6) which was at par with treatment T_9 (50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*) and significantly increased over rest of treatment and control. The highest oil content (41.50%) and oil yield (872.65 kg ha^{-1}) was recorded at T_9 (50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*) which were at par with T_6 (75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*) but significantly higher (14.67%) and (89.43%) over control. Application of chemical fertilizers with FYM, Zn and seed treatment with *Azotobacter* increased the yield component and oil content over STR fertilizers alone and control. It was due to improved physic-chemical properties of soil and provides a better soil environment for the biological activity and improved microbial population of the experiment soil, fixing the atmospheric nitrogen in soil and also supplies micronutrient which beneficial to the crop growth and productivity. The greater stover yield at higher fertility was attributed to increased plant height and leaf area and finally dry matter accumulation $plant^{-1}$.

Table.1 Effect of integrated nutrient management on seed and stover yield (kg ha^{-1}), oil content (%) and oil yield (kg ha^{-1}) of mustard

	Treatments	Seed yield	Stover yield	Oil content	Oil yield
T_1	Control	1270.09	3659.48	36.19	460.66
T_2	100 % STR.	1538.00	4146.72	37.40	575.23
T_3	100 % STR + Zn @ 5 kg ha^{-1}.	1648.33	4303.74	37.74	621.98
T_4	75 % STR + FYM @ 5 t ha^{-1}.	1604.05	4285.15	38.16	612.15
T_5	75% STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1}.	1898.86	4629.49	39.44	748.92
T_6	75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*.	2139.37	4993.83	40.13	858.52
T_7	50 % STR + FYM @ 5 t ha^{-1}.	1594.28	4306.32	39.00	621.76
T_8	50% STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1}.	1876.32	4573.45	39.76	746.28
T_9	50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*.	2102.72	4915.59	41.50	872.65
T_{10}	FYM @ 5 t ha^{-1}.	1508.46	4092.04	37.30	562.40
	SEm±	75.698	106.579	0.334	30.939
	CD (5%)	224.910	316.665	0.993	91.926

Table.2 Effect of integrated nutrient management on nutrient uptake by mustard

		Total nutrient uptake by mustard				
	Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Sulphur (kg ha^{-1})	Zinc (g ha^{-1})
T_1	Control	61.73	20.03	48.70	29.72	145.45
T_2	100 % STR.	77.74	23.98	59.59	39.02	178.04
T_3	100 % STR + Zn @ 5 kg ha^{-1}.	84.74	25.84	63.80	41.85	196.85
T_4	75 % STR + FYM @ 5 t ha^{-1}.	82.12	25.32	62.84	41.73	192.51
T_5	75% STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1}.	99.91	29.04	74.12	50.85	225.47
T_6	75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*.	116.72	33.12	87.78	57.69	258.58
T_7	50 % STR + FYM @ 5 t ha^{-1}.	81.11	25.32	62.43	41.33	191.51
T_8	50% STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1}.	99.40	28.43	70.44	47.80	221.00
T_9	50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter*.	113.47	32.46	83.80	55.77	251.68
T_{10}	FYM @ 5 t ha^{-1}.	75.77	23.33	57.24	38.25	175.04
	SEm±	3.044	0.733	1.759	1.384	5.947
	CD (5%)	9.045	2.177	5.227	4.111	17.669

The results of the present investigation are in agreement with the findings by several researchers (Das, *et al.,* 2010, Kumpawat, 2010 and Singh and Pal 2011). The increase in oil content under FYM, zinc and seed treatment with *Azotobacter* might be attributed to the increased availability of S and Zn that involved in an increased conversion of primary fatty acids metabolites to the end products of fatty acid as supported by Tripathi *et al.,* (2010). Further higher levels of STR fertilizers improved more availability of N which increased the proportion of protein aciuous substance in the seed. Under high N supply, a large proportion of potosynthates may have diverted to protein formation leaving a potential deficiency of carbohydrates to be degraded to 'acetyl co-enzyme A' precursor of fatty acids resulted in to low oil content. These results are in close conformity with the findings of (Shukla *et al.,* 2002, Singh and Pal, 2011)

Nutrient Uptake by Mustard

Data presented in Table 2 reveals that different treatment of integrated nutrient management significantly increased total uptake of N, P, K, S, and Zn by mustard over control and STR fertilizers alone. The highest total uptake of nitrogen (116.72 kg ha^{-1}), phosphorus (33.12 kg ha^{-1}), potassium (87.78 kg ha^{-1}) and sulphur (57.69 kg ha^{-1}) was recorded under 75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_6) which was at par with 50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_9). The highest nutrient uptake of N, P, K, and S by mustard was noted with the application of STR along with FYM, Zn and *Azotobacter* that could be ascribed to all nutrients availability to crop that increased biomass production and thus uptake. Similar results were reported by Tripathi *et al.*, 2010. The higher amount of uptake of these nutrient elements are closely correlated with their increased availability in soil. 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 the observation are in agreement with those of (Mandal and Sinha, 2002). The finding on the increase uptake of nutrient by application of chemical fertilizers with FYM and biofertilizers are in agreement with the observations made by Mitra and Mandal, (2012), Singh and Pal, (2011) and Chand, *et al.,* (2007). The highest total Zn uptake by mustard (258.58 g ha^{-1}) was obtained under 75 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_6) which was at par with 50 % STR + FYM @ 5 t ha^{-1} + Zn @ 5 kg ha^{-1} + *Azotobacter* (T_9) and significantly increased (77.78%) and (45.24%) higher over control and 100% STR. Tripathi *et al.,* (2010) also reported that application of Zn with FYM, *Azotobacter* and fertilizers in balanced proportion or at recommended level enhanced the efficiency of Zn, thus maintained synergistic interaction by which in content and uptake is significantly increased in seed and stover of Zn. Similar findings were also reported by Mandal and Sinha, 2002.

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