Original Research Article

Effect of Integrated Nutrient Management (INM) on Growth and Yield of Mustard (*Brassica Juncea* L.)

ABSTRACT

The present study was conducted at Crop Research Centre (CRC), School of Agriculture, ITM University, Gwalior (MP) to investigate the effect of integrated nutrient management (INM) on growth, yield and quality of mustard (*Brassica juncea* L.). The experiment was laid out in the randomized block design with three replications and each replication was comprised of eleven treatment combinations comprising FYM (Farm Yard Manure) and *Azotobactor* with recommended dose of N, P, K and S (80: 60: 30: 30). These treatments were investigated for different morphophysiological, yield and quality attributes of miaze crop. Significant improvement in different morpho-physiological attributes *viz.*, plant height, number of branches per plant and dry matter at 30, 60 and 90 days after sowing (DAS), was recorded with T_5 treatment. The seed yield was recorded highest (11.33 q/ha) with T_5 treatment (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha). Maximum harvest index (25.54 %) was also calculated highest for T_5 treatment followed by T_3 treatment (18.77%) (100% RDF + FYM @ 15 t/ha). Comparatively, the improvement in protein (34.67%) and oil content (39.30%) in mustard cake was maximum for T_5 treatment to other treatments. The results of the study revealed that T_5 treatment had the maximum significant effect on yield and quality of the mustard crop.

Key words: Mustard, Integrated Nutrient Management, NPK enrichment, yield parameters, quality traits

Introduction

Oilseed crops have crucial role in Indian agriculture due to their significant contribution in national economy [1]. Mustard (*Brassica juncea* L.) belongs to the family *cruciferae* popularly known as rai and is one of the important *Rabi* season oilseed crops of North India. India is the third largest producer (11.30%) of rapeseed and mustard in the world [2]. In India, it is the second most important edible oilseed after soyabean and groundnut. Total area under rapeseed and mustard in India is 6.85 Mha (Million hectare) with a total production of 9.12 MT (Metric tonnes) with the productivity of 1331 kg ha^{-1} [3]. India meets 60% of the domestic edible oil requirements through imports and is ranked the 7th largest importer, thus improving the yield and quality of mustard is one of the important objectives of sustainable crop production in the country [2]. Among different *Brassica* species, Indian mustard share about 80% in area and production, occupies prominent position in India. The rapeseed-mustard group broadly includes Indian mustard, yellow sarson, brown sarson, raya, and toria crops. Indian mustard is predominantly cultivated in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat. The area under rapeseed and mustard in MP is 0.69 Mha (M with production of 0.92MT [4]. It is also grown under some non-traditional areas of South India including Karnataka, Tamil Nadu, and Andhra Pradesh. The crop can be raised well under both irrigated and rainfed conditions. Lack of improved cultural practices, cultivation of mustard on soil having low fertility status is major constraints responsible for poor mustard yield, therefore investigation on a efficient nutrient management strategy is warranted.

Integrated Nutrient Management (INM) has been found quite effective not only in maintaining soil health and productivity but also in stabilizing crop production as compared to sole application of different nutritional components [5]. Fertilizer, organic manures, legumes, crop residues or wastes and bio-fertilizers are the main component of INM. To maintain the soil health and sustaining the crop productivity, INM approach involving the use of FYM, bio-fertilizers and inorganic fertilizers together needs to be standardized for different crops including mustard [6]. The present study was conducted to investigate the effect of integrated nutrient management on yield and quality of mustard crop in Gwalior region of Madhya Pradesh.

Material and Methods

The experiment was laid out in the Randomized Block Design with three replications. Each replication was comprised of eleven different treatment combinations of FYM and *Azotobactor* with RDF (Recommended Dose of Fertilizer) (80 : 60 : 30 : 30) dose of N, P K, & S are T_1: Control, T_2: 100% RDF, T_3: 100% RDF + FYM @ 15 t/ha, T_4: 100% RDF + *Azotobactor* @ 5kg/ha, T_5: 100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha, T_6: 75% RDF + FYM @ 19 t/ha, T_7: 75% RDF + *Azotobactor* @ 5kg/ha, T_8: 75% RDF + @ 19 t/ha + *Azotobactor* @ 5kg/ha, T_9 – 50% RDF + FYM @ 23 t/ha, T_{10}: 50% RDF + *Azotobactor* @ 5kg/ha and T_{11} – 50% RDF + FYM @ 23 t/ha + *Azotobactor* @ 5kg/ha application in mustard (*Brassica juncea* L.). Recommended dose of N, P, K, S *viz.*, 80 kg nitrogen, 60 kg P_2O_5, 30 kg K_2O and 30 kg sulphur ha^{-1} was applied uniformly through DAP (Di Ammonium Phosphate) and MOP, (Muriate of Potash) respectively. Nitrogen was applied through urea and sulphur was applied through bentonite sulphur as per treatment. Quantity of fertilizer for each plot was calculated on the basis of gross plot size. Half dose of nitrogen and full dose of phosphorus, potassium and sulphur were applied as basal dressing at the time of sowing and remaining half dose of nitrogen was top dressed in two equal split doses each after first and second irrigation. Observations on plant height, number of branches per plant and dry matter at 30, 60 and 90 DAS (Days after sowing) and number of siliqua/plant, number of seeds/siliqua, length of siliqua/plant, were recorded for five randomly selected competitive plants from each plot. The protein content (%) in mustard cake was estimated using Micro Kjeldhal Method [7]. Oil content was estimated using Soxhlet method [7]. All data related to growth and yield was collected and subjected to statistical analysis using the One Way Anova [8].

Result and Discussion

Morpho-physiological attributes are directly associated with economic and biological yield from any crop and change with the prevailing environmental conditions. The plant height, number of branches per plant and dry matter at 30, 60 and 90 DAS and number of siliqua/plant, number of seeds/siliqua, length of siliqua/plant are important yield attributing characteristics of mustard. From the results of the study, it was evident that treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) was significantly influenced all growth parameters as compared to other treatments. The maximum significant effect on plant height, number of branches per plant and dry matter at 30, 60 and 90 DAS) was recorded for

treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) (Table-1). This could be due to adequate supply of readily available nitrogen, phosphorus, potash and other nutrients produced taller and superior plants. It will be expected that plants grow taller with more number of leaves having bigger size and higher chlorophyll content. Taller plants produced more dry matter because of more opportunity for production and accumulation of photosynthates and improve plant growth. The beneficial effect of chemical fertilizers with FYM and seed treatment on growth parameters was also observed by several researchers in mustard [10-14].

Yield attributing and yield characters

The results clearly indicated that the yield attributing and yield characters were significantly influenced by the different treatments. The maximum yield attributing and yield characters (viz., number of siliqua/plant, number of seeds/siliqua, length of siliqua/plant, seed yield, and seed test weight) were found in treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) and it was significantly superior as compared to other treatments. It was observed that the treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) gave maximum seed yield (11.33 q) as compared to other treatments. Maximum harvest index (25.54 %) was calculated for T_5 treatment (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) and was found significantly superior to other treatments. It was closely followed by treatment T_3 (100% RDF + FYM @ 15 t/ha), where as the minimum harvest index (18.77 %) was estimated for the treatment T_1 (Control), respectively. Treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) gave maximum biological yield (53.39 q) as compared to other treatments. Treatments except T_3 (100% RDF + FYM @ 15 t/ha) and T_4 (100% RDF + *Azotobactor* @ 5kg/ha) was at par with treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) (Table-2). However, the minimum biological yield (42.73 q) was recorded for treatment T_1 (Control). The minimum stover yield (33.03 q) was recorded with treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha). Mustard responds well to integrated nutrient management which might be owing to the favourable soil condition. Application of FYM with chemical fertilizers improved the physio-chemical condition of the soil, provided favourable environment, stimulated the uptake of nutrients and almost continuous supply of N, P, K, S and micro nutrient distributed over the entire crop and better availability of plant nutrients throughout the growth period and especially at critical period of crops growth which has resulted in better plant vigour and superior yield attributes. The use of growth stimulating seed inoculants (*Azotobacter*) help in

greater uptake of plant nutrients from applied chemical fertilizers by increasing the root growth beside improving the availability of nutrient particularly N and enhanced the seed yield. These results are supported by the findings of Saikia *et al.* [15], Singh and Singh [16], Sahoo *et al*. [17], Singh *et al.* [18] and Mhetre *et al*. [19].

Protein and oil content (%)

In the present study, T_5 treatment (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha) was significantly influenced the % protein content in mustard cake and % oil content as compared to other treatments (Table-1). The results indicated that various chemical fertilizers treatment with FYM and seed treatment with *Azotobactor* have significant impact on protein and oil content of mustard seed. Increased protein content might be due to increased nitrogen concentration in seed due to the additional application of FYM and seed treatment. Nitrogen is an integral part of protein which increased the protein content in seed. The results are in confirmation with the results of Chaturvedi *et al.* [20], Tripathi *et al.* [21], Basumatary and Talukdar [22], Singh and Pal [23], Mohammadi and Rokhzadi [24], Shekhawat *et al*. [25], and Dubey and Shukla [14]. The increase in the oil content with sulphur fertilization may be attributed to its role in oil synthesis. Integrated application of FYM with bio-fertilizers resulted insignificant increase in the oil content positively and hence resulted increasing oil yield compared to alone application of any of the chemical fertilizers.

Economic analysis of the study revealed that maximum gross income in treatment T_5 (100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha), maximum net income and B:C ratio in T_2 treatment (100% RDF). However the minimum gross income was recorded in treatment T_1 (Control), Minimum net income and B:C was recorded in treatment T_{11} (50% RDF + FYM @ 23 t/ha + *Azotobactor* @ 5kg/ha) (Table-2).

The study concluded that T_5 treatment (100% RDF + FYM @ 15 tons/ha + *Azotobactor* @ 5kg/ha) was the effective treatment for optimization of seed yield, stover yield and quality parameters of mustard crop.

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Table 1: Effect of integrated nutrient management (INM) on growth and quality parameters of mustard

Treatment	Treatment Details	Plant height at 30 DAS (cm)	Plant height at 60 DAS (cm)	Plant height at 90 DAS (cm)	Number of branches per plant at 30 DAS	Number of branches per plant at 60 DAS	Number of branches per plant at 90 DAS	Dry matter at 30 DAS (%)	Dry matter at 60 DAS (%)	Dry matter at 90 DAS (%)	Protein (%) in mustard cake	Oil content (%)
T_1	Control	45.02	128.04	144.01	6.00	12.02	16.03	11.51	29.00	56.03	33.34	37.50
T_2	100% RDF	46.74	136.67	157.23	6.25	14.04	18.28	12.14	30.63	64.68	34.23	38.90
T_3	100% RDF + FYM @ 15t/ha	47.56	140.38	160.17	6.28	14.76	18.89	12.26	30.91	67.54	34.59	39.18
T_4	100% RDF + *Azotobactor* @ 5kg/ha	47.33	139.46	159.46	6.33	14.59	18.77	12.20	30.81	66.89	34.51	39.02
T_5	100% RDF + FYM @ 15t/ha + *Azotobactor* @ 5kg/ha	48.01	141.03	162.05	6.31	15.01	19.02	12.30	31.04	68.00	34.67	39.30
T_6	75% RDF + FYM @ 19 t/ha	46.44	134.92	152.41	6.17	13.42	17.93	12.03	30.35	62.65	34.01	38.47
T_7	75% RDF + *Azotobactor* @ 5kg/ha	46.03	133.16	151.56	6.16	13.22	17.58	11.91	30.04	61.87	33.95	38.32
T_8	75% RDF + @ 19 t/ha + *Azotobactor* @ 5kg/ha	46.62	135.24	155.24	6.22	13.91	18.00	12.08	30.42	63.56	34.09	38.80
T_9	50% RDF + FYM @ 23 t/ha	45.67	130.69	147.69	6.09	12.38	16.96	11.74	29.55	59.46	33.59	37.95
T_{10}	50% RDF + *Azotobactor* @ 5kg/ha	45.39	129.64	146.25	6.06	12.15	16.83	11.65	29.43	57.00	33.58	37.79
T_{11}	50% RDF + FYM @ 23 tha + *Azotobactor* @ 5kg/ha	46.00	132.25	149.27	6.10	12.77	17.17	11.80	29.80	60.57	33.77	38.12
	SE(m) ±	**0.405**	**0.798**	**0.681**	**0.050**	**0.327**	**0.439**	**0.112**	**0.335**	**0.588**	**0.123**	**0.195**
	CD (5%)	**1.193**	**2.354**	**2.010**	**0.146**	**0.964**	**1.295**	**0.330**	**0.989**	**1.734**	**0.363**	**0.574**

Table 2: Effect of integrated nutrient management (INM) on yield parameters of mustard

Treatment	Treatment details	Number of siliqua per plant	Number of seeds per siliqua	Length of siliqua per plant (cm)	Seed yield (Q/ha)	Stover yield (Q/ha)	Biological yield (Q/ha)	Harvest index (%)	Seed test weight (g)	Cost benefit ratio
T_1	Control	270.03	12.00	6.10	9.70	42.06	42.73	18.77	4.48	3.90
T_2	100% RDF	291.42	15.02	6.59	10.95	36.33	51.28	23.16	4.68	4.10
T_3	100% RDF + FYM @ 15 t/ha	302.05	15.85	6.70	11.22	34.37	52.24	24.62	4.72	3.20
T_4	100% RDF + *Azotobactor* @ 5kg/ha	296.23	15.57	6.66	11.08	35.27	51.84	23.91	4.70	3.70
T_5	100% RDF + FYM @ 15 t/ha + *Azotobactor* @ 5kg/ha	306.02	16.02	6.80	11.33	33.03	53.39	25.54	4.75	2.90
T_6	75% RDF + FYM @ 19 t/ha	287.23	14.26	6.42	10.67	38.23	48.90	21.83	4.61	2.70
T_7	75% RDF + *Azotobactor* @ 5kg/ha	285.24	13.74	6.32	10.45	39.05	47.03	21.12	4.59	3.80
T_8	75% RDF + @ 19 t/ha + *Azotobactor* @ 5kg/ha	290.15	14.63	6.55	10.84	36.58	49.89	22.86	4.65	2.80
T_9	50% RDF + FYM @ 23 t/ha	280.15	12.81	6.26	9.96	40.76	45.24	19.64	4.54	2.30
T_{10}	50% RDF + *Azotobactor* @ 5kg/ha	277.69	12.63	6.19	9.81	41.02	44.17	19.31	4.51	4.00
T_{11}	50% RDF + FYM @ 23 t/ha + *Azotobactor* @ 5kg/ha	282.41	13.24	6.29	10.12	40.33	46.45	20.07	4.55	2.20
	SE(m) ±	**1.878**	**0.288**	**0.047**	**0.082**	**0.656**	**0.662**	**0.280**	**0.048**	
	CD (5%)	**5.541**	**0.850**	**0.138**	**0.241**	**1.935**	**1.953**	**0.826**	**0.143**	