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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD, QUALITY, NUTRIENT CONTENT AND UPTAKE OF MUSTARD (*BRASSICA JUNCEA* L. CZERN AND COSS)

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ABSTRACT

A field experiment was conducted during the *rabi* season of 2021-22 at Agronomy Instructional Farm, Department of Agronomy, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat to study the "Effect of integrated nutrient management on yield, quality, nutrient content and uptake of mustard" grown under loamy sand soil. The experiment was laid out in randomized block design consisted of six treatments *viz*., T_1: 50% RDF, T_2: 50% RDF+ *Azotobacter* + PSB, T_3: 75% RDF, T_4: 75% RDF+ *Azotobacter* + PSB, T_5: 100% RDF and T_6: 100% RDF + *Azotobacter* + PSB with four replications. The results revealed that an application of 100% RDF along with seed inoculation of *Azotobacter* and PSB recorded significantly higher seed and straw yield, oil content, oil yield, protein content and N content as well as N and P uptake in seed and straw of mustard.

***Keywords*:** *Azotobacter*, PSB, Nutrient content and uptake, Mustard.

Introduction

Mustard [*Brassica juncea* L. (Czern & Coss)] is one of the major oilseed crops of North Gujarat region and respond favourably to fertilizer application. Proper management of fertilizers plays an important role for enhancing the productivity of mustard, which can be realized by providing adequate plant nutrients.

Nitrogen is one of the essential elements of plant food for better growth and development of plant which is low in the soils of North Gujarat region. Rapeseed-mustard group of crops have relatively higher demand of N than many other crops owing to larger N content in seeds and plant tissues (Malagoli *et al*., 2005).

Among the primary nutrients, phosphorus plays key role in plant growth and development particularly root development. It is also an important structural component of nucleic acid, co-enzymes nucleotides, phospholipids, phosphoproteins and sugar phosphates. Addition of phosphatic fertilizers to mustard crop helps to hasten the crop maturity and ensures timely and uniform ripening of the crop with higher seed yield (Lanjewar and Sclukar, 2005).

Azotobacter is free living non-symbiotic aerobic nitrogen fixing bacteria found in rhizosphere zone of many plants. *Azotobacter* produces a variety of growth promoting substances like indole acetic acid (IAA), gibberellins (GA), vitamin-B and antifungal substances. It fixes approximately 20-30 kg of biological nitrogen per hectare per season. PSB provides alternative biotechnology solution in sustainable agriculture to meet the P demand of the plant. These organisms in addition to providing P to plants also facilitate plant growth by different mechanism (Dubey *et al*, 2000). The phosphate solubilizing bacteria mineralizes organic phosphate into soluble form and vender more P into soil solution results in an increased reproduction of P ion.

In light of above facts, the present experiment was formulated to study the effect of integrated nutrient management on yield, nutrient content and uptake and economics of mustard.

Material and Methods

A field experiment was conducted during *rabi* season of 2021-22 at the Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha (Gujarat) to study the impact of integrated nutrient management on yield, quality, nutrient content and uptake of mustard [*Brassica juncea* L. (Czern and Coss)]" grown under loamy sand soil. The experiment was laid out in randomised block design with four replications having six treatments *viz*., T_1: 50% RDF, T_2: 50% RDF+ *Azotobacter* + PSB, T_3: 75% RDF, T_4: 75% RDF+ *Azotobacter* + PSB, T_5: 100% RDF and T_6: 100% RDF + *Azotobacter* + PSB. Geographically, Sardarkrushinagar Dantiwada Agricultural University is situated at 24˚19' North latitude and 72˚19' East longitude with an elevation of 154.52 metre above the mean sea level. The soil of the experimental plot was loamy sand in texture and slightly alkaline in reaction (pH=7.42), low in organic carbon (0.31%) and available nitrogen (142.4 kg/ha) and medium in available phosphorus (32.5 kg/ha) and potassium (246.6 kg/ha).

Mustard variety Gujarat Dantiwada Mustard 4 was sown on 27th October, 2021 with a of spacing 45 cm × 10 cm and harvested on 14th February, 2022.

The seed oil content was determined as per the method suggested by Tiwari *et.al* (1974). Oil yield was computed by multiplying seed yield and oil content. The protein content in mustard seed was determined by Near Infrared Analyzer and recorded separately for each treatment. Fatty acids in oil were determined by method of AOAC, 2000.

The N and P content in seed and straw were analyzed by micro Kjeldhal's method (Warnake and Barber, 1974) and vanado-molybdate phosphoric yellow color method (Jackson, 1978), respectively. Uptake of each nutrient was computed on the basis of content of nutrient and yield of seed and straw. The representative soil sample from 0-15 cm depth were collected from each net plot after harvest of mustard crop. These samples were analyzed for available N and P_2O_5 in soil as per standard analytical methods. Data were statistically analyzed by the procedure suggested by Panse and Sukhatme (1985).

Results and Discussion

Seed and straw yield

Significantly higher seed yield of mustard (2258 kg/ha) was secured with combined application of 100% RDF along with *Azotobacter* and PSB, but failed to produce significant variation over 100% RDF and 75% RDF + *Azotobacter* + PSB which recorded seed yield of 2108 and 2090 kg/ha, respectively (Table 2). The highest seed yield obtained under these treatments might be due to application of higher level of RDF from chemical fertilizers in conjunction with biofertilizers particularly *Azotobacte*r and PSB might have provided favourable soil environment and balanced nutrition resulted in maximum seed yield per hectare. Singh *et al*. (2015) noted that significantly higher seed yield of mustard was recorded with application of 100% RDNP + *Azotobacter* + PSB.

Significantly higher straw yield of 5118 kg/ha (Table 2) of mustard was produced under application of 100% RDF along with *Azotobacter* + PSB (T_6), and remained statistically at par with treatments 100% RDF (T_5), 75% RDF + *Azotobacter* + PSB (T_4) and 75% RDF (T_3). The outstanding performance in case of straw yield with application of 100% RDF along with seed inoculation with *Azotobacter* and PSB appeared on account of complementary interactions between vegetative and reproductive growth of the crop. Choudhary *et al.* (2024) noted that significantly higher seed and straw yield of mustard was recorded with application of 100% RDF in conjunction with seed inoculation with *Azotobacter* and PSB.

Quality parameters

Significantly higher oil yield (863 kg/ha) was recorded under treatment 100% RDF + *Azotobacter* + PSB (T_6) being at par with treatments 100% RDF (T_5) and 75% RDF + *Azotobacter* + PSB (T_4). Increase in oil yield under these treatments evidently resulted due to higher seed yield (Table 2) as well as marginal improvement in oil content (Table 1) in these treatments. Similar results were also reported by Meena *et al*. (2013).

Significantly higher protein content of 19.84% (Table 1) was recorded with treatment T_6 (100% RDF + *Azotobacter* + PSB). However, it did not differ significantly over treatments T_5 (100% RDF) and T_4 (75% RDF + *Azotobacter* + PSB). An application of RDF in conjunction with biofertilizers might have improved availability of nitrogen in soil lead to the remarkable increase in protein content as nitrogen is primary component of amino acids which constitute basis of protein. Dabi *et al*. (2015) observed significantly higher protein content in mustard seed with application of 125% RDNP + *Azotobacter* + PSB.

However, different treatments failed to reach the level of significance with respect to oil content, oleic acid, linoleic acid and erucic acid content in mustard seed.

N and P content

The nitrogen content in seed and straw of mustard was influenced significantly with increasing dose of fertilizer and recorded maximum N content in seed (3.175%) and straw (0.450%) with application of 100% RDF along with seed inoculation with *Azotobacter* and PSB (Table 3). However, it remained statically at par with 100% RDF (T_5) and 75% RDF + *Azotobacter* + PSB (T_4). Whereas, lower nitrogen content of 2.918 and 0.398% were recorded in seed and straw, respectively with application of 50% RDF. The increment in nitrogen content in seed and straw with application of 100% RDF + *Azotobacter* + PSB increased the availability of nitrogen consistently for a longer period due to higher level of N accomplished with *Azotobacter* that facilitate higher removal of N from soil reflected in improvement of N concentration in vegetative parts and relocated towards seed from their reserves in vegetative organs. These results are in close conformity with the findings of Dubey *et al.* (2021).

N and P uptake

An examination of data outlined in Table 3 showed that significantly higher nitrogen uptake (71.7 and 23.0 kg/ha) and phosphorus uptake (13.16 and 10.39 kg/ha,) by seed and straw, respectively was observed under 100% RDF + *Azotobacter* + PSB (T_6), but did not differ significantly over 100% RDF (T_5) and 75% RDF + *Azotobacter* + PSB (T_4).

The considerable increase in N uptake was ascribed to higher N content in seed and straw (Table 3) as well as higher seed and straw yields evidenced in present study and P uptake by mustard seed and straw could be attributed to the fact that PSB solubilize insoluble phosphorus to soluble form and increased the availability of phosphorus in soil that stimulates early root development which facilitate better utilization of phosphorus from the deeper soil layer. Similarly, Meena *et al.* (2013) reported higher N and P uptake in mustard under higher fertilizer level combined with seed inoculation of biofertilizers.

Available N and P_2O_5 in soil

Integrated nutrient management treatments did not improve available N and P_2O_5 in soil after harvest of mustard (Table 2). Numerically, higher available N (150.3 kg/ha) was noticed with application of 100% RDF in conjunction with seed treatment of *Azotobacter* and PSB (Table 2). The improvement in available N status over initial N in soil due to integration of inorganic fertilizer and biofertilizers might be due to direct addition of N through inorganic fertilizer and conversion of organically bound nitrogen into inorganic form besides biological N fixation by soil microbe (*Azotobacter*) which enhanced the available N pool in soil. These findings are in agreement with Chand (2007) and Patel *et al.* (2018).

Conclusion

It is concluded that mustard crop should be fertilized with 75% RDF (37.5-37.5-00 kg N-P_2O_5-K_2O/ha) along with seed treatment of *Azotobacter* and PSB @ 5 ml/kg seed each to obtain higher seed yield and nutrient uptake.

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

Treatments	Oil content (%)	Oil yield (kg/ha)	Protein content (%)	Fatty acid (%)		
				Oleic acid	Linoleic acid	Erucic acid
T_1: 50 % RDF	37.21	576	18.24	11.72	14.16	47.43
T_2: 50 % RDF + *Azotobacter* + PSB	37.32	633	18.50	11.73	14.42	47.08
T_3: 75 % RDF	37.57	695	18.54	11.82	14.43	46.89
T_4: 75 % RDF + *Azotobacter* + PSB	37.75	789	18.68	11.93	14.47	46.72
T_5: 100 % RDF	38.08	803	19.74	12.26	14.96	46.50
T_6: 100 % RDF + *Azotobacter* + PSB	38.24	863	19.84	12.87	15.54	46.36
S.Em. ±	1.08	52.2	0.40	0.36	0.37	1.21
C.D. (P = 0.05)	NS	157.3	1.19	NS	NS	NS
C.V. %	5.76	14.36	4.18	5.96	5.10	5.17

Table 2: Effect of integrated nutrient management on yield and residual soil fertility in mustard

Treatments	Seed yield (kg/ha)	Straw yield (kg/ha)	Available N (kg/ha)	Available P_2O_5 (kg/ha)
T_1: 50 % RDF	1549	4102	137.2	34.4
T_2: 50 % RDF + *Azotobacter* + PSB	1695	4294	140.9	35.7
T_3: 75 % RDF	1850	4579	144.9	35.9
T_4: 75 % RDF + *Azotobacter* + PSB	2090	4898	147.3	37.1
T_5: 100 % RDF	2108	4934	147.9	37.2
T_6: 100 % RDF + *Azotobacter* +PSB	2258	5118	150.3	38.6
S.Em. ±	120.4	232.9	5.4	1.30
C.D. (P = 0.05)	363.0	702.0	NS	NS
C.V. %	12.51	10.01	7.49	7.11

Table 3: Effect of INM on N and P content and uptake by seed and straw of mustard

Treatments	Nitrogen content (%)		Phosphorus content (%)		Nitrogen uptake (kg/ha)		Phosphorus uptake (kg//ha)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
T_1: 50 % RDF	2.918	0.398	0.554	0.194	45.2	16.3	8.58	7.96
T_2: 50 % RDF + *Azotobacter* + PSB	2.966	0.408	0.565	0.198	50.3	17.5	9.58	8.50
T_3: 75 % RDF	2.959	0.413	0.558	0.196	54.7	18.9	10.32	8.97
T_4: 75 % RDF + *Azotobacter* + PSB	3.088	0.430	0.574	0.201	64.5	21.1	11.99	9.84
T_5: 100 % RDF	3.108	0.440	0.572	0.199	65.5	21.7	12.06	9.82
T_6: 100 % RDF + *Azotobacter* + PSB	3.175	0.450	0.583	0.203	71.7	23.0	13.16	10.39
S.Em. ±	0.059	0.012	0.016	0.005	3.9	1.1	0.63	0.39
C.D. (P = 0.05)	0.18	0.04	NS	NS	11.6	3.2	1.90	1.18
C.V. %	3.85	5.52	5.50	5.21	13.1	10.86	11.54	8.46

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