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Effect of integrated nutrient management on growth, yield attributes and yield of Indian mustard [*Brassica juncea* L. (Czern and Coss)]

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Abstract
A field experiment on "Effect of integrated nutrient management on growth, yield attributes and yield of Indian mustard [*Brassica juncea* L. (Czern and Coss)]" was carried out at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during *rabi* 2018-19. The field experiment was laid out in randomized block design with twelve treatments and three replications. The results revealed that seed yield and stover yield as well as most of the growth and yield attributing characters of mustard were significantly influenced due to integrated nutrient management. Treatment T_{12} consistently gained superior in plant height of 134.95 cm and 183.46 at 60 DAS and at harvest, respectively. However, it remains at par with treatments T_{11}, T_{10}, T_9, T_8, T_7 and T_6 at 60 DAS and at harvest. Minimum plant height was observed under treatment T1 at 60 DAS and at harvest. Significantly higher number of primary and secondary branches per plant (7.2) and (20.1) were recorded under treatment T_{12} (50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB). However, it remains at par with T_{11}, T_{10}, T_9, T_8, T_7 and T_6. Yield attributing characters *viz*., number of siliquae per plant (260.6), length of siliqua (6.04 cm) and number of seeds per siliqua (13.4) were found significantly superior Abstract ii und retreatments T_{12} (50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB). While it remained at par with T_{11}, T_{10}, T_9, T_8, T_7 and T_6 for length of siliqua and with T_{11}, T10, T_9 and T_8 for number of siliquae per plant and number of seeds per siliqua. Significantly higher seed yield (2688 kg/ha) of mustard was also recorded under the treatment T_{12} (50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB) and it was at par with T_{11}, T10, T_9 and T_8. Similarly, the same treatment recorded significantly higher stover yield (5329 kg/ha) of mustard and found at par with treatments T_{11}, T_{10}, T_9 and T_8.

Keywords: Indian mustard, FYM, Castor cake, RDF, *Azotobacter*, PSB, INM

Introduction

Oilseed crops have the unique significance in recent era of energy crisis as they play prominent role in the agricultural industries and export trade of India. However, under rainfed conditions vagaries of nature tends to great fluctuations in productivity of oil seed crops. Mustard (*Brassica juncea* L.) commonly known as rai, raya, laha and raiya has many uses. The green tender plant is used for preparing vegetable commonly called "Sarson ka Saag". The whole seed is used in preparing pickles and flavouring vegetables and curries. Mustard oil mainly used for cooking, frying and in pickles. Oil is also used in preparing vegetable ghee, hair oil, medicines, soaps, lubricating oil and in tannin industries. The oil cake left after extraction is utilized as cattle feed and manure. The oil cake contains 25-30 percent crude protein, 5 percent nitrogen, 1.8-2.0 percent phosphorus and 1.0-1.2 percent potassium. The per capita land is declining rapidly with increase in demographic pressure, soil degradation, urbanization and transformation of agricultural land to non-agricultural land use. Thus, area under oilseeds is not likely to increase in the near future. Indian farmers pay reasonable attention to cultivation, especially in respect of seedbed preparation, manuring and irrigation, however sufficient attention has not been paid to fertilizer management which remains one of the constraints in boosting up the production. Among various agronomic practices for augmenting productivity of oilseed crops, nutrient management plays an important role. Independent use of neither the chemical fertilizers nor the organic sources can sustain the fertility of soil and productivity of crops in high input production system. The better alternative is Integrated Nutrient Management (INM) which ensures high crop production along with maintaining soil health and fertilizer use efficiency.

Keeping the above facts and views in mind, the present investigation entitled, "Effect of integrated nutrient management on growth, yield attributes and yield of Indian mustard [*Brassica juncea* L. (Czern and Coss)]".

Methodology

A field experiment was conducted in plot B-8 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during *rabi* season of the year 2018-19. Geographically, Sardarkrushinagar is situated at 24˚19' N latitude and 72˚19' E longitude with an altitude of 154.52 m above the mean sea level. It is located in the North Gujarat Agroclimatic Zone. The soil of the experimental field was loamy sand in texture, low in organic carbon (0.18%) and available nitrogen (175 kg/ha), medium in available P2O5 (37.1 kg/ha), high in available potash (285 kg/ha) and low in available sulphur (7.0 mg/kg) with soil pH of 7.3. The experiment was laid out in Randomized Block Design with three replication assigning 12 treatment T1: 100% RDF, T2: 100% RDF + *Azotobacter* + PSB, T3: 75% RDF + 2.5 t FYM, T4: 75% RDF + 0.5 t castor cake, T5: 50% RDF + 5 t FYM, T6: 50% RDF + 1 t castor cake, T7: 50% RDF + 2.5 t FYM + 0.5 t castor cake, T8: 75% RDF + 2.5 t FYM + *Azotobacter* + PSB, T9: 75% RDF + 0.5 t castor cake + *Azotobacter* + PSB, T10: 50% RDF + 5 t FYM + *Azotobacter* + PSB, T11: 50% RDF + 1 t castor cake + *Azotobacter* + PSB and T12: 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB. The mustard variety Gujarat Dantiwada Mustard 4 was sown with spacing of 45 cm × 15 cm by using seed rate of 3.50 kg/ha. The recommended dose of fertilizer @ 50-50-00-40 NPKS kg/ha through urea, di-ammonium phosphate and sulphate.

The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance.

Table 1: Treatment details

No.	Treatments
T1	100% RDF
T2	100% RDF + *Azotobacter* + PSB
T3	75% RDF + 2.5 t FYM
T4	75% RDF + 0.5 t castor cake
T5	50% RDF + 5 t FYM
T6	50% RDF + 1 t castor cake
T7	50% RDF + 2.5 t FYM + 0.5 t castor cake
T8	75% RDF + 2.5 t FYM + *Azotobacter* + PSB
T9:	75% RDF + 0.5 t castor cake + *Azotobacter* + PSB
T10	50% RDF + 5 t FYM + *Azotobacter* + PSB
T11	50% RDF + 1 t castor cake + *Azotobacter* + PSB
T12	50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB

RDF: Recommended dose of fertilizers through chemical fertilizers = 50 kg N ha-1 + 50 kg P2O5 ha-1 + 0 kg K2O ha-1 + 40 kg S ha-1

Results

Effect on growth attributes

Effect on plant population: The results indicated that different treatments of integrated nutrient management did not exert significant effect on plant population at 30 DAS and at harvest. It means that the plant population in all treatments was found uniform. It is ascertained from the data that the variations observed in growth and yield attributes as well as yield are obtained due to treatment effects and not due to plant population.

Table 2: Effect of integrated nutrient management on plant population of Indian mustard

Treatments	Plant population (per meter row length)	
	30 DAS	At harvest
T1: 100% RDF	6.53	6.40
T2: 100% RDF + *Azotobacter* + PSB	6.53	6.40
T3: 75% RDF + 2.5 t FYM	6.60	6.47
T4: 75% RDF + 0.5 t castor cake	6.73	6.47
T5: 50% RDF + 5 t FYM	6.67	6.47
T6: 50% RDF + 1 t castor cake	6.80	6.53
T7: 50% RDF + 2.5 t FYM + 0.5 t castor cake	6.80	6.53
T8: 75% RDF + 2.5 t FYM + *Azotobacter* + PSB	6.87	6.53
T9: 75% RDF + 0.5 t castor cake + *Azotobacter* + PSB	6.93	6.67
T10: 50% RDF + 5 t FYM + *Azotobacter* + PSB	6.93	6.60
T11: 50% RDF + 1 t castor cake + *Azotobacter* + PSB	7.00	6.73
T12: 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB	7.07	6.73
S. Em ±	0.21	0.23
CD at 5%	NS	NS
CV%	5.30	6.04

Effect on plant height

The data on plant height (cm) of mustard was recorded at 30, 60 DAS and at harvest are presented in Table 3. Data clearly revealed that the plant height increased progressively up to the harvest with the advancement of crop growth and significantly affected by the treatments.

Plant height was influenced significantly by different integrated nutrient management treatments at various growth stages except 30 DAS. Significantly higher plant height (134.95 and 183.46 cm) at 60 DAS and at harvest was found under treatment T12 (50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB) as compared to other treatments, but it was statistically at par with treatments T11 (50% RDF + 1 t castor cake + *Azotobacter* + PSB), T10 (50% RDF + 5 t FYM + *Azotobacter* + PSB), T9 (75% RDF + 0.5 t castor cake + *Azotobacter* + PSB), T8 (75% RDF + 2.5 t FYM + *Azotobacter* + PSB), T7 (50% RDF + 2.5 t FYM + 0.5 t castor cake) and (50% RDF + 1 t castor cake). The lower plant height was observed with treatment T1 (100% RDF) at 60 DAS (110.40 cm) and at the harvest (144.88 cm) than other treatments. The increase in plant height under the INM treatment 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB (T12) over 100% RDF (T1) was to the tune of 22.3 and 26.6 percent at 60 DAS and at harvest, respectively. This might be due to adequate supply of N and P2O5 through chemical fertilizers and seed inoculation with *Azotobacter* + PSB which enhanced cell division and cell enlargement which converted more solar energy into chemical energy there by faster growth in term of increase in plant height. Such findings have been also reported by Kumar *et al.* (2014) [7], Nagar *et al.* (2015) [11] and Narinder and Ashwani (2018) [12].

The interactive effect of FYM, castor cake and biofertilizers might have improved physical and biological properties of soil and thereby enhanced the supply of macro and micronutrient to the plants. Thus, favourable influence of nutrients to produce larger cell with thinner cell wall and its contribution in cell elongation was improved vegetative growth and ultimately increased plant height. The similar results were found by Santosh *et al.* (2007) [17], Hadiyal *et al.* (2017) [2], Murali *et al.* (2018) [10] and Saxena *et al.* (2018) [18].

Table 3: Effect of integrated nutrient management on plant height at 30, 60 DAS and at harvest of Indian mustard

Treatments	Plant height (cm)		
	30 DAS	60 DAS	At harvest
T1: 100% RDF	36.48	110.40	144.88
T2: 100% RDF + *Azotobacter* + PSB	36.78	112.30	150.23
T3: 75% RDF + 2.5 t FYM	37.06	113.48	154.34
T4: 75% RDF + 0.5 t castor cake	37.86	117.99	162.94
T5: 50% RDF + 5 t FYM	37.59	115.51	159.24
T6: 50% RDF + 1 t castor cake	38.39	122.47	164.70
T7: 50% RDF + 2.5 t FYM + 0.5 t castor cake	38.65	124.48	169.69
T8: 75% RDF + 2.5 t FYM + *Azotobacter* + PSB	39.18	127.17	174.57
T9: 75% RDF + 0.5 t castor cake + *Azotobacter* + PSB	39.93	132.55	180.19
T10: 50% RDF + 5 t FYM + *Azotobacter* + PSB	39.43	130.24	177.62
T11: 50% RDF + 1 t castor cake + *Azotobacter* + PSB	40.17	133.43	181.80
T12: 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB	40.40	134.95	183.46
S.Em ±	0.96	5.68	7.93
CD at 5%	NS	16.65	23.27
CV%	4.31	8.00	8.23

Effect on number of branches per plant

The data regarding number of primary and secondary branches per plant as influenced by different treatments are presented in Table 4.

Scrutiny of data in Table 4 revealed that different integrated nutrient management treatments exerted their significant influence on number of primary and secondary branches per plant. Significantly the highest number of primary and secondary branches per plant (7.2 and 20.1) were obtained with treatment (T12) 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB, but it remained statistically at par with treatments T11 (50% RDF + 1 t castor cake + *Azotobacter* + PSB), T10 (50% RDF + 5 t FYM + *Azotobacter* + PSB), T9 (75% RDF + 0.5 t castor cake + *Azotobacter* + PSB), T8 (75% RDF + 2.5 t FYM + *Azotobacter* + PSB), T7 (50% RDF + 2.5 t FYM + 0.5 t castor cake) and T6 (50% RDF + 1 t castor cake). Whereas, lowest number of primary and secondary branches per plant (5.7 and 15.3) were observed with an application of 100% RDF (T 1). Percent increase in number of primary and secondary branches under treatment (T12) 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB over (T1) 100% RDF was to the extent of 26.2 and 31.3, respectively.

It might be due combine application of 50% RDF through inorganic fertilizer and FYM and castor cake through organic manures as well as seed inoculation with PSB and *Azotobacter* increased the availability of nitrogen and phosphorous to the plant at early growth stages and nitrogen being an essential constituent of nucleic acid, protoplasm and protein, play a fundamental role in metabolism, growth, development, reproduction and transmission of heritable characters, so the number of primary and secondary branches also increased by this condition. The similar results were found by Mandal and Sinha (2002) [9], Shukla *et al.* (2002) [19], Kashved *et al.* (2010) [4], and Saxena *et al.* (2018) [18].

Table 4: Effect of integrated nutrient management on number of branches per plant of Indian mustard

Treatments	Primary branches	Secondary branches
T1: 100% RDF	5.7	15.3
T2: 100% RDF + *Azotobacter* + PSB	5.9	15.7
T3: 75% RDF + 2.5 t FYM	6.0	16.3
T4: 75% RDF + 0.5 t castor cake	6.1	17.3
T5: 50% RDF + 5 t FYM	6.1	16.9
T6: 50% RDF + 1 t castor cake	6.6	18.3
T7: 50% RDF + 2.5 t FYM + 0.5 t castor cake	6.7	18.6
T8: 75% RDF + 2.5 t FYM + *Azotobacter* + PSB	6.7	18.7
T9: 75% RDF + 0.5 t castor cake + *Azotobacter* + PSB	6.9	19.1
T10: 50% RDF + 5 t FYM + *Azotobacter* + PSB	6.8	18.8
T11: 50% RDF + 1 t castor cake + *Azotobacter* + PSB	7.0	19.7
T12: 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB	7.2	20.1
S. Em ±	0.30	0.83
CD at 5%	0.88	2.44
CV%	8.07	8.04

Effect on yield and yield attributes

Effect on number of siliquae per plant: The mean data on number of siliquae per plant as influenced by integrated nutrient management are presented in Table 5.

An application of 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB (T12) registered significantly higher number of siliquae per plant (260.6), but it stood statistically at par with treatments T11 (50% RDF + 1 t castor cake + *Azotobacter* + PSB), T10 (50% RDF + 5 t FYM + *Azotobacter* + PSB), T9 (75% RDF + 0.5 t castor cake + *Azotobacter* + PSB) and T8 (75% RDF + 2.5 t FYM + *Azotobacter* + PSB). All these treatments did not differ from each other. The lowest number of siliquae per plant (209.7) was observed with Treatment T1 (100% RDF). The increase in number of siliquae per plant under treatments T12, T11, T10, T9 and T8 over T1 was to the tune of 24.27, 22.12, 15.87, 17.31 and 10.20 percent, respectively. The increase in number of siliquae per plant might be due to the better availability of nutrients from starter dose of fertilizers through 50% RDF which enabled to produce higher number of siliquae per plant. The latter easily availability of nutrients through organic manure to plants as well as seed inoculation with *Azotobacter* and PSB might be the reason for enhancement in yield attributes. These results are in close vicinity with the findings of Pir *et al.* (2005) [15], Singh and Kanaujia (2009) [14] and Reddy and Singh (2018) [16].

Effect on length of siliqua (cm)

The data pertaining to the length of siliqua as influenced by different treatments are presented in Table 5.

Result indicated that length of siliqua (6.04 cm) was found significantly higher with treatments of 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB (T12). But, it was statistically at par with treatments T11 (50% RDF + 1 t castor cake + *Azotobacter* + PSB), T10 (50% RDF + 5 t FYM + *Azotobacter* + PSB), T9 (75% RDF + 0.5 t castor cake +

Azotobacter + PSB), T8 (75% RDF + 2.5 t FYM + *Azotobacter* + PSB), T7 (50% RDF + 2.5 t FYM + 0.5 t castor cake) and T6 (50% RDF + 1 t castor cake). While, significantly the lowest length of siliqua (4.59 cm) was noticed with an application of 100% RDF (T1).

This might be due to combine application of chemical fertilizers, organic manures and biofertilizers and their integrated positive effect on length of siliqua. The length of siliqua was directly influenced by the enhanced vegetative growth of the plants leading to increase of plant height and number of branches. This might have accumulated more carbohydrates, resulting in to increased length of siliqua. These finding are in agreement with those of Singh and Meena (2004) [20], Patel *et al.* (2009) [14], Kashved *et al.* (2010) [4], Jat *et al.* (2017) [3] and Yadav and Dhanai (2018) [24].

Table 5: Effect of integrated nutrient management on number of siliquae per plant and length of siliqua of Indian mustard

Treatments	Number of siliquae per plant	Length of siliqua (cm)
T1: 100% RDF	209.7	4.59
T2: 100% RDF + *Azotobacter* + PSB	214.2	4.69
T3: 75% RDF + 2.5 t FYM	216.7	4.79
T4: 75% RDF + 0.5 t castor cake	229.9	5.38
T5: 50% RDF + 5 t FYM	222.3	5.23
T6: 50% RDF + 1 t castor cake	225.1	5.47
T7: 50% RDF + 2.5 t FYM + 0.5 t castor cake	228.0	5.55
T8: 75% RDF + 2.5 t FYM + *Azotobacter* + PSB	231.1	5.61
T9: 75% RDF + 0.5 t castor cake + *Azotobacter* + PSB	246.0	5.85
T10: 50% RDF + 5 t FYM + *Azotobacter* + PSB	243.0	5.69
T11: 50% RDF + 1 t castor cake + *Azotobacter* + PSB	256.1	5.93
T12: 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB	260.6	6.04
S. Em ±	10.86	0.24
CD at 5%	31.84	0.72
CV%	8.11	7.82

Effect on number of seeds per siliqua

The mean data to number of seeds per siliqua as influenced by different treatments of integrated nutrient management are outlined in Table 6.

An appraisal of data presented in Table 6 showed that treatment T12 (50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB) produced significantly higher number of seeds per siliqua (13.4) as compared to rest of the treatments except treatments T11 (50% RDF + 1 t castor cake + *Azotobacter* + PSB), T10 (50% RDF + 5 t FYM + *Azotobacter* + PSB), T9 (75% RDF + 0.5 t castor cake + *Azotobacter* + PSB) and T8 (75% RDF + 2.5 t FYM + *Azotobacter* + PSB). While, lowest number of seeds per siliqua (10.5) were recorded with an application of 100% RDF (T1) and 100% RDF + *Azotobacter* + PSB (T2). This might be due to combined application of chemical fertilizer, organic manure and biofertilizer did cause about significant improvement in overall growth of the crop expressed in terms of plant height and number of branches per plant by virtue of increased photosynthetic efficiency. Thus, greater availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased number of seeds per siliqua. The present findings are within the close proximity of Kashved *et al.* (2010) [4] and Kumar *et al.* (2015) [6].

Effect on test weight (g)

The mean data of test weight as influenced by different treatments of integrated nutrient management are summarized in Table 6.

The results indicated that different treatments did not differ significantly with respect to test weight. However, numerically higher test weight of 5.18 g was noticed with 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB (T12) followed by 50% RDF + castor cake 1 t/ha + *Azotobacter* + PSB (T11), whereas, the lowest test weight (4.45 g) was recorded with 100% RDF (T1).

Table 6: Effect of integrated nutrient management on number of seeds per siliqua and test weight of Indian mustard

Treatments	Number of seeds per siliqua	Test Weight (g)
T1: 100% RDF	10.5	4.45
T2: 100% RDF + *Azotobacter* + PSB	10.5	4.60
T3: 75% RDF + 2.5 t FYM	10.7	4.68
T4: 75% RDF + 0.5 t castor cake	11.0	4.73
T5: 50% RDF + 5 t FYM	10.8	4.79
T6: 50% RDF + 1 t castor cake	11.4	4.84
T7: 50% RDF + 2.5 t FYM + 0.5 t castor cake	11.6	4.92
T8: 75% RDF + 2.5 t FYM + *Azotobacter* + PSB	12.1	4.89
T9: 75% RDF + 0.5 t castor cake + *Azotobacter* + PSB	12.9	5.01
T10: 50% RDF + 5 t FYM + *Azotobacter* + PSB	12.6	4.97
T11: 50% RDF + 1 t castor cake + *Azotobacter* + PSB	13.3	5.11
T12: 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB	13.4	5.18
S. Em ±	0.56	0.15
CD at 5%	1.63	NS
CV (%)	8.22	5.35

Effect on seed yield (kg/ha)

The data regarding seed yield of mustard as influenced due to integrated nutrient management are exhibited in Table 7.

It is clearly seen from the results that differences in seed yield due to various treatments were significant and significantly the higher seed yield (2688 kg/ha) of mustard was secured with treatment T12 (50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB), being at par with treatments T11 (50% RDF + 1 t castor cake + *Azotobacter* + PSB), T10 (50% RDF + 5 t FYM + *Azotobacter* + PSB), T9 (75% RDF + 0.5 t castor cake + *Azotobacter* + PSB) and T8 (75% RDF + 2.5 t FYM + *Azotobacter* + PSB). While, lowest seed yield (2041 kg/ha) was found with an application of 100% RDF (T1). The increment in seed yield of mustard under INM treatments T12, T11, T10, T9 and T8 over 100% RDF (T1) was to the tune of 31.70, 30.32, 22.39, 25.23 and 19.01 percent, respectively. Higher yield in these treatments might be due to cumulative effect of elevated growth stature as well as yield structure. Increase in seed yield is mainly because of increase in plant height (Table 3), number of branches per plant (Table

4), number of siliquae per plant, number of seeds per siliqua (Table 5) and test weight which resulted from combined effect of 50% RDF + 2.5 t FYM + 0.5 t castor cake as well as combination of biofertilizers (*Azotobacter* + PSB) that provided balanced nutrition and favourable soil environment for better plant growth and ultimately the yield. It is obvious that *Azotobacter* and phosphate solubilizing bacteria produced higher quantity of organic acids which dissolved mineral nitrogen and phosphate and made it available to plants. These acids associate with metals and increase the concentration of nutrients. They also synthesize growth promoting substances and produce vitamins which augment the plant growth. These results are supported by the findings of Chand (2007) [1], Singh *et al.* (2017) [22], Reddy and Singh (2018) [16], Yadav *et al.* (2018) [23, 24].

Effect on stover yield (kg/ha)

The data pertaining to stover yield of mustard as influenced by different treatments of integrated nutrient management are presented in Table 7.

Results indicated that variations in stover yield were found significant due to different integrated nutrient management practices. Significantly higher stover yield (5329 kg/ha) of mustard was obtained with treatment T12 (50% RDF + 2.5 t FYM + 1.5 t castor cake + *Azotobacter* + PSB) and remained at par with treatments T11 (50% RDF + 1 t castor cake + *Azotobacter* + PSB), T10 (50% RDF + 5 t FYM + *Azotobacter* + PSB), T9 (75% RDF + 0.5 t castor cake + *Azotobacter* + PSB) and T8 (75% RDF + 2.5 t FYM + *Azotobacter* + PSB). Whereas, lowest stover yield (4067 kg/ha) was registered with an application of 100% RDF (T1). Treatment T12 recorded 31.03 percent higher stover yield than T1.

Since, stover yield of the crop is a function of several yield components which are dependent on complementary interactions between vegetative and reproductive growth of the crop. As these growth and yield attributes evidently resulted in higher yields under different organic manure levels. Significant increase in stover yield under 50% RDF + FYM 2 t/ha + castor cake 0.5 t/ha as well as seed inoculation with *Azotobacter* + PSB appears to be on account of their influence on increase in plant height (Table 3), number of branches per plant (Table 4) and higher uptake of nutrients ultimately effect of increase stover yield of mustard. The present findings are in close agreement with the results obtained by Santosh *et al.* (2007) [17], Kumar and Kumar (2011), Hadiyal *et al.* (2017) [2] and Murali *et al.* (2018) [10].

Effect on harvest index (%)

The data related to harvest index as influenced due to different treatments are narrated in Table 7.

It is evident from the results that various integrated nutrient management treatments had failed to exert any significant influence on the harvest index of mustard.

Table 7: Effect of integrated nutrient management on seed yield, stover yield and harvest index of Indian mustard

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
T1: 100% RDF	2041	4067	33.51
T2: 100% RDF + *Azotobacter* + PSB	2085	4142	33.61
T3: 75% RDF + 2.5 t FYM	2112	4162	33.57
T4: 75% RDF + 0.5 t castor cake	2181	4284	33.71
T5: 50% RDF + 5 t FYM	2162	4247	33.72
T6: 50% RDF + 1 t castor cake	2249	4397	33.83
T7: 50% RDF + 2.5 t FYM + 0.5 t castor cake	2285	4467	33.82
T8: 75% RDF + 2.5 t FYM + *Azotobacter* + PSB	2429	4774	33.71
T9: 75% RDF + 0.5 t castor cake + *Azotobacter* + PSB	2556	5038	33.65
T10: 50% RDF + 5 t FYM + *Azotobacter* + PSB	2498	4926	33.65
T11: 50% RDF + 1 t castor cake + *Azotobacter* + PSB	2660	5248	33.62
T12: 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB	2688	5329	33.53
S. Em ±	135.41	259.73	0.55

Conclusions

Based on results of one-year experimentation, it is concluded that to achieve maximum yield and net profit from mustard (GDM 4), it should be fertilized with 50% RDF + 2.5 t FYM + 0.5 t castor cake + *Azotobacter* + PSB under loamy sand soil of North Gujarat Agro-climatic Zone.

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