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Effect of integrated nutrient management on nutrient content and uptake of mustard in mustard-cowpea cropping sequence

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Abstract
An experiment entitled "Effect of integrated nutrient management on nutrient content and uptake of mustard in mustard-cowpea cropping sequence" was conducted at college farm of Navsari Agricultural University, Navsari (Gujarat) during the years 2017-18 and 2018-19. An experiment consisted of different treatments *viz*., T_1 (Control), T_2 (10 t FYM/ha), T_3 (5 t biocompost/ha), T_4 (4 t vermicompost/ha) T_5 (RDF 50:50:00 kg N:P_2O_5:K_2O/ha), T_6 (RDF + 5 t FYM/ha), T_7 (RDF + 2.5 t biocompost/ha) and T_8 (RDF + 2.0 t vermicompost/ha) to mustard during *rabi* season and it was replicated three times in RBD design. On the base of two-year pooled experiment results, the Nitrogen, Phosphorus and potassium content in mustard seed was recorded significantly higher in the treatment T_6 while, Nitrogen, Phosphorus and potassium uptake of mustard straw was recorded significantly higher by T_8. Lower values was recorded with Treatment T_1 respect to N, P and K content and uptake by both mustard seed and stover. Organic carbon content, available N and K_2O in soil after harvest of mustard was recorded Significantly higher in the treatment consisting of RDF + 5 t FYM/ha (T_6) during both the years.

Keywords: Mustard**,** nutrient management, biocompost, FYM, vermicompost

Introduction
Indian mustard (*Brassica juncea* L.) is cultivated in different states India *viz*, Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Gujarat, Punjab and Bihar. Also, It is cultivated in non-traditional areas of southern states *viz*, Karnataka, Andhra Pradesh and Tamil Nadu. Rapeseed-mustard are grown under irrigated and rainfed conditions during *rabi* season in India. It is more responsive to fertilizers so it gives more returns under irrigated conditions (Davari and Mirzakhani, 2009) [2]. Indian mustard is rich in nutrients and oil content. The oil content varies from 37-49%. Seed and oil are used as a condiment for the preparation of pickles, flavouring, curries and vegetables.Mustard oil is used in industrial products and green leaves for vegetable and green fodder (Chauhan *et al.*, 2011) [1].

Mustard is one of oilseed crop of India. It is cultivated over 57.62 lakh ha in India and it's annual gross production and productivity is (68.2 lakh tonnes and 1184 kg/ha, respectively) during year 2015-16.

Increasing the level of production can be achieved through use of inorganic fertilizers but it may cause soil pollution and deteriorate the soil health. It can improved by integrated nutrient approach. Now a days organic manures is becoming very popular. Integrated use of fertilizer inorganic and organic lead to improve the soil health and soil properties.

Long term fertilizer experiments results revealed that use of organic fertilizer *viz.*, farm yard manures, vermicompost, biocompost, *etc.* in integrated manner with graded levels of chemical fertilizers is promising in maintaining higher productivity and providing stability in crop production. Chemical N fertilizer is more responsive when it is used in combination with organic mannures *viz.*, FYM, vermicompost, *etc* and saves chemical N fertilizer.

Nutrient management in soil is the most important agronomic factors which affect the crop yield. Continuous and improper use of chemical fertilizers in crop production lead to deterioration of soil health also increasing per unit area cost of production and decline in productivity. Balanced application of nutrient through integrated nutrient management approach in mustard based cropping system which improving physio-chemical properties of soil. It leach out of salts and reduces salt accumulation in the root zone.

Nutrient Management helps in sustain and maintain soil fertility and crop productivity. It check the deficiency of nutrients other than major nutrient (NPK). It improve fertilizer use efficiency and improve physical, chemical and biological environment of soil. Hence, adoption of proper nutrient management approach boosting the mustard crop production. Therefore, nutrient management is most important for increasing the yield but also for the improvement of soil health.

Material and Methods

A field experiment was laid out on "Effect of integrated nutrient management on nutrient content and uptake of mustard in mustard-cowpea cropping sequence" at college farm, Navsari Agricultural University, Navsari (Gujarat) during the year 2017-18 and 2018-19. Data of soil analysis showed that soil of experimental plot was clayey, low in available N (196.80 kg/ha) and organic carbon (0.42%), medium in available P_2O_5 (38.30 kg/ha) and high in available K_2O (351.43 kg/ha). The soil was slightly alkaline (pH 8.23) and normal EC (0.30 dS/m). The field experiment consisted different INM treatments *viz*., T_1 (Control), T_2 (10 t FYM/ha), T_3 (5 t biocompost/ha), T_4 (4 t vermicompost/ha) T_5 (RDF 50:50:00 kg N:P_2O_5:K_2O/ha), T_6 (RDF + 5 t FYM/ha), T_7 (RDF + 2.5 t biocompost/ha) and T_8 (RDF + 2.0 t vermicompost/ha) to mustard in *rabi* season and it was replicated three times in RBD design.

The mustard *cv*. GDM - 4 was sown with spacing of (45 cm × 15 cm) in November and harvested in March during both the years. The required well decomposed biocompost, vermicompost and FYM as a different treatment in mustard crop. The N fertilizer was applied in form of urea (46% N) whereas P_2O_5 was applied through SSP (16% P_2O_5). The 50% dose of N fertilizer and 100% dose of P_2O_5 were applied at the time of sowing and remaining 50% dose of N fertilizer was applied at 30 DAS and seeds were inoculated with biofertilizer *Azotobacter* @ 20 ml, suspended in 80 ml water and used for inoculating 2 kg seed. Mustard seeds were well mixed with *Azotobacter*, air-dried and sown in field during both the years. The observations of N, P_2O_5 and K_2O content (%) N, P_2O_5 and K_2O uptake (kg/ha), OC (%), Available N, P_2O_5 and K_2O (kg/ha) was noted. Samples of seed and straw of mustard plant collected at different stages of crop as per observation from each plot during both the years. The sample was collected in bags and used for chemical analysis. N, P_2O_5 and K_2O content from seed and stover were estimated by using standard procedures which given by Jackson (1973) [3].

The nutrient (N, P and K) uptake of seed and straw of mustard was worked out by using following formula:

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%)}}{100} \times \text{Yield (kg/ha)}$$

The soil samples were collected from 0-22.5 cm depth of soil before starting of experiment and after harvest separately from each net plots for each crop during both the years. The soil samples were dried, grind and then sieved through 2 mm size sieve. The initial and after harvest soil samples were analysed for different soil properties.

Results and Discussion

That data of content and uptake of seed and straw of mustard are presented in Tables 1 and 2 which revealed that the N, P_2O_5 and K_2O content in seed and straw of mustard was found to be significant based on pooled analysis of two years. The significant N, P_2O_5 and K_2O content was observed in treatment T_6 and remained at par with treatment T_7, T_8 and T_5 for N content in seed and straw. In case of P_2O_5 and K_2O content in seed and straw treatment T_6 is remained at par with treatment T_7 and T_8 Similarly, uptake of N, P_2O_5 and K_2O by seed and straw of mustard.

The results showed that the N, P_2O_5 and K_2O uptake by seed and straw of mustard was found to be significant based on pooled analysis of two years. The significant N, P_2O_5 and K_2O upatke was noted in treatment T_8 and remained at par with T_7 and T_6.

The results noted in Tables 1 and 2 were showed that the nutrient content in different part of plant influence by application of different fertilizers (organic and inorganic sources). It may be due to increasing the availability of nutrient when its apply through organic manure and inorganic fertilizers. The increased uptake by plant might be due to improvement in soil properties by integrated nutrient management approach. Similar findings were reported by Meena *et al*. (2013) [4], Pati and Mahapatra (2015a) [5] and Singh *et al* (2018a) [8].

The data on soil OC and nutrient status in soil after the harvest of mustard of different treatments are noted in Table 3. Result showed that OC content in the soil was increased significantly because of use of organic manures (biocompost, vermicompost and FYM). It is improved over initial level (0.42) and recorded that the higher OC content was noted in treatment 10 t FYM/ha (T_2) during 2017-18 (0.45 %), 2020-21 (0.47 %) and remained at par with treatments T_3, T_4, T_6, T_7 and T_8 during both year. OC content in soil is directly connected with the quantity of OM in the soil. The treatment which getting organic manures as a treatment content higher carbon in soil. These results are in similar with the findings of Rauniyar and Bhattarai (2017) [6].

The available N, P_2O_5 and K_2O in soil significantly improved with integrated nutrient management treatments (Table 3) and data of soil N, P_2O_5 and K_2O after harvest of mustard crop was found significant higher in treatment T_2 (10 t FYM/ha) during both year and remained at par with treatments T_5, T_6, T_7 and T_8. In case of Available phosphorus after harvest of crop found non-significant during both the years of study. Organic manures contributed essential nutrients also improving soil health. It might be due to supplementation of nutrients with organic mannures and inorganic chemical fertilizer resulted in mineralization of nutrients from organic matter through increased activity of soil microorganisms. These results are in similar with the findings of Rauniyar and Bhattarai (2017) [6] and Singh *et al.* (2018a) [8].

Table 1: Nutrient content and uptake of mustard seed as influenced by different INM treatments (Two years pooled results)

Treatments	Nutrient content in seed (%)			Nutrient uptake in seed (kg/ha)		
	N	P	K	N	P	K
T_1: Control	2.51	0.97	0.67	22.52	8.70	6.03
T_2: 10 t FYM/ha	2.58	1.02	0.69	25.86	10.24	6.95
T_3: 5 t Biocompost/ha	2.65	1.07	0.73	29.17	11.83	7.99
T_4: 4 t Vermicompost/ha	2.72	1.13	0.76	32.75	13.48	9.13
T_5: RDF (50:50:00 kg N:P_2O_5:K_2O /ha)	2.79	1.18	0.79	36.18	15.27	10.16
T_6: RDF + 5 t FYM/ha	3.00	1.34	0.88	41.79	18.72	12.31
T_7: RDF + 2.5 t Biocompost/ha	2.93	1.29	0.85	43.77	19.23	12.67
T_8: RDF + 2.0 t Vermicompost/ha	2.86	1.24	0.82	45.33	19.71	12.98
SEm±	0.08	0.03	0.02	1.98	0.91	0.57
CD (P=0.05)	0.22	0.09	0.06	5.74	2.64	1.65
CV (%)	6.81	6.91	6.41	13.99	15.27	14.30
General mean	2.75	1.15	0.77	34.67	14.65	9.78
*RDF - Recommended dose of fertilizer CD - Critical Difference, CV – Co-efficient of Variation						

Table 2: Nutrient content and uptake of mustard straw as influenced by different INM treatments (Two years pooled results)

Treatments	Nutrient content in seed (%)			Nutrient uptake in seed (kg/ha)		
	N	P	K	N	P	K
T_1: Control	0.41	0.20	1.44	7.40	3.61	26.10
T_2: 10 t FYM/ha	0.44	0.21	1.48	9.02	4.39	30.47
T_3: 5 t Biocompost/ha	0.47	0.23	1.52	10.80	5.16	34.78
T_4: 4 t Vermicompost/ha	0.50	0.24	1.57	12.66	6.02	39.55
T_5: RDF (50:50:00 kg N:P_2O_5:K_2O /ha)	0.54	0.25	1.61	14.83	6.88	44.39
T_6: RDF + 5 t FYM/ha	0.64	0.29	1.75	18.95	8.58	52.19
T_7: RDF + 2.5 t Biocompost/ha	0.61	0.28	1.70	19.54	9.04	54.75
T_8: RDF + 2.0 t Vermicompost/ha	0.57	0.27	1.66	19.64	9.18	57.27
SEm±	0.01	0.01	0.03	0.75	0.40	1.97
CD (P=0.05)	0.03	0.02	0.09	2.17	1.17	5.70
CV (%)	5.22	6.77	4.95	13.02	14.92	11.36
General mean	0.52	0.24	1.59	14.11	6.61	42.44
*RDF - Recommended dose of fertilizer CD - Critical Difference, CV – Co-efficient of Variation						

Table 3: Organic carbon and available nutrient status of soil as influenced by different treatments after harvest of mustard

Treatments	Organic carbon (%)		Available N (kg ha^{-1})		Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	0.41	0.43	172.5	172.1	35.4	34.5	286.4	307.9
T_2	0.45	0.47	198.4	204.0	37.1	39.5	332.5	351.2
T_3	0.45	0.46	194.7	199.4	36.9	38.8	325.9	345.0
T_4	0.44	0.45	191.0	194.9	36.6	38.1	319.3	338.8
T_5	0.41	0.43	176.2	176.6	35.6	35.3	293.0	314.1
T_6	0.43	0.44	187.3	190.3	36.4	37.4	312.7	332.7
T_7	0.42	0.44	183.6	185.7	36.1	36.7	306.2	326.5
T_8	0.42	0.44	179.9	181.2	35.9	36.0	299.6	320.3
SEm±	0.01	0.01	5.41	6.67	1.32	2.17	9.65	9.02
CD (P=0.05)	0.03	0.03	16.42	20.24	NS	NS	29.28	27.35
CV (%)	3.45	3.27	5.06	6.15	6.30	10.14	5.40	4.74
General mean	0.43	0.45	185.5	188.0	36.3	37.0	309.4	329.6

CD - Critical Difference, CV – Co-efficient of Variation

Conclusion

Mustard crop should be fertilized with recommended dose of inorganic fertilizer (50:50:00 kg N:P_2O_5:K_2O/ha) combined with 2.5 t biocompost/ha or 2 t vermicompost/ha for getting higher nutrient uptake and to maintain the organic carbon content and nutrient status of soil in mustard-cowpea cropping sequence.

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