International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 3625-3629

Received: 25-11-2020
Accepted: 10-01-2021

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Effect of INM on quality, nutrient content and uptake of various nutrients by *Brassica Juncea* L. (Indian mustard)

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DOI: https://doi.org/10.22271/chemi.2021.v9.i1ay.11794

Abstract
A field experiment was conducted on student instructional farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (UP) during Rabi season 2017-18 on *Brassica Juncea* (Indian mustard) with the objective of studying different doses of fertilizers on growth, yield and quality of crop during the crop growth. The research was conducted by taking 10 treatments replicated thrice, various combinations of treatments with 100 % RDF dose of N:P:K:S (RDF) @ 120:60:40:40 kg ha^{-1} to 50% RDF 60:30:20:20 kg ha^{-1} along with different combinations of FYM @ 5 t ha^{-1} or 2.5 t ha^{-1}, vermicompost @ 1.25 t ha^{-1} or 0.62 t ha^{-1}, Bio-fertilizers (Azotobacter + PSB) @ 7.5 Kg ha^{-1}, $ZnSO_4$ @ 10Kg ha^{-1} were made to see the effect of various sources of fertilizers individually on growth characters, yield attributes, quality characters *viz* oil quality, oil content, protein content, protein quality, N P K S Zn content in straw and grain were obtained separately, and their uptake by straw and grain etc. In the following experiment, results reveals that the highest oil content recorded was (40.15 %) with oil yield of 933.48 (kg ha^{-1}), similarly protein content as 17.37 % and protein yield as 403.85 (kg ha^{-1}) all these observations were recorded best in the treatment having 50% RDF + FYM @ 2.5 t ha^{-1} + Vermicompost @ 0.62 t ha^{-1} + Bio-fertilizers @ 7.5kg ha^{-1} + $ZnSO_4$ @10 kg ha^{-1} followed by treatment T_7 having 75% RDF + Vermicompost @ 0.62 t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1}, treatments T_6 and T_8 also showed similar results and were significantly at par from treatments having 100 % RDF, control and other treatments T_1 to T_5. Therefore these treatments were recommended on the basis of this research work for obtaining better results *viz*., oil quality, oil content, protein content, protein quality, nutrient uptake and for producing quality mustard.
The variety Pusa Mustard – 30 having its specialisation in low Erucic acid content (<2%) was found true while extracting oil, hence it is good for edible purpose.

Keywords: nutrient, Indian mustard, *Brassica Juncea* L.

Introduction
Rapeseed and mustard are the major Rabi oilseed crops of India and stand next to groundnut in the oilseed economy. Oilseeds are considered as the second largest agricultural commodity after cereals in India, which plays a significant role in India's agrarian economy, sharing 14% of the gross cropped area and accounting for nearly 1.5% of the gross national production and 8% of the value of all agricultural products. The gap in supply is being met through huge imports costing more than Rs. 26000 crores during 2009-10.
Oilseeds provide basic raw materials for agro based industries and have large acreage covering 20.7 million ha under various oilseeds in different agro-climatic zones of this country. Integrated Nutrient Management (INM) involves efficient and judicious use of all the major components of plant nutrient sources *viz*. chemical fertilizer in conjunction with animal manures, compost, green manures, legumes in cropping system, bio fertilizers, crop residues, or recyclable waste and other locally available nutrient sources for sustaining soil fertility, health and productivity. Balance fertilization at right time with proper method and sources nutrient uses efficiency and productivity and enhance production of better quality seed production, nutrient content in grain and uptake of nutrients by grain in mustard. Organic manures also play a vital role in enhancing soil fertility, crop productivity and better crop production in agriculture as they are eco-friendly and can be replaced by using 25 percent

chemical fertilizers that are not toxic for health and enable farmer to get maximum crop yields. Application of organic manure in addition to chemical fertilizers results in increased mineral content in soil and water holding capacity of field and uptake of nutrients is also increased to a great extent, besides this several other changes such as root development, vegetative growth and nitrogen fixation increases crop yield as reported by Tomar *et al*., 2017, 2019 [27, 26]. Similarly, present study deals with the Effect of Integrated Nutrient Management on soil properties and Performance of Mustard (*Brassica Juncea* L.) in quality crop production. Phosphorus fertilization improves growth of rapeseed crops and its deficiency restricts growth of roots and aerial part, role of potash in rapeseed mustard is to activate a wide range of enzyme systems, Sulphur can be rightly called as fourth major element of the plant because it is a constituent of three amino acids and helps in the formation of chlorophyll and synthesis of oils, Zinc is one of the essential micronutrient and plays important role in various enzymatic and physiological activities of the plant. Significant response of oilseed to the tune of 30-40% was recorded due to the use of secondary major nutrients and micronutrients and with significant residual effect in cropping system Singh *et al.* (2017) [15].

Methods and Materials

The present investigation entitled, "Effect of Integrated nutrient management on yield, quality and Nutrient uptake by mustard (*Brassica juncea* L.) Carried out during *Rabi* season of 2017-2018. The geographical and climatic conditions under which the experiment was conducted and the materials and methods employed for obtaining better quality seed(including oil yield, protein yield, oil content, protein content, various amount of nutrient content increased in mustard grain due the application of integrated nutrient management technique and as a result uptake of nutrients by grain of mustard, basically five nutrients we have studied in this experiment *viz*, Nitrogen, phosphorus, potassium, Sulphur and Zinc. The results revealed on the basis of this experiment are described briefly in this research paper.

Firstly, when we talk about integrated nutrient management Quality attributes are necessary to study so that we can have a comparison between normal crop and crop grown with integrated nutrient management. The major factors which come under quality attributes are Oil content, Oil yield, protein content, protein yield, etc. The oil content in seed sample was excreted by a technique based on NMR nuclear magnetic resonance and chemo metrics combined for simultaneous determination of water, oil, and protein contents in oilseeds. (DRMR, Bharatpur, and Rajasthan).

Secondly, effect of integrated nutrient management on grain yield, quality grain production, presence of various nutrient in mustard increasing its nutrient value, for this the plant samples collected at harvest were air dried, the dried samples were provided in a grinder having stainless steel blades to avoid contamination of micronutrients and estimation of N, P, K, S, Zn content in seed and Stover. The respective samples were analyzed for available nitrogen determination by alkaline potassium permanganate method, the data were noted as kg ha^{-1}. Available phosphorus in the soil samples determined by Olsen's method in kg ha^{-1}, Available potassium (kg ha^{-1}) in the soil samples were determined by Flame photometric method. Sulphur was estimated by turbid metric method. Plant samples were digested with tri – acid mixture (nitric acid, perchloric acid and hydrochloric acid) using barium chloride solution for development of turbidity. The turbidity was measured by colorimeter and the concentration was expressed as percentage on dry weight basis. While in calculating Zn content, digestion of samples was done by tri acid mixtures using double distilled water. The Zinc content was estimated with atomic spectrophotometer (AAS) by Lindsay and Norvell (1978) method.

Similarly, nutrients uptake by grain can be clearly studied by following certain formulae

The uptake of Nitrogen, Phosphorus, Potassium, Sulphur at harvest in seed and stover was estimated using the formulae:

$$\text{N, P, K, S. Uptake} = \frac{\text{Nutrient content(\%)in seed/ Stover (kg/ ha) X Seed / Stover yield (kg ha}^{-1}\text{)}}{100}$$

Similarly Nutrient uptake by gain as well as straw can be studied by the formulae

$$\text{Zn Uptake} = \frac{\text{Nutrient content(mg/kg)in Seed/Stover X Seed /Stover yield (kg ha}^{-1}\text{)}}{100}$$

Using the above methods, we can determine various aspects of nutrient content and nutrient uptake in both grain as well as straw. Also, the difference between crop produced normally with farmer's recommendation and with immediate effect of different sources of nutrient management can be determined and studied by drawing a comparison between the same. Various factors showing a significant amount of difference is also observed during the experiment which can further be used to help the farmers to attain a better profitability using almost the same input.

This experiment throws light on the emerging integrated nutrient management using various comparative studies and the nutrient content in grain and straw, both. The various sources involved in the same improves the quality of seed production and also leads to production of high quality oil.

Results and Discussion

The discussion about the results of this experiment is as given in this research paper. To gain some scientific knowledge and the major revolving principles of agronomy, it is a vital requisite. Interpretations have been made in the view of the factors governing the manifestation of results and their corroboration in the light of results obtained by other scientists/workers engaged in the relevant field of research.

The experiment was carried out to find out the effect of organic fertilizers, manures, Bio fertilizers, micronutrients and inorganic fertilizers on growth, quality, nutrient content and uptake of mustard. Mustard is a productive, remunerative, as well as adaptive crop in the Northern parts of India as well as in the neighbouring countries. However, some futuristic attempts have been made to compare the present results with the past practice of mustard cultivation in this niche of cropping system.

Quality

The use of integrated nutrient management in the mustard cultivation lead to a significant change in the quality of mustard including oil yield, oil content, protein content and protein yield where treatment T_{10} - [50% RDF + FYM @ 2.5t ha^{-1} + Vermicompost @ 0.62t ha^{-1} + Bio-fertilizers @ 7.5kg ha^{-1} + $ZnSO_4$ @ 10kg ha^{-1}] shows highest return followed by

treatment T_7 [75% RDF + Vermicompost @ 0.62t ha^{-1} + Bio-fertilizers @ 7.5kg ha^{-1}], T_8, all these treatments were significantly at par and were much superior than control plot or we can say farmers practise. The variety taken in the present experiment Pusa Mustard-30 was tested good in oil quality, having low Erucic acid content (<2) which has several health benefits on our body reduces cholesterol, heart diseases, etc.

Nutritional Content

Owing to the data related to Nitrogen content in grain and straw depicted in table 2. N, P, K content in grain and straw recorded significant result with the application of different fertility treatments. The treatment T_{10} [50% RDF + FYM @ 2.5t ha^{-1} + Vermicompost @ 0.62 t ha^{-1} + Bio-fertilizers 7.5 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1}] recorded maximum N, P, K content in grain as well as in straw followed by T_7, all these treatments were significantly at par but superior over control plot. However, the minimum N content in grain and straw recorded in control plot.

The Sulphur and Zinc content in grain as well as in straw recorded significant result with the application of different fertility treatments given in this experiment. The treatment T_{10} recorded maximum sulphur and zinc content recorded in grain as well as in straw while, except T_7, T_8 and T_9, all these treatments were statistically at par but significantly superior over control in terms of sulphur and zinc content in grain as well as in straw. The minimum sulphur and zinc content in grain as well as straw was recorded in control plot.

Nutritional uptake

The uptake of nutrient is the function of dry matter formulation and percentage of nutrient content of the seed. Since, N, P, K, S and Zn uptake was higher in treatments where treatments are applied in adequate and balanced proportion. The N uptake recorded 2-2.5 times higher in seed than without treatment. It is further observed that uptake of N was directly proportional to the amount of N applied to the crops as reported by Singh Bharat, 2006 and Tomar 2018.

The adversely affected ones are the treatments where P and K were omitted the uptake of N. When sulphur and zinc were added in junction with major nutrients (NPK) uptake of N was highly appreciated over their individual application. It shows the importance of balanced nutrition, Singh (2006) and Tomar (2016) [25]. Supported the present results. Farmers' practice recorded lowest uptake due to low doses of N applied that ultimately resulted into low yield in mustard such.

Maximum uptake of potassium was associated with higher application of potassium. The maintenance of high level of potassium in the soil arrested the declining trend in productivity and also supported the sustainability of the system.

The farmers' practice receiving low amount of nutrients yielded little amount of nitrogen in both seed and straw. Phosphorus uptake was found 2 to 2.5 times more in seed an straw. The uptake of P was proportional to the amount of P. applied.

Contrary to N application the total uptake of P was lower to P application. It may possibly be due to fixation of P in the soil. Due to the fixation of native soil P the fertility was increased by it placement. As a result of high P fixation resulting from the higher application of phosphorus led to downward movement of phosphorus in the soil. The downward movements of P enriched the phosphorus status of the soil.

The uptake of K fluctuated during the crop growth season. The uptake of K was greater in straw than seed Naklang *et al*., (2006) also backed up the present findings. The maximum uptake was observed in treatment T_{10} followed by T_8 and T_7. The Maximum uptake of potassium is associated with its higher application. Maintenance of high level of K in the soil arrested the declining trend in productivity and improved the sustainability of the crop. These findings are in close conformity of the findings of Shajatulwardah *et al.*, (2007), Shen *et al.* (2007) confirmed the results and reported and found that inadequate amount of K was responsible for declining trend in yield.

The total Zn uptake was found directly proportional to the amount added. The maximum uptake was recorded in treatment T_{10} and well established in the nutrition of mustard mainly in soil having pH 7.5 as it influenced both seed and straw. The combined application of Zn and S along with recommended dose of NPK greatly appreciated the uptake as compared to their individual application.

Table 1: Effect of treatment on oil content, oil yield, protein content & protein yield in grain

S. No	Treatments	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
T_1	Control	38.37	566.11	16.18	238.65
T_2	100% RDF(120:60:40:40), (N:P:K:S, kg ha^{-1})	39.15	753.92	16.93	325.56
T_3	100% RDF + Bio-fertilizers (Azotobacter+PSB) @ 7.5kg ha^{-1}	39.31	779.38	17.00	336.94
T_4	75% RDF + FYM @ 2.5t ha^{-1} + $ZnSO_4$ @ 10kg ha^{-1}	39.39	793.88	17.06	343.75
T_5	75% RDF + Vermicompost @ 0.62t ha^{-1} + $ZnSO_4$ @ 10kg ha^{-1}	39.43	826.05	17.12	358.66
T_6	75% RDF + FYM @ 2.5t ha^{-1}+ Bio-fertilizers 7.5kg ha^{-1}	39.46	850.36	17.25	373.46
T_7	75% RDF + Vermicompost @ 0.62t ha^{-1} + Bio-fertilizers@ 7.5kg ha^{-1}	39.57	906.15	17.35	397.315
T_8	50% RDF + Vermicompost@1.25t ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	39.50	872.95	17.25	381.225
T_9	50% RDF + FYM@ 5t ha^{-1}+$ZnSO_4$ @10kg ha^{-1}	39.46	866.93	17.25	378.98
T_{10}	50% RDF + FYM @ 2.5t ha^{-1} + Vermicompost @ 0.62t ha^{-1} + Bio-fertilizers @ 7.5kg ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	40.15	933.48	17.37	403.85
S.E. (d) ±		0.293	35.471	0.151	31.615
C.D. at 5%		0.617	74.547	0.318	66.419

Table 2: Nutrient Content in grain

S. No	Treatments	Nutrient Content in grain				
		N (%)	P (%)	K (%)	S (%)	Zn (ppm)
T_1	Control	2.59	0.45	0.46	0.78	33.74
T_2	100% RDF (120:60:40:40), (N:P:K:S, kg ha^{-1})	2.71	0.47	0.48	0.81	35.52
T_3	100% RDF + Bio-fertilizers (Azotobacter + PSB) @ 7.5kg ha^{-1}	2.72	0.47	0.48	0.81	34.87
T_4	75% RDF + FYM @ 2.5t ha^{-1} + $ZnSO_4$ @ 10kg ha^{-1}	2.73	0.48	0.48	0.82	34.98
T_5	75% RDF + Vermicompost @ 0.62t ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	2.74	0.48	0.49	0.82	35.21
T_6	75% RDF +FYM @ 2.5t ha^{-1}+ Bio-fertilizers @ 7.5kg ha^{-1}	2.76	0.48	0.49	0.83	35.47
T_7	75% RDF + Vermicompost @0.62t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1}	2.77	0.48	0.50	0.83	36.89
T_8	50% RDF + Vermicompost @1.25t ha^{-1} + $ZnSO_4$ @10 kg ha^{-1}	2.76	0.48	0.49	0.83	36.62
T_9	50% RDF + FYM @ 5t ha^{-1}+$ZnSO_4$ @10kg ha^{-1}	2.76	0.48	0.49	0.83	36.61
T_{10}	50% RDF + FYM @ 2.5 t ha^{-1} + Vermicompost @ 0.62 t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	2.78	0.48	0.50	0.84	37.55
S.E. (d) ±		0.045	0.0063	0.0058	0.009	0.789
C.D. at 5%		0.093	0.0132	0.0121	0.018	1.658

Table 3: Nutrient Content in straw

S. No.	Treatments	Nutrient Content in straw				
		N (%)	P (%)	K (%)	S (%)	Zn (ppm)
T_1	Control	0.53	0.20	1.13	0.46	13.02
T_2	100% RDF (120:60:40:40), (N:P:K:S, kg ha^{-1})	0.56	0.22	1.18	0.48	13.22
T_3	100% RDF + Bio-fertilizers (Azotobacter + PSB) @ 7.5kg ha^{-1}	0.55	0.23	1.18	0.49	13.19
T_4	75% RDF + FYM @ 2.5t ha^{-1} + $ZnSO_4$ @ 10kg ha^{-1}	0.56	0.23	1.19	0.49	13.20
T_5	75% RDF + Vermicompost @ 0.62t ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	0.56	0.24	1.19	0.49	13.21
T_6	75% RDF +FYM @ 2.5t ha^{-1}+ Bio-fertilizers @ 7.5kg ha^{-1}	0.57	0.25	1.20	0.50	13.21
T_7	75% RDF + Vermicompost@0.62t ha^{-1} + Bio-fertilizers@7.5 kg ha^{-1}	0.58	0.27	1.21	0.51	13.82
T_8	50% RDF + Vermicompost @1.25t ha^{-1} + $ZnSO_4$ @10 kg ha^{-1}	0.57	0.27	1.20	0.49	13.76
T_9	50% RDF + FYM @ 5t ha^{-1}+$ZnSO_4$ @10kg ha^{-1}	0.57	0.26	1.20	0.50	13.72
T_{10}	50% RDF + FYM @ 2.5 t ha^{-1} + Vermicompost @ 0.62 t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	0.58	0.28	1.21	0.51	13.83
S.E. (d) ±		0.008	0.012	0.0077	0.008	0.058
C.D. at 5%		0.017	0.024	0.0163	0.017	0.121

Table 4: Nutrient uptake by grain

S. No	Treatments	Nutrient uptake by grain				
		N (%)	P (%)	K (%)	S (%)	Zn (g ha^{-1})
T_1	Control	38.16	6.64	6.80	11.48	497.03
T_2	100% RDF (120:60:40:40), (N:P:K:S, kg ha^{-1})	53.72	9.08	9.29	15.65	683.86
T_3	100% RDF + Bio-fertilizers (Azotobacter + PSB) @ 7.5kg ha^{-1}	53.95	9.39	9.61	16.23	691.26
T_4	75% RDF + FYM @ 2.5t ha^{-1} + $ZnSO_4$ @ 10kg ha^{-1}	55.09	9.59	9.83	17.25	704.95
T_5	75% RDF + Vermicompost @ 0.62t ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	57.57	10.01	10.26	17.32	737.75
T_6	75% RDF +FYM @ 2.5t ha^{-1}+ Bio-fertilizers @ 7.5kg ha^{-1}	59.87	10.41	10.67	18.01	767.92
T_7	75% RDF + Vermicompost @0.62t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1}	63.60	11.06	11.33	19.14	844.89
T_8	50% RDF + Vermicompost @1.25t ha^{-1} + $ZnSO_4$ @10 kg ha^{-1}	61.74	10.65	10.89	18.43	809.30
T_9	50% RDF + FYM @ 5t ha^{-1}+$ZnSO_4$ @10kg ha^{-1}	60.71	10.56	10.81	18.28	804.62
T_{10}	50% RDF + FYM @ 2.5 t ha^{-1} + Vermicompost @ 0.62 t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	64.63	11.16	11.62	19.53	873.03
S.E. (d) ±		1.807	0.336	0.266	0.516	32.658
C.D. at 5%		3.718	0.705	0.559	1.085	68.405

Table 5: Nutrient uptake by straw

SI. No.	Treatments	Nutrient uptake by straw				
		N (%)	P (%)	K (%)	S (%)	Zn (g ha^{-1})
T_1	Control	23.25	8.77	49.57	20.18	571.18
T_2	100% RDF (120:60:40:40), (N:P:K:S, kg ha^{-1})	29.33	11.52	61.80	25.14	692.46
T_3	100% RDF + Bio-fertilizers (Azotobacter + PSB) @ 7.5kg ha^{-1}	29.07	12.15	62.37	25.90	697.22
T_4	75% RDF + FYM @ 2.5t ha^{-1} + $ZnSO_4$ @ 10kg ha^{-1}	29.88	12.27	63.49	26.14	704.35
T_5	75% RDF + Vermicompost @ 0.62t ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	31.00	13.28	65.89	27.13	731.43
T_6	75% RDF +FYM @ 2.5t ha^{-1}+ Bio-fertilizers @ 7.5kg ha^{-1}	32.37	14.19	68.14	28.39	750.19
T_7	75% RDF + Vermicompost @0.62t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1}	34.15	16.17	72.50	29.96	828.09
T_8	50% RDF + Vermicompost @1.25t ha^{-1} + $ZnSO_4$ @10 kg ha^{-1}	33.97	15.81	70.29	28.70	819.82
T_9	50% RDF + FYM @ 5t ha^{-1}+$ZnSO_4$ @10kg ha^{-1}	33.90	15.46	71.38	29.74	816.20
T_{10}	50% RDF + FYM @ 2.5 t ha^{-1} + Vermicompost @ 0.62 t ha^{-1} + Bio-fertilizers @ 7.5 kg ha^{-1} + $ZnSO_4$ @10kg ha^{-1}	35.19	16.99	73.42	30.94	839.20
S.E. (d) ±		1.342	0.989	1.632	1.342	30.798
C.D. at 5%		2.820	2.077	4.445	2.810	64.726

References

1. Dongarkar KP, Pawar WS, Khawale VS, Khutate NG, Gudadhe NN. Effect of nitrogen and sulphur on growth and yield of mustard (*Brassica juncea* L.) Journal of soils and crops 2005;15(1):163-167.
2. Gangwal TV, Patel MV, Jadav NJ. Effect of phosphorus, sulphur and phosphate solubilising bacteria on yield, nutrient uptake and soil fertility after harvest of mustard. Indian Journal of fertilizers 2011;7(8):32-40.
3. Grewal KS, Godara OP, Malik RS. Effect of potassium application on mustard yield, quality and nutrient uptake in soils of Southern. Haryana Journal of Agronomy 2009;25(1/2):43-47.
4. Gundalia JD, Hadial TM, Polara JV. Effect of S and K carriers on yield, quality and nutrient uptake by mustard. Advances in Plant Sciences 2005;18(1):201-205.
5. Joghee, Nanjudan, Thakral NK, Singh, Dhiraj, Mohanraj K. Sulphur assimilation and partitioning in Indian mustard [*Brassica juncea* (L.)]. Indian Journal of Plant Physiology 2012;17(1):65-70.
6. Kumar, Raman, Trivedi SK. Effect of levels and source of sulphur on yield, quality and nutrient uptake by mustard (*Brassica juncea*). Progressive Agriculture 2012;12(1):69-73.
7. Kumar, Santosh, Verma SK, Singh TK, Singh, Shyambeer. Effect of nitrogen and sulphur on growth, yield and nutrient uptake by Indian mustard (*Brassica juncea*) under rainfed condition. Indian Journal of Agricultural Sciences 2011;81(2):145-149.
8. Lone NA, Mir MR, Payne WA, Khan AV, Dilshada Tabassum, Mir S *et al*. Effect of phosphorus and potassium on yield and quality characteristics of mustard. Applied Biological Research 2010;12(2):78-80.
9. Mishra SK. Effect of sulphur and potassium on yield, nutrient uptake and quality characteristics of mustard (*Brassica juncea* L.) in Udic Haplu stepts of Kanpur. Journal of the Indian Society of Soil Science 2003;51(4):544-548.
10. Mohiuddin M, Pual AK, Sutradhar GNC, Bhuiyan MSI, Zubair HM. Response of nitrogen and sulphur fertilizers on yield, yield components and protein content of oilseed mustard (*Brassica spp.*). International Journal of Bio-resource and stress management 2011;2(1):93-99.
11. Pachauri RK, Trivedi SK, Kumar Yogendra. Effect of sulphur levels on growth, yield and quality of Indian mustard genotypes and their economics. Journal of soils and crops 2012;22(2):258-263.
12. Premi OP, Sinsinwar BS, Kumar Manoj, Kumar Arvind. Influence of organics and inorganics on yield and quality of Indian mustard, *Brassica juncea* (L.) Czern & Coss. In semi arid region of Rajasthan. Journal of Oilseed Research 2005;22(1):45-46.
13. Ramesh P, Panwar NR, Singh AB, Ramana S. Effect of organic nutrient management practices on the production potential nutrient uptake, soil quality, input use efficiency and economics of mustard (*Brassica juncea*). Indian Journal of Agricultural Sciences 2009;79(1):40-44.
14. Saxena KK, Kumar Arun, Verma HR. Growth yield and oil content of mustard (*Brassica juncea* L.) as influenced by application of phosphorus and iron. Farm Science Journal 2005;14(1):197-198.
15. Singh Jagendra Pratap, Tomar Saurabh, Chaudhary Mahendra, Maurya Jayant Kumar. Yield and Quality of Aonla (*Emblica officinalis Gaertn*.) as Influenced by Foliar Application of Different Sources of Potassium with and without Urea Spray. Int. J Curr. Microbiol. App. Sci 2017;6(9):1530-1533.
16. Singh H, Singh RP, Meena BP, Lal B, Dotaniya ML, Shirale AO *et al*. Effect of integrated nutrient management (INM) modules on late sown Indian mustard [*B. juncea* (L.) Cernj. & Cosson] and soil properties. Journal of Cereals and Oilseeds 2018;9(4):37-44.
17. Singh PK, Imnuksungba, Kanaujia SP. Effect of Integrated nutrient management on growth, yield, its attributes and nutrient uptake of mustard crop in acidic. Environment and Ecology 2009;27(3):1036-1039.
18. Singh RP, Singh SK, Yadav PK, Singh SN. Effect of sulphur and calcium on yield and quality of mustard (*Brassica juncea*). Journal of oilseeds Research 2010;27(2):183-184.
19. Singh Rakesh, Singh SB, Manhar SS, Kumar Anil. Effect of different levels of sulphur and varieties on growth, yield and quality of Indian mustard. International Journal of Plant Sciences (Muzaffarnagar) 2012;7(2):290-294.
20. Singh SP, Pal MS. Effect of integrated nutrient management on productivity, quality, nutrient uptake and economics of mustard (*Brassica juncea*). Indian Journal of Agronomy 2011;21(1):60-61.
21. Singh SP, Pal MS. Effect of integrated nutrient management on productivity, quality, nutrient uptake and economics of mustard (*Brassica juncea*). Indian Journal of Agronomy 2011;21(1):60-61.
22. Sipal H, Sevak K, Modi DB, Khorajiya KU, Jigar RJ. Effect of sulphur and zinc with and without fym on yield, content and uptake of nutrients after harvest of mustard [*brassica juncea* l. Czern & coss] grown on light textured soil of kachchh. International Quarterly Journal of Envrmental Science 2016;10(3&4):527-534.
23. Thipathi MK, Chaturvedi S, Shukla K, Saini K. Influence of integrated nutrient management on growth, yield and quality of Indian mustard (*Brassica juncea* L.) in *tarai* region of northern India. Journal of Crop and Weed 2011;7(2):104-107.
24. Tomar Saurabh, Dubey AK, Chaudhary Mahendra, Singh Jagendra Pratap, Jeevan Ram. Effect of Different Dates of Transplanting and Mulching on Flowering and Fruiting Behaviour of Tomato (*Lycopersicon esculentum* Mill.) Int. J Pure App. Biosci. SPI: 2018;6(3):676-680.
25. Tomar Saurabh, Dubey AK, Singh Sanjiv, Ujjwal Vivek. Effect of different levels of NAA, GA_3 and 2, 4-d on growth and Yield of tomato (*lycopersicon esculentum* mill). Annals of Horticulture 2016;9(1):97-100.
26. Tomar Saurabh, Rajiv, Beniwal Deepa, Sourabh. Effect of transplanting dates and mulching on growth and yield of tomato (*Solanum lycopersicm* L.) Vegetable Science 2019;46(1&2):39-43.
27. Tomar Saurabh, Singh Sanjive Kr, Dubey AK, Singh Jagendra Pratap, Abhishek. Role of Plant Hormones on Vegetative Growth of Tomato (*Lycopersicon esculentum* Mill.) Int. J Curr. Microbiol. App. Sci 2017;6(9):3319-3323.
28. Tripathi MK, Chaturvedi, Sumit, Shukla DK, Mahapatra BS. Yield performance and quality in Indian mustard (*Brassica juncea*) as affected by integrated nutrient management. Indian Journal of Agronomy 2010;55(2):138-142.
29. Verma CK, Prasad Kedar, Yadav DD. Studies on response of sulphur, zinc and boron level on yield, economics and nutrient uptake of mustard (*Brassica juncea*). Crop Research (Hisar) 2012;44(1/2):75-78.
30. Zheljazkov VD, Vick B, Ebelhar MW, Buehring N, Astatkie T. Nitrogen application modify seed and oil yields and fatty acid composition of winter mustard. Industrial crops and products 2012;36(1):28-32.