Interaction effect of sulphur and NPK on growth parameters and yield of mustard

Abstract

A field experiment was conducted on sandy clay loam soil having low status of organic carbon and available nitrogen, medium in available phosphorous and high in available potassium at Rajaula Agriculture farm, of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.) during Rabi season of 2021-22. To study the effect of sulphur and NPK on growth parameters, yield components and yield of chickpea the experiment comprised of 12 treatment combinations in randomized block design with three replications. Mustard variety Pitambariwas grown with the recommended agronomic practices. On the basis of the results emanated from present investigation, it could be concluded that application of S @ 40 kg ha^{-1} + 125%RDF (Recommended dose of fertilizers) significantly recorded maximum growth parameters such as viz. plant height (198.4 cm), number of leaves (36.9) and number of branches (13.2) at 90 days, maximum yield attributing characters such as no. of siliquaplant^{-1} (327.7), number of seed siliqua^{-1} (12.1) and seed index (6.9 gm). Similarly the maximum seed yield (11.53 q ha-1) was associated with the treatment fertilized with S @ 40 kg ha^{-1} + 125%RDF.

Key Words: Mustard (*Brassica juncea* L.), growth, RDF, sulphur and yield.

1. Introduction

India is one of the important among the 3rd leading oilseed producing countries of the world after Canada and China. In world, during 2020-21, Rapeseed-mustard occupied almost 37.08 million ha area with total production was 71.62 million tonnes and 1920 kg ha^{-1} productivity **(Anonymous, 2018)**.

It is grown in Rajasthan, UP, Haryana, Madhya Pradesh and Gujarat states. InIndia mustard occupy 6.23 million ha area with production of 9.34 million tonnes and productivity of 1499 kg ha^{-1} respectively. In UP Mathura district have the highest area, production and productivity which is 0.053 mha, 0.077 mt and 1453 kg ha^{-1}**(INDIASTAT, 2019-20).**

The oil is utilized for human consumption, preparation of hair oils, medicines, soap making. Mustard seed contains 30-33% oil, 17-25% proteins, 8-10% fibres, 10-12% extractable substances **(Mishra *et al.*, 2019).**The cake obtained after extraction of oil is used as cattle feed and manure. The oil cake contains 25-30% crude protein, 5% nitrogen, 1.8-2.0% phosphorous and 1.0-1.2% potassium **(Mutha *et al.*, 2021).**

Generally, oilseed crops are raised under rainfed conditions with low input and poor management practices leading to lower productivity level. Imbalanced nutrition is one of the important constraints towards higher mustard productivity, oil content and other quality parameters **(Lal *et al.*, 2015).** In present agriculture scenario use of chemical fertilizer is increasing to boost up crop production. Simultaneously, cost of chemical fertilizer is increased constantly, besides these, indiscriminate use of inorganic fertilizers is injurious to soil health and soil productivity **(Eyhorn *et al*., 2007).**

Nutrient management is one of the most important agronomic factors that affects the yield of all the crops. Continuous and imbalanced use of selected fertilizer nutrients have resulted in deterioration of soil health, increasing per unit cost of production and decline in the rate of growth of productivity. Mustard responds strongly to N fertilization and yield increases of 30% or more are common. Recommended rates of N are 50 to 80lbs/acre of actual N in soils where N is deficient, but it is best to follow the soil test recommendations. Increasing N levels above the soil test recommendation does not always lead to further increased yields. The highest response to added N occurs when moisture is not limiting. In dry years, N rates near the low range of the recommendation will be adequate since realistic target yields will be lower than when moisture is not a limiting factor. **(Kumar *et al.*, 2017)**

Phosphorus (P) is important for the establishment of a healthy and robust root system. Deficiency will result in dwarfed plants with stunted roots. With severe deficiency, plants will be spindly, and if extremely deficient, mustard plants will have purple discolouration of the stems and leaves as well as be stunted.

Potassium is one of the essential nutrients which is needed for the growth and development of plants. It is a major plant nutrient because of large amount in which it is absorbed by plants. The quantity of K absorbed by roots is second to that of nitrogen for most of the cultivated crops. As low soil K status is an important limiting factor responsible for poor yields of the crops, it is imperative to evaluate the response of K nutrition on mustard productivity. Since not much work has been done to assess the response of mustard to K fertilization, present study was therefore, undertaken to study the effect of potassium on yield and quality of Indian mustard.**(Sharma *et al.*, 2020)**

2. Material and Methods

2.1 Experimental Site

The experiment was carried out at Rajaula Agriculture farm, Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya Chitrakoot, Satna (M.P.) which lies in the semi- arid and sub-tropical region of Madhya Pradesh between 25°148’ North latitude and 80°855’ East longitude. The altitude of town is about 190-210 meter above mean sea level.

2.2 EdaphicCondition

The soil was moist, well drained with uniform plane topography. The soil of the experimental field was sandy loam in texture and slightly alkaline in reaction having pH 7.28 (1:2.5 soil: water suspension method given by **Jackson, 1973**), Organic carbon percentage in soil is 0.24 per cent (Wet oxidation method given by **Walkley and Black, 1934**), with available nitrogen 98 kg ha^{-1} (Alkaline permanganate method given by **Subbiah and Asija, 1956**), available phosphorus as sodium bicarbonate-extractable P was 17.32 kg ha^{-1} (Olsen’s calorimetrically method**, Olsen *et al.*, 1954**), available potassium was 305.99 kg ha^{-1}(Flame photometer method given by **Hanwey and Heidel, 1952**) and available sulphur was 15.51 kg ha^{-1} (Turbidometric method, **BardsleyandLancaster,1960)**

2.3 Detail of treatments and design

The 12 treatments combination of nutrient management practices having four each RDF levels (0, 75, 100 and 125 % and vermicompost 3 levels (20, 30 and 40 kg ha^{-1}). Experiment was laid out in Factorial Randomized Block Design with three replications.

Table -1: Detail of the treatment combinations:

Symbol	Treatment Combinations	Details of Treatment
T_1	RDF_0S_1	0 % RDF + 20 kg S ha^{-1}
T_2	RDF_0S_2	75 % RDF + 20 kg S ha^{-1}
T_3	RDF_0S_3	100 % RDF + 20 kg S ha^{-1}
T_4	RDF_1S_1	125 % RDF + 20 kg S ha^{-1}
T_5	RDF_1S_2	0 % RDF + 30 kg S ha^{-1}
T_6	RDF_1S_3	75 % RDF + 30 kg S ha^{-1}
T_7	RDF_2S_1	100 % RDF + 30 kg S ha^{-1}
T_8	RDF_2S_2	125 % RDF + 30 kg S ha^{-1}
T_9	RDF_2S_3	0 % RDF + 40 kg S ha^{-1}

T_{10}	RDF_3S_1	75 % RDF + 40 kg S ha^{-1}
T_{11}	RDF_3S_2	100 % RDF + 40 kg S ha^{-1}
T_{12}	RDF_3S_3	125 % RDF + 40 kg S ha^{-1}

Note:Recommended doseof fertilizer(80:40:40kgha^{-1})wasapplied.

2.4 Preparation of experimental field

The field was prepared by ploughing with a tractor drawn disc plough by cross harrowing and planking. The field was levelled and weeds, grasses were removed with the help rake. There after field was laid out as per plan of layout manually.

2.5 Application of manures and fertilizers

Sulphur was applied @ 20, 30, 40 kg ha^{-1} as basal dose. After the layout of experimentalplot, the fertilizers were weighed and applied in the plots and thoroughly mixed with soil.As per the experimental recommended doses of Nitrogen, Phosphorus, Potassium andSulphurwere applied to all the plots. Recommended dose of Nitrogen, Phosphorus andPotassiumwereappliedthroughUrea,DAPandMOP(80:40:40kgha^{-1})whereassulphurwereappliedthroughgypsum@20,30,40kgha^{-1}recommendedaspertreatment.

2.6 Harvesting and Threshing

The crop was harvested on 25thFeb.,2022 when it reached to its physiologicalmaturity i.e. when the leaves were turned yellow and more than 70% capsules were fullmaturedtoavoidshatteringofthecrop.Threshingof28thFeb,2022plotwiseproduce was done manually. The seed weight was recorded after sun drying the seed forthree days. The straw weight was recorded after deducting the seed weight from thebundle weight. The seed and straw weight thus obtained were converted into quintals perhectareon the basisofnet plot size.

2.7 Statistical analysis:

The growth parameters and yields were recorded and analyzed as per Gomez and Gomez (1984) the tested at 5% level of significance to interpret the significant differences.

3. Results and Discussion

3.1 Growth Parameters

The data given in Table-2 clearly illustrated that among the growth parameters of mustard such as plant height, number of leaves and number of branchesat 90 DAS are significantly affected by application of different levels of sulphur and NPK. It is also clear from the data is that the interaction of sulphur and NPK significantly affected all the growth parameters. Plant height at 90 days varied from 175.6-198.4 cm, number of leaves at 90 days varied from 30.5-36.9, number of branches at 90 days varied from 10.7-13.2. Maximum plant height (198.4 cm) at 90 days, number of leaves (36.9) and number of branches (13.2) are associated with the treatment T_{12}[S @ 40 kg ha^{-1} + 125%RDF]. Minimum plant height (175.6 cm) at 90 days, number of leaves (30.5) and number of branches (10.7) are associated with the treatment T_1[S @ 20 kg ha^{-1} + 0%RDF]. Similar findings were reported by **Upadhyay*et al.* (2017), Singh *et al.* (2016), Tripathi *et al.* (2011)**

3.2 Yield attributes

It is obvious from the data given in Table-3 that among the yield components of mustard such as no. of siliquaplant^{-1}, number of seed siliqua^{-1} and seed index are significantly affected by application of different levels of sulphur and RDF. It is also clear from the data is that the interaction of sulphur and RDF significantly affected all the yield attributing parameters. Number of siliqua plant^{-1} varied from 301.4-327.7, number of seed siliqua^{-1} varied from 9.7-12.1 and seed index varied from 5.2-6.9 g. Maximum no. of siliquaplant^{-1} (327.7), number of seed siliqua^{-1} (12.1) and seed index (6.9 gm)were recorded under the treatment T_{12}[S @ 40 kg ha^{-1} + 125%RDF] while the minimum no. of siliquaplant^{-1} (301.4), number of seed siliqua^{-1} (9.7) and seed index (5.2 gm) were recorded under the treatmentT_1[S @ 20 kg ha^{-1} + 0%RDF]. The consequences of the current investigation are additionally in concurrence with the investigation of**Singh *et al.* (2004), Sahu *et al.* (2017) and Reddy *et al.* (2009)**

3.3 Seed Yield

The data presented in Table-4 clearly shows that the seed yield was significantly affected by the application of different levels of sulphur and RDF levels. The surge in seed yields under adequate nutrients supply might be attributed to mainly to the collective effect of a greater number of siliqua plant^{-1}, seed siliqua^{-1} and higher seed index, which was the result of improved translocation of photosynthates from source to sink ultimately yield is increased. The increase in seed yield under adequate nutrients supply mainly due to more yield attributes ultimately produced more seed yield. Maximum seed yield (11.53 q ha^{-1}) was recorded under the treatment T_{12}[S @ 40 kg ha^{-1} + 125%RDF] while minimum seed yield (9.64 q ha^{-1}) was recorded under the treatmentT_1[S @ 20 kg ha^{-1} + 0%RDF]. These results also confirms the findings of**Singh *et al.* (2017), Sahoo *et al.* (2017) and Rathore *et al.* (2015)**

Table-2: Effect of different treatment combinations of growth parameters of mustard.

Treatments	Combinations	Plant Height(cm) 90 DAS	Number of Leaves 90 DAS	Number of Branches 90 DAS
T_1	RDF_0S_1	175.6	30.5	10.7
T_2	RDF_0S_2	177.4	31.2	11.0
T_3	RDF_0S_3	179.8	31.6	11.3
T_4	RDF_1S_1	182.4	32.2	11.5
T_5	RDF_1S_2	184.9	32.9	11.7
T_6	RDF_1S_3	186.2	33.4	11.9
T_7	RDF_2S_1	190.8	34.0	12.0
T_8	RDF_2S_2	192.7	34.4	12.2
T_9	RDF_2S_3	193.4	35.0	12.4
T_{10}	RDF_3S_1	194.6	35.5	12.6
T_{11}	RDF_3S_2	196.3	36.1	12.9
T_{12}	RDF_3S_3	198.4	36.9	13.2
C.D. at 5%	**RDF**	**4.71**	**0.83**	**0.33**
	S	**4.13**	**0.72**	**0.30**
	RDF×S	**8.27**	**1.47**	**0.61**
S.E(m)±	**RDF**	**1.59**	**0.28**	**0.11**
	S	**1.38**	**0.24**	**0.10**
	RDF×S	**2.76**	**0.49**	**0.20**

Table-3 Effect of different treatment combinations on yield components of mustard.

Treatments	Combinations	No. of Siliqua $Plant^{-1}$	No. of Seed $Siliqua^{-1}$	Seed Index (g)
T_1	RDF_0S_1	301.4	9.7	5.2
T_2	RDF_0S_2	302.8	10.0	5.3
T_3	RDF_0S_3	303.7	10.3	5.4
T_4	RDF_1S_1	306.7	10.5	5.6
T_5	RDF_1S_2	309.5	10.7	5.7
T_6	RDF_1S_3	312.7	10.8	5.8
T_7	RDF_2S_1	315.4	10.9	5.9
T_8	RDF_2S_2	318.7	11.2	6.0
T_9	RDF_2S_3	321.5	11.3	6.2
T_{10}	RDF_3S_1	323.2	11.5	6.4
T_{11}	RDF_3S_2	325.5	11.8	6.7
T_{12}	RDF_3S_3	327.7	12.1	6.9
C.D. at 5%	**RDF**	**6.93**	**0.37**	**0.12**
	S	**6.01**	**0.30**	**0.10**
	RDF×S	**12.1**	**0.64**	**0.22**

S.E(m)±	**RDF**	**2.31**	**0.12**	**0.04**
	S	**2.00**	**0.10**	**0.03**
	RDF×S		**0.21**	**0.07**

Table-4: Effect of different treatment combinations on seed yield (q ha^{-1}) of mustard.

Treatments	**Combinations**	**Seed Yield (q ha^{-1})**
T_1	RDF_0S_1	9.64
T_2	RDF_0S_2	9.92
T_3	RDF_0S_3	10.16
T_4	RDF_1S_1	10.30
T_5	RDF_1S_2	10.46
T_6	RDF_1S_3	10.59
T_7	RDF_2S_1	10.75
T_8	RDF_2S_2	10.88
T_9	RDF_2S_3	11.02
T_{10}	RDF_3S_1	11.17
T_{11}	RDF_3S_2	11.35
T_{12}	RDF_3S_3	11.53
C.D. at 5%	**RDF**	**0.25**
	S	**0.22**
	RDF×S	**0.43**
S.E(m)±	**RDF**	**0.08**
	S	**0.07**
	RDF×S	**0.14**

4. Conclusion

The study showed that the application of sulphur along with RDF (125%) resulted in higher growth parameters, yield components consequently seed yield of mustard. It will help in uplifting the socioeconomic status of the farmers. Application of sulphur along with RDFdeserves a special attention for increasing of production of mustard.

References

Anonymous. (2018). Agricultural Statistics at a Glance 2018. Directorate of Economics & Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi, p. 63.

Kumar A., Mahapatra B.S., Singh V.P., Shukla A., Negi M.S., Yadav A. S., Singh P., Gaurendra G. and Singh M. (2017). Effect of nutrient levels on yield, nutrient uptake and economics of Indian mustard (Brassica juncea) in tarai region of Uttarakhand. *Indian Journal of Agronomy* 62 **(3**): 378-381.

Lal, G., Mehta, R. S., Chand, P., Godara, A. S., & Cheriyan, H. (2015). Performance of improved varieties and technological interventions at farmers' fields for cumin cultivation.

Mishra, J., Singh, R. K., Deshraj Yadav, S. S., & Mishra, A. P. (2019). Quality of Indian mustard [Brassica juncea (L.) Czernj and Cosson] as influenced by tillage and irrigation frequency. *Journal of Pharmacognosy and Phytochemistry*, *8*(1), 2280-2283.

Mutha Sravya, V. S., & George, S. G. (2021). Effect of nitrogen and zinc levels on growth, yield and economics of safflower (*Carthamus tinctorius* L.).

Rathore, S.S., Shekhawat, K., Kandpal, B. K., Premi, O.P., Singh, S.P., Singh, G.C. And Singh, D. (2015) Sulphur Management for Increased Productivity of Indian mustard: A Review. *Annals of Plant and Soil Research* 17 (1): 1-12 (2015)

Reddy, R.U., Reddy, S.N. and Reddy, M.S. (2009). Yield, yield attributes and oil content of soybean as influenced by integrated nutrient management in soybean-maize cropping system. International of Journal of Agricultural Sciences, **5**: 15-17.

Sahoo, G.C., Biswas, P.K. and Santra, G.H. (2017) Effect of Different Sources of Sulphur on Growth, Productivity and Oil Content of Brassica campestris var. toria in the Red Soil of Odisha. *IJAEB*: 10(6): 689-694

Sahu, D.K., Swaroop, N., Thomas, T., David A.A., and Rao, S. P.(2017). Effect of Different Doses of Sulphur and Zinc with NPK on Physico-Chemical Properties of Soil and Yield Attribute of Yellow Mustard (*Brassica compestris* L.) Cv. Sunanda. *Int.J.Curr.Microbiol.App.Sci.* 6(6): 1897-1902.

Singh, Amar and Meena N.L. (2004). Effect of nitrogen and sulphur on growth, attributes and seed yield of mustard (*Brassica juncea*) in eastern plain of Rajasthan. Indian Journal of Agronomy, 49: 186-188.

Sharma, M., & Kumar, P. (2020). Biochemical alteration of mustard grown under tin contaminated soil. *Plant Archives*, *20*(2), 3487-3492.

Singh, V., Singh, A.K., Raghuvanshi, N. and Singh, R.A. (2016) Effect of Sulphur Levels on Growth and Yield of Mustard (*Brassica Juncea* L. Czern and Coss) Varieties. Progressive Research, *an International Journal.* Volume 11 (Special-II): 845-848

Singh, R.; Singh, Y., and Singh, S. (2017). Yield, quality and nutrient uptake of Indian mustard (*Brassica juncea*) under sulphur and boron nutrition. *Annals of Plant and Soil Research*, 19(2), 227-231.

Tripathi, M.K.; Chaturvedi, S.; Shukla, D.K. & Saini, S.K. (2011). Influence of integrated nutrient management on growth, yield and quality of Indian mustard (Brassica juncea L.) in tarai region of northern India. J. Crop and Weed, 7(2): 104-107.

Upadhyay, Y., Swaroop, N., Dhruw, S.S., Mashih, A. and Verma, P.D. (2017). Interaction Effects of different doses of Sulphur and Zinc with NPK on Growth of Yellow Mustard (*Brassica compestris* L.). *Journal of Pharmacognosy and Phytochemistry*, 7(1): 1260-1263