

Interaction effect of sulphur and NPK on growth parameters and yield of mustard (*Brassica juncea* L.)

Comment [A1]: It is preferable to remove the scientific name from the title and include it only in keywords

Abstract

Comment [A2]: Include general objective at the beginning, Experimental design used, treatments (quantity and its repetitions), parameters evaluated, analyzes used and the most important results.

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 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 siliqua plant⁻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, growth, RDF, sulphur and yield.

Comment [A3]: Include scientific name

Introduction

Comment [A4]: Include results of other previous studies, in addition the general objective is not observed at the end of the 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. In India 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 (Muthaet *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 (Eyhornet *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 discoloration 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)

Material and Methods

Experimental Site

Comment [A5]: Use citations not older than 10 years.

Comment [A6]: More procedurally describe the experiment setup process so that readers can replicate the experiment

parameters evaluated?

used statistical analysis and software?

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.

Edaphic Condition

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 (Walkley and Black's rapid titration 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, **Bardsley and Lancaster, 1960**)

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 ₀ S ₁	0 % RDF + 20 kg S ha ⁻¹
T ₂	RDF ₀ S ₂	75 % RDF + 20 kg S ha ⁻¹
T ₃	RDF ₀ S ₃	100 % RDF + 20 kg S ha ⁻¹
T ₄	RDF ₁ S ₁	125 % RDF + 20 kg S ha ⁻¹
T ₅	RDF ₁ S ₂	0 % RDF + 30 kg S ha ⁻¹
T ₆	RDF ₁ S ₃	75 % RDF + 30 kg S ha ⁻¹
T ₇	RDF ₂ S ₁	100 % RDF + 30 kg S ha ⁻¹
T ₈	RDF ₂ S ₂	125 % RDF + 30 kg S ha ⁻¹

T₉	RDF ₂ S ₃	0 % RDF + 40 kg S ha ⁻¹
T₁₀	RDF ₃ S ₁	75 % RDF + 40 kg S ha ⁻¹
T₁₁	RDF ₃ S ₂	100 % RDF + 40 kg S ha ⁻¹
T₁₂	RDF ₃ S ₃	125 % RDF + 40 kg S ha ⁻¹

Note: Recommended dose of fertilizer (80:40:40 kg ha⁻¹) was applied.

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.

Application of manures and fertilizers

Sulphur was applied @ 20, 30, 40 kg ha⁻¹ as basal dose. After the layout of experimental plot, the fertilizers were weighed and applied in the plots and thoroughly mixed with soil. As per the experimental recommended doses of Nitrogen, Phosphorus, Potassium and Sulphur were applied to all the plots. Recommended dose of Nitrogen, Phosphorus and Potassium were applied through Urea, DAP and MOP (80:40:40 kg ha⁻¹) where as sulphur were applied through gypsum @ 20, 30, 40 kg ha⁻¹ recommended as per treatment.

Harvesting and Threshing

The crop was harvested on 25th Feb., 2022 when it reached to its physiological maturity i.e. when the leaves were turned yellow and more than 70% capsules were full matured to avoid shattering of the crop. Threshing of 28th Feb, 2022 plot wise produce was done manually. The seed weight was recorded after sun drying the seed for three days. The straw weight was recorded after deducting the seed weight from the bundle weight. The seed and straw weight thus obtained were converted into quintals per hectare on the basis of net plot size.

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.

Result and Discussion

Growth Parameters

Comment [A7]: Update references used. Improve reference format

Improve considering material and methods

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 branches at 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 T₁₂[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 T₁[S @ 20 kg ha⁻¹ + 0%RDF]. Similar findings were reported by **Upadhyayet al. (2017), Singh et al. (2016), Tripathiet al. (2011)**

Yield attributes

It is obvious from the data given in Table-3 that among the yield components of mustard such as no. of siliqua plant⁻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 siliqua plant⁻¹ (327.7), number of seed siliqua⁻¹ (12.1) and seed index (6.9 gm) were recorded under the treatment T₁₂[S @ 40 kg ha⁻¹ + 125%RDF] while the minimum no. of siliqua plant⁻¹ (301.4), number of seed siliqua⁻¹ (9.7) and seed index (5.2 gm) were recorded under the treatment T₁[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)**

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 resulted more seed yield. Maximum seed yield (11.53 q ha⁻¹) was recorded under the treatment T₁₂[S @ 40 kg ha⁻¹ + 125%RDF] while minimum seed yield

(9.64 q ha⁻¹) was recorded under the treatment T₁[S @ 20 kg ha⁻¹ + 0% RDF]. These results also confirm 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 ₀ S ₁	175.6	30.5	10.7
T ₂	RDF ₀ S ₂	177.4	31.2	11.0
T ₃	RDF ₀ S ₃	179.8	31.6	11.3
T ₄	RDF ₁ S ₁	182.4	32.2	11.5
T ₅	RDF ₁ S ₂	184.9	32.9	11.7
T ₆	RDF ₁ S ₃	186.2	33.4	11.9
T ₇	RDF ₂ S ₁	190.8	34.0	12.0
T ₈	RDF ₂ S ₂	192.7	34.4	12.2
T ₉	RDF ₂ S ₃	193.4	35.0	12.4
T ₁₀	RDF ₃ S ₁	194.6	35.5	12.6
T ₁₁	RDF ₃ S ₂	196.3	36.1	12.9
T ₁₂	RDF ₃ S 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 ₀ S ₁	301.4	9.7	5.2
T ₂	RDF ₀ S ₂	302.8	10.0	5.3
T ₃	RDF ₀ S ₃	303.7	10.3	5.4
T ₄	RDF ₁ S ₁	306.7	10.5	5.6
T ₅	RDF ₁ S ₂	309.5	10.7	5.7
T ₆	RDF ₁ S ₃	312.7	10.8	5.8
T ₇	RDF ₂ S ₁	315.4	10.9	5.9
T ₈	RDF ₂ S ₂	318.7	11.2	6.0
T ₉	RDF ₂ S ₃	321.5	11.3	6.2

T₁₀	RDF ₃ S ₁	323.2	11.5	6.4
T₁₁	RDF ₃ S ₂	325.5	11.8	6.7
T₁₂	RDF ₃ S 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)
T₁	RDF ₀ S ₁	9.64
T₂	RDF ₀ S ₂	9.92
T₃	RDF ₀ S ₃	10.16
T₄	RDF ₁ S ₁	10.30
T₅	RDF ₁ S ₂	10.46
T₆	RDF ₁ S ₃	10.59
T₇	RDF ₂ S ₁	10.75
T₈	RDF ₂ S ₂	10.88
T₉	RDF ₂ S ₃	11.02
T₁₀	RDF ₃ S ₁	11.17
T₁₁	RDF ₃ S ₂	11.35
T₁₂	RDF ₃ S 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

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 RDF deserves a special attention for increasing of production of mustard.

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