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Effect of potassium and sulphur on growth and yield of Sarson (*Brassica juncea*) under irrigated conditions

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Abstract

During the Rabi season of 2012–2013, a field experiment was undertaken at IGKV, Bhartiya College of Agriculture, Durg (C.G.) with the goal of determining how potassium and sulphur affected the growth and yield of mustard under irrigation. With 12 treatments and three replications, the experiment was set up using a factorial randomised block design (FRBD). Treatments comprised applying mustard plants with three levels of potassium (25 kg/ha, 50 kg/ha, and 75 kg/ha) and three levels of sulphur (40 kg/ha, 60 kg/ha, and 80 kg/ha).

The plant height, number of green leaves per plant, number of primary and secondary branches, dry matter output, number of siliquae per plant, seed yield per plant, and stover yield per plant were only a few of the growth and yield characteristics of mustard that were measured.

According to the findings, applying potassium at a rate of 75 kg per ha led to significantly higher values for the majority of growth and yield parameters than applying potassium at a rate of 25 kg per ha. However, it was discovered that for the majority of features, potassium application at 50 kg/ha was equivalent to treatment at 75 kg/ha.

Similar to this, applying sulphur at a rate of 60 kg/ha resulted in noticeably higher values for growth and yield attributes than applying sulphur at a rate of 20 kg/ha. However, it was discovered that for the majority of qualities, the 40 kg/ha application of sulphur was equivalent to the 60 kg/ha treatment.

In terms of seed yield and stover output, the 75 kg/ha potassium application produced yields that were noticeably larger than the 25 kg/ha potassium treatment (1290 kg/ha for seed and 4100 kg/ha for stover). The 50 kg/ha potassium treatment, however, had yields of seeds and stover that were comparable to those of the 75 kg/ha treatment.

In terms of sulphur application, the 60 kg/ha treatment yielded significantly more stover yield (41.46 quintals/ha) and seed yield (13.41 quintals/ha) than the 20 kg/ha treatment. However, the seed and stover yields from the 40 kg/ha sulphur treatment were comparable to those from the 60 kg/ha treatment.

In general, the results showed that higher potassium and sulphur application rates (75 kg/ha and 60 kg/ha, respectively) led to better growth and higher mustard yields, but lower application rates (25 kg/ha and 20 kg/ha) demonstrated worse performance. The results emphasise the need of effective nitrogen management for improving mustard crop development and yield under irrigation.

Keywords: Mustard, NPK, sulphur

1. Introduction

The lack of edible oils in India is a major worry, and Chhattisgarh's mustard crop suffers from low productivity because of a lack of vital plant nutrients. The lower productivity of cultivated fields is attributed mostly to the declining soil fertility. Less than 15% of the nutrients needed by oilseeds are thought to be supplied by fertilisers, with the majority coming from a variety of other sources, including soil resources, organic manures, biological sources, crop residues, and agricultural wastes.

Integrated nutrient management techniques must be used to solve the problems caused by dwindling soil fertility and boost mustard productivity. To improve soil fertility and nutrient availability, this comprises the careful application of chemical fertilisers based on soil nutrient analysis, supplemented with organic manures and biofertilizers. Natural soil nitrogen replenishment can also be aided by crop rotation and the inclusion of legumes in the cropping system.

One of the minerals that plants require in order to grow and develop is potassium. The amount of protein in seeds and the transport of nitrogenous substances to growing fruits are both influenced by potassium intake, which also boosts seed production. For the production of proteins and oils in oilseed crops, sulphur is a key ingredient. It is necessary for the synthesis of protein and chlorophyll and is a constituent of amino acids including cysteine, cystine, and methionine. Additionally, oilseeds need sulphur to create oil. Thioglucosides and glucosinolates are both significantly impacted by sulphur shortage in plants. A sulphur deficit can cause a 10–34% decrease in crop output.

Low soil potassium (K) status can, in fact, be a significant limiting factor causing subpar crop yields. It is crucial to assess how K nutrition affects crops like mustard in order to increase productivity. Despite the fact that Vertisols are naturally rich in potassium, the availability of potassium is minimal in areas with 2:1 kind of clay. The potassium availability for plants is decreased as a result of potassium fixation in the clay minerals. Even in potassium-rich soils like Vertisols, leaching and erosion losses further exacerbate the nutrient deficits and reduce crop production. As a result, the plants' ability to grow, develop, and produce are hampered by their inability to get enough potassium. Various growth and yield characteristics, such as plant height, number of branches, number of siliqua per plant, and seed output, can be used to identify the detrimental impacts of potassium deficiency.

Due to the scant amount of study that has been done on the necessity of potassium (K) and sulphur (S) in mustard farming, the proposed investigation on the Effect of "Potassium and sulphur on growth and yield of Sarson (*Brassica juncea*) under irrigated conditions" is of utmost relevance. The development of plants as a whole and many physiological processes depend heavily on the mineral's potassium and sulphur.

The purpose of this study is to evaluate how potassium and sulphur affect the quantitative and qualitative traits of mustard crops. The investigation's main goal is to comprehend how diverse potassium and sulphur applications affect the development, growth, and crop yield of irrigated mustard plants.

2. Materials and Methods

The goal of the study, which was carried out at IGKV, Bhartiya College of Agriculture, Durg (C.G.) during the Rabi season 2012–2013, was to determine how potassium and sulphur affected growth and yield in irrigated plants. The experimental plot's soil had a clay texture, low nitrogen availability, medium phosphorus availability, and a very high potash availability. Medium levels of organic carbon were present, and the soil reaction was only mildly alkaline. The available sulphur levels in the soil, however, were below the threshold level, indicating a sulphur deficiency.

TAM-108-1 was the variety used for the experiment, and seeds were sown on November 13, 2012, at the ideal soil moisture level. The crop was picked on February 26, 2013. The crops were planted in rows 45 cm apart, and 104.8 mm of rain fell throughout the crop growing period. Twelve treatment combinations were replicated three times in the experiment, which used a factorial randomised block design (FRBD) with three levels of potassium (25, 50, and 75 kg ha-1) and three levels of sulphur (20, 40, and 60 kg ha-1).

Muriate of Potash (MOP) and Bensulf, respectively, provided the potassium and sulphur. Half of the nutrients—nitrogen, phosphorus, potassium, and sulfur—were added during planting, while the remaining half was added as a top dressing. The season's restricted cool time had a negative impact on yield levels. During the time when the crops were growing, the pan evaporation varied from 1.6 to 8.8 mm. Pest activity was minimal throughout the season, especially with aphids, which were managed with a systemic insecticide.

To evaluate the effects of varying potassium and sulphur levels on the mustard crop, a variety of growth and yield parameters were recorded throughout the crop's growth stages and maturity. The purpose of the study was to determine how the application of these nutrients impacts the overall growth, development, and production of the irrigated mustard crop. It is possible to gather important knowledge on how to improve nitrogen management practises and the productivity of mustard crops in the area by analysing the data collected from this experiment.

3. Results and Discussion

3.1 Plant height (cm)

In general plant hight increased at successive stage till hervest, Perusal of data revealed that increasing rates of sulphur as well as potassium Significantly increase the plant hight at all the stages except the firet stage where potassium application remains in effective. Sulphur application by and large proved much effective in increasing the plant height at all the stages and in corporation of 40 Kg s/ha. Similarly, application of 60 kg S/ha proved much effective in corporation to 20 Kg S/va in this respect, there trends of response of sulphour on plants height remained almost the same at all the successive stages of plant growth. Application of potassium with effect from 2nd stages of growth i.c. 60th day after sowing period instrumental in increasing the plant height at all other stages. Medium rate of k application at the rate of 50 Kg K_2O/ha. proved markedly superior to 75 and 25 kg K_2O/ha. In as much as even the incorporation of 60 Kg K_2O per he proved significantly superior to 20 kg K_2O /ha in increasing the plant height at all the stages of growth.

Table 1: Effect of different levels of sulphur and potassium on the plant height (cm).

	Days after Sowing			
Treatments	**30**	**60**	**90**	**Harvest**
Sulphur (Kg/ha)				
20	23.75	137.84	166.83	168.89
40	24.57	139.52	168.4	170.42
60	25.36	140.43	169.47	171.31
SD	0.254	0.494	0.365	0.37
C.D at 5%	0.8	1.55	1.14	1.16
Potassium (Kg/ha)				
25	24.27	137.87	167.24	169.12
50	24.61	139.54	168.41	170.31
75	24.81	140.38	169.09	170.31
SD	0.254	0.495	0.365	0.37
C.D at 5%	NS	1.55	1.14	1.16

3.2 Green leaves per plant

In general, number of green leaves per plant increased at successive stages till 90 days but decreased at harvesting stages of the crop. Perusal of data revealed that 40 Kg/ha of sulphur as well as 50 kg of potassium significantly increased the number of green leaves pes plant at all the stages. Sulphur application by and large proved much effective in increasing the no of green leaves per plant at all the stages and incorporation of 40 kg S/ha proved significantly superior to the 60 kg as well as 20 Kg S/ha. Similarly, application of 60 kg S/ha proved much effective in comparisons to 20 kg S/ha in this respect, these strands of response of sulphur on number of green leaves per plant remained almost the same at all the successive stages in respect to number of green leaves per plant. Application of potassium Showed marked variation on this attribute from 2nd stage of growth i.e., 60th day after sowing and proved instrumental in increasing the number of green leaves per plant at all other stages. Potassium application at the rate of 50 kg k_20/he proved markedly superior to 75 and 25 kg K_2O/ha.

Table 2: Effect of Different levels of Sulphur and Potassium on green leaves per plant.

	Days after Sowing			
Treatments	30	60	90	Harvest
Sulphur (Kg/ha)				
20	6.19	18.92	32.4	0.51
40	6.68	21.86	33.34	0.59
60	6.84	22.78	34.02	0.64
SEM+	0.094	0.33	0.275	0.02
C.D at 5%	0.03	1.02	0.86	0.06
Potassium (Kg/ha)				
25	6.31	20.34	31.4	0.52
50	6.64	21.4	33.32	0.58
75	6.77	21.83	33.44	0.63
SEM+	0.094	0.33	0.275	0.02
C.D at 5%	0.3	1.02	0.83	0.06

3.3 Number of primary and secondary branches per plant

Data on number of primary and secondary branches per plant recorded at successing growth stage still 90th days. perusal of data recorded that application of 40 kg/ha S and 50 kg of K significantly increased the number of primary branche/plant at later stages i.e. after 60th days and 90th days. However there was a shorp decline in number of primary bramches after 90th days in comparision to its number at 60th day. Application of S and K proved effective in increasing the number of primary branches/plant at both the stages and in corporation of 40 kg S/ha and 50 kg k_20/ha proved significantly superior to its lower and higher doses. Similary application of 40 kg s and 50 kg k_20/ha also proved much effective in increasing the number of secondary branches, in comparison to their higher and lower doses.

Table 3: Effect of different levels of Sulphur and Potassium on number of primary and secondary branches per plant

	Primary Branches/Plant (No.) Days after Secondary branches sowing (Day)		
Treatments	60	90	Harvest
Sulphur (Kg/ha)			
20	7.21	5.97	12.12
40	8.18	6.77	13.74
60	8.61	7.16	14.55
SEM+	0.19	0.16	0.31
C.D at 5%	0.58	0.49	0.98
Potassium (Kg/ha)			
25	7.53	6.23	12.66
50	8.17	6.76	13.74
75	8.33	6.9	14.01
SEM+	0.19	0.16	0.31
C.D at 5%	0.58	0.49	0.98

3.4 Dry matter production

Dry Metter production per plant increased at subsequent growth stages till harvest. Scanning of data revealed that application of sulphur as well as potassium brought about marked increased in dry mattes production at all the stages. Increasing rates of Sulphur production proved much effective in increasing the dry matter production at all the stages and incorporation 40 kg and 60 kg S/he though remained equally effective but proved significantly superior to 20 kg /ha. These trend of response of sulphur on dry matter production was found true at all the stage of dry matter production application of potassium with effect from 2nd stage of growth i.e 60th days after sowing proved instrumental in increasing the Dry matter production at rest of the stages. Medium rate of K application i.e 50 kg k_2O proved markedly superior to 75 and 25 kg/he.

Table 4: Effect of different levels of Sulphur and Potassium on dry matter per plant. (g)

	Days after Sowing			
Treatments	30	60	90	Harvest
Sulphur (Kg/ha)				
20	3.56	14.5	26.88	31.13
40	3.78	12.42	29.02	33.97
60	3.97	16.7	13.28	35.6
SEM+	0.067	0.291	0.446	0.526
C.D at 5%	0.21	0.91	1.39	1.64
Potassium (Kg/ha)				
25	3.61	14.75	27.58	32.23
50	3.81	15.51	29.02	33.91
75	3.88	15.81	29.59	34.58
SEM+	0.067	0.291	0.446	0.526
C.D at 5%	0.21	0.91	1.39	1.64

3.5 Number of siliqua per plant

Scanning of data on number of siliqua per plant revealed masked effect of sulphur and potassium. Maximum number of siliqua per plant (i.e.193.14) was found under application of 40 dg s/ha. Higher rate of sulphuri.e. 60 and 40 kg s/ha showed 2.49 percent and 1.5 percent increase in production of siliqua per plant over 20 kg s/ha. Potassium incorporation proves statistically significant in increasing number of siliqua per plant. Maximum number of siliqua per plant of about 189.40 was obtained under application of 50 kg k_20/ha, which proved significantly superior to 25 and k_20/he and proved at par with 75 kg K_2O/ha.

3.6 Number of seeds/siliqua

Data pertaining to number of seeds/siliqua of mustard are presented in Table 5 of Examination of data on number of seed/siliqua revealed marked effect of sulphur application, however incorporation of potassium failed to brought about significant variation on number of seed/siliqua. Not with standing in general, number of seed/siliqua increased due to increasing rate of potassium. Maximum number of seeds/siliqua of about 12.42 was obtained under application of 40 kg S/ha, which proved significantly superior to 20 kg S/ha and at par with 60 kg s/ha. Higher rates of sulphur i.e. 60 and 40 kg S/ha showed 6.34 percent and 3.75% increase in number of seeds per siliqua over 20 kg S/ha. Potassium incorporation though could not prove statistically significant in increasing the number of seeds/siliqua but in general its application showed some improvement in production of no of seed/siliqua.

3.7. Length of siliqua (cm)

Data on length of siliqua of mustard are presented in Table 5 Scanning of data on length of siliqua revealed marked effect of sulphur application. Incorporation of potassium failed to produce significant variation on length of siliqua, however, in general, length of siliqua increased due to increasing rates of potassium. Maximum length of siliqua was observed under application of 40 kg S/ha which proved significantly superior to 20 kg S/ha, but remained at par with 60 kg S/ha. Higher rate of sulphur i.e. 60 and 40 kg S/ha showed 7.12 % and 7% increase in length of siliqua over 20 kg S/ha. Potassium incorporation though could not prove statistically significant in increasing the length of siliqua but in general its application showed some improvement in length of siliqua.

3.8. Test weight (g)

Data pertaining to test weight of mustard are presented in Table 5. Perusal of data on test weight revealed marked effect of sulphur application, however, incorporation of potassium failed to bring about significant variation on test weight. Maximum test weight of about 3.58 g/1000 seed weight was obtained under application of 40 kg S/ha, which proved significantly superior to 20 kgs/ha and at par with 60 kg S/ha. Higher rate of sulphur i.e. 60 and 40 kg S/ha showed 6.67% and 3.37% increase in test weight over 20 kg s/ha. Potassium incorporation in general could not prove statistically significant in increasing the test weight but its application showed some improvement in test weight.

3.9. Seed Yield

Data pertaining to seed yield of mustard are presented in table 5. Scanning of seed yield data revealed marked effect of sulphur application. However, incorporation of potassium failed to brought about significant variation on seed yield. Not with standing, in general seed yield increased due to increasing rates of potassium. Maximum seed yield of about 12.86 q/ha was observed under application of 40 kg S/ha which proved significantly superior to rates i.e. 60 and 20 kg S/ha. Similarly in corporation of 60 kg S/ha brought about significant increase in seed yield over 20 kg S/ha. Higher rate of sulphuric. 60 and 40 kg s/ha showed 19.41% and 14.52% increase in seed yield over 20 kg S/ha. Potassium incorporation proved significant in increasing the seed and yield. However, the higher rate of its application i.e. 75 and 50 kg k_20/ha, though proved equally effective but brought about significant increase in seed yield over 25 kg k_20/ha.

3.10. Stouer Yield

Data on stouer yield of mustard are presented in Table 5 Scanning of stouer yield data revealed marked effect of sulphur and potassium applications, Maximum stouer yield of about 39.91 q/ha was observed under application of 40 kg s/ha which proved significantly superior to 20 kg S/ha. however it remained at par with 60 kg S/He. Higher sate of sulphur i.e. 60 and 40 kg S/ha showed 18.35% and 12.84 % increase in stouer yield over 20 kg S/ha.

3.11. Oil content

Data pertaining to oil content of mustard are presented in table 5. Maximum oil content of about 37.41% was observed under application of 40 kg S/ha. Which proved highly significant over 20 kg s/ha, however it remained at par with 60 kg s/ha. Higher rate of sulphur i.e. 60 and 40 kg S/ha. showed 3.85% and 2.24% in crease in oil content over 20 kg S/ha. Potassium incorporation proves statistically significant in increasing the oil content. Maximum oil content of about 37.44% was obtained under application of 50 kg K_2O/ha. It proved significantly superior to 25 kg K_20/ha. showed 2.04 %, 1.63% increasing oil content over 25 kg K_2O/ha.

Table 5: Effect of different Levels of sulphur and Potassium on the yield attributes and yields.

Treatments	No. of Siliqua/Plant	No. of Seed/siliqua	Length of siliqua (cm)	Test weight 1000 seed wt. (g).	Oil Content	Seed yield (q/ha.)	Staves yield (q/ha)
Sulphur (Kg/ha)							
20	186.37	11.97	4.93	3.47	35.69	11.23	35.37
40	189.17	12.42	4.73	3.58	37.41	12.86	39.91
60	191.02	12.73	5.08	3.68	37.9	13.41	41.86
SEM+	0.835	0.125	0.047	0.033	0.188	0.483	0.783
C.D at 5%	2.61	0.4	0.16	0.11	0.059	1.57	2.83
Potassium (Kg/ha)							
25	186.75	12.23	4.86	3.53	36.84	11.46	36.71
50	189.5	12.4	4.92	3.58	37.44	12.66	39.44
75	190.91	12.5	4.97	3.61	37.57	12.9	41
SEM+	0.835	0.125	0.047	0.033	0.188	0.48	0.783
C.D at 5%	2.61	NS	NS	NS	NS	1.57	2.45

Conclusion

Based on the results of the experiments, it can be said that the mustard crop had the highest growth and production characteristics when potassium was applied at a rate of 75 kg ha^{-1}. The maximum seed and straw yields were recorded with this treatment at 1290 kg ha^{-1} and 4100 kg ha^{-1}, respectively. Additionally, it resulted in the mustard crop's highest financial results. It's interesting to note that growth, yield characteristics, and financial returns were all comparable when potassium was applied at a lower rate of 50 kg ha^{-1}.

Similarly, the mustard crop's growth and yield characteristics responded very well to the treatment of sulphur at a rate of 60 kg ha^{-1}. The highest seed yield of 1341 kg ha^{-1} and the highest straw yield of 4186 kg ha^{-1}, as well as the largest financial returns, were produced by this treatment. The application of sulphur at a lower rate of 40 kg ha^{-1} was shown to be comparable.

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