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EFFECT OF DIFFERENT SOURCES OF SULPHUR ON GROWTH AND YIELD OF KNOL-KHOL (*BRASSICA OLERACEA* VAR. *GONGYLODES*)

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ABSTRACT

A field experiment was conducted to study the effect of different sources of sulphur on growth and yield of Knol-khol (*Brassica oleracea* var. *gongylodes*) during *Rabi* 2024 at College of Agriculture, V. C. Farm, Mandya. The experiment comprised of two factors in eight treatment combination replicated thrice, consisting of four sulphur sources such as- Single super phosphate (A_1), 20:20:0:13 (A_2), gypsum + DAP (A_3) and DAP alone (A_4) with two foliar spray levels i.e., SOP @ 1% (B_1) and no spray (B_2), which were tested in factorial RCBD design. The application of gypsum @ 75 kg S ha^{-1} + DAP (A_3) recorded the highest growth parameters i.e., plant height (39.60 cm), number of leaves (15.12 $plant^{-1}$), leaf area (1910.07 cm^2), Chlorophyll content (65.79 SPAD) and dry matter accumulation (10.17 g leaf and 17.09 g knob $plant^{-1}$). Yield parameters such as knob diameter (7.60 cm), knob volume (199.64 cm^3), fresh knob weight (215.27 g $plant^{-1}$), total knob yield (201.44 q ha^{-1}) and marketable yield (189.64 q ha^{-1}) were significantly showed higher in the same treatment combination. Further, foliar spray of SOP @ 1% enhanced the performance. Interaction A_3B_1 recorded maximum values for plant height (40.22 cm), number of leaves (15.60 $plant^{-1}$), leaf area (1911.05 cm^2), Chlorophyll content (66.49 SPAD) and dry matter accumulation (10.31 g leaf and 17.16 g knob $plant^{-1}$). knob diameter (7.93 cm), fresh knob weight (220.54 g $plant^{-1}$), total knob yield (210.53 q ha^{-1}) and marketable yield (199.93 q ha^{-1}). The lowest growth and yield were recorded in DAP alone without foliar spray of SOP (A_4B_2). Economic analysis revealed that A_3B_1 recorded the highest net returns (Rs. 1,97,591 ha^{-1}) and benefit:cost ratio (2.93), indicating that application of gypsum @ 75 kg S ha^{-1} along with foliar spray of SOP is optimum for obtaining higher growth and yield of knol-khol.

Keywords : Gypsum, SOP, Single super phosphate, Knol-Khol.

Introduction

Soil fertility management through the supply of balanced nutrients is fundamental for achieving the higher crop productivity and sustaining the agricultural systems. Along with the primary nutrients, the importance of secondary nutrients also increasing, especially sulphur, which is now widely deficient in many cultivated soils. The intensive use of sulphur-free fertilizers and reducing the use of organic manures have contributed significantly to this emerging nutrient imbalance.

Sulphur plays an important structural component of essential amino acids, enzymes and vitamins (Tiwari and Gupta, 2021). It also involved in nitrogen metabolism and contributes to chlorophyll synthesis, increase in photosynthetic efficiency, protein formation and also helps in synthesis of secondary metabolites such as glucosinolates in cole crops that is mainly

responsible for aroma and for providing defense against pests and diseases (Falk *et al*., 2007). Adequate amount of sulphur supply improves crop vigour, enhances nutrient uptake and promotes better yield, whereas its deficiency results in stunted growth, yellowing of leaves and poor productivity.

Knol-khol (*Brassica oleracea var. gongylodes* L.) is an annual cool-season vegetable that is originated from western coastal regions of Europe which belongs to Cruciferae or Brassicaceae family which is also known as cole crops or kohlrabi. The term kohlrabi derived from 02 German words where kohl means 'cabbage' and rube means 'rabi' which is also called as turnip. Its early form was grown more in Northern Europe during 15th century (University of Kentucky, 2016).

Knol-khol is mainly cultivated in few states of India like Maharashtra, Madhya Pradesh, Himachal Pradesh, Punjab, Haryana, West Bengal and Jammu and Kashmir and also in some southern states (Nagar, 2016). It produces edible swollen stem which is called as knob, usually round to flat in shape and violet or green in colour (Hange *et al*., 2020). It is rich in dietary fibres, antioxidants, Vitamin A, C, E and carotene, nutrients like potassium and calcium, secondary metabolites like glucosinolates that indicates defensive mechanisms against pest, disease and also herbivores (Mishra *et al*., 2012).

In recent years, vegetable cultivation in many areas has relied heavily on fertilizers that do not supply sulphur. This practice has gradually led to the depletion of sulphur in soils and reduced its use efficiency. Incorporation of sulphur through sulphur containing fertilizers like single super phosphate, gypsum, 20:20:0:13 etc., helps in restoring sulphur nutrient balance and crop response. Despite, farmers are cultivating Knol-khol with poor secondary nutrition management. Especially, sulphur found to be critical to Knol-khol. The reduction in growth and yield due to reduced supply of sulphur extensively recorded under the soils of Southern Dry Zone of Karnataka. Hence, considering the above facts, an attempt has been made to evaluate the effect of different sources of sulphur on growth and yield of Knol-khol.

Materials and Methods

The field experiment was carried out at the College of Agriculture, V.C. Farm, Mandya, which comes Region III and Agro-climatic Zone VI (Southern Dry Zone) of Karnataka. The experimental site is situated at 12°34′ N latitude and 76°49′ E longitude, with an elevation of about 705 m above mean sea level. The region experiences a semi-arid tropical climate that is favourable for rabi season vegetable cultivation. The normal rainfall of the V.C. Farm, Mandya during the crop-growing period stood at 139.40 mm. The foremost part of the rainfall was in November (54.4 mm). Normal mean monthly maximum air temperature ranged from 28.6 °C to 35.80 °C. Whereas, the minimum air temperature ranged from 16.20 °C to 21.30 °C. Further, the mean sunshine hours varied from 6.8 to 9.1 hours during November 2024 to April 2025.

The actual rainfall received during the cropping period (November 2024 to April 2025) in V. C. Farm, Mandya was 225.00 mm. The major quantity of rainfall was attained in April (119.00 mm). The mean maximum air temperature varied from 28.6 °C to 35.80 °C. The highest mean maximum air temperature was perceived during March (35.8 °C). The mean minimum air temperature ranged from 16.20 °C to 21.30 °C. The lowest mean minimum temperature was recorded during January (16.2 °C) and February (16.2 °C). The mean bright sunshine hours varied from 6.9 to 7.7 hours during November to April. The relative humidity varied from 82-83.7 *per cent* during morning and afternoon hours, respectively during the crop growing period.

The soil of the experimental site was loamy sand with neutral soil reaction (pH 7.17), organic carbon content was low (0.41 *per cent*) with low electrical conductivity (0.21 dS m^{-1}). The soil was low in available nitrogen (225.17 kg ha^{-1}), medium in available phosphorus (33.54 kg ha^{-1}), available potassium (230.68 kg ha^{-1}) and available sulphur (17.97 mg kg^{-1}). The high exchangeable calcium and magnesium content of the soil was 5.65 and 4.11 cmol (p+) kg^{-1}, respectively. DTPA extractable Fe, Mn, Zn, Cu were sufficient and B was low *viz*., 14.98, 8.96, 0.71, 0.69 and 0.18 mg kg^{-1} respectively.

The investigation was carried out in Factorial Randomized Complete Block Design with 02 factors such as factor-A and factor-B. Factor-A consisting of four sulphur sources and factor-B consisting of foliar spray and without foliar spray of sulphur. These eight-treatment combination were replicated thrice. Layout of the experiment was done with plot size of 3.8m × 3.6m. Plots in each of the replication were separated by 0.5 m distance and each replication was separated by a 01 m channel, which was used for irrigation. The bund height of 30 cm was raised in the space available between replications and plots. The study involved applying different sulphur sources and FYM (12.5 t ha^{-1}) two weeks before transplanting and mixing systematically.

Knol-khol seedlings of 15 days old with average height of 5 to 7 cm were watered before transplanting and transplanting was done in the field at a spacing of 30 x 22.5 cm^2 with gap filling on 4-5 days after transplanting to ensure the ideal plant population. The recommended dose of fertilizer for knol-khol was 150:100:125 kg ha^{-1} N: P_2O_5: K_2O. Nitrogen was applied through urea (46 % N) and potassium was applied through muriate of potash (60 % K) whereas, phosphorous was applied through different sources of sulphur fertilizers like SSP, 20:20:0:13, DAP + gypsum and DAP which acts as a control where sulphur was absent. Full dose of sulphur sources, MOP and half dose of urea were applied as a basal into all the treatments. The remaining half dose of urea was given as top dressing in one split dose at 25 days after transplanting. Foliar spray of 1% sulphate of potash was done after one week of transplanting of knol-khol seedlings for a particular treatment. First irrigation was given on the day of transplanting and subsequent irrigation was given as and when required by the crop throughout the crop growth period. Hand weeding was done at 15 DAT to keep the plots weed free.

Five plants were randomly selected from each plot and labelled to record growth parameters at different growth stages *viz*., 20, 30 DAT and at harvest of the crop. The data collected from the experiment was subjected to statistical analysis, following Gomez and Gomez's (1984) guidelines.

Treatment details

Factor-A: - Sulphur Sources

A_1: - Sulphur through SSP (equivalent to 100%RDP)

A_2: - Sulphur through 20:20:0:13 (equivalent to 100% RDP)

A_3: - Sulphur through gypsum (equivalent to SSP, Sulphur @ 75kg) + 100% RDP through DAP

A_4: - 100% RDP through DAP (No Sulphur)

Factor-B: - Foliar spray of Sulphur

B_1: - Foliar spray of SOP @1%

B_2: - No Foliar spray

Note: FYM - Farm yard manure @ 12.5 t ha^{-1} and recommended dose of fertilizer (150:100:125 N: P_2O_5: K_2O kg ha^{-1}) was common for all treatments and solubor spray of 0.1% @ 25 DAT.

Details of experimental data collection

Five plants were randomly selected from each plot and labelled to record the growth parameters at different growth stages *viz*., 20, 30 DAT and at harvest of the crop.

Growth parameters

Plant height (cm)

The plant height (cm) of five randomly selected plants at different growth stages was recorded with the support of a meter scale from the base of the plant up to the tip.

Number of leaves plant^{-1}

The number of fully opened leaves of five randomly selected plants in each plot was counted and the average number of leaves plant^{-1} was expressed in numbers.

Leaf length (cm)

The length of leaf was measured from the base of the leaf to the tip of the leaf with a scale and expressed in centimetres (cm) and the average leaf length was calculated.

Leaf area (cm^2)

The leaf area of five randomly selected plants in each experimental plot was measured with leaf area meter (Model Biovis) and averages were worked out for each growth stage and average leaf area per plant was calculated.

Chlorophyll content (SPAD reading)

Chlorophyll content was recorded by SPAD meter (SPAD-502, MINLOTA Japan) and then mean value for each treatment was calculated.

Yield parameters

Knob diameter (cm)

The diameter of knob of five randomly selected plants at knob harvesting stage was measured using digital vernier calliper and expressed in centimetres.

Knob volume (cm^3)

The volume of knob was recorded by measuring the displaced water which was obtained by dipping the knob in a measuring cylinder and average volume of knobs was calculated in cm^3.

Fresh weight of knob (g plant^{-1})

Weight of five knobs at edible maturity stage was recorded using electronic weighing balance. The average knob weight was expressed in grams.

Fresh weight of plant (g plant^{-1})

The fresh weight of five randomly selected plants at knob harvesting stage was determined using weighing balance. The fresh weight of plant was expressed in g plant^{-1}.

Dry matter (g plant^{-1})

After taking fresh weight, plants along with knob were dried in hot air oven at 65 ^{o}C till constant weight is obtained. The dry weight of plant was expressed in g plant^{-1}.

Total knob yield (q ha^{-1})

The total knob weight per plot was recorded at the time of harvesting and which was converted to knob yield per ha in quintals.

Marketable knob yield (q ha^{-1})

The knob weight (excluding leaves, over matured and damaged knobs) was recorded, marketable yield per plot is calculated and it was converted into marketable yield per ha in quintals.

Results and Discussion

Plant height

Plant height at 20 and 30 DAT and at harvest was significantly influenced by different sources of sulphur, whereas foliar spray of SOP @ 1% and the interaction effects were non-significant. Among sulphur sources, gypsum + DAP (A_3) recorded the tallest plants at all stages (23.03, 35.74 and 39.60 cm at 20 DAT, 30 DAT and harvest, respectively), while DAP alone (A_4) resulted in the shortest plants. Although SOP foliar spray slightly increased plant height compared to no spray, the differences were not statistically significant. The interaction A_3B_1 produced the maximum plant height at all stages, whereas minimum was observed under A_4B_2.

Number of leaves plant^{-1}

The number of leaves per plant at 20 and 30 DAT and at harvest was significantly affected by different sulphur sources, while SOP foliar spray @ 1% and interaction effects were non-significant. Gypsum + DAP (A_3) consistently produced the highest leaf numbers at all stages (8.68, 13.41 and 15.12), whereas DAP alone (A_4) resulted in the lowest. Although foliar application of SOP showed a numerical increase in leaf count over no spray, the differences were not statistically significant. Among interactions, A_3B_1 recorded the maximum number of leaves, while A_4B_2 showed the minimum.

Leaf length (cm^2)

Leaf length at 20 and 30 DAT and at harvest was significantly influenced by sulphur sources, whereas SOP foliar spray @ 1% and interaction effects were non-significant. Leaf length increased progressively from 20 DAT to harvest. Gypsum + DAP (A_3) produced the longest leaves at all stages (13.45, 20.98 and 24.19 cm), while DAP alone (A_4) recorded the shortest. Although foliar application of SOP showed a numerical increase in leaf length over no spray, the differences were not statistically significant. Among interactions, A_3B_1 recorded the maximum leaf length, whereas A_4B_2 registered the minimum at all growth stages.

Leaf area (cm^2)

Leaf area of knol-khol at 20 and 30 DAT and at harvest was significantly influenced by different sulphur sources, whereas the effect of SOP foliar spray @ 1% was marginal. Among the sulphur treatments, gypsum + DAP (A_3) recorded the highest leaf area at all stages (841.63, 1257.30 and 1910.07 cm²), while DAP alone (A_4) produced the lowest. Foliar application of SOP showed a slight numerical increase in leaf area compared to no spray. In the interaction effect, A_3 B_1 registered the maximum leaf area at all stages, whereas A_4B_2 resulted in the minimum.

Chlorophyll content (SPAD reading)

Chlorophyll content of knol-khol differed significantly due to various sulphur sources, whereas foliar spray of SOP @ 1% and its interaction with sulphur sources were non-significant. Among the treatments, gypsum + DAP (A_3) recorded the highest SPAD values at all stages (64.73, 67.33 and 65.79 at 20 DAT, 30 DAT and harvest, respectively), while the lowest values were observed with DAP alone (A_4). Although foliar application of SOP showed a slight numerical increase in chlorophyll content over no spray, the differences were not statistically significant. The interaction A_3B_1 registered the maximum chlorophyll content, whereas A_4B_2 recorded the minimum across all growth stages.

Growth parameters of Knol-khol was significantly influenced by sulphur sources and foliar SOP application. Gypsum + DAP (A_3) produced the highest plant height, leaf size, number of leaves, chlorophyll content and biomass, while DAP alone (A_4) showed the lowest. The improved growth under A_3 is attributed to adequate sulphur, which supports chlorophyll synthesis, enzyme activity, and cell division. Foliar SOP @ 1% slightly enhanced growth by supplying readily available sulphur and potassium, with the combined treatment (A_3B_1) showing the best results. This confirms that knol-khol being sulphur-loving requires sufficient sulphur for optimal vegetative growth. The above findings are corroborated

by the research findings of Singh and Pandey (2017), Yadav *et al*. (2019) and Meena (2016).

Yield parameters

Knob diameter (cm)

The average knob diameter of knol-khol was significantly influenced by sulphur sources, while the interaction with SOP foliar spray was non-significant. Gypsum + DAP (A_3) produced the largest knobs (7.60 cm), whereas DAP alone (A_4) resulted in the smallest (4.36 cm). Foliar spray of SOP @ 1% slightly increased knob diameter (6.48 cm) compared to no spray (5.85 cm). At the interaction level, A_3B_1 recorded the highest diameter (7.93 cm), while A_4B_2 showed the lowest (3.88 cm).

Knob volume (cm^3)

Knob volume of knol-khol was significantly affected by sulphur sources and foliar SOP application, while their interaction was non-significant. Among sulphur treatments, gypsum + DAP (A_3) produced the largest knobs (199.64 cm^3), and DAP alone (A_4) the smallest (105.10 cm^3). Foliar SOP @ 1% (B_1) slightly increased knob volume (164.40 cm^3) compared to no spray (B_2: 153.55 cm^3). At the interaction level, A_3B_1 recorded the maximum volume (205.82 cm^3), while A_4B_2 showed the minimum (101.07 cm^3).

Fresh weight of plant (g $plant^{-1}$)

Fresh weight of knol-khol at harvest was significantly influenced by sulphur sources, foliar SOP, and their interaction. Gypsum + DAP (A_3) produced the highest fresh weight (301.70 g $plant^{-1}$), while DAP alone (A_4) gave the lowest (169.92 g). Foliar SOP @ 1% (B_1) slightly increased weight (273.44 g) over no spray (254.57 g). The highest interaction value was observed in A_3B_1 (302.28 g), due to adequate sulphur and potassium enhancing protein synthesis, chlorophyll formation, and photosynthesis (Yadav *et al*., 2019).

Dry matter (g $plant^{-1}$)

Dry matter of knol-khol leaves and knobs at harvest was significantly influenced by sulphur sources, foliar SOP, and their interaction. Gypsum + DAP (A_3) recorded the highest dry matter in leaves (10.17 g) and knobs (17.09 g), while DAP alone (A_4) had the lowest (8.19 g leaf, 13.59 g knob). Foliar SOP @ 1% (B_1) slightly increased dry matter compared to no spray (B_2). Among interactions, A_3B_1 showed the maximum accumulation (10.31 g leaf, 17.16 g knob), whereas A_4B_2 recorded the minimum (8.38 g leaf, 13.52 g knob), reflecting the synergistic effect of sulphur and potassium in enhancing growth and metabolism, while their absence limited biomass production (Bhutia & Misal, 2024).

Total knob yield (q ha^{-1})

Total knob yield of knol-khol was significantly affected by sulphur sources, foliar SOP, and their interaction. Gypsum + DAP (A_3) produced the highest yield (201.44 q ha^{-1}), while DAP alone without sulphur (A_4) gave the lowest (121.38 q ha^{-1}). Foliar SOP @ 1% (B_1) increased yield (168.54 q ha^{-1}) compared to no spray (B_2: 155.69 q ha^{-1}). The highest yield was observed under A_3B_1 (210.53 q ha^{-1}) due to the combined effect of sulphur and potassium enhancing protein synthesis, chlorophyll formation, photosynthesis, and assimilate translocation, whereas A_4B_2 recorded the lowest (115.63 q ha^{-1}) because of nutrient deficiency (Chhipa, 2005).

Marketable knob yield (q ha^{-1})

Marketable knob yield of knol-khol was significantly influenced by sulphur sources, foliar SOP, and their interaction. Gypsum + DAP (A_3) recorded the highest yield (189.64 q ha^{-1}), while DAP alone without sulphur (A_4) had the lowest (112.79 q ha^{-1}). Foliar SOP @ 1% (B_1) increased yield (157.78 q ha^{-1}) compared to no spray (B_2: 144.60 q ha^{-1}). The highest marketable yield was observed under A_3B_1 (199.93 q ha^{-1}) due to the combined effect of sulphur and potassium enhancing protein synthesis, chlorophyll formation, photosynthesis, and assimilate translocation, whereas A_4B_2 recorded the lowest (109.17 q ha^{-1}) (Chhipa, 2005).

Yield parameters of Knol-khol, including knob diameter, volume, fresh weight, total and marketable yield, were significantly influenced by sulphur sources and foliar SOP application. Gypsum + DAP (A_3) consistently gave the highest values, while DAP alone without sulphur (A_4) had the lowest, highlighting the importance of sulphur in protein synthesis, carbohydrate metabolism, and assimilate partitioning to knobs. Foliar SOP @ 1% (B_1) further improved yield by enhancing translocation of photosynthates and turgor maintenance. The combined treatment A_3B_1 recorded the maximum knob size and yield, whereas sulphur deficiency in A_4 limited growth and marketable produce. These results confirm that adequate sulphur and potassium together optimize both yield and quality of knol-khol. These findings are as per previous studies of Choudhary *et al*. (2015), Sharma *et al*. (2018), Patel *et al*. (2020) and Devi *et al*. (2021).

Conclusion

The present study clearly demonstrated that growth and yield of knol-khol were significantly improved by the application of sulphur, particularly through gypsum in combination with DAP. Among the treatments, soil application of gypsum @ 75 kg S ha^{-1} along with 100% RDP supplemented with foliar spray of SOP @ 1%, proved most effective in enhancing vegetative growth, chlorophyll content, dry matter accumulation, knob size and both total and marketable yield. In contrast, omission of sulphur resulted in poor growth and yield, indicating that knol-khol, being a sulphur-demanding crop, requires adequate sulphur nutrition for optimal performance. Thus, integrated use of soil-applied sulphur and foliar SOP is recommended for achieving higher productivity and better quality of knol-khol.

Table 1: Effect of different sources of sulphur on growth parameters of Knol-khol

Treatments	Plant height (cm)			Number of leaves $plant^{-1}$			Leaf length (cm)			Leaf area (cm^2)			Chlorophyll (SPAD)		
	20 DAT	30 DAT	At harvest	20 DAT	30 DAT	At harvest	20 DAT	30 DAT	At harvest	20 DAT	30 DAT	At harvest	20 DAT	30 DAT	At harvest
Sulphur sources (A)															
A1	20.83	30.03	32.07	6.67	11.44	11.93	12	17.38	19.53	683.75	923.76	1205.16	50.21	51.26	50.97
A2	22.29	33.58	34.78	7.23	12.48	13.09	12.6	19.09	21.82	770.35	1123.55	1524.7	56.23	57.69	56.79
A3	23.03	35.74	39.6	8.68	13.41	15.12	13.45	20.98	24.19	841.63	1257.3	1910.07	64.73	67.33	65.79
A4	18.31	27.1	27.77	5.1	9.95	10.41	8.95	15.13	16.78	536.02	573.4	683.05	41.02	46.67	45.26
S. Em±	0.65	0.96	1.02	0.21	0.36	0.38	0.36	0.55	0.62	21.43	29.18	39.73	1.6	1.67	1.65
CD @ 5%	1.96	2.91	3.09	0.64	1.09	1.16	1.1	1.67	1.89	65	88.51	120.5	4.86	5.08	5
Foliar spray of Sulphur (B)															
B1	21.68	32.22	34.02	7.09	12.08	12.95	11.96	18.49	20.84	710.2	971.88	1332.45	53.53	56.55	55.64
B2	20.55	31	33.09	6.75	11.56	12.33	11.54	17.8	20.32	705.67	967.13	1329.04	52.57	54.93	53.76
S. Em±	0.46	0.68	0.72	0.15	0.25	0.27	0.26	0.39	0.44	15.15	20.63	28.09	1.13	1.18	1.17
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (AxB)															
A1B1	21.04	30.35	32.66	6.86	11.63	12.16	12.18	17.61	19.72	685.39	926.08	1206.81	50.51	51.7	51.52
A1B2	20.63	29.72	31.49	6.48	11.25	11.69	11.81	17.15	19.35	682.11	921.44	1203.51	49.91	50.83	50.43
A2B1	22.55	34.32	34.99	7.28	12.66	13.33	12.67	19.47	22.2	772.42	1126.22	1526.6	56.83	58.31	57.52
A2B2	22.02	32.84	34.56	7.18	12.29	12.85	12.53	18.7	21.44	768.29	1120.88	1522.8	55.62	57.07	56.05
A3B1	23.35	36.43	40.22	8.88	13.85	15.6	13.7	21.27	24.47	843.08	1259.3	1911.05	65.06	68.29	66.49
A3B2	22.7	35.05	38.98	8.48	12.97	14.63	13.21	20.68	23.9	840.18	1255.3	1909.09	64.39	66.37	65.1
A4B1	19.76	27.78	28.2	5.33	10.17	10.69	9.28	15.59	16.97	539.93	575.92	685.35	41.71	47.9	47.05
A4B2	16.86	26.41	27.35	4.87	9.73	10.14	8.62	14.68	16.58	532.1	570.88	680.75	40.33	45.44	43.47
S. Em±	0.91	1.35	1.44	0.3	0.51	0.54	0.51	0.78	0.88	30.31	41.27	56.18	2.26	2.37	2.33
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

A_1: Sulphur through SSP (equivalent to 100% RDP)
A_2: Sulphur through 20:20:0:13(equivalent to 100% RDP)
A_3: Sulphur through gypsum (equivalent to SSP, Sulphur @ 75kg) + 100% RDP through DAP
A_4: - 100% RDP through DAP (No Sulphur)
B_1: Foliar spray of SOP @1%
B_2: No Foliar spray

Table 2: Effect of different sources of sulphur on yield parameters and yield of Knol-khol

Treatments	Average knob Diameter (cm)	Knob volume (cm^3)	Fresh weight (g $plant^{-1}$)	Dry matter (g $plant^{-1}$)		Total knob yield (q ha^{-1})	Marketable knob yield (q ha^{-1})
				Leaf	Knob		
Sulphur sources (A)							
A1	6.09	149.37	286.15	8.87	14.66	144.97	134.43
A2	6.62	181.8	292.26	9.66	16.09	180.69	167.89
A3	7.6	199.64	301.7	10.17	17.09	201.44	189.64
A4	4.36	105.1	169.92	8.19	13.59	121.38	112.79
S. Em±	0.19	4.79	8.25	0.28	0.47	4.82	4.49
CD @ 5%	0.57	14.53	25.02	0.85	1.42	14.61	13.62
Foliar spray of Sulphur (B)							
B1	6.48	164.4	273.44	9.47	16.44	168.54	157.78
B2	5.85	153.55	254.57	8.66	15.27	155.69	144.6
S. Em±	0.13	3.39	5.83	0.2	0.33	3.4	3.18
CD @ 5%	0.4	10.27	17.69	0.6	1	10.33	9.63
Interaction (AxB)							
A1B1	6.39	156.67	286.97	8.98	14.76	151.67	142.42
A1B2	5.78	142.07	285.32	8.76	14.55	138.27	126.44
A2B1	6.78	185.97	293.54	9.78	16.18	184.84	172.34
A2B2	6.46	177.62	290.98	9.54	15.99	176.53	163.43
A3B1	7.93	205.82	302.28	10.31	17.16	210.53	199.93
A3B2	7.26	193.45	301.12	10.02	17.01	192.34	179.36
A4B1	4.83	109.13	170.96	8	13.65	127.12	116.41
A4B2	3.88	101.07	168.87	8.38	13.52	115.63	109.17
S. Em±	0.27	6.77	11.67	0.4	0.66	6.81	6.35
CD @ 5%	NS	NS	35.38	1.21	2	20.66	19.27

A_1: - Sulphur through SSP (equivalent to 100% RDP)
A_2: - Sulphur through 20:20:0:13(equivalent to 100% RDP)
A_3: - Sulphur through gypsum (equivalent to SSP, Sulphur @ 75kg) + 100% RDP through DAP
A_4: - 100% RDP through DAP (No Sulphur)

B_1: - Foliar spray of SOP @1%
B_2: - No Foliar spray

Fig. 1: General view of experimental site.

(a) A_3B_1: Sulphur through gypsum (equivalent to SSP, Sulphur @ 75kg) + 100% RDP through DAP with foliar spray of SOP

(b) A_4B_2: 100% RDP through DAP (No Sulphur) with no foliar spray

Fig. 2: Effect of different sources of sulphur application on plant height and leaf area of Knol-khol at 45 DAT

(a) A_3B_1: Sulphur through gypsum (equivalent to SSP, Sulphur @ 75kg) + 100% RDP through DAP with foliar spray of SOP

(b) hrough DAP (No Sulphur) with no foliar spray

Fig. 3: Effect of different sources of sulphur application on Knob size of Knol-khol

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Conflict of interest

The author declares that there are no conflicts of interest associated with this research.

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