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Effect of different levels of sulphur and soil fertility on growth and yield of summer black gram (*Vigna mungo* L.)

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Abstract
Summer black gram (*Vigna mungo* L.) is an important legume crop with significant potential to improve soil health and nutritional outcomes. Black gram production is lower due to factors such as shattering losses, pest and disease damage, irregular supply of nutrient fertilizers and limited resource availability. Sulphur is a critical nutrient for protein synthesis and nitrogen fixation which is often overlooked despite its importance. Although several studies have examined the effects of individual sulphur and soil fertility treatments on summer black gram, there is a notable gap in understanding the effect of different levels of sulphur with soil fertility treatments, addressing this gap is crucial for developing efficient nutrient management strategies and sustainable production tailored to summer black gram cultivation. The present investigation on the effect of different levels of sulphur and soil fertility treatments is essential for optimizing nutrient management and enhancing crop productivity the field experiment was carried out in split plot design with three sulphur levels (0, 30 and 60 kg ha^{-1}) in main plot and five soil fertility treatments in sub plot (control, *rhizobium* (R), farmyard manure (FYM), recommended dose of fertilizer (RDF) and combined application of R + FYM + RDF) with three replications at Lovely Professional University, Phagwara, Punjab. The results revealed that there was a significant in growth, yield attributes and yield at 60 kg S ha^{-1} followed by 30 kg S ha^{-1} and the application of FR+FYM+RDF produced highest growth, yield attributes and yield followed by FRDF, FFYM and FR whereas the interaction effect was significant in plant height (cm), leaf area index, chlorophyll content, pod length, pods plant^{-1}, test weight, seed yield, stover yield and harvest index.

Keywords: Summer black gram (*Vigna mungo* L.), sulphur levels, soil fertility treatments, growth and yield, nutrient management

1. Introduction
One of the significant pulse crops is black gram (*Vigna mungo* L.). It belongs to the family Leguminosae and the subfamily papilionaceae. India is its main origin and is largely grown in Asian nations such as Pakistan, Myanmar and parts of Southern Asia. India is the largest producer and consumer of black gram in the world. India yield is approximately 23.4 lakh tonnes of black gram from an area of 46.7 lakh hectares with a productivity of 501 kg per hectare on average in 2020-21. Black gram area accounts for about 15.7 per cent of India's total pulse acreage and contributes 9.09 per cent of total pulse production. (ANGRAU Black gram Outlook Report- January to December 2021) [1]. Black gram is a very significant pulse crop with a high price that is grown in practically every part of India. Black gram seed contains a perfect balance of all nutrients, including carbs (60%), proteins (26%), fat (1.5%), calcium (154 mg), minerals (3.2%), phosphorous (385 mg), fibre (0.9%), iron (9.1 mg), and vitamin B-complex (9.1 mg) (Jadhav *et al.*, 2019) [12]. Black gram production faces several challenges that highlight the need for comprehensive strategies and interventions. The crops are susceptible to various pests and diseases, which can significantly reduce yield. Fertilizer management is crucial, with black gram requiring specific doses of nitrogen, phosphorous, potash, and sulphur. 'Sulphur is increasingly honoured as the fourth major factory nutrient after nitrogen, phosphorous and potassium' (Malik *et al.*, 2006) [22]. Sulphur helps in chlorophyll formation, stimulating growth, seed formation and N fixation by enhancing nodule formation. Sulphur boosts productivity and

improves the quality of the crop. Sulphur plays a crucial role in the synthesis of certain amino acids, enhancing nutrient uptake. Studies have shown that sulphur application can significantly increase the yield of black gram and positively influence growth parameters like plant height, number of branches plant' and plant dry weight (Khatana *et al*., 2021) [20]. Integrated nutrient management includes the smart use of organic, inorganic, and biological resources so as to sustain optimum yields, improve or maintain the soil physical and chemical properties, and provide crop nutrition packages, economically attractive, practically feasible and environmentally safe (Awasya., 2018) [3]. Adding organic matter such as compost or farmyard manure improves soil structure and promotes vigorous seed production. Farm Yard manure (FYM) is although not as effective as a single source of nutrients but an effective complimentary and supplementary source with mineral fertilizers. Utilization of FYM not only nourishes crop on decomposition but also enhances the nutrient and water holding capacity of soil. Incorporation of FYM also checks the phosphate depletion from the soil and sustains phosphate balance by minimizing its fixation. There is immense scope for improving the production potential of black gram by use of organic manures, inorganic manures and biofertilizers (Verma *et al*., 2017) [36]. Exclusive use of organics alone does not lead to dramatic rise in crop yield, as they contain low nutrient content. Thus, the said effects have paved the way to cultivate black gram with inorganic coupled with biofertilizers. Biofertilizers are inexpensive, environment friendly and sustainable plant nutrient sources to augment fertilizer for sustainable development of agriculture. They can contribute significantly towards the immobilization of atmospheric nitrogen and plant growth promoting substances as well as the provision of phosphorus to plants by initiating beneficial change in soil micro environment resulting in solubilization of insoluble organic phosphate sources. Rhizobium, in particular known for its ability to enhance biological fixation of atmospheric nitrogen into ammonia and improve phosphorus availability to crops (Kumar *et al*., 2014) [16]. The combined application of biofertilizers and chemical fertilizers which is often complemented by sulphur, is known to enhance crop productivity and soil fertility (Sharma *et al*., 2014) [17]. Thus, the present investigation aimed to study the effect of different levels of sulphur and soil fertility on growth and yield of summer black gram (*Vigna mungo* L).

2. Materials and Methods

The study was carried out during the summer season of 2024 at Research Farm, School of Agriculture, Lovely Professional University, Phagwara Punjab. The trial was conducted on clay loam soil with pH 8.1, available phosphorus content was 48.22 kg ha^{-1}. The experiment was conducted using split plot design with three replications and each plot measurement covered an area of 5×2.25 m2. The three levels of sulphur i.e., S0- sulphur @ 0 kg ha^{-1}, S30- sulphur @ 30 kg ha^{-1} and S60- sulphur @ 60 kg ha^{-1} were kept in main plot and five soil fertility treatments i.e., FC- control, FR- *Rhizobium* sp., FFYM- FYM, FRDF- recommended dose of fertilizer, FRDF+R+FYM- combined application of RDF, *Rhizobium* sp. and FYM were kept in sub plots. The sowing was done on 21 March 2024 with line sowing method. The variety used for sowing summer mash Mash 1137. The 1st irrigation was applied after 10 days after sowing (DAS) and subsequent irrigations were applied depending upon the climatic conditions. The crop was harvested on 5th June, 2024 from 22 m of net plot were taken from the middle of each plot and left under the sun to dry. After that, threshing of crop was done and seeds were cleaned. The seeds were weighed of each plot on an electronic balance. The analysis was done on OPSTAT.

The growth attributes *viz*. plant height (cm) and number of leaves plant^{-1} at maturity whereas number of nodules Plant^{-1} at 42 DAS, and chlorophyll index at 56 DAS. Yield parameters *viz*. number of pods plant^{-1}, number of seeds pod-1 and pod length (cm) were recorded at harvest whereas test weight (g), seed yield (kg ha^{-1}) and stover yield (kg ha^{-1}) and harvest index (%) at threshing. For chlorophyll measurement, select healthy leaves for testing, Calibrate the SPAD meter, then place a leaf on the meter to obtain a reading. Record the SPAD value, and repeat the process on multiple leaves. Calculated the average of the readings.

3. Results and Discussion

Growth parameters

The data regarding plant height (cm), number of leaves plant^{-1}, number of nodules plant^{-1}, leaf area index and chlorophyll content are presented in Table 1.

Plant height

Plant height is an important parameter for growth and yield of black gram. The data regarding plant height were recorded at maturity of crop are presented in Table 1. Irrespective of soil fertility treatments, there was a significant increase in plant height at S30 as compared to S0 and there was further significant increase at S60. Irrespective of sulphur levels, FR resulted in a significant increase in plant height as compared to FC and the application of FFYM resulted in a significant increase as compared to FR. FRDF increased the plant height significantly as compared to FFYM and combined application of FR+FYM+RDF caused a further significant increase. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments produced significantly higher plant height when applied in combination with S30 as compared to S0 which was further increased significantly at S60. The application of FR increased the plant height significantly at S0 which was further increased significantly at S30 and S60 as compared to FC and the application of FFYM significantly increased the plant height at all levels of sulphur as compared to FR. The application FRDF significantly increased the plant height at S0 and S30 but failed to increase significantly at S60 as compared to FFYM and the combined application FR+FYM+RDF has significantly increase the plant height at S0 and S60 but failed to increase the plant height significantly at S30 as compared to FRDF.

The findings reported are in agreement with the results obtained by Arunraj *et al.* (2018) [2], Javaid *et al.* (2009) [14] and Phogat *et al*. (2018) [28].

Number of leaves plant^{-1}

The number of leaves plant^{-1} is an important growth parameter and has a significant impact on plant growth, yield and overall crop quality. The data regarding number of leaves plant^{-1} recorded at maturity of crop are presented in Table 1. Irrespective of soil fertility treatments, there was a significant increase in number of leaves plant^{-1} at S30 as compared to S0. However, there was no significant increase when S was increased to S60. Irrespective of sulphur levels, FR resulted in a significant increase in number of leaves plant^{-1} as compared FC and application of FFYM caused a significant increase as compared to FR. FRDF caused a significant increase as compared to FFYM and combined application of FR+FYM-

RDF resulted in a further significant increase in number of leaves plant^{-1}. However, the interaction affect between various levels of sulphur and soil fertility treatments was nonsignificant.
The findings reported are in agreement with the results obtained by Dixit *et al.* (2023) [9], Kumari *et al.* (2023) [19] and Verma *et al.* (2017) [36].

Number of nodules plant^{-1}
Number of nodules per plant are important growth parameter and was recorded at maturity of crop are presented in Table 1. At maturity, irrespective of soil fertility treatments, there was a significant increase in chlorophyll index at S30 as compared to S0 and there was further significant increase at S60. Irrespective of sulphur levels, FR resulted a significant increase in chlorophyll index as compared to FC and the application of FFYM caused a significant increase in chlorophyll index as compared to FR. The addition of FRDF further increased the chlorophyll index significantly as compared to FFYM and the combined application of FR+FYM-RDF resulted in a significant increase as compared to FRDF. However, the interaction between the various levels of sulphur and Soil fertility levels was non-significant.
The findings reported are in agreement with the results obtained by Das *et al.* (2016) [6], Dixit *et al.* (2023) [9], Khatkar *et al.* (2007) and Kumar *et al.* (2020) [18].

Leaf area index
Leaf area index is an important parameter for growth and yield of black gram. The data regarding leaf area index were recorded at maturity of crop are presented in Table 1. Irrespective of soil fertility treatments, there was a significant increase in leaf area index at S30 as compared to S0 which was further increased significantly when S was increased to S60. Irrespective of sulphur levels, FR resulted in a significant increase in leaf area index as compared to FC and the application of FFYM caused a further significant increase in leaf area index. The addition of FRDF resulted further significant increase. The combined application of FR+FYM-RDF resulted in a significant increase as compared to FRDF. However, the interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments resulted significantly higher leaf area index when applied in combination with S30 as compared to S0 which was further increased significantly at S60. The application FR increased the leaf area index significantly as compared to FC at S0 which was also increased significantly at S30 and at S60 and the FFYM increased the leaf area index significantly at S0 which was further increased significantly at S30 and S60. The addition of FRDF increased the leaf area index significantly at S0, S30 and S60 as compared to FFYM and the combined application of FR+FYM-RDF further increased the leaf area index significantly at all levels of sulphur as compared to FRDF.
The findings reported are in agreement with the results obtained by Bairwa *et al.* (2012) [4], Jaga and Sharma. (2015) [32], Jamir *et al.* (2022) [13], Jha *et al.* (2015) [15] and Sahu *et al.* (2023) [31].

Chlorophyll content
Chlorophyll content plays a crucial role directly influencing plant growth and yield. The data regarding chlorophyll content were recorded at 56 DAS of crop are presented in Table 1. Irrespective of soil fertility treatments, there was a significant increase in chlorophyll index at S30 as compared to S0 which was further increased significantly when S was increased to S60. Irrespective of sulphur levels, FR resulted in a significant increase in chlorophyll index as compared FC and the application of FFYM caused a significant increase as compared to FR. The addition of FRDF caused a significant increase as compared to FFYM and combined application of FR+FYM-RDF resulted in a further significant increase in chlorophyll index. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments produced significantly higher chlorophyll index when applied in combination with S30 as compared to S0 which was further increased significantly at S60. The application FR increased the chlorophyll index significantly as compared to FC at all levels of S (S0, S30 and S60). The FFYM increased the chlorophyll index significantly at S0 which was further increased significantly at S30 and at S60 as compared to FR. The application FRDF increased the chlorophyll index significantly at S0, S30 and S60 and the combined application of FR+FYM-RDF increased the chlorophyll index significantly at all levels of sulphur as compared to FRDF.
The findings reported are in agreement with the results obtained by Das *et al.* (2016) [6], Kumar *et al.* (2020) [18] and Kumari *et al.* (2023) [19].

Yield attributes
The data regarding pod length, number of pods plant^{-1}, number of seeds pod-1, test weight (g) are presented in Table 2.

Pod length
The data regarding the pod length at harvest stage are presented in Table 2. Irrespective of soil fertility treatments, there was significant increase in pod length at S30 as compared to S0 which was further increased significantly at S60. Irrespective of sulphur levels, FR resulted in a significant increase in pod length as compared to FC and the application FFYM caused a further significant increase. The application of FRDF resulted in a significant increase of pod length as compared to FFYM whereas the combined application of FR+FYM+RDF resulted in a further significant increase. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments resulted in significantly higher pod length when applied in combination with S30 as compared to S0 except FCS30 and FRS30 and when S was increased to S60 all the soil fertility treatments resulted significant increase in pod length as compared to S30 except FCS60. The application FR increased the pod length significantly as compared to FC at S0 which was further increased at S30 and at S60. The application of FFYM also increased the pod length significantly at all the levels of sulphur. The application FRDF increased the pod length significantly at all levels of S as compared to FFYM and the combined application FR+FYM+RDF increased the pod length significantly at all levels of sulphur as compared to FRDF.
The findings reported are in agreement with the results obtained by Javaid. (2009) [14], Kumar *et al.* (2016) [17], Kumari *et al.* (2023) [19], Mahamud *et al.* (2022) [21], Sahu *et al.* (2023) [31] and Singh *et al.* (2020) [33].

Number of pods plant^{-1}
The data regarding the number of pods plant^{-1} at maturity stage are presented in Table 2. Irrespective of soil fertility treatments, there was significant increase in number of pods plant^{-1} at S30 as compared to S0 which was further increased significantly at S60. Irrespective of sulphur levels, FR resulted in a significant increase in number of pods plant^{-1} as compared to FC and the application of FFYM caused a further significant increase. The

addition of FRDF resulted in a significant increase in number of pods plant^{-1} as compared to FFYM and combined application of FR+FYM+RDF resulted a further significant increase. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments resulted in significantly higher number of pods plant^{-1} when applied in combination with S30 as compared to S0 and when S was increased to S60 all the soil fertility treatments resulted in a significant increase in number of pods plant^{-1} as compared to S30. The application FR increased the number of pods plant^{-1} significantly as compared to FC at S0 which was further increased at S30 and but failed to increase at S60. The application of FFYM also increased the number of pods plant^{-1} significantly at S0 but failed to increase at S30 and S60. The application FRDF failed to increase the number of pods plant^{-1} significantly at S0, S30 and S60 as compared to FFYM and the combined application of FR+FYM+RDF increased the number of pods plant^{-1} significantly at S0 but failed to increase at S30 and S60 as compared to FRDF.

The findings reported are in agreement with the results obtained by Danga *et al.* (2022) [5], Khatana *et al.* (2021) [20], Kumari *et al.* (2023) [19], Phogat *et al.* (2018) [28] and Rathi *et al.* (2009) [30].

Number of seeds pod-1

The data regarding the number of seeds pod-1 are presented in Table 2. Irrespective of soil fertility treatments, there was significant increase in number of seeds pod-1 at S30 as compared to S0 which was further increased significantly at S60. Irrespective of sulphur levels, FR resulted in a significant increase in number of seeds pod-1 as compared to FC and the application FFYM caused a further significant increase. The application of FRDF resulted in a significant increase in number of seeds pod-1 as compared to FFYM and combined application of FR+FYM+RDF resulted a further significant increase. However, the interaction affect between various levels of sulphur and soil fertility treatments was nonsignificant.

The findings reported are in agreement with the results obtained by Meena *et al.* (2015) [23], Pandey *et al.* (2019) [25], Patel *et al.* (2016) [26], Patil *et al.* (2021) [27] and Sahu *et al.* (2023) [31].

Test weight

The data regarding the test weight are presented in Table 2. Irrespective of soil fertility treatments, there was significant increase in test weight at S30 as compared to S0 which was further increased significantly at S60. Irrespective of sulphur levels, FR resulted in a significant increase in test weight as compared to FC and the application FFYM caused a further significant increase. The application of FRDF resulted in a significant increase in test weight as compared to FFYM and combined application of FR+FYM+RDF resulted in a further significant increase. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments resulted in significantly higher test weight when applied in combination with S30 as compared to S0 and when S was further increased to S60 all the soil fertility treatments resulted significant increase in test weight as compared to S30. The application FR increased the test weight significantly as compared to FC at S0, S30 and S60. The application of FFYM also increased the test weight significantly at all the levels of sulphur. The application FRDF increased the test weight significantly at S30 and S60 but failed to increase at S0 as compared to FFYM and the combined application FR+FYM+RDF increased the test weight significantly at all levels of sulphur as compared to FRDF.

The findings reported are in agreement with the results obtained by Das *et al*. (2016) [6], Divyavani *et al.* (2020) [8], Gupta *et al.*, (2025) [10] and Kumar *et al.* (2020) [18].

Yield

The data regarding Seed yield (kg ha^{-1}), Stover yield (kg ha^{-1}) and Harvest index (%) are presented in Table 3.

Seed yield

The data regarding the seed yield are presented in Table 3. Irrespective of soil fertility treatments, there was significant increase in seed yield at S30 as compared to S0 which was further increased significantly at S60. Irrespective of sulphur levels, FR resulted in a significant increase in seed yield as compared to FC and the application FFYM caused a further significant increase. FRDF resulted in a significant increase of seed yield as compared to FFYM and combined application of FR+FYM+RDF resulted a further significant increase. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments resulted significantly higher seed yield when applied in combination with S30 as compared to S0 and S60 as S30 except FCS60. The other treatments also significantly increased the seed yield as compared to their previous levels. The application FR increased the seed yield significantly as compared to FC at S0, S30 and S60. The application of FFYM also increased the seed yield significantly at all the levels of sulphur as compared to FR except S60FFYM. The application FRDF increased the seed yield significantly at all levels of sulphur as compared to FFYM and the combined application FR+FYM+RDF further increased the seed yield significantly at all levels of sulphur as compared to FRDF.

The findings reported are in agreement with the results obtained by Divyavani *et al.* (2020) [8], Kumar *et al.* (2016) [17], Pandey *et al.* (2019) [25], Sahu *et al.* (2023) [31], Singh *et al.* (2020) [33] and Tyagi and Upadhyay, (2015) [35].

Stover yield

The data regarding the stover yield are presented in Table 3. Irrespective of soil fertility treatments, there was significant increase in stover yield at S30 as compared to S0 which was further increased significantly at S60. Irrespective of sulphur levels, FR resulted in a significant increase in stover yield as compared to FC and the application FFYM caused a further significant increase. FRDF resulted in a significant increase of stover yield as compared to FFYM and combined application of FR+FYM+RDF resulted a further significant increase. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments resulted significantly higher stover yield when applied in combination with S30 as compared to S0 and S60 as compared to S30. The other treatments also increased significantly the stover yield as compared to their previous levels. The application FR increased the stover yield significantly as compared to FC at S0, S30 and S60. The application of FFYM also increased the stover yield significantly at all the levels of sulphur as compared to FR except. The application FRDF increased the stover yield significantly at all levels of sulphur as compared to FFYM and the combined application FR+FYM+RDF further increased the stover yield significantly at all levels of sulphur as compared to FRDF.

The findings reported are in agreement with the results obtained by Dash *et al.* (2017) [7], Khatana *et al.* (2021) [20], Kumari *et al.*

(2023) [19], Patil *et al.* (2021) [27], Phogat *et al.* (2018) [28] and Tripathi and Tiwari, (2022) [34].

Harvest index

The data regarding the harvest index are presented in Table 3. Irrespective of soil fertility treatments, there was significant increase in harvest index at S30 as compared to S0 which was further increased significantly at S60. Irrespective of sulphur levels, FR resulted in a significant increase in harvest index as compared to FC and the application FFYM caused a further significant increase. FRDF resulted in a significant increase of harvest index as compared to FFYM and combined application of FR+FYM+RDF resulted a further significant increase. The interaction affect between various levels of sulphur and soil fertility treatments was significant. All the soil fertility treatments failed to result significantly higher stover yield when applied in combination with S30 as compared to S0 and S60 as compared to S30 except FCS60 and FRDFS30. The other treatments also significantly increased the stover yield as compared to their previous levels. The application FR increased the stover yield significantly as compared to FC at S30 and S60 except S0. The application of FFYM also increased the stover yield significantly at S60 as compared to FR except S0 and S30. The application FRDF increased the stover yield significantly at all levels of sulphur as compared to FFYM except S60FRDF and the combined application FR+FYM+RDF further increased the stover yield significantly at all levels of sulphur as compared to FRDF.

The findings reported are in agreement with the results obtained by Danga *et al.* (2022) [5], Hepsibha *et al.* (2024) [11], Khatana *et al.* (2021) [20], Kumari *et al.* (2023) [19], Mishra *et al.* (2024) [24] and Rathi *et al.* (2009) [30].

Table 1: Effect of different levels of sulphur and soil fertility treatments on growth parameters of summer black gram.

Sulphur levels	Soil fertility treatments					Mean
	Fc	FR	FFYM	FRDF	FRDF+R+FYM	
Plant height (cm)						
S0	51.6	52.5	53.6	54.7	55.8	53.6
S30	53.5	54.7	55.5	56.5	57.0	55.4
S60	55.6	56.3	57.0	57.5	58.7	57.0
Mean	53.6	54.5	55.4	56.2	57.2	
Number of leaves plant^{-1}						
S0	19.32	19.41	19.62	19.78	20.38	19.70
S30	21.28	21.65	22.05	22.17	22.49	21.93
S60	21.64	21.82	22.15	22.35	22.56	22.10
Mean	20.75	20.96	21.27	21.43	21.81	
Number of nodules plant^{-1}						
S0	16.01	16.22	16.42	16.63	16.85	16.42
S30	17.16	17.33	17.46	17.65	17.82	17.48
S60	18.10	18.19	18.28	18.41	18.73	18.34
Mean	17.09	17.24	17.39	17.56	17.80	
Leaf area index						
S0	1.360	1.390	1.420	1.443	1.470	1.417
S30	1.447	1.483	1.527	1.560	1.590	1.521
S60	1.567	1.607	1.630	1.660	1.693	1.631
Mean	1.458	1.493	1.526	1.554	1.584	
Chlorophyll index						
S0	46.51	47.57	48.54	49.30	50.52	48.49
S30	49.46	51.52	52.77	53.46	54.61	52.36
S60	53.51	54.71	55.13	55.58	56.71	55.13
Mean	49.83	51.27	52.15	52.78	53.95	
	Sulphur levels			**Soil fertility treatments**	**Interaction**	
	Plant height (cm)		0.39	0.24	0.54	
	Number of leaves plant^{-1}		0.213	0.133	NS	
	Nodules plant^{-1}		0.065	0.083	NS	
	Leaf area index		0.001	0.005	0.008	
Chlorophyll index			0.148	0.211	0.357	

Table 2: Effect of different levels of sulphur and soil fertility treatments on yield attributes of summer black gram.

Sulphur levels	Soil fertility treatments					
	Fc	FR	FFYM	FRDF	FRDF+R+FYM	Mean
Pod length (cm)						
S0	6.46	6.85	7.24	7.44	7.78	7.15
S30	6.57	6.86	7.53	7.88	8.23	7.41
S60	7.65	8.10	8.44	8.77	9.52	8.50
Mean	6.89	7.27	7.74	8.03	8.51	
Number of pods plant^{-1}						
S0	19.68	20.58	21.33	21.61	22.45	21.13
S30	20.61	21.48	22.57	22.78	22.93	22.07
S60	22.47	22.75	22.99	23.30	23.63	23.03
Mean	20.92	21.60	22.30	22.56	23.00	

Number of seeds pod-1						
S0	6.31	6.47	6.72	6.87	7.09	6.69
S30	6.34	6.61	6.76	7.03	7.21	6.79
S60	6.50	6.68	6.95	7.15	7.29	6.91
Mean	6.38	6.58	6.81	7.01	7.20	
Test weight (g)						
S0	34.85	35.24	35.66	35.82	36.84	35.68
S30	35.88	36.12	36.56	36.84	37.51	36.58
S60	36.87	37.22	37.76	38.33	38.77	37.79
Mean	35.86	36.19	36.66	37.00	37.71	
	Sulphur levels			**Soil fertility treatments**	**Interaction**	
LSD (0.05)	Pod length (cm)		0.059	0.149	0.238	
	Number of pods plant^{-1}		0.191	0.181	0.336	
	Number of seeds pod^{-1}		0.037	0.058	NS	
	Test weight (g)		0.097	0.128	0.219	

Table 3: Effect of different levels of sulphur and soil fertility treatments on yield of summer black gram.

Sulphur levels	**Soil fertility treatments**					**Mean**
	Fc	**FR**	**FFYM**	**FRDF**	**FRDF+R+FYM**	
Seed yield (kg ha^{-1})						
S0	529	573	618	646	677	608
S30	576	639	646	671	705	647
S60	588	666	682	727	768	686
Mean	564	626	649	681	717	
Stover yield (kg ha^{-1})						
S0	624	783	907	1204	1490	1002
S30	917	1245	1314	1400	1590	1293
S60	1075	1310	1583	1661	1779	1482
Mean	872	1113	1268	1422	1620	
Harvest index (%)						
S0	30.10	30.17	30.44	33.72	35.33	31.95
S30	30.72	32.38	32.93	33.91	38.59	33.70
S60	31.21	35.01	40.59	42.51	46.08	39.08
Mean	30.68	32.52	34.65	36.71	40.00	
	Sulphur levels			**Soil fertility treatments**	**Interaction**	
LSD (0.05)	Seed yield (kg ha^{-1})		6.91	13.5	22.0	
	Stover yield (kg ha^{-1})		31.1	27.7	52.5	
	Harvest index (%)		0.428	0.829	1.349	

4. Conclusion

The results of the present investigation revealed that the application of sulphur 60 kg ha^{-1} in combination with R, FYM and RDF significantly enhanced the growth and yield attributes of summer black gram (*Vigna mungo* L.). The higher growth parameters like, plant height number of leaves plant^{-1}, number of nodules plant^{-1}, leaf area index and chlorophyll content was obtained in treatments with sulphur 60 kg ha^{-1} + combined application of R, FYM and RDF. The yield attributes and yield like, pod length (cm), number of pods plant^{-1}, number of seeds pod-1 and test weight (g), seed yield (kg ha^{-1}), stover yield (kg ha^{-1}) and harvest index (%) was also obtained in treatment with sulphur 60 kg ha^{-1} + combined application of R, FYM and RDF followed by sulphur 60 kg ha^{-1} + RDF. Hence, it is concluded that sulphur 60 kg ha^{-1} + combined application of R, FYM and RDF, as well as sulphur 60 kg ha^{-1} + RDF are the most effective nutrient management practices for achieving higher growth and productivity of summer black gram.

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