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Effect of sulphur and zinc on growth, yield and quality of summer Greengram (*Vigna radiata* L. Wilezeck) under Middle Gujarat conditions

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Abstract
The field experiment was carried out to study the effect of sulphur and zinc on growth, yield and quality of summer Greengram (*Vigna radiata* L. Wilezeck) under Middle Gujarat Conditions. The experiment was comprised with twelve treatment combinations of four levels of S (0, 10, 20 and 30 kg S ha^{-1}), and three levels of Zn (0, 1 and 2 kg Zn ha^{-1}) which were replicated three times. The results indicated that application of S @ 30 kg S ha^{-1} significantly increase in yield attributes thereby increasing seed (1039 kg ha^{-1}) and stover yield (1967 kg ha^{-1}) of green gram over 20 kg S ha^{-1} (S_2), 10 kg S ha^{-1} (S_1) and control (S_0). Likewise, Zn application @ 2 kg ha^{-1} also resulted in the highest seed (1008 kg ha^{-1}) and stover (1883 kg ha^{-1}) yield over 1 kg Zn ha^{-1} (Zn_1) and control (Zn_0). The results indicated that application of S @ 30 kg S ha^{-1} significantly increase in yield attributes No. of branches, seeds per pod and pods per plant of green gram over 20 kg S ha^{-1} (S_2), 10 kg S ha^{-1} (S_1) and control (S_0). Likewise, Zn application @ 2 kg ha^{-1} also resulted in the no. of branches, seeds per pod and pods per plant over 1 kg Zn ha^{-1} (Zn_1) and control (Zn_0). The results indicated that application of S @ 30 kg S ha^{-1} significantly increase in No. of nodules per plant and dry wt. of nodules of green gram over 20 kg S ha^{-1} (S_2), 10 kg S ha^{-1} (S_1) and control (S_0). Likewise, Zn application @ 2 kg ha^{-1} also resulted in the no. of nodules per plant and dry wt. of nodules over 1 kg Zn ha^{-1} (Zn_1) and control (Zn_0). In the light of the results obtained from the present investigation, it is concluded that the application of 30 kg S ha^{-1} and 2 kg Zn ha^{-1} on loamy sand soil of Anand, deficient in sulphur and zinc increased the yield and protein content in the seeds besides increasing their content in the soil.

Keywords: Greengram, *Vigna radiata* L. Wilezeck, middle

Introduction
Green gram (*Vigna radiata* L.) commonly known as “Mung” or “Mungbean” is one of the most important pulse crop in India ranking fourth in respect of cultivated area next to chickpea, pigeon pea and urd bean. In India, it is grown in about 3.44 million hectares with an annual production of 1.80 million tonnes with a productivity of 523 kg ha^{-1} (Anon., 2011). In Gujarat, It is covering 0.248 million hectares and producing about 0.128 million tonnes of grain with a productivity of 526 kg ha^{-1} (Anon., 2010) [1].
Sulphur is called the fourth major nutrient. Sulphur is essential for chlorophyll formation, synthesis of protein, vitamins, thiourea, plant hormones, thiamin, biotin, glutathione and S-containing essential amino acids *viz*. methionine, cystine and cysteine. About 90% of plant sulphur is present in these amino acids. Sulphur also markedly enhanced content of phosphorus, sulphur, protein and gum in grain and ultimately the yield. Sulphur increase crop yields and improve quality of produce, both of which are important for determining the market price. After phosphorus, sulphur nutrition has been found to be a major limiting factor in green gram production. (Saraf, 1988) [11].
Micronutrient malnutrition, particularly of Zn, is presently at an alarming proportion in many developing nations (Hortz and Brown, 2004) [5]. Very little Zinc is needed for the plants, and the focous centres on the tasks, like many other micronutrients in plants are unknown. But of necessity it can be measured on its lack of side effects. Appears Zinc in formation and growth hormones, elongation of the nodes and in the chloroplast and starch regain is effective. It also promotes nodulation and nitrogen fixation in leguminous crops. Zinc deficiency is a major problem not only because of the direct effect of low Zn levels but also because it contributes to susceptibility and progression in other diseases, especially infectious diseases in childhood (Maret and Standstead, 2006) [6].

The soil of middle Gujarat is light in texture and farmers are practicing intensive cropping, introduction of high yielding varieties, use of high analysis chemical fertilizers particularly sulphur free due to sufficient irrigation facilities. The reports indicate that soils are deficient in sulphur to the extent of 40% (Patel *et al*., 1999) [9]. In order to generate location specific information, the present study was conducted

Materials and Methods

In order to achieve the pre-set objectives behind present investigation, a field experiment was conducted during the *summer* season of 2013 at College Agronomy Farm, B. A. College of Agriculture, AAU, Anand, Gujarat. The experimental soil is alluvial in origin, loamy sand in texture, locally known as *Goradu*. The water holding capacity is 35.5 g 100 g soil^{-1} and bulk density is 1.34 Mg m^{-3}. The soil had low salinity (EC 0.20 dSm^{-1}) and moderately alkaline reaction (pH 7.9). The soil can be considered as low in organic carbon (2.3 g kg^{-1}), available N (184.67 kg ha^{-1}), S (7.27 ppm) and medium in available P_2O_5 (41.58 kg ha^{-1}), K_2O (210 kg ha^{-1}) and Zn (0.61 ppm). The treatments were comprised with four level of sulphur (0 10, 20 and 30 kg S ha^{-1}) and three level of zinc (0, 1 and 2 kg Zn ha^{-1}).

The Green gram Variety Meha was used in this present experiment. Starting from the sowing of seed, till harvesting of crop uniform time was maintained and practices in vogue were followed. After removal of residues of the previous crop and weeds, the pre-sowing irrigation was given in the permanent plots. The proper tilth was achieved by light harrowing before sowing. Then the net plot was harvested separately and kept for sun drying in the respective plot. The entire dose of Phosphorus application (chemical fertilizer as DAP) was common as basal dose. Levels of sulphur and zinc supplied through gypsum and zinc chloride respectively. During the season two times picking is carrying out. First picking is done after half drying of the total pods of green gram crop and second is done at complete drying of green gram crop, harvested produce was weighed just before threshing to record total dry matter yield. Thereafter, threshing was done with help of thresher and seeds per plot were cleaned and weighed.

The biometric observations like a Nodule count/no. of root nodule plant^{-1} and Dry weight of root nodules plant^{-1} (mg) were taken at 40-45 DAS, Number of pods plant^{-1} at pod development stage while Plant height (cm), No. of branches plant^{-1}, No. of seeds plant^{-1}, Seed and straw yield (kg ha^{-1}) were taken at harvest. The data of all the characters studied were subjected to statistical analysis of variance appropriate to the Randomized Block Design (Factorial) as described by Panse and Sukhatme (1967) was used.

Result and Discussion

Yield attributes

Effect of Sulphur

Application of sulphur produced significant effect on plant height. Significantly higher plant height (47.0 cm) was recorded due to 30 kg S ha^{-1} (S_3) as compared to control (S_0) and 10 kg S ha^{-1} (S_1). However, it was at par with that of 20 kg S ha^{-1} (S_2). The plant height recorded from control (S_0) and 10 kg S ha^{-1} (S_1) was at par with each other. The descending order for S levels was: $S_3>S_2>S_1>S_0$. Application of sulphur had significant effect on number of branches per plant. The number of branches per plant was increased with increasing level of sulphur. The maximum (12.2) number of branch per plant was noticed under 30 kg S ha^{-1} (S_3) which at par with that of 20 kg S ha^{-1} (S_2) but significantly higher than control (S_0) and 10 kg S ha^{-1} (S_1). The number of branch per plant recorded under control (S_0) and 10 kg S ha^{-1} (S_1) as well as 10 kg S ha^{-1} (S_1) and 20 kg S ha^{-1} (S_2) was at par with each other.

Application of sulphur produced significant effect on number of pod per plant. The number of pods per plant recorded under 30 kg S ha^{-1} (S_3) was significantly higher (20.1) than control (S_0) and 10 kg S ha^{-1} (S_1). However, it was at par with that of 20 kg S ha^{-1} (S_2). The number of seeds per plant was significantly influenced due to application of sulphur, which was increased with increasing level of sulphur. Application of 30 kg S ha^{-1} (S_3) noticed significantly higher number of seeds per pod (11.2) than control (S_0) and 10 kg S ha^{-1} (S_1). However, it was at par with 20 kg S ha^{-1} (S_2). The descending order for S levels was: $S_3> S_2>S_1>S_0$.

The different levels of S showed significant effect on plant height, number of branches per plant, number of pods per plantand seeds per pod. Application of 30 kg S ha^{-1} (S_3) gave significantly higher result on it. This might be due to the fact that sulphur application improved over all nutritional environment of the *Rhizosphere* as well as plant system which could be more advantageous for profused vegetative and root growth which activated higher absorption of nutrients from the soil. All these had resulted into higher yield attributes. Similar results were reported by Singh *et al*. (1994) [13] in greengram and Bhadoria *et al*. (1997) [4] in cluster bean.

Numbers of root nodules per plant was significantly affected due to sulphur application (Table 2). The maximum (30.8) number of root nodules per plat was recorded under sulphur level S_3 (30 kg S ha^{-1}), which was significantly higher over control (S_0) and 10 kg S ha^{-1} (S_1), but statistically at par with that of 20 kg S ha^{-1} (S_2). The non-significant difference in number of root nodules per plant was found between control (S_0) and 10 kg S ha^{-1} (S_1). Dry weight of root nodules per plant was significantly affected due to sulphur levels, which was increased with increasing levels of sulphur (Table 2). The maximum (38.6 mg) dry weight of root nodules per plant was observed with the application @ 30 kg S ha^{-1} (S_3), which was significantly higher over control (S_0) and 10 kg S ha^{-1} (S_1), but statistically at par with that of 20 kg S ha^{-1} (S_2). The non-significant difference in dry weight of root nodules per plant was found between control (S_0) and 10 kg S ha^{-1} (S_1).

Number of root nodules and dry weight of nodules were significantly affected due to sulphur level. The maximum root nodules and dry weight of nodules were observed with sulphur level S_3 (30 kg S ha^{-1}). The increase in number of root nodules plant^{-1} and dry weight of nodules could be attributed to ascribe its pivotal role in regulating the metabolic and enzymatic processes including photosynthesis and respiration. Due to good *Rhizosphere* more activities of micro-organism in soil so increases in number of nodules plant^{-1}. The results are in line of the results of those reported by Singh *et al.* (2004) [1].

A perusal of data summarized in Table 2 revealed that levels of sulphur showed significant influence on test weight. Application of sulphur @ 30 kg S ha^{-1} (S_3) registered significantly higher (35.9 g) test weight over control (S_0) and 10 kg S ha^{-1} (S_1), but it was at par with that of 20 kg S ha^{-1} (S_2). The test weight of green gram was minimum (34.0 g) under control (S_0), which was at par with that of 10 kg S ha^{-1} (S_1).

Table 1: Effect of treatments on yield attribute of Greengram

Treatments	Plant height (cm)	Number of branches plant^{-1}	Number of pods plant^{-1}	Number of seeds pods^{-1}
Levels of sulphur (kg ha^{-1})				
S_0: 00	37.4	10.0	16.5	9.9
S_1: 10	39.2	10.7	17.1	10.2
S_2: 20	44.1	11.5	18.8	10.6
S_3: 30	47.0	12.2	20.1	11.2
S. Em. +	1.13	0.29	0.44	0.22
CD (P = 0.05)	3.3	0.9	1.3	0.6
Levels of zinc (kg ha^{-1})				
Zn_0: 0	39.4	10.1	15.9	9.7
Zn_1: 1	40.9	11.4	18.4	10.5
Zn_2: 2	45.5	11.7	20.1	11.2
S. Em. +	0.98	0.25	0.38	0.19
CD (P = 0.05)	2.9	0.8	1.11	0.6
S × Zn	NS	NS	NS	NS
CV %	8.07	7.96	7.26	6.19

Effect of zinc

Application of zinc produced significant effect on plant height. The plant height noticed due to application of 2 kg Zn ha^{-1} (Zn_2) was significantly higher (45.5 cm) than control (Zn_0) and 1 kg Zn ha^{-1} (Zn_1). However, the plant height recorded from control (S_0) and 1 kg Zn ha^{-1} (Zn_1) was at par with each other. The descending order for Zn levels was: $Zn_2 > Zn_1 > Zn_0$. Application of zinc showed significant effect on number of branches per plant. Application of 2 kg Zn ha^{-1} (Zn_2) gave significantly higher number of branches per plant (11.7) than control (Zn_0) but it was at par with that of 1 kg Zn ha^{-1} (Zn_2).

Application of zinc had significant effect on number of pods per plant. The number of branches per plant was increased with increasing levels of zinc. Significantly the highest number of branches per plant (20.1) was noticed under 2 kg Zn ha^{-1} (Zn_2) as compared to control (Zn_0) and 1 kg Zn ha^{-1} (Zn_1). The number of seeds per plant was significantly influenced due to application of zinc, which was increased with increasing level of zinc. Significantly the highest number of branches per plant (11.2) was observed under 2 kg Zn ha^{-1} (Zn_2) as compared to control (Zn_0) and 1 kg Zn ha^{-1} (Zn_1).

The different levels of Zn showed significant effect on plant height, number of branches per plant, number of pods per plant and seeds per pod. Application of 2 kg Zn ha^{-1} (Zn_2) gave significantly higher result. This might be due to the fact that zinc application improved over all nutritional environments. Similar results were reported by Tayyeba *et al*. (2013) [16].

Number of root nodules per plant was significantly affected due to zinc application, which was increased with increasing level of zinc (Table 2). Significantly the highest (30.1) number of root nodules per plant was observed with 2 kg Zn ha^{-1} (Zn_2) over control (Zn_0) and 1 kg Zn ha^{-1} (Zn_1). However, the difference in number of root nodules per plant due to control (Zn_0) and 1 kg Zn ha^{-1} (Zn_1) was found non-significant. The dry weight of root nodules per plant did not reach to the level of significance due to different rates of zinc application. Number of root nodules and dry weight of nodules were significantly affected due to zinc levels. The maximum root nodules and dry weight of nodules was observed with zinc level Zn_2 (2 kg Zn ha^{-1}) over control (Zn_0) and 1 kg Zn ha^{-1} (Zn_1). The increase in number of root nodules plant^{-1} and dry weight of nodules of greengram could be attributed to ascribe its pivotal role of zinc in regulating the metabolic and enzymatic processes including photosynthesis and respiration. Balance nutrition provides good *Rhizosphere* around roots so increase in number of nodules plant^{-1}. Similar work has been also reported by Meena *et al.* (2001) [7] in clusterbean and Quah *et al*. (1996) [10] reported same result in greengram.

Test weight of greengram seed was found non- significant due to zinc levels. However, numerically the maximum (35.6 g) and minimum (34.6 g) test weight was observed with 2 kg Zn ha^{-1} and control, respectively.

Interaction effect

The S x Zn interaction was found non-significant in case of Plant height, number of branches per plant, Number of pods plant^{-1}, Number of seeds pods^{-1}, Number of root nodules plant^{-1}, Dry weight of root nodules (mg plant^{-1}) and test weight of greengram at harvest.

Table 2: Effect of treatments on yield attributes, yield and quality of green gram

Treatments	Number of root nodules plant^{-1}	Dry weight of root nodules (mg plant^{-1})	Test weight (g)	Protein content (%)	Yield (kg ha^{-1})	
					Seed	Stover
Levels of sulphur (kg ha^{-1})						
S_0: 00 kg	26.1	35.1	34.0	18.78	822	1706
S_1: 10 kg	27.5	36.2	34.9	20.11	894	1759
S_2: 20 kg	29.9	37.5	35.5	22.30	970	1801
S_3: 30 kg	30.8	38.6	35.9	22.66	1039	1967
S. Em. +	0.67	0.77	0.37	0.29	25	30
CD (P = 0.05)	2.0	2.3	1.1	0.84	73	88
Levels of zinc (kg ha^{-1})						
Zn_0: 0 kg	27.5	35.5	34.6	19.47	868	1702
Zn_1: 1 kg	28.3	37.0	35.1	21.15	918	1840
Zn_2: 2 kg	30.1	38.0	35.6	22.28	1008	1883
S. Em. +	0.58	0.67	0.32	0.25	22	26
CD (P = 0.05)	1.7	NS	NS	0.73	64	76
S × Zn Interaction	NS	NS	NS	Sig.	Sig.	Sig.
CV %	7.00	6.28	3.20	4.10	8.1	5.0

Protein content

Effect of sulphur

An appraisal of data given in Table 3 showed significant differences in protein content of seed due to S levels. Application of 30 kg S ha^{-1} (S_3) recorded significantly higher protein content in seed as compared to control (S_0) and 10 kg S ha^{-1} (S_1), but statistically at par with that of 20 kg S ha^{-1} (S_2). Significantly the lowest (18.78 %) protein content was noticed under control. (S_0). An application of different levels of S showed significantly higher protein content in seed of greengram. The treatment 30 kg S ha-1 (S3) recorded significantly higher protein content in seed. The increase in protein content may be due to the increase in sulphur containing amino acids like methionine, cystein and cystine as they are building blocks of proteins. These results corroborated with the findings of Surendra ram and Katiyar, T.P.S (2013) and similar results were also found by Srivastva *et al*. (2006) in summer greengram.

Effect of Zinc

Among different levels of zinc, application of 2 kg Zn ha^{-1} (Zn_2) recorded significantly the highest (22.28 %) protein content in seed as compared to control (S_0) and 1 kg Zn ha^{-1} (Zn_1). The increased in protein content due to 2 kg Zn ha^{-1} (Zn_2) was to the tune of 14.4 and 5.3 per cent over control (S_0) and 1 kg Zn ha^{-1} (Zn_1), respectively. Among the levels of treatment 2 kg Zn ha-1 (Zn2) recorded significantly higher protein content in seed as compared to control (S0) and 1 kg Zn ha-1 (Zn1). The increase in protein content may be due to the increase in sulphur and all nutritional absorption of nutrition from the soil. The similar results were found by Tayyeba *et al*. (2013) [16] in greengram. And Surendra ram and Katiyar, T. P. S (2013) reported same result in greengram.

Interaction effect

The S x Zn interaction showed significant effect on protein content of greengram seeds, wherein increasing levels of both the factors generally recorded higher proteint content indicating the sinergestic effect of one on another. The combined application of 20 kg S and 1 kg Zn ha^{-1} (S_2Zn_2) recorded higher (23.75 %) protein content, which was statistically at par with that of S_1Zn_2, S_2Zn_1, S_3Zn_1 and S_3Zn_2. The protein content recorded under S_1Zn_0 and S_0Zn_0 was lower and at par with each other. The interaction effect of sulphur and zinc was found significant on protein content of seed of greengram at harvest. It might be due to sulphur play an important role in synthesis of sulphur base amino acids and zinc play good role in metabolism of protein synthesis.

Yield

Effect of sulphur

Seed yield of greengram was significantly increased with increasing levels of sulphur, wherein, seed yield recorded due to application of sulphur @ 30 kg S ha^{-1} (S_3) was significantly higher as compared to control (S_0) and 10 kg S ha^{-1} (S_1), but statistically at par with that of 20 kg S ha^{-1} (S_2). The difference in seed yield due to control and 10 kg S ha^{-1} was at par with each other. The seed yield recorded with 30 kg S ha^{-1} (S_3) was 26.4, 16.2 and 7.1 per cent higher over control, 10 and 20 kg S ha^{-1}, respectively. Similarly, the seed yield recorded with 20 kg S ha^{-1} (S_2) was 18.0 and 8.5 per cent higher over control and 10 kg S ha^{-1}, respectively.

Stover yield of greengram was significantly increased with increasing levels of sulphur, wherein, stover yield recorded due to application of sulphur @ 30 kg S ha^{-1} (S_3) was significantly higher as compared to control (S_0) and 10 kg S ha^{-1} (S_1), but statistically at par with that of 20 kg S ha^{-1} (S_2). Similarly, the difference in stover yield noticed due to control and 10 kg S ha^{-1} as well as application of sulphur @ 10 and 20 kg ha^{-1} was at par with each other. The straw yield recorded with 30 kg S ha^{-1} (S_3) was 15.3, 11.8 and 9.2 per cent higher over control, 10 and 20 kg S ha^{-1}, respectively. Similarly, the straw yield recorded with 20 kg S ha^{-1} (S_2) was 5.6 and 2.3 per cent higher over control and 10 kg S ha^{-1}, respectively.

Seed yield and stover yield of greengram were significantly increased with increasing levels of sulphur from 0 to 30 kg S ha^{-1}, wherein, sulphur level S_3 (30 kg S ha^{-1}) produced significantly the highest seed yield as well as stover yield. Sulphur is an essential element which increases root growth, promote nodules formation and stimulates seed formation ultimately resulting into better growth and development of the crop plants, which might have increase the values of growth and yield attributes *viz*., pods plant^{-1}, seeds pod^{-1} and test weight. These are the important growth and yield parameters of which had combined effects on seed yield and stover yield. The results are in close agreement with the findings of Kaprekar *et al.* (2003) and Singh *et al.* (2004) [12].

Effect of zinc

The seed yield of greengram was significantly increased with increasing levels of zinc, wherein, significantly the highest (1008 kg ha^{-1}) seed yield was noted with the application of 2 kg Zn ha^{-1} (Zn_2). The difference in seed yield due to control and 1 kg Zn ha^{-1} (Zn_1) was non-significant. Per cent increased in seed yield with 2 kg Zn ha^{-1} was to the tune of 16.1and 9.8 per cent over control and 1 kg Zn ha^{-1}, respectively. Similarly, the seed yield recorded with 1 kg Zn ha^{-1} (Zn_1) was 5.8 per cent higher over control.

The stover yield of greengram was significantly increased with increasing levels of zinc. Being non-significant difference between application of 1 and 2 kg Zn ha^{-1} were significantly higher as compared to control. The per cent increased in stover yield due to 2 kg Zn ha^{-1} (Zn_2) over control (Zn_0) and 1 kg Zn^{-1} (Zn_1) was to the tune of 10.6 and 2.3 per cent, respectively. Similarly, the straw yield recorded with 1 kg Zn ha^{-1} (Zn_1) was 8.1 per cent higher over control.

Seed yield and stover yield of greengram were significantly increased with increasing levels of zinc from 0 to 2 kg Zn ha^{-1}, wherein, zinc level Zn_2 (2 kg Zn ha^{-1}) produced significantly higher seed yield and stover yield. Zinc is an essential element which increases root growth, promote nodules formation and stimulates seed formation ultimately resulting into better growth and development of the crop plants, which might have increase the values of growth and yield attributes *viz*., pods plant^{-1}, seeds pod^{-1} and test weight. These are the important growth and yield parameters of which had combined effects on seed yield. It play a vital role in metabolic activities in plant body. Surendra ram and Katiyar, T.P.S (2013) reported same result in greengram. Babhulkar *et al.* (2000) also reported same result in safflower.

Interaction effect

The interaction effect of sulphur and zinc was found significant on seed yield of greengram. The results revealed that at a given level of sulphur, increasing level of zinc increased the seed yield. Similarly, at a given level of zinc, increasing level of sulphur increased the seed yield. Treatment combination of 30 kg S and 20 kg Zn ha^{-1} (S_3Zn_2) recorded significantly the highest (1233 kg ha^{-1}) seed yield, whereas control of both the factors (S_0Zn_0) recorded the minimum (773 kg ha^{-1}) seed yield which was at par with that of S_0Zn_1, S_0Zn_2 and S_1Zn_0 treatment combinations.

Table 3: Interaction effect of treatments on protein content and yield of Greengram

Level of zinc	Level of sulphur			
	S_0	S_1	S_2	S_3
Protein content (%)				
Zn_0	18.07	17.38	20.75	21.67
Zn_1	18.90	20.58	22.39	22.71
Zn_2	19.37	22.37	23.75	23.62
S. Em. ±	0.50			
CD (P = 0.05)	1.46			
C.V. %	4.10			
Seed yield (kg ha^{-1})				
Zn_0	773	823	960	913
Zn_1	850	918	932	969
Zn_2	843	940	1016	1233
S. Em. ±	43			
CD (P = 0.05)	127			
C.V. %	8.1			
Stover yield (kg ha^{-1})				
Zn_0	1553	1643	1767	1844
Zn_1	1767	1767	1893	1933
Zn_2	1800	1867	1743	2123
S. Em. ±	52			
CD (P = 0.05)	153			
C.V. %	5.0			

The interaction effect of sulphur and zinc was found significant on stover yield of greengram. The results revealed that at a given level of sulphur, increasing level of zinc increased the stover yield. Similarly, at a given level of zinc, increasing level of sulphur increased the stover yield. Treatment combination of 30 kg S and 20 kg Zn ha^{-1} (S_3Zn_2) recorded significantly the highest (212 kg ha^{-1}) stover yield, whereas control of both the factors (S_0Zn_0) recorded the minimum (1553 kg ha^{-1}) stover yield which was at par with that of S_1Zn_0 treatment combination.

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