

Original Research Article

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Study on Interaction Effect of Sulphur and Zinc on Different Parameters of Greengram under Rainfed Condition

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ABSTRACT

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The experiment was conducted, during the kharif season of 2014-15 on Green gram Variety PDM-139 at the Rajola Farm of the Faculty of Agricultural Sciences, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot – Satna (Madhya Pradesh) located from 24° 31' N latitude and 81° 15' E latitude. Chitrakoot is situated at an altitude of 306 m above mean sea level at The climate of the region is semi-arid and sub-tropical having extreme winter and summer. The experiment was Randomized Block Design with three replication. application of 30kg S with 60kg P/ha proved the most optimum and the beneficial fertility management for the PDM-139 Variety Green gram for the Bundelkhand/Chitrakoot region of Madhya Pradesh. This fertility management (S₃₀Zn₁₀) resulted in maximum seed productivity up to 12.63q/ha and straw yield up to 12.63q/ha.

Introduction

Greengram is also known as mung, moong, mungo, goldengram, chick a saw pea and oregon pea. Development of short duration as well as photo and thermo insensitive varieties provided excellent opportunity for greengram cultivation both in *kharif* as well as in *summer* season, where adequate irrigation facilities are available (Patel *et al.* 2013). Mungbean, being a rich source of protein, needs to be judiciously fertilized with S, as this element plays a key role in protein synthesis. Sulphur is a constituent of essential amino acids –

methionine, cysteine and cystine– the building blocks of protein. Sulphur fertilization is considered critical for seed yield and protein synthesis and for improvement in quality of produce in legumes through their enzymatic and metabolic effects (Bhattacharjee *et al.*, 2013). Cobalt, being a constituent of cobalamine enzyme, plays a key role in governing the number and size of the nodules. Moreover, Co application also increases formation of leghemoglobin required for nitrogen fixation, thereby improves the nodules activity (Awomi *et al.* 2012).

Sulphur is considered to be some times forgotten secondary nutrient in crop production. However it is very essential for the synthesis of amino acids and activity of proteolytic enzymes. Sulphur fertilization improves both yield and quality of crops if adequate supply in the field is ensured.

Zn is involved in auxin metabolism like, tryptophane synthesis, tryptamine metabolism, protein synthesis, formation of nucleic acid and helps in utilization of nitrogen as well as phosphorus by plants. Zn also stimulates resistance for dry and hot weather, bacterial and fungal diseases and ribosomal fraction in the plants. It also promotes nodulation and nitrogen fixation in leguminous crops (Demeterio *et al.*, 1972). In view of the above the attempts have been made through the present investigation to study the effect of sulphur and zinc on growth, yield and quality of mungbean (*Vigna radiata* L.) (Ram *et al.*, 2013). Zinc is one of the important heavy metals, which is needed as a micronutrient for plants for various metabolic processes. However at excessive levels, zinc has the potential to become toxic to plants. Zinc has been used increasingly in different forms like nutrients, fungicide, pesticide or disinfectant.

In legumes, sulphur being the constituent of some amino acids, promotes the biosynthesis of protein. Likewise, zinc also plays a vital role in the synthesis of protein and nucleic acids and helps in the utilization of nitrogen and phosphorus by plant. These nutrients play a vital role in bio-synthesis of protein and amino acids. Application of S and Zn, therefore, has shown significant effects on yield, uptake of nutrients and quality of the crop (Tripathi *et al.*, 1997). The interaction of these nutrient elements may affect the critical levels of available Zn and S below which response to their application could be observed (Upadhyay, 2013).

Materials and Methods

The experiment was conducted, during the kharif season of 2014-15 on Green gram Variety PDM-139 at the Rajola Farm of the Faculty of Agricultural Sciences, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot – Satna (Madhya Pradesh) located from 24° 31' N latitude and 81° 15' E latitude. Chitrakoot is situated at an altitude of 306 m above mean sea level at The climate of the region is semi-arid and sub-tropical having extreme winter and summer. During the winter months, the temperature drops down to as low as 2°C while in the summer the temperature reaches above 47°C. hot desiccating winds (Loo) are regular feature during summers whereas there may be occasional spell of frost during the winters.. The experiment was laid out in a Randomized Block design with three replication. There were twelve treatment including a control. Treatment combination used of Sulphur and Zinc @ 10 kg/ha, 20kg/ha and Sulphur 30kg/ha. Growth parameters were taken Plant height, Number of branches, Number of leaves per plant, number of capsules per plant number of seeds per capsules and Yield.

Results and Discussion

Growth Parameters

The plant height increased steadily with the increase of plant growth up to 60 days of observation. The plant height at 20 days stage ranged from 8.64 to 12.25 cm in different treatments, where at 60 days stage, it increased from 44.52 to 50.92cm. The applied sulphur and Zinc levels exerted significant influence upon this parameter at each stage of observation except at 60 days in case of S levels. The treatment interactions were found to be significant at every stage. At 20 and 60 days stages, applied Zinc up to 10kg/ha raised

the plant height significantly over zero level. Thus the maximum height was up to 9.04 and 50.61 cm, respectively rather increase in Zn level up to 15 kg/ha decreased the plant height significantly. Thus, 0 kg Zn/ha were found statistically at par in their influence.

The increasing levels of sulphur only up to 30 kg/ha increased the plant height significantly at every stage of observation. Thus the maximum height at 20, 40 and 60 days was 12.25, 31.20 and 50.92 cm, respectively. Further increase in S level up to 30 kg/ha tended to increase the plant height almost significantly.

The results in Table 1 reveal that the best treatment interaction was 30 kg. S plus 10 kg Zn/ha which recorded the maximum height i.e. 13.66 cm at 20 days, 34.30 cm at 40 days and 52.66 cm at 60 days stage. This treatment interaction was found significantly superior to most of the remaining having S level only up to 30kg/ha with all the Zn level. However, the second best interaction was 30kg S plus 15kg Zn/ ha. In contrast to this, the significant lowest plant height was recorded in case of without S and Zn application (absolute control).

The number of secondary and tertiary branches/plant was recorded in each treatment and the mean values are presented in Table 2. The different sulphur and Zinc levels brought about significant changes in the number of branches per plant. The sulphur and Zinc interaction was also found significant in both the types of branches.

Application of Zinc only up to 10kg/ha resulted in significant increase in the secondary branches (5.14/plant) as well as tertiary branches (6.25/plant) over no Zinc. The corresponding values at zero level were 3.54 secondary and 6.25 tertiary branches/plant.

The treatment interaction as were found to be significant (Table 2) accordingly, 30 kg S plus 10 Zn kg/ha brought about significantly higher secondary and tertiary branches/ plant over most of the remaining interactions. However, the second best interaction was 30kg S plus 10 kg Zn/ha which recorded 6.53 secondary and 7.80 tertiary branches/plant. Both the interactions ($S_{30}Zn_{10}$) were found to differ significantly only in case of secondary branches. The significantly lowest branches (2.80 secondary and 3.73 tertiary) were noted in case of absolute control ($S_0 Z_n0$).

The number of trifoliolate leaf green gram at 20, 40, and 60 days growth intervals. The mean values are presented in Table 3. The different sulphur and Zinc levels brought about significant changes in the number of trifoliolate leaf/ plant. The sulphur and Zinc interaction was also found significant in both the types of trifoliolate leaf. Application of sulphur only up to 30 kg/ha resulted in significant increase in the trifoliolate leaf (33.41/plant) as well as no sulphur (29.13) at the 60 days. The increasing Zinc levels only up to 10kg/ha increased these parameters significantly (29.14 to 33.05/plant) at the 60days. Farther increased in Zn levels up to 15 kg/ha resulted increased in this parameter significantly. This was noted at every stage of observation. The best treatment interaction was 30kg S plus 10 Zn kg/ha which recorded the maximum trifoliolate leaf i.e. 13.76 at 20 days, 23.73 at 40 days and 36.76 at 60 days stage. This treatment interaction was found significantly superior to the remaining having S level only up to 30kg/ha with all the Zn level. In contrast to this, the significant trifoliolate leaf was recorded in case of without S and Zn application (absolute control).

The increasing levels of sulphur up to 30kg/ha increased the root length significantly at each stage of observation. Accordingly the maximum root length at 20, 40 and 60 days

stage was 5.62, 7.34 and 10.25 cm respectively. Further increase in S levels up to 30kg/ha resulted increase in this parameter significantly. This was noted at every stage of observation. The applied Zn levels brought about significant influence up on this parameter only at 20 days stage, where as S-levels exerted significant impact at every stage of observation. The treatment interactions were found to be significant at every stage. At 40 days stage, applied Zinc up to 10 kg/ha encouraged the root length significantly (7.00cm) there was significant difference between 15 kg Zn/ha. At 20 and 60 days stage the root length were found statistically identical.

The best treatment combination was 30kg S plus 10kg Zn/ha which recorded the maximum root length i.e. 6.33, 8.50 and 11.63cm at 20, 40 and 60 days stage, respectively (Table 4). This was followed by 30 kg S plus 10 kg Zn/ha interaction. Both these interactions were found be significantly superior to most of the remaining interactions. On the other hand the significant lowest root length was noted in case of absolute control (S_0Zn_0).

Yield-attributing parameters

The number of pod/plant were counted from the randomly sample plants in each plot and the mean data. Sulphur and Zinc levels as well as their interactions were found to exact significant impact upon the formation of pod/plant. Accordingly, the numbers of pod/plant were enhanced significantly up to 21.90 pod due to 30 kg S/ha over no sulphur (19.02 pod). Further increase in S level up to 30 kg/ha bring about any significant change (21.90pod/plant).

As regards with the Zinc levels, the pod were increased significantly with each increased in the Zn levels only up to 10 kg/ha 22.16

pod/plant. Thus the maximum 22.16 pod/plant were counted in case of 10kg Zn/ha as against 18.15 pod /plant in case of no Zinc. The interactions exerted significant changes in this yield-attributing parameter. The best treatment interaction was 30 kg S plus 10kg Zn/ha which recorded significantly higher number of pod (23.80 pod/plant) over all the remaining S x Zn interactions except $S_{30}Zn_{10}$ and $S_{20}Zn_{10}$ (23.80 to 22.60 pod/plant). In contrast to this, the significantly lowest pod (16.80pod/plant) was counted in case of absolute control (S_0Zn_0).

The different treatments as well as treatment interactions were found it deviate this parameter significantly. Accordingly, 30 kg S/ha produced maximum 11.26 seeds/pod and seeds/pod proved significantly superior to no sulphur (8.23 seed/pod).The increasing levels of Zinc only up to 10kg/ha enhanced the seed number significantly (11.02 seeds/pod). However further increase in Zn level this parameter. Higher dose of Zinc proved advantageous (9.95 seeds/pod). The significantly lowest seeds (8.05/pod) were obtained in case of no Zinc. The treatment interactions were found to be significant in accordingly this parameter. Thus the best interaction was 30kg S plus 10kg Zn/ha which recorded significantly higher seed count (12.70 plant/pod).In contrast to this the significantly lowest seed count only 6.60 seeds/pod were noted in case of absolute control (S_0Zn_0).

The test weight of 1000 grains was recorded treatment wise and the The mean values are presented in Table 5. The different levels of Zinc as well as S x Zn interactions were found to exact significant influence upon the test weight. The sulphur levels were found to have identical influence upon this parameter. The test weight ranged from 17.08 g in case of 30 kg S/ha to 11.81g in case of no sulphur. The increasing levels of Zinc up to 10kg/ha

increased the test weight significantly (16.98g). Thus the maximum test weight 16.98 g was recorded in case of no Zinc applications (11.56 g). Amongst the treatment interactions which were significant, S₃₀Zn₁₀ resulted in maximum test weight up to 19.46 g, being significantly superior to S₃₀Zn₁₀ interactions (19.46 g) were found statistically identical in their influence. The lowest test weight (9.43 g) was recorded in case control (S₀Zn₀).

Productivity parameters

The different levels of sulphur and Zinc brought about significant influence upon the grain yield of green gram however the treatment interactions were found to be significant. Applications of sulphur up to 30kg/ha the grain yield significantly up to 10.96q/ha the father increase in S level up to 30kg/ha, as compared to no sulphur (8.23 q/ha) (Table 6 and 7).

Table.1 Plant height (cm) different growth intervals as influenced by sulphur and zinc levels as well as their interactions

Level of S (kg/ha)	Levels of Zn (kg/ha)			Mean
	0	10	15	
20DAS				
0	7.90	9.36	8.66	8.64
10	8.60	10.76	9.53	9.63
20	9.03	10.66	9.53	9.74
30	10.63	13.66	12.46	12.25
Mean	9.04	11.11	10.05	
40DAS				
0	22.03	27.76	24.93	24.91
10	24.03	28.86	26.30	26.40
20	27.10	32.03	29.83	29.65
30	28.76	34.30	30.53	31.20
Mean	25.48	30.74	27.90	
60DAS				
0	37.43	48.50	47.63	44.52
10	45.46	49.53	48.40	47.80
20	47.50	51.76	49.33	49.53
30	48.60	52.66	51.50	50.92
Mean	44.75	50.61	49.21	
		S	Zn	SxZn
20DAS	SE(M)±	0.07	0.06	0.12
	CD(p=0.05)	0.21	0.18	0.37
40DAS	SE(M)±	0.13	0.12	0.24
	CD(p=0.05)	0.40	0.35	0.70
60DAS	SE(M)±	0.10	0.09	0.18
	CD(p=0.05)	0.31	0.27	0.54

Table.2 Number of secondary and tertiary branches/plant of Green gram as influenced by sulphur and zinc levels as well as their interactions

Level of S(kg/ha)	Levels of Zn (kg/ha)			Mean
	0	10	15	
	Secondary Branches			
0	2.80	3.73	3.26	3.26
10	3.23	4.60	3.63	3.82
20	3.96	5.70	4.50	4.72
30	4.16	6.53	5.40	5.36
Mean	3.54	5.14	4.20	
	Tertiary Branches			
0	3.73	4.80	4.03	4.18
10	3.93	5.80	4.80	4.84
20	4.20	6.60	5.70	5.50
30	5.23	7.80	6.20	6.41
Mean	4.27	6.25	5.18	
		S	Zn	SxZn
Secondary Branches	SE(M)±	0.05	0.05	0.10
	CD(p=0.05)	0.17	0.14	0.29
Tertiary Branches	SE(M)±	0.07	0.06	0.12
	CD(p=0.05)	0.21	0.18	0.37

Table.3 Trifoliolate leaf /plant of green gram as influenced by sulphur and Zinc levels as well as their interactions

Level of S (kg/ha)	Levels of Zn (kg/ha)			Mean
	0	10	15	
	20DAS			
0	7.76	10.70	9.60	9.35
10	8.73	11.66	10.70	10.36
20	9.40	12.76	11.56	11.24
30	10.70	13.76	12.50	12.32
Mean	9.15	12.22	11.09	
	40DAS			
0	17.66	20.70	19.40	19.25
10	18.60	21.56	20.36	20.17
20	19.53	22.66	21.13	21.11
30	20.43	23.73	22.50	22.22
Mean	19.05	22.16	20.85	
	60DAS			
0	27.93	30.06	29.40	29.13
10	28.46	32.46	31.16	30.70
20	29.56	33.93	31.40	31.63

30	30.60	35.76	33.86	33.41
Mean	29.14	33.05	31.45	
		S	Zn	SxZn
20DAS	SE(M)±	0.05	0.05	0.10
	CD(p=0.05)	0.17	0.15	NS
40DAS	SE(M)±	0.09	0.08	0.16
	CD(p=0.05)	0.28	0.24	NS
60DAS	SE(M)±	0.14	0.12	0.25
	CD(p=0.05)	0.43	0.37	0.74

Table.4 Root length of green gram at different growth intervals as influenced by sulphur and Zinc levels as well as their interactions

Level S(kg/ha)	Levels of Zn (kg/ha)			Mean
	0	10	15	
	20DAS			
0	3.33	4.70	4.50	4.17
10	4.26	5.33	4.83	4.81
20	4.63	5.86	5.23	5.24
30	4.93	6.33	5.60	5.62
Mean	4.29	5.55	5.04	
	40DAS			
0	4.56	6.33	5.33	5.41
10	5.23	6.46	5.86	5.85
20	5.46	6.73	6.43	6.21
30	6.20	8.50	7.33	7.34
Mean	5.36	7.00	6.24	
	60DAS			
0	6.46	8.36	7.53	7.45
10	7.06	9.46	8.40	8.31
20	8.16	10.66	9.56	9.46
30	8.90	11.63	10.23	10.25
Mean	7.65	10.03	8.93	
		S	Zn	S xZn
20DAS	SE(M)±	0.08	0.07	0.15
	CD(p=0.05)	0.26	0.22	NS
40DAS	SE(M)±	0.10	0.09	0.18
	CD(p=0.05)	0.31	0.27	NS
60DAS	SE(M)±	0.08	0.07	0.15
	CD(p=0.05)	0.26	0.22	NS

Table.5 Test weight of 1000-grains (g) of green gram as influenced by sulphur and Zinc levels

Level of S(kg/ha)	Levels of Zn (kg/ha)			Mean
	0	10	15	
0	9.43	13.56	12.43	11.81
10	10.46	16.26	14.56	13.76
20	11.73	18.63	17.63	16.00
30	14.63	19.46	17.16	17.08
Mean	11.56	16.98	15.45	
	S	Zn	SxZn	
SE(M)±	0.08	0.07	0.14	
CD(p=0.05)	0.24	0.21	0.42	

Table.6 Grain yield (q/ha) from of green gram as influenced by sulphur and Zinc levels

Level of S(kg/ha)	Levels of Zn (kg/ha)			Mean
	0	10	15	
0	6.90	9.43	8.36	8.23
10	7.33	9.83	9.06	8.74
20	8.26	10.66	9.43	9.45
30	9.16	12.63	11.10	10.96
Mean	7.91	10.64	9.49	
	S	Zn	SxZn	
SE(M)±	0.07	0.06	0.12	
CD(p=0.05)	0.21	0.18	0.37	

Table.7 Straw yield (q/ha) from of green gram as influenced by sulphur and Zinc levels

Level of S(kg/ha)	Levels of Zn (kg/ha)			Mean
	0	10	15	
0	7.80	10.56	9.40	9.25
10	8.56	11.53	10.43	10.17
20	9.43	12.63	11.10	11.05
30	10.43	12.63	11.50	11.52
Mean	9.05	11.84	10.60	
	S	Zn	SxZn	
SE(M)±	0.07	0.06	0.12	
CD(p=0.05)	0.22	0.19	0.38	

The increasing Zinc level only up to 10kg/ha the grain yield significantly up to 10.64 q/ha, as compared to no Zinc (7.91 q/ha).Although the treatment interactions were found to be significant, the best treatment combination appeared to be S₃₀Zn₁₀ producing 12.63q/ha

grain. This was followed by S₃₀Zn₁₀ interactions producing equal grain (12.63q/ha) on the other hand the lowest yield only 6.90q/ha were recorded in case of absolute control (S₀Zn₀).

The sulphur level only up to 30kg/ha enhanced the straw yield significantly (11.52 q/ha) as against no sulphur application (9.25 q/ha). As regards with the Zinc levels, the significantly increasing trend in straw yield was observed up to 10kg Zn/ha. Thus the maximum straw yield was 11.84q/ha as against no Zinc application (9.05q/ha).

The treatment interactions proved much more beneficial in augmenting this productivity parameter. The highest straw yield up to 12.63q/ha was obtained from S₃₀Zn₁₀ interaction, which was significantly superior to all the remaining interactions except S₂₀Zn₁₀ (12.63q/ha). Thus, S₂₀Zn₁₀ proved the second best interaction. On the other hand, the significantly lowest yields (7.80 q/ha) were recorded in case of control (S₀Zn₀).

In conclusion the findings elude that application of 30kg S with 60kg P/ha proved the most optimum and the beneficial fertility management for the PDM-139 Variety Green gram for the Bundelkhand/ Chitrakoot region of Madhya Pradesh. This fertility management (S₃₀Zn₁₀). Resulted in maximum seed productivity up to 12.63q/ha and straw yield up to 12.63q/ha.

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