

Studies on sulphur, zinc and biofertilizers on yield, yield attributes and nutrient content at different growth stages in mungbean

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ABSTRACT

The experiments were conducted to study the effect of sulphur, zinc and biofertilizers application on yield, yield attributes and nutrient content in mungbean. The results showed that mungbean responded significantly to the application of sulphur, zinc and biofertilizers. Application of nitrogen @ 15 kg/ha together with *Rhizobium* and *Azotobacter* inoculation, 40 kg S/ha, and 15 kg ZnO/ha resulted in grain yield of 936.74, 939.78 and 909.38 kg/ha, respectively. All the three factors individually showed significant effect on yield attributes and nutrient content. It was observed that application of S @ 40 kg/ha resulted in higher contents of N, P, K, and S and lower Zn content in mungbean whereas ZnO @ 15 kg/ha increased N, K, Zn contents and decreased the P and S contents at different growth stages in mungbean. These treatments had significant influence on dry matter weight, height and branches/plant, number of pods/plant, pod length, number of seeds/pod and 1000-grain weight.

Key words : Biofertilizers, Mungbean, Nutrient content, Sulphur, Yield attributes, Zinc

Mungbean is one of the popular short duration grain legumes in India and occupies third place after the chickpea and pigeonpea. Majority of farmers hardly use any manures or fertilizers in mungbean cultivation. However, there is possibility of raising the productivity by judicious use of nutrients and biofertilizers. Biofertilizer inoculum has been proved as the cheapest source of N fertilizer input for better yield particularly in legumes. *Rhizobium* is responsible for symbiotic nitrogen fixation. *Azotobacter* is an obligate aerobic nitrogen fixer and is known to synthesize some beneficial active substances in soils. Sulphur influences plant growth by acting as a nutrient and affecting the availability of other nutrients by lowering the soil pH. Zinc is involved in the biosynthesis of plant hormones. Therefore, the present investigation was carried out to assess the influence of sulphur, zinc and biofertilizers application on yield, yield attributes and nutrients concentration at different growth stages in mungbean.

MATERIALS AND METHODS

Field experiments were conducted with mungbean cv. PDM 54 during *kharif* season of 1996 and 1997 on an Ustochrept (Inceptisol) at New Research Farm, Indian Institute of Pulses Research, Kanpur with three levels of nitrogen (N_1 : starter dose @ 15 kg N/ha, N_2 : starter dose + *Rhizobium* inoculation, N_3 : starter dose + *Rhizobium* and *Azotobacter*

inoculation), two levels each of sulphur (0. 40 kg S/ha) and zinc (0. 15 kg ZnO/ha). The treatments were replicated thrice in a factorial randomized block design. The soil characteristics of experimental site were: sand 61.46%, silt 21.40%, clay 16.84%, pH (1:2.5) 7.6, EC 0.33 dS/m, organic carbon 5.1 g/kg, and available N, P, K and S 157.0, 7.8, 145 and 16.4 kg/ ha, respectively. Its Zn status was 0.33 mg/kg. A basal dose of fertilizers @ 15, 40, 20 kg/ha of N, P and K were applied uniformly through urea, triple superphosphate, muriate of potash, respectively. Sulphur and zinc were applied as per treatments through elemental sulphur and zinc oxide. The required quantity of seeds was inoculated before sowing with carrier based multistrain inoculum of *Rhizobium*. Carrier based multistrain inoculum of *Azotobacter chroococcum* mixed with suitable quantities of field soil was used as soil inoculation and uniformly broadcasted in furrows at the sowing time as per treatment. Normal agronomic practices and plant protection measures were adopted as and when needed. Plant samples were taken at 30 and 45 days after sowing. The grain and stover yields were recorded at maturity and their samples were first dried, ground in Willey Mill having all stainless steel part and stored in polythene bags for analysis. Nitrogen was determined by micro-Kjeldahl's method (Piper 1966). Grain, stover and plant samples after digestion in diacid mixture were analyzed for total S by turbidimetric method of Chesnin and Yien (1951), for total P by Vanadomolybdate phosphoric yellow colour method (Jackson 1967) and zinc by Atomic Absorption Spectrophotometer (Pye Unicam SP 2900). Total K was determined by flame photometric procedure as described by Chapman and Pratt (1961). Biometric observations were recorded at different growth stages.

RESULTS AND DISCUSSION

Yield attributes and yield: There was significant increase in yield and yield attributes due to application of biofertilizers, S and Zn (Table 1). Average values of dry matter (%), dry matter weight/plant, height/plant, branches/plant, pods/plant, pod length, seeds/pod and 1000-grain weight increased considerably with *Rhizobium* inoculation over the starter dose of N @ 15 kg/ha. Although the values further increased due to *Azotobacter* inoculation but the effect was not substantial one. Sulphur when applied @ 40 kg/ha caused significant increase in these yield attributes. The values though tended to increase significantly with Zn application, but the effect in few attributes was not pronounced at different

Table 1. Effect of sulphur, zinc and biofertilizers on yield attributes of mungbean (Two year pooled data)

Factors & levels	Dry matter (%)			Plant height (cm)			Dry matter weight/plant at maturity (g)	Number of branches/plant	Number of pods/plant	Length/pod (cm)	Number of seeds/pod	1000-grain wt. (g)	Grain yield (kg/ha)
	30 days	45 days	Maturity	Pre-flowering	Flowering	Maturity							
N ₁	17.66	25.56	38.35	31.68	43.72	49.12	8.08	3.87	27.11	8.80	11.46	26.13	804.83
N ₂	18.82	27.31	41.03	36.05	46.61	52.76	10.17	4.23	33.21	10.21	12.15	28.14	922.13
N ₃	19.08	27.62	41.11	36.73	47.78	53.99	10.40	4.34	35.73	10.28	12.28	29.86	936.74
CD(P=0.05)	0.476	0.514	0.538	0.77	0.87	0.74	0.089	0.076	0.94	0.36	0.42	1.62	9.58
S ₀	18.10	26.35	39.47	33.82	45.13	50.88	9.06	3.96	28.16	9.14	11.56	26.80	836.01
S ₁	18.94	27.30	40.88	35.83	46.93	52.59	10.05	4.33	35.87	10.39	12.37	30.75	939.78
CD(P=0.05)	0.299	0.436	0.438	0.63	0.71	0.61	0.078	0.062	0.77	0.29	0.34	1.32	7.79
Zn ₀	18.21	26.65	39.74	34.64	45.47	51.40	9.39	4.06	30.66	9.53	11.73	27.35	866.40
Zn ₁	18.88	27.02	40.62	35.03	46.58	52.58	9.71	4.23	33.37	10.05	12.22	28.79	909.38
CD(P=0.05)	0.299	NS	0.438	NS	0.71	0.61	0.078	0.062	0.77	0.29	0.34	1.32	7.79

Note: N₁ = Starter dose @ 15 kg N/ha. N₂ = Starter dose + *Rhizobium* inoculation. N₃ = Starter dose N + *Rhizobium* + *Azotobacter* inoculation. S₀ = 0 kg S/ha. S₁ = 40 kg S/ha. Zn₀ = 0 kg ZnO/ha. Zn₁ = 15 kg ZnO/ha.

growth stages. These results supported the findings of Singh *et al.* (1993). The grain yield increased significantly due to application of each biofertilizer. S @ 40 kg/ha and Zn @ 15 kg ZnO/ha. The magnitude of the positive effect of S was a bit higher than that of Zn. Seed inoculation with *Rhizobium* showed significant increase in grain yield over the starter dose N @ 15 kg/ha. The yield further increased considerably when inoculation was done with both *Rhizobium* and *Azotobacter*. The results are in close conformity with the findings of Khurana and Dudeja (1997).

Nutrient content: The concentration of all the five nutrients (N, P, K, S and Zn) at different growth stages in mungbean plants were highest at 30 days (pre-flowering stage) which decreased with growth advancement (Table 2). The rate of decrease in concentration of N, P, S, and Zn in plants was slow up to 45 days as compared with later stages. The K concentration on the other hand, substantially decreased at 45 days stage and thereafter the rate of decrease was comparatively slower. Possible explanation of the behaviour may be that the plant roots are metabolically active at early

growth stages and start decreasing slowly as the growth advances and the absorption of nutrients also followed the same trend. Rapid increase in dry matter production not coupled with consequent absorption rate during later growth stages caused dilution effect, resulting in lowering of nutrient concentration with growth advancement. These results are similar to findings of Prasad and Ram (1986). The concentration of N, P, S and Zn in grains were higher than those in stover. It indicated that these nutrients were translocated from plant parts to the grains during later growth stages. These findings are in line with those reported by Dhillon and Dev (1978). The concentration of K in stover were higher than in grains, indicating less translocation of the nutrient to the grains as also observed by Singh and Kanungo (1987).

The concentration of N, P, K, S and Zn in plants at 30 days, 45 days, maturity stages and in grains after the harvest increased significantly over the starter dose of N @ 15 kg/ha when inoculated with *Rhizobium*. Similar observations were also recorded with *Azotobacter* inoculation but the magnitude of its effects was, by and large, lower than that of *Rhizobium*.

Table 2. Effect of sulphur, zinc and biofertilizers on nutrient contents in mungbean at different growth stages (Two year pooled data)

Factors & Levels	Nitrogen (%)				Phosphorus (%)				Potassium (%)				Sulphur (%)				Zinc (mg/kg)			
	30 days	45 days	Stover	Grain	30 days	45 days	Stover	Grain	30 days	45 days	Stover	Grain	30 days	45 days	Stover	Grain	30 days	45 days	Stover	Grain
N ₁	2.90	2.56	1.57	3.95	0.40	0.37	0.20	0.51	1.54	1.42	1.33	0.98	0.29	0.23	0.14	0.31	52.4	49.4	39.7	45.6
N ₂	3.10	2.85	1.71	4.23	0.48	0.40	0.24	0.59	1.68	1.56	1.44	1.07	0.33	0.26	0.16	0.34	56.8	51.8	41.8	47.0
N ₃	3.16	2.94	1.79	4.31	0.50	0.42	0.26	0.63	1.75	1.61	1.49	1.10	0.35	0.28	0.17	0.37	58.0	52.7	42.9	48.6
CD(P=0.05)	0.05	0.04	0.04	0.07	0.008	0.006	0.003	0.007	0.05	0.04	0.02	0.01	0.003	0.004	0.008	0.009	0.9	0.4	0.4	0.4
S ₀	2.96	2.71	1.64	4.03	0.43	0.38	0.23	0.55	1.58	1.47	1.36	1.01	0.25	0.20	0.11	0.26	58.2	52.9	43.5	47.9
S ₁	3.14	2.86	1.75	4.30	0.49	0.41	0.24	0.60	1.73	1.59	1.48	1.09	0.39	0.31	0.20	0.42	53.4	49.7	39.3	46.3
CD(P=0.05)	0.04	0.03	0.03	0.06	0.007	0.006	0.003	0.006	0.04	0.03	0.01	0.008	0.002	0.003	0.008	0.007	0.7	0.4	0.3	0.3
Zn ₀	3.01	2.73	1.66	4.13	0.48	0.40	0.24	0.56	1.60	1.50	1.37	1.03	0.34	0.27	0.16	0.35	51.3	48.2	38.4	44.2
Zn ₁	3.11	2.84	1.73	4.20	0.43	0.38	0.22	0.53	1.71	1.56	1.47	1.07	0.31	0.24	0.15	0.32	60.1	54.6	44.6	49.9
CD(P=0.05)	0.04	0.03	0.03	0.06	0.007	0.006	0.003	0.006	0.04	0.03	0.01	0.008	0.002	0.003	0.008	0.007	0.7	0.4	0.3	0.3

Note: N₁ = Starter dose @ 15 kg N/ha. N₂ = Starter dose N + *Rhizobium* inoculation. N₃ = Starter dose N + *Rhizobium* + *Azotobacter* inoculation. S₀ = 0 kg S/ha. S₁ = 40 kg S/ha. Zn₀ = 0 kg ZnO/ha. Zn₁ = 15 kg ZnO/ha.

Table 3. Correlation studies between yield and yield attributes in mungbean

Yield attributes	'r' values	Regression equation
Dry matter at maturity	+0.928	$y = 239.73 + 67.860 x$
Plant height at maturity	+ 0.924	$y = -810.728 + 32.669 x$
Number of branches/plant	+0.995	$y = -176-786 + 257.21 x$
Number of pods/plant	+0.950	$y = 417.46 + 14.695 x$
Pod length	+0.931	$y = 103.562 + 80.276 x$
Number of grains/pod	+0.927	$y = -665.425 + 129.845 x$
N content in grain	+0.974	$y = -721.94 + 386.52 x$
P content in grain	+0.773	$y = 324.16 + 982.164 x$
K content in grain	+0.944	$y = -408.41 + 1234.6 x$
S content in grain	+0.725	$y = 666.69 + 658.43 x$
Zn content in grain	+0.303	NS

Since *Rhizobium* and *Azotobacter* increased the amount of available N in soil through fixation of atmospheric nitrogen, they increased the concentration of these nutrients in the plants. Solubilizing effect of biofertilizers might be responsible for its stimulating effect on P, K, S and Zn absorption in the plants. These results are in close conformity with the findings of Shock *et al.* (1984). Application of S @ 40 kg/ha caused significant increase in N, P, K, and S concentrations in plants while decreased the Zn concentration at different growth stages of mungbean. Since S is required for conversion of reduced N into protein in symbiotic N fixing legumes, its positive effect on N absorption is quite likely. Similar findings were also recorded by Dwivedi *et al.* (1993). The concentration of Zn in plants at different growth stages increased significantly due to both the inoculants and Zn individually while decreased due to application of sulphur. Application of Zn @ 15 kg/ha ZnO increased the concentration of N, K and Zn in plants and decreased the P and S contents in all the growth stages due to antagonistic effect. The above findings are supported with the findings of Biswas and Prasad (1991).

The analysis of correlation (r) and regression equation (Table 3) revealed positive correlation of grain yield with dry

matter/plant and height/plant at maturity, number of branches/plant, number of pods/plant, pod length, grains/pod, and N, P, K, S and Zn contents in grains.

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