

The effect of various doses of Zinc on the growth and yield of soybean crop, *Glycine max*, L

Abstract

Investigate Zn application effects on soybean (*Glycine max* L.) yield and its components (number of pods per plant, number of seeds per pod and 1000 grain weight), a field experiment conducted at unit research farm, School of Agriculture, Eklavya University, Damoh, Madhya Pradesh in *Kharif* Session 2022-23. The experiment was arranged in split plot of a randomized complete block design and replicated three times. Parameters measured were grain yield, harvest index, first pod height, number of pods per plant, number of seeds per pod and 1000 grain weight. There was a significant and positive correlation between grain yield and its components. The plant height increased with the increasing levels of Zn at 30, 45, and 90 DAS over control. The higher Zn levels *i.e.* 2.5, 5.0, 7.5 and 10 kg Zn ha⁻¹ was statistically at par. Lowest height was observed at control and highest at 10 kg Zn ha⁻¹. The highest stover yield of 3.78 t ha⁻¹ was observed with 5.0 kg Zn ha⁻¹ and higher levels were found statistically at par.

Key words: Zn at 45 DAS, 5.0 kg Zn ha⁻¹, lowest height, levels of DAS, plant height.

Introduction

Soybean (*Glycine max* (L.) Merrill) belongs to family *Leguminosae* syn. *Fabaceae*, sub family *Papilionaceae*, is an important global crop and known as the "GOLDEN BEAN". The general soil type of the experimental field is Deep Red Brown Terrace soil and the soil. The soil was consuming a texture of silty clay with pH and organic matter 6.5 to 7.5 and 1 to 1.3%, respectively. The availability of Zn to plants has been observed to vary with different Zn fractions. The form in which Zn is present in soil plays a crucial role in determining its availability to plants. Distribution of zinc forms in soils depends on the chemical and physical properties in soil. The experimental area was flat having available irrigation and drainage system and above flood level. The selected plot was medium high land. In Madhya Pradesh the area under Soybean cultivation during *Kharif* 2014 is 55.462 lac hectare as compared to 62.605 lac hectare during *Kharif* 2013 showing a decrease of 11.40 percent (SOPA, 2014). The productivity of soybean in Madhya Pradesh is decreasing which might

be due to wide spread deficiency of Zn. Crop production is affected by multiple environmental stresses, including disease and pest infestations, low soil fertility, and inadequate water supply. If we feed the soil, it will feed us; therefore, only productive soil that provides all essential nutrients required by plants can support successful crop production [Thapa et al. 2021; Dimkpa et al. 2017; Adisa et al. 2019]. Khamparia et al. (2010) reported 71% Zn deficiency in soil of Madhya Pradesh. Zinc occurs in soil in a number of discrete chemical pools differing in their solubility viz., primary and secondary minerals; insoluble inorganic and organic precipitates; soluble organic complexes; exchangeable and adsorbed forms and soil solution. These forms are in a state of dynamic equilibrium. These pools differ in strength (or reversibility) and therefore in their susceptibility to plant uptake, leaching and extractability. The amount and rate of transformation of these forms determine the size of the labile Zn pools. Adequate supply of soil Zn to plants depends upon the relative abundance of these different pools and their equilibrium which is greatly influenced by crop growth stage and environmental conditions. Plants absorb Zn from soil solution which is replenished by various Zn fractions. The availability of Zn to plants has been observed to vary with different Zn fractions.

Material and methods

The experiment was conducted during 2022-23 with three (M_1 -Single year application; M_1 - Alternate year application; M_2 - application year) main and five (T_1 : 0.0 kg Zn ha⁻¹ + N P₂O₅ K₂O (20:80:20); T_2 : 2.5 kg Zn ha⁻¹ + N P₂O₅ K₂O (20:80:20); T_3 : 5.0 kg Zn ha⁻¹ + N P₂O₅ K₂O (20:80:20); T_4 : 7.5 kg Zn ha⁻¹ + N P₂O₅ K₂O (20:80:20) and T_5 : 10.0 kg Zn ha⁻¹ + N P₂O₅ K₂O (20:80:20)) sub treatment replicated three times in a Split plot design. The variety of JS 97-52, plot size 4.0 m x 4.0 m, distance between replication 1.5 m, row to row distance 40 cm, fertilizer dose 20-80-20 (N-P₂O₅-K₂O kg ha⁻¹), seed rate 100 kg ha⁻¹.

Plant height

Periodical measurement of plant height was done in three tagged soybean plants in net plot area at 30, 45 and 90 days after sowing (DAS) from the base of the plant to the tip of the top leaf with the help of measuring scale. The plant height was expressed as average plant height in cm.

Number of pods per plant

The number of pods per plant was counted in each plots from the previously tagged three plants and mean was calculated for statistical analysis.

Number of seeds per pod

The number of seeds per pod was counted from three tagged plants from each plot and mean was calculated for statistical analysis.

Test weight (1000 (g))

Thousand seeds from each plot were counted and weighed accurately on electronic balance after drying in sunshine at about 10% moisture content.

Seed/grain and stover/straw yield

After threshing and winnowing, seed/grain and stover/straw yield of soybean of each plot was recorded and converted into t ha⁻¹.

Results and discussion

Plant height

The application of 10.0 kg Zn ha⁻¹ significantly increased the plant height by 17.00, 20.74 and 25.08 percent at 30,45 and 90 DAS, respectively over control while higher level of zinc *i.e.* 2.5, 5.0 and 7.5 kg Zn ha⁻¹ was statistically at par with that of 10 kg Zn ha⁻¹, periodicity of each year Zn application increased the plant height by 20.82,11.10 and 12.64 percent over single year. Each year and alternate year Zn application was found statistically at par. This might be due to more availability and absorption of Zn from soil solution which caused more seed respiration rate, oxygen carrier, auxin metabolism, synthesis of cytochrome and stabilization of ribosomal fraction, faster cell division and cell elongation and root and shoot development ultimately increased plant height of soybean. However, increasing the rates of photosynthesis and chlorophyll formation due to the Zn, accelerated the meristem activity of plant that led to progressive increase in internode length (Maurya *et al.*, 2010). Chaudhary *et al.* (2014) and Kulhare *et al.* (2014) have also observed significant increase in plant height with the application of Zn.

Table 1. Effect of different levels of zinc on qualitative and yield attributing of soybean

Treatment (kg Zn ha ⁻¹)	Plant height (cm)			Number of pods plant ⁻¹	Number of grain pod ⁻¹	1000grain wt. (g)	Soybean yield (t ha ⁻¹)	
	30DAS	45 DAS	90 DAS				Grain	Straw
0.0	24.70	30.08	35.24	57.78	2.78	69.49	1.50	2.33
2.5	27.15	33.40	39.72	67.67	3.10	77.98	1.74	3.15
5.0	28.32	35.41	43.31	80.78	3.37	83.85	2.06	3.78
7.5	28.62	36.15	44.04	78.56	3.32	82.20	2.03	3.77
10.0	28.90	36.32	44.08	74.78	3.13	81.20	1.86	3.50
SEm±	0.86	0.84	0.76	2.47	0.13	2.96	0.08	0.23
CD (P=0.05)	2.47	2.40	2.19	7.06	0.36	8.47	0.23	0.66

Yield attributing characters

The number of seed pod⁻¹ ultimately reflects the total economic yield which was highest (3.37 seed pod⁻¹) under 5.0 kg Zn ha⁻¹ which was 21.22 percent higher over control. The test weight was highest (83.85 g) under 5.0 kg Zn ha⁻¹ level and significantly superior over control (69.49 g) which was 20.66 percent higher over control. The periodicity of each year Zn application increased by 22.91, 9.76 and 21.50 percent in number of pods per plant, number of grain per pod and test weight respectively over single year. Each and alternate year Zn application was found statistically at par. Such effects of Zn application might be due to pivotal role of Zn in crop growth, involving in photosynthesis processes, respiration and nitrogen metabolism-protein synthesis. Zn plays a key role in biosynthesis of IAA, regulating the auxin concentration in plant and other biochemical and physiological activities and initiation of primordial for reproductive parts and thus ascribed the beneficial effect of to better translocation of desired metabolites to the yield contributing parts of plant. Similar results have been reported by Chaudhary *et al.* (2014), Nagajyothiet *al.* (2013) and Singh *et al.* (2001).

Grain and straw yield

Zn fertilization @ 5.0 kg ha⁻¹ enhanced both grain and straw yields significantly by 37.33 and 62.23 percent, respectively, as compared to control. However, the application of increasing level 5 and 7.5 kg Zn ha⁻¹ were statistically at par. The periodicity of each year Zn application increased by 26.11 and 29.49 percent in grain and straw yield respectively over single year Zn application. However each and alternate year Zn application was found statistically at par. This was perhaps due to abundant supply of Zn nutrition, which increased the protoplasmic constituents, accelerates the process of cell division and elongation, photosynthesis processes, respiration other biochemical and physiological activities (Maurya *et al.*, 2010). This increases the values of all growth and yield attributing parameters, which finally reflected in increased both grain and straw yield. Nandanware *et al.* (2007) reported that grain and straw yield of soybean increased significantly with Zn 5.0 kg Zn application as compared to control. Kanase *et al.* (2008) and Pableet *et al.* (2010) reported that zinc application increased the grain and straw yield of soybean over control.

Conclusion

Among the application of 5.0 kg Zn ha⁻¹ significantly increased the seed yield of soybean over 2.5 kg Zn ha⁻¹ and control but the higher Zn levels were found statistically on par. The application of increasing levels of Zn significantly increased the stover yield over control. The highest stover yield of 3.78 t ha⁻¹ was observed with 5.0 kg Zn ha⁻¹ and higher levels were found statistically at par.

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