Effect of sulphur, zinc and bio-fertilizer on soybean

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Summary

Madhya Pradesh, Maharashtra and Rajasthan are the major soybean growing states in India. MP and Maharashtra grow soybean largely on Vertisols and associated soils and constitute about 86.8% of total area. Considering the need to augment the supply of edible oil and protein, the productivity can be increased by expanding the soybean cultivation area and yield of soybean in mainly due to poor supply of nutrients and poor utilization by crops have led to the utilization of bio-fertilizers. Further, zinc has assumed greater significance due to wide occurrence of its deficiency. The magnitude of sulphur removal is much higher due to intensive cropping. Therefore, the research findings on various aspects of the integrated use of sulphur zinc and bio-fertilizers in soybean are reviewed.

Key words: Sulphur, Zinc, Bio-fertilizer, Soybean

Introduction

Soybean [Glycine max (L.) Merrill] is one of the most important oil seed crops of the world. Soybean is a sulphur loving plant and its sulphur requirement is much more than any other crops for better growth and development. MP is the largest producer of soybean in the country with the state accounting for almost 50 per cent of the entire production in the country. The state had registered an 18 per cent growth in the agriculture sector during 2011-12. The crop survey suggests that during Kharif 2012-soybean production could hit 66.850 lakh MT as against 61.66 lakh MT last year. The area under soybean cultivation in MP has gone up from 57.3 lakh hectares in 2011 to 58.128 lakh hectares in 2012 a rise of 0.83 lakh hectares.

Influence of sulphur on soybean:

Application of sulphur fertilizer also exerted significant influence on the 100-seed weight. Similar trends were observed for seed/pods. Generally sulphur application up to 60 kg/ha increased plant height/pod length and pods/plants. (Nasreen and Farid, 2006). Application of 60 kg S/ha gave significantly more seed yield of soybean (Sharma and Gupta, 1992). Aggrwal and Nayyar (1997) also reported that application of 40 kg S/ha increased yield of soybean over control (without sulphur). Sharma and Gupta (1992) reported that the application of 60 kg S/ha to soybean resulted in greater uptake of sulphur. Further, addition of sulphur decreased the sulphur uptake due to antagonistic effect of higher dose of sulphur by sulphur uptake (Dubey and Billore, 1995). Number, fresh and dry weight of nodules also significantly increased with successive increasing of S up to the application of 30 kg S/ha (Ganeshmurthy and Reddy, 2000). Application of S significantly increased the concentration of N,P,S and Mg in stover and seed of soybean over control. However and Ca concentration did not increased significantly (Najar et al., 2011). Favourable effects of S fertilizers on absorption of other elements are reported by Singh et al. (2006). Adequate availability of S may also help in mineralization of nutrients (Saini et al., 2005). Application of successive increase of Sulphur (up to 40 kg S/ha) increased protein, oil content and amino acid content (Kiyoko et al., 2004). Increased in oil content in oilseeds due to S application was also reported (Singh et al., 2006). A sulphur dose of 40 kg S/ha increased protein content in soybean crop (Sonune et al., 2001, Potkile
and Bobade, 1996). S application improved protein, oil content and yield of soybean up to 40 kg S/ha (Ganeshmurthy, 1996). An experiments was conducted at six Iowa state university research area of Iowa reported that soybean grain yield increased to S application was consistent across fertilizer materials, rates and sites (Sawyer et al., 2002). Significant effect of sulphur and nitrogen, when applied together, helps to increase the growth characteristics, yield components and seed and oil yield of soybean crop (Jamal et al., 2005). Application of S @ 30 kg/ha registered significantly higher LA and LAI over the remaining S levels, whereas CGR continued to rise up to 40 kg S/ha (Chaurasia and Chaurasia, 2010). The B/C ratio continued rise up to 40 kg S/ha with the highest value of 2.03 in soybean was reported by Patidar (2006). The relationship between soybean yield and sulphur levels was found to be curvilinear. The economic optimum levels was worked out for soybean to be 24.39, 51.27, 33.83 and 32.28 kg S per ha for north plain, north eastern, central and southern zones respectively (Billore and Vyas, 2012).

**Influence of zinc on soybean:**

Zinc deficiency in various crops grown on Indian soils was eloquently discussed by Takkar et al. (1989). It is involved in nitrogen and protein metabolism by controlling RNase activity, auxin bio-synthesis and carbohydrate metabolism (Sharma et al., 1981). Mathematical relationship between added zinc and built-up zinc was worked out by Barman et al. (1998) and reported that 21.5 to 33% of the added zinc contributed toward the pool of DTPA-Zn in soils. The critical level presently used to categories soils for deficiency is based on the DTPA extract methods and is fixed as 1.2 ppm (Anonymous, 1992). Zinc critical deficiency level in youngest fully expanded leaf for soybean was 22.1 ppm using Mitscherlich function (Singh and Nayar, 1997). Zinc concentration in recently matured leaves associated with 95% maximum yield ware 22 mg kg−1 for soybean (Rashid and Fox, 1992). In soybean, critical Zn level concentration for full bloom stage was 10 ppm for M-DRIS method (Bell et al., 1995). The p:Zn ratio above 130 and below 61 might be detrimental to plant growth (Gupta and Singh, 1996). The P:Zn ratio was 130 in leaves of healthy and chlorotic plants had 239 in soybean (Korcerc et al., 1991). Zinc deficiency symptoms occurred in plants when p:Zn ratio in leaves was more than 122.5 (Ma et al., 1989). Zinc application invariably increased the DMP of soybean (Sarkar and Aery, 1990). CRG and NAR were higher but RGR was lower due to foliar spray of 0.1% ZnSO4 (Selim, 1992). Maximum nodulation and their dry weight plant−1, nitrogen fixation and yield of soybean were recorded with 10 kg Zn/ha (Bhanavase, 1994; Abadi et al., 1995). A yield response of 0.05-0.10 t/ha with 25 kg Zn/ha reported in 5 out of 7 trial of soybean in MP (Parik et al., 1993). Use of zinc oxide at 20 kg/ha significantly increased the growth and yield parameters and yields of soybean (Singh and Singh, 1995). Application of zinc enhanced the growth by increasing the plant height, seed weight and yield of soybean (Wang Xuegin, 1995). Plant height, seed weight CGR, RGR, yield attributes and yield of soybean were increased due to zinc application @ 5 kg/ha (Saxena and Chandel, 1997). 15 kg/ha (Gupta and Vyas, 1994), and 25 kg/ha (Tomar et al., 1991). Application of 6 kg Zn/ha significantly increased the number of nodules dry weight yield attributes and grain yield of soybean (Khamparia, 1996). Sulphur application increased nodulation of soybean (Singh and Bansal, 2000; Hemantarajan and Trivedi, 1997). Leaf area index at 60 DAS, branches/plant and nodules/plant were increased significantly with increase in S level up to 30 kg/ha (Singh and Bansal, 2000). Incorporation of zinc in conjunction with N, P and K (N-30, P0-60 and K0-20) for soybean has increased the yields by 6.3 to 8.6 per cent and 29.9 to 33.9 per cent with the application of zinc @ 1.8 and 5 kg/ha, respectively (Tiwari et al., 2006).

**Combined effect of zinc and sulphur on soybean:**

Application of zinc and sulphur with increasing levels significantly increased the protein and oil content of soybean grain over control. Highest protein (37.25%) and oil (2042%) content was observed due to application of 3 kg Zn/ha, while 40 kg S/ha gave the highest protein (37.25%) and oil (21.29%) content of soybean grain (Sonune et al., 2001). The interaction effect of Zn and S was observed significantly only 90 and 110 DAS. The highest Zn content was observed in S0, Zn0 and the lowest in control; therefore, it is evident that the application of different levels of S and Zn accelerated nodulation, increased dry matter yield and nutrient content of soybean (Awlad et al., 2003). The interaction effect of S and Zn were not significant in respect of nodulation (Singh et al., 1995). Application of S @ 8.92 and 13.38 mg/kg also increased the oil content in soybean grain. A dose of 26.8 mg P and 8.92 mg S preferably with 12.7 mg Zn/kg soil appeared to be optimum for overall yield and quality of soybean crops (Varavipour et al., 1999). The oil content (%) in soybean was not affected by P application at any rate but S addition at the medium and high dose of 8.92 and 13.38 mg/kg significantly increased the contents from 17.8 in control to 18.7 and 19.0%, respectively. Application of Zn did not have any effect on oil content (Aulakh et al., 1990; Fazal and Sisodia, 1989). The fertilizer (13-33-0-15S) was found to be significantly superior in increasing the nodulation, yield attributes, uptake of phosphorus, potassium, and DTPA zinc, oil and protein content in soybean (Sharma et al., 2004). The application of P and S in most cases and to Zn in some in terms of high grain yield and nutrient uptake, N uptake which is directly linked with protein content in both wheat and soybean improved with low dose of phosphate, while the medium and high doses of S performed better than low dose for oil content in soybean.
grain. The three nutrient interactions were not found to be consistently effectively (Varavipour et al., 1999).

**Influence of bio-fertilizers on soybean:**

It is necessary and useful to inoculate plants with bio-fertilizers that stimulate growth of plant. It is reported that in soybean the VAM fungi help to make the node to *B. Japonicum* (Sreenivasa et al., 1995). Inoculation of soybean seed with *P. fluorescens* and *B. Japonicum* improved germination of seeds and the strength of seedlings (Zaidi, 2003). In the condition of normal condition, the inoculation of bio-fertilizers (*B. Japonicum* and *G. mosseae*) with soybean seeds increased final germination per cent and seedling vigor index. (Alahbadi et al., 2009). The effect of mycorrhiza fungi on soybean increased the length of the root (Allen, 2003). It is reported that the inoculation of the soybean with VAM increased primary stem length. Primary root and stem lengths are very important (Ilbs and Sahin, 2005). The application of inorganic fertilizer conjunction with composted paddy straw or inoculants was effective to achieve higher grain yield of soybean under rice-based cropping system (Son and Ramaswami, 1997). The application of organic and bio-fertilizer could be substantiated for the N inorganic fertilizer to an extent of 40 kg N/ha while the agronomic traits and grain yield of soybean were comparable to the control (conventional dose applied by farmers). Chicken manure or sulfur fertilization in the presence or absence Bradyrhizobium inoculation significantly increased mineral composition of soybean especially at a level of 10 t/fed of chicken manure or 100 kg /fed of sulphur (Ibrahim et al., 2008). Phosphobacteria produced organic acids such as lactic, gluconic citric and Alfa–keto gluconic acids which rendered the insoluble phosphate to soluble one (Stevenson, 1967). Soybean yield increased with increasing level of both P fertilizer and d application of Rhizobium and PSB (Tomar et al., 2010). Component of INM also significantly improved the productivity of soybean –wheat system (Rao et al., 1998). INM is the best option as far as productivity and profitability of the soybean-wheat system is concerned (Singh et al., 2008). Inoculation with PSB or VAM was shown to save up to 8-10 kg P₂O₅/ha in soybean and other crops (Rao, 2007). Balanced plant nutrition through conjoint use of organics and chemical fertilizer may help enhance productivity (Behera et al., 2007). Application of Zn (@ 5 kg/ha) along with *B. japonicum* inoculation and *B. japonicum* plus Mo (@ 4 g/kg seed) plus B (@ 0.5 kg/ha) have significantly increased plant dry weight, nutrient uptake and yield of soybean (Singh and Kumar, 2012). The combined use of manures, bio fertilizer and inorganic fertilizer played a significant role in increasing seed and stover yield of soybean (Tripathi et al., 2008). The maximum plant height, highest number of pods per pant and highest test weight was recorded in the treatment where 50% recommended applied through urea + 50% N through FYM+ PSB and the lowest of these were found in the control treatment (Koushal and Singh, 2011). The application of phosphate-solubilizing bacteria in most examined traits was better than chemical fertilizer. Moreover, the inoculation with *B. japonicum* in most examined traits did not have significant difference with chemical fertilizer. So the impact of phosphate solubilizing on examined traits was more than inoculation with *B. japonicum*. Between examined fertilizer levels, treatment of b4, including *B. japonicum*, phosphate-solubilizing and 50% super phosphate triple, provided the best conditions for achieving maximum grain yield and oil yield in soybean. (Iraj Zarei et al., 2012). Shanna and Pahelwan (1985) and Alam et al. (1988) also reported similar positive effects of bacterial inoculation and N application in soybean.

**Literature Cited**


