Sulphur Nutrition in Soybean [Glycine max (L.) Merril] in India

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***Abstract*—**A field experiment on "sulphur nutrition in soybean" was initiated during Kharif 2005-06 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka state) India. The soils found deficient in sulphur (<10 mg/kg). To workout the optimum sulphur dose for increased soybean yield and oil content, an experiment was planned and executed in Factorial Randomized Block Design replicated thrice on vertisol during kharif 2006, 2007 and 2008. The treatments comprised of four sulphur levels (0, 10, 20, 30, and 40 kg ha-1).Gypsum as sulphur source was applied along with the basal fertilizer dose (40:80:25 N, P205 and K2O kg ha-1). The soybean Cv.JS 335 was sown at 30X10 cm spacing. Pooled data (2006-08) revealed that the soybean seed yield was significantly increased with the application of sulphur @ 20 kg ha-1 (2534 kg ha-1) compared to sulphur levels; 30 kg ha-1 (2494 kg ha-1), 40 kg ha-1 (2376 kg ha-1) and 10 kg ha-1 (2226 kg ha-1). The oil content, net return and benefit cost ratio followed the similar trend. Based on the findings, the technology "sulphur application @ 20 kg ha-1" was evaluated in farmers field during kharif 2009-10 and 2010-11. The mean results of farm trails over two years (2009-10 and 2010-11) indicated that, the soybean seed yield increased to the tune of 12.01% with the application of sulphur @ 20 kg ha-1 (through Gypsum @ 100 kg ha-1) along with the basal dose compared to with no sulphur application (0 kg ha-1). Thus, it is well proved the importance of sulphur in developing integrated nutrient management strategy for soybean cultivation in India. The technology "sulphur application @ 20 kg ha-1" is recommended and included in the "Package of Practices" of the University of Agricultural Sciences, Dharwad (Karnataka) for soybean cultivation in India.

***Keywords*—** Gypsum, Sulphur (S), Sulphur nutrition.

I. Introduction

RECENTLY soybean [Glycine max (L.) Merril] is being cultivated as an oilseed crop in India. It supplies nearly 40% protein and 20% edible oil with sulphur containing amino acid (methionine). Research evidences raveled that sulphur nutrition is essential in increasing the oil content in soybean [1]. Sulphur (S), one of the 16 essential plant nutrients, is now considered as the fourth major nutrient. It is absorbed by plants in amounts comparable to P. Sulphur is no doubt a master nutrient in oil production as almost 12 kg S is required to produce one tonne of soybean or in other words 9.4 kg grain is produced per kg of sulphur applied It was observed that the yield of soybean increased by 37% with the application of 20 kg sulphur/ha-1, giving an overall net profit of Rs 10150 over the farmers practice. A balanced fertiliser management practice is, thus, imperative to mitigate the effect of sulphur deficiency and to break the plateau of yield stagnation of the Gold bean of this century. Higher S use efficiency in soybean-wheat and/or chickpea based cropping system was observed [1]. Keeping this in view an investigation on "sulphur nutrition in soybean" was initiated during Kharif 2005-06 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka state) India.

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II. Materials And Methods

A field experiment was planned and executed in Factorial Randomized Block Design replicated thrice on medium vertisol at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka state) India. The initial soil nutrient content was analyzed for available nitrogen (218 kg ha-1), phosphorus (32.0 kg ha-1) and potassium (310.0 kg ha-1) before initiation of the experiment.The soil sulphur content was analysed. The soils found deficient in sulphur (<10 mg/kg). To workout the optimum sulphur dose for increased soybean yield and oil content, an experiment was planned and executed in Factorial Randomized Block Design replicated thrice on vertisol during kharif 2006, 2007 and 2008. The treatments comprised of four sulphur levels (0, 10, 20, 30, and 40 kg ha-1).Gypsum as sulphur source was applied along with the basal fertilizer dose (40:80:25 N, P205 and K2O kg ha-1). The soybean Cv.JS 335 was sown at 30X10 cm spacing. The yield and seed yield per plant were recorded at harvest. Oil content in soybean seeds was estimated as per the standard method.The data was subjected to statistical analysis. The economics of cost of cultivation, net return and return per rupee investment (B:C ratio) were worked out taking into account the cost of various inputs as well as the price of seed cotton yield prevailed during 2007-08 and 2008-09. The outcome of the investigation was evaluated in farmers field during 2009-10 and 2010-11.

III. Results And Discussion

Pooled data (2006-08) revealed that the soybean seed yield was significantly increased with the application of sulphur @ 20 kg ha-1 (2534 kg ha^{-1}) compared to sulphur levels; 30 kg ha^{-1} (2494 kg ha^{-1}), 40 kg ha^{-1} (2376 kg ha^{-1}) and 10 kg ha^{-1} (2226 kg ha^{-1}) (Table 1). The oil content, net return and benefit cost ratio followed the similar trend. Increased soybean seed yield and higher oil content with the application of sulphur had been reported (Dixit et al., 2009). Based on the

findings, the technology "sulphur application @ 20 kg ha^{-1}" was evaluated in farmers field during kharif 2009-10 and 2010-11. The mean results of farm trails (Table 2) over two years (2009-10 and 2010-11) indicated that, the soybean seed yield increased to the tune of 12.01% with the application of sulphur @ 20 kg ha^{-1} (through Gypsum @ 100 kg ha^{-1}) along with the basal dose compared to with no sulphur application (0 kg ha^{-1}). Thus, it well proved the importance of sulphur in developing integrated nutrient management strategy for soybean cultivation in India. The technology "sulphur application @20 kg ha^{-1}" is recommended and included in the "Package of Practices" of the University of Agricultural Sciences, Dharwad (Karnataka) for soybean cultivation in India. The beneficial effect of sulphur on soybean yield and oil content has been reported [1 and 2]..

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TABLE I
RESPONSE OF SOYBEAN TO SULPHUR AND BORON NUTRITION (POOLED DATA , 2006-08)

Sulphur levels (kg/ha)	Yield (kg/ha)	Seed yield (g/plant)	Oil content (%)	Net returns (Rs./ha)	B:C ratio
10	2226	11.10	18.36	24856	3.39
20	2534	12.28	18.68	29769	3.79
30	2494	12.00	18.35	27716	3.56
40	2376	11-44	18.37	26648	3.52
Mean	2408	11.68	18.44	27247	3.57
Absolute control	2123	10.13	18.33	-	-
CD (P=0.05)	**159.83**	**1.01**	**0.22**	**2296**	**0.19**

TABLE II
FARM TRIAL RESULTS

	T_1- Sulphur 20 kg/ha	**T_2- Sulphur 0 kg/ha**	**The percent increase in soybean seed yield**
Mean soybean seed yield during 2009-10	1538	1386	11.4
Mean soybean seed yield during 2010-11	1693	1480	12.0
Mean soybean seed yield (over two years 2009-10 & 2010-11)	1616	1433	12.01