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Yield and Economics of Soybean (*Glycine max* (L.) Merill) As Influenced by different Levels of sulphur and Plant growth regulator

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Abstract: *The field investigation entitled "Effect of different level of sulphur and plant growth regulators on seed yield and quality of Soybean (*Glycine max *(L.) Merill)" was conducted at farm, Department of Agronomy, College of Agriculture, Latur during kharif 2012-13. The experiment was laid out in a factorial randomized block design with twelve treatments. From the results it was revealed that application of sulphur 40 kg ha^{-1} and 30 kg ha^{-1} recorded significantly higher yield and gross as well as net monetary returns as compared to remaining levels of sulphur. Whereas application of kinetin 40 ppm recorded significantly higher yield and net returns followed by NAA 40 ppm and salicylic acid 50 ppm.*

Keywords: Soybean, levels of sulphur and plant growth regulator, Yield and Economics.

INTRODUCTION

Soybean being a high protein and energy crop has high nutrient requirements and its productivity is often limited by the low availability of essential nutrients or imbalanced nutrition forming one of the important constraints to soybean productivity in India.

Sulphur is very important nutrient for optimum production of high-yielding soybeans. Sulphur is a component of several amino acids, the building blocks of proteins. This element is therefore, very important with respect to quality. It is essential for the formation of nodules on the roots of legumes. Soybean growing on soil that are low or deficient in sulphur are poorly nodulated and therefore nitrogen fixation is depressed. It is also involved in the formation of oils.

In soybean, a large number of flowers and pods are aborted naturally, representing a significant and negative impact on the yield. Reducing this losses is an important way to raise the yield of the crop. Plant growth regulators can play crucial role in decreasing the flower abortion.

Plant growth regulators are organic compounds which in small amount modify a given physiological plant process. They are extensively used to manipulate flower formation and fruit set in different crops. Salicylic acid is a common plant-produced phenolic compound, which function's as a plant growth regulators. Exogenous application of salicylic acid may influence a range of diverse process in plant's including stomatal closure, ion uptake and transport, ethylene synthesis and seed yield (Khan and Balakrishnan, 2003).

Plant growth regulators when added in small amounts; modify the natural growth regulatory system right from seed germination to senescence in several crop plants. Plant growth regulators (promoters, inhibitors or retardants) play key role in contributing internal mechanisms of plant growth by interacting with key metabolic processes such as, nucleic acid metabolism and protein synthesis.

The yield of soybean can be enhanced through physiological growth manipulation by way of foliar application of growth regulators like NAA. The synthetic auxin naphthalene acetic acid (NAA) promote rooting in soybean hypocotyls. Whereas, aqueous solutions of salicylic acid, applied as a spray to the shoots of soybean significantly increased the growth of shoots and roots as measured after seven days of treatment.

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Table 1
Pod yield g plant^{-1}, Seed yield g plant^{-1}, Number of seeds plant^{-1} and Seed index (g) as influenced by different treatments

Treatment	*Pod yield g plant^{-1}*	*Seed yield g plant^{-1}*	*Number of seeds plant^{-1}*	*Seed index (g)*	*Seed yield (q ha^{-1})*
Sulphur levels (S)					
S_1= 0 kg S ha^{-1}	12.67	9.21	70.35	11.80	21.62
S_2 = 20 kg S ha^{-1}	13.24	10.35	76.44	12.14	23.64
S_3 = 30 kg S ha^{-1}	15.72	12.51	85.00	12.31	28.36
S_4 = 40 kg S ha^{-1}	18.88	14.35	89.55	12.40	30.20
S.E.	1.46	0.70	1.55	2.03	0.83
C.D. at 5%	4.38	2.06	4.55	NS	2.44
Growth regulator levels (R)					
R_1= Kinetin 40 ppm	17.85	13.05	88.58	12.35	27.94
R_2 = NAA 40 ppm	14.71	11.09	79.76	12.12	25.04
R_3 = Salicylic acid 50 ppm	12.83	10.67	76.91	12.00	24.89
S.E.	1.26	0.61	1.34	1.76	0.72
C.D. at 5%	3.78	1.79	3.94	NS	2.11
Interaction (S × R)					
S.E.	2.53	1.22	2.69	3.52	1.44
C.D. at 5 %	7.59	3.66	8.07	NS	NS
G.M.	15.13	11.60	80.94	12.16	25.95

In spite of positive results regarding the isolated use of exogenous plant growth regulator there are very few studies concerning it's effect, under Indian conditions and few studies have been carried out in the field.

Therefore, attempts were made to know the agronomic aspects of different level of sulphur and growth regulator on soybean.

MATERIALS AND METHODS

The field experiment was conducted during kharif 2012-13 at farm, Department of Agronomy, College of Agriculture, Latur. The experimental field was leveled and well drained. The soil was clayey in texture, low in nitrogen, medium in phosphorus and alkaline in reaction. The environmental conditions prevailed during experimental period was favourable for normal growth and maturity of soybean crop.

The experiment was laid out in a factorial randomized block design with twelve treatments. With First Factor *i.e.* four Sulphur levels *viz.* S_1-control (0 kg ha^{-1}), S_2-20 kg ha^{-1} of sulphur, S_3-30 kg ha^{-1} of sulphur and S_4 - 40 kg ha^{-1} of sulphur whereas Second factor was three growth regulators *viz.* R_1-Kinetin spray 40 ppm, R_2-NAA 40 ppm and R_3-Salicylic Acid 50 ppm.

Each experimental unit was repeated three times. Sowing was done on 2st July, 2012 by dibbling the seeds at spacing 45 cm × 5 cm. The recommended cultural practices and plant protection measures were taken. The recommended dose of fertilizer (30:60:30 kg NPK ha^{-1}) was applied at the time of sowing through Urea, DAP and MOP. The crop was harvested on 13th October, 2012.

RESULTS AND DISCUSSION

Yield and Yield Attributes

Effect of sulphur levels

The mean pod yield (g) per plant was significantly influenced by the various treatments. The application of sulphur 40 kg ha^{-1} recorded significantly higher dry pod yield per plant (18.88 g) statistically similar results were recorded for application of sulphur 30 kg ha^{-1} (15.72 g). More pod yield due to higher level of sulphur may be due to more growth and photosynthesis which resulted in better filling of pod hence more pod yield (g) plant^{-1} was obtained.

The effect of different levels of sulphur fertilizer on mean grain yield (g plant^{-1}) was found to be significant. The application of sulphur 40 kg ha^{-1} recorded significantly higher mean seed yield (14.35 g plant^{-1}) followed by the application of sulphur 30 kg ha^{-1} (12.51 g plant^{-1}). The increased levels of sulphur fertilizer might have also provided more sulphur nutrient resulting in increased number of grains and higher uptake of nutrients by the plant consequently might have increased yield contributing characters.

The effect of different levels of sulphur fertilizer on mean number of seed per plant was found to be significant. The application of sulphur 40 kg ha^{-1}

Table 2
Mean seed yield (kg ha^{-1}), Gross monetary returns (Rs ha^{-1}), Cost of cultivation (Rs ha^{-1}), Net monetary returns (Rs ha^{-1}), and Benefit: Cost (B:C) ratio as influenced by different treatments

Treatment	*Seed yield (q ha^{-1})*	*Gross monetary returns (Rs ha^{-1})*	*Cost of cultivation (Rs ha^{-1})*	*Net monetary returns (Rs ha^{-1})*	*B:C ratio*
Sulphur levels (S)					
S_1= 0 kg S ha^{-1}	21.62	66181	22667	43514	2.92
S_2 = 20 kg S ha^{-1}	23.64	72253	23476	48777	3.08
S_3 = 30 kg S ha^{-1}	28.36	86598	24285	62313	3.57
S_4 = 40 kg S ha^{-1}	30.20	92397	25420	66977	3.63
S.E.	0.83	2532	–	2532	–
C.D. at 5%	2.44	7442	–	7442	–
Growth regulator levels (R)					
R_1= Kinetin 40 ppm	27.94	85400	26189	59211	3.26
R_2 = NAA 40 ppm	25.04	76581	25939	50642	2.95
R_3 = Salicylic acid 50 ppm	24.89	76105	25854	50251	2.94
S.E.	0.72	2196	–	2196	–
C.D. at 5 %	2.11	6436	–	6436	–
Interaction (S × R)					
S.E.	1.44	4392	–	4392	–
C.D. at 5 %	NS	NS	–		–
G.M.	25.95	79359	24833	54526	3.19

recorded significantly higher mean number of grains per plant (89.55) followed by the application of sulphur 30 kg ha^{-1} (85.00). More number of seeds plant^{-1} was due to better growth of plant and pod bearing capacity which was enhanced due to higher level of sulphur.

The effect of different levels of sulphur fertilizer on mean seed index (100 seeds) was found to be non significant.

Seed yield q ha^{-1} as influenced by different levels of sulphur fertilizer was found to be significant. The application of sulphur 40 kg ha^{-1} recorded higher mean seed yield (30.20 q ha^{-1}) and it was at par with the application of sulphur 30 kg ha^{-1} (28.36 q ha^{-1}). This might because of the cumulative effect in increasing growth contributing characters which have been clearly exhibited on the final produce i.e. seed and straw yield ha^{-1}. Similar kind of results were reported by Sangle and Sonar (2004), Sriramachandrasekharan and Muthukkaruppan (2004) and Gokhale *et al.*, (2005)

Effect of plant growth regulators

The mean pod yield (g) per plant, seed yield (g plant^{-1}) and mean number of seeds plant^{-1} was significantly influenced by the various treatments. The application of kinetin 40 ppm recorded significantly higher results than other growth regulators. The results are in line with those reported by Martins *et al.*, (2008)

The effect of different levels of plant growth regulators on mean seed index (100 seeds) was found to be non significant. But the highest seed index was observed by the application of kinetin 40 ppm (12.35 g) followed by the application of NAA 40 ppm (12.12 g) and salicylic acid 50 ppm (12.00 g).

The application of kinetin 40 ppm recorded significantly higher mean seed yield (27.94 q ha^{-1}) over rest of the levels of plant growth regulators.

Economics of Soybean Cultivation

Effect of sulphur levels

The data on gross monetary returns revealed that the application of sulphur 40 kg ha^{-1} gave significantly higher gross monetary returns (Rs 92397 ha^{-1}) which was at par with the application of sulphur 30 kg ha^{-1} (Rs 86598 ha^{-1}), The data on net monetary returns per hectare revealed that the application of sulphur 40 kg ha^{-1} gave significantly higher net monetary returns (Rs 66977 ha^{-1}) but statistically it was similar to the application of sulphur 30 kg ha^{-1} (Rs 62313 ha^{-1}). Maximum gross and net monetary return were higher with 30 and 40 kg application of sulphur ha^{-1} which was due to higher yield obtained with them.

The data on benefit : cost ratio revealed that the application of sulphur 40 kg ha^{-1} gave higher on benefit : cost ratio (3.63) followed by the application of sulphur 30 kg ha^{-1} (3.57), sulphur 20 kg ha^{-1} (3.08) and sulphur 0 kg ha^{-1} (2.92).

Effect of plant growth regulators

The data on gross and net monetary returns it was revealed that the application of kinetin 40 ppm gave significantly higher gross and net monetary returns (Rs 85400 ha^{-1} and Rs 59211 ha^{-1}). The data on benefit: cost ratio it was seen that the application of kinetin 40 ppm gave higher on benefit: cost ratio (3.26) followed by the application of NAA 40 ppm (2.95) and salicylic acid 50 ppm (2.94).

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