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Effect of various levels of Sulphur, nitrogen and phosphorous on growth and yield of soybean under Jatropha based agroforestry

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Abstract
An experiment was conducted at the Forest Nursery of the Sam Higgibottom University of Agricultural Technology and Sciences Allahabad, India during the *kharif* 2017-18 to evaluate the Effect of various levels of Sulphur, nitrogen and phosphorous on growth and yield of soybean (*Glycine max*. L.) under Jatropha based Agroforestry. The study was revealed that the growth parameters like plant height (84.22), No. of Branches (13.55), Dry weight. (46.47) And yield parameters like No. of pods(93.09), No of seeds per pod (5.35), Test weight (95.15) seed yield (26.29), Stover yield (42.15) and harvest index (38.87) were significantly increased with the treatment T_9 (100% N + 100% P + 50% S). The treatment T_3(50%N + 100% P + 100% S) was statistically significant and at par to treatment T_9. The treatment T_0 (control) is recorded the lowest values of all treatments regarding to growth parameters and yield.

Keywords: soybean, jatropha, sulphur, nitrogen and phosphorus

Introduction
Agroforestry is primarily a system where agriculture and forestry are practiced either simultaneously or separately on some unit of the land has affinities with “taungya” system of regenerating forest which in Burmese means cultivation of trees and crop. Agroforestry makes use of the complimentarily relationship between trees and crops, so that the availability of resources can be effectively utilized. The potential benefit of growing trees in combination with annual and perennial crops is to maintain the productivity and fertility. *Jatropha curcas* L. has various socio-economic benefits which makes it more economical when cultivated on commercial scale. A hectare of Jatropha plantation is reported to yield 2.5- 3.5tonnes of seeds in the third year and increases sharply to 5000-12,000 tonnes per hectare from the sixth year onwards. Like other vegetable oils, Jatropha oil can be used directly in modified diesel engines for automobile applications in Europe, North America and some other parts of the world. In the northern part women engaged, use Jatropha oil in place of diesel the MFPs. In the rural areas where Jatropha plantation and extraction are done, the drying of the seeds is done by spreading the fruit on the ground or a dark-coloured mesh net to dry in sun. The oil extracted from Jatropha can be used as a substitute for kerosene without any further processing. This is more economical compared to kerosene from crude oil, which are used for rural electrification. Soybean is important crop that is grown in diverse environments throughout the world. Its adaptation to tropical and subtropical regions is still involving extensive breeding work. To use land continuously for crop cultivation, incorporating *Soybean* (*Glycine max* L.) is a member of Leguminaceae family, rich in nutrients, and it is regarded as a nutrient storage. Soybean is not only seen as an oil plant but also used for various purposes. Among grain legumes, soybean is economically organic and inorganic fertilizers to soil would provide multiple benefits for improving the chemical and physical status of the soil which results in improved crop yield. Nitrogen is a vitally important for plant nutrient. Nitrogen is essential constituent of protein and is present in many other compounds of great physiological importance in plant metabolism. Nitrogen is called a basic constituent of life. Nitrogen also impart vigorous vegetative growth dark green colour to plant and it produce early growth of soybean. Nitrogen governs the utilization of potassium, phosphorus and other elements in soybean crop. Phosphorus has a great role in energy storage and transfer and closely related to cell division and development of soybean. Phosphorus is essential for transformation of energy, in carbohydrate metabolism, in fat metabolism, in respiration of plant and early maturity of soybean. Sulphur is essential in the structural and enzymatic components in plants. Sulphur is a key component of some essential amino acids and is needed for protein synthesis.

Chlorophyll synthesis also requires S. Sulphur is not readily translocated within plants, so all plants need a continuous supply of sulphur from emergence to crop maturity.

Materials and Methods

The field experiment was conducted at Forest Nursery, college of Forestry, Allahabad, Sam Higginbottom Institute of Agriculture, Technology and Sciences Allahabad during the period of 2017-18. The experiment was laid out in randomized block design with eleven treatments combination with different ratios of the nutrient sources were urea, Nitrogen, phosphorus, and Sulphur. The recommended dose of 20:80:40 kg N: P: S ha^{-1}. As per the treatments and recommended dose of nitrogen was applied basally through urea. Weeding, gap filling, thinning, irrigation and pesticide application were done and when necessary. Phosphorous @ 80 kg P2O5 ha-1 through Single super phosphate (SSP) and elemental Sulphur @ 40 kg/ha was applied basally to all the treatments. The plants selected for growth studies were also utilized for recording the growth parameters such as plant height and yield components such as number of pods per plant, number of seeds for pod and seed yield per plant. Grain yield and straw yield altogether were considered as biological yield.

Results and Discussion

Growth Attributes

The growth parameters like plant height, No. of Branches and Dry weight were affected significantly by different fertilizers. The maximum plant height (65.88, 83.78 and 84.5 cm), was observed in T_9 (100% N + 100% P + 50% S), followed by T_3 (50% N + 100% P + 100% S) was (65.59, 83.49 and 84.22 cm). The plant height was increased by applying fertilizers. the maximum Number of branches /plant (11.25, 12.35 and 13.55), was observed in T_9 (100% N + 100% P + 50% S), which was significantly superior to rest of the treatments, followed by T_3 (50% N + 100% P + 100% S) was (10.96, 12.06 and 13.26), while the minimum Number of branches /plant (8.43, 11.20 and 11.73), were recorded in T_0 control. The balanced nutrient application made higher nutrient available to plants resulted into more growth. The maximum dry weight (g) (27.35, 40.15 and 46.47), was observed in T_9(100% N + 100% P + 50% S), which was significantly superior to rest of the treatments, followed by T_3 (50% N + 100% P + 100% S) was (27.06, 39.86 and 46.18), while the minimum dry weight (g) (14.60, 24.40 and 28.52), were recorded in T_0 control. Higher availability of essential nutrients particularly nitrogen increased the plant height (cm), Dry weight (g) and number of branching per plant.

Table 1: Effect of various levels of sulphur, nitrogen and phosphorous on Pre-harvest observation of soyabean under jatropha based agroforestry

Treatments	Plant height (cm)	Number of branches /plant	Dry weight (g)
T_0	79.76	11.73	28.52
T_1	82.96	11.86	32.78
T_2	83.09	11.93	35.25
T_3	84.22	13.26	46.18
T_4	83.16	13.00	35.52
T_5	82.91	11.43	35.02
T_6	83.42	12.06	42.32
T_7	82.93	12.93	35.07
T_8	82.88	11.23	34.99
T_9	84.22	13.55	46.47
T_{10}	82.39	12.43	34.33
F- test	S	S	S
S. Ed. (±)	1.212	0.533	0.499
C. D. (P = 0.05)	2.502	1.1	1.031

Yield attributes

The number of pod per plant (Table 2), showed that treatment T_9(100% N + 100% P + 50% S) recorded the maximum number of pod per plant (*i.e.* 93.09), followed by (92.80) observed under treatments T_3(50% N + 100% P + 100% S), while, the minimum (85.33) number of pod per plant was recorded in T_0 control. Number of seed per pod showed that treatment T_9(100% N + 100% P + 50% S) recorded the maximum number of seed per pod (*i.e.* 5.35), followed by (5.06) observed under treatments T_3(50% N + 100% P + 100% S), while, the minimum (3.26) number of seed per pod was recorded in T_0 control. Test weight (g) showed that treatment T_9(100% N + 100% P + 50% S) recorded the maximum test weight (*i.e.* 95.15), followed by (94.86) observed under treatments T_3(50% N + 100% P + 100% S), while, the minimum (85.73) test weight was recorded in T_0 control. Grain yield (q/ha) showed that treatment T_9(100% N + 100% P + 50% S) recorded the maximum grain yield (*i.e.* 26.29), followed by (25.00) observed under treatments T_3(50% N + 100% P + 100% S), while, the minimum (15.86) grain yield was recorded in T_0 control. Straw yield (q/ha) showed that treatment T_9(100% N + 100% P + 50% S) recorded the maximum straw yield (*i.e.* 42.15), followed by (41.86) observed under treatments T_3(50% N + 100% P + 100% S), while, the minimum (28.20) straw yield was recorded in T_0 control. Harvest index (%) showed that treatment was observed in T_9(100% N + 100% P + 50% S), recorded the maximum harvest index (*i.e.* 38.87), followed by (38.69) observed under treatments T_3 (50% N + 100% P + 100% S), while, the minimum (36.42) harvest index was recorded in T_0 control

Table 2: Effect of various levels of sulphur, nitrogen and phosphorous on Post-harvest observations of soyabean under jatropha based agroforestry

Treatments	Number of pod per plant	No. of seeds per pod	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
T_0	85.33	3.26	85.73	15.86	28.20	36.42
T_1	88.66	3.86	88.58	21.93	36.13	38.41
T_2	89.00	4.20	89.60	22.26	36.93	38.23
T_3	92.80	5.06	94.86	25.00	41.86	38.69
T_4	90.73	4.46	90.13	23.26	38.40	38.39
T_5	88.47	4.02	89.45	22.11	36.53	38.07
T_6	91.80	4.66	90.80	24.46	40.40	38.40
T_7	90.13	4.11	90.03	22.98	38.20	38.13
T_8	88.97	4.07	89.53	22.01	36.45	38.03
T_9	93.09	5.35	95.15	26.29	42.15	39.87
T_{10}	88.32	4.09	89.99	23.04	38.02	38.22
F- test	S	S	S	S	S	S
S. Ed. (±)	1.693	0.39	1.935	2.272	0.86	0.523
C. D. (P = 0.05)	3.494	0.805	3.995	4.69	1.776	1.079

Conclusion

Based on field experiment conducted on effect of different doses of Nitrogen, phosphorus, and Sulphur on growth and yield of Soybean under Jatropha based agroforestry system concluded that the treatment T_9(100% N + 100% P + 50% S) was found superior among the all treatment for growth and seed yield 26.29 q/ha and stalk yield 42.15 q/ha.

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