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Growth and Yield Performance of Soybean (*Glycine max* L. Merril) Varieties Under Rainfed Condition of Nagaland

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Abstract The field experiment was conducted during *kharif* season of 2015, with seven soybean varieties viz., MACS –1614, SL–982, DS – 2705, MAUS – 612, JS – 20-69, RKS – 19 and JS– 9752, to study the growth and yield performance of different soybean varieties and also to identify the best soybean variety suitable for the agro-climatic condition of Nagaland. The results revealed that there was a significant difference among all the soybean varieties for all the growth and yield parameters studied. Among the seven soybean varieties, JS– 9752 appeared by and large the most suitable for the agro-climatic conditions of Nagaland. This variety gave significantly higher plant height (61.08 cm), number of leaves per plant (25.35), shoot dry weight (27.90 g plant^{-1}), leaf area index (1.50), crop growth rate (28.78 g m^{-2} day^{-1}), number of nodules per plant (71.33), pods per plant (62.13), number of seeds per pod (2.25), test weight (145.35 g), grain yield (2.71 t ha^{-1}) and stover yield (3.48 t ha^{-1}) respectively.

Keywords Soybean, Varieties, Growth, Yield.

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Introduction

Soybean (*Glycine max* L. Merril) popularly known as golden bean has become the miracle crop of the 21st century. It belongs to the family Leguminosae and is native to North China, It is multi-dimensional in its uses but widely grown for its edible beans. Due to rich in best quality protein it is regarded as "the meat that grows on plant" [1]. Soybean is one of the most nutritious crops and also one of nature's most versatile crops, is increasingly becoming an important food and cash crop in the tropics due to its high protein content (40%), high oil content (20%) and adaptability to various growing environments [2]. The growth and yield components of a crop depend on some physiological traits. Growth, development and yield are result of a variety's genetic potential interacting with environment and farming practices. For the proper understanding of seed yield performance of any crop variety, identification of suitable plant traits showing maximum contribution to final seed yield is necessary. It will help in selecting suitable variety for a particular agro-ecological zone. Performance of a crop also differs among crop varieties depending upon environment. The difference in varietal performance across environment may be attributed to variations in agro ecological factors such as temperature, wind, rainfall, relative humidity, soil type. Proper variety selection is crucial to achieving high potential yield and better grain composition; therefore it is one of the most important decisions a farmers make for economic and higher productivity.

The yield of soybean under rainfed condition is

low. To understand the performance of different soybean varieties in terms of yield which mainly include the contribution of various growth and yield components towards yield, several studies have been made [3]. Lack of availability of appropriate genotype with higher potentiality in crop yield to suit the agro climatic condition of this zone is the most disadvantageous reason for its wider acceptability. The agroclimatic condition of Nagaland offers favorable situation for the cultivation of this crop, however limited work has been done for identification and proper recommendation of economically potential varieties. This study was therefore, undertaken with seven varieties of soybean to observe the growth and yield performance of soybean under rainfed condition of Nagaland.

Materials and Methods

The field experiment was conducted in the Agronomy experimental research farm of School of Aricultural Sciences and Rural Development, Nagaland University, Medziphema Campus, during *kharif* season of 2015. Seven soybean varieties viz. MACS-1614, SL-982, DS-2705, MAUS-612, JS-20-69, RKS-19 and JS-9752 were grown in randomized block design (RBD) with three replications in plots of 4.5 m × 2 m at spacing of 40 cm between rows and 10 cm between plants in a row. Well decomposed FYM @ 10 t ha^{-1} was uniformly broadcasted over the field and incorporated thoroughly 2 weeks before sowing. The recommended doses of fertilizers (RDF-25 kg N + 100 kg P_2O_5 + 50 kg K_2O ha^{-1}) were applied to the plots in the form of urea, single super phosphate and muriate of potash.

The crop was sown on 29th of June, 2015. The thinning and gap filling operation was carried out at 15 DAS with a view to maintain optimum plant population. To control weeds, two hand weedings were done at 20 and 40 DAS respectively. For protection from pests and diseases, seeds were treated with bavistin @ 3g kg^{-1} of seeds before sowing. Five plants from each plot were selected randomly and tagged with a label for recording various growth parameters such as plant height, number of leaves, leaf area index, number of root nodules, shoot dry weight and crop growth rate. The crop was harvested at two intervals, firstly in the last week of October and final harvesting was done in first week of November. The five tagged plants were used for recording various yield parameters and thereafter compilation and statistical analyses of the collected data was done.

Results and Discussion

Effect of different soybean varieties on growth attributes of soybean

The analysis of variance revealed significant differences among the varieties for all the growth parameters studied (Table 1). Significantly higher plant height was recorded with JS-9752 (61.08 cm). This finding is in agreement with the findings of Dubey et al. [4] who reported on the faster growth habit of JS–9752 as compared to other soybean varieties at different growth stages. JS-9752 produced significantly higher number of leaves (25.35) and significantly higher leaf area index. All the varieties showed an increase in number of leaves per plant with successive increase in crop growth. This may be due to an increase in plant height at successive stages of growth. The above findings is in agreement with the findings of Ali et al. [5] who reported significant difference among soybean varieties on number of leaves per plant at different growth stages. All the varieties showed low LAI during the first 30 DAS followed by rapid increase after commencement of flowering (45 to 50 DAS) depending upon the varieties [6]. Consequently, the increased LAI in soybean varieties at successive growth stages may be due to higher number of leaves per plant [7]. As a result, JS-9752 recorded the highest LAI due to highest number of leaves per plant. In contrast, SL-982 recorded the lowest LAI at different growth stages which is due to lower number of leaves per plant.

JS-9752 (27.90 g) recorded the highest shoot dry weight per plant which was found to be statistically at par with MAUS-612 (24.52 g) and RKS– 19 (24.17 g) and the lowest was recorded in MACS-1614 (16.88 g). The shoot dry weight per plant increased slowly till 45 DAS, and then increased sharply upto 60 DAS. However, the total dry matter accumulation varied depending on varieties and the stages of growth. Among the varieties, JS-9752 significantly recorded

Table 1. Effect of different soybean varieties on growth and growth attributes of soybean.

Treatments	Plant height (cm)	Number of leaves	Number of root nodules	Leaf area index	Shoot dry weight (g plant^{-1})	Crop growth rate (g m^{-2} day^{-1})
MACS-1614	46.51	17.33	56.00	1.15	16.88	13.34
SL-982	49.69	17.07	54.33	1.10	18.04	16.34
DS-2705	56.15	22.50	66.00	1.36	22.16	19.65
MAUS-612	57.69	23.00	68.80	1.39	24.52	22.56
JS-20-69	51.73	22.50	57.67	1.13	20.86	19.31
RKS-19	52.08	22.67	61.00	1.28	24.17	22.71
JS-9752	61.08	25.35	71.33	1.50	27.90	28.78
SEm ±	2.81	1.70	3.63	0.09	1.39	1.36
CD (p=0.05)	8.65	5.23	11.20	0.27	4.27	4.18

the highest shoot dry weight at all stages of growth, which may be attributed to successive increase in plant height in JS-9752 as reported by Dubey et al. [4]. Differences in plant height and number of leaves per plant which determine canopy structure and light interception may have been responsible for differences in dry matter accumulation [8].

JS– 9752 also recorded significantly higher crop growth rate (28.78 g m^{-2} day^{-1}). CGR is positively correlated with leaf area index [9]. Higher the LAI, faster was the total dry matter accumulation especially after the start of the reproduction stage as reported by Khan and Khalil [10]. The present finding is in agreement with the findings of Tandale and Ubale [3] who reported significant influenced of soybean varieties on CGR at different stages of growth. JS-9752 (71.33) significantly recorded the highest number of nodules which was found to be statistically at par with DS – 2705 (24.00),MAUS – 612 (35.77) and RKS-19 (61.00). The higher nodulation capacity of JS-9752 has also been reported by Dubey et al. [4] where soybean varieties JS-9752 gave highest number of root nodules per plant as compared to other soybean varieties.

Effect of different soybean varieties on yield attributes and yield

Significantly, the maximum number of pods per plant was recorded in JS-9752 (62.13) as compared with the rest of the treatments (Table 2). The higher number of pods in JS-9752 might be due to higher plant height at the crop growth stages coupled with optimum photosynthetic efficiency due to higher number of leaves and leaf area index which might have resulted in larger sink in terms of pods per plant. JS-9752 (2.25) recorded highest number of seeds per pod which was statistically at par with DS-2705 (2.18), MAUS-612 (2.20) and RKS-19 (2.13) respectively.

Table 2. Effect of different soybean varieties on yield attributes and yield.

Treatments	No. of pods per plant	No. of seeds per pod	Test weight (g)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
MACS-1614	32.20	2.01	132.65	1.20	2.40	33.34
SL-982	35.27	2.05	133.78	1.28	2.64	32.56
DS-2705	48.53	2.18	139.90	1.89	2.91	39.37
MAUS-612	52.20	2.20	141.06	2.32	3.12	42.20
JS-20-69	38.54	2.02	136.05	1.33	2.69	33.08
RKS-19	45.47	2.13	138.77	1.56	2.80	35.82
JS-9752	62.13	2.25	145.35	2.71	3.48	44.96
SEm ±	2.86	0.05	1.35	0.12	0.17	2.14
CD (p= 0.05)	8.81	0.17	4.16	0.38	0.52	6.60

The differences observed in number of seeds per pod of the different soybean varieties may be associated with photoperiodic response of soybean to daylength duration among the varieties. The higher number of seeds per unit land area resulted from increments in the number of pods, as seeds per pod remained unchanged [11]. There was considerable variation in the size of the seed; the differences in seed weight were mainly due to genetic characters of the varieties under study. As a results, significantly the highest test weight was recorded in JS-9752 (145.35 g) while the lowest test weight was recorded in MACS – 1614 (132.65 g).

Significantly, higher grain yield and stover yield was obtained with JS-9752 (2.71 t ha^{-1} and 3.48 t ha^{-1}), while the lowest grain yield was recorded in MACS-1614 (1.20 t ha^{-1}). The high seed yielding ability of JS-9752 may be attributed to its high nodulation capacity, leaf area index, shoot dry weight and crop growth rate. This result is in consistent with that of Tandale and Ubale [3] who reported that high yielding genotypes of soybean had greater capacity of total dry matter for higher LAI and CGR. The greater yield of JS-9752 can be attributed to significantly superior number of pods per plant, number of seeds per pod and 1000 seed weight produced by it, as compared to the other varieties in experiment. This result is consistent with the result of Deokar et al. [12] and Garud et al. [13] who reported that number of pod per plant, number of seed per plant and 1000 seed weight were the most effective selection indices for high seed yield in soybean. The higher stover yield ability of JS – 9752 has also been reported by Dubey et al. [4]. The variation in stover yield of the different soybean varieties may be attributed to genetic differences in growth habit, dry matter production and other growth parameters.

Significantly, highest harvest index was obtained with JS-9752 (44.96%) and the lowest was recorded in SL-982 (32.56%)which was statistically at par with MACS-1614 (33.34%). Harvest index showed high degree of positive significant association with biological yield, thus the soybean variety JS-9752 with highest seed yield and stover yield produced the highest harvest index significantly as compared with the other varieties cultivated. Reni and Rao [14] and Malek et al. [6] have reported on significant effect of soybean variety on harvest index.

The result obtained from the present investigation leads to the conclusion that JS-9752 resulted in better growth and yield attributing characters as compared to rest of the varieties. Performance of JS-9752 was found to be the best and thus found to be the most adoptable soybean variety suitable for the agroclimatic condition of Nagaland.

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