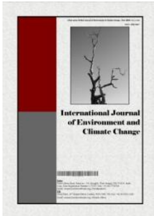

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Effect of Varieties and Crop Geometries on Yield and Profitability of Soybean in Semi – Arid Climate of Telangana

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Authors' contributions

This work was carried out in collaboration among all authors. Author KBSD managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

A field study entitled ''Evaluation of varieties at varied crop geometry for yield maximization in soybean'' was conducted at College farm, Agricultural College, Polasa, Jagtial, PJTSAU, during the kharif season of 2018. The experiment was laid out in split-plot design with three replications to evaluate the performance of promising varieties of soybean (V_1- Basar, V_2- JS 335, V_3- KDS 756 and V_4- MACS 1281) and to standardize the crop geometry for Soybean varieties (S_1- 45 x 10 cm, S_2- 30 x 10 cm, S_3- 45 x 05 cm and S_4- 35 x 05 cm) under rainfedsemi arid conditions of Telangana. The results obtained from the present experiment indicated that among the varieties the yield attributes and yield are numbers of pods plant^{-1}, number of seeds pod^{-1}, seed yield, stalk yield and harvest index (%) and monetary returns of KDS 756 variety was significantly higher as

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compared to other varieties followed by Basar, MACS 1281, respectively. Hundred seed weight was significant among varieties and was higher with variety KDS 756 followed by MACS 1281, JS 335 and Basar. JS 335 showed inferior performance regarding yield attributes yield and monetary returns. Among crop geometry 30 x 10 cm recorded higher yield characters and monetary returns followed by 45 x 05 cm, 30 x 05 cm and 45 x 10 cm, respectively.

Keywords: Economics; harvest index; seed yield; stalk yield.

1. INTRODUCTION

Soybean (*Glycine max*.L), often designated as a wonder crop, is an important pulse as well as oil seed crop of the world. In India, oilseed crops constitute the second largest agricultural produce, next to food grains and these are the important source of our economy contributing five per cent to Gross Net Profit (GNP). Soybean [*Glycine max* (L.) Merrill] the miracle crop of 21st century is called as poor meat and golden bean because of its multiple uses. Soybean crop is rich in high quality protein (40-42%), oil (18-20%) and other nutrients like calcium, iron and glycine. Being a legume plant, soybean has the ability to fix atmospheric nitrogen with the help of root nodules and also it adds organic matter to the soil, thereby increasing the productivity of soil. It is a good source of isoflavones and therefore it helps in preventing heart diseases, and cancer [1]. In the Indian area, the production and productivity of soybean during 2017 is 101.5 lakh ha, 91.4 lakh million tonnes and 900 kg ha^{-1} [1]. The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Telangana and Andhra Pradesh. In Telangana and Andhra Pradesh, the crop is grown in an area of 110 lakh ha with 147 Lakh tons of production and productivity of 1350 q ha^{-1} [2]. The cultivation of the soybean crops is increasing at a faster rate and is extensively grown in the Adilabad, Nizamabad, Medak and Karimnagar districts of Telangana state.

Soybean, *Glycine max* (L.) Merrill is a legume that grows in tropical, subtropical and temperate climates. It is generally grown under rainfed conditions. The optimum number of plants per unit area is one of the important parameters in increasing crop productivity. The optimum plant density with proper geometry of planting is dependent on variety, its growth habit and agro-climatic conditions. The competition for resources like nutrients, light, moisture and carbon di-oxide may be optimized by the suitable geometry of plants. Hence, row spacing and varieties both are the main factors of crop production.

The present investigation was, therefore, undertaken to generate the information on the ability of different soybean varieties and crop geometries on yield of soybean

2. MATERIALS AND METHODS

A field experiment was conducted at College farm, Agricultural College, Polasa, Jagtial, PJTSAU, during the kharif season of 2018 in split-plot design with three replications. To evaluate the performance of promising soybean varieties, namely (V_1- Basar, V_2- JS 335, V_3- KDS 756 and V_4- MACS 1281) and to standardize the crop geometry for promising soybean varieties (S_1- 45 x 10 cm, S_2- 30 x 10 cm, S_3- 45 x 05 cm and S_4- 35 x 05 cm) under rainfed semi-arid conditions of Telangana.

The experimental soil was sandy clay loam with pH 7.4, medium in organic carbon (0.5%), low in available nitrogen (247.3 kg ha^{-1}), high in available phosphorus (23.05 kg ha^{-1}) and potassium (326.8 kg ha^{-1}). The crop was supplied with recommended dose of fertilizer, i.e. 60 kg N, 60 kg P2 O5 and 40 kg K2 O/ha, through urea, single superphosphate and muriate of potash respectively. The weekly mean maximum and minimum temperature during the crop-growth period was 31.7°C and 23.1°C, respectively, and total rainfall received was 618 mm in 31 rainy days.

Crop was sown on on 3rd July, 2018 at varied geometry levels and each variety was harvested according to their duration as variety Variety KDS 756, JS 335 was harvested at 95 DAS while MACS 1281 at 98 DAS and Basar was harvested at 103 DAS respectively. The observations were recorded on yield attributes, yield and economics number of pods $plant^{-1}$, number of seeds pod^{-1}, seed yield, stalk yield and harvest index (%) from all the five tagged plants of each plot and analyzed statistically by split-plot design and the significance was tested by F-test [3] at 5 percent level of probability.

While regarding the observations on economics are gross monetary return, net monetary return and benefit cost ratio of the soybean were recorded. Gross monetary returns were calculated on the basis of prevailing market rate of produce. Net monetary returns were calculated treatment wise by substracting the cost of cultivation per hectare from the gross monetary returns. The prevailing market price of inputs and seeds were taken to calculate cost of cultivation. Benefit cost ratio calculated treatment wise. The gross income per hectare of each treatment was divided by the cost of cultivation of respective treatment

3. RESULTS AND DISCUSSION

3.1 Yield Attributes and Yield

3.1.1 Number of pods plant^{-1}

The data pertaining to number of pods plant^{-1}as influenced by varieties and crop geometry presented in Table 1.

Among the varieties tested, higher number of pods plant^{-1}was produced by KDS 756 (68.6) variety which was significantly higher over all other varieties. Followed to this, Basar has higher number of pods plant^{-1}(63.0) and was followed by MACS 1281 (57.8) and JS 335 (51.8). KDS 756 has recorded higher no of pods plant^{-1}(8.1%, 15.7% and 24.4%) compared to Basar, MACS 1281 and JS 335. The variety KDS 756 showed superiority over rest of the varieties due to the increase in plant height that has increased the number of nodes which in turn increased dry matter and number of branches plant^{-1}. It resulted in effective translocation and distribution of photosynthates from source to sink and finally resulted in maximum number of pods plant^{-1}in the soybean genotypes. Variation among varieties was also noticed [4].

With every increase in crop geometry from 30 x 10 to 45 x 10 cm, the number pods plant^{-1}decreased significantly due to lesser plant population m^{-2}. Among the various crop geometry levels, highest number pods plant^{-1}observed at medium spacing of 30 x 10 cm (64.6) which was closely followed by 45 x 05 cm (61.7). Spacing of 30 x 10 cm might have created favourable environment for optimum branching and resulted in production of higher number of pods plant^{-1}. This was supported by [5]. Spacing of 30 x 05 cm produced higher number of pods plant^{-1}(58.2) which was at par with 45 x 10 cm spacing (56.8). Spacing of 30 x 10 cm showed marked increase in number of pods plant^{-1}compared to other spacings. This was supported by [6].

The interaction between varieties and crop geometry was found non significant on number of pods plant^{-1}.

3.1.2 Number of seeds pod^{-1}

The data pertaining to number of seeds pod^{-1}as influenced by varieties and crop geometry was presented in Table 1. Maximum numbers of seeds pod^{-1} was recorded by the variety KDS 756 (2.8) and was at par with Basar (2.7) which was in turn at par with MACS 1281 (2.5) which was also in turn at par with JS 335 (2.4). KDS 756 has recorded higher number of seeds pod^{-1}(3.5%, 10.7% and 14.2%) compared to Basar, MACS 1281 and JS 335. The numbers of seeds pod^{-1} is another important yield attributing character that determines the yield of varieties. The differential response of varieties in respect of number of seeds pod^{-1} was reported by [7,4].

Among the various crop geometry levels, highest number of seeds pod^{-1}was recorded by 30 x 10 cm (2.8). Spacing of 45 x 05 cm produced higher number of seeds pod^{-1} (2.6) was at par with 30 x 05 cm (2.5). Lower number of seeds pod^{-1}was recorded by 45 x 10 cm (2.3). Spacing of 30 x 10 has showed marked increase in number of pods plant^{-1} compared to other spacings. This was supported by [6].

Interaction between varieties and crop geometry levels was found significant on number of seeds pod^{-1}. Treatment combination of KDS 756 along with crop geometry of medium spacing 30 x 10 cm registered significantly higher number of seeds pod^{-1} (3.1) and was at par with Basar with 30 x 10 cm (2.9) which was in turn at par with MACS 1281 with 30 x 10 cm (2.7). MACS 1281 were at par with JS 335 (2.5) with the spacing 30 x 10 cm.

3.1.3 100 seed weight

The data pertaining to hundred seed weight as influenced by varieties and crop geometry was presented in Table 1. Maximum hundred seed weight was recorded by the variety KDS 756 (13.6 g) was at par with MACS 1281 (13.3 g) which was in turn at par with JS 335 (12.6 g). Basar has lower seed weight (10.8 g) because of smaller size of seeds. The bold seed quality KDS

756 was the main reason for higher seed weight. Similar observation was also reported by [4].

Among the different spacing treatments, highest hundred seed weight recorded at 30 x10 cm (13.0 g) which was at par with 45 x 05 cm (12.6 g) and in turn at par with 30 x 05 cm (12.4 g). 30 x 05 cm was also at par with 45 x 10 cm (12.3 g) this might be due to effective translocation and distribution of photosynthates from source to sink at medium spacing treatments. Similar observation was also reported by [1,8].

The interaction between varieties and crop geometry was found non significant on hundred seed weight.

3.1.4 Seed yield (kg ha^{-1})

The data pertaining to seed yield as influenced by varieties and crop geometry presented in Table 2. Maximum seed yield was recorded by the variety KDS 756 (2178 kg ha^{-1}) was at par with Basar (2006 kg ha^{-1}) which was in turn at par with MACS 1281 (1885 kg ha^{-1}). Lowest seed yield was observed in JS 335 (1538kg ha^{-1}). KDS 756 has recorded highest seed yield (7.8%, 13.4%, 29.3%) compared to Basar, MACS 1281 and JS 335. The highest seed yield in KDS 756 can be attributed to highest dry matter production, more number of pods $plant^{-1}$, and numbers of seeds pod^{-1} was presented in Table 1. The higher chlorophyll content might have increased the photosynthate production and their translocation to developing seeds, thereby increasing the seed yield. The differential varieties response in respect of seed yield was reported by [9,10].

Seed yield of soybean was decreased as widening the crop geometry. Among the different spacing's, highest seed yield was obtained under 30 x 10 cm (2064 kg ha^{-1}) which was followed by 45 x 05 cm (1954 kg ha^{-1}), 30 x 05 cm (1843 kg ha^{-1}) and 45 x 10 cm (1746 kg ha^{-1}). Spacing of 30 x 10 cm has recorded highest seed yield (5.3%, 10.7%, 15.4%) compared to 45 x 05 cm, 30 x 05 cm and 45 x 10 cm. These results indicated that medium spacing (30 x 10 cm) resulted in higher assimilation and energy production for optimum vegetative growth and yield attributes like number of pods $plant^{-1}$, number of seeds pod-1 and hundred seed weight which ultimately resulted in higher seed yield. Similar results were reported by [11,12].

The interaction between varieties and crop geometry was found non significant on seed yield. However, combination of variety KDS 756 along with spacing of 30 x 10 cm produced higher seed yield and was closely followed by the same variety at 45 x 05 cm and 30 x 05 cm. The variety Basar along with geometry level of 30 x 10 cm produced next higher seed yield.

3.1.5 Stalk yield (kg ha^{-1})

The data pertaining to stalk yield (kg ha^{-1}) of soybean as influenced by different varieties and various crop geometry presented in Table 1.

Stalk yield was significantly influenced by varieties and crop geometry. Among the varieties tested, the stalk yield obtained by KDS 756 (4815 kg ha^{-1}) which was at par with Basar (4758 kg ha^{-1}) which was in turn at par with MACS 1281 (4620 kg ha^{-1}). Lowest stalk yield was recorded by JS 335 (4034 kg ha^{-1}). This may due to higher vegetative growth of KDS 756 as evident from higher plant height, leaf area and dry matter production. Similar results in respect of stalk yield were reported by [5] and [4].

Spacing of 30 x 05 cm (8348 kg ha^{-1}) recorded highest stalk yield which was significantly superior over other spacing's and lowest stalk yield was observed with wider spacing 45 x 10 cm. This indicates that stalk yield decreased as increased inter and intra plant spacing. This was attributed to higher vegetative growth, due to efficient utilization of available resources under closer spacing i.e., higher plant population per unit area. This was supported by [6,13].

The interaction between varieties and crop geometry was found non significant on stalk yield.

3.1.6 Harvest index

The data pertaining to harvest index as influenced by varieties and crop geometry presented in Table 1.1. Maximum harvest index was recorded by the variety KDS 756 (37.3%) followed by Basar (34.2%), MACS 1281 (33.8%) and JS 335 (32.3%). The harvest index was found not significant among the varieties. This was supported by [14].

Harvest index of soybean was increased as widening the crop geometry. Among the different spacings, highest harvest index was recorded by the wider spacing of 45 x 10 cm (53.5%) which was followed by 30 x 10 cm (37.9%), 45 x 05 cm (28.2%) and 30 x 05 cm (18.1%). They found not

Table 1. Number of seeds pod^{-1}, Number of pods plant^{-1} and hundred seed weight (g) of soybean as influenced by varieties and crop geometry

Treatments	Yield attributes			Yield (kg ha^{-1})		
	Numbers of seeds pod^{-1}	Number of pods plant^{-1}	100 seed weight	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
Varieties						
V_1:Basar	2.7	63.0	10.8	2006	4758	34.2
V_2:JS-335	2.4	51.8	12.6	1538	4034	32.3
V_3: KDS-756	2.8	68.6	13.6	2178	4815	37.3
V_4:MACS1281	2.5	57.8	13.3	1885	4620	33.8
S.Em ±	0.06	0.9	0.3	52	95	1.4
CD (P=0.05)	0.2	3.3	0.9	184	334	NS
Crop geometry (cm)						
S_1 : 45 × 10	2.3	56.8	12.3	1746	1515	53.5
S_2 : 30 × 10	2.8	64.6	13.0	2064	3373	37.9
S_3 : 45 × 05	2.6	61.7	12.6	1954	4994	28.2
S_4 : 30 × 05	2.5	58.2	12.4	1843	8348	18.1
S.Em ±	0.04	0.8	0.2	30	114.2	1.0
CD (P=0.05)	0.12	2.4	0.5	86	335.4	NS
Interaction V × S						
S.Em ±	1.7	0.1	0.4	73	219	2.0
CD (P=0.05)	NS	0.3	NS	NS	NS	NS
Interaction S × V						
S.Em ±	1.9	0.1	0.5	73	219	2.0
CD (P=0.05)	NS	0.3	NS	NS	NS	NS

significant among the crop geometry levels. Similar results were repoted by [15].

The interaction between varieties and crop geometry was found non significant on harvest index.

3.2 Economics

3.2.1 Cost of cultivation, Gross returns, Net returns and B:C ratio

The data pertaining to economics in terms of cost of cultivation, gross returns, net returns and benefit cost ratio of soybean as influenced by different varieties and various crop geometries presented in Table 2.

Maximum gross returns (Rs. 77841 ha^{-1}), net returns (Rs. 56380 ha^{-1}) and benefit-cost ratio (3.6) were obtained with KDS 756 variety and closely followed by Basar which was superior to MACS 1281 and JS 335. Low monetary returns were obtained with JS 335. B:C ratio of Basar (3.3) was at par with MACS 1281 (3.1). Cost of cultivation was higher with variety JS 335 (Rs. 21773 ha^{-1}) due to the failure of seed germination so, more number of seeds required. Least cost of cultivation was recorded with the variety of KDS 756 (Rs. 21460 ha^{-1}) due to better performance of the variety. Selection of the suitable variety is important non monetary input that influences the seed yield and gross returns and was supported by [8,16].

Table 1.1. Interaction between varieties and crop geometry on of number of seeds pod^{-1}soybean at harvest

Treatments	Crop geometry (cm)				
	S_1 :45 × 10	S_2 :30 × 10	S_3 :45 × 05	S_4: 30 × 05	Mean
Varieties					
V_1:Basar	2.5	2.9	2.7	2.5	2.7
V_2:JS-335	2.3	2.5	2.4	2.3	2.4
V_3: KDS-756	2.3	3.1	3.0	2.8	2.8
V_4:MACS1281	2.3	2.7	2.5	2.4	2.5
Mean	2.3	2.8	2.6	2.5	
InteractionV × S	**S.Em ±**0.1		**CD (P=0.05)** 0.3		
Interaction S× V	**S.Em ±**0.1		**CD (P=0.05)** 0.3		

Table 2. Gross returns (ha^{-1}), net returns (Rs. ha^{-1}) and benefit cost ratio of soybean as influenced by varieties and crop geometry

Treatments	Cost of cultivation	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Benefit cost ratio
Varieties				
V_1:Basar	21648	71916	50267	3.3
V_2:JS-335	21773	59268	37494	2.7
V_3: KDS-756	21460	77841	56380	3.6
V_4:MACS1281	21710	67287	45576	3.1
S.Em ±	-	1120	1120	0.05
CD (P=0.05)	-	3953	3953	0.18
Crop geometry (cm)				
S_1 : 45 × 10	20002	61383	41318	3.1
S_2 : 30 × 10	21472	75510	54163	3.5
S_3 : 45 × 05	22207	71568	49298	3.2
S_4 : 30 × 05	22912	67851	44939	3.0
S.Em ±	-	1112	1112	0.05
CD (P=0.05)	-	3265	3265	0.15
Interaction V × S				
S.Em ±	-	2228	2228	0.11
CD (P=0.05)	-	NS	NS	NS
Interaction S × V				
S.Em ±	-	2241	2241	0.11
CD (P=0.05)	-	NS	NS	NS

Cost of cultivation was higher with the closer spacing of 30 x 05 cm (Rs. 22912 ha^{-1}) due to usage of more inputs like higher seed rate for sowing, gap filling and thinning operations. Least cost of cultivation was with the wider spacing of 45 x 10 cm (Rs. 20002 ha^{-1}). Plant density also significantly influenced the economics of soybean seed production With each decrease in crop geometry from 30 x 10 cm to 30x 05 cm, gross returns, net returns and benefit-cost ratio increased, however B: C ratio of crop geometry 45 x 05 was at par with 45 x 10 cm (3.1) which was in turn at par with 30 x 05 cm (3.0). This was supported by [15].

Therefore, for realizing maximum seed yields, KDS 756 variety with medium crop geometry (30 x 10 cm) may be adopted in sandy clay loam soils in semi arid regions of Telangana.

The interaction between varieties and crop geometry was found non significant on net returns, gross returns and benefit cost ratio.

4. CONCLUSIONS

From the above studies it is concluded that among the varieties tested KDS 756 gave higher yield attributes, yield and economics. Under crop geometry of 30 x 10 cm which gave highest yield attributes, yield and economics. The interaction of KDS 756 at geometry level 30 x 10 cm followed by same variety at next closer spacing 45 x 05 cm had higher yield attributes, seed yield, stalk yield and economics . Accumulation of dry matter was higher at closer spacing 30 x 05 cm due to higher plant population per unit area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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