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PERFORMANCE OF NEW SOYBEAN GENOTYPES ON GROWTH AND YIELD ATTRIBUTES UNDER DIFFERENT ROW SPACING IN VERTISOL SOIL

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ABSTRACT

A field experiment entitled "Performance of new soybean genotypes under different row spacing in vertisol soil" was conducted at Regional Research Centre Amravati, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season of 2021-22. The experiment was laid out in Split plot design with four replication and twelve treatment combinations. Treatment combinations were comprised of two row spacing *viz.*, S_1 (30 × 7 cm), S_2 (45 × 5 cm) and six genotypes *viz.*, NRC-165, NRC-152, HIMSO-1689, JS-2172, AMS-1001 (PDKV Yellow Gold), AMS -100-39 (PDKV Amba). The gross and net plot size were 3.6 m × 6.0 m and 2.7 m × 5.4 m respectively. The crop was sown as per treatments with spacing S_1 (30 × 7 cm) and S_2 (45 × 5 cm). Row spacing S_2 (45 × 5 cm) was found to be significantly superior over row spacing S_1 (30 × 7 cm) in respect of various growth, yield attributes and economics of Soybean *viz.*, Number of branches, dry matter (g), number of nodules, number of pod plant^{-1}, weight of pod plant^{-1} and seed yield plant^{-1}, GMR, NMR and B:C ratio. Row spacing of S_2 (45 × 5 cm) recorded higher GMR ¹ 94053, NMR, 51676 and B: C ratio of 2.21. In respect of various genotypes, AMS-100-39 (PDKV Amba) resulted in higher growth, yield attributes and economics. Sowing of soybean with row spacing S_2 (45 × 5 cm) and genotype G_6- AMS-100-39 was found more efficient for increasing the growth and yield attributes under vertisol soil. Genotype G_6- AMS-100-39 recorded higher GMR Rs 105859, NMR 63288 and B: C ratio of 2.48

***Key words*:** Genotypes, Row spacing, Soybean, Vertisols

Introduction

Soybean (*Glycine max* (L.) Merrill) is a major leguminous oilseed crop which fixes nitrogen from the atmosphere. Soybean crop produces a considerable quantity of biomass, which boosts the soil's organic matter content. As a result, there is a lot of room to boost soybean production by raising the productivity. Soybean is the world's second largest source of edible oil. It is primarily grown during *kharif* season. Soybean is considered as the "wonder crop" of the twentieth century, since it is widely used as an oilseed, vegetarian food and milk purpose. It contains a rich content of iron and vitamin C. With symbioses of *Rhizobium japonicum* bacterium, soybean is capable of fixing atmospheric nitrogen at the rate of 65-115 kg N ha^{-1} year^{-1} (Alexander,1977).

In the world it is grown on an area of 121.20 million hectare with production of 384.06 million tonnes. In India the area occupied by soybean has been steeply increased from 101 lakh ha in 2011-12 to 121.93 lakh ha in 2019-20 with an average productivity of 9.21 q ha^{-1} whereas in Maharashtra the area is 41.25 lakh ha which produced 48.25 lakh MT with productivity of 1170.13 kg ha^{-1}. In Vidarbha, area is 17.49 lakh ha which produced 19.21 lakh MT with productivity of 1098.35 kg ha^{-1}. The Cabinet Committee on Economic Affairs has increased the minimum support price (MSPs) of Soybean crop from Rs.3880 per quintal to Rs. 3950 per quintal for marketing season 2021-22, i.e., 1.8 percent increase over last year.

(AICRP, 2020-21).

Plant population is a significant non-monetary input and an ideal factor for increased realisation through crop canopy light penetration. Plant competition increases as row spacing decreases, causing canopy stress and reducing the benefit of narrow row spacing, especially when climatic conditions limit plant development. Whigham and Whigham and Lundvall (1996) optimised the optimum plant population for soybean crop based on row spacing. The optimal plant density with suitable planting geometry prevails on agroclimatic conditions. For increased crop development and yield, the row-to-row spacing with plant population should be maintained. Plant spacing that is equidistant increases plant growth rate, dry matter accumulation and seed yield. Moisture stress has been documented to reduce the yield benefit from narrow spacing (Heitholt *et al.*, 2005). Therefore, it is imperative to find out the optimum row spacing for newly released soybean genotypes under different agro-climatic condition to improve yield potential of soybean.

Optimum row spacing improves the efficiency of individual plant as it is ultimately associated with root development and shoot growth. Plant may show better growth and development and give increased yield per plant but may not give maximum yield per unit area because of less plant population. Thus, for assessment of potential economic yield, the optimum row spacing is essential.

The ability to explore the environment to the best of one's ability is a crucial characteristic of an ideal genotype that can be portrayed through yield and economics. Therefore, the only way to make this plant's potential cost-effective is to adjust the optimum plant population. The optimum row spacing is the foundation for achieving the proper plant population that can produce good results with minimal input. According to changes in the physiological and morphological features, the row spacing varies with genotypes. Furthermore, by defining the plant population, different row spacing of the same genotypes will differ in accordance with the nutrients, moisture and light use patterns paving the way for the evaluation of the most suitable and cost-effective combination of row spacing of given genotypes by researching about the performance of new soybean genotypes under different row spacing in vertisols soil.

Materials and Methods

Field experiment was carried out during *kharif* season of 2021-2022 at the Agronomy farm of Regional Research Centre Amravati, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil of experimental plot was vertisol with uniform and levelled topography. The chemical composition according to criteria laid by Subbiah and Asija (1956) indicate that, soil was low in available nitrogen 192 kg ha^{-1}, low in available phosphorus 16.50 kg ha^{-1} and rich in potassium 325 kg ha^{-1}. The soil was slightly alkaline in reaction (pH 7.75) with an electrical conductivity of 0.35 dSm^{-1}.

Table 1: Plant height (cm), No. of branches, Leaf area (dm^2) plant^{-1}, No. of root nodules and Total dry matter (g) accumulation plant^{-1} (g) of soybean as influenced by different treatments.

Treatments	At harvest				
	PH	NBP	LA	NRNP	TDAP
Row spacing (cm)					
S_1 (30 × 7 cm)	74.31	2.38	6.60	78.78	26.57
S_2 (45 × 5 cm)	70.81	2.79	7.10	87.39	30.82
SE ±	**0.72**	**0.12**	**0.30**	**1.07**	**1.39**
CD at 5%	**2.11**	**0.93**	**NS**	**3.16**	**4.09**
Genotypes					
G_1- NRC-165	70.64	2.53	6.61	77.33	26.30
G_2- NRC-152	71.26	2.22	6.55	82.50	25.50
G_3- HIMSO-1689	71.46	2.51	6.85	83.66	27.70
G_4- JS-2172	76.86	2.69	7.75	82.50	28.08
G_5- AMS-1001	71.98	2.20	6.45	79.16	30.77
G_6- AMS-100-39	73.14	3.32	7.08	93.33	33.80
SE ±	1.34	**0.32**	**0.58**	**3.33**	**1.76**
CD at 5 %	**3.96**	**0.93**	**NS**	**9.83**	**5.18**
Interaction (S × G)					
SE ±	**1.51**	**0.18**	**0.39**	**3.95**	**1.56**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**
GM	**72.56**	**2.58**	**6.85**	**83.08**	**28.69**

PH: Plant height (cm); NBP: No. of branches plant^{-1};
LA: Leaf area (dm^2) plant^{-1}(80 DAS);
NRNP: No. of root nodules plant^{-1} (at 40 DAS);
TDAP: Total dry matter accumulation plant^{-1}(g)

Geographically Amravati is situated at latitude of 20° 55' 53.82" North and longitude of 77° 45' 32.57" East and semi-arid climate. Total rainfall received during the crop growth period was 1139.8 mm.

The experiment was conducted with twelve treatment combinations comprising of two row spacing *viz.*, S_1 (30 × 7 cm) and S_2 (45 × 5 cm) and six genotypes *viz.*, G_1- NRC-165, G_2- NRC-152, G_3- HIMSO-1689, G_4- JS-2172, G_5- AMS-1001 (PDKV Yellow Gold) and G6- AMS-100-39 (PDKV Amba). The experiment was laid out in split plot design with four replications in *kharif* season of 2021-22. The recommended cultural practices and plant protection measures were taken. Growth, yield and economic attributes were estimated as per the standard procedure.

Table 2: No. of pods plant^{-1}, No. of seeds pod^{-1}, Wt. of pods plant^{-1} (g), No. of seeds plant^{-1}, Seed weight plant^{-1} of soybean as influenced by different treatments.

Treatments	NP	NSP	WPP	NSP	SWP
Row spacing (cm)					
S_1 (30 × 7 cm)	24.56	2.65	13.47	87.81	7.92
S_2 (45 × 5 cm)	29.83	2.78	15.61	95.69	9.86
SE ±	**0.46**	**0.18**	**0.63**	**2.62**	**0.45**
CD at 5%	**1.34**	**NS**	**1.86**	**7.73**	**1.34**
Genotypes					
G_1- NRC-165	22.06	2.79	13.19	78.84	7.38
G_2- NRC-152	23.03	2.76	12.24	82.69	7.06
G_3- HIMSO-1689	27.43	2.20	12.14	73.81	7.20
G_4- JS-2172	25.77	2.83	14.32	92.69	8.79
G_5- AMS-1001	31.48	2.76	15.40	104.69	10.45
G_6- AMS-100-39	33.10	2.93	19.93	117.78	12.42
SE ±	**1.34**	**0.11**	**0.62**	**0.12**	**0.34**
CD at 5 %	**3.95**	**0.34**	**1.82**	**0.34**	**1.00**
Interaction (S × G)					
SE ±	**0.95**	**0.07**	**0.51**	**0.07**	**0.21**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**
GM	**27.19**	**2.71**	**14.54**	**91.75**	**8.89**

NP: No. of pods plant^{-1}; NSP:No. of Seeds pod^{-1};
WPP: Wt. of pods plant^{-1} (g);
NSP: No. of Seeds plant^{-1}; SWP: Seed Wt. plant^{-1};

Results and Discussion

Growth attributes

The various growth parameters of soybean *viz*., plant height, number of branches plant^{-1}, Leaf area (dm^2) plant^{-1} number of root nodules plant^{-1} and dry matter accumulation plant^{-1} (g) were significantly influenced due to row spacings and genotypes which are recorded and results are provided in Table 1. The mean plant height (cm) of soybean was significantly influenced by different row spacing during crop growth period, in the treatment of row spacing S_1 (30 × 7 cm) recorded significantly higher plant height (74.31 cm) at harvest over row spacing S_2 (45 × 5 cm). This might be due to the inter-competition for sunlight owing to high plant population at S_1 (30 × 7 cm) which attributed to more stem elongation and higher plant height. These results were also supported by Jaybhay *et al.*, (2014 and Verma *et al.*, (2020). Row spacing at 80 DAS has not effect on leaf area plant$^{-1.}$ Row spacing S_2 (45 × 5 cm) recorded higher number of branches plant^{-1} (2.79) and dry matter accumulation plant^{-1} (30.82 g) over other row spacing S_1 (30 × 7 cm) at harvest and similar trend was observed with the number of root nodules (87.39) at 40 DAS. These results were in close agreement with the results of Nimje (1996) and Verma *et al*., (2020). The data presented in Table 1 indicate that genotype G_4- JS-2172 recorded significantly higher plant height (76.86 cm) at harvest and leaf area plant^{-1} at 80 DAS. The genotype G_6- AMS-100-39 (PDKV Amba) recorded highest number of branches plant^{-1} (3.32) and dry matter accumulation plant^{-1} (33.80 g) at harvest and similar trend was observed with the number of root nodules (93.33) at 40 DAS. Similar results were also reported by Malek *et al*., (2012) and Vyas and Khandwe (2014). Interactions between row spacings and genotypes had no significant effect on plant height, leaf area plant^{-1}, number of branches plant^{-1}, number of root nodules plant^{-1} and dry matter accumulation plant^{-1}.

Table 3: Gross monetary returns, cost of cultivation, net monetary returns (Rs. ha$^{-1)}$ and benefit cost ratio of soybean as influenced by different treatments.

Treatments	GMR (Rs. ha^{-1})	COC (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C ratio
Row spacing (cm)				
S_1 (30 × 7 cm)	85055	42142	42913	2.01
S_2 (45 × 5 cm)	94053	42377	51676	2.21
SE ±	**492**	-	**475**	-
CD at 5%	**1450**	-	**1402**	-
Genotypes				
G_1- NRC-165	84137	42028	42108	2.00
G_2- NRC-152	77554	41865	35689	1.85
G_3- HIMSO-1689	80527	41929	38597	1.92
G_4- JS-2172	93925	42260	51665	2.22
G_5- AMS-1001	95323	42302	53021	2.25
G_6- AMS-100-39	105859	42571	63288	2.48
SE ±	**1478**	-	**1443**	-
CD at 5 %	**359**	-	**4257**	-
Interaction (S × G)				
SE ±	**1362**	-	**1335**	-
CD at 5%	**NS**	-	**NS**	-
GM	**89554**	**42259**	**47294**	**2.11**

Yield attributes and seed yield

From the data depicted in Table 2, it was revealed that effect of row spacing on yield attributes and seed yield was found to be significant. Row spacing S_2 (45 × 5 cm) recorded significantly higher number of pods plant^{-1}, No. of seeds pod^{-1}, Wt. of pods plant^{-1} (g), No. of seeds plant^{-1}, Seed weight plant^{-1} and seed yield (kg ha^{-1}) at harvest. This might be due to higher growth characters exhibited by the plants in wide row spacing. The adverse effect of narrow row spacing on pod bearing ability in soybean was also reported by Ibrahim (2012), Mahesh *et al*., (2017) and Verma *et al*., (2020), respectively.

From the data presented in Table 2, it was revealed that yield attributes and seed yield were significantly influenced due to different genotypes. The No. of pods plant^{-1}, No. of seeds pod^{-1}, Wt. of pods plant^{-1} (g), No. of seeds plant^{-1}, Seed weight plant^{-1} and seed yield (kg ha^{-1})

were recorded significantly higher in genotype G_6- AMS-100-39 (PDKV Amba) but it was at par with genotype G_5- AMS-1001 (PDKV Yellow Gold). Whereas significantly lowest seed yield (kg ha^{-1}) was recorded in genotypes G_2- NRC-152. It was evident from the data that significant difference recorded in pods $plant^{-1}$ could attributed to growth behaviour of genotypes like branching. Further, variation in pod bearing ability among genotypes might be due to genetic inheritance. Similar results were reported by Sharma and Sharma (1993) and Lyimo *et al.*, (2017), respectively. Interactions between row spacings and genotypes had no significant effect on number of pods $plant^{-1}$, No. of seeds pod^{-1}, Wt. of pods $plant^{-1}$ (g), No. of seeds $plant^{-1}$, Seed weight $plant^{-1}$ and seed yield (kg ha^{-1}).

From the data presented in Table 3, it was revealed that different row spacing had significant influence on Gross Monetary Returns, Net Monetary Returns and benefit-cost ratio. Significantly highest GMR, NMR and B:C ratio was recorded under row spacing S_2 (45 × 5 cm) and lowest NMR was recorded for row spacing S_1 (30 × 7 cm). The results were in close confirmity with the results reported by Vyas and Khandwe (2014) and Pallavi *et al.*, (2015). From the data presented in Table 3, it was revealed that GMR, NMR and B:C ratio was found to be influenced significantly due to different genotypes. The highest GMR, NMR and B:C ratio was registered by the genotype G6- AMS-100-39 (PDKV Amba) followed by G_5- AMS-1001 (PDKV Yellow Gold). Whereas lowest GMR was recorded by the genotype G_2- NRC-152. Similar results were reported by Singh *et al.*, (2014). Interactions between row spacings and genotypes had no significant effect on GMR, NMR and B:C ratio.

Conclusions

Row spacing (45 × 5 cm) recorded better growth parameters, yield attributes and significantly higher GMR, NMR and B:C ratio. However, the higher plant height was recorded by genotype JS-2172 under row spacing of (30 × 7 cm). Genotype AMS-100-39 (PDKV Amba) recorded better growth parameters, yield attributes and higher GMR, NMR and B:C ratio.

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