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RESEARCH ARTICLE :

Influence of plant density on the performance of soybean (*Glycine max* L.) genotypes

M. PALLAVI, N. SANDHYA KISHORE, J. KAMALAKAR, U. NAGABHUSHANAM AND FIRDOZ SHAHANA

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SUMMARY : The aim of the study was to identify optimum intra row spacing for higher yields in different soybean genotypes. A field experiment was conducted during *rainy* 2013 at Regional sugarcane and rice research Station, Rudrur with eight elite soybean genotypes and three intra row spacings (5cm, 7.5 cm and 10cm). Experiment was laid out in randomized complete block design in split plot arrangement randomizing genotypes in the main plot and three intra row spacings in the sub plots with two replications. Grain yield was found to be non significant at three intra row spacings and significant among varieties, however intra row spacing of 10 cm was found to be superior, while genotype V4 (Basar) recorded highest grain yield of 33.67 Q/ha. Among the three population densities studied there is no significant difference in yield hence a spacing of 30 x 10cm can be taken up so that seed cost can be reduced. Higher yield at a spacing of 30 x 10 cm is due to significant increase in yield contributing characters i.e number of clusters/plant (23.35) and number of pods/plant (74.16) at this spacing. An intra row spacing of 30 X 10 cm with a population density of (0.30 million plants / ha) was found to be optimum for soybean production.

KEY WORDS:
Genotypes, Intra row spacing, Soybean, Grain yield

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Author for correspondence :
M. PALLAVI
Regional Sugarcane and Rice Research Station, Rudrur, NIZAMABAD (M.S.) INDIA
Email : sripal7276 @gmail.com

See end of the article for authors' affiliations

BACKGROUND AND OBJECTIVES

The world population is increasing at alarming rate and obviously overwhelming majority of this populous world is suffering due to the insufficient and imbalanced diet. The plant Scientists are facing the challenge that how to meet the food requirements of this unchecked population (Thirftle *et al.*, 2003). As resources are squeezing and population is hiking therefore crop scientists are focusing on improved varieties coupled with improved management practices and advanced crop husbandry techniques. In this acute context, leguminous crops are excellent option of dietary protein and these crops when used as food with other cereals these definitely meet the requirement of a balanced diet. Legume crops are used with zeal as delicious food in the poor countries and in the modern world; these are being utilized to maintain a good health. Being leguminous, they

maintain soil health and fertility by fixing atmospheric nitrogen in available from through symbiosis with rhizobial strains and are also important component of animal feed and their dried straw is used as hay.

Soybean is aptly called as "Miracle crop" of the 20th century, because of its multiple uses. It has highest protein (42%), Oil (20%) (Gopalan *et al.*, 1994) rich in lysine and vitamins A, B and D. Many developing countries in the tropics show interest in the production of soybean to meet their increasing demand for protein and vegetable oil. In the international world trade markets, soybean is ranked number one in world among the major oil crops such as rape seed, ground nut, cotton seed, sunflower, linseed, sesame and safflower (Chung and Singh, 2008).

Soybean being cultivated as rainfed crop during Rainy season. Presently India ranks fifth in acerage and in production in the globe. Area with respect to soybean cultivation has steadily increased over the years from 300 ha in 1961 to the present area of 120.37 million ha (2013) Producing a whopping 120.345 million tones with productivity level of 1017 kg/ha. (SOPA, 2013). In Andhra Pradesh the soybean area has increased from 1.55 lakh ha in 2011 to 2.84 lakh ha in 2013.

Among many other crop production constraints, seed production technology particularly post harvest seed losses in soybean *viz.*, rapid loss of vigour and germination percentage are the major challenging problem for the crop scientists and which in turn creating shortage in the availability of quality soybean seed to the farmers every year. In this context due emphasis must be given to utilize the optimum seed rate per acre without reducing yield per unit area by modifying agronomic management practices. Therefore, the present study was initiated to find out the optimum requisite intra row spacing of soybean (*Glycine max* L) varieties under agro-climatic conditions of Rudrur.

RESOURCES AND METHODS

The field experiment was conducted during Rainy 2013 at Regional sugarcane and rice research station, Rudrur ($77^0$88'N, $18^0$58'E) with eight soybean (*Glycine max* L) varieties collected from Agricultural Research Station, Adilabad grown under varying intra row spacings laid out in Randomized complete Block Design (RCBD) with split plot arrangement randomizing varieties in the main and intra row spacings in the sub plots with two replications using the net plot size of 6m X 3m. The experiment comprised of the following treatments.

A. varieties (Main plot)		B. Intra row spacing (Sub plot)
V1 AMS MB 5-18	V5 KS-103	S1 5 cm
V2 AMS MB 5-19	V6 KDS-344	S2 7.5 cm
V3 BHEEM	V7 JS-335	S3 10 cm
V4 BASAR	V8 JS 93-05	

Seed bed was prepared uniformly for the whole experiment and the sowing was carried out in respective plots in the second fortnight of June, 2013 according to the treatments with recommended doses of fertilizers. All other agronomic practices were kept normal and uniform. The crop was harvested during the first fortnight of October when 90% pods were matured and was properly dried in the sun before threshing.

The data recorded were tabulated and analyzed statistically using fisher's analysis of variance technique and least significant difference (LSD) test at 5% probability level was applied to compare the differences among treatment means (Steel *et al.*, 1997).

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads :

Growth attributes:

The different growth attributes *viz.*, days to 50% flowering, plant height, no. of nodes plant^{-1} and no. of branches plant^{-1} is presented in table 2. Days to 50% flowering and plant height showed significant difference among varieties. The variety V6 (KDS-344) has taken maximum days for 50% flowering while V8 (JS-93-05) recorded lowest no. of days to 50% flowering similarly variety KDS-344 recorded highest plant height.

However these characters was found to be non significant under different spacings. These results are in accordance with Ahmed *et al.* (2010) who suggested that days to 50% flowering is a varietal character and genetically controlled and spacing cannot influence this character. The significant variation in plant height among varieties may be due to genetic characteristics for this trait.

Number of nodes plant^{-1} and no. of branches plant^{-1} showed non significant influence among different varieties. Number of branches plant^{-1} showed significant

variation among different spacings and no. of branches plant^{-1} increased with increased intra row spacing. Similar increase in no. of branches plant^{-1} with decreased plant density was observed by Rahman & Hussain (2011), Reddy *et al.* (1999) and Rahman *et al.* (2004), while Reddy *et al.* (1999) resealed that plants at higher densities accumulate less carbon which is not sufficient to support more branching.

Yield attributes :

The different yield attributes viz no. of clusters plant^{-1}, no. of pods plant^{-1}, 100 seed weight and grain yield (q/ha) is presented in table 2. The characters number of clusters plant^{-1}, number of pods plant^{-1}, 100 seed weight and grain yield ha^{-1} was found to be significant among varieties. The variety V4 (Basar) recorded highest number of clusters / plant, no. of pods / plant and grain yield ha^{-1}., while variety V8 (JS-93-05) recorded highest 100 seed weight among the varieties. High yield & yield contributing characters in some genotypes may be attributed to varietal character and genetically controlled and due to better growth, higher tolerance to diseases, adequate crop duration etc.,

The number of clusters plant^{-1} and number of pods plant^{-1} showed significant variation among different inter row spacings and increased with increased inter row spacings. Similar increase in number of pods plant^{-1} with decreased plant densities were observed by Rahman & Hussain (2011). This may be explained by the fact that per plant light interception (PPLI) in less at higher plant population density which results in per plant lower carbon fixation that reduces the plant ability in carbon assimilation & translocation towards new branches production and thus potentially reduces the growth rates, size of plant

Table 1 : Meteorological data during crop season, 2013

Month	Temp (^{o}C)		Relative Humidity (%)	Total Rainfall (mm)	Rainy days
	Min.	Max.			
June	27.6	36.4	82.36	194.3	13
July	26.03	32.16	87.58	380	16
August	25	32	84.19	145	10
September	24.8	32.53	82.1	84	2
October	23.96	32.12	87.61	87	2

Table : 2. Effect of genotypes and intra row spacing on the yield and yield components of Soybean

Treatments	Days to 50% flowering	Plant population/m2	Plant Height (cm)	No of nodes / plot	No of Branches / Plant	No of Clusters / Plant	No of Pods / plant	100 Seed Weight (gms)	Grain yield Q/ha
Genotypes									
V_1	46.17	36.90	28.97	9.87	3.67	23.73	78.87	13.12	23.39
V_2	46.17	38.54	38.28	10.10	4.63	21.37	73.27	12.99	29.13
V_3	45.67	45.16	24.31	8.40	5.30	14.60	41.90	13.21	19.69
V_4	46.33	42.69	39.40	9.97	5.03	25.53	81.13	13.08	33.67
V_5	47.17	39.00	34.97	11.03	5.43	22.03	70.77	12.95	25.65
V_6	49.50	38.90	43.00	12.67	5.57	25.00	76.13	13.04	21.88
V_7	44.00	40.10	30.73	10.28	5.00	16.30	44.33	14.25	22.65
V_8	42.17	38.20	31.17	8.97	4.77	16.77	41.87	14.38	18.67
S.E. ±	1.393	1.4	2.25	0.744	0.649	1.202	5.29	0.179	1.792
CD	0.417	0.00	7.51	NS	NS	0.013	17.66	0.599	5.983
Intra row spacing									
S_1	45.75	51.60	35.24	9.27	4.08	17.20	55.54	13.50	21.93
S_2	45.88	37.80	34.28	10.55	4.96	21.45	60.90	13.20	23.79
S_3	46.06	28.00	34.03	10.64	5.74	23.35	74.16	13.44	27.30
S.E. ±	0.27	0.00	1.11	0.599	0.41	1.019	2.29	0.099	1.538
CD	NS	2.50	NS	NS	1.231	3.055	6.87	NS	NS

NS=Non-significant

Table 3 : Influence of spacing on plant population and grain yield

Spacing	Net Returns	Gross returns	BC
	Rainy	*Rainy*	*Rainy*
30 X 5	56142.22	25058.22	1.806
30 X 7.5	60906.67	31850.67	2.097
30 X 10	69946.67	41878.67	2.493
CD	10624.50	10624.50	0.3598
Genotypes			
AMSMB 5-18	59875.56	30472.89	2.057
AMSMB 5-19	74571.85	45169.18	2.548
Bheem	50394.07	20991.41	1.730
Basar	86186.67	56784.00	2.937
KS-103	65659.26	36256.59	2.242
KDS-344	56011.85	26609.18	1.913
JS-335	57979.26	28576.59	1.993
JS-93-05	47976.30	18573.63	1.637
CD	17349.73	17349.73	0.5875

organs & node addition rates (Harper, 1977).

The grain yield ha^{-1} and 100 seed weight was found to be non significant among different intra row spacings. However of the three spacings tested S3 (30x10 cm) recorded highest grain yield of 27.3 q ha^{-1} followed by S2 (30x7.5 cm, 23.79 q ha^{-1}) and S1 (30x5 cm, 21.93 q ha^{-1}) which are on par with each other.

On contrary Guriqbal Singh (2010) reported that grain yield was better at plant densities of 0.45 & 0.6 million plants ha^{-1} over 0.3 million plants ha^{-1} and yield increased in plant density from 0.222 to 0.666 million plants ha^{-1} (El din *et al.*, 1997) and from 0.166 to 0.476 million plants ha^{-1} (El douby *et al.*, 2002). The 100 seed weight was found to be non significant among different intra row spacings according to Guriqbal Singh (2011) and suggested that it is a varietal character and genetically controlled and hence cannot be influenced by intra row spacing.

Economics :

This study reveals that these are no significant variation in grain yield under three different intra row spacings. The seed rate and plant population ha^{-1} under three different intra row spacing is presented in table 3. This reveals that the seed rate was 49.6% and 24.4% higher at 30x5 cm and 30x7.5 cm, respectively over 30x10 cm spacing. Thus by adopting the spacing of 30x10 cm the seed cost can be reduced to almost half over 30x5 cm and to 3/4th over 30 x 7.5 cm. The lower seed rate at 30x10 cm reduced the cost of cultivation, coupled with higher yields, results in higher benefit cost ratio.

It may be concluded that a spacing of 30x10 cm in soybean may be beneficial over other spacings as it recorded numerically higher yields which may be due to increase in yield contributing characters *i.e.*, number of clusters plant^{-1} and number of pods plant^{-1}.

Authors' affiliations :

N. SANDHYA KISHORE, J. KAMALAKAR, U. NAGABHUSHANAM AND FIRDOZ SHAHANA, Regional Sugarcane and Rice Research Station, Rudrur, NIZAMABAD (M.S.) INDIA

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