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Response of Soybean to Sowing Dates and Spacing under Rainfed Condition

P. R. Jaybhaye[1], P. B. Shinde[2] and B. V. Asewar[3]

ABSTRACT: *In order to study the effect of sowing date and spacing on growth attributes and yield components of soybean, an experiment was conducted in* kharif *seasons (2013-2014) at Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out in split plot design with three replications comprising three sowing dates i.e. 25th MW, 26th MW and 28th MW as main treatments and three spacing consists of 30 x 10 cm, 45 x 05 cm, 60 x 05 cm as sub-treatments. Data were collected on number of pods, seed yield, biological yield as yield components of soybean. The data were analyzed statistically, which showed that with early sowing gave higher yield and quality as compared to the late sowing . The results revealed that the crop sown on 25th MW with spacing 30 x10 cm gave significantly highest number of pods and yield of soybean.*

Keywords: *dry matter, sowing dates, soybean, spacing, yield.*

INTRODUCTION

Soybean is one of the important oil and protein crops of the world. Many developing countries in the tropics show interest in the production of soybean to meet their increasing demand for protein and vegetable oil. Soybean is an important N_2 fixing leguminous crop, due to its high quality protein and input of combined N_2 into the soil. Soybean is known for its wide adaptability coupled with its higher productivity per unit area compare to other grain legumes.

Soybean (*Glycine max* (L.) Merrill) belongs to family Leguminoaceae. It is also referred as green manure crop that sheds about 32 to 35 q/ha of crop residue at the time of harvesting and an important source of protein and oil in human diet which can tolerate drought as well as sustain uniform moisture conditions. Under rainfed conditions soybean yields are higher when sown with the onset of monsoon as discussed by Jansani [4]. However, during the recent years the monsoon rains, particularly after the onsets are erratic, leading to failure of early sown *kharif* crops.

Generally, the time of planting varies depending on the climatic condition of the region and the variety to be grown. Different varieties of soybean are sensitive to change in environmental conditions where the crop is being grown. Therefore, it is necessary to study the genotype x environment interaction to identify the varieties which are stable in different environment as given by Seyyed M. S. and Seyyed A. N [8]. Planting date is an important factor affecting soybean growth, development and yield. Delayed sowing generally shifts reproductive growth into less favourable conditions with shorter days, lower radiation and temperatures as reported by Egli and Bruening [3].

In general soybean occupies an unique position in human nutrition and agriculture by virtue of high protein and ability to fix atmospheric nitrogen with the help of root nodule bacteria. Cultivation of soybean is mostly confined to vertisols of Maharashtra. Mostly vertisols are inversely poor in nitrogen. Average yield of soybean is much below the national average. This is due to inadequate knowledge of agro technique required to be adopted for exploiting a potential in this crop. It is well known that the yield of crop is a function of plant population ha^{-1} and the yield of economic product per plant. The optimum number of plant per unit area is an important parameter in increasing the crop productivity. However, optimum plant density with proper planting geometry varies with the agroclimatic conditions, genotypes and growth habit of the variety.

* Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431 402 (MS), *E-mail: agmetprj@gmail.com*

The work on these aspects of soybean in Maharashtra is very meager and needs specific in quest. Therefore, the present investigation was carried out with a view to find out suitable and optimum sowing time and spacing in *kharif* for better production of soybean under rainfed condition.

MATERIALS AND METHODS

The experiment was conducted at experimental farm, Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani ($19^0 16^1$ N, $76^0 47^1$ E and 409.0 MSL) (MH) during *kharif*, 2013-14 under rainfed condition to assess the response of soybean to different spacing under different sowing dates. The experiment was laid out in split plot design with three replications comprising three sowing dates i.e 25th MW, 26th MW and 28th MW as main treatments and three spacing consists of 30 x 10 cm, 45 x 05 cm, 60 x 05 cm as sub-treatments. The first sowing was taken up before onset of monsoon, second with onset of monsoon and third was at a week interval. Fertilizer dose of 30:60:30 NPK Kg per hectare was incorporated into the soil at the time of sowing. Sowing was carried out manually by using dibbling method. The crop was raised as per package of practices. Five plants were randomly selected for observation from each replication. All statistical analyses were carried out by using appropriate methods.

RESULTS AND DISCUSSION

The data on mean number of pods plant^{-1} as influenced by different treatments at 15 days interval presented in Table 1 and 2. Among the yield attributing characters the number of pods per plant was significantly influenced by sowing date and spacing.

Effect of sowing dates: Significantly highest number of pods was observed in sowing date of 25th MW than other date of sowing. At 75 days, 25th found to be at par with 26th MW and significantly superior over other stages. Significant trend of increase in number of pods plant^{-1} -from 60 DAS to 90 DAS and thereafter decreased at harvest. The earlier sowing probably had more period compared to later dates of sowing which had smaller vegetative and reproductive period causing reduction in growth and development and ultimately produced smaller number of pods per plant. These results corroborate the findings of Shah [9].

Effect of spacing: Amongst the geometry, significantly highest no. of pods plant^{-1} was observed in 60 x 05 cm spacing over all the geometry at all the growth stages. The data given in Table 1 clearly reveals that the decreasing the plant population (i.e. Spacing) increasing the no. of pods per plant. It might be due to increase in seed size at wider spacing. Also the plants get more nutrients and light at wider spacing as compared to closer spacing at which plants compete from each other for sunlight and nutrition etc. At wider spacing there is better source sink relationship due to which yield attributing characters get increased. The increase in pods per plant with respect to increase in row to row spacing also reported by Lone [5] and Shamsi and Kobraee [11]. Boydak [1] reported that in soybean, narrow row spacing ensured early canopy coverage and maximized light interception, crop growth rate and crop biomass, resulting in increasing the number of pods.

Table 1
Effect of sowing dates and spacing on number of pods of soybean as influenced by different treatments

Treatments	*Number of pods at 60 DAS*	*Number of pods at 75 DAS*	*Number of pods at 90 DAS*	*Number of pods at harvest*
Sowing date				
D_1 (25 MW)	31.53	39.18	43.69	40.42
D_2 (26 MW)	26.81	37.07	40.24	37.84
D_3 (28 MW)	24.78	30.93	32.29	31.03
S. E. ±	0.33	1.13	0.18	0.45
C. D. at 5%	1.28	4.43	0.70	1.76
Spacing				
S_1 (30 x 10 cm)	26.81	33.30	36.59	34.33
S_2(45 x 05 cm)	26.94	35.93	39.31	36.34
S_3(60 x 05 cm)	29.37	37.95	40.32	38.61
S. E. ±	0.50	0.91	0.50	0.78
C. D. at 5%	1.54	2.80	1.55	2.40
Interaction (D x S)				
S. E. ±	0.87	1.57	0.87	1.35
C. D. at 5%	2.67	4.85	2.69	4.16

Effect of interaction between sowing dates and spacing: It is interesting to note that the interaction results (Table 2) between date of sowing and spacing found to be significant at all growth stages. At 60 DAS, The highest number of pods (33.89) was obtained by the interaction of 25th MW and 60 x 05 cm spacing which was statistically at par with interaction between 25th MW and 30x10cm (32.48). the lowest (23.70) number of pods was obtained from the interaction of 28th MW and 30x10cm spacing. However at 75 DAS, The highest number of pods (45.47) was obtained by the interaction between 25th MW and 60 x 05 cm spacing which were statistically superior over other treatment combinations. The lowest (29.94) was found from the interaction of 28th MW and 30x10cm spacing. Whereas, at 90 DAS, The maximum number of pods (50.64) was obtained by interaction between

Table 2
Interactive effect of sowing date and spacing on periodical number of pods of soybean

Treatments	*Number of pods*											
Sowing date	*60 DAS Spacing*			*75 DAS Spacing*			*90 DAS Spacing*			*At harvest Spacing*		
	S1	*S2*	*S3*	*S1*	*S2*	*S3*	*S1*	*S2*	*S3*	*S1*	*S2*	*S3*
D1	32.48	28.22	33.89	36.49	35.58	45.47	39.42	41.00	50.64	37.33	36.76	47.18
D2	24.24	27.67	28.53	33.47	40.58	37.16	39.22	42.96	38.53	36.13	39.71	37.67
D3	23.70	24.94	25.69	29.94	31.62	31.22	31.11	33.97	31.80	29.53	32.57	30.98
S.Em.±	0.87			1.57			0.87			1.35		
C.D. at 5%	2.67			4.85			2.69			4.16		

25th MW and 60 x 05 cm spacing which were statistically superior over other treatment combinations. The lowest (31.11) was in the interaction of 28th MW and 30x10cm spacing. At harvest stage, The highest number of pods (47.18) was obtained by the interaction between 25th MW and 60 x 05 cm spacing which were statistically superior over other treatment combinations. The lowest (29.53) was found from the interaction of 28th MW and 30x10cm spacing.

Yield of Soybean: The data on yield of soybean were presented in Table 3 and 4.

Effect of sowing dates: Sowing time significantly influenced the days taken to flowering, maturity, plant height, pods per plant, and consequently yield of soybean. There was significant reduction in yield with each delay in sowing. Soybean sown on 25th MW (1087.0 Kg ha^{-1}) out yielded later sowing dates, it was on par with 26th MW (1043.63 kg ha^{-1}) and gave 4.21% more grain yield over 26th MW and 50.09% over 28th MW. Delayed sowing adversely affected the grain production. The increase in grain yield in early sowing dates may be ascribed to its longer duration and significant improvement in pods per plant. More number of days taken for 50% flowering and longer duration of crop in early sowing might have led to the development of better sink by better utilization of growth resources which were later on translocated to pods and seeds than its delayed sowing.

Soybean sown on 25th MW gave significantly higher straw yield (2008.58 kg ha^{-1}) over the 28th MW. 25th MW was significantly at par with 26th MW. The per cent increase in yield was noted 8.63% over 26th MW and 66.13% over 28th MW. Highest Biological yield (3095.98 Kg ha^{-1}) was obtained with sowing date 25th MW. Similar results were recorded by Wandhekar [12], Shaikh [10]. The earlier sowing had more period compared to later dates of sowing which had smaller vegetative and reproductive period causing reduction in growth and development and ultimately reduced the yield. The probable reason for this the late sown soybean might have caught in rains during flowering and ultimately it hampered the soybean yield.

Table 3
Effect of sowing dates and spacing on yield of soybean (kg ha^{-1})as influenced by different treatments

Treatments	*Seed Yield (kg ha^{-1})*	*Straw Yield (kg ha^{-1})*	*Biological Yield (kg ha^{-1})*
Sowing dates			
D_1 (25th MW)	1087.00	2008.58	3095.58
D_2 (26th MW)	1043.63	1848.96	2892.59
D_3 (28th MW)	724.23	1209.00	1933.23
S. E. ±	27.51	43.84	48.48
C. D. at 5%	107.98	172.11	190.31
Spacing			
S_1 (30 x 10 cm)	1193.90	2145.67	3339.57
S_2(45 x 05 cm)	930.93	1681.85	2612.78
S_3(60 x 05 cm)	730.04	1239.02	1969.06
S. E. ±	22.24	31.82	35.80
C. D. at 5%	68.54	98.05	110.31
Interaction (D x S)			
S. E. ±	38.52	55.11	62.00
C. D. at 5%	118.71	169.82	191.07

Effect of spacing: Among spacing, results revealed that decreasing row spacing reduced the seed yield per plant but led to an increase in yield per hectare. Soybean sown with 30 x 10 cm spacing gave significantly higher and superior grain yield (1193 kg ha^{-1}), straw yield (2145.67 kg ha^{-1}) and biological yield (3339.57 kg ha^{-1}) than the 45 and 60 cm spacing. The per cent increase in grain yield 63.53, straw yield 73.17 and biological yield 69.60 with S_2 (30 x 10 cm) spacing as compare to 60 cm respectively. The yield per hectare generally decreased relatively with increase in row spacing. This probably resulted from the fact that the increase in leaf unit index in a defined area caused an increase in the photosynthetic capacity of the plants in per unit area that would eventually lead to better uptake of plant nutrients. In addition, in row spacing due to plant canopy the risk of water loss by evaporation could be less and the plants are less affected by atmospheric temperature. The increase in the number of plants in a narrow area provides much better uptake from the soil. This

Table 4
Interactive effect of sowing dates and spacing on grain, straw and biological yield of soybean

Treatments *Sowing dates*	*Grain Yield (kg ha^{-1})* *Spacing*			*Straw yield (kg ha^{-1})* *Spacing*			*Biological yield (kg ha^{-1})* *Spacing*		
	S1	*S2*	*S3*	*S1*	*S2*	*S3*	*S1*	*S2*	*S3*
D1	1420.07	1056.10	784.84	2629.86	1909.85	1486.03	4049.93	2965.94	2270.87
D2	1275.89	993.79	861.22	2332.40	1919.68	1294.80	3608.28	2913.47	2156.02
D3	885.73	742.90	544.06	1474.77	1216.02	936.22	2360.50	1958.91	1480.28
S.Em.±	38.52	55.11	62.00						
C.D. at 5 %	118.71	169.82	191.07						

naturally leads to an increase in the yield. our results are in similarity with some research done by Boydak [1], Shaikh [10]. Deshmukh [2] also observed similar results and reported that the relationship between yield per plant with plant density showed that yield per plant was decreased with increase in plant population per unit area. Shamsi and Kobraee [11] also reported that the increasing plants population reduced yield of individual plants but increased yield per unit of area and also noted that the density had highly significant effect on biological yield.

Effect of interaction between sowing dates and spacing: The interaction of sowing dates and spacing (Table 4) were significant as in grain yield, straw yield and biological yield. The highest grain yield (1420.07 kg ha^{-1}) was obtained by the interaction of 25th MW and 30x10 cm spacing which was statistically superior over other interactions while, the lowest grain yield (544.06 kg ha^{-1}) was obtained from the interaction of 28th MW and 60 x 05 cm spacing. In case of straw yield, maximum yield (2629.86 kg ha^{-1}) was obtained by the interaction of 25th MW and 30x10 cm spacing which was significantly superior over other interactions. As such among biological yield of soybean, highest yield was obtained by the combination of 25th MW and 30x10 cm spacing and it is also significantly superior than other treatments.

CONCLUSION

The seed yield reduction is found due to delayed sowing, which is a combined effect of photoperiod, temperature and precipitation. Delayed planting date may decrease the seed germination, root function, crop growth rate and duration of growth stages and ultimately resulted into reduction in seed yield of soybean. The insensitivity of seed yield response to sowing date from early maturity varieties ensures farmers to gain higher production. The results implies that, soybean should be sown as in first date of sowing matches with monsoon set and spacing 30 x 10 cm to obtain maximum grain yield, straw yield and biological yield.

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