Growth and Yield of Soybean Genotypes as Influenced by Sowing Time at Different Locations under Climate Change Situation in Maharashtra, India

D. K. Kathmale[1*], A. U. Andhale[2] and M. P. Deshmukh[3]

National Agricultural Research Project, Agricultural Research Station, Mahatma Phule Agricultural University, K. Digraj, Sangli, Maharashtra (416 305), India

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Correspondence to

*E-mail: kathmaledk@rediffmail.com

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Abstract

An experiment was taken up at five locations viz. K. Digraj (Dist: Sangli), Karad (Dist: Satara, Gadhinglaj (Dist: Kolhapur), Savalvihir (Dist: Ahmednagar) and Jalgaon in a Split plot design with three replications. Main plot treatments comprised different five sowing dates from 25th June to 5th August with 10 days interval and sub plot treatments were different nine genotypes viz., JS 335, P. Kalyani, MACS 450, MAUS 71, KDS 321, KDS 344, KDS 345, KDS 347 and KDS 378. The results revealed that at all the locations, significantly higher soybean grain yield was noticed in first two sowing dates i.e., on 25th June and 5th July, however, drastic reduction in grain yield (15.82 q ha^{-1}) was witnessed under delayed sowing conditions (15th July to 5th Aug). Over the locations, the genotype KDS 347 performed better and recorded average yield of 20.84 q ha^{-1}. At Digraj, highest grain yield was recorded by the genotype KDS-378 (27.95 q ha^{-1}) and at Karad, highest grain yield (35.56 q ha^{-1}) was recorded by MACS-450. At Gadhinglaj, different genotypes did not differ significantly in respect of mean soybean grain yield. At Savalvihir, the genotype KDS-378 recorded grain yield increase to the tune of 19.35% over all other genotypes tested. At Jalgaon, highest grain yield of soybean was recorded by KDS-321 (14.76 q ha^{-1}). The sowing of soybean should not be delayed after 5th July in Southern Maharashtra and genotypes like KDS 347, KDS 378, MAUS 71 and MACS 450 are preferred for higher yield.

1. Introduction

Globally, soybean [*Glycine max* (L.) Merill] continues to rank first amongst various oilseed crops, contributing approximately 25% to the world's total oil and fat production, which is next only to palm oil, having 26% share. Thus soybean is expected to play a pivotal role in meeting the continuously increasing demand of the edible oil across the world. The USA, Brazil, Argentina, China and India are the major producers of soybean accounting for 90% of world production. In many Asian countries, soybean is an integral part of the diet. The demand for food-grade soybean is growing both in the national and international markets (Carter and Wilson, 1998). In India, soybean has emerged as main oil seed crop in a short span of time. Soybean has occupied first rank among oil seeds in India since 2005 onwards. The country has seen an unprecedented growth in soybean area which was just 0.03 m ha in 1970 and has reached to 10.69 mha in 2012 and production reaching to 12.67 mt in 2012 from 0.014 mt in 1970. It contains about 20% oil and 40% high quality protein (as against 7.0% in rice, 12% in wheat, 10% in maize and 20-25% in other pulses). Soybean protein is rich in valuable amino acid lycine (5%) in which most of the cereals are deficient. In addition, it contains a good amount of minerals, salts and vitamins (thiamine and riboflavin) and its sprouting grains contain a considerable amount of Vitamin C, Vitamin A is present in the form of precursor carotene, which is converted into vitamin A in the intestine. Maharashtra is a major soybean growing states having an area of 3.0 mha next to Madhya Pradesh (5.3 mha). In Maharashtra, area under soybean cultivation is increasing rapidly resulting into parallel growth of oil industry by commissioning solvent extraction plants, which, apart from expelling oil are also earning foreign exchange through export of de-oiled cake (DOC). The occurrence of soybean rust is a greater obstacle in increasing the area and productivity. Soybean productivity is above 2000 kg ha^{-1} in the Kolhapur region, however, recently declining trend in productivity was observed mainly due to heavy rainfall during harvesting and occurrence of soybean rust. Soybean crop found to be more sensitive to higher cumulative heat units during cropping season and is vulnerable to increases in maximum temperature than in minimum temperature. Deficient rainfall with uneven distribution during the monsoon season could be a critical factor for the soybean productivity even under the positive effects of elevated CO_2 in the future (Lal et al., 2004). Negative effects of climate change on soybean yields were observed as on an average, the climate change scenarios resulted in a 60% increase in estimated water requirements for irrigation (Bruce Curry et al., 1995). Optimum sowing time is very important as delayed sowing increased rust disease incidence while early sowing increases pest problem like girdle beetle, leaf minor etc. Newly developed genotypes having good yield potential and disease and pest resistance are better suited under climate change scenario. Hence in order to study the performance of different soybean genotypes under different sowing times under climate change situation and to find out suitable soybean genotype under delayed sowing situation a present experiment has been planned.

2. Materials and Methods

A field experiment on soybean genotypes was conducted during *kharif* season of 2010-11 in the university farm of Mahatma Phule Agricultural University, Rahuri (Maharashtra) at five different locations viz., K. Digraj (Dist: Sangli), Karad (Dist: Satara), Gadhinglaj (Dist: Kolhapur), Savalvihir (Dist: Ahmednagar) and Jalgaon (Dist: Jalgaon) representing NARP plane zone (Assured rainfall), sub montane zone (heavy rainfall) and scarcity zone (low rainfall). The experiment was laid out in a Split plot design with three replications. Main plot treatments comprised of five sowing dates from 25th June to 5th August with 10 days interval and sub plot treatments were nine genotypes viz; JS 335, P. Kalyani, MACS 450, MAUS 71, KDS 321, KDS 344, KDS 345, KDS 347 and KDS 378. The plot size was gross 5.00×3.15 m^2 and net 3.00×2.25 m^2. The soils were medium deep and neutral to slightly alkaline (pH 7 to 8.2), low in soil organic carbon, medium in available nitrogen, phosphorus and high in potassium content. The crop was sown at a spacing of 45×5 cm^2. A recommended dose of fertilizer 50 kg N and 75 kg P_2O_5 ha^{-1} was applied in the form of Urea (46% N) and single super phosphate (16% P_2O_5), respectively at the time of sowing.

3. Results and Discussion

3.1. *Effect of sowing time*

Irrespective of the location, significantly higher soybean grain yield was noticed in first two sowing dates i.e., on 25th June and 5th July beyond which drastic reduction in yield (64%) was observed (Table 1). It clearly indicated that the sowing of soybean should not be delayed after 5th July in Southern Maharashtra. Kumar et al. (2002) revealed that the optimum sowing dates for rainfed mono-cropping are between weeks 28th (9th July to 15th July) and 29th (16th July to 22nd July) in Madhya Pradesh.

3.2. *Effect of genotypes*

Over the locations, the genotype KDS 347 performed better and recorded higher average yield of 20.84 q ha^{-1}, however it was at par with KDS 378, KDS 344, KDS 345, MAUS 71

Table 1: Yield of soybean as influenced by sowing dates

Sowing dates	Locations					
	Digraj	Karad	Gadhinglaj	Savalvihir	Jalgaon	Mean
S_1 (25th June)	30.07	30.14	25.79	17.88	18.99	26.25
S_2 (5th July)	32.33	30.61	25.32	12.95	18.96	25.02
S_3 (15th July)	21.97	26.91	16.72	10.16	13.16	18.34
S_4 (25th July)	18.88	*	10.62	8.84	7.73	11.85
S_5 (5th August)	15.41	*	8.90	5.60	5.09	9.56
SEm±	1.67	1.04	1.23	0.30	0.42	0.93
CD (p=0.05)	5.37	3.12	3.95	0.96	1.36	2.95

*No germination due to continuous and heavy rains

Table 2: Yield of soybean genotypes as influenced by sowing dates

Varieties	Locations					
	Digraj	Karad	Gadhinglaj	Savalvihir	Jalgaon	Mean
V_1 (JS 335)	22.56	24.21	16.08	11.26	13.36	17.49
V_2 (P. Kalyani)	22.14	28.04	16.18	9.77	12.16	17.66
V_3 (MACS 450)	20.64	35.56	17.20	9.44	11.67	18.90
V_4 (MAUS 71	19.69	27.92	18.30	12.65	12.46	18.20
V_5 (KDS 321)	22.04	22.28	16.22	10.61	14.76	17.18
V_6 (KDS 344)	27.21	30.46	17.00	11.34	13.24	19.85
V_7 (KDS 345)	24.53	28.69	18.8	10.07	11.69	18.76
V_8 (KDS 347)	26.85	34.55	19.40	11.65	11.75	20.84
V_9 (KDS 378)	27.95	31.25	17.74	12.95	14.00	20.78
SEm±	1.26	1.58	0.99	0.41	0.57	0.96
CD (p=0.05)	3.48	4.37	NS	1.21	1.56	2.66

and MACS 450 (Table 2). At Digraj, the highest grain yield was recorded by the genotype KDS-378 (27.95 q ha^{-1}) and it was followed by KDS-344 (27.21 q ha^{-1}) and KDS-347 (26.85 q ha^{-1}), respectively. At Karad, the highest grain yield (35.56 q ha^{-1}) was recorded by MACS-450 and was followed by KDS-347 (34.55 q ha^{-1}). At Savalvihir, significantly superior grain yield (12.95 q ha^{-1}) was recorded by genotype KDS-378 and was followed by MAUS-71 (12.65 q ha^{-1}), the genotype KDS-378 recorded grain yield increase to the tune of 19.35% over all other genotypes tested. At Jalgaon, the highest grain yield of soybean was recorded by KDS-321 (14.76 q ha^{-1}) and was followed by KDS-378 (14.00 q ha^{-1}) and JS-335 (13.36 q ha^{-1}). On the contrary, different genotypes did not differ significantly in respect of mean soybean grain yield at Gadhinglaj.

3.3. Effect of sowing date×genotypes interaction

Interaction effects due to sowing date×genotypes in respect of soybean grain yield were significant at Karad, Savalvihir and Jalgaon, respectively, while at Digraj and Gadhinglaj interaction effects were non significant. At Karad, the significantly higher grain yield (42.10 q ha^{-1}) was recorded from the genotype MACS-450 with 25th June sowing date over rest of the treatment combinations except KDS-347 and KDS-345 with the same sowing date and MACS 450 sown on 5th July which were at par with each other (Table 3). At Savalvihir, the genotype KDS-378 with sowing on 25th June recorded the highest grain yield (20.87 q ha^{-1}) while the lowest grain yield was noticed in sowing of 5th August with variety MAUS-71 (4.36 q ha^{-1}) (Table 4). At Jalgaon, the highest grain yield (22.62 q ha^{-1}) was recorded in sowing 5th July with genotypes KDS-321 and followed by KDS-321 (22.22 q ha^{-1}) sown on 25th June (Table 5).

Table 3: Seed yield of soybean (q ha^{-1}) as influenced by sowing datesgenotypes interactions at Karad

Varieties / Sowing dates	V_1 JS335	V_2 P. Kalyani	V_3 : MACS 450	V_4 MAUS 71	V_5 KDS 321	V_6 KDS 344	V_7 KDS 345	V_8 KDS 347	V_9 KDS 378
S_1 (25th June)	19.60	31.43	42.10	25.43	17.06	32.67	34.69	38.37	29.95
S_2 (5th July)	26.89	25.41	37.78	33.90	31.33	28.15	25.83	33.70	32.52
S_3 (15th July)	26.15	27.28	26.81	24.44	18.49	30.57	25.56	31.58	31.28
SEm±	2.72								
CD (p=0.05)	7.41								

Table 4: Seed yield of soybean (q ha^{-1}) as influenced by sowing dates×genotypes interactions at Savalvihir

Varieties / Sowing dates	V_1 JS335	V_2 P. Kalyani	V_3 : MACS 450	V_4 MAUS 71	V_5 KDS 321	V_6 KDS 344	V_7 KDS 345	V_8 KDS 347	V_9 KDS 378
S_1 (25th June)	19.05	20.46	14.25	19.45	17.61	19.61	16.30	13.29	20.87
S_2 (5th July)	14.07	10.30	9.76	16.04	10.44	13.50	12.41	15.07	14.93
S_3 (15th July)	10.98	7.91	9.50	12.15	9.41	9.36	8.73	11.36	12.00
S_4 (25th July)	6.53	5.07	7.64	11.27	9.41	8.58	6.96	12.12	11.98
S_5 (5th August)	5.69	5.13	6.03	4.36	6.18	5.66	5.97	6.40	4.98
SEm±	0.41								
CD (p=0.05)	1.21								

Table 5: Seed yield of soybean (q ha^{-1}) as influenced by sowing dates×genotypes interactions at Jalgaon

Varieties / Sowing dates	V_1 JS335	V_2 P. Kalyani	V_3 : MACS 450	V_4 MAUS 71	V_5 KDS 321	V_6 KDS 344	V_7 KDS 345	V_8 KDS 347	V_9 KDS 378
S_1 (25th June)	21.73	17.97	16.79	19.73	22.22	19.01	16.91	15.60	20.99
S_2 (5th July)	21.26	18.32	17.16	20.17	22.62	18.64	16.59	15.41	20.49
S_3 (15th July)	12.96	13.63	12.02	12.69	13.31	14.94	12.15	13.51	13.19
S_4 (25th July)	7.16	7.21	7.11	5.70	11.65	8.00	8.05	7.41	7.31
S_5 (5th August)	3.68	3.65	5.26	4.00	4.00	5.63	4.77	6.81	8.00
SEm±	1.26								
CD (p=0.05)	3.48								

4. Conclusion

The sowing of soybean should not be delayed beyond 5th July in Southern Maharashtra and genotypes like KDS 347, KDS 378, MAUS 71 and MACS 450 are be preferred for realising higher seed yield of soybean under climate changing scenario in Maharashtra.

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