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Short Communication

Heat use efficiency of kharif soybean (Glycine max (L.Merr.)) cultivars at Akola

M. B. NAGDEVE, M. D. GIRI and M.M. GANVIR

AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola 444 104 (M. S.) India

Soybean is an important protein and oil producing crop containing 44 per cent protein and 20 per cent oil. Its forage and cake are excellent nutritious food for livestock and poultry. It has a vast multiplicity of uses as food like TOFU or soypaneer, soyflour and beverages, chunk and milk. The Soya feeds are beneficial for the patient suffering from rheumatism and high blood cholesterol. Soybean possesses special characteristic like tolerance to short period drought and to water logging when well established, it is suitable for multiple and intercropping system. Weather parameters strongly influence the crop performance. It is therefore useful to identify such parameters and quantify their contribution besides developing relations with growth and yield of the crop.

The experiment was conducted during the *kharif* season of the year 2006-07 at the farm of AICRP for Dryland Agriculture Research Project at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS), India ($22^0$42'N latitude, $77^0$02'E longitude and 307.41m above MSL). The experimental soil was clayey having organic carbon 0.41 per cent, pH 7.9, E.C. 0.24 (d Sm^{-1}), available nitrogen 210.30 kg ha^{-1}, available P_2O_5 17.50 kg ha^{-1} and available K_2O 275.30 kg ha^{-1}. The experiment was laid out in factorial randomized block design with four sowing dates (D_1-26th MW, D_2-27th MW, D_3-28th MW and D_4-29th MW) and 3 varieties of soybean crop (V_1-MACS-450, V_2-PK-472 and V_3-JS-335) replicated four times. The gross plot size was 4.5m x 6.0m and net plot size was 3.6m x 5.8m. The sowing was done at a spacing of 30cm x 10cm in all the treatments. The crop was fertilized with a dose of 30 kg nitrogen and 75kg P_2O_5 ha^{-1} through urea and single super phosphate. All the observations were recorded as per the treatments and statistical analysis was made by using suitable computer programme.A base temperature of 10^0C was used to compute the thermal units.

Grain yield

Crop sown on first date of sowing (26th MW) recorded the overall significantly highest grain yield than all the other treatments. The fourth sowing date (29th MW) produced significantly lowest yield of soybean which is attributable to continuity of the rains during subsequent weeks to onset of monsoon which resulted in higher dry matter accumulation. Yields from crop sown during 27th and 28th MW were at par with each other. Similar results were observed by Singh *et al*. (1985); Jansani, *et al*. (1993), Rajput and Shrivastava (1999).

The grain yield differences due to varieties were found to be non significant (Table 1). Numerically, PK-472 recorded higher grain yield than other varieties. The grain yield differences due to interaction of sowing dates and varieties were found to be non significant (Table 1).

Biomass production

Biomass produced under the 2nd (27th MW), 3rd (28th MW) and 4th (29th MW) date of sowing was found to be at par (Table 1). However the biomass under 2nd date of sowing (27th MW) was significantly superior over the 1st (26th MW) date of sowing. The differences in biomass production were significant (Table 1); variety PK-472 recorded the significantly highest biomass production of 33.82 q ha^{-1}.

The interaction effects were significant (Table 2). Variety PK-472 sown on 1st sowing date (26th MW) recorded significantly highest biomass production of 44.29 q ha^{-1}. It was at par with variety MACS-450 (37.11 q ha^{-1}) and JS-335 (36.51 q ha^{-1}) sown on 1st sowing date (26th MW). The lowest biomass production of 8.86q ha^{-1} was observed with variety JS-335 sown on the last sowing date (29th MW).

Thermal units

Data regarding thermal units availed by different soybean varieties under various sowing dates are presented in Table 3,4 and 5 in respect of MACS-450, PK-472 and JS-335 respectively. During vegetative phase of growth, variety MACS-450 availed the thermal units in the range of 552^0C to 626 ^{0}C, soybean PK-472 and JS-335 availed the thermal units in the range of 552^0C to 594 ^{0}C and 518^0C to 609 ^{0}C respectively under different dates of sowing. During reproductive stage variety MACS-450 availed the thermal units in the range of 1200^0C to 1421 ^{0}C, PK-472 and JS-335 availed the thermal units in the range of 1082 to 1156 and 1067 to 1132 respectively. Similar trend of the results were observed by Pallavi Bayasthakur (2002).

Table 1: Grain and biomass production (q ha^{-1}) of soybean as influenced by sowing dates and varieties

Treatments	Grain production (q ha^{-1})	Biomass production (q ha^{-1})	Harvest Index (%)
A. Date of sowing			
D_1 26th MW (30.6.06)	13.44	39.30	34.20
D_2 27th MW (06.07.06)	9.24	30.32	30.47
D_3 28th MW (13.07.06)	10.97	35.71	30.72
D_4 29th MW (20.07.06)	1.87	12.13	15.42
F test	Sig.	Sig.	-
S. E. (m) ±	0.57	1.42	-
C. D. at 5%	1.63	4.09	-
B. Varieties			
V_1 (MACS-450)	8.55	26.48	32.29
V_2 (PK-472)	9.19	33.82	27.17
V_3 (JS-335)	8.89	27.80	31.98
F test	NS	Sig.	-
S. E. (m) ±	0.49	1.23	-
C. D. at 5%	NS	3.54	-
Interaction			
S. E. (m) ±	0.98	2.91	-
C. D. at 5%	NS	8.38	-

Table 2: Biomass yield (q ha^{-1}) of soybean as influenced by sowing dates and variety interactions.

Sowing dates	Varieties			
	MACS-450	PK-472	JS-335	Mean
D_1 26th MW (30.6.06)	37.11	44.29	36.51	39.30
$D_2$27th MW (06.07.06)	26.32	33.52	31.12	30.32
$D_3$28th MW (13.07.06)	32.92	39.51	34.71	35.71
$D_4$29th MW (20.07.06)	9.58	17.96	8.86	12.13
Mean	26.48	33.82	27.80	29.36
F test	Sig.			
S.E. (m) ±	2.91			
C. D. at 5%	8.36			

Table 3: Thermal units (^{O}C) availed by soybean variety MACS-450 during different phenophases under various dates of sowing.

Phenophase	Sowing dates			
	D_1 (26th MW)	D_2 (27th MW)	D_3 (28th MW)	D_4 (29th MW)
Vegetative stages				
Emergence	104	109	119	111
Seedling	308	263	279	286
Branching	182	180	214	229
Total from sowing	594	552	612	626
Reproductive stages				
Flowering	180	234	214	252
Pod formation	195	301	302	250
Grain formation	206	216	218	270
Pod development	179	217	220	197
Pod containing full size grain	164	169	138	135
Dough stage	157	170	158	114
Maturity	119	114	98	124
Flowering to maturity	1200	1421	1348	1342
Sowing to maturity	1794	1973	1960	1968

Table 4: Thermal units (^{O}C) availed by soybean variety PK-472 during different phenophases under various dates of sowing.

Phenophase	Sowing dates			
	D_1 (26^{th} MW)	D_2 (27^{th} MW)	D_3 (28^{th} MW)	D_4 (29^{th} MW)
Vegetative stages				
Emergence	104	109	101	111
Seedling	308	278	312	319
Branching	182	165	182	162
Total from sowing	594	552	595	592
Reproductive stages				
Flowering	146	183	163	173
Pod formation	247	162	173	163
Grain formation	189	190	162	164
Pod development	147	146	147	173
Pod containing full size grain	134	136	207	226
Dough stage	150	152	180	150
Maturity	102	113	124	102
Flowering to maturity	1115	1082	1156	1151
Sowing to maturity	1709	1634	1751	1743

Table 5: Thermal units (^{O}C) availed by soybean variety JS-335 during different phenophases under various dates of sowing.

Phenophase	Sowing dates			
	D_1 (26^{th} MW)	D_2 (27^{th} MW)	D_3 (28^{th} MW)	D_4 (29^{th} MW)
Vegetative stages				
Emergence	104	108	118	110
Seedling	293	262	309	301
Branching	165	148	182	178
Total from sowing	562	518	609	589
Reproductive stages				
Flowering	145	181	162	173
Pod formation	230	162	173	163
Grain formation	157	139	181	182
Pod development	150	147	146	155
Pod containing full size grain	135	178	173	180
Dough stage	148	208	165	167
Maturity	102	117	108	106
Total from flowering onward and till maturity	1067	1132	1108	1126
Total from sowing to maturity	1629	1650	1717	1715

Table 6: Thermal units (kg ha^{-1} ^{O}C^{-1}) availed by soybean varieties in terms of grain and biomass production under different dates of sowing.

Varieties		Sowing dates			
		D_1 (26^{th} MW)	D_2 (27^{th} MW)	D_3 (28^{th} MW)	D_4 (29^{th} MW)
MACS-450	Grain	0.77	0.44	0.53	0.08
	Biomass	1.71	1.34	1.68	0.49
PK-472	Grain	0.80	0.54	0.62	0.17
	Biomass	2.59	1.93	2.26	1.03
JS-335	Grain	0.78	0.58	0.68	0.06
	Biomass	2.20	1.83	2.02	0.52
Mean	Grain	0.78	0.52	0.62	0.10
	Biomass	2.16	1.70	1.98	0.68

Thermal use efficiency

Data pertaining to thermal use efficiency by different soybean varieties in terms of grain and biomass production under various sowing dates are presented in Table 6. Soybean variety PK-472, sown on the 1st sowing date (26th MW) recorded the highest thermal use efficiency of 0.80 kg ha^{-1} $^{O}C^{-1}$for grain yield , which was followed by JS-335 (0.78 kg ha^{-1} $^{O}C^{-1}$).

As regards thermal use efficiency in terms of biomass production, data revealed that variety PK-472 sown on the 1st date of sowing (26th MW) recorded the highest heat use efficiency of 2.59 kg ha^{-1} $^{O}C^{-1}$, which was followed by the same variety sown on the 3rd date of sowing (28th MW). Variety JS-335 and MACS-450 sown on the 1st date of sowing (26th MW) recorded the thermal use efficiency of 2.10 kg ha^{-1} $^{O}C^{-1}$ and 1.71 kg ha^{-1} $^{O}C^{-1}$ respectively. Similar results were observed by Pallavi Bayasthakur (2002).

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