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Effect of irrigation and management practices for water use efficiency of soybean

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Abstract : Field experiments were conducted on soybean (var. Col) during summer and Kharif seasons of 1996 with two irrigation schedules *viz.*, 0.40 and 0.60 IW/CPE ratio and three methods of irrigation *viz.*, all furrow, alternate furrow and double row furrow irrigation coupled with three management practices which included application of coirpith at 12.5 t ha^{-1} as soil mulch; KCl at 0.5 per cent foliar spray and control. Higher grain yield was recorded during *kharif* than *summer*. Scheduling irrigation at 0.60 IW/CPE ratio through all furrow method along with coirpith application at 12.5 t/ha recorded higher grain yield during both the seasons. *(Key words : Soybean, Water use efficiency, Irrigation management practices).*

In soybean, delayed or excessive irrigation affect the growth and yield parameters. Irrigation management research in soybean will be useful to optimise water use and to achieve higher yields. Hence, timely irrigation with relatively lesser quantum of water is aimed to produce maximum grain yield per unit quantity of water used. Modification of irrigation layouts in conjunction with application of moisture conserving materials to soil would considerably reduce the quantum of water and the total evapotranspiration and enhance water holding capacity of the soil. The present study was carried out to optimise the irrigation scheduling, irrigation methods and irrigation management practices for soybean.

Materials and Methods

Field experiments were carried out at Tamil Nadu Agricultural University, Coimbatore during *summer* and *kharif* seasons, 1996 to study the effect of irrigation levels, methods and management practices on growth, yield and water use efficiency of soybean. The soil of the experimental fields was sandy clay loam. The available nutrient status of the soil was low nitrogen; medium phosphorus and high potassium. The field capacity and wilting point of the soil were 24.5 and 12.1 per cent respectively. The bulk density was 1.30 g cc^{-1}; the soil pH and EC were 7.9 and 0.43 dSm^{-1} respectively. Soybean cv. Co1, with a duration of 85-90 days was used, as the test crop. Irrigation scheduling was based on the ratio between irrigation water (IW) and cumulative pan evaporation (CPE) recorded for USWB open pan evaporimeter. The depth of irrigation adopted was 50mm. The effective rainfall was calculated by the method described by Dastane (1974).

The experiment was laid out in a split plot design with two irrigation levels *viz.*, irrigation at 0.40(I_1) and 0.60 (I_2) IW/CPE ratio and three methods of irrigation *viz.*, all furrow (m_1), alternate furrow (m_2) and paired row furrow or double - row furrow (m_3) were allotted in main plots and four management practices *viz.*, control (A_0), coirpith application at 12.5 t/ha (A_1), kaolin at 3 per cent foliar spray (A_2) at 30, 45 and 60 days after sowing (DAS) and (KCl) at 0.5 per cent during peak flowering stage (A_3) in subplots were tried. Recommended package of practices was adopted. Biometric observations on plant height, dry matter production (DMP), no. of pods per plant, test weight of the grain and seed yield were recorded and the results are discussed hereunder.

Results and Discussion

Plant height

Plant height was observed to be better in kharif season than in summer. Irrigation regimes, methods and managements practices had no effect on the plant height during the early stage (30 DAS) in both the seasons. Plant height at 60 DAS revealed that irrigation at 0.6 IW/CPE ratio (I_2) recorded increased plant height of 50.6 cm during *summer* and 53.4 cm during *kharif* season over 0.4 IW/CPE ratio (I_1). Similarly at harvest stage also irrigation at I_2 recorded increased plant height of 60.2 cm during *summer* and 62.4 cm during *kharif* over I_1 regime recording 54.3 and 58.4 cm respectively. The increased plant height in I_2 could be attributed to the availability of optimum level of soil moisture whereas reduced plant height in I_1 (0.40 IW/CPE ratio) could be due to inadequate soil moisture in the root zone. This is in support of the results obtained by Hoogenboom *et al.*, (1987); Sharma and Dixit (1988) in soybean.

In respect to different methods of irrigation, plant height at 60 DAS recorded increased values under all furrow method to the tune of 2.5 and 6.7 cm during *summer*, 4.1 and 6.7 cm during *kharif* season over double row furrow and alternate furrow methods respectively. This might be due to the

Table 1 a. Effect of treatments on plant height and dry matter production at different stages of soybean

Treatments	Plant height (cm)						Dry matter production (kg ha^{-1})			
	30 DAS		60 DAS		Harvest		60 DAS		Harvest	
	S	K	S	K	S	K	S	K	S	K
Irrigation levels										
I_1 : 0.4 IW/CPE ratio	20.20	22.18	45.86	47.83	54.28	58.42	1334	1715	2638	2947
I_2 : 0.6 IW/ CPE ratio	20.20	22.22	50.58	53.41	60.24	62.40	1787	2473	3609	3918
SE_d	0.02	0.07	1.14	1.31	1.92	1.35	75.2	82.3	114.6	143.2
CD (P=0.05)	NS	NS	2.55	2.90	4.28	3.02	167.1	183.4	255.3	319.0
Methods of irrigation										
M_1 : All furrow	20.23	22.31	50.08	55.33	60.25	62.70	1705	2194	3286	3595
M_2 : Alternate furrow	20.18	22.20	43.37	48.66	54.33	56.00	1558	2007	2962	3277
M_3 : Paired row or double row furrow	20.20	22.25	47.63	51.25	57.20	61.62	1653	2105	3122	3431
SE_d	0.04	0.08	1.05	1.13	0.70	1.25	36.3	38.6	54.6	56.4
CD (P=0.05)	NS	NS	2.34	2.51	1.57	2.78	80.8	86.0	121.7	125.7
Management Practices										
A_0 : Control	20.17	22.11	44.05	52.44	49.88	59.82	1321	1586	2900	3208
A_1 : Coir pith @ 12.5 t/ha	20.23	22.14	50.66	55.25	60.10	63.72	1672	2100	3289	3597
A_2 : Kaolin 3% foliar spray	20.20	22.12	47.22	52.52	55.20	60.25	1452	1766	3127	3406
A_3 : KCl 0.5% foliar spray	20.22	22.12	47.94	52.93	55.81	60.58	1574	1846	3180	3426
SE_d	0.02	0.06	0.56	0.81	0.63	0.73	20.5	36.48	37.09	43.14
CD	NS	NS	1.13	1.65	1.27	1.48	41.5	74.00	75.23	87.48
Interaction										
I x M	Absent		Absent		Absent			SE_d	53.29	56.83
								CD (P=0.05)	118.52	126.61
I x A	Absent		Absent		Absent			SE_d	52.27	53.24
								CD (P=0.05)	120.27	110.10
M x A	Absent		Absent		Absent			SE_d	61.27	56.23
								CD (P=0.05)	126.70	116.28

S : summer season; K: kharif season

increased available soil moisture in both sides of furrows in all furrow method. This findings are in agreement with that of Ravi Bharathi (1994) in soybean and Rangaraj (1991) in sunflower.

Significant increase in plant height was observed in plots applied with coirpith as compared to other management practices at 60 DAS and at harvest stage in both the seasons. The increase was 2.0 cm during summer and 3.0 cm during kharif seasons over Kcl and Kaolin spray. The reason might be due to availability of better soil moisture environment as a result of coir pith application. Similar results have been reported by Bharati. *et al.*, (1986).

Dry matter Production

In general DMP was found to be higher during Kharif than in summer. Higher DMP was recorded with irrigation scheduled at 0.60 IW/CPE ratio through all furrow method during both the seasons. Increase in DMP under higher moisture regime was the result of improved growth components. This is in accordance with the findings of Ramesh and Gopalaswamy (1992) Coirpith applied plots recorded higher DMP than other treatments. This might be due to conservation and release of more moisture to the crop to promote the growth characters. Similar results were reported by Liyanage and De (1989).

Number of pods per plant

Higher number of pods were recorded in higher moisture regime of 0.6 IW/CPE ratio through all furrow irrigation than that at lower moisture regime of 0.4 ratio.

Coirpith applied plots recorded higher number of pods than other treatments. Increased pod number per plant with irrigation scheduled at higher moisture regime might be due to better accumulation and translocation of assimilates coupled with longer filling period. Similar findings were reported by Rajagopal and Velu (1995).

Table 1 b. Effect of treatments on number of pods plant^{-1} test weight and seed yield

Treatments	Number of Pods plant^{-1}		Test weight (g/100 seeds)		Seed yield (kg ha^{-1})	
	S	K	S	K	S	K
Irrigation levels						
I_1 : 0.4 IW/CPE ratio	31.80	34.54	10.180	10.182	1188	1296
I_2 : 0.6 IW/ CPE ratio	43.90	46.27	10.190	10.197	1560	1642
SE_d	1.59	1.74	0.003	0.004	52.26	56.37
CD (P=0.05)	3.52	3.91	0.007	0.010	116.43	125.59
Methods of irrigation						
M_1 : All furrow	44.28	47.76	10.190	10.192	1443	1525
M_2 : Alternate furrow	33.60	44.53	10.173	10.176	1296	1378
M_3 : Paired row or double row furrow	42.26	45.58	10.181	10.184	1362	1464
SE_d	1.46	0.77	0.002	0.002	32.56	33.87
CD (P=0.05)	3.25	1.73	0.004	0.004	72.56	75.47
Management Practices						
A_0 : Control	30.46	34.23	10.170	10.171	1202	1284
A_1 : Coir pith @ 12.5 t/ha	42.43	45.35	10.189	10.197	1515	1597
A_2 : Kaolin 3% foliar spray	38.23	41.34	10.177	10.180	1355	1437
A_3 : KCI 0.5% foliar spray	40.21	43.23	10.183	10.188	1420	1504
SE_d	0.60	0.65	0.002	0.003	36.12	37.23
CD	1.23	1.35	0.004	0.006	73.25	75.52
Interaction						
I x M	Absent		Absent		22.91	56.49
SE_d						
CD (P=0.05)					51.24	125.86
I x A	Absent		Absent		25.32	52.27
SE_d						
CD (P=0.05)					54.63	108.09
M x A	Absent		Absent		28.35	55.20
SE_d						
CD (P=0.05)					58.64	114.15

S : summer season; K: kharif season

Test weight

The test weight was influenced by irrigation regimes, methods of irrigation and management practices. Among the two seasons, summer sown crop resulted in higher test weight than the crop sown in *kharif* season in all the treatments. Irrigation scheduled at 0.6 IW/CPE ratio had significantly increased the test weight when compared to 0.4 ratio. Similarly, irrigation given through every furrow had recorded higher test weight, followed by that at double - row furrow than at alternate furrow method. With regard to management practices, coirpith application at 12.5 t ha^{-1} had improved the test weight when compared to other practices tried.

Seed yield

The seed yield was higher during *kharif* season than *summer*. Irrigation at 0.6 IW/CPE ratio (I_2) recorded significantly higher seed yield than that at 0.4 IW/CPE ratio (I_1). Irrigation through all furrow recorded higher seed yield followed by double row furrow irrigation, whereas alternate furrow irrigation recorded lower grain yield. Coirpith recorded higher seed yield followed by KCI and Kaolin. This might be due to increased growth parameters (plant height and DMP) and yield attributes (no. of pods per plant and test weight) recorded by this treatments. These results confirm the findings of Ravi Bharathi (1994).

Water used and water use efficiency

Total water used was higher in *kharif* season than in *summer* (Table 2). Irrigation at 0.6 IW/CPE ratio through all furrow method recorded higher water use amounting to 433 and 442 mm during *summer* and *kharif* season respectively whereas, the lower water use was with irrigation at 0.4 IW/CPE

Table 1 b. Water used and water use efficiency.

Treatments	Number of irrigations	Irrigation water applied (mm)	Effective rainfall (mm)	Total water used (mm)	Yield (kg ha^{-1})	WUE (kg ha mm^{-1})
Summer						
I_1M_1	5	250	92	342	1255	3.66
I_1M_2	5	147	92	239	1144	4.66
I_1M_3	5	134	92	226	1194	5.26
I_2M_1	7	350	83	433	1633	3.76
I_2M_2	7	217	83	300	1480	4.93
I_2M_3	7	202	83	285	1570	5.50
Monsoon						
I_1M_1	5	250	109	359	1337	3.72
I_1M_2	5	135	109	244	1195	4.89
I_1M_3	5	122	109	231	1276	5.52
I_2M_1	7	350	92	442	1714	3.87
I_2M_2	7	209	92	301	1461	5.18
I_2M_3	7	197	92	289	1652	5.71

ratio through double row furrow method consuming 226 and 231 mm in *summer* and *kharif* season respectively. The water use efficiency was higher in 0.6 IW/CPE ratio through double row furrow irrigation. This might be due to the fact that there was proportionate yield increase to the quantity of water used resulting in higher WUE. This is in line with the results of Crabtree *et al.*, (1985).

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