ould be obtained from any type of parental ombinations. But majority of the high SCA ombinations involved at least one parent ossessing high GCA effect; the other parent could ave high, average or low GCA effects (Yuan and Virmani 1988). This suggested that either additive , additive and/or additive x non-additive genetic nteraction was predominant in the materials tudied. In some other high SCA combinations, the arental combinations were either average x verage, average x poor or poor x poor, and the uperiority of these crosses may be due to omplementary type of gene interaction.

On the whole based on mean performance and GCA effects, TM 4309 and TKM 6 were the best ale parents, followed by IR 64, CO 37, ADT 36, ya, ASD 18 and TNAU 88013, and these parents an be used advantageously in the crossing rogramme with CMS lines for the development of uperior rice hybrids. Based on mean performance nd SCA effects, five hybrids *viz.,* IR 2829A/TKM 6, V20A/TNAU 88013, IR 2829A/TM 4309, IR 58025A.TKM 6 and IR 58025A/TM 4309 were found to be the best combinations for grain yield and most component raits, and can be exploited further to fix stable erforming heterotic hybrids.

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IMPACT OF IRRIGATION AND MANAGEMENT PRACTICES ON PHYSIOLOGY OF WATER RELATION AND PRODUCTIVITY IN SOYBEAN

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ABSTRACT

Investigations were carried out in the field in *kharif* 89 and *rabi* 90 employing the variety Co.1 with three irrigation scheduling *viz.*, 60, 80 and 100 mm of cumulative pan value and six management (ameliorative) practices comprising, incorporation of decomposed coir pith (coconut fibre waste) at 12.5 t ha^{-1}, split application of potassium at 40 kg ha^{-1} (50 per cent basal and 50 per cent top dressed at 30 and 60 DAS), spraying cycocel (250 ppm) at peak flowering stage, spraying 0.5 per cent Kcl at peak flowering stage, incorporation of crystal rain (Soil moisturiser) at 12 kg ha^{-1} and a control. The crop growth and yield was better in *kharif* than in *rabi*. Irrigation at 60 mm pan value improved the crop growth by recording more LAI, RGR, CGR, lower canopy temperature, transpiration rate higher RLWC and SDR which resulted in higher seed yield. Among the management practices, the foliar application of cycocel, and Kcl, separately maintained higher tissue water content, followed by split application of potassium and other treatments. Irrigation at 60 mm pan vale in combination with cycocel at 250 ppm recorded maximum seed yield in both the season, followed by split application of potassium in *kharif* and coirpith in *rabi* seasons respectively.

The water management for augmenting the crop productivity has become a most indispensable factor especially in a crop like soybean because of its high susceptibility to water stress at various growth stages. This can be achieved by proper crop management *viz.*, regulation of transpiration, improved water use efficiency and better root penetration. The water demand of the crop at critical stages can also be considerably reduced by potassium nutrition which maintains higher tissue water potential. However, the stress reduced the leaf water potential, stomatal conductance and transpiration (Munger *et al.,* 1987). According to Itoh and Kamura (1986) the water stress decreased the RGR and NAR which ultimately resulted in poor dry matter accumulation and seed yields. The deleterious effect of water stress on crop growth can be minimised by nutrition and hormonal application which are able to protect the crop from moisture stress by conserving adequate water in plants and reduce the yield reduction. Achitov (1961) suggested that potassium supply increased water uptake and further improved water use efficiency. Leaf temperature was found to be a good indicator of stress and potassium applied plants have maintained lower canopy temperature (Ehler, 1973). Application of cycocel reduced the water loss of plant by minimising the of area development and make the plants adoptive under water stress condition (Reggiardo *et al.,* 1981). Therefore a better understanding of ameliorants with water conserving, ability under water stress conditions has become absolutely essential for mitigating the water stress and needs thorough investigations. The present study was aimed to investigate the effect of irrigation and management practices on the water relation and their impact on crop productivity.

MATERIALS AND METHODS

Investigations were carried out in the field of Tamil Nadu Agricultural University, Coimbatore to study the effect of irrigation scheduling and management practices on growth physiology and yield of soybean (variety Co.1) *kharif* 1989 and *rabi,* 1990. The soils of experimental fields were of clay loam to sandy loam with low available nitrogen and high phosphorus and potash. The field capacity (19.7 to 19.9 %), permanent wilting point (9.2 to 9.5%), bulk density (1.35 to 1.44 gcm $^{-3}$), total porocity (46.6 to 47.7%), pH (8.3) and Ec (0.5 to 0.7 mmhos cm^{-1}) were also estimated. The following treatments were followed in both years.

Main plot treatment (Irrigation scheduling)

I1 - Irrigation at 60 mm of pan value of open pan evaporimeter

I2 - Irrigation at 80 mm of pan value of open pan evaporimeter

I3 - Irrigation at 100mm of pan vale of open pan evaporimeter

Table 1. Effect of irrigation scheduling and management practices on LAI, CGR and RGR of soybean

Treatment	LAI				CGR (gm^{-2} day^{-1})				RGR (g g^{-1} day^{-1}) x 10^{-2}			
	30 DAS		60 DAS		30-60 DAS		60-90 DAS		30-60 DAS		60-90 DAS	
	Kharif 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90
Irrigation												
I1 (60 mm)	0.47	0.41	1.31	1.13	10.60	9.14	7.93	5.54	2.73	2.74	0.69	0.60
I2 (80 mm)	0.40	0.34	1.18	1.02	9.12	7.14	5.44	4.36	2.90	3.14	0.64	0.60
I3 (100 mm)	0.31	0.22	1.06	0.32	6.79	6.34	4.48	3.20	2.97	2.25	0.60	0.52
CD 5%	0.02	0.07	0.05	0.04	0.32	0.13	0.35	0.43	NS	0.03	0.05	0.03
Management Practices												
M1	0.43	0.36	1.29	1.11	9.04	7.91	6.06	4.54	2.82	2.79	0.67	0.55
M2	0.44	0.37	1.36	1.13	8.97	7.86	6.30	4.47	2.82	2.83	0.66	0.55
M3	0.40	0.36	1.21	1.04	9.03	7.66	5.77	4.08	2.83	2.76	0.62	0.58
M4	0.40	0.34	1.29	1.08	8.97	7.56	6.09	4.46	2.79	2.37	0.66	0.61
M5	0.38	0.33	1.05	0.96	8.78	7.26	5.96	4.26	3.23	3.18	0.67	0.62
M6	0.32	0.29	0.89	0.62	8.24	6.90	5.52	4.41	2.73	3.30	0.59	0.52
CD 5%	0.02	0.04	0.10	0.17	0.03	0.19	0.39	NS	NS	NS	0.04	0.04

NS : Not Significant, LAI : Leaf area index, CGR : Crop gorwth rate, RGR : Relative growth ratio, DAS : Days after sowing.

Table 2. Effect of irrigation scheduling and management practices on RLWC (%) and TC (°c) in soybean.

Treatment	RLWC (%)						TC (°C)			
	Vegetative		Flowering		Pod filling		Flowering		Pod filling	
	Kharif 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90
Irrigation										
I1 (60 mm)	87.2	83.5	84.5	84.7	83.6	81.7	27.36	32.51	29.47	30.10
I2 (80 mm)	85.8	81.9	80.4	83.2	79.1	80.0	27.63	83.38	29.63	31.43
I3 (100 mm)	80.4	77.5	78.5	78.7	71.7	75.7	28.66	34.33	30.36	32.42
CD 5%	0.45	0.65	1.36	0.46	1.19	1.00	0.24	0.26	0.11	0.24
Management Practices										
M1	85.5	81.6	81.1	82.8	79.6	79.8	27.92	33.50	29.96	31.30
M2	84.9	81.8	81.8	82.7	80.8	79.4	27.66	33.15	29.62	31.35
M3	84.6	80.9	82.4	82.2	81.3	79.4	27.70	33.16	29.57	31.15
M4	84.8	81.6	81.7	83.0	81.1	79.9	27.71	33.23	29.61	31.25
M5	84.4	81.0	80.3	82.2	79.6	78.9	27.87	33.63	30.00	31.63
M6	82.8	79.3	79.0	80.4	78.3	77.3	28.45	33.78	30.17	31.83
CD 5%	1.40	0.97	1.07	0.98	0.98	0.88	0.24	0.20	0.13	0.39

RLWC : Relative leaf water content, TC : Canopy temperature.

Sub-plot treatment (Management practices)

M1 - Incorporation of decomposed coir pith at 12.5 t ha^{-1}

M2 - Split application of potassium at 40 kg K_2O ha^{-1} 50% at basal and 50% as top dressing on 30 and 60 DAS

M3 - Spraying cycocel 280 ppm at peak flowering stage

M4 - Spraying 0.5% Kcl at peak flowering stage

M5 - Incorporation of crystal rain (a water conserving synthetic gelatinous material)

M6 - Control

Recommended package of practices were followed. The plant samples were drawn at different stages and were analysed for leaf area index (Williams, 1946), crop growth rate (Watson, 1958), relative growth rate (Williams, 1946) relative leaf water content (Satyer and Barrs, 1965), canopy temperature (Jackson *et al*, 1981) stomatal diffusion resistance and transpiration rate (LI - 1600 steady state porometer). The grain yield was recorded at harvest and expressed as kg ha^{-1}. The data were subjected to statistical analysis by the method adopted by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Leaf area index (LAI)

Higher LAI was recorded in *kharif* than in *rabi*. Scheduling irrigation at 60 mm of pan value recorded higher LAI followed by 80 mm in *Kharif* and *rabi* seasons respectively. Application of coirpith and potassium increased the LAI significantly during both the seasons. Cycocel application reduced the LAI and all other treatments were comparable with control (Table 1).

Crop growth rate (CGR)

Higher CGR was recorded during *kharif* than in *rabi*. Irrigation influenced the CGR at all stages in both the seasons. Irrigation scheduling at 60 mm of pan values recorded maximum CGR followed by 80 mm and 100 mm at 30 - 60 and 60 - 90 DAS in *Kharif* and *rabi* seasons. This may be attributed to rapid rate of increase in plant growth components with the supply of copious water during the crop period (Taylor *et al.*, 1982). Incroporation of coirpith and split application of potassium recorded higher CGR because of better growth and development. Cycocel spray significantly decreased the CGR during both the seasons at later stage of crop growth (Table 1).

Table 3. Effect of irrigation scheduling and management practices on TR ($\mu g\ H_2O\ cm^2\ Sec^{-1}$) and SDR ($S\ cm^{-1}$) in soybean

Treatment	TR				SDR			
	Flowering		Pod muturation		Flowering		Pod muturation	
	Kharif 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90	*Kharif* 89	*Rabi* 90
Irrigation								
I1 (60 mm)	70.56	74.30	67.47	70.27	0.92	1.26	1.71	1.96
I2 (80 mm)	69.40	72.38	66.86	69.20	1.23	1.52	1.99	2.21
I3 (100 mm)	68.67	71.38	66.29	68.36	1.45	1.95	2.58	2.54
CD 5%	0.83	0.63	0.17	0.32	0.01	0.03	0.43	0.02
Management Practices								
M1	70.15	72.94	67.21	69.88	1.21	1.58	2.04	2.21
M2	69.02	72.46	66.48	68.98	1.22	1.62	2.44	2.26
M3	68.50	71.94	66.02	68.30	1.22	1.65	2.13	2.34
M4	69.00	72.30	66.75	69.14	1.21	1.62	2.09	2.28
M5	69.44	73.11	67.27	69.57	1.19	1.53	2.03	2.19
M6	71.14	75.38	67.51	69.84	1.18	1.48	1.83	2.14
CD 5%	0.84	0.81	0.20	0.25	0.01	0.03	NS	0.03

TR : Transpiration rates; SDR : Somatat diffusion resistance, NS : Not Significant.

Relative growth rate (RGR)

The RGR was high in *kharif* than in *rabi*. Higher values of RGR were recorded under irrigation of lesser pan value than in wider pan values treatments. Irrigation scheduling did not influence RGR at 30-60 DAS in both the seasons. There was significant difference between control and other treatments (Table 1).

Relative leaf water content (RLWC)

In general, RLWC decreased from vegetative to flowering stage. Comparatively higher values of RLWC were recorded in *kharif* than *rabi* at all stages of crop growth. Irrigation at low pan values associated with shorter intervals of irrigation recorded higher values of RLWC followed by wider intervals with higher pan values of 80 mm and 100 mm during *kharif* and *rabi* seasons at vegetative, flowering and pod filling stages respectively. It may be attributed to frequent supply of water to soil, that has resulted in increased uptake of water. Among the management practices, potassium considered to be a better Osmoticum for stomatal regulation and for the maintenance of better internal water balance in tissues (Table 2).

Canopy temperature (TC)

Canopy temperature during flowering and pod maturation stage was lower in *kharif* than in *rabi*. Shorter pan value of irrigation (60 mm) treatment lowered the canopy temperature compared to wider pan value of 80 mm and 100 mm at flowering and pod maturation stages. The increased uptake of water and higher tissue turgidity reduced the canopy temperature and high TC at wider pan

Table 4. Effect of irrigation scheduling and management practices on seed yield (kg ha^{-1}) in soybean

Treatment	*Kharif* 89				*Rabi* 90			
	I1 (60 mm)	I2 (80 mm)	I3 (100 mm)	Mean	I1 (60 mm)	I2 (80 mm)	I3 (100 mm)	Mean
M1	1581	1523	1345	1482	1477	1453	1402	1444
M2	1628	1663	1327	1539	1438	1427	1424	1430
M3	1667	1561	1313	1514	1507	1410	1348	1421
M4	1568	1448	1448	1438	1425	1397	1315	1379
M5	1478	1328	1181	1329	1321	1244	1222	1262
M6	1390	1205	1037	1210	1242	1149	1040	1144
Mean	1552	1455	1275	-	1402	1347	1295	-
CD 5%	I	25.73				13.90		
	M	21.01				21.35		
	M at I	28.20				28.65		
	I at M	41.60				36.25		

value was due to low availability of water to the crop. All the management practices treatments reduced the TC compared to control which recorded higher TC. Cycocel spray resulted in reduced rate of transpiration and it increased the internal water balance thereby it cooled the canopy. Lugg and Sinclair (1979) reported that potassium functioned as a better osmoticum for stomatal regulation and retained good tissue water balance (Table 2).

Transpiration rate (TR)

Higher TR was noticed during *rabi* than in *kharif*. This may be attributed due to lower atmospheric humidity and higher day temperature. TR was high at flowering and slightly decreased at pod maturation stage. Irrigation scheduling at 60 mm of pan values recorded higher TR than 80 mm and 100 mm at flowering and pod maturation stages.

Cycocel spray reduced the transpiration rate by increasing the stomatal resistance which was on par with Kcl spray and split application of potassium. However the incorporation of coirpith and crystal rain could not reduce the water loss and they were on par with control (Table 3).

Stomatal diffusion resistance (SDR)

In general the SDR was high in *rabi* compared to *kharif* crop. Irrigation scheduling at 60 mm of pan value recorded lower values of resistance than 80 mm and 100 mm of pan values. Higher values of SDR were associated with low water availability and were noticed during pod maturation stage than at flowering stage during both the seasons. The foliar spraying of cycocel increased the SDR to considerable extent, which was on par with split application of potassium and foliar Kcl at peak flowering period (Table 3.)

Seed yield

The *kharif* crop recorded higher seed yield, than *rabi*. The irrigation at 60 mm of pan value recorded higher yield followed by 80 mm and 100 mm in *kharif* and *rabi* seasons respectively. The higher seed yield recorded in low pan value was due to maintenance of plant water relations favouring growth and yield components. Management practices significantly influenced the seed yield. Split application of potassium increased yield in *kharif* followed by other treatments. Similarly in *rabi* coirpith application recorded higher yield .

Significant interactions were observed between irrigation and management practices. Irrigation at 60 mm of pan value with cycocel spray recorded higher seed yield 1667 kg ha^{-1} in *kharif* and 1507 kg ha^{-1} in *rabi* seasons. All other treatments gave significantly comparable yield but recorded higher yield than control during both the seasons (Table 4).

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