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# EFFECT OF IRRIGATION AND AGRONOMIC MANAGEMENT PRACTICES FOR WATER USE EFFICIENCY IN SOYBEAN

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**ABSTRACT**

Investigations were carried out in soybean (Var:Co 1) with three irrigation scheduling at 60, 80 and 100 mm of cumulative pan value from open pan evaporimeter and six management practices of incorporation of decomposed coconut fibre waste (DCFW) at 12.5 ha$^{-1}$, split application of potassium @ 40 kg ha$^{-1}$ (50 per cent basal and remaining 50 per cent top dressed at 30 DAS and 60 DAS) spraying cycocel 250 ppm, spraying 0.5 per cent at peak flowering stage and incorporation of crystal rain (soil moisturiser) at 12 kg ha$^{-1}$ and a control. Soybean gave higher yield during Southwest monsoon season as compared to winter sown crop. Scheduling irrigation at 60 mm of pan value recorded higher yield of seed followed by 80 mm and 100 mm in both the seasons. Among the management practices split application of potassium @ 40 kg ha$^{-1}$ recorded higher yield during Southwest monsoon and incorporation of DCFW in winter sown crop.

KEYWORDS : Soybean, Water use Efficiency, Irrigation, Management Practices.

Optimum water use efficiency is crucial in irrigated soybean production for higher profit and for the economical use of limited water resource. Irrigation management in soybean will be useful to optimise water use to obtain reasonable yield to higher yield. Hence, appropriately timed with relatively lesser quantum of water is to be aimed at Irrigation scheduling techniques are one of the means of attaining this goal. Application of moisture conserving material to soil will enhance the yield by retaining more moisture holding ability. The present study aims at to fix the optimum irrigation scheduling, identification of management practices to improve the plant water relationship and effect of potassium, cycocel and potassium chloride spray, moisture conservation materials like coconut fibre waste and crystal rain on yield and yield components of soybean.

## MATERIALS AND METHODS

Field investigations were carried out at the Tamil Nadu Agricultural University, Coimbatore to study the effect of irrigation scheduling and management practices on growth, physiology, yield and water use efficiency of soybean during South West Monsoon (SWM) 1989 and winter seasons of 1990. The soils of experimental fields were of clay loam to sandy loam. Available nitrogen status was low and phosphorus and potassium levels were high. Field capacity (19.7 - 19.9%), wilting point (9.2-9.5) and bulk density (1.35-1.35 cm$^3$) and total porosity (46.6-47.7%) soil pH 7.6 and E.C. (4.8 m.mhos cm$^{-1}$) were also evaluated and used for interpretation. Soybean cultivar Co.1 with a duration of 85-90 days was used. Irrigation Scheduling was based on open pan evaporimeter. The depth of irrigation adopted was 50 mm. Three irrigation scheduling treatments included irrigation at 60 mm ($I_1$), 80 mm ($I_2$) and 100 mm ($I_3$) CPE (Cumulative pan evaporation). Six management practices were involved *viz.*, incorporation of decomposed coconut fibre was (DCFW) at 2.5 t ha$^{-1}$.(M1), split application of potassium at 40 kg $K_2O$ ha$^{-1}$ 50 per cent at basal and remaining 50 per cent applied as top dressing, 30 days after sowing (DAS) and at 60 DAS ($M_2$), spraying cycocel 250 ppm at peak flowering stage (M3), spraying 0.5 per cent Kcl spray at peak flowering stage (M4), Incorporation of 'Crystal rain' (a water concerving synthetic gelatinous material) (M5) and control (6). Recommended package of practices for soybean (var.Co1) were adopted. Coconut fibre waste containing 0.2, 0.3 and 0.02 per cent of NPK with high percentage of lignin (43%) with maximum water holding capacity of 500 per cent. One month prior to sowing, the row of coconut fibre waste was decomposed by spreading the coconut fibre waste in a shaded place having 5 x 3 m dimension. Uniformly 100 kg of coconut fibre waste was spreaded. One bottle of *Pleurotus sajorcaju* was uniformly broadcasted on the spreaded coconut fibre waste. On the surface of the second layer spreaded one kg urea uniformly. This sandwiching process was repeated. Finally on the top layer and

**Table 1.** Effect of irrigation scheduling and management practices on dry matter production (kg ha$^{-1}$) seasonwise and stagewise.

| Treatment | 30 DAS | | 60 DAS | | 90 DAS | |
|---|---|---|---|---|---|---|
| | Kharif '89 | Rabi '90 | Kharif '89 | Rabi '90 | Kharif '89 | Rabi '90 |
| Irrigation scheduling | | | | | | |
| $I_1$ (60 mm) | 564.8 | 399.9 | 4045.9 | 3152.6 | 5153.2 | 4832.5 |
| $I_2$ (80 mm) | 343.2 | 343.5 | 3470.8 | 2568.5 | 4507.1 | 3815.8 |
| $I_3$ (100 mm) | 229.2 | 255.5 | 3350.2 | 2155.1 | 3812.7 | 3172.0 |
| $SE_d$ | 3.9 | 2.1 | 31.4 | 37.1 | 44.3 | 7.4 |
| CD at 5% level | 11.0 | 6.0 | 87.2 | 103.0 | 123.0 | 20.7 |
| Management practices | | | | | | |
| $M_1$ DCFW 2.5 t ha$^{-1}$ | 391.5 | 340.2 | 3801.1 | 2731.2 | 4571.6 | 3970.6 |
| $M_2$ Potassium 40 kg ha$^{-1}$ | 390.3 | 340.3 | 3721.1 | 2752.3 | 4532.5 | 3990.4 |
| $M_3$ Cycocd 250 ppm | 391.3 | 335.1 | 3674.9 | 2646.6 | 4413.6 | 3968.8 |
| $M_4$ Kcl 0.5% spray | 388.7 | 333.6 | 3664.6 | 2605.2 | 4634.2 | 3982.7 |
| $M_5$ Crystal rain | 375.4 | 328.6 | 3613.7 | 2540.7 | 4472.1 | 3898.2 |
| $M_6$ Control | 337.2 | 320.1 | 3258.6 | 2476.5 | 4322.0 | 3830.0 |
| $SE_d$ | 17.1 | 3.7 | 64.7 | 67.7 | 82.1 | 28.2 |
| CD at 5% level | 35.0 | 7.7 | 132.2 | 138.3 | 167.7 | 57.6 |

Interaction not significant

**Table 2.** Effect of irrigation scheduling and management practices on number of pods per plant in seasorwise

Kharif '89

| Treatment | $I_1$ (60 mm) | $I_2$ (80 mm) | $I_3$ (100 mm) | Mean |
|---|---|---|---|---|
| $M_1$ | 66.77 | 55.65 | 46.33 | 56.25 |
| $M_2$ | 58.33 | 57.88 | 41.66 | 52.62 |
| $M_3$ | 73.21 | 69.55 | 41.33 | 61.36 |
| $M_4$ | 87.88 | 49.22 | 43.00 | 60.03 |
| $M_5$ | 52.00 | 47.66 | 39.33 | 46.33 |
| $M_6$ | 46.33 | 35.66 | 31.33 | 37.77 |
| Mean | 64.08 | 52.61 | 40.50 | |
| | | $SE_d$ | CD | |
| | I | 1.00 | 2.77 | |
| | M | 2.77 | 5.66 | |
| | M at I | 3.71 | 7.59 | |
| | I at M | 4.49 | 9.34 | |

Rabi '90

| Treatment | $I_1$ (60 mm) | $I_2$ (80 mm) | $I_3$ (100 mm) | Mean |
|---|---|---|---|---|
| $M_1$ | 48.55 | 38.19 | 25.33 | 37.35 |
| $M_2$ | 42.55 | 38.19 | 20.33 | 33.69 |
| $M_3$ | 48.10 | 37.99 | 21.44 | 35.84 |
| $M_4$ | 42.00 | 36.55 | 26.32 | 34.95 |
| $M_5$ | 42.44 | 35.00 | 18.55 | 31.99 |
| $M_6$ | 39.88 | 32.75 | 16.55 | 29.73 |
| Mean | 43.92 | 36.44 | 21.42 | |
| | | $SE_d$ | CD | |
| | I | 0.41 | 1.15 | |
| | M | 0.89 | 1.82 | |
| | M at I | 1.20 | 2.45 | |
| | I at M | 1.47 | 3.09 | |

around the heap water was sprinkled now and then to the heap to keep the moisture level approximately to 200 per cent and the heap was allowed to decompose for a month to obtain decomposed coconut fibre waste (DCFW). It was incorporated into the soil in the normal tillage practice. Crystal rain is a super concentrated polymer. It is a gelationized starch hydroloyzed polyacrylo nitrile graft copolymer using potassium hydroxide. It acts like a super sponge, absorbing and storing many times of its own weight. Water is held in it at 0.1 to 2.0 atmosphere. The recommended dose of 12 kg of crystal rain per $ha^{-1}$ was broadcasted uniformly in the treated plots and levelled.

## RESULTS AND DISCUSSIONS

Number of parameters were studied in this experiment. However few important yield components are discussed besides grain yield, water use efficiency and economics.

### Dry matter production (DMP)

In general, DMP was higher during SWM season than winter season. Higher DMP was recorded with irrigation scheduling at 60 mm ($I_1$) of pan value followed by 80 mm ($I_2$) and 100mm ($I_3$) of pan value. There was no significant difference among the management practices at all stages of the crop (Table 1).

Increased DMP under high moisture status accomplished favourable growth as evidenced from increased levels of growth components. Increased DMP in soybean with higher moisture regimes (Korte *et al.*, 1983) and reduced DMP under moisture stess (Eck *et al.*, 1987) have bee reported.

**Table 3. Effect of irrigation scheduling and management practices on seed yield (kg $ha^{-1}$).**

| Treatment | Seed yield | |
|---|---|---|
| | Kharif '89 | Rabi '90 |
| Irrigation scheduling | | |
| $I_1$ (60 mm) | 1552 | 1402 |
| $I_2$ (80 mm) | 1455 | 1347 |
| $I_3$ (100 mm) | 1275 | 1292 |
| $SE_d$ | 9.26 | 5.00 |
| CD at 5% level | 25.72 | 13.90 |
| Management practices | | |
| $M_1$ DCFW 2.5 t $ha^{-1}$ | 1483 | 1444 |
| $M_2$ Potassium 40 kg $ha^{-1}$ | 1539 | 1430 |
| $M_3$ Cycocd 250 ppm | 1514 | 1422 |
| $M_4$ Kcl 0.5% spray | 1488 | 1379 |
| $M_5$ Crystal rain | 1329 | 1262 |
| $M_6$ Control | 1211 | 1144 |
| $SE_d$ | 10.29 | 10.45 |
| CD at 5% level | 21.01 | 21.25 |

Interaction are significant

### Number of pods per plant

More number of pods were recorded during SWM than in winter season. Irrigation at $I_1$ of pan values recorded higher number of pods. This treatment significantly differed from $I_2$ and $I_3$. Lower number of pods were recorded under irri gation $I_3$ of pan value in both the seasons (Table 2).

Among the management practices, potassium chloride spray at peak flowering (M4) and CCC spray (M3) recorded increased number of pods. All other treatments were on a par during SWM season. In winter sown crop, DCFW increased the number of pods. It was on par with all other treatments except control (M6) which registered

**Table 4. Water use components, seasonwise.**

| Treatment | Number of Irrigation | Seasonal water applied (mm) | Soil moisture + Effective rainfal (mm) | Seasonal total water requirement (mm) | Water use rate for crop period (mm) | Water use efficiency (kg $ha^{-1}$ $mm^{-1}$) |
|---|---|---|---|---|---|---|
| | | | Kharif '89 | | | |
| $I_1$ (60 mm) | 9 | 450 | 90 | 540 | 6.00 | 2.87 |
| $I_2$ (80 mm) | 7 | 350 | 88 | 438 | 4.86 | 3.32 |
| $I_3$ (100 mm) | 6 | 300 | 109 | 409 | 4.54 | 3.11 |
| | | | Rabi '90 | | | |
| $I_1$ (60 mm) | 8 | 400 | 41 | 441 | 4.90 | 3.17 |
| $I_2$ (80 mm) | 6 | 300 | 45 | 345 | 3.83 | 3.90 |
| $I_3$ (100 mm) | 5 | 250 | 46 | 296 | 3.28 | 4.36 |

Table 5. **Effect of irrigation scheduling and management practices on economics - Rabi '90.**

| | Gross returns $ha^{-1}$ (Rs.) | Cost of cultivation $ha^{-1}$ (Rs.) | Net returns $ha^{-1}$ (Rs.) | B.C. ratio | Per day grpss return $ha^{-1}$ (Rs.) |
|---|---|---|---|---|---|
| Irrigation scheduling | | | | | |
| $I_1$ (60 mm) | 5604 | 2430 | 3174 | 2.31 | 62 |
| $I_2$ (80 mm) | 5384 | 2310 | 3074 | 2.33 | 60 |
| $I_3$ (100 mm) | 5168 | 2250 | 2918 | 2.29 | 57 |
| Management practices | | | | | |
| $M_1$ | 5776 | 2035 | 3741 | 2.84 | 64 |
| $M_2$ | 5716 | 2015 | 3701 | 2.83 | 63 |
| $M_3$ | 5684 | 2100 | 3584 | 2.70 | 63 |
| $M_4$ | 5516 | 1950 | 3566 | 2.82 | 61 |
| $M_5$ | 5048 | 1965 | 3083 | 2.56 | 56 |
| $M_6$ | 4575 | 1920 | 2655 | 2.38 | 50 |

significantly lowest number of pods in both the seasons.

Increased pod number per plant with irrigation scheduled at shorter pan values is attributed to better accumulation and translocation of assimilates coupled with longer seed filling periods. Treatments received irrigation of higher pan value and prolonged interval gave comparable value for pod number. Similar observations were also reported by Thompson (1984) and Muchow (1985) that moisture stress reduced pods per plant through pod and ovule abortion. Significantly increased number of pods per plant with management practices may be attributed to the active role in water transport by K, reduction of transporting distance by CCC with shortening of internodes and favourable soil moisture and nutritional status contributed by DCFW.

## Seed yield

The seed yield was higher during SWM season as compared to winter sown crop. All the three irrigation treatments differed significantly for seed yield. The $I_1$ treatment recorded highest seed yield followed by $I_2$ and $I_3$ of cumulative pan value (Table 3).

Among the management practices, split application of potassium (M2) significantly increased the seed yield in SWM season. In the winter sown crop, DCFW gave higher yield and it was on par with split application of potassium and rest of the treatments were on par. The control gave the lowest seed yield.

Scheduling irrigation at lower pan value resulted in higher seed yield which might be possibly due to maintenance of plant water relations favouring growth components and yield components. Increased yield of seeds with split application of potassium in SWM season and DCFW application in winter sown crop may be due to favourable effect on different yield components besides on growth factors. Scheduling irrigation at 100 mm of pan value with Kcl spray also recorded significantly higher yield as compared to without Kcl spray as evidenced from interaction effect between irrigation scheduling and management practices.

## Water use and water use efficiency

In general, seasonal water requirement was higher during SWM than winter sown crop. Scheduling irrigation at ($I_1$) of pan values recorded higher total water requirement followed by $I_2$ and $I_3$ during both the seasons. Water use efficiency was higher in winter sown crop as compared to SWM season crop. Scheduling irrigation at $I_2$ in SWM season and at $I_3$ in winter sown crop maximum water use efficiencies were recorded (Table 4).

## Economics

Gross and net return were higher in SWM season than winter sown crop. Higher net returns were recorded with soybean irrigated at $I_1$ of cumulative pan evaporation in both seasons. It was followed by scheduling irrigation at $I_2$ and at $I_3$ of pan values. The cost of cultivation was comparatively lower during winter sown crop than

SWM season crop. Gross returns and net returns were higher with increased quantum of water applied under 60 mm pan value (Table 5).

Among management practices, cost of cultivation was not much varying except cycocel spray. Higher cost of cultivation was recorded with CCC spray in both the seasons. All other treatments were comparable. Gross and net returns were higher due to split application of potash. DCFW incorporation also gave higher gross and net returns. Economic returns was higher at scheduling of irrigation at 60 mm pan value, split application of Kcl spray at peak flowering stage and incorporation of DCFW are useful.

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# ANALYSIS OF RAINFALL DATA AND SUITABLE CROPPING SYSTEMS FOR TRICHY DISTRICT

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**ABSTRACT**

The rainfall data pertaining to 40 years were analysed and contingent crop plan was developed for Trichy district. The annual mean rainfall was 742.02 mm. The distribution pattern of annual rainfall over the 40 years reveals that in 15 years, it was normal (37.5%) and in 10 years, it was deficit (25.0%). Excess rainfall was recorded in 13 years (32.5%). In two years, the rainfall was scanty (5.0%). Among the four seasons, North East monsoon contributes the highest quantity rainfall (47.2%) followed by South West monsoon (37.5%). The sowing rains of 20 mm and above were recorded in the third week of August through the end of the year. Based on the rainfall pattern, suitable crops are recommended for various soil types like red, black and salt affected soils.

KEYWORDS : Rainfall, Cropping Systems, Trichy.

Rainfall is the ultimate source of moisture for human activities, more so for agriculture. Hence a knowledge on the probable dates of commencement, end of the rainy season and the duration of intermittent dry/wet spells are very useful for planning various agricultural operations. This will subsequently help to minimise the risk in crop production, and also to optimise the utilization of the limited resources like labour, fertiliser, herbicides and insecticides.

## MATERIALS AND METHODS

Keeping the importance of rainfall, the daily rainfall data of Trichy centre pertaining to the years 1950 to 1989 (40 years) was collected. The data has been analysed through variability and probability methods (Kulandaivelu *et al.*, 1979; Budhar and Ramasamy, 1985). Mean, standard deviation and coefficient of variation were worked out for standard week, month, season and year. The conditional probability to find out the per cent chance to get the sowing rain was also worked out for different operations like summer ploughing, pre monsoon sowing of seeds, etc.

## RESULTS AND DISCUSSION

### Annual rainfall

The annual mean rainfall of Trichy centre was 742.0 mm. The highest rainfall of 1224.3 mm was recorded during 1983, while the lowest amount of 283.7 mm was observed in 1980. The annual rainfall has been classified into four categories *viz.*, excess, normal, deficient and scanty (Table 1). The