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Water stress management for young coffee plantation

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Abstract: Field experiment was conducted for two years, at Pollibetta, Kodagu district, Karnataka. The treatments were the combination of three irrigation intervals (pot irrigation once in two, four and six weeks) and six stress mitigation practices (control, urea and KCl spray, Rallidhan spray, mulch alone, mulch + urea and KCl spray and mulch + Rallidhan spray). It was tested on two year old Arabica coffee cv. cauvery. Considering the plant water status, vegetative growth and establishment of young coffee plants it was concluded that application of mulch at the start of dry period (first week of December) and giving irrigation once in two weeks interval @ 14 litres per plant througout the dry period (December to April) was considered as the suitable irrigation and stress management practice to young Arabica coffee. *(Key words: Water stress, Coffee, Management)*

Although coffee is grown in heavy rainfall areas, it is exposed to drought for a period of three to six months in a year under South Indian conditions. After planting young seedlings, the establishments and its growth is mostly affected due to prolonged drought during summer months. As the water availability is scarce, the available water should be judiciously used. Mitigating water stress by mulching, spray of urea and KCl or antitranspirant are common practice for annual field crops. The present study was conducted with objective of determining the optimum interval of irrigation and suitable stress management practice for reducing water stress and obtain a vigorous plant growth for early flowering.

Materials and Methods

The trial was conducted for two years during 1988-89 and 1989-90 at Pollibetta, Kodagu district. The soil type was sandy clay loam with field capacity and permanent wilting point of 22.2 % and 11.7 % respectively. The test variety was two years old Arabica cv. cauvery. The trial was conducted in split plot design replicated thrice with nine plants per plot. The treatments were:

Main plot: (Irrigation schedules)
I_1 - Irrigation once in two weeks (short interval)
I_2 - Irrigation once in four weeks (medium interval)
I_3 - Irrigation once in six weeks (long interval)

Pot irrigation was adopted @ 14 litres per plant per irrigation

Sub plot: (Stress management practices)
M_1 - Control (water spray)
M_2 - Spray of Urea 2% and KCl 1%
M_3 - Spray of Rallidhan (an antitranspirant) 0.1%
M_4 - Mulch (dried plant materials)
M_5 - Mulch + Urea and KCl spray as in M_2
M_6 - Mulch + Rallidhan spray as in M_3.

Totally 11 spray of nutrients/Rallidhan was given at 15 days interval and 11, 6 and 5 irrigations were given for I_1, I_2, and I_3 treatments respectively during the period of December to April. The leaf water potential (LWP) of 4th node from the tip of a branch was estimated using pressure chamber (model S- pms, Plant Moisture Stress Instrument Co., New Delhi) between 12.00 and 14.00 h. The LWP was measured at 15 days interval and totally 10 observations were made. The critical LWP for stress was taken as 2.0 MPa (Marimuthu and Iruthayaraj, 1994). The growth characters were recorded at pre-and post-treatment period and the increment over the period of 20 weeks were calculated. Leaf area was estimated by the formula (Awatramani and Gopalakrishna, 1965),

$$LA = L \times W \times K$$

Where LA - leaf area in cm^2, L and W - length and width of leaf at 4 th node of primary branch, and K - constant factor of 0.63.

Results and Discussion

Critical limit of LWP (2.0 MPa.) was crossed five times in short interval (I_1) whereas it was six to seven times and nine times under medium (I_2) and long intervals (I_3) irrigation (Table 1). This result revealed that plants under all the irrigation treatments suffered due to water stress with varied duration. Decreasing the interval of irrigation showed better plant water status with reduced moisture starving duration.

Observation made on growth parameters during both years indicated that the highest increment in all the growth parameters was found in irrigation at short interval (I_1) while the lowest was in irrigation at long interval (I_3). The plants under long interval irrigation (I_3) suffered stress for a long period which resulted in reduction

Table 1. Effect of irrigation and stress management practices on growth in coffee

Treatments	No.of observations LWP reached below critical limit		Increment in plant height (cm)		Increment in stem girth (mm)		Primary branch production / plant		Shoot extension (cm)	
	88-89	89-90	88-89	89-90	88-89	89-90	88-89	89-90	88-89	89-90
Irrig. interval										
I_1 - 2 weeks	4	5	4.89	4.95	3.86	3.77	3.49	3.45	3.06	3.11
I_2 -4 weeks	6	7	4.39	4.40	3.48	3.40	3.40	3.25	2.93	3.04
I_3 -6 weeks	9	9	3.54	3.58	3.28	2.90	2.78	2.70	2.65	2.49
CD(P=0.05)	-	-	0.63	0.42	0.35	0.64	0.53	0.52	0.39	0.43
Stress management										
M_1-Control	10	10	4.19	4.26	3.61	3.34	2.84	2.85	2.64	2.55
M_2-Urea & KCl	6	6	4.24	4.25	3.52	3.27	3.01	3.01	2.87	2.83
M_3-Rallidhan	8	8	4.27	4.25	3.58	3.20	3.18	3.05	2.90	2.90
M_4-Mulch	6	6	4.30	4.34	3.54	3.40	3.31	3.20	2.96	2.98
M_5-Mulch+ Urea & KCl	5	6	4.33	4.37	3.58	3.50	3.46	3.28	2.92	3.01
M_6-Mulch+ Rallidhan	5	5	4.32	4.37	3.44	3.37	3.54	3.42	2.99	3.00
CD(P=0.05)	-	-	NS	NS	NS	NS	0.33	0.34	0.29	0.35

Table 2. Effect of irrigation and stress management practices on node and leaf production

Treatments	Node production / branch		Leaf production / branch		Defoliation/ branch		Change in leaf area/branch (cm^2)	
	88-89	89-90	88-89	89-90	88-89	89-90	88-89	89-90
Irrigation intervals								
I_1-2 weeks	1.66	1.51	3.45	3.32	4.81	4.81	-91.5	-100.4
I_2 - 4 weeks	1.49	1.50	3.14	3.13	5.19	5.26	-90.1	-107.3
I_3 - 6 weeks	1.43	1.40	2.82	2.75	6.18	6.10	-115.2	-125.1
CD(P=0.05)	0.20	0.05	0.33	0.35	0.66	0.77	12.0	11.0
Stress management								
M_1 - Control	1.46	1.39	2.97	2.92	5.70	5.66	-106.1	-112.3
M_2 - Urea & KCl	1.49	1.42	3.11	3.02	5.50	5.47	-104.3	-113.8
M_3 - Rallidhan	1.51	1.45	3.11	3.04	5.45	5.43	-101.8	-111.9
M_4 -Mulch	1.54	1.46	3.22	3.02	5.28	5.31	-99.7	-112.6
M_5 - Mulch + Urea & KCl	1.57	1.53	3.21	3.24	5.22	5.22	-98.8	-107.3
M_6-Mulch+ Rallidhan	1.56	1.54	3.20	3.16	5.2	5.25	-98.9	-107.8
CD(P=0.05)	NS	NS	NS	NS	0.32	0.26	4.8	3.9

of growth. Hsiao (1973) reported that water stress influenced growth by affecting cell elongation directly and indirectly by influencing mineral uptake. Irrigation at long interval (I_3) not only reduced the leaf production but also caused the highest leaf senescence (Table 2). The highest leaf senescence with less leaf production due to high water stress under long interval irrigation (I_3) resulted in the reduction of leaf area available for photosynthesis which could lead to drastic reduction of growth. This was in accord with the results of Jones and Higgs (1979) who observed reduction in photosynthesis with increased moisture stress.

Comparison of stress management practices showed that in control (M_1) LWP crossed the critical limit ten times out of ten observations was made, whereas it was only six times in urea and KCl spray (M_2), Rallidhan spray (M_3) and mulch alone (M_4). Similarly either mulch + urea and KCl spray (M_5) or mulch + Rallidhan spray(M_6) recorded only five times the LWP below the critical limit. This result revealed that urea and KCl spray (M_2) or Rallidhan (M_3) or mulch (M_4) improved the plant water status of plants equally but higher than control (M_1). Mulch + Rallidhan (M_6) and mulch + urea and KCl (M_5) sprayed plants showed better water status than the other treatments. The way by which various stress management practices improved the plant water status differed. Unger (1971) showed that mulching the soil could improve the plant water status by improving the availability of soil moisture to the plant by reducing the evaporation loss. There are few reports about the plant water improvement due to urea and KCl sprays. Kumar (1979) reported that under limiting water supply N - rich plants had less wide open stomata and lost water slowly and hence the urea sprayed coffee tree had high LWP compared to unsprayed ones. Mottram (1985) stated that K content of leaves favoured water status of plants through maintenance of solute or osmotic potential favouring water relation of guard cells and reducing the transpiration rate. Similarly in the present study also urea and KCl spray recorded higher LWP compared to control. Improvement of water status in Rallidhan sprayed plants might be due to its antitranspirant characteristic. It has been experimetally proved that when Rallidhan was sprayed on Robusta coffee reduced the transpiration by 45% (Anonymus 1986). Devenport *et al.* (1974) reported that antitranspirant films increased LWP in peach.

Observation made during both the years indicated that the primary branch production and shoot extension were the highest in mulch treatments (M_4, M_5 and M_6). Though plant height, stem girth, node production and leaf production per branch were not significantly affected by various stress management practices in both years, increment in the above parameters were higher in mulched treatments (M_4, M_5 and M_6) than non mulched treatments (M_1,M_2 and M_3). Stress management practices did not considerably influence the leaf production in branch however it significantly influenced the leaf senescence. Leaf senescence was found to be more in non-mulched treatments (M_1,M_2 and M_3) than in mulched treatments (M_4, M_5 and M_6) resulting in greater reduction of leaf area. Higher leaf senescence and reduced leaf area were attributed by severe water stress of plants under these treatments.

It was obvious that among various stress management practices tested either mulch alone (M_4) or mulch + urea and KCl spray (M_5) or mulch + Rallidhan spray (M_6) equally favoured the growth parameters. Favourable effects of mulching on growth parameters was attributed by better water status of plants. Evenson and Rambaugh (1972) reported the beneficial effect of mulching on vegetative growth. Similarly the beneficial effect of urea and KCl spray treatment was attributable to the higher nutrient content of plants and better water status. Rallidhan sprayed plants also showed better vegetative growth compared to control. This was attributed to better water status in the plants, these results were in line with the findings of Devanport *et al.*, (1974) in Peach and cherry.

From the above results it may be summarised that among different irrigation schedules tested in the present experiment on young cauvery coffee plantation, irrigation once in 15 days @ 14 litres per plantl was considered as the optimum irrigation schedule. The amount of water required for this irrigation practice was 8,44,998 litres per ha. To mitigate the stress effect in young coffee plants during dry period, application of mulch was considered the best stress management practice.

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Sulphur management in blackgram and its effect on yield and economics

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Abstract: Field trials were conducted during *kharif* and *rabi* seasons of 1995 and 1996 to study the effect of sources and levels of sulphur on the growth, yield and economics of irrigated blackgram. Three different sources of sulphur *viz.* Gypsum, Elemental sulphur, and Pyrite were tried at five levels of sulphur *viz.* 0,10,20,30 and 40 kg ha^{-1}. The results proved that gypsum was the superior sulphur source which was evident from the yield increase due to gypsum application. Elemental sulphur and pyrite were on par in their effect. Among the levels 30 kg S/ha was best, but this was on par with 40 kg S/ha. Highest benefit cost ratio was also realised from gypsum source and at levels of 30 and 40 kg S/ha. *(Key Words: Sulphur, Gypsum, Elemental sulphur, Pyrite, Blackgram).*

Pulses are recognised as the cheapest and main source of dietary vegetarian protein of majority of Indian. They have the inherent ability to enrich soil through root nodules. The production scenario of pulses in our country has remained stagnant over decades. Blackgram is the most favoured pulse crop of South India, especially in Tamil Nadu, because it is frequently used in the commonly cooked day to day dishes. In the modern dynamic multi component system approach, a major factor of increasing importance is equal to that of nitrogen and in terms of crop uptake it exceeds that of even phosphorus (Tandon, 1995). During the recent years, due to intensive agriculture and use of sulphur free high analysis fertilizers, there has been a steady decline in the sulphur status of soil leading to its deficiency (Rajagopalan, 1985). Application of sulphur has to be deliberately built into a balanced fertilizer programme for achieving sustainable yield in blackgram. Hence this trial was formulated to find the best sulphur source and level for blackgram.

Materials and Methods

Field experiments were conducted at National Pulses Research Centre, Vamban, Padukottai district, during *kharif* and *rabi* seasons of 1995 and 1996, under irrigated conditions, to find out the effect of sulphur application on the growth and yield of blackgram. The soil of the experimental field was red soil with sandy clay loam texture. The fertility status of the soil was classified as low in available N, low in available P and medium in available K. The sulphur content of the soil was below the critical limit value of 10 ppm. Blackgram variety Vamban-1 was taken for the study. The trial was laid out in a factorial