Irrigation Scheduling Based on Evaporation and Crop Water Requirement for Summer Peanuts[1]

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ABSTRACT

Field experiment was conducted during dry season of 1981 and 1982 to determine the optimal irrigation schedule for summer peanuts (*Arachis hypogaea* L.) in relation to evaporative demand and crop water requirement at different growth stages. It was observed that peanut crop requires a higher irrigation frequency schedule during pegging to pod formation stage followed by pod development to maturity and planting to flowering stages. The higher pod yield and water use efficiency was obtained when irrigations were scheduled at an irrigation water to the cumulative pan evaporation ratio of 0.5 during planting to flowering, 0.9 during pegging to pod formation and 0.7 during pod development to maturity stage. The profile water contribution to total crop water use was higher under less frequent irrigation schedules particularly when the irrigations were scheduled at 0.5 irrigation water to the cumulative pan evaporation ratio up to the pod formation stage.

Key Words: Water use, water use efficiency, IW/CPE ratio, growth.

Efficient scheduling of irrigation maximizes the production and prevents under and/or over watering of the crop. Dehatonde (4) obtained the maximum peanut yield by irrigating the crop at 75 mm CPE while Shelke and Khuspe (14) recommended irrigation at 40 mm CPE without taking into account the quantity of water applied at each irrigation. At the same time, considering the depth of water applied at each irrigation and cumulative pan evaporation, the maximum yield of peanuts in sandy loam soils, which have a low water holding capacity, was recorded under the irrigation schedule of 1.0 IW/CPE ratio (10,12). Contrary to the above, under similar soil condition, Khan and Datta (6) obtained best results by irrigating the crop at 0.75 IW/CPE ratio continuously with each irrigation of 6 cm depth.

Conflicting results are available in the literature with respect to critical stage(s) of peanuts to soil water stress (1,2,7,9,11). It has been reported that evapotranspiration was comparatively low during the vegetative stage and from pod development to maturity stage. Whereas it was maximum during the flowering and continued up to the pod formation stage (5). However, Cheema et al. (3) observed that from 60 days after planting to harvest, the consumptive use of water was about 50 percent of the total crop water use.

The above review suggests that a combination approach, which considers the irrigation water to the cumulative pan evaporation (IW/CPE) as well as the stage(s) susceptibility of peanut to soil moisture deficits, is necessary for scheduling of irrigation to optimize the irrigation requirement. The present investigation was, therefore, carried out to outline an efficient cumulative pan evaporation based irrigation schedule during different growth stages of summer peanuts so as to maximize the pod yield.

Materials and Methods

The experiment was conducted on a sandy loam soil during dry season (summer) of 1981 and 1982 at Tutiyamunebgarh village of Midnapore district (West Bengal) situated about 88°E longitude and 22°N latitude. The experimental field was low in available nitrogen, phosphorus and organic carbon, and high in available potassium content, with a pH value of 6.7. The moisture content at field capacity and wilting points were 13.21 and 6.54 percent (by weight) respectively.

Keeping in view the previous results, out of the twenty seven possible combinations of three IW/CPE ratios (0.5, 0.7, 0.9) at three different growth stages, viz. planting to flowering (S_F), pegging to pod formation (S_P) and pod development to maturity (S_M), 14 treatment combinations were selected and replicated four times in a randomized block design. The selected treatment combinations are presented in table 1.

Table 1. Treatment combinations of different crop growth stages and irrigation water to the cumulative pan evaporation (IW/CPE) based irrigation scheduling

Symbol	IW/CPE ratio crop growth stage		
	S_F	S_P	S_M
T_1	0.5	0.5	0.5
T_2	0.5	0.7	0.5
T_3	0.5	0.7	0.7
T_4	0.5	0.7	0.9
T_5	0.5	0.9	0.5
T_6	0.5	0.9	0.7
T_7	0.5	0.9	0.9
T_8	0.7	0.7	0.5
T_9	0.7	0.7	0.7
T_{10}	0.7	0.7	0.9
T_{11}	0.7	0.9	0.5
T_{12}	0.7	0.9	0.7
T_{13}	0.7	0.9	0.9
T_{14}	0.9	0.9	0.9

S_F - planting to flowering, S_P - pegging to pod formation, S_M - pod development to maturity stage.

Daily evaporation was recorded from an open pan evaporimeter (USWB class 'A' pan). The desired ratio was computed by dividing the water applied in cm (IW) by the cumulative pan evaporation in cm (CPE). At each irrigation 6 cm water was applied by using a water meter. If a particular stage was passed without sufficient CPE to re-irrigate, the CPE of that treatment from its last irrigation day was included in irrigation schedule of the succeeding growth stage.

The seeds (CV.J-11, a spanish bunch type) were planted on February 11, 1981 and February 15, 1982. The size of the net plot was 20m². A common basal dose of 45 kg N, 90 kg P_2O_5 and 30 kg K_2O/ha was applied through urea, single super phosphate and muriate of

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potash, respectively. The corresponding harvesting dates were June 13, 1981 and June 18, 1982. The total water use included cumulative water applied, effective rainfall and water contribution from soil profile. The water contribution from a soil profile of 180 cm depth was estimated by taking the difference in soil water storage at planting and harvest time. The water use efficiency (kg/ha/cm) was calculated as the ratio of pod yield in kg/ha to total water use in cm.

Results and Discussion

In general, the pod yield increased with the increase in irrigation frequency. This may be due to increase in the yield-attributes (Table 1 and 2). Lenka and Mishra (8) also reported that lower pod yield was associated with low irrigation frequency.

Table 2. Yield-attributes of peanut crop as influenced by different irrigation schedules.

Treatments	Pods per plant (no)		1000-kernel weight (g)		Shelling percentage (%)	
	1981	1982	1981	1982	1981	1982
T_1	12.0	13.3	330.0	339.4	65.2	61.2
T_2	12.4	13.8	332.2	340.3	64.3	61.0
T_3	15.4	16.0	342.3	346.3	69.2	64.3
T_4	16.5	17.8	347.0	353.8	69.9	66.0
T_5	13.9	13.5	336.4	341.2	67.2	62.5
T_6	18.0	19.9	350.4	358.8	72.2	68.1
T_7	18.5	20.4	354.0	360.6	73.0	68.5
T_8	13.7	13.7	333.5	340.2	64.5	62.8
T_9	15.8	18.0	346.2	350.7	69.5	65.6
T_{10}	17.0	19.2	348.2	356.8	71.2	67.7
T_{11}	14.2	15.0	338.0	345.2	68.8	63.7
T_{12}	18.4	19.8	353.4	358.6	72.5	68.0
T_{13}	19.5	21.2	353.9	361.5	74.0	68.3
T_{14}	18.8	20.0	354.0	363.2	73.2	70.0
L.S.D. (P = 0.05)	1.6	1.6	5.7	4.9	1.9	1.7

Scheduling of irrigation at lower frequency i.e. either at 0.5 or 0.7 ratio from planting to flowering followed by 0.9 ratio during pegging to pod formation or 0.7 and 0.9 ratio during pod formation to maturity (T_6, T_7, T_{12} and T_{13}), had little or no effect on pod yield as compared to the treatment which was maintained at 0.9 IW/CPE ratio throughout the crop growth (T_{14}). Further, maintaining a 0.5 ratio during pegging to pod formation or pod development to maturity reduced the pod yield significantly as compared to 0.7 and 0.9 ratios. This indicates the need for higher soil moisture during the latter stages of the crop for better pod and kernel development (14). A lower frequency of scheduling of irrigation during these stages led to a moisture deficit condition which may have increased the soil strength thus affected the pod-yield as reflected by the number of pods, kernel weight and shelling percentage. In general, irrespective of growth stages, higher top dry weight (haulm) were obtained with the higher irrigation frequency schedule (Table 3).

During pegging to pod formation and pod development to maturity stages, adoptation of a 0.9 ratio was found to be better than the 0.7 ratio. However, the former stage seemed to be more sensitive to moisture deficits than the latter (1,2). This might be due to comparatively higher water requirement (5,7).

A higher irrigation frequency increased the crop water use which ranged from 40.4 to 67.3 cm in the first year (1981) and 44.2 to 67.4 cm during the second year (1982) under different irrigation schedules (Table 3). During both years the highest water use (67.3 and 67.4 cm) was recorded with the irrigation schedule of continuous 0.9 IW/CPE ratio (T_{14}). The profile water contribution was comparatively more under the less frequent irrigation schedules, particularly when the irrigations were scheduled at 0.5 IW/CPE ratio during first two growth stages.

The highest water use efficiency (42.4 and 42.0 kg/ha/cm in the year 1981 and 1982 respectively) was obtained

Table 3. Yield, irrigation requirement, water use, and water use efficiency of peanut crop as influenced by different irrigation schedules.

Treatments	Yield (kg/ha)				Irrigation water applied (cm)		Water use (cm)		Water use efficiency (kg/ha/cm)	
	Pods		Haulms							
	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982
T_1	1582	1617	1905	2038	30	30	40.4	44.2	39.1	36.5
T_2	1641	1600	1993	2288	36	36	44.6	46.6	36.7	34.4
T_3	1965	1966	2398	2558	42	42	48.3	49.3	40.6	39.8
T_4	2095	2233	2576	2800	48	54	54.2	59.8	38.6	37.3
T_5	1740	1820	2170	2510	42	42	47.2	47.8	36.8	38.0
T_6	2260	2445	2719	3000	48	54	53.3	58.2	42.4	42.0
T_7	2340	2488	2802	3107	54	60	58.8	64.1	39.8	38.8
T_8	1660	1750	2232	2466	42	42	47.1	47.2	35.2	37.0
T_9	2050	2140	2501	2750	48	48	53.0	53.9	38.6	39.7
T_{10}	2110	2339	2616	2880	54	60	57.0	63.0	37.0	37.1
T_{11}	1880	1850	2368	2560	48	48	50.9	50.7	36.9	36.5
T_{12}	2290	2307	2786	3189	54	54	56.4	56.3	40.6	40.8
T_{13}	2421	2488	2861	3268	60	60	62.4	63.4	38.8	39.2
T_{14}	2410	2509	2873	3455	66	66	67.3	67.4	35.8	37.2
L.S.D. (P = 0.05)	192	208	205	262						

when the irrigations were scheduled at 0.5 ratio during planting to flowering (S_F), 0.9 ratio during pegging to pod formation (S_P) and 0.7 ratio during pod development to maturity stage (S_M). The experiments conducted at Hydrabad (India) revealed that the maximum pod yield (20.5 q/ha) was recorded in the continuous 0.9 IW/CPE ratio. However, the highest water use efficiency (39.5 kg/ha/cm) was obtained in the continuous 0.8 IW/CPE irrigation schedule (5).

Summary and Conclusion

The peanut crop requires a higher irrigation frequency schedule during pegging to pod formation stage. Higher pod yield (22.6 and 24.4 quintals per hectare) could be harvested by irrigating the crop at an IW/CPE ratio of 0.5 during planting to flowering, 0.9 during pegging to pod formation and 0.7 during pod development to maturity with an irrigation requirement of 48 and 54 cm in 1981 and 1982, respectively. Following above practice, the total crop water use was found to be 53.3 and 58.2 cm and water use efficiency to the extent of 42.4 and 42.0 kg/ha/cm in 1981 and 1982 respectively. The profile water contribution to the total crop water use was higher under less frequent irrigaiton schedule particularly when the irrigations were scheduled at 0.5 IW/CPE ratio up to the pod formation stage.

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