

CONSUMPTIVE USE AND WATER REQUIREMENT OF COWPEA

S.P.Bhardwaj\*

ABSTRACT

Various components of hydrologic cycle viz. rainfall, run-off, seepage, soil moisture and evapotranspiration (ET) were measured daily in a weighing type lysimeter having undisturbed soil monolith and sensitivity of 0.14 mm of water. Cowpea of 12 weeks duration received 1077 mm rainfall and 26 mm irrigation and yielded 471 mm run-off, 243 mm deep percolation averaged for three crop seasons. There was a net gain of 52 mm soil profile recharge. Average seasonal ET was 335 mm. The water use efficiency was 59 green pods for vegetable with 1934 kg/ha pod yield.

INTRODUCTION

Water is a limited and important resource and its scientific management is much more important for maximising production of land and factories on sustained basis. Agriculture is the largest consumer of water. Therefore, the information on evapotranspiration (ET) and water budgeting of crops is needed for judicious and scientific planning, development, management of water resources and irrigation scheduling (Bhardwaj, 1980). The study was undertaken to monitor complete hydrologic cycle comprising of ET, rainfall, run-off, seepage and soil moisture for cowpea (*Vigna unguiculata* L.) over 3 years (1983, 1985 and 1986) in a weighing type lysimeter at Central Soil & Water Conservation Research & Training Institute, Dehradun, located in the Doon Valley in the outer Himalayan region of North India. Total ET of crops (mm) such as maize (385 mm, Bhardwaj and Khullar, 1983), Soyabean (545 mm, Bhardwaj, 1985) and wheat (407 mm), paddy (499 mm) and alfalfa (1057 mm) by Bhardwaj, (1983) were found out on the basis of daily observations.

MATERIALS AND METHODS

The experiment was conducted in a weighing type lysimeter having undisturbed soil monolith and provision for measuring run-off and seepage. The mechanical weighing system had a capacity of 4 tons (3 tons + 0.8 tons back balance) with an accuracy of 0.14 mm (200 g) of water which is suitable for daily as well as hourly measurement of ET (Bhardwaj and Sastry, 1979). The undisturbed soil monolith of the lysimeter (120 x 120 x 120 cm) was silty clay loam (Udic haplustalf) with an infiltration rate of 1.0 mm per hour under saturated condition. The texture changes from silty clay loam to silty clay deeper in the soil profile. The

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\* Senior Soil Scientist & Head of Division,  
Division of Extension & ORPs, Central Soil & Water  
Conservation Research & Training Institute,  
Dehradun - 248 195, (U.P.), INDIA.

field capacity and wilting point are 24.0 and 12.0 per cent, respectively.

Cowpea was sown in lysimeter and its peripheral area of about 40 to 50 m. The crop of 12 weeks duration was grown during late June to mid September. Only one irrigation of 70 mm was given during 1985 only. The crop never experienced soil moisture stress. The observations of various components of hydrologic cycle were recorded daily. The values of irrigation, pan evaporation, yield and water use efficiency of crop were also recorded. The climate of the area is sub-humid with 1705 mm average rainfall during June to September. Run-off was measured daily by providing one per cent slope to soil surface and three drainage outlets with delivery tubes leading to collection tank. A layer of perforated bricks and two outlets at the bottom of lysimeter tank were provided for seepage measurement. Soil moisture accretion/depletion was determined on the basis of increase/decrease in weight of lysimeter at harvest over its initial weight at the time of sowing. During experiment, it was noticed that minor variations in water balance is due to the fact that seepage of a rain storm does not complete on the same day/week and the exchange of splash between lysimeter and surrounding area may not be perfectly equal.

## RESULTS AND DISCUSSIONS

Cowpea received on an average 1077 mm rainfall, 26 mm irrigation (Table 1). Run-off (471 mm) and seepage (243 mm) was dependent upon rainfall pattern (Table 2). Run-off and seepage as percentage of rainfall were slightly affected by rainfall characteristics (amount, intensity and duration), antecedent soil moisture and crop canopy. Run-off (40 per cent) was more than seepage (22 per cent) due to very low water intake rate of soil under saturated condition (1.0 mm/hr) and less time of concentration. The run-off and seepage losses as percent of rainfall in case of other kharif crops were 45 and 12 in maize and 41 and 12 in soybean. Reduction in run-off was also observed in run-off plots (100 x 20 m on 4% slope) by strip cropping of cowpea with maize. Thus, cowpea is a good crop for soil and water conservation.

Total intake of rain + irrigation water by soil was 631 mm. Part of this retained by the soil profile (388 mm) and rest (243 mm) drained out as deep percolation for ground water recharge. During rainy season soil profile was having sufficient moisture for meeting ET demand of crop as evident by rainfall pattern and appearance of seepage (Fig. 1 and Table 2). Soil profile showed moisture accretion in all the three years with an average value of 52 mm. The figure 1 and 2 clearly indicate the cumulative and weekly budget of rainfall, run-off and water intake, seepage and ET. The degree and source of total water gain and loss is also clear in fig. 2 to give comparative and clear picture of water balance at the harvest of crop.

The area of the lysimeter was undoubtedly too small to use run-off and deep percolation data for predicting water yield and ground water recharge for watershed and cultivated field. Even then



Table 1 : Water budgeting, water use efficiency and yield of cowpea

S.No.	Particulars	Years			
		I	II	III	Average
1.	Crop growth duration (days)	84	80	95	86
2.	Source of water (mm)				
	a. Rainfall	1190	981	1060	1077
	b. Irrigation	--	77	--	26
	c. Soil moisture depletion	--	--	--	--
	Total	1190	1058	1060	1103
3.	Loss of water (mm)				
	a. Evapotranspiration	322	263	419	335
	b. Run-off	475	469	468	471
	c. Percolation	337	225	168	243
	d. Soil moisture accretion	53	100	2	52
	Total	1187	1057	1057	1101
4.	Yield (kg/ha)				
	a. Green pods (vegetables)	2986	1250	1567	1934
	b. Straw	7219	3194	3958	4790
5.	Water use efficiency (kg/ha-cm)				
	a. Pods	92.7	47.5	37.4	59.2
	b. Straw	224	121	95	147

Table 2 : Mean weekly rainfall, disposition (mm) evaporation and LAI of coupea (av. of 3 years)

Week	Rainfall + irrigation		Run-off		Percolation		Evapo- transpiration (ET)	Evaporation (Ep)	Leaf area index
	Total	% of rainfall	Total	% of rainfall	Total	% of rain- fall			
1	26.47	0.00	0.00	0.00	0.00	0.00	13.29	13.10	0.0
2	90.01	19.34	21.49	21.49	4.67	5.19	25.49	40.57	0.136
3	57.25	16.10	28.12	28.12	10.89	18.02	32.19	31.20	0.362
4	77.57	34.67	44.70	44.70	11.39	14.68	32.76	28.56	1.257
5	99.59	40.97	41.14	41.14	11.04	11.09	33.19	21.28	2.394
6	108.55	58.58	53.97	53.97	18.29	16.85	25.87	17.04	3.804
7	180.88	74.95	41.44	41.44	28.16	15.57	30.78	21.79	4.114
8	141.81	65.95	46.51	46.51	36.60	25.81	30.45	18.50	4.752
9	65.14	22.05	33.85	33.85	29.49	45.27	29.19	19.03	4.528
10	102.97	46.85	45.50	45.50	26.50	25.74	27.34	18.76	3.689
11	77.02	36.77	47.74	47.74	37.77	49.04	28.85	19.13	3.090
12	75.40	28.50	37.80	37.80	28.89	38.32	33.64	23.47	2.600
Total/ average	1102.66	444.73	36.9	36.9	243.69	22.2	343.04	272.43	--

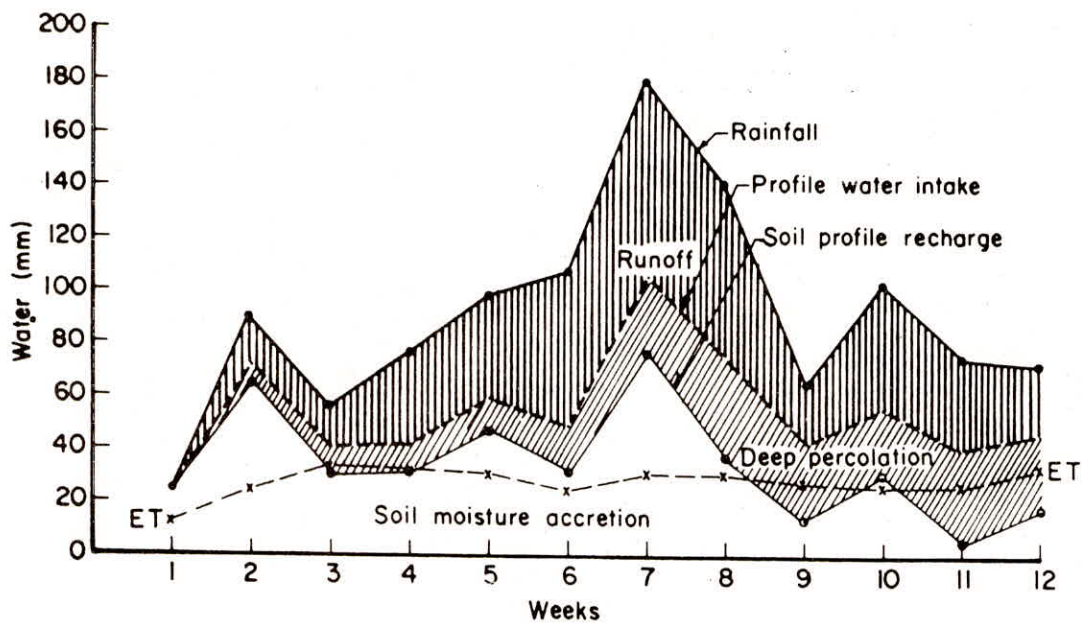


Fig. 1 Weekly water budgeting in cowpea (Average - 3yrs)

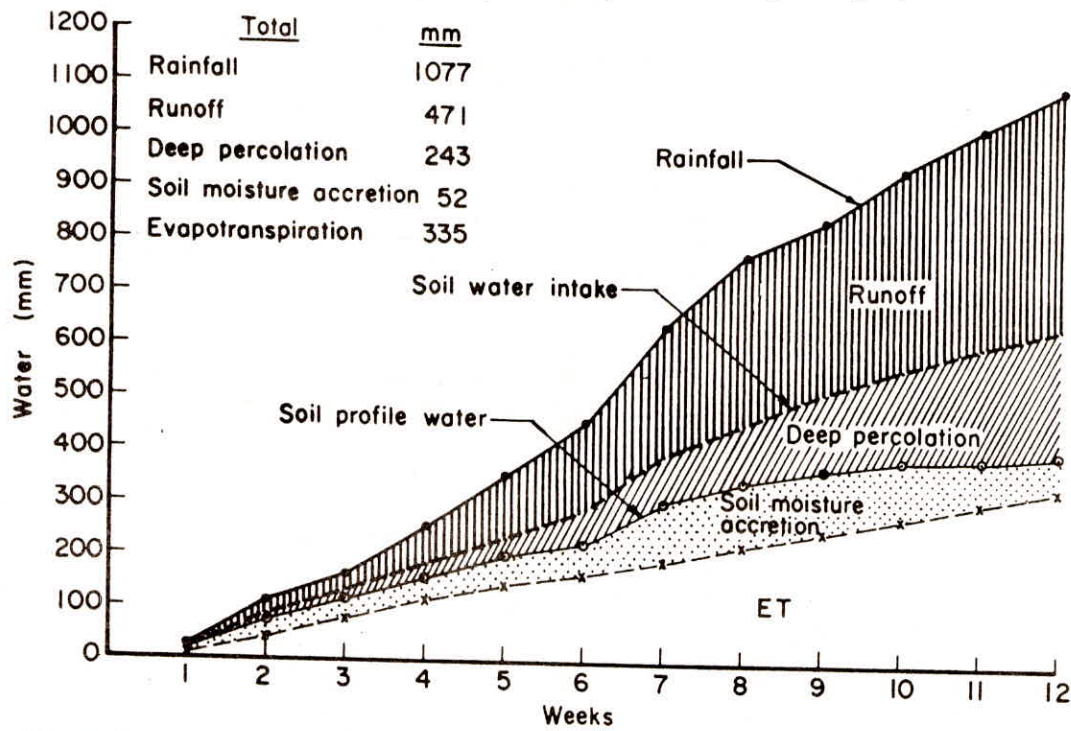


Fig. 2 Cumulative rainfall, runoff, deep percolation and evapotranspiration in cowpea (Average - 3yrs)



Fairly good estimates have been recorded as the run-off values were quite close to field size run-off plots. The run-off was 37 per cent of rainfall which is quite close to run-off (41 per cent) from plot (100 x 20 m) having strip cropping of cowpea and maize in the ratio of 1:2 on 4 per cent slope (Bhardwaj, 1984). The run-off data of lysimeter must be modified considering low time of concentration before their application for predicting water yields from larger areas. Run-off in a lysimeter with corn was 63 per cent of rainfall (Bhardwaj and Khullar, 1983) because unlike cowpea, it is an open tilled crop. The soil moisture accretion and depletion were dependent on rainfall pattern, irrigation and ET. The soil moisture was not deficient, therefore, ET was effected by living crop canopy and climatic conditions especially solar radiation.

ET values did not show much variation during crop cycle and varied from 26 to 33 mm per week excluding 13 mm in the first week (Table 2). ET was higher than Class A pan evaporation after germination of seed and development of crop canopy. A few places worldwide besides India also experience ET in excess of pan evaporation (Pruitt, 1966 and Bhardwaj, 1983). This may be due to at least in part to greater surface area for water transpiration from crop. The water use efficiency was highest in 1983 due to high yield. The average 59.2 kg/ha-cm is the water use efficiency with the yield of 1934 kg/ha of green pods for vegetables. The water use efficiency of other common crop of Doon Valley such as wheat, barley, green gram, maize and paddy ranges between 25 - 114 kg/ha-cm.

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