

WATER BALANCE AND CROP YIELDS : A CASE STUDY OF GROUNDNUT

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ABSTRACT

Associations between groundnut (*Arachis hypogaea* L.) kernel yield and the components of water balance were studied in the tropical semi-arid climate of Bangalore. Linear correlation coefficients and regression equations between seed yield and the water balance components revealed that rainfall, moisture index, water surplus and moisture adequacy ratio were positively correlated while potential evapo-transpiration, actual evapo-transpiration, water deficit and aridity index were negatively correlated. Prolonged spell of low crop-water-stress index during early vegetative and flowering stages reduced the kernel yields.

INTRODUCTION

Groundnut yields are positively correlated with most of the weather elements (Krishnan and Ramana Rao, 1980 and Suryanarayana et al., 1984). Ramanarao et al. (1979) analysed the utility of available water to groundnut crop in different types of soils of Karnataka state. The importance of moisture adequacy or the crop water stress index i.e. the ratio of actual evapo-transpiration (AET) to potential evapo-transpiration (PET) for the selection of crops in areas of low rainfall and for evaluation of agricultural droughts has been illustrated by Victor et al. (1982) and Victor and Sastry (1984). In the present study, this index has been applied to groundnut with reference to crop development phases.

MATERIAL AND METHODS

The data regarding seed yield and other agronomic informations such as sowing and harvesting times were obtained from the results of the runoff experimental plots (Anonymous, 1973-85). The runoff experimental plots (200 sq m) had 1.5% slope. The soils were sandy loam to clay loam (1.0 m deep). All agricultural operations were performed across the slope and the crop was raised rainfed according to the recommended practices (Anon., 1985). The yields were considered as good, bad and normal on the basis of the per cent departures from average : good ($> +25$), bad (> -25) and normal (± 25). The weather data used in the computations of water balance parameters were recorded in a 'B' class agrometeorological observatory near the experimental plots. The year to year variabilities of the dates of sowing, 50% flowering and

harvesting were more or less of the same order. The cropping season was considered to be of three critical growth phases, viz. establishment phase (sowing to seedling stages, corresponding to standard meteorological weeks 27 to 31), vegetative phase (seedling to flowering, weeks 32 to 41) and reproductive phase (flowering to harvesting, weeks 42 to 50).

The standard weekly potential evapo-transpiration was computed through Penman's method (1984) and the weekly climatic water balance computations through Thornthwaite and Mather (1955) book keeping procedure. Cumulative water balance parameters, the average moisture adequacy ratio (I_m), aridity index (I_a) and humidity index (I_h) etc. during the cropping periods were worked out (Table 1). Standard weekly climatic moisture indices including I_m (moisture index) at three critical phases of the cropping season for each of the good yield year (1975), bad yield year (1980) and normal yield year (1979) were computed (Table 2). The intensity of the climatic moisture indices was regarded as low ($< 25\%$), moderate (from 25% to 50%) and high ($> 50\%$).

Simple linear correlation coefficients and regression equations between groundnut kernel yields and the water balance components were worked out (Table 3).

RESULTS AND DISCUSSION

The groundnut kernel yields, cumulative components of water balance and average moisture indices computed for the 13 year period of study are given in Table 1. Out of the 13 years of study, four (1974, 1975, 1976 and 1985) were good yield years, five were poor yield years (1978, 1980-83) and rest of the years (1973, 1977, 1979 and 1984) were normal yield years.

Good yield year (1975)

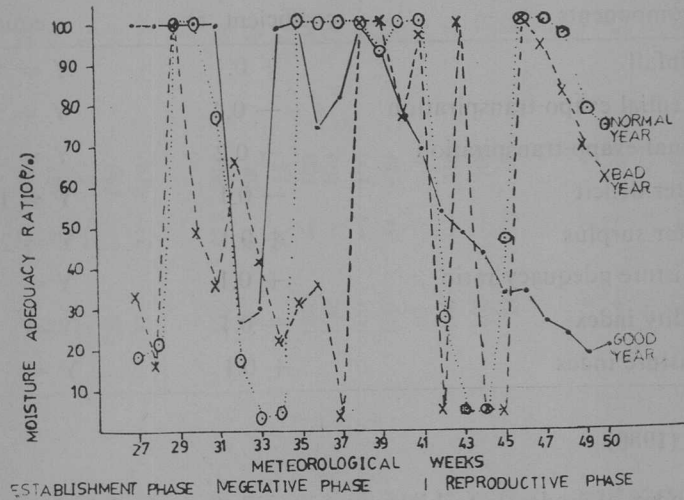
Moisture adequacy ratio of moderate to high intensity, associated till the end of the vegetative phase, had increasing effect on yield but during the latter part of the growing season, decreasing effect was observed (Table 2). The soil water availability pattern was excellent throughout the cropping period although there was no significant amount of surplus water. Low aridity index together with moderate to high moisture index during establishment and vegetative phases had increasing tendency on yield but the effect was contrary if this situation was present during the reproductive phase. During the cropping seasons of the good yield years like 1974 to 1976 and 1985, on an average, moderate weather conditions like rainfall (494 mm), potential evapo-transpiration (506 mm), moisture adequacy ratio (63%), aridity index (36%) and moisture index (24%) were observed.

Table 1 : The groundnut seed yield and the components of water balance at Bangalore during 1973-85

* Years	Seed yield (q/ha)	Date of		Cumulative water balance components (mm)					Av climatic moisture indices (%)			
		Sowing	Harvesting	R	PET	AET	WD	WS	Ima	Ia	Ih	
1973	9.4	18 Aug	9 Dec	504.9	441.7	327.9	120.9	242.4	77	24	30	
+1974	14.9	26 Jul	4 Dec	555.5	521.5	355.4	166.1	303.2	65	35	27	
+1975	15.0	4 Jul	24 Oct	555.0	456.4	362.6	87.5	187.2	65	35	16	
+1976	16.7	9 Jul	10 Nov	414.0	560.7	259.1	301.6	156.4	58	39	31	
1977	12.7	12 Jul	10 Nov	593.7	497.7	345.0	152.7	222.1	69	31	30	
-1978	7.5	22 Jul	28 Nov	591.4	552.3	398.9	153.4	446.0	72	28	31	
1979	12.5	24 Jul	14 Nov	788.8	480.9	285.7	195.2	557.2	65	37	33	
-1980	5.7	22 Jul	21 Nov	321.2	546.0	299.0	247.0	124.0	55	45	14	
-1981	3.0	28 Jul	15 Dec	528.1	588.0	404.3	183.7	222.2	63	38	17	
-1982	6.8	9 Jul	6 Nov	515.0	507.5	309.1	198.4	227.9	59	41	12	
-1983	5.3	25 Jul	28 Nov	440.8	518.7	368.6	149.9	174.0	62	39	20	
1984	10.0	20 Jul	17 Nov	567.5	460.5	323.8	146.7	348.3	63	36	23	
+1985	24.0	24 Jul	22 Nov	452.8	484.7	353.5	131.2	198.3	66	35	22	
Mean	11.0			525.3	509.0	337.9	171.9	262.3	65	36	23	
S.D.	5.7			111.4	44.3	42.7	55.6	123.3	5.8	5.5	7.3	
C.V %	52			21	9	13	32	47	9	15	31	

*Good yield years marked +, bad yield years marked - ; others normal yield years

during each year at each of the three critical crop growth phases were more close to the weekly averages (1973-'85) during normal yield years compared to bad and good yield years (Fig 1). The same results could be applicable to stover yields also. In climatic



moisture indices, I_m had the lowest coefficient of variation. The grain yields were found to have 52% CV throughout the course of the experiment. The potential evapo-transpiration was found to have the highest negative correlation ($r = -0.4$) followed by actual evapo-transpiration ($r = -0.2$) and the regression equations are found to be best fit.

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