

Correlation between Weather Parameters at Different Phenophases and Growth and Yield Parameters of Groundnut (*Arachis hypogaea* L.)

S.K. Krishna Murthy and A. Yogeswara Rao

Agricultural Research Station, Acharya N.G. Ranga Agricultural University,
Anantapur 515 001, India

Abstract: Agricultural productivity is greatly influenced by uncontrollable forces of weather. A field experiment was conducted at the Agricultural Research Station, Anantapur, on red sandy loam soils, to study the crop-weather relationship in groundnut during two *kharif* seasons of 1989 and 1990. While the fluctuations in weather during vegetative phase had little influence on crop growth, they had significant effect on the reproductive phase. Rise in night temperature during reproductive phase favored the ultimate pod yield and its attributes. Among the phenophases, pod filling was found most sensitive and fluctuations in weather, including water use, during this phase, controlled most of the final yield. Solar radiation did not show any significant influence on ultimate yield, since radiations received were sufficient to meet the minimum needs of the crop.

Key words: Groundnut, phenophases, crop-weather relationship, *Arachis hypogaea*.

Climatic variability is accepted to be a major cause of inter-annual variability of crop yield in all environments. Yield is the outcome of the effects of environmental and genetic factors. In the tropics, rainfall is the major climatic factor whose variability affects farming practices and crop yield. Besides rainfall, temperature (maximum, minimum and their diurnal variation) is known to influence crop phenology, dry matter production, yield components and ultimate yield. Understanding the influence of weather parameters on growth and yield of groundnut helps to reduce the loss in crop yields by adopting suitable agronomic practices.

Majority of reports revealed that pod development stage is the most sensitive to moisture (Pathak *et al.*, 1988; Stirling *et al.*, 1989; Meisner, 1991; Ramachandrapa *et al.*, 1992). A close relationship between

seed yield and minimum air temperature in groundnut was observed by Kudo and Syodai (1986). Exposure of late sown groundnut crop to cool night temperature (less than 20°C), and lack of further rainfall during reproductive and maturity stages of the crop at Ludhiana, Anand and Anantapur, gave lowest pod yield (CRIDA, 1995). At Ludhiana, reduction in biomass production due to cool nights (less than 20°C) from the beginning of October was observed in late-sown groundnut crop (CRIDA, 1995).

Materials and Methods

A field experiment was conducted at the Agricultural Research Station, Anantapur, during two *kharif* seasons of 1989 and 1990. A split-split plot design with three replications was used to study the crop-weather relationships in groundnut. There were twelve treatment combinations.

The main plots were provided with two irrigation treatments (rainfed and supplemental irrigation), sub-plots with 3 dates of sowing (early, normal and late), and sub-sub plots with two varieties of groundnut (TMV2 and Robut 33-1). The sowing was done on three dates during *kharif*, 1989, and on three during *kharif*, 1990, as listed below.

	1989	1990
D ₁	11.7.89	16.6.90
D ₂	11.8.89	4.8.90
D ₃	3.9.89	3.9.90

The soil of the experimental site is red sandy loam, well drained, neutral in reaction, medium in both available nitrogen and phosphorous, and low in available potassium.

The crop growth, expressed as accumulated dry mater, leaf area index, crop growth rate and ultimate yield and yield attributes, are the results of combined effects of weather parameters that prevailed over different phenophases, including the water utilized. These yield attributes were formed at different phenophases and thus, had a cumulative effect on ultimate yield. Further, the weather requirements varied at different

phenophases within a crop variety, thus requiring phenophasewise study.

It is difficult to understand the influence of an individual weather parameter as the parameters are interdependent in nature, and act together to bring in the ultimate effect. Therefore, the only way out is application of statistical methods. Maximum and minimum temperatures, and their diurnal variations on daily basis, solar radiation, and rain are known to have profound influence on crop yields. Thus, the data collected from all the treatments (except early sowings of 1990, whose pod filling phase was abnormally extended due to drought) were considered, and simple correlations carried out between weather parameters that prevailed over different phenophases, and the resultant crop growth and yield parameters to find out qualitative relationship between them, as per the procedure outlined by Snedecor and Cochran (1968).

The phenological events of groundnut, as suggested by Boote (1982), were adopted. The phenophases recorded were: emergence (VE), 50% flowering (R₁), pegging (R₂), seed initiation (R₅) and pod development

Table 1. Correlation coefficients for relation between weather parameters during vegetative phase (S1) and crop growth parameters in vegetative (S1) and reproductive (S2) phases

Weather parameters during vegetative phase	Crop growth parameters during					
	Vegetative phase			Reproductive phase		
	DM	LAI	CGR	DM	LAI	CGR
Reproductive phase						
Daily mean max. temp. (°C)	0.3271	0.1711	0.3117	-0.4546	0.1294	0.0836
Daily mean min. temp. (°C)	0.3865	0.1245	0.3883	-0.2450	0.2493	-0.1191
Daily mean diurnal temp. variation (°C)	0.0262	0.0774	0.0067	-0.3365	-0.0857	0.2133
Daily mean solar radiation (MJ m ⁻² day ⁻¹)	0.1304	0.3692	0.1031	-0.0994	-0.0984	0.4467
Accumulated water use (mm)	0.2787	0.5428*	0.2665	-0.0833	-0.0227	0.3592

*Significant at 0.05.

Table 2. Correlation coefficients for relation between weather parameters during reproductive phase (S2) and crop growth parameters during reproductive (S2) and pod-filling (S3) phases

Weather parameters during vegetative phase	Crop growth parameters during					
	Reproductive phase			Pod filling phase		
	DM	LAI	CGR	DM	LAI	CGR
Daily mean max. temp. (°C)	0.06235**	0.0444	-0.0028	0.0490	0.1353	0.0264
Daily mean min. temp. (°C)	0.464	0.1566	-0.2178	0.5295*	0.1681	0.6791*
Daily mean diurnal temp. variation (°C)	0.5650**	-0.1206	0.2510	-0.4947	0.1025	0.7051*
Daily mean solar radiation (MJ m ⁻² day ⁻¹)	0.4813*	-0.2667	-0.0168	0.4459*	0.0107	0.5145*
Accumulated water use (mm)	0.4681*	0.3444	0.2142	0.2719	0.3718	0.1700

*Significant at 0.05; **Significant at 0.1.

(R₆ to R₈). These phenophases were further grouped into three phases: vegetative (VE to R₁), reproductive (R₁ to R₅) and pod filling (R₆ to R₈). The accumulated water use, considered to represent rain and/or irrigation, was worked out following Frere and Popov (1979). Since solar radiation was not measured directly, the data on sunshine hours were converted into solar radiation (MJ m⁻² day⁻¹) by using Angstrom equation (Doorenbos and Pruitt, 1979).

Results and Discussion

Correlation between weather and crop growth parameters at different phenophases

Vegetative phase: The results of the correlation studies (Table 1) indicated that neither temperature nor solar radiation prevailing over vegetative phase had any influence on growth parameters during vegetative and reproductive phases. However, increased use of water from 18.2 to 96.7 mm helped to increase the LAI, due to more leaf expansion during vegetative phase.

Reproductive phase: The results of the correlation studies (Table 2) revealed that all the weather parameters that prevailed during reproductive phase, excluding

minimum temperature, were having positive and significant influence on the dry matter accumulation during reproductive phase. The results further indicated that the daily mean of minimum temperature, diurnal temperature variation and solar radiation during reproductive phase were positively and significantly correlated with crop growth rate (CGR), and that daily mean for minimum temperature and solar radiation during reproductive phase positively and significantly influence the dry matter accumulation during pod-filling phase.

Pod-filling phase: The results of the correlation studies (Table 3) showed that increase in minimum temperature or solar radiation during pod filling phase increased the LAI. Either increase in minimum temperature or decrease in diurnal temperature variations, or increase in water use, also significantly increased the crop growth rate during pod-filling phase.

Correlations between weather parameters at different phenophases and yield, and yield attributes of groundnut

Vegetative phase: The correlation studies revealed that the weather, including accumulated water use during vegetative

Table 3. Correlation coefficients for relation between weather parameters during pod-filling phase (S3) and crop growth parameters

Weather parameters during vegetative phase	Crop growth parameters during pod-filling phase		
	DM	LAI	CGR
Daily mean max. temp. (°C)	-0.1123	0.6726**	-0.1102
Daily mean min. temp. (°C)	0.4792*	0.3961	0.6667**
Daily mean diurnal temp. variation (°C)	0.5671**	0.0946	-0.7511*
Daily mean solar radiation (mJ m ⁻² day ⁻¹)	-0.2758	0.5782**	-0.3451
Accumulated water use (mm)	0.8376**	0.3098	.0.7071**

*Significant at 0.05; **Significant at 0.1.

phase, had no significant influence on the ultimate yield and yield attributes of groundnut.

Reproductive phase: The correlation studies (Table 4) carried out between the weather parameters during reproductive phase and the yield attributes and yield, indicated that increase in minimum temperature or decrease in diurnal temperature variations through increase in minimum temperature, increased the ultimate total biomass, pod yield and yield components, as well as harvest index. Further, the results showed that decrease in solar radiation during reproductive phase significantly increased total biomass, pod yield and test weight, but higher solar radiation increased the shelling percentage.

Pod-filling phase: The results of the correlation studies (Table 4) clearly indicated that increase in minimum temperature or decrease in diurnal temperature variation significantly increased the total biomass, yield and yield attributes, including harvest index. Similar influence of minimum temperature on groundnut was also observed (Kudo and Syodai, 1986; CRIDA, 1995). Increase in accumulated water use during this phase significantly increased all the yield components and yield,

including harvest index, indicating that supply of water during pod-filling phase had dominant influence, more or less deciding the ultimate pod yield. Many researchers also reported the importance of water use during pod-filling (pod development) phase for groundnut (Pathak *et al.*, 1988; Stirling *et al.*, 1989; Meisner, 1991; Ramachandrappa *et al.*, 1992).

Conclusions

Weather parameters during vegetative phase had no significant relationship with growth, yield and yield attributes, except the water utilized and the LAI during vegetative phase, which were positively and significantly correlated. All the weather parameters, except the daily mean minimum temperature, during reproductive phase, positively and significantly influenced the dry matter accumulation during reproductive phase. Daily mean minimum temperature and solar radiation during reproductive phase, positively and significantly influenced the dry matter accumulation during pod-filling phase. Weather parameters prevailing over reproductive phase had definite impact on yield and its attributes that are formed during subsequent pod-filling phase.

Table 4. Correlation coefficients for relation between weather parameters during reproductive (R) and pod-filling phases (PF) and yield attributes and yield

Weather parameters	Yield attributes and yield							
	Filled pods		Test weight		Shelling (%)		Pod yield	
	R	PF	R	PF	R	PF	R	PF
Daily mean max. temp. (°C)	0.071	0.078	-0.086	-0.231	0.018	0.194	0.045	-0.126
Daily mean min. temp. (°C)	0.626**	0.622**	0.434	0.274	0.643**	0.685**	0.591**	0.548*
Daily mean diurnal temp. variation (°C)	-0.539**	-0.681	-0.539**	-0.461*	-0.612*	-0.533**	-0.553**	-0.648**
Daily mean solar radiation (mJ m ⁻² day ⁻¹)	-0.398	-0.288	-0.482*	-0.338	0.586**	-0.011	-0.441*	-0.314
Accumulated water use (mm)	0.284	0.833**	0.035	0.623**	-0.032	0.453*	0.214	0.863**

*Significant at 0.05; **Significant at 0.1.

The weather fluctuations during pod-filling phase had predominant influence on growth, yield and yield attributes, and more or less controlled the pod yield.

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