Annals of Arid Zone 44(1): 23-28, 2005

Correlation of Weather Parameters with Growth, Yield Attributes and Pod Yield of Groundnut (*Arachis hypogaea* L.) during Different Phenophases under Irrigated Condition of Western Rajasthan

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Abstract: The experiment was conducted during 1998 and 1999 on loamy sand soil at Agricultural Research Station, Beechwal, Bikaner, to study the correlation of weather parameters with growth, yield attributes and pod yield of groundnut (*Arachis hypogaea* L.) during different phenophases under irrigated condition of western Rajasthan. Pod and dry matter yields of groundnut sown on 15th March and 1st April was higher compared to late sowings under irrigated condition of western Rajasthan. Dry matter accumulation correlated positively with mean temperature, leaf area index with diurnal temperature variation during sowing to flower initiation, whereas during flower initiation to physiological maturity most of weather parameters correlated positively with dry matter accumulation, crop growth rate and leaf area index. Number of pods/plant, test weight and pod yield was positively correlated with diurnal temperature variation during sowing to flower initiation, but during flower initiation to physiological maturity phenophase most of weather parameters namely maximum temperature, diurnal temperature variation, bright sunshine hours, evaporation rate, growing degree days, photothermal units and heat-use efficiency were significantly and positively correlated.

Key words: Groundnut, weather parameters, phenophases, growth, yield attributes and pod yield

Weather variability is considered a major factor of inter-annual variability in crop growth and yield. Yield is a result of the interaction of weather prevailing during crop growing period and genetic constitution of the crop plants. In tropics and semi-tropics, rainfall is the major climatic factor which affects crop growth, cultural practices and crop yields. Besides rainfall, temperature (maximum, minimum and their diurnal variation), bright sunshine hours and evaporation at different phenophases have different bearing on dry matter accumulation, crop growth and yield. Shift in sowing dates directly influence both thermo and photo-period, consequently have a great bearing on the phasic development and partitioning of dry matter to pods (Nigam *et al.*, 1994). Pod development stage is the most critical stage to weather parameters (Pathak *et al.*, 1988, Ramachandrappa *et al.*, 1992). The late sown groundnut exposed to cool nights during reproductive and maturity stages of crop growth resulted in decreased pod yields (CRIDA, 1995). Therefore, there is sufficient scope to examine correlation of weather parameters with growth, yield attributes and pod yield of groundnut at different phenophases under irrigated

condition of western Rajasthan and hence this study was undertaken.

Materials and Methods

The study was conducted at Agricultural Research Station Bikaner, during 1998 and 1999. Groundnut variety MA-10 (Chitra) was grown in a randomized block design having nine treatments of sowing dates (15 March, 1 April, 15 April, 1 May, 15 May, 1 June, 15 June, 1 July and 15 July) under irrigated condition on loamy sand soil in Indira Gandhi Canal Command area. The treatments were replicated four times. The experimental soil was alkaline in reaction (pH 8.3) with 0.10% organic carbon and low in available nitrogen (85.0 kg N ha^{-1}) and phosphorus (14.6 kg P_2O_5 ha^{-1}), medium in potassium (195.0 kg K_2O ha^{-1}). A recommended dose of 20 kg N and 40 kg P_2O_5 ha^{-1} was applied through DAP and urea at the time of sowing. The observations recorded at the Meteorological Observatory of Agricultural Research Station, Beechwal, Bikaner (28°01" N latitude and 73°32" E longitude, 234 amsl) during both the crop seasons were used to correlate the groundnut growth, yield attributes and pod yield by using mean values of temperature (maximum, minimum and their diurnal variation), evaporation, bright sunshine hours and accumulated heat indices (growing degree days, photothermal units and heat unit efficiency) prevailed during crop growing period for all treatments. The data on biomass, crop growth rate and leaf area index were taken at flower initiation (IF) and at physiological maturity (PM).

Daily values of maximum and minimum temperature and day length were used to calculate accumulated heat indices (Wilsie, 1962) namely growing degree days (GDD) and photothermal unit (PTU) during various phenological stages as follows:

$$GDD = \sum \frac{(Tmax.+ Tmin)}{2} - Tb$$

where,

Tmax. and Tmin. are daily maximum and minimum temperatures and Tb is base temperature. The base temperature for various phenological stages for groundnut is 9.5 to 11.4°C which is close to the value of 10°C and was used to calculate the heat indices in the present study (McCloud *et al.*, 1980; Leong and Ong, 1983). Photothermal units were calculated by multiplying the heat units by maximum possible sunshine hours of the day. The accumulated heat units and dry matter accumulation from sowing (S) to flower initiation (IF) and flower initiation to physiological maturity (PM) phenophases were used to calculate heat-use efficiency (kg ha^{-1} day^{-1} °C) of the groundnut.

The phenological stage of flower initiation was identified as the date on which few flowers appear in the respective sowing dates of the crop. Because of the indeterminate growth habit of groundnut, the continuous growth of the crop posed the problem of phenological stage identification so for simplicity, the life cycle was divided into sowing to flower initiation (vegetative phase) and flower initiation to maturity phase (reproductive phase).

Results and Discussion

Effect of sowing dates on dry matter and yield

Dry matter production and pod yield are the best measures to evauate overall performance and response of the groundnut

April sowings were superior to other sowing dates (Table 1) with a decreasing trend for later sowings in both the years. The seasonal variation in dry matter production was negatively correlated with all weather parameters namely maximum temperature, diurnal temperature variation, evaporation rate, bright sunshine hours, GDD, PTU and

Table 1. Pod yield and dry matter production of groundnut as influenced by sowing dates

Treatment (sowing dates)	Dry matter production from S to IF phenophase (kg ha^{-1})			Dry matter production from IF to PM phenophase (kg ha^{-1})			Pod yield (kg ha^{-1})		
	1998	1999	Mean	1998	1999	Mean	1998	1999	Mean
15 March	1909	2014	1962	11623	13916	12632	4484	4432	4457
1 April	1881	1985	1933	10441	14105	12125	3382	4682	4128
15 April	1881	1968	1925	5994	10312	8177	2358	3930	3144
1 May	1853	1880	1867	5201	6630	5916	1954	2702	2328
15 May	1892	1898	1895	3840	4372	4107	1857	2072	1964
1 June	1920	1896	1908	3376	3334	3355	1752	1630	1691
15 June	1948	1902	1925	4621	3188	3930	2178	1610	1894
1 July	1943	1816	1889	2157	2254	2186	1300	1060	1180
15 July	1926	1814	1870	1257	1196	1226	977	527	752
CD (P=0.05)	89.5	102.3	90.8	815.1	640.2	801.9	619.2	327.4	461.0

S = Sowing, IF = Flower initiation, PM = Physiological maturity

and pod yield in some of the sowing dates might be due variability in weather variables. Purushothaman *et al.* (1974) from their fortnightly sowing experiment also reported that mid March was the best time for sowing groundnut.

Effect of weather parameters on growth

The dry matter accumulation was positively correlated with mean temperature and negatively correlated with diurnal temperature variation and minimum temperature negatively during S to IF phenophase of groundnut. Other weather parameters had no significant effect on dry matter accumulation. Murthy and Rao (2000) also found that most of weather parameters had no significant effect on dry matter accumulation during early growth phase of groundnut. The crop growth rate HUE during S to IF phenophase. Leaf area index at IF was negatively correlated with the minimum temperature of S to IF phenophase whereas diurnal temperature variation had positive correlation. Maximum and mean temperature, bright sunshine hours, evaporation rate, GDD, PTU and HUE had no significant correlation with leaf area index (LAI) at this stage.

Dry matter (DM) accumulation and crop growth rate (CGR) had significant and positive correlation with maximum temperature, diurnal temperature variation, bright sunshine hours, evaporation rate, GDD, PTU and HUE during IF to PM phenophase (Table 2). The minimum temperature and daily mean temperature had no significant correlation with dry matter accumulation and crop growth rate.

Table 2. Correlation coefficients between weather parameters and crop growth characters during different phenophases (Mean over two years)

Weather parameters	DM (kg ha^{-1})		CGR (g m^{-2} day^{-1})		Leaf area index	
	S - IF	IF - PM	S - IF	IF - PM	at IF	at PM
Daily mean maximum temperature (°C)	-0.231	0.642*	-0.739*	0.658*	-0.012	0.575
Daily mean minimum temperature (°C)	-0.750*	-0.565	0.239	-0.507	-0.804**	-0.584
Daily mean temperature (°C)	0.661*	0.027	-0.160	0.091	-0.581	-0.005
Daily mean diurnal temperature variation (°C)	-0.640*	0.986**	-0.772*	0.978**	0.871**	0.969**
Bright sunshine hours (hours/day)	-0.009	0.939**	-0.684*	0.802*	0.284	0.742*
Evaporation (mm day^{-1})	-0.552	0.978**	-0.616	0.976**	-0.316	0.955**
GDD (day °C)	-0.173	0.952**	-0.852**	0.949**	0.092	0.941**
PTU (day °C)	-0.263	0.955**	-0.795*	0.951**	-0.014	0.943**
HUE (kg ha^{-1} day^{-1} °C)	0.252	0.987**	0.703*	0.995**	0.002	0.961**

S = Sowing, IF = Flower initiation, PM = Physiological maturity;
* = Significant at 5%, ** = Significant at 1%.

had no significant correlation with dry matter accumulation and crop growth rate. The effect of maximum and minimum temperatures and mean temperature was not significantly correlated with LAI at PM phenophase.

Table 3. Correlation coefficients of weather parameters prevailed during sowing to flowering initiation with yield attributes and pod yield of groundnut (Mean over two years)

Weather parameters	Yield attributes					Pod yield (kg ha^{-1})
	No. of pod/plant	Shelling (%)	Kernels/ pod	Test weight (g)	Harvest index	
Daily mean maximum temperature (°C)	0.128	0.578	0.111	0.293	0.509	-0.012
Daily mean minimum temperature (°C)	-0.824**	-0.126	-0.231	-0.668*	0.146	-0.882**
Daily mean temperature (°C)	-0.530	0.170	-0.215	-0.345	0.335	-0.638*
Daily mean diurnal temperature variation (°C)	0.9894**	0.537	0.176	0.932**	0.193	0.956**
Bright sunshine hours (hours/day)	0.557	0.146	-0.478	0.401	0.107	0.437
Evaporation (mm day^{-1})	-0.094	0.329	-0.411	0.002	0.399	-0.262
GDD (day °C)	0.294	0.542	-0.201	0.417	0.377	0.153
PTU (day °C)	0.174	0.538	-0.200	0.322	0.421	0.027

* = Significant at 5%, ** = Significant at 1%.

Table 4. Correlation coefficients of weather parameters prevailed during flowering to physiological maturity with yield attributes and pod yield of groundnut (Mean over two years)

Weather parameters	Yield attributes					Pod yield (kg ha^{-1})
	No. of pod/plant	Shelling (%)	Kernels/ pod	Test weight (g)	Harvest index	
Daily mean maximum temperature (°C)	0.729*	0.790**	0.264	0.845**	0.424	0.647*
Daily mean minimum temperature (°C)	-0.428	0.299	-0.094	-0.224	0.373	-0.535
Daily mean temperature (°C)	0.188	0.667*	0.303	0.386	0.494	0.067
Daily mean diurnal temperature variation (°C)	0.974**	0.432	0.097	0.906**	0.058	0.991**
Bright sunshine hours (hours/day)	0.682*	0.119	0.416	0.638*	-0.242	0.791**
Evaporation (mm day^{-1})	0.995**	0.510	0.281	0.931**	0.162	0.990**
GDD (day °C)	0.993**	0.534	0.208	0.934**	0.186	0.965**
PTU (day °C)	0.993**	0.527	0.206	0.932**	0.177	0.967**
HUE (kg ha^{-1} day^{-1} °C)	0.981**	0.513	0.358	0.934**	0.072	0.990**

IF = Flower initiation, PM = Physiological maturity;
* = Significant at 5%, ** = Significant at 1%.

Effect of weather parameters on yield attributes and pod yield

Among the yield attributes number of pods/plant and test weight was positively correlated with diurnal temperature variation and negatively correlated with minimum temperature during S to IF phenophase, while shelling per cent, kernels/pod and harvest index had no correlation with weather parameters that prevailed during this phenophase. Minimum temperature and mean temperature during S to IF phenophase had negative correlation with pod yield whereas diurnal temperature variation was positively correlated (Table 3). Nigam *et al.*(1994) also reported similar effect of temperature and photoperiod on groundnut crop.

Correlation values between weather parameters during IF to PM with yield attributes indicate that number of pods/plant, test weight and pod yield were significantly and positively correlated with maximum temperature, diurnal temperature variation, bright sunshine hours, evaporation rate, GDD, PTU and HUE. The influence of minimum temperature and mean temperature was not significant for number of pods/plant and pod yield during this phenophase. Kernels/pod and harvest index were not influenced by any of the weather parameter prevailed over this stage (Table 4). Similar findings have been reported by Dreyer *et al.* (1981) and Murthy and Rao (2000).

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