AJES
ASIAN JOURNAL OF ENVIRONMENTAL SCIENCE ■ VOLUME 8 | ISSUE 2 | DECEMBER, 2013 | 72-76

RESEARCH ARTICLE

Effect of weather conditions on *Kharif* groundnut (*Arachis hypogaea* L.) at Anand in middle Gujarat agro-climatic zone

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Article Chronicle :
***Received* :**
16.09.2013;
***Revised* :**
17.10.2013;
***Accepted* :**
04.11.2013

SUMMARY : A field experiment for the two years was conducted during the *kharif* seasons of 2009 and 2010 with the first sowing at the onset of monsoon followed by successive sowings at an interval of 15 days with the varieties namely V_1-M 335 (Virginia spreading type), V_2-GG 20 (Virginia semi-spreading type) and V_3-GG 5 (Spanish bunch type) to study the effect of weather conditions on pod yield of groundnut. The overall performance of groundnut crop in terms of pod yield from the present study suggest that, sowing of groundnut should be taken up for variety V_1 between 26th to 27th week, as a good rainfall amount and distribution of 823 to 852 mm under early/ normal onset of monsoon as observed during 2010 resulted in commercial production of groundnut. Whereas, sowing of groundnut should be taken up for variety V_2 between 26th to 27th, because reasonably a good crop can be produced on as little as 269 to 298 mm of rainfall under late onset of monsoon as observed during 2009 crop growing season. However, during pod development phase (P_6) 79% of mean relative humidity, 23.5 mm of Hg mean vapour pressure and 135 mm of rainfall amount were found optimum with an R^2 of 0.61, 0.54 and 0.63, respectively to have significantly influenced the pod yield. Similarly, the values beyond for mean maximum air temperature of 32.5 ^{0}C, evaporation rate of 3.2 mm and bright sunshine hours of 4.8 were found detrimental with an R^2 of 0.53, 0.77 and 0.59, respectively. The decrease in each unit of maximum air temperature, evaporation rate and BSS hours had resulted in decrease of 567, 332 and 474 kg ha^{-1} in pod yield levels.

HOW TO CITE THIS ARTICLE : Guled, P.M., Shekh, A.M., Pandey, Vyas and Patel, H.R. (2013). Effect of weather conditions on *Kharif* groundnut (*Arachis hypogaea* L.) at Anand in middle Gujarat agro-climatic zone. *Asian J. Environ. Sci.*, **8**(2): 72-76.

Key Words :
Date of sowing, Pod yield, Rainfall, Groundnut, Weather conditions

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Goundnut is the predominant oilseed crop in Saurashtra region and about 80% of the crop is grown under rainfed. The crop is generally sown between 15th June and 15th July, depending on the normal onset of monsoon. However, the erratic onset of monsoon and commencement of sowing rains, some times force the farmers to sow the crop late in the season. Yield variation in rainfed groundnut can be attributed to rainfall variability *i.e.*, amount and distribution of rainfall. The effectiveness of rainfall in crop production depends mainly on commencement of sowing rains and amount and distribution of rainfall during the season as water deficit is a major constraint in peanut production, especially during the critical period of pod set which results in reduced pegging (Chandrika *et al.*, 2008 and Sahu *et al*., 2004). Therefore, to ascertain the influence of different weather conditions and rainfall distribution and its amount on the performance of groundnut productivity for Anand region in middle Gujarat agroclimatic condition which receives an annual rainfall distribution of 834 mm, the present experiment was conducted to study the behaviour of *Kharif* sown rainfed groundnut under different dates of sowing with three different cultivars to assess the performance of groundnut under rainfed condition during 2009 and 2010.

EXPERIMENTAL METHODOLOGY

The field experiments were conducted on sandy loam soils of Agronomy farm, B. A.

College of Agriculture, Anand Agricultural University, Anand (22°35" N lat. and 72°55" E long. at an elevation of 45.1 m) during the *Kharif* seasons of 2009 and 2010 with the first sowing done at the onset of monsoon followed by successive interval gap of 15 days as of 2nd July *i.e.*, 27th week (D_1: Normal onset of monsoon), 17th July *i.e.*, 29th week (D_2: Very late onset of monsoon), 1st August *i.e.*, 31st week (D_3: Very very late onset of monsoon) in 2009 and 15th June *i.e.*, 24th week (D_1: Early onset of monsoon), 30th June *i.e.*, 26th week (D_2: Normal onset of monsoon), 14th July *i.e.*, 28th week (D_3: Late onset of monsoon) in 2010 with the varieties as sub plot treatments namely V_1- M 335 (Virginia spreading type), V_2- GG 20 (Virginia semi-spreading bunch type) and V_3- GG 5 (Spanish bunch type). The experiment was laid out in Split Plot Design. Size of the gross plot was 21 m^2 and net plot was 12 m^2. Spacing adopted was 30 × 10 cm. Recommended dose of fertilizers (12.5 N, 25 P_2O_5, 0 K_2O kg ha^{-1}) were applied to the crop as basal. Weather data for the experimental period were recorded at meteorological observatory, Anand Agricultural University, Anand and the weekly prevailed weather parameters were embraced at each phenological week as depicted in Fig. 1 and 2. The data for yield and yield components were determined for net plot and were worked out for kg ha^{-1}. The crop period was divided into eight growth phases P_1 (sowing to germination), P_2 (emergence to first flowering), P_3 (first flowering to 50 % flowering), P_4 (50 % flowering to peg initiation), P_5 (peg initiation to pod initiation), P_6 (pod initiation to pod development), P_7 (pod development to pod maturity) and P_8 (sowing to maturity) for yield weather relationship study.

EXPERIMENTAL FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Effect of dates of sowing and varieties on pod yield of groundnut :

The data pertaining to pod yield of groundnut for different dates of sowing and varieties are presented in Table 1. The differences in the pod yield were significantly higher for D_1 (1838 kg ha^{-1}) than D_2 (56%) and D_3 (74%) dates of sowing during 2009. Whereas, during 2010 the differences in the pod yield of groundnut sown on D_2 (2866 kg ha^{-1}) being at par with D_3 (2799 kg ha^{-1}) were significantly higher than D_1 (8 and 2%), respectively. However, among the varieties the differences in the pod yield were significantly higher for variety V_2 (1157 kg ha^{-1}) being at par with V_3 (1063 kg ha^{-1}) than V_1 (22 and 8%), respectively, during 2009. Whereas, the pod yield of groundnut for variety V_1 (3035 kg ha^{-1}) was significantly higher than V_2 (15%) and V_3 (11%) during 2010.

Effect of weather conditions on pod yield of groundnut :

To ascertain the influence of different weather parameters on the pod yield of groundnut. Correlation and regression studies were performed between pod yield of groundnut and different weather parameters at respective phenophases which are presented in Table 2 and depicted in Fig. 1 and 2. From the results it was found that there was a highly significant positive correlations for afternoon relative humidity (RH_2), afternoon vapour pressure (VP_2) and mean vapour pressure (VP_{mean})

Table 1 : Average pod yield (kg ha^{-1}) of groundnut under different dates of sowing and varieties during *Kharif* 2009 and 2010

Treatments	Pod yield (kg ha^{-1})		
	2009	2010	Pooled
Mean for dates of sowing			
D_1	1838	2650	2244
D_2	813	2866	1840
D_3	471	2799	1635
Overall mean	1041	2772	1906
S.E. ±	53.82	52.48	403.86
C.D. (P=0.05)	169.58	165.36	NS
C.V. %	21.94	8.03	11.83
Mean for variety			
V_1	903	3035	1969
V_2	1157	2590	1873
V_3	1063	2691	1877
Overall mean	1041	2772	1906
S.E. ±	38.89	110.00	180.26
C.D. (P=0.05)	112.31	317.65	NS
C.V. %	15.85	16.84	18.36

during first flower appearance (P_2). However, the stepwise regression revealed that the afternoon vapour pressure (VP_2) had resulted in 88% of variation in the pod yield. Similarly during pod initiation stage (P_5) there was a significant positive correlation for evaporation (EP) and mean air temperature (T_{mean}) with highly significant negative correlations for morning relative humidity (RH_1) and mean relative humidity (RH_{mean}). The stepwise regression revealed that the morning relative humidity (RH_1) had resulted in 77% variation in the pod yield. Whereas, during pod development phase (P_6) there was a significant positive correlations for minimum air temperature (T_{min}), morning relative humidity (RH_1), afternoon relative humidity (RH_2), mean relative humidity (RH_{mean}), morning vapour pressure (VP_1), afternoon vapour pressure (VP_2), mean vapour pressure (VP_{mean}) and highly significant positive correlation for rainfall (RF) which were found to be optimum to have significantly influenced the pod yield. Whereas, significant negative correlation was observed for evaporation (EP), bright sunshine hours (BSS) and maximum air temperature (T_{max}) as depicted in Fig 3. These significant negative correlations were found to have detrimental effect which had resulted in poorer pod yield levels. However, after performing the stepwise regression, it revealed that the rainfall had resulted in 68% variation in the pod yield. The polynomial regression analysis during pod development phase (P_6) suggest that 79% mean relative humidity, 23.5 mm of Hg mean vapour pressure and 135 mm of rainfall amount were found optimum with R^2 of 0.61, 0.54 and 0.63, respectively where an increase in each unit of relative humidity, vapour pressure and 50 mm of rainfall had resulted an increase in 153, 739 and 287 kg ha^{-1} of pod yield. Similarly, the values beyond for mean maximum air temperature of 32.5 ^{0}C, evaporation rate of 3.2 mm and bright sunshine hours of 4.8 were found detrimental which had resulted in decrease in the pod yield levels with R^2 of 0.53,

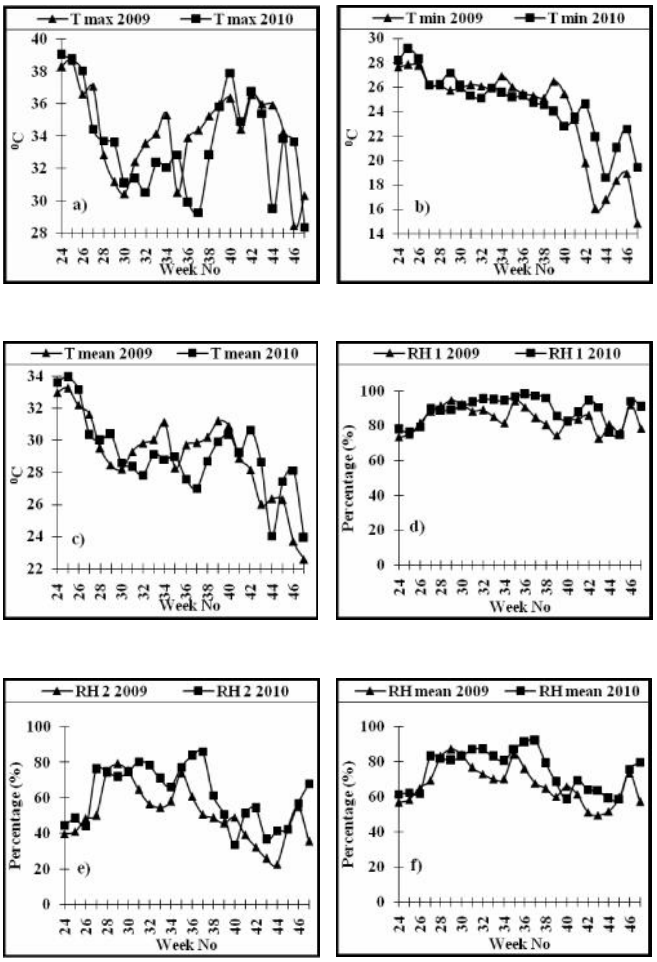

Fig. 1 : Weekly mean maximum (a), minimum (b), mean air temperature (c), mean morning (d), afternoon (e) and mean relative humidity (f) as prevailed during the crop growth period during *Kharif* seasons of 2009 and 2010.

Table 2 : Correlation co-efficients between phenophasewise pod yield and weather parameters

Phases	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	LC
					Weather parameters				
EP	-0.02	-0.26	0.26	-0.39	0.71*	-0.73*	0.49	0.66	0.64
BSS	-0.36	-0.61	0.12	-0.60	-0.04	-0.78*	0.28	0.58	-0.44
T_{max}	0.20	-0.18	0.56	-0.25	0.58	-0.73*	0.28	0.53	0.77*
T_{min}	-0.13	0.01	0.61	0.31	0.56	0.71*	0.53	0.57	0.66
T_{mean}	0.18	-0.13	0.47	-0.03	0.74*	0.60	0.48	0.50	0.75*
RH_1	0.15	0.16	-0.33	-0.13	-0.88**	0.69*	-0.05	0.30	-0.48
RH_2	0.13	0.69*	-0.40	0.30	-0.34	0.74*	0.04	-0.49	0.11
RH_{mean}	0.14	0.57	-0.39	0.25	-0.71*	0.73*	0.01	-0.40	-0.11
VP_1	0.08	0.40	0.41	-0.34	-0.48	0.71*	0.52	0.60	0.64
VP_2	-0.03	0.94**	-0.02	0.11	-0.37	0.73*	0.34	0.44	0.63
VP_{mean}	-0.01	0.86**	0.19	-0.15	-0.43	0.72*	0.46	0.62	0.64
RF	0.75*	-0.46	-0.56	0.04	-0.30	0.82**	-0.16	-0.41	0.85**

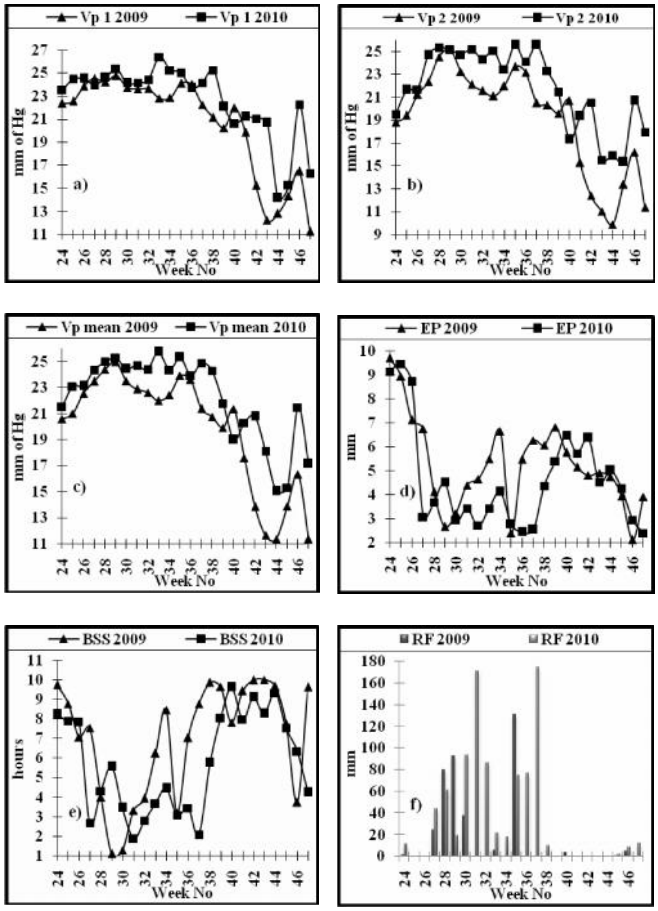

Fig. 2 : Weekly mean morning vapor pressure (a), afternoon vapor pressure (b), mean vapor pressure (c), evaporation (d), bright sunshine hours (e) and rainfall (f) as prevailed during the crop growth period during *Kharif* seasons of 2009 and 2010.

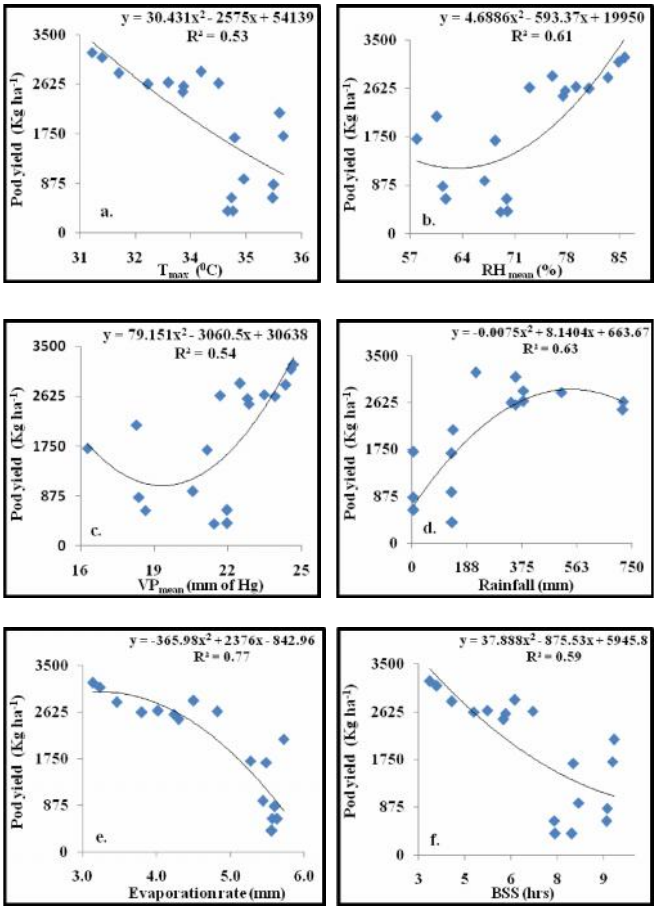

Fig. 3 : Relationship between pod yield and maximum air temperature (a), mean relative humidity (b), mean vapor pressure (c), rainfall (d), evaporation rate (e) and bright sunshine hours (f) during pod development phase for *Kharif* seasons of 2009 and 2010.

0.77 and 0.59, respectively. The decrease in each unit of maximum air temperature, evaporation rate and BSS hours had resulted in decrease of 567, 332 and 474 kg ha^{-1} in pod yield levels as presented in Fig 3.

The overall performance of groundnut crop with respect to pod yield for the entire crop duration showed significant positive correlations for maximum (T_{max}), mean air temperature (T_{mean}) and highly significant positive correlation for rainfall (RF). The above presented results for different weather elements were found to be optimum which had significantly influenced the pod yield. However, after performing the stepwise regression, it was revealed that the rainfall had resulted in 73% variation in the pod yield.

The above presented results are in confirmation with the findings of Cox (1979), Nigam *et al*. (1994), Bapuji Rao *et al*. (2011), Patel *et al*. (2010) and Caliskan *et al*. (2008) as they reported that cooler temperatures during flowering (P_2) due to higher afternoon vapour pressure (VP_2) had favored production of more number of flowers during both the years as they partitioned more dry matter to pods and hence had higher dry matter indicating better utilization of photosynthate carbon in growth, especially leaf area development. Whereas, the cooler temperatures due to higher morning relative humidity (RH_1) during pod initiation (P_5) had affected the biomass production suggesting that at one age photosynthesis may be the most limiting process whereas at another, the limiting process may be the utilization of the photosynthetic carbon, the effect was more during 2010 in comparison to 2009. However, rainfall amount and distribution pattern during pod development stage (P_6) had synergetic effect on the pod yield especially during 2010 in comparison to 2009 which had resulted in higher pod yield levels. During 2009 rainfall amount was found insufficient to meet the water requirement of the crop leading to occurrence of water stress during pod development which resulted in drastic reduction of drymatter produced resulting in lower yield levels due to higher air temperatures, evaporation rate and bright sunshine hours which were found to be detrimental affecting the reproductive phases

which reduced dry matter accumulation, proportion of pegs forming pods and consequently resulting in poorer pod yields as reported by Bapuji Rao *et al*. (2011), Patel *et al*. (2010), Sahu *et al*. (2004), Padmalata *et al*. (2006), Caliskan *et al*. (2008) and Chandrika *et al*. (2008). Whereas, for the entire crop duration during both the years it was found that the rainfall amount and distribution was found more optimum during 2010 to have synergetic effect on the pod yield as compared to 2009.

Conclusion :

The overall performance of groundnut crop in terms of pod yield from the present study suggest that, sowing of groundnut should be taken up for variety V_1 between 26th to 27th week, as a good rainfall amount and distribution of 823 to 852 mm under early/normal onset of monsoon as observed during 2010 which resulted in commercial production of groundnut. Whereas, sowing of groundnut should be taken up for variety V_2 between 26th to 27th, because reasonably a good crop can be produced on as little as 269 to 298 mm of rainfall under late onset of monsoon as observed during 2009 crop growing season.

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