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Effect of soil moisture, evapotranspiration, stress degree days on pod yield of groundnut (*Arachis hypogaea* L)

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ABSTRACT

Field experiments were conducted during the *kharif* seasons of 2009 and 2010 to study the effect of soil moisture content (SMC), transpiration rate (T) and stress degree days (SDD) on pod yield of three cultivars of groundnut sown on 3 dates at 15 days interval from onset of monsoon. The results revealed that the SMC, T and SDD significantly influenced the pod yield of groundnut. SMC and T were positively correlated while SDD was negatively correlated with the pod yield. The varietal differences in transpiration rate and SDD were non-significant.

Keywords: Stress degree days, soil moisture content and transpiration rate.

The groundnut is extensively cultivated in Gujarat contributing 28.9% area and 42.4% production generating high profits. Production of groundnut is concentrated mostly in the semiarid region where periods of adequate precipitation are often followed by drought periods. Unpredictable and intermittent periods of water deficit occur almost every year, and are usually more frequent during pod growth as the drought stress affects the whole plants life from molecular level through physiological processes to the whole stand (Collino *et al*., 2001). Predicting yield response to crop water stress is important in both developing strategies and decision making concerning irrigation management under limited water conditions. Therefore, combine drought tolerance and drought escape strategies would be advantageous. Thus the main objective of this study was to determine the effect of soil moisture content, transpiration rate and stress degree day on the pod yield of groundnut.

MATERIALS AND METHODS

The field experiment was conducted on sandy loam soils at Agronomy farm, B. A. College of Agriculture, AAU, 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 three dates of sowings (D_1- onset of monsoon, D_2- 15 days after D_1 and D_3- 15 days after D_2) as main plot with three varieties (V_1- M 335, V_2- GG 20 and V_3- GG 5) as sub plot treatments. The experiment was laid out in split plot design with gross plot area of 21 m^2 and net plot area of 12 m^2 and spacing of 30 X 10 cm. Recommended dose of fertilizers were applied to the crop. Weather data for the experimental period was recorded at meteorological observatory, located near the experimental plot.

AGRI-THERM II Portable Infrared Thermometer (Model 6110.4ZL) was used to measure canopy and air temperature differences to compute stress degree day (SDD) values in ^{0}C, using the equation given by (Jackson *et al.*, 1977). Gravimetric soil moisture content (SMC) was determined and was expressed in percent moisture and PMR-5 make steady state porometer was used for the measurements of leaf transpiration rate (T). The average data on SMC, SDD and T were recorded at all the growth phases *viz.*, P_1 (sowing to germination), P_2 (emergence to first flowering), P_3 (first flowering to fifty percent flowering), P_4 (fifty percent 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).

RESULTS AND DISCUSSION

The pod yield of groundnut, transpiration rate (T), soil moisture content (SMC) and stress degree days (SDD) as influenced by dates of sowing are presented in Table 1. The results show that the pod yield was significantly influenced by the dates of sowing in both the years but in

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Table 1: Average pod yield, transpiration rate (T), stress degree days (SDD) and soil moisture content (SMC) of groundnut under different dates of sowing and varieties during *kharif* 2009 and 2010.

Treatment	Pod yield (kg ha^{-1})			T (mol m^{-2} s^{-1})			SDD (^{0}C)			Soil moisture content (%)		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
Mean for dates of sowing												
D_1	1838	2650	2244	2.88	3.58	3.23	2.78	0.86	1.82	65.9	78.6	72.3
D_2	813	2866	1840	2.65	3.56	3.11	2.88	0.87	1.88	56.1	84.6	69.9
D_3	471	2799	1635	2.36	3.53	2.95	3.05	1.08	2.06	55.5	81.1	68.3
Overall mean	1041	2772	1906	2.63	3.56	3.10	2.90	0.94	1.92	59.2	81.4	70.2
S. Em. ±	53.82	52.48	403.86	0.061	0.092	0.06	0.067	0.018	0.035	0.81	0.98	0.63
C.D. at 5%	169.58	165.36	NS	0.192	NS	0.16	0.211	0.055	0.102	2.55	3.07	1.87
C.V. %	21.94	8.03	11.83	10.09	10.75	10.69	9.81	7.94	10.84	5.42	5.08	5.25
Mean for variety												
V_1	903	3035	1969	2.60	3.76	3.18	2.70	0.84	1.77	62.3	86.4	74.4
V_2	1157	2590	1873	2.84	3.42	3.13	2.92	1.08	2.00	66.6	75.9	70.3
V_3	1063	2691	1877	2.26	3.69	2.97	3.09	0.89	1.99	60.7	74.9	68.3
Overall mean	1041	2772	1906	2.57	3.62	3.09	2.90	0.94	1.92	63.2	79.1	71.0
S. Em. ±	38.89	110.00	180.26	0.170	0.132	0.22	0.169	0.100	0.098	0.77	1.63	0.90
C.D. at 5%	112.31	317.65	NS	NS	NS	NS	NS	NS	NS	2.23	4.72	2.56
C.V. %	15.85	16.84	18.36	28.19	15.41	20.88	25.63	45.25	30.61	5.15	8.51	7.48
S.I. effect		Y_1XY_2			Y_1XY_2			Y_1XY_2			Y_1XY_2	

Table 2: Correlation coefficients between pod yield and soil moisture content and stress degree days during different phenophases

Phases	Soil moisture content (SMC)	Transpiration rate (T)	Stress degree days (SDD)
P_1- sowing to germination	-0.49	0.52	-0.34
P_2- emergence to first flowering	0.41	0.48	0.01
P_3- first flowering to fifty percent flowering	-0.34	0.41	-0.53
P_4- fifty percent flowering to peg initiation	0.42	0.48	-0.40
P_5- peg initiation to pod initiation	0.35	0.58	-0.37
P_6- pod initiation to pod development	0.74*	0.67*	0.45
P_7- pod development to pod maturity	0.74*	0.62	-0.07
P_8- pod to physiological maturity	0.66	0.01	-0.61
LC- entire crop duration	0.68*	0.41	-0.86**

pooled analysis it was not significant. This was because of interaction effect different weather parameters particularly encountered the crop during year and dates of sowing. Both the years behaved differently in terms of rainfall and its distribution that resulted in differential yield response due to year and dates of sowing. In the first year pod yield reduced drastically (about 4 times) due to successive delay in sowings, whereas in the second year the highest yield (2866 kg ha^{-1}) was obtained with second date of sowing and lowest in first date. Even the yield levels between the years differed significantly. In second year the yields were generally 2.5 times higher than the first year. In respect of variety different trends were obtained in two years. in the first year the highest yield (1157 kg ha^{-1}) was obtained by V_2 and lowest (903 kg ha^{-1}) by V_1 while in second year V_1 secured highest yield (3035 kg ha^{-1}) as V_2 secured the lowest (2590 kg ha^{-1}) yield.

Relation of SMC, SDD and T with pod yield

The perusal of data presented in Table 1 further revealed that the SMC also varied significantly with dates of sowing as well as between the years. Higher SMC resulted in higher pod yield. This is also evident from the positive correlation obtained between SMC at different stages of crop and pod yield (Table 2), which were significant in later phases of crop growth. Overall SMC for crop life period was also significantly positively correlated with pod yield.

The varietal response to soil moisture content was not linear, although highest SMC was associated with highest yield (Table 1). Variety V_3 responded better under lower SMC in comparison to other varieties. As far as stress degree days (SDD) are concerned, it may be seen from Table 1 that SDD less than 1.0 has resulted in higher pod yield. As the SDD increased the yield decreased which is evident from the negative correlations obtained (Table 2). Transpiration rate (T) significantly varied due to date of sowing in 2009 but it was non significant in 2010. This was because the transpiration rate of 3.0 (mol m^{-2} s^{-1}) was found to have favourable effect on pod yield. Thus higher transpiration rate resulted in higher pod yield which was also evident from the positive correlations obtained in most of the phases. The varietal differences in transpiration rate were non significant (Table 1). The results presented are in confirmation with that obtained by Canvar and Kaynak (2010).

CONCLUSION

Finally, it is concluded that the soil moisture content during pod development were found to have significantly influenced the transpiration rate and resulting in attaining higher pod yield. Whereas, as the stress degree days beyond 0.94 ^{0}C had resulted in 77% variation in the pod yield, the variation was more during the year 2009 as compared to 2010. Therefore it is recommended that under periods of dry spell the irrigation should be provided as the canopy and air temperature difference reaches 0.94 ^{0}C to obtain higher pod yield for Anand region.

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