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Effect of temperature on phenology of groundnut (*Arachis hypogaea* L.) during *rabi* season

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ABSTRACT

Field investigation was carried out to study the effect of temperature on phenology of groundnut during rabi season. Results revealed that the rate of emergence was highest at mean temperature of 23.9°C and lowest at 19.9°C. Increase in mean temperature significantly increased the emergence rate (r = 0.6708**) of groundnut seedlings. Number of days taken to 50 per cent flowering was less at higher mean temperatures. Rate of flowering significantly increased with increase in mean temperature (r = 0.9592**). Low minimum temperature during pod filling phase extended the duration of November sown crop.

Key words: Groundnut, Phenology, Temperature

The productivity of *rabi* groundnut is usually limited by poor emergence of seedlings if sown early and sprouting of pods if sown late due to early onset of monsoon. However, the upper limit of groundnut productivity depends on crop weather relations during the crop growth period, which in turn depends on time of sowing. The objective of identifying optimum time of sowing is to expect that different growth phases would pass through congenial weather conditions. Of all weather parameters, rate of plant development is predominantly determined by temperature. With this background, the effect of temperature on phenology of groundnut is studied during *rabi* season.

MATERIALS AND METHODS

Field experiments were conducted for two years (1994-95 and 1995-96) during *rabi* at Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Reddipalli in the Scarce Rainfall Zone of Andhra Pradesh. The station is located at 14°41' N latitude, 77°40'E longitude and at an altitude of 350 m above mean sea level. Soil of the experimental field is shallow in depth (20 - 25 cm), sandy loam in texture, slightly alkaline in reaction (7.5 pH), low in available nitrogen (109.7 kg ha^{-1}), medium in available phosphorus (15.6 kg ha^{-1}) and potassium (176.7 kg ha^{-1}) with a bulk density of 1.45 g cm^{-3}.

The experiment was laid out in a split plot design with twenty one treatment combinations, replicated thrice. In both the years under study, the treatments included seven dates of sowing (November 1, November 16, December 1, December 16, December 31, January 15 and January 30) as main plots and three irrigation

Table 1: Mean maximum, minimum, mean and diurnal variation in temperatures (°C) prevailed over different phenophases of groundnut crop sown on different dates

Dates of sowing	Maximum temperature		Minimum temperature		Mean temperature		Diurnal variation	
	1994-95	1995-96	1994-95	1995-96	1994-95	1995-96	1994-95	1995-96
Vegetative phase								
November 01	28.5	31.7	14.9	18.0	21.7	24.9	13.6	13.7
November 16	29.1	30.8	12.0	15.4	20.6	23.1	17.1	15.4
December 01	28.3	29.9	11.5	13.6	19.9	21.8	16.8	16.4
December 16	28.3	30.2	13.2	13.9	20.7	22.1	15.1	16.3
December 31	29.2	30.9	12.7	13.5	20.6	22.2	15.7	17.4
January 15	30.6	31.8	12.8	13.6	21.7	22.6	17.8	18.2
January 30	32.9	32.9	14.2	14.2	23.6	23.5	18.7	18.7
Reproductive phase								
November 01	28.2	29.6	11.8	13.0	20.0	21.3	16.3	16.6
November 16	28.5	30.0	13.1	13.9	20.8	22.0	15.4	16.1
December 01	29.5	31.4	13.2	13.6	21.4	22.5	16.3	17.8
December 16	30.9	31.4	13.0	12.4	22.0	21.9	17.9	19.0
December 31	34.2	33.6	14.7	15.2	24.4	24.4	19.5	18.4
January 15	35.7	36.0	16.7	15.1	26.2	25.5	19.1	20.9
January 30	36.6	38.9	18.7	18.3	27.2	28.6	17.8	20.6
Pod filling phase								
November 01	31.8	32.4	14.0	13.8	22.9	23.1	17.9	18.6
November 16	33.6	33.0	14.8	14.1	24.2	23.6	18.7	19.0
December 01	34.5	33.9	15.6	14.0	25.0	23.9	18.9	19.8
December 16	36.1	36.7	17.4	17.3	26.8	27.0	18.7	19.4
December 31	37.2	37.9	19.1	19.6	28.2	28.7	18.1	18.3
January 15	38.2	38.5	20.6	20.4	29.4	29.4	17.5	18.1
January 30	37.7	38.9	21.2	21.1	29.4	30.0	16.6	17.9

schedules (IW/CPE ratios of 1.0, 0.8 and 0.6 with 5 cm depth of irrigation) as sub plots. The test variety was spanish bunch vemana (K-134) with a duration of 100-110 days during rabi. Recommended package of practices were followed and care was taken against biotic stresses. Crop-weather relations were worked out for the data of IW/CPE ratio of 1.0 so as to keep the weather as the only variable in bringing the change in phenology of groundnut. Weather data

Table 2 : Variation of phenological parameters of groundnut as influenced by temperatures and sowing dates

Date of sowing	Days to 50 per cent emergence	Emergence rate per day	Tmean from sowing to 50% emergence (°C)	Flowering rate per day	Tmean from sowing to 50% flowering (°C)	Occurrence of phenological event (days)		
						Vegetative phase	Reproductive phase	Pod filling phase
1994-95								
November 01	8	0.13	21.2	0.030	21.7	33	25	64
November 16	8	0.13	22.4	0.029	20.6	34	26	64
December 01	12	0.08	19.9	0.027	19.9	37	19	55
December 16	9	0.11	20.8	0.028	20.7	36	23	56
December 31	9	0.11	20.8	0.029	20.6	35	21	59
January 15	10	0.10	21.0	0.030	21.7	33	23	57
January 30	8	0.13	22.2	0.034	23.6	29	28	51
1995-96								
November 01	9	0.11	24.9	0.036	24.9	28	25	67
November 16	8	0.13	24.4	0.033	23.1	30	26	59
December 01	8	0.13	22.9	0.030	21.8	33	23	54
December 16	10	0.10	21.2	0.030	22.1	33	23	58
December 31	7	0.14	22.2	0.030	22.2	33	24	61
January 15	6	0.16	23.9	0.030	22.6	33	24	53
January 30	8	0.13	22.0	0.033	23.5	30	27	55

recorded in Class A observatory situated in the adjoining field were made use of.

The number of days from sowing to 50 per cent seedling emergence was recorded. To study the phenology, three groundnut plants from each treatment were uprooted carefully, from the area earmarked for sampling at 5 days interval and the following phenological events were recorded (Boote 1982).

Emergence (VE)

Fifty per cent flowering (R_1)

Pegging (R_2)

Seed initiation (R_5)

Pod development (R_6 to R_8)

These phenophases were further grouped into the following three phases for studying correlations (Krista Rao, 1996).

Vegetative(VE to R_1)

Reproductive(R_1 to R_5)

Pod filling (R_5 to R_8)

The mean maximum, minimum, mean and diurnal variation in temperatures prevailed over different phenophases of the crop sown in different dates are presented in Table 1. There is a considerable variation in these parameters under different dates of groundnut sowings. The crop sown in different dates was exposed to different thermal regimes during the growth period. During 1994 - 95, minimum temperature during vegetative, reproductive and pod filling phases ranged from 11.5° - 14.9°C; 11.8° - 18.7°C and 14.0° - 21.2°C respectively. During 1995 - 96, the values ranged from 13.5° - 18.0°C; 12.4°- 18.3°C and 13.8°- 21.1°C, coinciding with vegetative, reproductive and pod filling phases respectively.

Diurnal temperature range during 1994 - 95 varied from 13.6° - 18.7°C; 15.4° - 19.5°C and 16.6° - 18.9°C, coinciding with vegetative, reproductive and pod filling phases. During 1995 - 96, it ranged from 13.7° - 18.7°C in vegetative phase; 16.1° - 20.9°C in reproductive phase and 17.9°- 19.8°C in pod filling phase.

RESULTS AND DISCUSSION

Days to 50 per cent emergence

The number of days from sowing to 50 per cent seedling emergence from the soil was recorded. Data for each sowing date on this parameter was related to mean temperature, averaged from the day of sowing until the day of 50 per cent emergence. The data (Table 2) were plotted as the inverse of duration against mean temperature (Ong, 1986). The reciprocal duration is effectively a rate, and this is a useful way to describe plant responses to temperatures. The inverse of duration with units day^{-1} represented the rate of development (Angus *et al.*, 1981).

Results revealed that the rate of seedling emergence increased with increase in mean temperature from 19.9 to 23.9°C followed by a decrease thereafter. Rate of emergence was the highest at 23.9°C (January 15 of 1995 - 96) and it took only 6 days to attain 50 per cent emergence as against 12 days at mean temperature of 19.9°C (December 1 of 1994-95). Correlation between weather parameters and days to 50 per cent emergence revealed that increase in mean temperature (T_{mean}) significantly increased the emergence rate ($r = 0.6633^{**}$) and the following prediction equation was derived to know the emergence rate (Er) which accounted for 44.0 per cent variation.

$$Er = 1/(39.29 - 1.434.T_{mean})$$

Germination was considerably reduced at lower temperatures with maximum emergence was recorded between mean temperatures of 21.2 and 23.9°C (0.10 to 0.16). Pandya and Patel (1986), Miller and Globerson (1987) and Goncalves and de Abreu (1988) also observed similar relationship between temperature and seedling emergence of groundnut crop.

Vegetative phase

The number of days from sowing to 50 per cent flowering of the plants in each treatment was recorded. Data for each sowing date were plotted as the inverse of duration against mean temperature of the day from sowing to 50 per cent flowering. The data (Table 2) indicated that the rate of flowering increased (0.027 to 0.036) with increase in mean temperature from 19.9 to 24.9°C. The results are in conformity with the findings of Wynne *et al* (1973), Yoshitaka Ono *et al* (1974) and Scandaliaries *et al* (1981). Days to 50 per cent flowering was only 28 at mean temperature of 24.9°C

(November 1 of 1995-96) as against 37 days (December 1 of 1994-95) at 19.9°C. Correlation studies revealed that increase in mean temperature (T_{mean}) significantly increased the rate of flowering ($r = 0.9592^{**}$). To predict the flowering rate (Fr) the regression equation is developed which accounted for 92.0 per cent variation.

$$Fr = 0.007 + 0.0017\ T_{mean}$$

Reproductive and pod filling phases

Weather has considerable influence on different phenophases of groundnut, especially on pod filling phase. When irrigation was not a constraint for pod filling (IW/CPE ratio 1.0), number of days to pod filling was 13 days more for November sowings in first year, 12 and 4 days more for November 1 and November 16 sowings respectively than the latest sowings in second year, leading to extended duration of November sown crop during both the years (Table 2). Duration of phenological stages were longer when sown during November (Ntare *et al.*, 1993) and number of days to maturity was reduced with delayed sowings (Patra *et al.*, 1981).

The extended duration of pod filling phase and hence the total duration of November sown crop might be due to low minimum temperature (13.8 to 14.8°C) during pod filling phase as against minimum temperature of 20.4 to 21.1°C with January sowings. Decrease in growth rate due to low temperatures increased the duration of pod filling phase (Ghadekar, 1988). However, the low minimum temperatures during pod filling phase with increase in diurnal variation in temperatures of early sown crop increased the pod yields of groundnut, ranging from 1655 kg ha^{-1} to 2152 kg ha^{-1} than the lateset sowings (1208 kg ha^{-1} and 1308 kg ha^{-1} in 1994-95 and 1995-96 respectively).

Thus understanding the phenology of groundnut in relation to the prevailed temperature may help in taking appropriate agronomic decisions in groundnut production systems.

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