

Temperature Requirement on growth and yield of Groundnut (*Arachis hypogaea* L.) under Dry Western Zone of India

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Abstract

A field experiment was conducted in loamy sand soil during *kharif* season of 2009 and 2010. The experiment was laid out in split-plot design with three replications, assigning 32 treatments consisting of four sowing dates (20 April, 15 May, 9 June and 4 July) and two varieties (HNG 10 and TG 37A) as main-plot treatments and four fertility levels of nitrogen and phosphorus application (0, 20 N-40 P₂O₅, 30-60 P₂O₅ and 40 N-80 P₂O₅ kg ha⁻¹) as sub-plot treatments. The results showed that significantly higher CGR at 30-60 and 60-90 DAS was observed in HNG 10 variety. Further delays in sowing significantly reduce crop growth rate. However, growth rate in every sowing dates of TG 37A variety was observed statistically at par with each other. In semi-spreading HNG 10 variety was recorded higher pod, kernel, haulm and biological yield were observed at par with each other from 20 April to 9 June sowing. Maximum heat unit efficiency was observed on sowing date of 9 June. While the highest yields were recorded in TG 37A variety with 4 July sowing. Harvest index in both the varieties was observed significantly higher in 4 July sowing. All the fertility treatments produced significantly higher crop growth rate, Heat unit and yields. Application of 30 kg N-60 kg P₂O₅ ha⁻¹ significantly enhanced the crop growth, Heat unit and yield over 20 kg N-40 kg P₂O₅ ha⁻¹ but at par with 40 kg N-80 kg P₂O₅ ha⁻¹.

Key words Crop growth, Sowing date, Fertility levels, Heat unit, Yields

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26 INTRODUCTION

27 Groundnut is an important oil crop in India. Between 2011-2012, India could produce groundnut
28 of 6.94 mt [1]. In dry agricultural area, farmers have limited time for crop sowing, but in irregular
29 irrigation is one of the most important non- monetary inputs affecting yield of crops. Sowing time
30 of groundnut is well documented in other regions [13]. In Bikaner region, groundnut sowing is
31 under irrigated conditions. It was started two decades ago in the command area of Indra Gandhi
32 Nahar Pariyojana (IGNP) and later on it spread to tube well irrigated area of the region. At that
33 time, dust storms were common in the region with minimum vegetation during optimum sowing
34 time of May and June months leading to poor crop establishment due to which the farmers started
35 sowing of groundnut in early summer in the months of April and May for better crop establishment
36 with its harvesting in between October to November. This practice is still followed, despite
37 reduction in frequency of dust storms in the region. The productivity is restrained by drought
38 stress, the use of low levels of inputs by smallholders and marginal farmers in dry land areas, high
39 incidence of aberrant weather conditions. These research was done in two varieties of groundnut to
40 fine suitable sowing time to escape adverse situations.

41 Materials and Methods

42 **Experimental Site:** The experimental was conducted during *kharif* season of 2009 and
43 2010 at Agronomy Research Farm, College of Agriculture, Bikaner (Rajasthan) under hyper
44 arid condition, which is situated at a 28° 01'N latitude and 73 ° 22' E longitudes at an
45 altitude of 234.70 meters above mean sea level (*Arabian Sea*).

46 **Soil:** The soil of the experimental site was loamy sand and having 156.33 kg ha⁻¹ alkaline
47 permanganate oxidizable N[16], 16.05 kg ha⁻¹ available P [12], 221.0 kg ha⁻¹ 1 N ammonium
48 acetate exchangeable K [15] and 0.80% organic carbon [8] The pH of soil was 8.4 (1:2.5 soil and
49 water ratio). Field capacity, permanent wilting point and bulk density recorded were 8.4.0% (w/w),
50 1.1.83% (w/w) and 1.66 Mg m⁻³, respectively in 0-30 cm soil depth.

51 **Statistics:** The experiment was laid out in split-plot design with three replications, assigning 32
52 treatments consisting of four sowing dates (20 April, 15 May, 9 June and 4 July) and two varieties
53 (HNG 10 and TG 37A) as main plot treatments and four fertility levels of nitrogen and phosphorus
54 application (0, 20 N: 40 P₂O₅, 30 N: 60 P₂O₅ and 40 N: 80 P₂O₅ kg ha⁻¹) as sub-plots. All the data
55 obtained from groundnut for two consecutive years of trails were statistically analyzed using the *F*-
56 test [5]Critical difference (CD) values at *P*=0.05 were used for determine the significance of
57 differences between mean values of treatments.

58 **Results and Discussion**

59 ***Crop and weather***

60 Maximum rainfall of 51.50 mm and 21.00 mm were recorded in the month of July 2009 and
61 August 2010, respectively (Table 1). Highest temperature was observed in the month of May in
62 both the years. Growth and development of groundnut were affected by different uncontrollable
63 environmental conditions. Interaction effect was observed in different sowing environment and
64 varieties on thermal temperatures. The heat unit efficiency went on increasing from vegetative
65 growth to pod filling and physiological maturity of the crop. Among the sowing environment, heat
66 unit efficiency was found to be higher in 9 June sowing than all other three sowing environments
67 (Fig.1). Significantly higher heat unite efficiency was observed in HNG 10 variety compared with
68 TG 37A variety HNG 10 variety used most heat units to reach maturity in vegetative growth [9].
69 These results are also enclose agreement with the findings [6,11].

70 ***Temperature use efficiency***

71 Efficiency of utilization of temperature in terms of dry matter accumulation depends on crop type,
72 genetic factors and sowing time and has great practical application [11] Initiation as well as
73 duration of crop phenophases is an essential component of weather based dynamic crop growth
74 rate and yield simulation models. Crop phenology can be used to specify the most appropriate date
75 and time of specific development process. The duration of each phenophase determines the
76 accumulation and partitioning of dry matter in different organs reported that the duration of a

77 particular crop growth stages was directly related to temperature and this duration of particular
78 species could be predicted using the sum of daily air temperature [9].

79 ***Crop growth rate***

80 Results show that of tested varieties in the study, in HNG 10 variety higher crop growth rate was
81 observed than TG 37A variety (Fig.2), primarily due to the differences in the genetic constitution
82 and growth habit of these varieties as evidenced from the similar variation in crop growth rate of
83 these varieties [10]. The variable behaviour of these varieties could be explained in genetic
84 constitution and variation in growth habit of these varieties the similar interaction effect recorded
85 on heat unit efficiency of these varieties. HNG 10 is semi-spreading variety which seems to have
86 indeterminate growth habit the considerable. This variety sown early was exposed to longer
87 duration for vegetative growth due to its indeterminate growth habit. On the other hand, the variety
88 sown on later dates was exposed to shorter duration for vegetative growth and there for recorded
89 less crop growth at these dates. In contrast, the TG 37A variety was a Spanish bunch type and
90 probably seems to be a variety of short duration maturity and determinate growth habit. Thus, the
91 variation in growth parameters of the two varieties with variation in sowing dates resulted due to
92 interaction between genetic constitution of the varieties and growth factors like manures,
93 fertilizers, moisture availability *vis-a-vis* environmental factor like temperature, day length,
94 relative humidity, rainfall, wind velocity and biotic and abiotic factors which have a considerable
95 bearing on important plant functions such as photosynthesis, respiration, transpiration, nutrient and
96 water absorption *etc.* [11,14]

97 ***Yields***

98 HNG 10 variety was recorded higher and almost similar pod and kernel yields under the first three
99 sowing dates beginning from 20 April to 9 June (Table 3). Delayed sowing of this variety beyond 9
100 June on 4 July resulted in significant reduction in these yields. On the contrary, yield of TG 37A
101 variety progressively increased under later dates of sowing with the highest yields recorded under
102 the last sowing date of 4 July. Since this is a short duration variety of determinate growth habit, it
103 recorded the highest yields in the last date of sowing as this sowing date provided optimum

maturity period requirement to this variety. The early sowing dates provided very longer than optimum periods and harsh environments to this variety of determinate growth habit, these dates recorded significantly lower yields. Since the pod and kernel yields are cumulative function of the yield attributes, the variation in pod and kernel yields of these varieties as affected by sowing dates. These results are also in close agreement with the findings of [3,7].

Dates of sowing also had significant interaction effects with crop varieties on haulm and biological yields of groundnut (Table 3). The HNG 10 variety was recorded the highest haulm and biological yields when planted on the earliest sowing date of 20 April. Sowing of this variety on latter dates resulted in significant reduction with each delay in sowing with the lowest haulm yield of 46.74 q ha⁻¹ and biological yield of 81.18 q ha⁻¹. This could be explained due to the similar variation in the maturity periods made available to this variety for overall growth. Thus the variation in the haulm yield recorded under different dates of sowing with the minimum haulm yield recorded in last date of sowing. The variety HNG 10 also recorded almost similar variation in biological yield as that observed in haulm yield due to the effect of sowing dates. Since biological yield was a cumulative function of haulm and pod yields, the variation in biological yield with sowing dates could be mainly attributed to the haulm yield with minor contribution from the pod yield, as the pod yield of this variety was almost similar in the three initial dates with reduction only under the last date of sowing. Similarly TG 37A variety was recorded significant reduction in haulm yield with every delay in sowing but the reduction was found to be considerably lower than that recorded in HNG 10 variety due to probably to its determinate growth habit. This type of growth habit did not allow the variety to widen the variation in haulm yield with variation in maturity periods as affected by sowing dates. In contrast to haulm yield, the TG 37A variety was recorded a reverse trend in pod yield as affected by sowing dates with the lowest yield recorded under the first date of 20 April sowing and the highest yield recorded under the last date of 4 July sowing. Since the biological yield is a cumulative function of haulm and pod yields, TG 37A variety was recorded almost similar biological yields with minor variations under various sowing dates due to certainly to

opposing trends in haulm and pod yields recorded as affected by sowing dates. Thus, the cumulative effect of the variation in growth and yield attributes of the two varieties recorded with variation in sowing dates resulted variation in various yields of groundnut namely pod, kernel, oil, haulm and biological yields as a result of interaction effect between genetic constitution of the varieties and environmental factors, These results was also in close agreement with the findings [4, 10].

Effect of fertility levels

Application of nitrogen and phosphorus up to 30 kg N-60 kg P₂O₅ ha⁻¹ was observed higher pod yield, kernel yield, haulm yield biological yield (Table 2) over control and 20 kg N-40 kg P₂O₅ ha⁻¹. Further increase the fertility level up 40 kg N-80 kg P₂O₅ ha⁻¹ was statistically at par with 30 kg N-60 kg P₂O₅ ha⁻¹. Early and plentiful availability of nitrogen and phosphorus to plants favourably influenced the kernel development and kernel size, which ultimately resulted in, increased pod and seed index and shelling percentage. Improved overall growth and profuse branching due to nitrogen and phosphorus fertilization led to increased net photosynthesis on one hand and greater mobilization of photosynthates towards reproductive structures on the other might have increased the yield attributes significantly result was agreement with those of [2].

Conclusion

Field study was recommended suitable sowing date of HNG 10 variety around 9 June and TG 37A variety for 4 July in western dry zone of India. Application of fertilizing dose recommended 30 kg N-60 kg P₂O₅ ha⁻¹ for better growth and higher productivity of groundnut. However, groundnut crop use maximum temperature in June moth for better growth.

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Table 1 Temperature and rainfall data during growing seasons of groundnut (2009-2010)

Months	Temperature (°C)				Rainfall			
	Maximum	Minimum	Maximum	Minimum	Total Rainfall (mm)	Rainy days	Total Rainfall (mm)	Rainy days
	2009	2009	2010	2010	2009	2009	2010	2010
April	39.70	24.65	42.15	28.25	0.00	0.00	0.00	0.00
May	43.75	28.95	43.00	28.63	0.50	0.00	0.88	0.25
June	41.58	27.26	41.12	29.44	11.42	0.80	15.10	0.60
July	38.38	27.23	38.18	29.40	51.50	2.00	19.33	0.75
August	37.78	28.32	36.30	27.44	9.00	0.60	21.00	1.40
September	38.90	25.65	34.95	24.50	4.45	0.75	27.00	0.50
October	36.50	22.40	36.35	22.48	0.00	0.00	0.00	0.00
November	33.70	17.85	31.80	16.30	0.00	0.00	0.00	0.00
Monthly average	38.79	25.29	37.98	25.81	9.61	0.52	10.41	0.44

Table 2 Effect of different growing environments and fertility levels on yields and harvest index of groundnut (Pooled data of 2 years)

Treatment	Pod yield (q ha⁻¹)	Kernel yield (q ha⁻¹)	Haulm yield (q ha⁻¹)	Biological yield (q ha⁻¹)	Harvest index (%)
Date of sowing					
20 April	29.71	18.91	62.27	91.98	32.53
15 May	30.84	19.62	53.32	84.16	38.00
09 June	32.31	21.00	49.42	81.73	40.86
04 July	33.44	21.25	40.90	74.34	45.53
CD (<i>P</i> =0.05)	1.62	1.07	1.81	1.93	1.57
Varieties					
HNG 10	36.87	23.27	63.26	100.13	37.64
TG 37A	26.28	17.12	39.69	65.97	40.82
CD (<i>P</i> =0.05)	1.15	0.76	1.28	1.36	1.11
Fertility levels					
Control	28.04	17.42	47.11	75.15	38.35
20kgN-40 kg P ₂ O ₅ /ha	32.00	20.35	50.00	82.00	40.22
30kgN-60 kg P ₂ O ₅ /ha	33.53	21.70	53.65	87.18	39.78
40kgN-80 kg P ₂ O ₅ /ha	32.74	21.31	55.15	87.89	38.57
CD (<i>P</i> =0.05)	1.05	0.70	1.58	1.91	1.14

Table 3 Interaction effect of different growing environments and varieties on yields of groundnut (Pooled data of 2 years)

Treatment	Pod yield (q ha ⁻¹)			Kernel yield (q ha ⁻¹)			Haulm yield (q ha ⁻¹)			Biological yield (q ha ⁻¹)			Harvest index (%)		
	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean
Date of sowing															
20 April	37.73	21.70	29.71	23.65	14.16	18.91	78.30	46.23	62.27	116.03	67.93	91.98	32.60	32.45	32.53
15 May	37.43	24.26	30.84	23.46	15.78	19.62	65.63	41.01	53.32	103.05	65.27	84.16	37.02	38.99	38.00
09 June	37.89	26.73	32.31	24.44	17.56	21.00	62.38	36.46	49.42	100.27	63.19	81.73	38.61	43.12	40.86
04 July	34.44	32.44	33.44	21.51	20.99	21.25	46.74	35.06	40.90	81.18	67.51	74.34	42.33	48.73	45.53
Mean	36.87	26.28		23.27	17.12		63.26	39.69		100.13	65.97		37.64	40.82	
CD (<i>P</i> =0.05)		2.30		1.52			2.56			2.73			2.22		

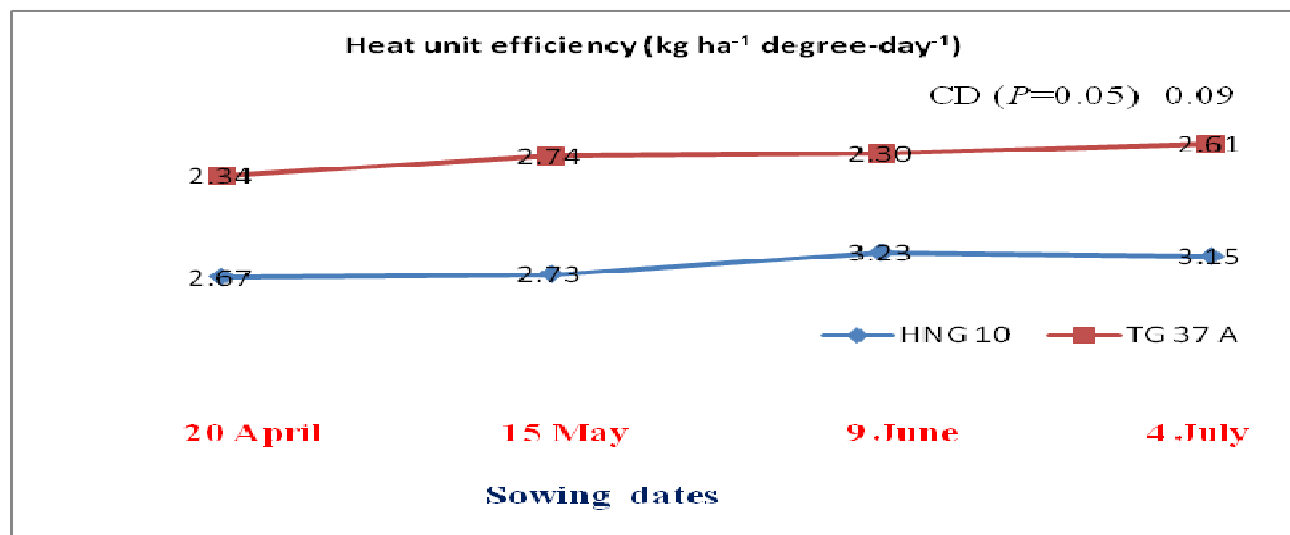


Fig. 1 Effect of sowing enviroments on heat unit efficiency of groundnut varieties (Pooled data of 2 years)

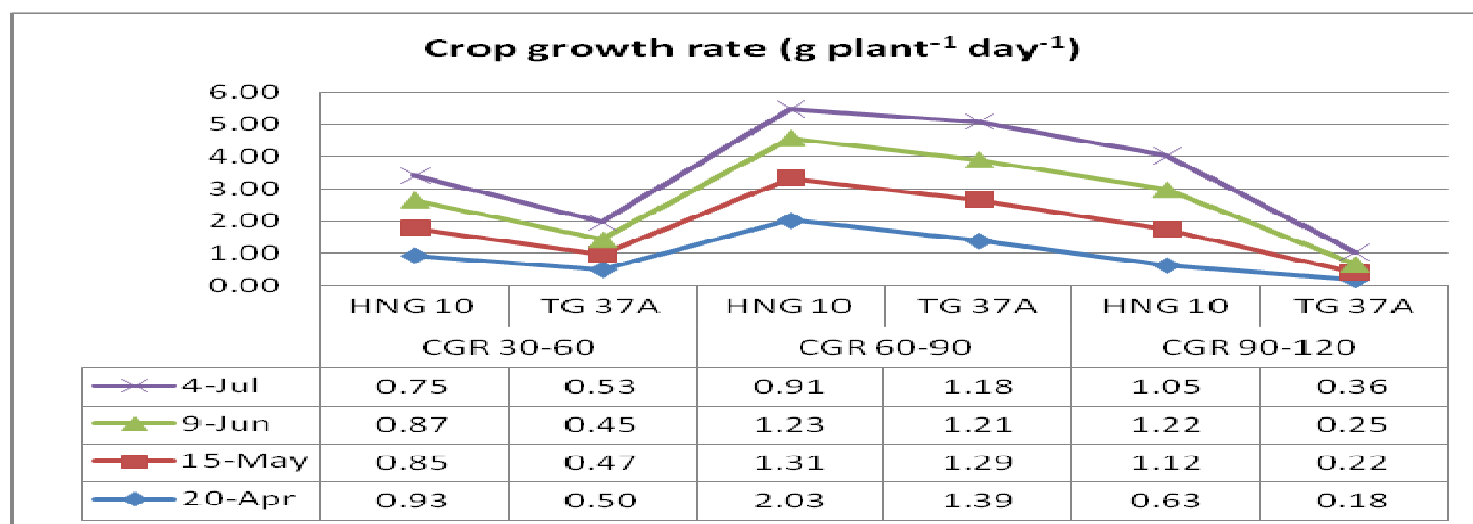


Fig. 2 Effect of sowing enviroments on crop growth rate of groundnut varieties cgrowth rate (Pooled data of 2 years)