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RESEARCH PAPER

Effect of temperature regimes on yield and yield components of groundnut genotypes (*Arachis hypogaea* L.)

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Abstract: Field experiment was under taken during late *rabi /summer,* 2019-20 with two temperature regimes (dates of sowing, 49th and 03rdSMW)and 23 groundnut genotypes (including 11 RIL populations) under factorial randomized block design at University of Agricultural Sciences, Dharwad. The results revealed that total biomass accumulation (42.22 g), number of pods per plant (19.18), pod weight per plant (16.82 g) and seed weight per plant (16.82 g) were remarkably higher under 49th SMW, while under 3rd SMW reduction in 32.6, 35.2, 37.75 and 36.8% was observed, respectively. The genotypes RIL-118 and RIL-99 recorded maximum value of above yield traits, whereas the genotype R-2001-2 and KADIRI-9 maintained the value of yield parameters under both temperature regimes.The total dry matter was positively correlated with pod number (0.538**), seed weight (0.592**) and pod weight (0.611**) under normal date of sowing, while no correlation was observed under delayed sown conditions.

Key words: Groundnut, Pod number, Pod weight, Seed weight, Temperature regimes, Total dry matter

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop grown largely under rain fed conditions (Jun/Jul - Oct/Nov) and with high oil (45-50%) as well as protein (25-28%) content. Groundnut seeds are rich in vitamins and minerals and thus an outstanding cash crop for domestic markets and foreign exchange. Moreover, it is classified as both a grain legume and an oil seed crop, which plays a major role in bridging the country's vegetable oil deficit. For sustainable groundnut production, temperature stress is one of the major threats. With the present trends of global warming, rise in mean temperature of 2^{o}C to 3^{o}C is predicted, which will diminish groundnut yield in India by 23 to 36 per cent (Hundal and Kaur, 1996).

Being a C_3 crop, groundnut growth and development is temperature dependent.The base temperature of peanut for first flower appearance is 10.8°C and the optimum temperature for growth and development was between 28^{o}C to 30^{o}C. The mean optimal air temperature range for vegetative growth of peanut is between 25 and 30^{o} C, which is warmer than the optimum range for reproductive growth, which is between 22 and 24^{o} C High temperature (>35°C) slows down plant growth and ultimately cause reduction in the yield. To meet out the increasing global demands and reduce the serious economic loss due to abiotic stress, climate resilient cultivars, which maintain the yield potential even in adverse conditions, should be developed. In the present study, reproductive parameters of groundnut were evaluated with respect to temperature regimes, genotypes and their interactions at different growth stages, which will be helpful in identification of temperature resilient groundnut genotype.

Material and methods

The field experiment was laid out in plot No. 125 of E-block of Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad. The treatment consisted of 12 genotypes (DH-86, DH-216, GBPD-4, GPBD-6, TMV-2, JL-24, G-2-52, ICGV 86031, TAG-24, KADIRI-9, R-2001-2, 55-437) and 11 RIL (Recombinant Inbreed Lines) populations and two different dates of sowing *viz.*, D_1: 49th SMW and D_2: 3rd SMW (the range of temperature as presented below in table) laid in a factorial randomised block design. From the mapping population of 250 RILs in F_{10} generation segregating for high-temperature tolerance derived from crossing JL 24 (heat sensitive) and 55-437 (heat tolerant) genotypes of groundnut, the 11 RIL (Recombinant Inbreed Lines) populations (RIL-21, RIL-59, RIL-77, RIL-81, RIL-96, RIL-99, RIL-110, RIL-118, RIL-143, RIL-193,RIL-237) were selected on the basis of temperature tolerance. The seeds of 11 RIL populations were obtained from IABT, UAS, Dharwad.

Five plants tagged earlier for recording various morphological observations were harvested at physiological maturity to record the data on the following yield and yield components. The observed yield and yield components were number of pods per plant, number of seeds per plant, pod weight, seed weight, test weight and harvest index. The number of pods, pod weight and seed weight obtained from five earlier tagged plants was recorded and averaged.Test weight was calculated by measuring weight of 100 groundnut seeds. The harvest index of groundnut was worked out using the method of Donald (1962).

Temperature regimes	Temperature			Relative humidity			Rainfall
	Max	Min	Range	Max	Min	Range	
D1 (49th - 15th SMW)	31.66	17.44	14.200	71.70	42.87	28.82	0.18
D2 (03rd - 19th SMW)	33.70	19.05	14.7	68.84	38.56	29.67	0.50

Results and discussion

Accumulation of dry matter and its partitioning towards the various sinks were the major trait involved in increasing productivity of a crop. Heat stress during beginning of flowering till maturity potentially retard total dry matter production and value of other yield components (Craufurd *et al*., 2003). Prasad *et al.* (2003) established that temperatures above 36°C /26°C (31°C) slows down pegging and podding (pod development) in groundnut. Thus, high temperatures hasten up the process of flowering, but have deleterious effect on fruit set.

The data on total dry matter, number of pods, pod weight and seed weight per plant differed significantly under dates of sowing, genotypes and their interactions (Table 1 & Fig 1, 2). Shravanakumar *et al*. (2014) and Mukesh (2015) observed reduced pod and seed weight under delayed sowing conditions. This confirms the results of present study where, significantly higher total dry matter (42.22 g plant^{-1}), number of pods per plant (19.18), pod weight per plant (16.82 g plant^{-1}) and seed weight per plant (9.52 g plant^{-1}) was recorded under D_1 temperature regime (49th SMW). On considering the genotypes, RIL-118 (25.44, 21.02 g plant^{-1}, 11.83 g plant^{-1}, respectively) and GPBD-6 (3.40, 9.49 g plant^{-1}, 4.90g plant^{-1}) recorded maximum and minimum number of pods per plant, pod weight per plant and seed weight per plant respectively. Similarly, RIL-118 (48.41g plant^{-1}) recorded the highest total dry matter and the lowest was observed in TAG-24 (29.64 g plant^{-1}).

Likewise among the interaction effects, RIL-118 had shown significantly higher mean total dry matter (62.58 g plant^{-1}), number of pods per plant (34.38), pod weight per plant (29.03 g plant^{-1}) and seed weight per plant (15.66g plant^{-1}) under D_1 temperature regime,while the least mean number of pods per plant (3.40), pod weight per plant (3.97g plant^{-1}) and seed weight

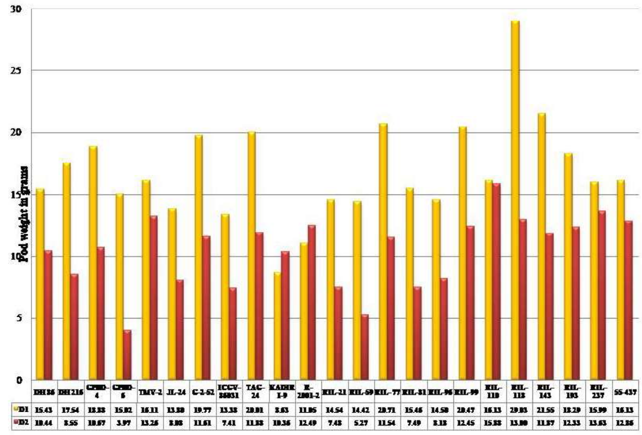

Fig 1. Effect of temperature regimes on pod weight of groundnut genotypes

Table 1. Effect of temperature regimes on number of pods per plant, test weight (g), harvest index (%) and total dry matter (g/plant) of groundnut genotypes

	Number of pods per plant			Test weight			Total dry matter			Harvest index		
Genotypes	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean
DH 86	15.45^{b-g}	10.90^{c-g}	13.18^{b-g}	32.70^{b-d}	44.40^{a-c}	38.55^{ab}	43.64^{a-d}	46.03^{a-d}	44.83^{ab}	21.14^{a-c}	18.93^{a-c}	20.04^{ab}
DH 216	21.40^{a-e}	10.70^{c-g}	16.05^{b-f}	34.60^{a-d}	34.80^{a-d}	34.70^{ab}	38.16^{a-d}	22.16^{cd}	30.16^{b}	26.35^{a-c}	22.21^{a-c}	24.28^{ab}
GPBD-4	21.20^{a-f}	14.90^{b-g}	18.05^{a-e}	36.05^{a-d}	28.50^{cd}	32.28^{b}	40.67^{a-d}	25.24^{b-d}	32.96^{b}	26.36^{a-c}	21.66^{a-c}	24.01^{ab}
GPBD-6	11.48^{c-g}	3.40^{g}	7.44^{g}	43.60^{a-c}	42.95^{a-c}	43.28^{a}	51.39^{ab}	28.91^{b-d}	40.15^{ab}	15.18^{a-c}	7.45^{c}	11.31^{b}
TMV-2	17.90^{b-f}	15.80^{b-g}	16.85^{b-f}	34.80^{a-d}	35.30^{a-d}	35.05^{ab}	43.47^{a-d}	28.93^{b-d}	36.20^{ab}	22.31^{a-c}	26.81^{a-c}	24.56^{ab}
JL-24	16.20 $^{b-g}$	10.20^{d-g}	13.20^{b-g}	37.20^{a-d}	37.80^{a-d}	37.50^{ab}	46.84^{a-d}	21.57^{d}	34.21^{ab}	20.08^{a-c}	22.80^{a-c}	21.44^{ab}
G-2-52	21.70^{a-e}	14.90^{b-g}	18.30^{a-e}	41.10^{a-d}	30.60^{b-d}	35.85^{ab}	39.46^{a-d}	29.45^{b-d}	34.46^{ab}	33.28^{ab}	15.76^{a-c}	24.52^{ab}
ICGV-86031	11.68 $^{b-g}$	8.10^{c-g}	9.89^{fg}	36.75^{a-d}	35.40^{a-d}	36.08^{ab}	41.44^{a-d}	20.87^{d}	31.15^{b}	15.18^{a-c}	15.33^{a-c}	15.26^{ab}
TAG-24	16.50 $^{b-g}$	13.70^{b-g}	15.10^{b-g}	49.30^{a}	37.55^{a-d}	43.43^{a}	35.74^{b-d}	23.53^{cd}	29.64^{b}	20.91^{a-c}	30.72^{a-c}	25.82^{a}
KADIRI-9	11.40^{c-g}	12.50^{b-g}	11.95^{c-g}	33.40^{a-d}	47.00^{ab}	40.20^{ab}	32.28^{b-d}	28.55^{b-d}	30.41^{b}	10.82^{a-c}	23.44^{a-c}	17.13^{ab}
R-2001-2	10.90^{c-g}	11.60^{c-g}	11.25^{d-g}	26.35^{d}	46.50^{ab}	36.43^{ab}	29.28^{b-d}	29.70^{b-d}	29.49^{b}	21.27^{a-c}	28.55^{a-c}	24.91^{ab}
RIL-21	18.70^{b-f}	8.80^{c-g}	13.75^{b-g}	28.90^{cd}	38.35^{a-d}	33.63^{b}	38.06^{a-d}	28.55^{b-d}	33.31^{ab}	21.76^{a-c}	11.83^{bc}	16.79^{ab}
RIL-59	14.50 $^{b-g}$	7.40^{fg}	10.95^{c-g}	37.10^{a-d}	38.55^{a-d}	37.83^{ab}	42.42^{a-d}	24.72^{b-d}	33.57^{ab}	24.68^{a-c}	12.80^{bc}	18.74^{ab}
RIL- 77	24.20^{a-c}	13.60^{b-g}	18.90^{a-e}	35.55^{a-d}	38.80^{a-d}	37.18^{ab}	46.73^{a-d}	30.39^{b-d}	38.56^{ab}	26.78^{a-c}	25.94^{a-c}	26.36^{a}
RIL-81	18.40^{b-f}	11.40^{c-g}	14.90^{b-g}	36.50^{a-d}	38.40^{a-d}	37.45^{ab}	48.85^{a-c}	36.68^{a-d}	42.77^{ab}	18.06^{a-c}	12.87^{bc}	15.47^{ab}
RIL-96	17.70^{b-f}	8.70^{c-g}	13.20^{b-g}	35.80^{a-d}	32.30^{b-d}	34.05^{ab}	37.63^{a-d}	27.69^{b-d}	32.66^{b}	27.01^{a-c}	16.57^{a-c}	21.79^{ab}
RIL-99	25.60^{ab}	15.40^{b-g}	20.50^{ab}	31.10^{b-d}	34.45^{a-d}	32.78^{b}	45.53^{a-d}	34.16^{b-d}	39.85^{ab}	24.16^{a-c}	19.77^{a-c}	21.96^{ab}
RIL-110	20.40^{b-f}	18.10^{b-f}	19.25^{a-d}	29.95^{cd}	34.30^{a-d}	32.13^{b}	39.23^{a-d}	25.52^{b-d}	32.38^{b}	20.86^{a-c}	37.91^{a}	29.38^{a}
RIL-118	34.48^{a}	16.40^{b-g}	25.44^{a}	34.95^{a-d}	31.90^{b-d}	33.43^{b}	62.58^{a}	34.24^{b-d}	48.41^{a}	25.04^{a-c}	21.28^{a-c}	23.16^{ab}
RIL-143	23.50^{a-d}	13.30^{b-g}	18.40^{a-e}	31.40^{b-d}	39.90^{a-d}	35.65^{ab}	38.15^{a-d}	27.82^{b-d}	32.98^{b}	24.31^{a-c}	25.28^{a-c}	24.80^{ab}
RIL-193	22.90^{a-d}	16.20^{b-g}	19.55^{a-c}	28.65^{cd}	34.90^{a-d}	31.78^{b}	42.85^{a-d}	28.16^{b-d}	35.51^{ab}	26.37^{a-c}	25.11^{a-c}	25.74^{a}
RIL-237	22.90^{a-d}	16.30^{b-g}	19.60^{a-c}	36.45^{a-d}	37.40^{a-d}	36.93^{ab}	42.16^{a-d}	28.10^{b-d}	35.13^{ab}	25.12^{a-c}	26.80^{a-c}	25.96^{a}
55-437	22.00^{a-e}	13.70^{b-g}	17.85^{a-e}	31.80^{b-d}	32.10^{b-d}	31.95^{b}	44.41^{a-d}	23.89^{cd}	34.15^{ab}	22.75^{a-c}	17.48^{a-c}	20.11^{ab}
Mean	19.18^{a}	12.43^{b}		34.96	37.05		42.22^{a}	28.47^{b}		22.6	21.19	
S.Em±	L.S.D. @5%		S.Em±	L.S.D. @5%		S.Em±	L.S.D. @ 5%		S.Em±	L.S.D. @5%		
D	0.84	2.39	0.99	NS	1.6	4.57	1.48	NS				
G	2.84	8.1	3.35	8.02	5.44	13.02	5.03	12.05				
DXG	4.02	11.77	4.74	13.89	7.69	22.55	7.12	20.87				

Note: DMRT: Values in the column followed by the same letter do not differ significantly (NS).

D_1: 04-12-2019 to 11-04-2020 *D_2: 17-01-2020 to 12-05-2020*

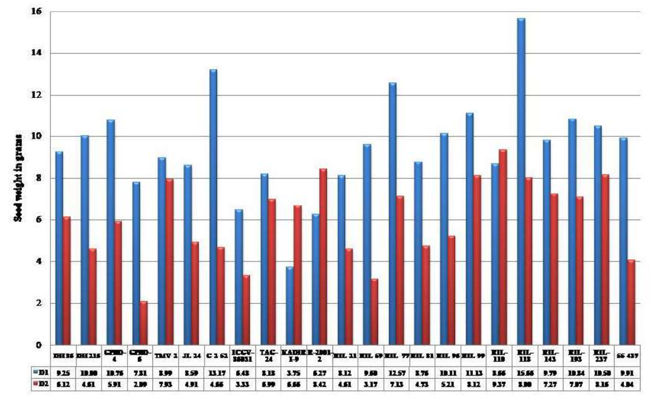

Fig 2. Effect of temperature regimes on seed weight of groundnut genotypes

Table 2. Correlation between various reproductive and yield parameters of groundnut genotypes for D1and D2 dates of sowing and pooled

		1	2	3	4	5
1	Number of pods per plant	1.000				
2	Pod weight / plant	0.874*	1.000			
3	Seed weight / pant	0.871**	0.865**	1.000		
4	Test weight	-0.157	0.162	0.069	1.000	
5	Total dry matter	0.538**	0.592**	0.611**	0.189	1.000
6	Harvest index.	0.622**	0.571**	0.803**	-0.039	0.066
1	Number of pods per plant	1.000				
2	Pod weight / plant	0.931**	1.000			
3	Seed weight / pant	0.808**	0.864**	1.000		
4	Test weight	-0.404	-0.235	0.025	1.000	
5	Total dry matter	0.107	0.114	0.248	0.308	1.000
6	Harvest index.	0.720**	0.803**	0.843**	0.005	-0.155
1	Number of pods per plant	1.000				
2	Pod weight / plant	0.920**	1.000			
3	Seed weight / pant	0.910**	0.920**	1.000		
4	Test weight	-0.590**	-0.410	-0.470*	1.000	
5	Total dry matter	0.340	0.350	0.420*	-0.010	1.000
6	Harvest index.	0.670**	0.690**	0.740**	-0.390	-0.210

**Correlation is significant at the 0.01 level (2-tailed).
n=8 *Correlation is significant at the 0.05 level (2-tailed).

per plant (2.09 g plant^{-1}) was found in GPBD-6 under D_2 temperature regime (3rd SMW) whereas, ICGV-86031 (20.87 g plant^{-1}) recorded minimal total dry matter under D_2 temperature regime (3rdSMW).The above observations was in conformity with the results of numerous works *viz.,* Prasad *et al*. (2000) and Kakani *et al*. (2015) where they observed longer reproductive phase and higher value of yield components under normal sowing conditions on comparing with delayed sowing dates. A significant positive correlation (Table 2) observed between total dry matter with pod number (0.538**), seed weight (0.592**) and pod weight (0.611**) under normal date of sowing, which indicates that better assimilate partitioning could be achieved with increased biomass accumulation.

There was no significant difference observed in the data on test weight and harvest index with respect to dates of sowing. Among genotypes TAG-24 (43.43 g) was noticed to have significantly higher test weight and the lowest test weight was found in RIL-193 (31.78 g). Moreover, among the interaction effects of dates of sowing and genotypes, TAG-24 (49.30 g) under 49th SMW (D_1 temperature regime) was measured maximum test weight whereas, R-2001-2 was measured significantly minimum test weight (26.35) under 49th SMW (D_1 temperature regime). The genotype RIL-110 (29.38) recorded maximum mean harvest index, which was on par with TAG-24, RIL-77, RIL-193 and RIL-237. Meanwhile, the minimum harvest index was spotted in GPBD-6 (11.31). Eventually, among the interaction effects, RIL-110 (37.91) was found to have significantly the highest harvest index under D_2date of sowing, whereas GPBD-6 (7.45) under D_2 date of sowing recorded significantly the lowest harvest index. The correlation studies estimated that, the values of harvest index was correlated positively with pod number (0.670**), seed weight (0.690**) and pod weight (0.740**) under both temperature regimes.

Thus, the data obtained on yield parameters clearly indicates that higher dry matter accumulation, number of pods, pod weight and seed weight per plant was found under D_1 temperature regime where the temperature was in optimum level and during the late sown elevated temperature conditions total dry matter was reduced. This was in conformity with observations of Asha (2016) and Dash (2017). Average rise in temperature of about 3.5^{o}C was observed under delayed sowing conditions, which significantly reduced all yield traits. Furthermore, significant damage to the reproductive system also contributed in reduction of yield components.

The genotype RIL-118 recorded higher amount of dry matter accumulation along with higher number of pods, pod weight and seed weight per plant. However, there was highly significant variation found between value of RIL-118 at D_1 and D_2 date of sowing in case of total dry matter, number of pods, pod weight and seed weight per plant. Conversely, the genotype R-2001-2 showed no variation among the two temperature regimes and maintained its total dry matter even under increased temperature and similarly no significant variation was shown by R-2001-2 regarding number of pods and pod weight between the two dates of sowing.The genotype, which is capable of maintaining its biomass among various temperature regimes should be preferred over the genotype, which shows higher mean value of total dry matter as far as the heat stress tolerance is concerned. Eventually, it was understood that by improving accumulation of biomass, one can improve most of the other yield parameters like pod number, pod weight, seed weight and ultimately the harvest index. By improving the harvest index crop productivity can be improved.

Conclusion

Delayed sowing resulted in a mean increase in ambient temperature of approximately 3.5°C, leading to terminal heat stress, which significantly reduced total dry matter accumulationand grain yield. Among the genotypes evaluated, RIL-118 exhibited superior performance for key yield-determining traitsin ambient conditions while, R-2001-2 demonstrated greater yield component stability across sowing dates, suggesting improved phenological plasticity and enhanced resilience under induced thermal stress.

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