Andhra Pradesh J Agril. Sci : 1(2): 58-61, 2015

IDENTIFICATION OF GROUNDNUT GENOTYPES FOR HEAT TOLERANCE AND HIGH YIELD FOR EARLY KHARIF SITUATION

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ABSTRACT

Field experiment was conducted at Regional Agricultural Research Station, Tirupati during early *kharif* 2013 with 16 pre release and released groundnut genotypes. Heat stress tolerance of these genotypes across the important growth phenophases were measured using reliable traits *viz.,* Relative injury to the cell membranes and Chlorophyll Stability Index. Among the pre release genotypes, TCGS-1375 recorded high CSI, moderate RI and high pod yield. TCGS-1375 possess high heat stress tolerance and high yield and hence farmers can grow this cultivar and is suitable for early *kharif* situation. Other genotypes, TCGS-1350, TCGS-1173, TCGS-1349, TCGS-1157 possess heat stress tolerance with moderate yields. These genotypes can be used as donor source in resistant breeding programmes.

KEY WORDS: Early *kharif*, Groundnut, Heat stress tolerance

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the important oilseed crop grown in India, which accounts for 45% of total area under oilseeds and 55% of total oilseed production. Though area and production of groundnut in India is high, average productivity is relatively low as groundnut is mostly grown under rainfed condition. Because of high productivity under assured irrigation, groundnut cultivation in summer season is gaining popularity (Patel *et al*., 2008). In Southern zone of Andhra Pradesh area under early *kharif* is increasing year by year. The early crop growth and flowering suffered due to high temperatures, low humidity, however genotypic variability exists in tolerating this adverse situation.

Heat stress due to high ambient temperatures is a serious threat to crop production worldwide (Hall, 2001). High temperature is often accompanied by drought stress under field conditions. Heat can be one of the major abiotic stresses that adversely affect crop production worldwide at different stages of development. High temperature causes irreversible damage to plant function and development.

Breeding of heat tolerant genotypes in crop species is therefore necessary. This requires sources of heat tolerance to be identified, an understanding of the mechanisms of heat tolerance and screening methods to rapidly measure tolerance to be produced.

Although several plant processes are more sensitive to heat, plant adaptation to high temperature essentially requires a cell membrane system that remains functional during heat stress (Raison, 1980). Hence the present study was taken up to study the identification of groundnut genotypes with heat stress tolerance for early *Kharif*.

MATERIAL AND METHODS

The present experiment was conducted during early *kharif* 2013 at Regional Agricultural Research Station, Tirupati. The experiment was laid out in a Randomized Block Design (RBD) with fourteen pre release and two released groundnut genotypes replicated thrice. The soil was sandy loam in texture, neutral in soil reaction, medium in organic carbon and available nitrogen, medium in available phosphorus and potassium. Recommended dose of fertilizers were applied. Prophylactic measures were taken for protecting the crop from pest and diseases. From sowing (May 25th) to 40 DAS (June 30th) crop was exposed to high temperature ranges from 38°C to 42°C. Mean evaporation from sowing to 40 DAS was also high and crop exposed to tissue water stress. The leaf samples were collected at two stages of crop growth *viz*., 30 and 60

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days after sowing for computing the relative injury and chlorophyll stability index. Cell membrane integrity is tested by exposing leaves to high temperature and computing relative injury to the membranes in terms of electrolytes leakage. Relative injury per cent was measured using third leaf from top of respective genotypes. The method used for measuring membrane damage was similar to the method given by Leopald *et al.* (1981). Per cent leakage (%) = $\frac{Ia}{Fa} \times 100$ (where, Ia: Initial absorbance, Fa: Final absorbance). Chlorophyll stability index CSI (%) was measured using third leaf from top of respective groundnut genotypes. Fresh leaf sample (0.1 g) was collected from the selected groundnut genotypes and placed in a 100 ml flask and heated it in a water bath for 60 min at 65°C. 10 ml of DMSO solution was added to treated and untreated samples. Respective check samples were also maintained without imposing heat treatment. Both treated and untreated conical flasks were kept for overnight and the concentration of total chlorophyll is quantified by reading the optical density at 663 nm and 645 nm.

Total Chl mg/g = 20.02 (D645) + 8.02 (D663) X V/ 1000 x W.

The CSI of the leaf sample was calculated using the following formula

$$CSI\% = \frac{\text{Total chlorophyll of the heated sample}}{\text{Total chlorophyll of unheated sample}} \times 100$$

RESULTS AND DISCUSSION

The results of the study indicated that genotypic variability existed between 16 groundnut genotypes for Relative injury. Mean genotypic variability for Relative injury (10.08 to 17.78%) and Chlorophyll Stability Index (32.25 to 69.75%) was observed during the crop growth, which denotes usefulness of these traits for screening groundnut genotypes for high heat stress tolerance (Table 1). Such genotypic variations in relative membrane injury were also reported in sorghum (Sullivan and Ross, 1979), blackgram (Sudhakar *et al.*, 2006) and groundnut (Pranusha *et al.*, 2012).

Relative membrane injury

Data presented in Table 1 revealed that relative injury values were high at 30 DAS compared to 60 DAS, as the crop suffers high temperature stress before 40 DAS. Significant differences in relative injury values were recorded between genotypes in both stages of crop growth. At flowering stage, among the pre release cultivars TCGS-1173 recorded low RI of 9.97 per cent compared to other genotypes. Cultivars, TCGS-1350 (11.16%) and Check, Narayani (10.70%) also recorded low RI values. Other cultivars TCGS-1360, TCGS-1323, TCGS-1375 and TCGS-1349 also recorded moderate RI values. Hence these genotypes had moderate tolerance for high temperature.

Thermostability of plasmamembranes can be considered important for detriment of heat tolerance (Talwar *et al.*, 1999). Hence measuring cell membrane thermostability in terms of relative injury percentage was a useful trait in screening genotypes for heat stress tolerance. It was reported that relative injury percentage could be useful trait in screening genotypes for thermostability at high temperatures in groundnut (Babitha *et al.*, 2006) and blackgram (Sudhakar *et al.*, 2006).

Chlorophyll stability index

The chlorophyll stability index is an indication of the stress tolerance capacity of plants. This leads to increased photosynthetic rate, more drymatter production and higher productivity. Hence, a high CSI value means that the temperature stress did not have much effect on chlorophyll content of plants.

Among the pre release genotypes, TCGS-1375, TCGS-1157 recorded significantly higher CSI compared to checks and other entries at two stages of crop growth (Table 1). These genotypes are considered to be temperature tolerant types.

The data on pod yield revealed that the genotype TCGS-1375 recorded high CSI (62%), moderate RI (11.73%) and high pod yield (3961.53 Kg ha^{-1}) (Table 2). TCGS-1375 possesses high heat stress tolerance and high yield and hence farmers can grow this cultivar and is suitable for early *kharif* situation. Other genotypes TCGS-1350, TCGS-1173, TCGS-1349, TCGS-1157 possess heat stress tolerance with moderate yields. These genotypes can be used as donor source in resistant breeding programmes.

Table 1. Relative injury (%) and chlorophyll stability index (%) of groundnut genotypes grown during early *kharif*, 2013

S. No.	Genotypes	Relative injury (%)		Chlorophyll stability index (%)	
		30 DAS	60 DAS	30 DAS	60 DAS
1.	TCGS-1330	15.27	13.30	70.00	40.00
2.	TCGS-1323	13.49	11.96	36.00	28.50
3.	TCGS-1342	17.26	13.02	70.00	45.00
4.	TCGS-1343	14.28	12.02	77.00	43.00
5.	TCGS-1346	16.37	13.42	66.00	36.00
6.	TCGS-1349	14.48	8.46	39.00	34.00
7.	TCGS-1350	11.16	9.81	59.76	41.50
8.	TCGS-1374	13.29	12.50	65.50	39.00
9.	TCGS-1375	13.50	11.73	69.00	62.00
10.	TCGS-1360	12.99	12.46	44.09	42.00
11.	TCGS-1073	14.94	14.38	65.02	48.50
12.	TCGS-1157	15.86	14.44	80.00	59.50
13.	TCGS-1157A	19.46	16.10	82.87	52.00
14.	TCGS-1173	9.97	13.93	60.56	35.00
15.	DHARANI	17.20	12.45	64.00	57.00
16.	NARAYANI	10.70	9.46	62.94	52.50
	Mean	**14.39**	**12.46**	**63.23**	**44.72**
	CD (P=0.05)	**4.250**	**2.796**	**9.292**	**5.128**
	SEm ±	**1.349**	**0.888**	**2.950**	**1.627**

Table 2. Yield and yield components of groundnut genotypes grown during early *kharif*, 2013

S.No	Genotype	Pod yield ($Kg\ ha^{-1}$)	Hundred pod weight (g)	Hundred kernel weight (g)
1.	TCGS-1330	4210.44	98.01	45.56
2.	TCGS-1323	3366.65	61.45	27.26
3.	TCGS-1342	3785.43	114.11	45.91
4.	TCGS-1343	3333.98	104.70	39.96
5.	TCGS-1346	3899.65	68.35	28.09
6.	TCGS-1349	3844.71	58.00	27.73
7.	TCGS-1350	3620.24	59.61	26.69
8.	TCGS-1374	2959.32	115.99	39.77
9.	TCGS-1375	3961.53	101.45	45.39
10.	TCGS-1360	2339.13	72.03	31.81
11.	TCGS-1073	3535.48	91.24	41.29
12.	TCGS-1157	3300.09	94.47	42.37
13.	TCGS-1157A	3414.32	105.15	41.89
14.	TCGS-1173	2938.26	84.20	40.45
15.	DHARANI	3799.64	94.68	39.75
16.	NARAYANI	2432.56	82.54	33.76
	MEAN	**3421.34**	**87.87**	**37.36**
	CD (P=0.05)	**365.672**	**17.22**	**3.843**
	SEm±	**127.717**	**6.01**	**1.342**

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