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Genotypic and seasonal variation in stomatal characters in Trombay Groundnut varieties

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ABSTRACT

Leaflet area, stomatal frequency, stomatal number per leaflet and their size in seven Trombay Groundnut varieties were compared in summer and rainy seasons. Among them were cvs TAG-24 and Somnath, which were already proved to have higher water use efficiency. In all cvs leaflet area was reduced during summer. In TAG-24, Somnath, TG-22 and TKG-19A, reduction of leaflet area was associated with increased stomatal frequency and stomatal number on adaxial surface. However, no significant differences were observed for stomatal length and breadth. Reduced leaflet area with corresponding increase in stomatal frequency and number of stomata on adaxial surface appear to be related with water use efficiency in TAG-24 and Somnath.

Key words: *Arachis hypogaea*, groundnut, leaf area, peanut, stomata, water use efficiency.

INTRODUCTION

Stomata are known to play a vital role in many physiological processes of plants. Stomatal number and frequency per unit leaf area have been extensively investigated. Higher stomatal frequency was associated with increased photosynthesis (Austin *et al.* 1982) and low frequency with reduced transpiration (Miskin *et al.* 1972). Changes in frequency in response to drought (Bhagwat and Bhatia 1993; Xia 1994 and Kebede *et al.* 1994), cold (Knecht and Orton 1970) and diseases (Ramos *et al.* 1992) have also been reported. In a collaborative research programme between ACIAR (Australia), ICAR (India) and ICRISAT (India), two Trombay Groundnut (TG) varieties, TAG-24 and Somnath were identified to have higher water use efficiency among several genotypes evaluated (Anonymous 1997). The objective of present experiment was to study the leaf area and stomatal characters and find their possible association with the reported higher water use efficiency in cvs TAG-24 and Somnath.

Abbreviations: ACIAR: Australian Council for International Agricultural Research, ICAR: Indian Council Agricultural Research. ICRISAT: International Crops Research Institute for Semi-arid tropics, cvs: cultivars, LA: leaflet area, SF: stomatal frequency, SI: Spanish Improved, SNL: stomatal number/leaflet, TG: Trombay Groundnut

MATERIAL AND METHODS

Induction of mutations in groundnut by radiations and using mutants in cross breeding was in progress at Bhabha Atomic Research Centre (BARC), Mumbai, India, (Patil and Chandramouli 1979, Chandramouli *et al.* 1989), resulting in the release of 9 TG varieties for commercial cultivation (Kale *et al.* 1998). Six TG cvs, TG-17, TKG-19A, TG-22, TAG-24, TG-26 and Somnath and their parent variety Spanish Improved (SI) were used in the present experiment. Their agronomic features are given in Table 1. During 1997, they were grown in summer (January-May) under irrigation and during the rainy season (June-October) in the experimental fields of the BARC. Weather data between January to October 1997 is shown in Table 2.

Plants used in this study were from the yield trial experiments with five replications. Terminal leaflets from the third leaf from the top on the stem of 70 days old plants were used for sampling. Leaflets were coated with 30% solution of plastic in xylol on both surfaces. After drying, the impressions were peeled off for taking stomatal number, length and breadth on adaxial and abaxial surfaces individually (Bhagwat and Bhatia 1993). Leaflet area (LA) was estimated by tracing leaflets on graph sheets. Stomatal counts were taken from five microscopic fields per leaflet, using lens combinations (Occular 8 X and Stage 40 X). Stomatal length and breadth were measured by an occular micrometer. Stomata were expressed as number per mm^2 of LA and termed as stomatal frequency (SF). Stomatal number per leaflet (SNL)

was calculated as the product of SF and LA.

RESULTS AND DISCUSSION

Information on stomatal characters in groundnut is scarce. In the present study, significant genotypic differences for LA, SF and SNL were observed among genotypes (Table 3). These parameters were found altered when genotypes were grown in summer or rainy seasons, indicating varietal response to seasons. In general, LA and SF are negatively correlated and under drought conditions, there is a reduction in leaf area accompanied by increased in SF (Bhagwat and Bhatia 1993 and Xia 1994). In rainy season continuous rainfall, high relative humidity and low solar radiation were recorded, compared to summer (Table 2) indicating dry situation in summer. As a result, the LA was reduced (10 to 41%) in all cvs. On adaxial surface, there was an increase in SF in all varieties (7 to 47%) and increased SNL only in TKG-19A, TAG-24, Somnath and TG-22 (9 to 29%). In summer, LA was negatively correlated with adaxial SF (- 0.339*). Suryakumari *et al.* (1983) reported higher SF on adaxial surface than on abaxial surface in most of the wild *Arachis* species. On abaxial side, there was reduction of SF in SI and TG-26 while in others, there was an increase (3 to 19%). However, abaxial SNL showed reduction in all except TG-22 and Somnath where there was a small increase (4 to 5%). These results indicated that in summer, there was reduction in LA in all cvs. with a corresponding increase in SF on adaxial surface. However, increase in SNL was limited to specific genotypes. On the other hand, although there was increase in SF on abaxial side, there was reduction for SNL in 5 out of 7 cvs.

There were no significant differences among

Table 1. Agronomic features of Trombay Groundnut (TG) varieties.

Variety	Habit[1]	Duration, days	Yield, kg ha^{-1}	HKW, g	Important features
TKG-19 A	SB	120	2260	60	Bold seeded variety
TAG-24	SB	105	2490	40	Semi-dwarf plant with high harvest index, tolerant to drought
TG-26	SB	110	2420	38	Semi-dwarf plant with high harvest index
Somnath	SR	120	1920	65	Early maturing, tolerant to drought
TG-17	SB	115	1400	61	Reduced plant height, less number of branches, dark green foliage
TG-22	SB	120	1680	58	Variety with medium bold seeds
Spanish Improved	SB	120	1250	35	Original parent

[1]SB- Spanish bunch, SR - Spanish runner, [2]HKW - Hundred kernel weight

Table 2. Weather data at Trombay during two crop seasons in 1997.

Month	Temperature, °C Max.	Min.	Relative Humidity, %	Solar Radiation, Cal cm^{-2} hr^{-1}	No. of rainy days	Rainfall, mm
Summer						
January	29.3	17.9	58.6	25.4	0	0.0
February	30.6	18.0	61.3	28.0	0	0.0
March	33.7	22.3	62.1	29.8	0	0.0
April	32.0	24.7	78.8	35.4	0	0.0
May	31.8	26.7	83.7	--	0	0.0
Rainy Season						
June	30.5	27.3	91.5	21.7	19	585.4
July	29.0	27.2	95.4	Cloudy	22	579.5
August	28.8	26.9	93.4	15.5	23	821.3
September	29.5	25.9	93.0	15.3	14	476.3
October	34.0	25.1	81.7	19.9	0	0.0

Table 3. Leaflet area and stomatal characters in Trombay Groundnut varieties in rainy and summer seasons.

Variety	Leaflet Area, cm^2	Stomatal frequency Adaxial surface	Abaxial surface	Stomatal number per leaflet (X 1000) Adaxial surface	Abaxial surface	Stomatal size (µ) Adaxial surface Length	Breadth	Stomatal size (µ) Abaxial surface Length	Breadth
RAINY SEASON 1997									
TKG-19 A	21.5^{a}	159.6^{bc}	163.9^{bc}	323^{bc}	352^{b}	19.7	16.0	21.1	16.9
TAG-24	12.8^{d}	159.4^{bc}	184.0^{ab}	203^{e}	236^{fg}	19.3	15.6	21.5	17.9
TG-26	16.8^{bc}	164.2^{bc}	175.2^{ab}	276^{cd}	295^{bc}	20.3	15.8	22.5	16.5
Somnath	15.0^{bcd}	142.3^{c}	145.5^{c}	214^{e}	218^{e}	21.5	16.9	21.4	17.3
TG-17	22.7^{a}	183.8^{ab}	188.8^{a}	413^{a}	425^{a}	20.8	15.5	19.8	17.5
TG-22	16.7^{bc}	148.8^{c}	168.2^{abc}	248de	282^{cd}	20.1	15.6	20.2	16.6
Spanish	18.0^{b}	192.1^{a}	163.2^{bc}	344^{b}	295^{bc}	18.8	15.2	21.1	16.8
S Em ±	1.0	8.4	7.8	18.9	19.9	0.7	0.4	0.8	0.6
CD at 5% Improved	2.9	24.7	22.9	55.3	58.2	NS	NS	NS	NS
SUMMER SEASON 1997									
TKG-19 A	17.0^{a}	206.7	192.1^{ab}	354^{a}	327^{a}	21.4	16.3	21.3	17.7
TAG-24	10.1^{c}	234.1	190.8^{abc}	236^{b}	191^{b}	17.3	14.4	19.2	16.0
TG-26	12.2^{bc}	211.3	174.2^{c}	257^{b}	212^{b}	18.0	14.7	20.0	16.3
Somnath	12.8^{b}	200.9	179.3^{b}	257^{b}	229^{b}	18.3	14.3	19.4	16.1
TG-17	16.1^{a}	217.0	204.7^{a}	349^{a}	331^{a}	20.7	15.0	19.6	15.5
TG-22	15.2^{a}	213.0	193.4^{ab}	321^{a}	294^{a}	20.1	15.5	20.4	16.2
Spanis h Improved	15.6^{a}	205.0	151.1^{d}	318^{a}	235^{b}	19.8	15.5	19.4	15.5
S Em ±	0.8	7.3	6.1	19.1	18.6	1.8	0.6	0.5	0.4
CD at 5%	2.3	NS	17.8	55.9	54.3	NS	NS	NS	1.2

Figures followed by same letter do not differ significantly at 5% level of significance according to DMRT.

genotypes for length and breadth of stomata in both the seasons except in TKG-19A, which showed broader stomata on abaxial surface in summer. Stomatal length and breadth were greater on abaxial surface in both seasons. There was a reduction in stomatal length and breadth on both surfaces in cvs. TAG-24 and Somnath during summer (Table 3). In summer, reduction in cell size rather than cell number may be useful in conserving photosynthetic potential. In wheat, a negative association was observed between cell size and photosynthetic rate (Bhagwat *et al.* 1997). Water stressed wheat (Bhagwat and Bhatia 1993) and faba beans (Xia 1994) also exhibited an increase in the SF. Agronomic trials conducted across locations and over years confirmed that cvs. Somnath and TAG-24 were superior in water use efficiency (Anonymous 1997). In the present study, all cvs exhibited reduced LA in summer with increased adaxial SF. TAG-24, Somnath, TKG-19A and TG-22 showed higher adaxial SF as well as SNL. Among these, there was reduction for stomatal sizes in TAG-24 and Somnath in summer. Thus, TAG-24 and Somnath showed summer adaptation through reduced LA, increased adaxial SF, increased adaxial SNL and reduced stomatal size. These characteristics in turn appear to be associated with the reported greater water use efficiency in these varieties. However, this needs further confirmation.

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