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Inheritance of leaf chlorophyll content in groundnut (*Arachis hypogaea* L.)

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Abstract

In groundnut, water-use efficiency is governed by the photosynthetic capacity which is dependent on leaf nitrogen status. Leaf nitrogen status is ultimately reflected in the chlorophyll content. Chlorophyll content of different genotypes/individual plants in segregating generations in a relative manner can be obtained through SPAD chlorophyll meter reading (SCMR). The experimental material consisted of 300-350 F_2 plants in each of five crosses involving a common male parent. Individual plants were screened for SCMR in F_2 populations of each cross and the data were grouped taking a class interval of two. From the perusal of F_2 frequency distributions of five groundnut crosses and the results of skewness and kurtosis, it could be inferred that leaf chlorophyll content in groundnut may be a quasi-quantitative trait with modifiers acting either to increase or decrease the expression of the trait in different genetic backgrounds as in the present study.

Key words: Groundnut, leaf chlorophyll content, inheritance, SPAD chlorophyll meter reading

Introduction

In India, groundnut is grown as a rainfed crop in dry lands under low inputs as well as irrigated crop under high input systems in about 8 million hectares with a production of 7.5 million tons and an average productivity of 938 Kg ha^{-1}. The major factor responsible for low productivity is drought in rainfed crop. For the crop cultivated under irrigated conditions during *rabi*-summer also, water is going to become a major limiting factor due to dwindling water resources because of continuous over-exploitation of ground water. In this context, incorporation of the traits that confer water-use efficiency into the existing high yielding varieties is a major research priority. In groundnut, variation for water-use efficiency is primarily due to variation in photosynthetic capacity that is reflected by carboxylation efficiency. A study by Nageswara Rao *et al.* [1] has shown significant correlations between the SPAD chlorophyll meter reading (SCMR), specific leaf area (SLA) and specific leaf nitrogen (SLN) in peanut and the results suggested that SCMR could be used as a rapid, low cost, non-destructive technique to screen large breeding populations for SLA or SLN. By understanding the nature of inheritance of leaf chlorophyll content obtained through SPAD chlorophyll meter content that is the most efficient breeder friendly screening tool for water-use efficiency, suitable selection procedures can be established for efficient selection in segregating generations.

Materials and methods

The experimental material consisted of F_2 populations of five groundnut crosses *viz.*, TCGS-320 × TCGS-647, Tirupati-4 × TCGS-647, K-134 × TCGS-647, VRI 2 × TCGS-647 and TCGS 29 × TCGS 647. The description of the parents is given in Table 1. F_2 population of each cross was grown in a plot of 9 rows of 5 meters length while parents were sown in a single row of 5 meters length adopting a spacing of 30 × 10 cm. Five F_1 plants raised separately in each cross were used to record SCMR. SCMR of individual plants was taken on leaflets of third leaf at 55-60 days after sowing. Individual plants of F_2 population were grouped into different classes taking a class interval of two. Skewness and kurtosis of F_2 distributions were calculated as per Snedecor and Cochran [2] to check departure from normality.

Results and discussion

The inheritance of SCMR was studied in F_2 populations of five groundnut crosses. The male parent, TCGS-647 was common in all the five crosses under study. The mean SCMR of the common male parent, TCGS-647 was 45 (Table 2). In screening studies during *kharif* 2002 and *rabi* 2002-03 the genotype TCGS 647 recorded high SCMR value. SCMR values of the female parents, TCGS 320, Tirupati-4, K-134, VRI 2 and TCGS 29 were lower than that of TCGS-647. SCMR of the female parents, TCGS 29 and VRI-2 was 38 and 39 respectively while it was 40, 40 and 42 in parents, TCGS 320, Tirupati-4 and K-134 respectively. The SCMR in F_1s was either intermediate between the parents involved in that particular cross combination or more nearer to the parent with high SCMR i.e. TCGS-647.

Table 1. Salient features of parental genotypes

Parents	Salient features
TCGS-320	Short duration (105-110 days), Kalahasti malady resistant, Spanish bunch variety, high yielder, suitable for *rabi* cultivation especially in Kalahasti malady endemic areas with high 100 pod weight of 100 to 105 gms and 100 kernel weight of 50 to 55 gms and high oil content of 52 per cent, leaves green and sparsely hairy, stem sparsely hairy, testa dark red in colour, a derivative of the cross, TCG1709 x TCG1518
Tirupati-4	Spanish bunch variety, maturing in 105 days,tolerant to moisture stress that occurs in the middle of the season, suitable for both *kharif* and *rabi* season, high yielder with 100 pod weight of 90 to 95 gms and 100 kernel weight of 45 to 47 gms, leaves light green, sparsely hairy, stem sparsely hairy,testa rose in colour, a derivative of the cross, JL24 x Ah316/s
K-134 (Vemana)	Spanish bunch variety, maturing in 105-110 days, suitable for both *kharif* and *rabi* seasons, possesses field tolerance to late leaf spot with 100 pod weight of 80 to 95 gms and 100-kernel weight of 37 to 49 gms, leaves green, glabrous, stem glabrous, testa rose in colour, a derivative of the cross, Kadiri-3 x JL24
VRI-2	Spanish bunch variety maturing in 105 days suitable for both seasons *kharif* and *rabi* with the 100 pod weight of 85 to 90 gms and 100 kernel weight of 42-45 gms, leaves green, sparsely hairy, stem sparsely hairy, testa rose in colour
TCGS-29	Early maturity (100 days) Spanish bunch variety suitable for both *kharif* and *rabi* season, specifically recommended for rain fed areas. High yielder with 100 pod weight of 85 to 90 gms and 100 kernel weight of 42 to 45 gms, leaves light green, sparsely hairy, stem sparsely hairy, testa rose in colour, a derivative of the cross, JL24 x Ah316/s
TCGS-647	Advanced breeding line with high pod yield potential, high SCMR, low SLA, tolerant to sucking insects, leaves dark green,densely hairy, stem densely hairy, testa rose in colour, a derivative of the cross, JL24 x ICGV 86398

Table 2. SCMR of parents and F_1s

S.No.	Cross/parent	SCMR
1.	TCGS-320	39.7
2.	Tirupati-4	40.2
3.	K-134	41.9
4.	VRI-2	36.6
5.	TCGS-29	37.6
6.	TCGS-647	44.8
7.	TCGS-320 x TCGS-647	44.0
8.	Tirupati-4 x TCGS-647	41.0
9.	K-I 34 x TCGS-647	44.0
10.	VRI-2 x TCGS-647	40.0
11.	TCGS-29 x TCGS-647	41.0

Based on SCMR values of individual F_2 plants in each cross, they were grouped into different classes taking a class interval of two. Frequency distribution of SCMR in F_2 generation of five crosses is presented in the form of line graphs (Fig. 1) taking SCMR values on X-axis and frequency of plants on Y-axis. Distribution of plants for SCMR was unimodal and continuous in all F_2 populations studied. But, shape of curve was different in different crosses. The continuous frequency distribution observed in F_2 populations of all the five crosses could be either due to moderately low heritability or moderately higher number of genes involved in the inheritance [3]. In the present study, the ranking of the parents with respect to SCMR was found to be consistent against seasons i.e. the parent that stood first in one season also stood first in another season with slight variation in values. The heritability of SCMR in broad sense was moderate to high which ranged from 38.85 to 66.49 percent in F_2 populations of different crosses in the present study. Thus, the SCMR could be considered as fairly highly heritable trait.

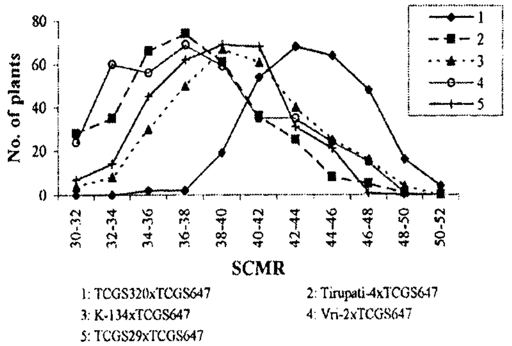

Fig. 1. F_2 frequency distribution in different groundnut crosses for leaf chlorophyll content (in terms of SCMR)

Results of skewness and kurtosis tests confirmed variable distribution in F_2 populations derived from different crosses. Skewness was significant in three out of five crosses studied. In F_2 population of Tirupati-4 x TCGS-647, skewness was negative while it was positive in F_2 population of K-134 x TCGS 647 and VRI 2 x TCGS 647. It was negligible in F_2 population of TCGS 29 x TCGS 647. Kurtosis was significant and positive in F_2 populations of TCGS 320 x TCGS 647 and Tirupati-4 x TCGS 647 while it was negative in F_2 population of TCGS 29 x TCGS 647 (Table 3). This kind of asymmetry and variability in F_2 distributions might be due to different allelic frequencies in the parents involved. In K-134 x TCGS 647, the SCMR of female parent K-134 was higher and near to the SCMR of TCGS 647 and so both parents might have contributed positive alleles resulting in positive skewness while in VRI 2 x TCGS 647, some favorable epistasis and dominance might have contributed for positive skewness. Essomba *et al.* [4] reported similar results

Table 3. Results of skewness and kurtosis tests in F_2 distribution of five groundnut crosses

Cross	n	g_1	b_2	g_2
TCGS-320 × TCGS-647	271	−0.18	3.71*	0.71
Tirupati-4 × TCGS-647	333	−0.86**	3.47*	0.47
K-I 34 × TCGS-647	373	0.29**	2.63	−0.37
VRI-2 × TCGS-647	336	0.41**	2.72	−0.29
TCGS-29 × TCGS-647	313	−0.08	2.36**	−0.64

in their study of inheritance of leaflet size in six F_2 populations of groundnut. The relative contribution of additive and dominance gene effects for specific leaf area, a correlated trait to SCMR was found to be different in different crosses by Nigam *et al.* [5].

Transgressive individuals with lower SCMR values than the lower SCMR parents were observed in F_2 populations of all the five crosses studied. The frequency of plants with lower SCMR value was higher in F_2 populations of Tirupati-4 × TCGS 647 and VRI 2 × TCGS 647. Transgressive individuals with high SCMR value exceeding the high SCMR parent were observed in F_2 populations of two crosses i.e. TCGS 320 × TCGS 647 and K-134 × TCGS 647. The female parents, TCGS 320 and K-134 also might have contributed positive alleles which are not present in TCGS 647 resulting in transgressive individuals with SCMR value higher than TCGS 647. In TCGS 29 × TCGS 647 combination, though there were transgressive individuals towards lower SCMR, the frequency was not as high as in Tirupati-4 × TCGS 647 and VRI-2 × TCGS 647 combinations. One more interesting feature involving the parentage of the female parents in crosses, TCGS 320 × TCGS 647 and K-134 × TCGS 647 is that both TCGS 320 and K-134 have Virginia bunch background i.e. the Virginia bunch lines TCG 1518 and Kadiri-3 are involved as one of the parents in their pedigree. Even the male parent, TCGS 647 has Virginia bunch background, one of its parent ICGV 86398 is a Virginia bunch line.

The fact that the extreme parental types and transgressive individuals were captured within a population of 300 to 350 F_2 plants is an indication that the trait may probably be governed by a fewer genes under the influence of modifiers and may be a quasi-quantitative trait. Many characters in groundnut were reported to be oligogenic which show quasi-quantitative inheritance. In groundnut, SCMR gives indirectly a relative quantity of chlorophyll that is ultimately responsible for intensity of greenness in leaves. Thus, phenotypically, different shades in leaf colour are observed from light green to bluish green in groundnut.

When the SCMR data was grouped into five classes in each cross and analysed by Chi square test, it fitted well to a phenotypic F_2 ratio of 1: 4: 6: 4: 1 in all the crosses. To a large extent, this is caused by duplication of factors which mask or inhibit the effects of genes and the presence of minor or modifying genes which increase the difficulties in correct classification of individual plant segregates [6]. Thus, it can be inferred that leaf chlorophyll content may be governed (as SCMR) by a few independent factor pairs with modifiers acting either to increase or decrease the expression of the trait in different genetic backgrounds as in the present study. F_3 and backcross population studies would help to further confirm the results.

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