

Inheritance of Spear-Shaped Leaf in Peanut

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ABSTRACT

Recently, a single Spear-shaped Leaf mutant plant was discovered in the 'Georgia-06G' peanut (*Arachis hypogaea* L. ssp. *hypogaea* var. *hypogaea*) cultivar. The mutant had narrow leaflets with each leaflet tapering to a point which gives the appearance of a spearhead shape. Three cross combinations were used to determine the inheritance of this new mutant. F₁, F₂, and F₃ segregation data strongly supported a single incompletely dominant gene, designated *SpL*, controlling the inheritance of the Spear-shaped Leaf trait. The F_{2:3} homozygous spear-shaped individual plants had taller mainstem heights, narrower leaflet width, reduced pod weight, and lower SMK percentages compared to the F_{2:3} homozygous normal leaf plants resulting from the same closely related cross combination (Georgia-06G x Spear-shaped Leaf mutant).

Key Words: groundnut, *Arachis hypogaea* L., genetic ratios, cross combinations

A small-leaf, spear-shaped leaflet peanut (*Arachis hypogaea* L.) mutant was first reported by Bhide and Desale (1970) and later by Desale (1987). This spear-shaped mutant was selected from a field increase of the semi-spreading cultivar 'Kopargaon No. 1' at Jalgaon, India during 1964. The mutant was subsequently crossed with Kopargaon No. 1, and the F₁ plants had normal leaves which suggest that this mutant was recessive. F₂ segregation fit a 3:1 ratio for normal and spear-shaped leaflet plants, respectively. The study by Bhide and Desale (1970), showed that the small-leaf, spear-shaped mutant was controlled by recessive monogenic inheritance.

During 2012, a new Spear-shaped Leaf mutant was isolated from the runner-type peanut cultivar 'Georgia-06G' (Branch, 2007). This mutant likewise had small spear-shaped leaflets with each leaflet tapering to a point at the top and bottom and the widest section being in the middle which gives the appearance of a spearhead shape (Figure 1). The objective of this study was to determine the

inheritance of the present Spear-shaped Leaf mutant.

Materials and Methods

Three cross combinations were made in the greenhouse between Georgia-06G x Spear-shaped Leaf, 'OLin' (Simpson *et al.*, 2003) x Spear-shaped Leaf, and 'Georgia-04S' (Branch, 2005) x Spear-shaped Leaf during 2013. F₁, F₂, and F₃ populations were grown during 2014, 2015, and 2016, respectively.

Each year, seed were space-planted 30.5 cm apart in two rows with variable length depending upon number of seed x 1.8 m wide beds on a Tifton loamy sand soil type (fine-loamy, siliceous, thermic, Plinthic Kandidult) at the agronomy research farm near the University of Georgia, Coastal Plain Experiment Station, Tifton Campus. Recommended cultural practices with irrigation were followed throughout the growing seasons.

Individual plants were harvested near optimum maturity based upon number of days after planting and above-ground plant appearance. After harvest, peanut pods were dried with forced warm air to approximately 6% moisture content before weighing and shelling.

Phenotypic classification was based on individual plants before digging and inverting. Segregation data was analyzed by chi-square analysis for goodness-of-fit ($P \leq 0.05$) to expected genetic ratios (Strickberger, 1968). Least significant difference (LSD) t-test was used to compare the ten plant average between F_{2:3} spear-shaped and normal leaf homozygous genotypes for mainstem height, leaflet length and width, pod weight, sound mature kernels (SMK), and 100 SMK weight.

Results and Discussions

Each F₁ plant from all three crosses had an intermediate Spear-shaped Leaf. This indicates that the Spear-shaped Leaf trait is incompletely dominant to normal leaves which is different from the first report by Bhide and Desale (1970).

The F₂ segregation from the two cross combinations (Georgia-06G x Spear-shaped Leaf and Georgia-04S x Spear-shaped Leaf) showed an acceptable fit for a 1 Spear-shape to 2

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Fig. 1. Shows a normal leaf shape (bottom) and the Spear-shape Leaf mutant (top) found in the runner-type peanut cultivar, Georgia-06G.

Intermediate to 1 Normal leaf expected ratio, respectively (Table 1). However, the F₂ segregation from the OLin x Spear-shaped Leaf cross combination did not fit the 1:2:1 ratio. This deviation from the expected ratio could be due to several albino seedlings observed in this infraspecific cross between subspecies (*ssp. fasti-*

giata and *ssp. hypogaea*) which died shortly after emergence. Because of this infraspecific cross combination, the total chi-square value was also found to be significantly different at $P \leq 0.05$, however the summed and homogeneity chi-square values were each found acceptable for the 1:2:1 expected genetic ratio. These F₂ results also disagree with the earlier report for the small-leaf, spear-shaped leaflets (Bhide and Desale, 1970).

F₃ results confirmed a single incomplete dominant inheritance model with a 1:2:1 expected ratio from F_{2:3} heterozygous intermediate Spear-shaped Leaf plants ($\chi^2 = 2.400$, $P = 0.25 - 0.50$). Likewise, the Spear-shaped Leaf plants and normal shaped leaf plants bred true-to-type in the F_{2:3} population from Georgia-06G x Spear-shaped Leaf cross combination as was expected. These F_{2:3} homozygous spear-shaped individual plants had taller mainstem, narrow leaflet width, reduced pod weight, and lower sound mature kernel (SMK) percentages compared to the F_{2:3} homozygous normal leaf plants resulting from this same closely related cross combination at maturity (Table 2). Early in the growing season, it also was observed that the spear-shaped F_{2:3} plants appear to have more thrips damage than the normal plants.

These findings strongly suggest that the inheritance of the present Spear-shaped Leaf mutant is controlled by a single incompletely dominant gene, designated (*SpL*). This data also disagrees with the past recessive monogenic inheritance for the spear-shaped leaflet trait reported by Bhide and Desale (1970) and Desale (1987). It would have been interesting to make allelism tests between these two spear-shaped mutants, unfortunately there were nearly 50 years between the occurrences of these two leaf mutants.

Table 1. F₂ plant segregation for number of spear, intermediate, and normal shaped leaf plants from three peanut cross combinations, 2015.

Cross	No. F ₂ Plants			χ^2 (1:2:1)	ρ
	Spear	Intermediate	Normal		
Georgia-06G x Spear-shaped Leaf	81	164	87	0.265	0.50-0.25
OLin x Spear-shaped Leaf	53	174	58	14.102	$\leq 0.05^a$
Georgia-04S x Spear-shaped Leaf	80	171	81	0.307	0.10-0.05
Total				14.674	$\leq 0.05^a$
Summed	214	509	226	5.320	0.10-0.05
Homogeneity				9.354	0.10-0.05

^aSignificantly different at $P \leq 0.05$.

Table 2. Ten plant average comparison between F_{2:3} normal leaf vs spear-shaped peanut genotypes from the Georgia-06G x Spear-shaped Leaf cross combination, 2016.

Peanut Genotype	Mainstem Height (cm)	Leaflet Length (mm)	Leaflet Width (mm)	Pod Weight (g)	Sound Mature Kernels (%)	SMK Weight (g/100)
Normal Leaf	26.4 b ^a	46.6 a	21.8 a	318.7 a	68.0 a	65.1 a
Spear-shaped	33.2 a	46.1 a	15.1 b	245.4 b	60.9 b	61.9 a

^aMeans within columns followed by the same letter are not significantly different at $P \leq 0.05$.

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