J. Oilseeds Res. 12(2) 1995 :167-170
ISSN 0970-2776

INHERITANCE OF ALBINISM IN CERTAIN CROSSES OF GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

Observations on F_2 and F_3 generations in crosses involving spanish bunch and virginia bunch/runner groundnuts confirmed that albinism is controlled by duplicate loci interacting with another locus in an epistatic manner. The Chi-square test of the observed frequencies indicated a good fit to the ratios expected on this genetic model.

Keywords: Peanut; Chlorophyll deficiency; Loci; Epistasis; Zygotic lethal.

INTRODUCTION

Albinism or chlorophyll deficiency is a deleterious character often observed in segregating generations of groundnut crosses involving varieties of different botanical types. Several groundnut workers have suggested that this character is controlled by duplicate (Patel *et al.*, 1936; Hull, 1937; Katayama and Nagatomo, 1963), triplicate (Badami, 1928; Dwivedi *et al.*, 1984) or quadruplicate factors (Tai *et al.*, 1970). However, Coffelt and Hammons (1971) reported the F_2 phenotypic ratio of 60 green, 3 albino and 1 zygotic lethal having triple recessive. The present study deals with the inheritance of albinism in crosses involving groundnut genotypes belonging to spanish (*A. hypogaea* ssp. *fastigiata* var. *vulgaris*) and virginia (*A. hypogaea* ssp. *hypogaea* var. *hypogaea*) groups.

MATERIAL AND METHODS

The F_1 and F_2 generations of 11 crosses between spanish (KRG 1, S 206, TMV 2, Dh 3-30, GBFDS 92, GBFDS 206) and virginia (TG 7, NC Ac 343) genotypes were initially studied. These were grown in the field during the 1988/89 postrainy and the 1989 rainy season, respectively. Frequencies of green and albino plants were recorded within seven days after emergence of seedlings in the crosses. All albino plants died within 15-20 days after emergence. The remaining green plants in the F_2 populations segregating for albinism character, were harvested separately. Four of these crosses (KRG 1 x NC Ac 343, KRG 1 x GBFDS 92, S 206 x GBFDS 206 and TMV 2 x GBFDS 206) had at least one hundred and eighty F_2 plants with number of pods sufficient to grow F_3 progenies. In all, 720 F_3 progenies of these crosses were raised in the field during the 1989/90 postrainy season. The number of non-segregating and segregating progenies for albinism was recorded in each cross. In segregating progenies the number of green and albino plants was counted within seven days after emergence.

The F_2 and F_3 data were subjected to chi-square test to test the goodness of fit of different di- and tri-genic ratios.

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Received for publication on April 29, 1991

RESULTS AND DISCUSSION

All F_1 plants in crosses were green. Of the 11 F_2 crosses only seven viz. KRG 1 x GBFDS 206, KRG 1 x NC Ac 343, KRG 1 x GBFDS 92, S 206 x GBFDS 206, TMV 2 x GBFDS 206, Dh 3-30 x GBFDS 206 and KRG 1 x TG 7, segregated for albinism. The F_2 data of these crosses were subjected to chi-square tests to test the goodness of fit of three genetic ratios (Table 1). The Chi-square values for the digenic ratio of 15 green:1 albino plants were highly significant for KRG 1 x GBFDS 206 and S 206 x GBFDS 206 crosses. Total and pooled chi-square were also highly significant for this ratio. None of the seven crosses individually or when pooled together showed a good fit to the trigenic ratio of 63 green:1 albino, indicating its failure in these crosses. However, when these F2 data were analyzed for a ratio of 60 green:3 albino, (derived from 60 green:3 albino:1 zygotic lethal), chi-square values for the individual crosses as well as the total and pooled were non-significant, indicating a good fit to this ratio.

Five out of seven crosses had also non-significant chi-square values for the ratio of 15 green:1 albino but in four such cases the values were higher than that of the 60 green:3 albino ratio. This indicated that goodness of fit was more in favour of 60:3 ratio than 15:1.

Based on 60:3 and 15:1 green vs. albino plants in F_2, the observed ratios of segregating and non-segregating F_3 progenies of four crosses (KRG 1 x NC Ac 343, KRG 1 x GBFDS 206, S 206 x GBFDS 206 and TMV 2 x GBFDS 206) were tested for goodness of fit for 36:24 and 7:8 non segregating vs. segregating ratios, respectively (Table 2). The ratio of non-segregating and segregating F_3 progenies gave a good fit in favour of 60:3 green vs. albino plants ratio in F_2. Subsequently each segregating F_3 progeny was tested for 60:3, 12:3, 15:1 and 3:1 green vs. albino plant ratios. Based on a 60:3 green vs. albino plants F_2 ratio these progenies are expected to occur with a ratio of 8:8:4:4: for 60:3, 12:3, 15:1 and 3:1 green vs. albino plant ratios. In all the four crosses a good fit for this distribution was observed in Chi-square tests (Table 3).

Table 1. Chi-square tests for different di-and tri-genic ratios in F_2 generations of seven crosses segregating for green and albino seedlings.

Cross	Number of plants		χ^2 values		
			Green: Albino		
	Green	Albino	15:1	60:3[d]	63:1
KRG 1 x GBFDS 206	763	30	8.24**	1.68NS	25.42**
KRG 1 x NC Ac 343	576	36	0.14NS	1.69NS	74.25**
KRG 1 x GBFDS 92	626	29	3.71NS	0.16NS	34.95**
S 206 x GBFDS 206	1118	44	12.03**	2.44NS	37.37**
TMV 2 x GBFDS 206	980	53	2.21NS	0.31NS	85.51**
Dh 3-30 x GBFDS 206	54	3	0.09NS	0.03NS	5.08*
KRG 1 x TG 7	119	5	1.04NS	0.15NS	4.92*
Total (7 d. f)			27.46**	6.46NS	267.50**
Pooled (1 d. f)	4236	200	22.96**	0.63NS	250.32**
Heterogeneity (6 d. f)			4.50NS	5.83NS	17.18**

[d] derived from a 60 green:3 albino:1 zygotic lethal ratio.

* and ** Significant at $p = 0.05$ and 0.01, respectively. NS = Non-significant.

Table 2. Chi-square tests for expected ratios of non-segregating and segregating F_3 progenies based on 60:3 and 15:1 F_2 ratios of green: albino plants.

Cross	Number of F_3 Progenies		F_3 ratios Non-segregating: Segregating	
	Non-segregating (green)	Segregating (green and albino)	36:24[a]	7:8[b]
KRG 1 x NC Ac 343	105	75	0.21^{NS}	9.84^{**}
KRG 1 x GBFDS 206	113	67	0.58^{NS}	18.77^{**}
S 206 x GBFDS 206	118	61	2.62^{NS}	26.66^{**}
TMV 2 x GBFDS 206	98	82	2.31^{NS}	4.38^{*}
Total (4 d. f)			5.72^{NS}	59.65^{**}
Pooled (1 d. f)	434	285	0.04^{NS}	54.18^{**}
Heterogeneity (3 d. f)			5.68^{NS}	5.47^{NS}

a = Expected F_3 ratio of non-segregating and segregating progenies based on an F_2 ratio of 60 green:3 albino plants.

b = Expected F_3 ratio of non-segregating and segregating progenies based on F_2 ratio of 15 green:1 albino plant.

* and ** significant at P = 0.05 and 0.01, respectively; NS = Non-significant.

Table 3. Chi-square tests for a ratio of 8:8:4:4 for the F_3 progenies segregating for 60:3, 12:3, 15:1 and 3:1 ratios of green and albino plants.

Cross	Total number of segregating progenies	Number of progenies segregating for Green: Albino				
		60:3	12:3	15:1	3:1	χ^2 ratios
KRG 1 x NC Ac 343	75	23	22	13	17	2.16^{NS}
KRG 1 x GBFDS 206	67	21	18	16	12	3.07^{NS}
S 206 x GBFDS 206	61	18	19	10	14	1.80^{NS}
TMV 2 x GBFDS 206	82	21	29	12	20	4.70^{NS}
Total (12 d. f)						11.73^{NS}
Pooled (3 d. f)		83	88	51	63	7.35^{NS}
Heterogeneity (9 d.. f)						4.38^{NS}

Ns = non-Significant.

The chlorophyll production under this genetic model is controlled by duplicate loci (A and B) interacting with a third locus (L) in an epistatic manner. The presence of one dominant allele at either A or B locus ensures normal chlorophyll production independent of recessiveness/dominance at L locus. The double recessive condition of both A and B and at least one dominant allele at the L locus (aabbL-) results in albino seedlings. Triple recessive (aabbll) are zygotic lethal. The results of this study and the one reported by Coffelt and Hammons (1971) reveal that Albinism in groundnut is controlled by two duplicate loci interacting with a third locus in epistatic manner and resulting into an F_2 ratio of 60 green:3 albino:1 zygotic lethal.

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