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COMBINING ABILITY ESTIMATES IN F_2 AND F_3 ENERATIONS FOR EARLY MATURITY AND AGRONOMIC TRAITS IN PEANUT *(ARACHIS HYPOGAEA* L.)

NAAZAR ALI, MALIK SHAH NAWAZ, KHURRAM BASHIR AND M. YASIN MIRZA

National Agricultural Research Centre, Park Road, Islamabad, Pakistan

Abstract

Development of early maturing and high yielding cultivars of peanut (*Arachis hypogaea* L.) is a major objective of groundnut breeding programme. To select the best combining parents, three high yielding virginia type cultivars No. 334, Banki and NC-9 were crossed with four early spanish type lines ICGSE-4, ICGSE-130, ICGSE-147 and Chico in a factorial mating design. F_2 and F_3 generations were evaluated in the field to determine the combining ability of the parents for maturity and other agronomic traits. General combining ability (GCA) estimates were significant for all traits except maturity index in F_2 and F_3 generations and seeds per 50 pods in F_3. Specific combining ability (SCA) estimates were non-significant for all the traits except oil contents in F_2 and pod length in F_3 generations. The magnitude of GCA was much greater than SCA for all traits in both the generations indicating that additive genetic variance (GCA) was more important than nonadditive genetic variance (SCA). Among male parents ICGSE-147 gave highest GCA for 20 pod length, seeds per 50 pods while Chico gave best GCA for maturity index. Among adapted female parents NO. 334 gave best GCA for seeds per 50 pod and maturity index while NC-9 gave best GCA for 100 seed weight.

Introduction

Groundnut (*Arachis hypogaea* L.), a leguminous crop, occupies an important place among oilseed crops. In Pakistan, groundnut has special importance due to wider adaptability and higher yield potential. High yield and early maturity is required to fit into a cropping system and to get two crops in a year. To develop the desired population, breeders are often facing problems of selecting those lines, which in different cross combinations can furnish higher frequency of most desirable segregants. To achieve this goal, knowledge of prepotency of parental lines for combining ability is very useful in selection of desirable lines possessing a built-in-genetic potential.

Studies on combining ability in crosses of spanish and virginia type peanuts have shown that general combining ability (GCA) and specific combining ability (SCA) were significant in almost all of the traits. However, the magnitude of GCA effects greater than SCA have been reported (Wynne *et al.*, 1975; Gregory *et al.*, 1980; Layrisse *et al.*, 1980; Sanun, 1988; Dwivedi *et al.*, 1989; Ali *et al.*, 1995). Makontehou (1987) studied inheritance and combining ability of early maturity and seed dormancy for selected group in spanish and virginia types of peanut and found that GCA was always larger than SCA for most of the maturity parameters in F_1 hybrid of virginia x spanish parents. Rachmeler (1988) suggested that selection for yield and earliness if practiced in later generation would be more effective. He found greater and significant GCA than SCA estimated for early maturity in F_2 and F_3 generation. Bansal *et al.*, (1991) indicated that non-additive gene effects were predominant for yield components although the magnitude of additive effects was substantial. They further reported that intra-group crosses were better than inter-group crosses.

The present studies were carried out to estimate the combining abilities of the selected virginia and spanish type parents for early maturity and agronomic traits for effective selection and use in groundnut breeding programme. Parents producing high yielding and early maturing progenies can be identified to include in a long term breeding programme.

Materials and Methods

Four spanish type lines ICGSE-4, ICGSE-130, ICGSE-147 and Chico and three virginia type lines No.334, Banki and NC 9 were used as parents in a 3 X 4 factorial mating design. Male parents selected have been identified by ICRISAT (International Crops Research Institute for Semi Arid Tropics) as small seeded and early maturing lines and have been tested at NARC for earliness. Female parents are high yielding varieties of Pakistan and North Carolina. No. 334 and Banki are local varieties of Pakistan while NC 9 is an adapted variety of North Carolina (Wynne *et al.*, 1986). Following 12 hybrids were produced:

i) Banki/ICGSE-4	ii) Banki/ICGSE-130
iii) Banki/ICGSE-147	iv) Banki/Chico
v) No.334/ICGSE-4	vi) No.334/ICGSE-130
vii) No.334/ICGSE-147	viii) No.334/Chico
ix) NC-9/ICGSE-4	x) NC-9/ICGSE-130
xi) NC-9/ICGSE-147	xii) NC-9/Chico

The crosses were made at North Carolina State University, USA and F_1 seed was produced during winter 1987 and spring 1988 (Ali, 1990). F_2 and F_3 generations were planted at NARC, Islamabad to observe heritability traits under local conditions.

F_2 and F_3 entries along with the parents were planted in April 1991 at NARC (National Agricultural Research Centre), Islamabad. A randomized complete block design with 4 replications was used. Four row plots with plant and row spacing of 25 and 91 cm, respectively were planted by hand. Standard cultural practices were followed during growing season. Experiment was harvested 120 days after planting. The pods were sun dried for a week. Seeds of 5 plants were bulked. A random sample of 50 pods was taken from each plot in each replication. The data recorded from this sample were: 20 pod length (cm), 50 pod weight (g), number of seeds per 50 pods, weight of seeds in 50 pods(g), number of pods in each maturity class (MC) based upon inner hull color ranging from white to black (white = MC1, yellow = MC2, light brown = MC3, dark brown = MC4, and black = MC5).

A sample of 50 pods was shelled and rated for maturity. From the recorded data the following variables were created:

a) Seed weight (g/100 seeds) $= \dfrac{\text{Weight of seeds in 50 pods}}{\text{Number of seeds in 50 pods}} \times 100$

b) Shelling % $= \dfrac{\text{Weight of seeds in 50 pods}}{\text{Weight of 50 pods}} \times 100$

c) Maturity index = (MC1*1)+(MC2*2)+(MC3*3)+(MC4*4)+(MC5*5)

For maturity index, pods in each class were multiplied by its class number and summed. Higher values of the maturity index reflect earlier maturity.

ANOVA was performed as a factorial design in which pooled sum of squares for males and females estimated general combining ability and male x female interaction sum of squares estimated specific combing ability (Hallauer & Miranada, 1981). General and specific combining ability effects of parents were estimated according to Simmonds (1979). Statistical significance of GCA and SCA effects were determined using t-test.

Results and Discussion

F_2 Generation: Results showed that the crosses differed significantly for all the characters under study except maturity index where the results were non-significant (Table 1). Male GCA mean square were highly significant for all traits except maturity index (Table 2). Female GCA mean squares were highly significant for 20-pod length and 100-seed weight, but was significant for oil content. SCA mean square was significant for oil content only. The SCA mean squares were much smaller than GCA for most of the traits, which indicated that additive genetic variance was more important than non-additive genetic variance. Gregory *et al.*, (1980) also found similar results who reported significant and many times greater GCA than SCA for yield and yield components in F_1 hybrid of most diverse peanut lines. Mekontchou (1987) found that GCA was always higher than SCA for most of the maturity parameters in F_1 hybrid of virginia x spanish parents. But Wynne *et al.*, (1970) and Dwivedi *et al.*, (1989) found significant SCA for seed weight indicating the importance of non additive genetic variance for this trait.

Table 1. Means of combining ability analysis of F_2 hybrids.

	20 pod length (cm)	Seeds/50 pods	100 seed wt (g)	Shelling %	Maturity index	Oil content (%)
No.334 x ICGSE-4	46.0	78.5	35.9	70.6	134.5	52.6
No.334 x ICGSE-130	49.0	76.0	40.2	66.3	132.8	55.1
No.334 x ICGSE-147	50.5	78.8	37.3	65.4	140.3	53.0
No.334 x CHICO	45.0	72.3	33.6	69.8	126.8	54.9
BANKI x ICGSE-4	47.0	74.5	36.5	68.5	112.8	55.7
BANKI x ICGSE-130	47.5	72.5	40.3	69.4	110.3	54.1
BANKI x ICGSE-147	53.0	78.3	35.4	62.1	137.8	53.1
BANKI x CHICO	44.5	72.8	34.7	66.4	135.5	54.4
NC-9 x ICGSE-4	47.8	67.0	40.0	66.5	128.3	52.9
NC-9 x ICGSE-130	51.5	70.8	43.6	65.3	128.5	54.7
NC-9 x ICGSE-147	55.0	83.0	41.2	64.8	106.5	51.8
NC-9 x CHICO	49.8	67.5	42.1	67.9	131.5	52.9
L.S.D.	4.24	9.13	4.41	4.09	N.S.	1.76

Table 2. Mean squares of combining ability analysis in F_2 and F_3 generation.

Source	df	20 pod length (cm)	Seeds/50 pods	100 seed wt (g)	Shelling %	Maturity index	Oil content (%)
			F_2 Generation				
Replications	3	29.4*	106.5	17.5	18.9	23493.7**	1.7
Crosses	11	41.6**	92.2*	41.6**	23.7**	507.3	5.9**
Females	2	52.3**	74.8	132.1**	15.9	507.3	6.7*
Males	3	103.7**	187.7**	49.6**	47.4**	133.7	8.8*
Female x Males	6	6.9	50.3	7.4	14.5	694.1	4.2*
Error	33	8.7	40.2	9.4	8.1	442.1	1.5
			F_3 Generation				
Replications	3	16.2*	77.5	92.3	6.7	26757.7**	4.6
Crosses	11	29.9**	87.2	92.7	34.4**	2275.6	4.6*
Females	2	14.5	112.0	105.5	14.8	4447.6	2.2
Males	3	72.9**	125.9	191.6*	102.9**	3773.2	10.9**
Female x Males	6	13.5*	59.6	39.0	6.7	802.8	2.3
Error	33	5.4	72.4	51.1	9.9	11500.1	1.6

The highest GCA effects for 20 pod length and number of seeds per 50 pods were obtained by male parent ICGSE-147. Male parent ICGSE-130 showed the highest GCA effects for 100 seed weight and oil contents (Table 3). For number of seeds per 50 pods and maturity index, ICGSE-130 was a poor parent showing negative GCA effects. Chico also showed positive GCA effects for shelling percentage, maturity index and oil content and proved to be the best male parent for maturity whereas the parents ICGSE-4 and Chico showed negative GCA effects for 20-pod length, seeds per 50 pods and 100-seed weight, which indicated that these are poor parents to combine these traits. Among females, No. 334 gave the highest GCA effects for seeds per 50 pods, shelling percentage and maturity index. Positive and significant SCA effects in crosses Banki/ICGSE-4, No.334/Chico and No.334/ICGSE-130 indicated that non additive genetic variance is also important for oil content (Table 4).

Table 3. Estimates of general combining ability effects in F_2 and F_3 generations.

	20 pod length (cm)	Seeds/50 pods	100 seed wt (g)	Shelling %	Maturity index	Oil content (%)
		F_2 Generation				
Male						
ICGSE-4	-02.00	-01.00	-00.93	01.61	-02.0	-0.1
ICGSE-130	00.57**	-01.23	02.97*	00.08	-03.22	0.8**
ICGSE-147	03.90*	05.70*	-00.43	-02.82*	01.11	-1.2*
CHICO	-02.50*	-03.46	-01.60	01.11	04.18	0.3
Female						
No. 334	-01.18	02.07	-01.65	01.11	06.51	0.1
BANKI	-00.93	00.20	-01.67	-00.32	-03.11	0.5
NC-9	02.10	-02.25	03.33**	-00.79	-03.39	-0.7
MALE LSD (5%)	2.5	5.3	2.5	2.4	NS	1.0
FEMALE LSD (5%)	2.1	NS	2.2	NS	NS	0.9
		F_3 Generation				
Male						
ICGSE-4	-1.05	0.42	-0.91	2.82**	00.09	1.1*
ICGSE-130	1.85**	-2.18	3.65*	-1.75	-12.42	0.1
ICGSE-147	2.18	4.42	2.49	-3.21*	11.42	-1.3*
CHICO	-2.99	-2.65	-5.25**	2.12	01.12	0.0
Female						
No. 334	0.36	2.90	-2.75	0.10	03.65	-0.1
BANKI	-1.09	-0.60	0.42	0.92	08.10	0.4
NC-9	0.73	-2.28	2.32	-1.03	-11.73	-0.3
MALE LSD (5%)	1.90	NS	NS	2.60	NS	1.1
FEMALE LSD (5%)	NS	NS	NS	NS	NS	NS

Table 4. Specific combining ability effects for oil content in crosses in F_2 generations.

	ICGSE-4	ICGSE-130	ICGSE-147	CHICO
No. 334	-1.2	0.4**	0.3	0.7*
BANKI	1.5*	-0.1	0.0	-0.2
NC-9	-1.0	0.8	-0.1*	-0.5
LSD (5%)	0.5478*			

These results indicated that the parents Chico and No.334 are the best general combiners for maturity index whereas the parents ICGSE-147 and No.334 are the best general combiners for 20-pod length and seeds per 50 pods. Selection for early maturity can be practiced among the progeny of No.334/Chico and selection for 20-pod length and seeds per 50 pods can be practiced among the progeny of No.334/ICGSE-147.

F_3 Generation: The differences among crosses were significant for 20-pod length, shelling percentage and oil content. However, non-significant differences were found for seeds per 50 pods, 100-seed weight and maturity index (Table 5). GCA mean squares for males were significant for all the traits except seed per 50 pods and maturity index, whereas, female GCA mean squares were non-significant for all the traits (Table 2). GCA mean squares for males were greater than females for all the traits except maturity index, indicating that the major contribution to additive variance for these traits was by the male parents. SCA mean squares were non-significant for all traits except 20-pod length. Estimates of GCA were larger in magnitude than SCA indicating that additive genetic variance was more important than non additive genetic variance. Similar results were found for the F_2 generation. These results support the findings of Wynne *et al.*, (1975), Layrisse *et al.*, (1980), and Sanun (1988) who reported significant and greater additive genetic effects (GCA) than nonadditive genetic effect (SCA) for most of the yield, fruit and seed traits in the F_2 generation of intersubspecific crosses of peanut. These results do not agree with Rachmeler (1988) who found significant SCA for maturity in F_2 generation of virginia x spanish crosses.

Table 5. Means of combining ability analysis of crosses in F_3 generation.

	20 pod length (cm)	Seeds/50 pods	100 seed wt (g)	Shelling %	Maturity index	Oil content (%)
No.334 x ICGSE-4	46.8	75.0	36.6	70.4	122.8	55.6
No.334 x ICGSE-130	50.5	73.0	42.2	67.2	106.0	54.0
No.334 x ICGSE-147	49.5	87.5	36.4	66.7	135.8	52.4
No.334 x CHICO	46.3	72.8	33.3	70.0	115.5	54.1
BANKI x ICGSE-4	46.0	77.0	37.3	71.8	123.3	55.5
BANKI x ICGSE-130	49.3	71.0	44.1	68.0	116.3	55.6
BANKI x ICGSE-147	51.0	73.5	47.5	64.9	132.3	52.8
BANKI x CHICO	41.0	72.8	32.3	72.9	126.0	53.9
NC-9 x ICGSE-4	47.8	71.8	43.0	71.7	103.3	54.4
NC-9 x ICGSE-130	49.5	72.0	44.3	65.0	89.0	53.1
NC-9 x ICGSE-147	49.8	74.8	43.2	64.2	115.3	53.3
NC-9 x CHICO	47.5	69.0	38.3	68.9	111.0	54.2
L.S.D.	5.43	N.S	N.S	4.09	N.S.	1.84

Estimates of GCA effects indicated that the male parent ICGSE-147, which gave the highest GCA effects in F_2 generation for 20-pod length and seeds per 50 pods, remained the best general combiner in F_3 generation for 20-pod length, seeds per 50 pods and maturity index (Table 3). Similarly male parent ICGSE-4 has shown the highest GCA effects for shelling percentage and oil content but has shown negative effects for 20-pod length and 100-seed weight. Chico showed negative GCA effects for 20-pod length, seeds per 50 pods and 100-seed weight indicating that these are poor general combiner for these traits. Among female parents NC-9 has shown the highest GCA effects for 20-pod length and 100 seed weight, but shown negative effects for seeds per 50 pods, shelling percentage, maturity index and oil content. Female parent Banki showed highest GCA effects for shelling percentage, maturity index and oil content. Negative GCA effects of NC-9 for maturity and oil content and of No.334 for seed weight and oil content indicated that these are poor general combiners for these traits.

Estimates of SCA effects in F_3 generation indicated that in the crosses Banki/ICGSE-147 and NC-9/Chico non additive variance was also important for 20-pod length (Table 6). The results suggested that selection for pod length in these crosses should be practiced in later generations. The results also indicated that female parent NC-9 and male parents ICGSE-147 and ICGSE-130 were the best general combiners for pod length and seed weight whereas, the parents No.334 and Banki were found good general combiners for maturity and oil content, respectively. Presence of non additive variance for pod length and oil content suggested that selection will be more effective in later generation for these traits.

Table 6. Specific combining ability effects for 20 pod length in crosses in F_2 generations.

	ICGSE-4	ICGSE-130	ICGSE-147	CHICO
No. 334	-0.43	0.37	-0.96	1.01
BANKI	0.22	0.62	1.99	-2.84**
NC-9	0.20	-1.00	-0.03	1.84
LSD (5%)	3.351			

* = Value for 12 specific combinations.

In conclusion, magnitude of GCA effect was larger than SCA effects for all the traits studied in F_2 and F_3 genration indicating importance of additive genetic variance over non-additive variance. The parents Chico and No-334 are the best general combiner for maturity index and selection for early maturity can be executed in their prognies. Improvement in pod length and seeds per pod can be done in prognies of No-334/ICGSE-147. Due to non-additive variance for pod length in F_3, selection should be practiced in later generations. Moreover, the female parent NC-9 and male parent ICGSE-147 and ICGSE-130 were the best general combiner for pod length and seed weight, whereas, for oil content and maturity, Banki and No-334 proved good general combiner respectively. Presence of non-additive variance, selection for pod length and oil content will be more effective in later generation.

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