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Genetic Diversity and their Effect in Gene Action of Some Soybean Diallel Crosses

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ABSTRACT

A half diallel cross of fifteen F1 crosses in addition to the six parental soybean genotypes namely, (Giza 82, Giza 35, Line 129, Line 105, Line 197 and 574476C) was evaluated to determine the genetic behavior of yield and its components in soybean in addition to seed contents of protein and oil as well as resistance to cotton leaf worm. For these purposes a field experiment was carried out at Etay EL-Baroud Agriculture Research Station, EL-Behaira Governorate, Egypt during 2020 and 2021 summer seasons. The obtained results confirmed that, mean squares associated with general combining ability were highly significant for all studied traits except specific combining ability of both flowering and maturity dates. The ratios of GCA/SCA exceeded the unity in all traits, except for number of pods/plant and seed yield/plant. The parental genotypes, Line 105, Line 129 and Line 197 seemed to be excellent combiners for resistance to cotton leaf worm. The significantly positive desirable ĝi effect were obtained by the three parents Giza 82, Giza 35 and 574476C for yield and yield component traits, the two parents Line 129 and 574476C for seed content of total protein and the parental genotypes, Giza 82, Line 105, and Line 197 for oil percentage. The crosses: Line 197 x Giza 82, Line 197 x Giza 35, 574476C x Giza 35 and Line 105 x Line 129, showed the most negative significant desirable Ŝij effects for defoliation values during growth and reproductive stages. The best (Ŝij) values were showed in the three crosses Line 197 x Giza 35, 574476 C x Giza 35 and Line 197 x Line 129 for pods number/plant and seed yield/plant, the three crosses Line 129 x Giza 82, 574476 C x Giza 82 and 574476 C x Line 105 for protein percentage and the three crosses Line 105 x Giza 82, Line 105 x Giza 35, Line 197 x Giza 35 for seed content of oil.

1. INTRODUCTION

Soybean [Glycine max (L.) Merrill] is among the top 10 of the most widely grown crops, with a total production of over 353.46 million tons in 2020 this production produced from harvested are reached126.95 million hectares worldwide. In Egypt the total harvested area in 2020 was 17000 ha with total production reached 50000 tons **(FAOSTAT, 2020)**. Soybean receives great interest in the developed world, because of their food and processing capabilities. Soybean seeds contain about 20% vegetable oil and 40% protein. Soybean seeds used in many industries such as baby milk, poultry feed as well as many pharmaceutical and cosmetic industries **(El-Agroudy *et al.*, 2011)**. Soybean also used as an attractive crop to production of biodiesel **(Pimentel and Patzek 2008)**. It also has the ability to fix atmospheric nitrogen **(Burris and Roberts 1993)**.

In the soybean breeding, the choice of parents to breed high yield lines associated with higher resistance to cotton leaf worm and seed quality is a hard task to be executed, due to the existence of a large number of genotypes with elevated potential for the attributes of interest **(Borém and Miranda, 2009)**. In order to minimize these effects, breeders take based on important information of these parents, such as, agronomic performance, genetic distance, combining ability and its behavior **(Carvalho *et al.*, 2017)**.

The selection of useful parents based on its phenotype not enough to predict the performance of their progenies, since it is sought allelic and genetic complementarities in order to maximize the combining ability, benefiting of additive gene effects **(Lorencetti *et al.*, 2005)**. When identifying the potential parents, we must made artificial crossed that help breeder to obtain transgressive heterozygous combinations and maximize the segregating populations variability, thus, proportion ting genetic gains to the character in evidence, as well, incrementing the probability to select superior segregating families **(Carvalho *et al.*, 2018)**. These limitations could be avoided through the choice of promising parents, identifying in the early generations its ability in directing alleles and genes of interest **(Ramalho *et al.*, 2012)**. These strategies can reduce, in the early generations, some issues with incompatibility, low complementarities and combining ability **(Borém and Miranda, 2009)**. Aiming to minimize these adversities, diallel crosses might be used to estimate the general combining ability (GCA), which represents the sum of additive gene effects, while the specific combining ability (SCA) base on the non-additive genetic effects **(Cruz *et al.*, 2011; Mebrahtu and Devine 2009)**. The combining ability is great tool that help the breeder in to identify superior genotypes that reveals the agronomic ideotype necessary to attend the breeding program requirements **(Nassar, 2013)**. In this sense, the GCA refers to the average performance of the determinant genes to that specific character, while the SCA explores the dominance, over-dominance, and epistatic deviances **(Daronch *et al.*, 2014)**.

When the absolute value of $\hat{g}i$ is low (be it negative or positive), one can state that the mean of the parent to which it is related does not differ from the mean observed in the diallel for a particular trait. A high value however indicates that the parent is superior or inferior to the other parents involved in the diallel. A positive or negative signal, associated to a particular value, indicates the respective superiority or inferiority of one parent over the others **(Cruz and Regazzi, 2001)**.

According to **Cruz *et al.* (1987)**, the best hybrid combinations are those with the most favorable estimates for the SCA effects that have at least one parent with the most favorable GCA effect for the target trait. According to **Cruz and Vencovsky (1989)**, the best hybrid is result of a cross between parent (a) selected based on GCA and parent (b), whose frequency of favorable alleles is superior to the mean population frequency and considerably divergent from parent (a). Crosses of two parents with high general ability do however not necessarily generate the best hybrid. Finally, this study concentrates on the following objectives: -

- Estimate the magnitude of general combining ability (GCA), specific combining ability (SCA) for some growth, yield and yield component as well as resistance to cotton leaf worm.

2. MATERIALS AND METHODS

The present work was conducted at Etay EL-Baroud Agriculture Research Station, EL-Behaira, Egypt during two summer agriculture seasons of 2020 and 2021 to estimates combining ability for some quantitative traits of set of half diallel crosses with their parents.

Six parental genotypes of soybean [Glycine max (L.) Merrill] 2n=40 were used with their fifteen F1 crosses in the present study. The parental genotypes: names, country of origin, maturity group and pedigree used in the present study are shown in Table 1.

Table 1: The parental genotypes; names, country of origin, maturity group and pedigree

No	Name	Countr	Maturit	Pedigree
1	Giza	Egypt	II	
2	Giza	Egypt	IV	Crawford
3	Line	Egypt	V	D76-
4	Line	Egypt	V	Giza 35 x
5	Line	Egypt	IV	Line 129
6	57447	USA	IV	Introduce

In the first season 2020, the six parental genotypes were sown in three planting dates to avoid the different in flowering time between them and to insure enough hybrid seeds. During this season, all the possible cross combinations of half diallel matting design (without reciprocals) among the six parental genotypes (fifteen crosses) were made by hand. In 2021 season, all the diallel mating progenies (6 parents and their 15 F1 seeds) were evaluated in an experiment designed in a Randomized Complete Block Design (RCBD) with three replications.

The plot size was one ridge in the parents and their F1. Each ridge was three meters long and 70 cm apart. Seeds were planting on one side of the ridge at 20cm hill spacing with one seed per hill. The wet planting method called (Herati) was used and all the other cultural practices were followed as recommended. The following readings and measurements were recorded at individual plants basis at harvesting. Data were recorded as average of 10individual guarded plants chosen for the parents and F1:

Studied characters were:

-Defoliation value: leaf feeding damage or foliage loss (defoliation%): visual rating of percentage defoliation was recorded as the average of three time (every seven days) beginning in vg2 two weeks after sowing and after two weeks flowering for reproductive stage, on each plant in the plot without insect control under the natural field infection, a stander diagram for estimating the percentage of defoliation was reported by **Smith and Brim (1979)** as shown in Fig.1.

-Flowering date: number of days from sowing to first flower in the main stem.

-Maturity date: number of days from sowing to 95% maturity of pods per plant.

-Plant height (cm): the average height of the distance from the soil surface to the terminal bud.

-Number of branches/plants: the number of bearing branches/plant at harvest.

-Number of pods/plant estimates by counting the number of total pods per plant at harvest.

-100 seed weight (g): the weight of 100 random seeds/plant after harvest.

-Seed weight/plant (g): the weight seeds of the individual plant after harvest.

-Seed content of total protein:

Total protein content: Total nitrogen in seeds was determined according to the methods of **Chapman and Pratt (1961)**.

The calculated total nitrogen percentage was multiplied by the factor 6.25 to obtain the percentage of total protein. Total protein content (g/100 g seed) was calculated by multiplying protein percentage by weight of 100 g seed.

Seed oil percentage (%): Seed oil was extracted using the Soxhlet extraction apparatus and petroleum ether (40 to 60°C) was used as a solvent. As 20 g of oil was needed for further analysis, 60 g of pumpkin seeds and 100 g of milk thistle seeds were taken for oil extraction. The extracted oil was separated from the organic solvent using a rotary vacuum evaporator. Seed oil percentage was determined according to **A.O.A.C. (1995)** using Soxhlet apparatus using petroleum ether as a solvent.

Statistical and genetically analysis

General and specific combining ability estimates were obtained by using **Griffin's (1956)** diallel cross analysis designated as method (2) model (1).

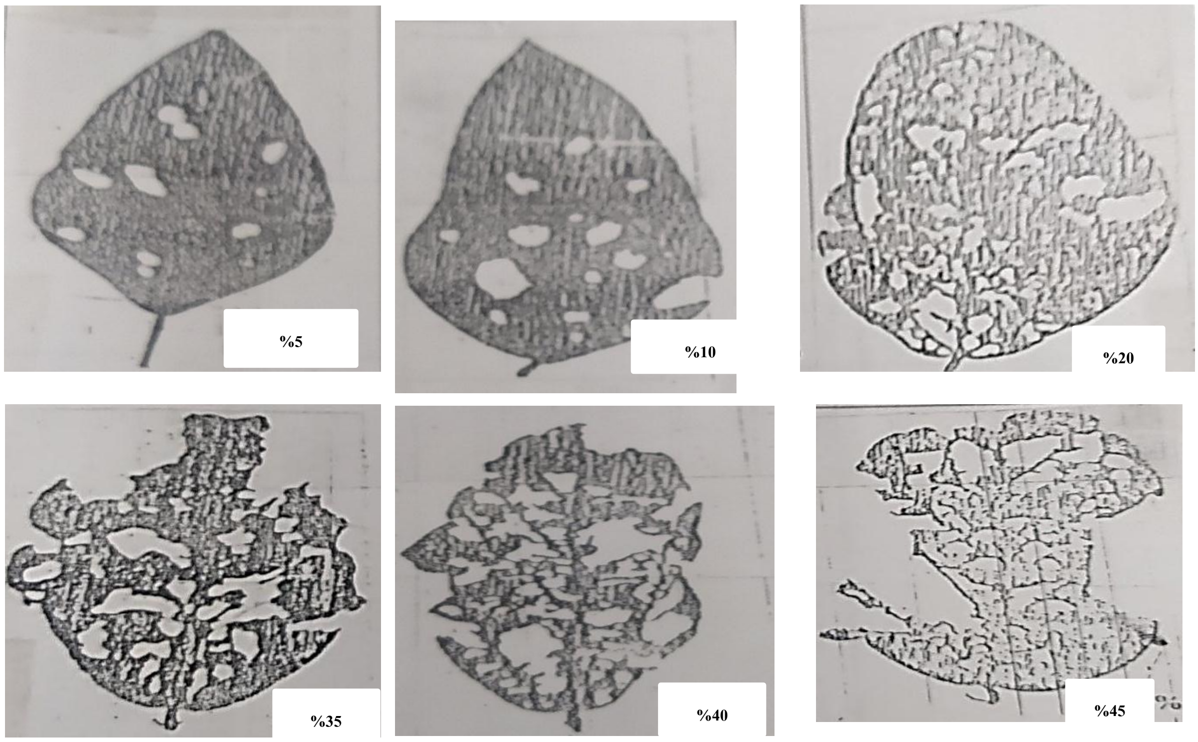

Fig. 1. Standard area diagram estimating the percentage of defoliation by **Smith and Brim (1979**)

3. RESULTS AND DISCUSSION

3.1 Analysis of variance for combining ability

Combining ability (general and specific combining ability) mean squares are present in Table 2.

Mean squares associated with general combining ability were highly significant for all studied traits except specific combining ability of both flowering and maturity dates. The significant of GCA and SCA mean square is evident that additive and non-additive types of gene action were important for the inheritance of these traits. To determine the dominant part of gene action in the inheritance these traits the ratio of GCA/SCA was identified.

The ratios of GCA/SCA exceeded the unity in all traits, except for number of pods/plant and seed yield/plant. The ratio of GCA/SCA which largely exceeded the unity indicate that the largest part of the total genetic variability associated with these traits a result of additive and additive x additive gene action. While the excepted trait number of pods/plant and seed yield/plant the non-additive gene effects seemed to be responsible to inheritance of the trait in question. similar result for significant general and specific combining ability variances were obtained by **EL-Hosary *et al.* (2001), Yassien and Abd EL-Mohsen (2000), Mansour (2002), Mansour *et al.* (2002b) and Fayiz (2009), Waly (2015) and Waly and Ibrahim (2021)**.

From the previous results, it is evident that, the presence of large amount of additive effects suggested that the potentiality for obtaining yield and yield components improvements also, selection procedures based on the accumulation of additive effect may be successful in improving all these studied characters. The large amount of non-additive gene in yield traits could be useful for breeder to release hybrids with large yield in F1.

Table 2: Mean square estimates of combining ability analysis for all traits studied in F1

S.O.V	DF	Defoliation value (%)		Flowering date (days)	Maturity date (days)	Plant height (cm)	Number of branches /plant
		Growth stage	Reproductive stage				
GCA	5	16.47**	62.73**	50.45**	477.80**	305.20**	0.48**
SCA	15	4.59**	9.33**	1.66	15.07	83.04**	0.24**
GCA/SCA		3.59	6.72	30.37	31.7	3.68	1.98
Error	40	0.13	0.36	0.98	8.87	6.02	0.02
G CA	5	378.71*	4.77**	33.71**	50.33**	17.24**	
S CA	15	434.90*	0.39**	37.64**	8.56**	2.91**	
GCA/SCA		0.87	12.28	0.90	5.88	5.92	
Error	40	9.30	0.04	0.71	1.16	0.25	

3.2 General combining ability effects

Estimates of general combining ability effects (ĝi) for individual parental genotype are presented in Tables 3, 4, 5, 6 and 7. General combining ability effects computed herein were found to be differing significantly from zero in all cases. High positive values would be interest under all traits studied in question except; defoliation values, flowering and maturity date where high negative values would be useful form the breeder's point of view.

3.2.1 Resistance to cotton leaf worm

The presented results in Table 3 confirmed that the parental genotypes, Line 105, Line 129 and Line 197, respectively seemed to be excellent combiners for resistance to cotton leaf worm where they showed highly significant negative desirable ĝi effects for defoliation values caused by cotton leaf worm during growth and reproductive stages. Also, Giza 35 was good combiner for resistance to cotton leaf worm where it showed negative significant ĝi effects during reproductive stage.

Mansour *et al.* (2002a) used a top cross among four female lines of soybean to each of three different male testers .They found that the variance due to general combining ability (GCA) and specific combining ability (SCA) indicated that (SCA) played a major role in the inheritance for all traits.

Mansour *et al.* (2002b), Fayiz (2009) and Waly and Ibrahim (2021)found significant negative GCA effect for defoliation value and leaf feeding damage in some parents such as Giza 21, Line 105, Line 129 and Line 154.

Table 3: Estimates of general combining ability effects for defoliation values during growth and reproductive stages of the parental varieties and /or lines

Parents	Defoliation value (%) during	
	Growth stage	Reproductive stage
Giza 82	-0.10	1.55**
Giza 35	-0.16	-0.91**
Line 129	-0.71**	-1.90**
Line 105	-1.30**	-2.77**
Line 197	-0.52**	-0.86**
574476 C	2.79**	4.90**
LSD gi 5%	0.23	0.39
LSD gi 1%	0.31	0.53
LSD gi-gj 5%	0.64	1.08
LSD gi-gj 1%	0.86	1.44

3.2.2 Earliness attributes

The obtained results in Table 4 showed that the parental cultivars, Giza 82, 574476C and Giza35consider excellent combiner for earliness where these genotypes recorded highly significant negative desirable ĝi effects for flowering date and maturity date. All other parental genotypes will delay the flowering and maturity date of their offspring's. The negative effect of general combining ability in earliness traits were observed before by **Refat (1998)**, **Mansour *et al.* (2002b), El-Shaboury *et al.* (2006), Chen *et al.* (2008), Perez *et al.* (2009) and Waly (2015)** which they found highly negative significant general combining ability for flowering and maturity date in soybean. **Agrawal *et al.* (2005) and Maloo and Sharma (2007)** found that Variety JS-335 had negative general combining ability (GCA) for days to flower and days to maturity. While, **Gavioli *et al.* (2008)** showed that highest GCA effects for the traits "days to flowering" was estimated for the cultivars Doko, Cristalina and Savana. As for the Egyptian genotypes **Abou Sen (2020)** confirmed that the parental variety Giza111 (P5) gave significant negative (gi) effects for flowering and maturity dates. While, **Waly and Ibrahim (2021)** reported that Dr101 expressed negative ĝi effect for maturity period.

Table 4: Estimates of general combining ability effects for flowering and maturity dates of the parental varieties and /or lines

Parents	Flowering date (days)	Maturity date (days)
Giza 82	-3.53**	-10.93**
Giza 35	-0.74**	-2.26**
Line 129	3.56**	10.88**
Line 105	1.47**	4.62**
Line 197	0.93**	2.83**
574476 C	-1.69**	-5.13**
LSD gi 5%	0.64	1.94
LSD gi 1%	0.86	2.60
LSD gi-gj 5%	1.77	5.34
LSD gi-gj 1%	2.37	7.14

3.2.3 Growth traits

For plant height the three parents Giza 35, Line 197 and 574476C exhibited highly significant positive desirable ĝi effects for plant height while, the two parents Giza 82 and Line 129 expressed significant positive desirable ĝi effects for number of branches/plant (Table 5). These parents consider good combiner for growth characters in this study.

The positive desirable general combining ability were showed in soybean growth traits by many authors before as **Mansour *et al.* (2002b), Agrawal *et al.* (2005), El-Shaboury *et al.* (2006), Maloo and Sharma**

(2007), Chen *et al.* (2008), Gavioli *et al.* (2008), Perez et al. (2009), Nassar (2013) and Waly (2015).All authors found highly positive significant general combining ability for branches number/plant and plant height in soybean.

3.2.4 Seed yield and its component traits

Data in Table 6 revealed that the three parents Giza 82, Giza 35 and 574476C are excellent combiner for yield and yield component traits. These parents expressed highly significant positive ĝi effects for number of pods/plant, 100-seed weight and seed yield/plant. In the same way the parental Line 197 was good combiner for seed yield/plant also where it exhibited positive desirable ĝi effect for this trait.

The positive desirable general combining ability effect for number of pods/plant, 100-seed weight and seed yield/plant were found before by, **Yassien and Abd EL-Mohsen (2000), Mansour *et al.* (2002b), Agrawal *et al.* (2005), El-Shaboury *et al.* (2006), Maloo and Sharma (2007), Chen *et al.* (2008), EL-Garhy *et al.* (2008), Fayiz (2009), Perez *et al.* (2009), Shiv, *et al.* (2011), Nassar (2013), Waly (2015), Bagateli *et al.* (2020) and Waly and Ibrahim (2021)**.

Table 5: Estimates of general combining ability effects for plant height and number of branches/plant of the parental varieties and /or lines

Parents	Plant height (cm)	Number of branches/plants
Giza 82	-5.06**	0.31**
Giza 35	5.74**	0.05
Line 129	-9.56**	0.14**
Line 105	0.15	-0.38**
Line 197	3.15**	-0.18**
574476 C	5.57**	0.06
LSD gi 5%	1.60	0.10
LSD gi 1%	2.14	0.13
LSD gi-gj 5%	4.40	0.27
LSD gi-gj 1%	5.88	0.37

Table 6: Estimates of general combining ability effects for number of pods/plant, 100-seed weight and seed yield/plant of the parental varieties and /or lines

Parents	pods number/plant	100-seed weight (g)	Seed yield/plant (g)
Giza 82	2.05*	0.47**	0.61*
Giza 35	6.31**	0.30**	1.74**
Line 129	-12.84**	0.02	-3.60**
Line 105	-0.97	-0.85**	-1.09**
Line 197	0.26	-0.96**	0.56*
574476 C	5.19**	1.01**	1.78**
LSD gi 5%	1.99	0.12	0.55
LSD gi 1%	2.66	0.16	0.74
LSD gi-gj 5%	5.46	0.34	1.51
LSD gi-gj 1%	7.31	0.45	2.02

3.2.5 Seed quality traits

The presented data in Table 7 indicated that only the two parents Line 129 and 574476C showed significantly positive desirable ĝi effect for seed content of total protein. These parents consider excellent combiner for increasing seed content of total protein in breeding programs. In the same line, the parental genotypes, Giza 82, Line 105 and Line 197 exhibited highly significant positive effects for oil percentages, these genotypes should be used in breeding programs to improve oil yield. The positive desirable general combining ability effect for seed quality traits (oil and protein percentage) were reported before by, **EL-Garhy *et al.* (2008), Nassar (2013), Waly (2015) and Rialch *et al.* (2017)** all of them found positive GCA effect for oil and protein percentage in soybean seeds.

Table 7: Estimates of general combining ability effects for seed content of total protein and oil percentage of the parental varieties and /or lines

Parents	Protein (%)	Seed oil (%)
Giza 82	-0.87*	0.84**
Giza 35	-0.29	-0.27
Line 129	1.61**	-1.43**
Line 105	-1.34**	0.99**
Line 197	-3.15**	1.80**
574476 C	4.04**	-1.93**
LSD gi 5%	0.70	0.33
LSD gi 1%	0.94	0.44
LSD gi-gj 5%	1.93	0.90
LSD gi-gj 1%	2.58	1.20

Table 8: Estimates of specific combining ability effects for defoliation values during growth and reproductive stages of the fifteen crosses evaluated in the F1

Cross	Defoliation value (%) during	
	Growth stage	Growth stage
Giza 35 x Giza 82	1.03**	0.19
Line 129 x Giza 82	0.15	-1.39**
Line 105 x Giza 82	-0.16	-0.90*
Line 197 x Giza 82	-1.72**	-3.04**
574476 C x Giza 82	-0.58*	-0.78
Line 129 x Giza 35	-0.42	-1.62**
Line 105 x Giza 35	0.41	0.85
Line 197 x Giza 35	-2.26**	-3.01**
574476 C x Giza 35	-3.18**	-5.31**
Line 105 x Line 129	-1.24**	0.24
Line 197 x Line 129	-0.01	0.97*
574476 C x Line 129	4.81**	5.86**
Line 197 x Line 105	-0.06	0.75
574476 C x Line 105	1.89**	-2.96**
574476 C x Line 197	2.23**	2.77**
LSD Sij 5%	0.53	0.89
LSD Sij 1%	0.71	1.19
LSD sij-sik 5%	0.96	1.61
LSD sij-sik 1%	1.29	2.16
LSD sij-skl 5%	0.89	1.49
LSD sij-skl 1%	1.19	2.00

3.3 Specific combining ability effects

Specific combining ability (Ŝij) effects of the parental combinations were computed for all traits in F1 are presented in Tables8, 9, 10, 11 and 12.

3.3.1 Resistance to cotton leaf worm

For defoliation value during growth stage the obtained result in Table 8 cleared that four crosses expressed negative desirable Ŝij effect. The highest negative significant

Ŝij effects were observed in the three crosses; Line 197 x Giza 35, 574476 C x

Giza 35 and Line 105 x Line 129. With respect to defoliation value during reproductive stage the result in Table 19confirmed that seven crosses showed negative desirable Ŝij effect. The highest negative significant Ŝij effects were presented in the three crosses; Line 197 x Giza 82, Line 197 x Giza 35 and 574476 C x Giza 35. In previous studies, **Mansour *et al.* (2002b); Waly and Ibrahim (2021)** found significant negative SCA effect for defoliation value and leaf feeding damage in some crosses related with Giza 21, Line 105, Line 129 and Line 154 used as parent.

Table 9: Estimates of specific combining ability effects for flowering and maturity dates of the fifteen crosses evaluated in the F1

Cross	Flowering date (days)	Maturity date (days)
Giza 35 x Giza 82	1.38*	4.14*
Line 129 x Giza 82	1.42*	4.23*
Line 105 x Giza 82	-1.17	-3.29
Line 197 x Giza 82	-0.29	-0.87
574476 C x Giza 82	-2.33**	-7.08**
Line 129 x Giza 35	1.29	3.95
Line 105 x Giza 35	0.04	0.17
Line 197 x Giza 35	-0.08	-0.42
574476 C x Giza 35	0.21	0.60
Line 105 x Line 129	-0.58	-1.81
Line 197 x Line 129	-1.38*	-4.15*
574476 C x Line 129	-1.42*	-4.24*
Line 197 x Line 105	0.04	-0.08
574476 C x Line 105	-0.67	-2.06
574476 C x Line 197	0.54	1.75
LSD Sij 5%	1.32	4.11
LSD Sij 1%	1.53	5.42
LSD sij-sik 5%	2.64	7.96
LSD sij-sik 1%	3.54	10.66
LSD sij-skl 5%	2.45	7.37
LSD sij-skl 1%	3.27	9.87

The negative effect of specific combining ability in earliness traits were observed before by **Refat (1998), Mansour *et al.* (2002b), El-Shaboury *et al.* (2006), Chen *et al.* (2008), Perez *et al.* (2009) and Waly (2015)** which they found highly negative significant general combining ability for flowering and maturity date in soybean. **Abou Sen (2020)** confirmed that the crosses obtained from parental variety Giza111 (P5) gave significant negative (gi) effects for flowering and maturity dates. While **Waly and Ibrahim (2021)** reported that the crosses produced from Giza 82 or Line 113 expressed negative ĝi effect for maturity period.

3.3.2 Earliness attributes

For flowering date, the presented data in Table 9 indicated that, only the three crosses 574476 C x Giza 82, Line 197 x Line 129 and 574476 C x Line 129 gave the best significant negative Ŝij values.

For maturity date, the most desirable Ŝijwere obtained by only the three crosses 574476 C x Giza 82, Line 197 x Line 129 and 574476 C x Line 129.

3.3.3 Growth traits

Concerning plant height, the results in Table 10 indicated that seven crosses exhibited highly significant positive (Ŝij) effects for this trait. The data indicated that the highest values for this trait were presented by the three crosses 574476 C x Line 105, 574476 C x Line 197 and Line 129 x Giza 35.

For number of branches/plants, nine crosses exhibited significantly positive (Ŝij) effects for this trait. Results indicated that, the four crosses, Line 129 x Giza 82, 574476 C x Giza 82, 574476 C x Giza 35 and Line 197 x Line 129 exhibited the best significant positive desirable (Ŝij) effects for this trait.

The positive desirable specific combining ability were showed in soybean growth traits by many authors before as **Mansour *et al.* (2002b), Agrawal *et al.* (2005), El-Shaboury *et al.* (2006), Maloo and Sharma (2007), Chen *et al.* (2008), Gavioli *et al.* (2008), Perez *et al.* (2009), Nassar (2013) and Waly (2015)** all authors found highly positive significant SCA for branches number/plant and plant height in soybean.

Table 10: Estimates of specific combining ability effects for plant height and number of branches/plant of the fifteen crosses evaluated in the F1

Cross	Plant height (cm)	Number of branches/plants
Giza 35 x Giza 82	3.11	0.35**
Line 129 x Giza 82	-8.93**	0.52**
Line 105 x Giza 82	-5.30**	0.38**
Line 197 x Giza 82	0.03	0.30**
574476 C x Giza 82	2.61	0.40**
Line 129 x Giza 35	8.61**	0.05
Line 105 x Giza 35	-1.76	0.30**
Line 197 x Giza 35	2.57	-0.04
574476 C x Giza 35	6.82**	0.53**
Line 105 x Line 129	4.20**	0.01
Line 197 x Line 129	6.20**	0.40**
574476 C x Line 129	-7.89**	-0.10
Line 197 x Line 105	6.49**	-0.34**
574476 C x Line 105	13.40**	0.03
574476 C x Line 197	11.07**	0.35**
LSD Sij 5%	3.63	0.23
LSD Sij 1%	4.86	0.30
LSD sij-sik 5%	6.56	0.41
LSD sij-sik 1%	8.78	0.55
LSD sij-skl 5%	6.07	0.38
LSD sij-skl 1%	8.13	0.50

3.3.4 Seed yield and its component traits

For number of pods/plants, the obtained results in Table 11revealed that eleven crosses expressed significant desirable positive (Ŝij) effects. The four crosses Giza 35 x Giza 82, Line 197 x Giza 35, 574476 C x Giza 35 and Line 197 x Line 129 gave the best (Ŝij) values for pods number/plant.

With regard to 100-seed weight, the data in Table 22showed that only the four crosses Giza 35 x Giza 82, Line 129 x Giza 82, Line 105 x Giza 35 and 574476 C x Line

105 exhibited significant desirable positive (Ŝij) effects for 100-seed weight.

For seed yield/plant (g), the presented data in Table 11 indicated that ten crosses expressed significant desirable positive (Ŝij) effects. The three crosses, Line 197 x Giza 35, 574476 C x Giza 35 and Line 197 x Line 129 gave the best Ŝij values for seed yield/plant among all the tested crosses.

The positive desirable SCA effect for number of pods/plant, 100-seed weight and seed yield/plant were found before by, **Yassien and Abd EL-Mohsen (2000), Mansour *et al.* (2002b), Agrawal *et al.* (2005), El-Shaboury *et al.* (2006), Maloo and Sharma (2007), Chen *et al.* (2008), EL-Garhy *et al.* (2008), Perez *et al.* (2009), Shiv *et al.* (2011), Nassar (2013), Waly (2015), Bagateli *et al.* (2020) and Waly and Ibrahim (2021)**.

Table 11: Estimates of specific combining ability effects for number of pods/plant, 100-seed weight and seed yield/plant of the fifteen crosses evaluated in the F1

Cross	pods number /Plant	100-seed weight (g)	Seed yield /Plant (g)
Giza 35 x Giza 82	18.92**	0.65**	4.89**
Line 129 x Giza 82	-1.25	0.64**	-0.71
Line 105 x Giza 82	11.22**	-0.27	3.13**
Line 197 x Giza 82	14.02**	-0.98**	4.17**
574476 C x Giza 82	14.99**	0.26	4.91**
Line 129 x Giza 35	-9.83**	0.26	-2.93**
Line 105 x Giza 35	11.28**	0.58**	3.63**
Line 197 x Giza 35	21.86**	-0.99**	6.27**
574476 C x Giza 35	24.42**	0.28	7.52**
Line 105 x Line 129	10.55**	0.12	4.13**
Line 197 x Line 129	18.54**	-0.50**	5.77**
574476 C x Line 129	-10.30**	-0.46**	-3.40**
Line 197 x Line 105	-18.47**	0.31*	-4.48**
574476 C x Line 105	4.62*	0.44**	0.95
574476 C x Line 197	13.33**	0.23	3.32**
LSD Sij 5%	4.51	0.28	1.25
LSD Sij 1%	6.04	0.37	1.67
LSD sij-sik 5%	8.15	0.51	2.26
LSD sij-sik 1%	10.91	0.68	3.02
LSD sij-skl 5%	7.55	0.47	2.09
LSD sij-skl 1%	10.10	0.63	2.80

3.3.5 Seed quality traits

With regard to protein percentage, the data in Table 12 showed that, six crosses expressed significant positive Ŝij for seed content of total protein. The four crosses Line 129 x Giza 82, 574476 C x Giza 82, Line 105 x Line 129 and 574476 C x Line 105 exhibited the highest significant desirable positive (Ŝij) effects for protein percentage.

For oil percentage, the presented data in Table 12 showed that, only the five crosses Line 105 x Giza 82, Line 105 x Giza 35, Line 197 x Giza 35, Line 197 x Line 129 and 574476 C x Line 129 had positive significant Ŝij effect for oil percentage among all tested crosses.

The positive desirable SCA effect for seed quality traits (oil and protein percentage) were reported before by, **EL-Garhy *et al*. (2008), Nassar (2013), Waly (2015) and Rialch *et al.* (2017)** all of them found positive SCA effect for oil and protein percentage in soybean seeds.

Conclusion: The three hybrids (Brand 197 x Giza 35), (574476 x Giza 35) and (Breed 197 x Giza 35) can be used to produce high yield lines of soybeans under the El-Beheira Governorate conditions. Also, the three parents, Giza 82, Giza 35 and 574476S, are considered excellent parents for improving seed yield and its components by using hybridization programs.

Pedigree method of selection considers an effective method for selecting high yielding and resistant lines of cotton leaf worm in this study.

Table 12: Estimates of specific combining ability effects for seed content of total protein and oil percentage of the fifteen crosses evaluated in the F1

Cross	Protein (%)	Seed oil (%)
Giza 35 x Giza 82	-0.43	-1.29**
Line 129 x Giza 82	3.75**	-1.56**
Line 105 x Giza 82	-0.69	0.89*
Line 197 x Giza 82	-0.77	-0.61
574476 C x Giza 82	2.80**	-1.84**
Line 129 x Giza 35	-0.26	0.43
Line 105 x Giza 35	0.77	1.87**
Line 197 x Giza 35	-3.24**	2.26**
574476 C x Giza 35	2.68**	-0.57
Line 105 x Line 129	2.81**	-2.26**
Line 197 x Line 129	-2.83**	1.91**
574476 C x Line 129	-2.81**	1.28**
Line 197 x Line 105	1.73*	-0.77*
574476 C x Line 105	4.02**	-1.73**
574476 C x Line 197	0.86	-0.39
LSD Sij 5%	1.59	0.74
LSD Sij 1%	2.13	0.99
LSD sij-sik 5%	2.88	1.34
LSD sij-sik 1%	3.85	1.79
LSD sij-skl 5%	2.66	1.24
LSD sij-skl 1%	3.56	1.66

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القدرةعلى التآلف لبعض هجن فول الصويا التبادلية

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الملخص العربي

تم تقييم السلوك الوراثي للمحصول ومكوناته في فول الصويا بالإضافة إلى محتوى البذور من البروتين والزيت وكذلك مقاومة دودة ورق القطن لخمسة عشر هجينًا فى الجيل الأول ناتجة من التهجين النصف دائري مع أبائها الستة وهي: (جيزة ٨٢، جيزة ٣٥، سلالة ١٢٩، سلالة ١٠٥، سلالة ١٩٧، ٥٧٤٤٧٦ج). لهذا الغرض تم إجراء تجربة حقلية في محطة البحوث الزراعية إيتاي البارود، البحيرة، مصر خلال مواسم صيف ٢٠٢٠/٢٠٢١م. أكدت النتائج المتحصل عليها ان التباين الراجع للقدرة العامة والخاصة على التآلف كان عالي المعنوية لجميع الصفات المدروسة باستثناء القدرة الخاصة على التآلف لميعادي الإزهار والنضج. تجاوز تنسب GCA/SCA الوحدة في جميع الصفات، باستثناء عدد القرون/نبات ومحصول البذور/نبات. كان للطرز الوراثية الأبوية، سلالة ١٠٥ والسلالة ١٢٩ والسلالة ١٩٧، قدرة عامة تألفيه ممتازة لمقاومة دودة أوراق القطن. تم الحصول على تأثير موجب مرغوب للقدرة العامة على التآلف فى الأباء جيزة ٨٢، جيزة ٣٥ و ٥٧٤٤٧٦ج لصفات المحصول ومكوناته، سلالة ١٢٩ و ٥٧٤٤٧٦ج لمحتوى البذور من البروتين الكلي والأباء جيزة ٨٢، سلالة ١٠٥ وسلالة ١٩٧ لصفة نسبة الزيت فى البذور. أظهرت الهجن سلالة ١٩٧ × جيزة ٨٢، وسلالة ١٩٧ × جيزة ٣٥، و ٥٧٤٤٧٦ج × جيزة ٣٥، وسلالة ١٠٥ × سلالة ١٢٩، أهم التأثيرات المعنوية السالبة والمرغوبة للقدرة الخاصة على التآلف لصفتي تأكل الأوراق بفعل دودة ورق القطن أثناء مراحل النمو والإثمار. ظهرت أفضل القيم المعنوية الموجبة لتأثير القدرة الخاصة على التآلف في الهجن الثلاثة سلالة ١٩٧ × جيزة ٣٥، ٥٧٤٤٧٦ج × جيزة ٣٥ وسلالة ١٩٧×سلالة ١٢٩ لصفات عدد القرون/نبات ومحصول البذور/نبات، والهجن الثلاثة سلالة ١٢٩ × جيزة ٨٢، ٥٧٤٤٧٦ × C جيزة ٨٢ و٥٧٤٤٧٦ج × سلالة ١٠٥ لنسبة البروتين فى البذور وسلالة الهجن الثالث ١٠٥ × جيزة ٨٢، سلالة ١٠٥ × جيزة ٣٥، سلالة ١٩٧ × جيزة ٣٥ لمحتوى البذور من الزيت.