Estimation of Hybrid Vigor and some Genetic Parameters in some growth traits of rice (*Oryza sativa L.*) and the hybrids derived from it using the factorial hybridization method

Haneen Mushtaq Abdhussian Abdullah Fadhil Sarheed

Abdulkadhim Jawad Musa

Al-Furat Al-Awsat Technical University - Al-Musaib Technical College

E-mail: com.abdf@atu.edu.iq

Abstract:

The research was conducted at the rice research station in Al-Mishkhab / Al-Najaf Al-Ashraf for the years 2021 and 2022, which is 20 km south of the center of Al-Najaf Al-Ashraf province and located at latitude 31.48 north and longitude 44.29 east, at an altitude of 70 m above sea level, using eight genotypes of rice, which are four. Local cultivars (Amber 33, Yasmine, Al-Furat, and Degla), which were obtained from the rice research station in Al-Mishkhab, and four Egyptian cultivars (Giza 201, Giza 178, Giza 179, and Basmati 1), with the aim of evaluating the performance of the cultivars used in the research and the hybrids derived from them using the factorial hybridization method, numbering (16). Hybrid and estimating the proportions of hybrid vigor and the combining ability in public and private GCA (General combining ability) SCA(Specific combining ability) with some other genetic parameters. In autumn fall season of 2021, hybridization was conducted according to the factorial hybridization method. Comparative experiments were carried out for hybrid and their parents for the year 2022 using a randomized complete block design (RCBD) with three replicates. The results showed the following:

Significant differences were found between the genotypes (cultivars and their hybrids) in all the studied traits. The results showed that the Hybrid Vigor values were significant for most of the studied traits and for the two seasons, indicating the effects of complete dominance and superdominance of the genes that control the inheritance of these traits. The genetic analysis of the study showed that the general (GCA) and specific (SCA) and the male parent (3) and female parent (8) showed high combination ability and in the desired direction in most of the traits. The values of the specific combination ability of the hybrids were significant in most of the traits. The hybrid (3×5) was distinguished by giving the best effect of the specific combination ability in most of traits, and the average degree of dominance was higher than one true in all traits. It was found that the percentage of heritability in the broad sense was high in all traits. The narrow sense heritability peracentage was low to moderate for all traits. The results indicate that the hybridization method is the most appropriate for improving these traits. The hybrid (3×5) (Giza 201 × Al-Furat) is one of the most promising hybrids

ISSN 2072-3857

introduction

Rice is one of the important and major grain crops in the world. It ranks second after wheat in terms of importance. About half of the world's population feeds on it. It is the main economic resource for hundreds of millions of Asian residents [1] (FAO STAT, 2021). The world's cultivated rice area is 162 million hectares and produces approximately 756 million tons[2] . In Iraq, an area of 388 thousand dunums was planted, with an annual production of 155 thousand tons for the year 2021 [3] . This production must be increased to meet the continued population growth, especially in the next 30 years, because a population increase of up to 40% is expected, as well as to increase the risk of environmental pressures and the limitation of arable areas[2]

Hybridization is considered one of the main sources for creating new genetic variations. Selection can be coundected from isolated populations with the aim of developing new cultivars suitable for environmental conditions and characterized by important economic characteristics. Among the mating systems used is factorial mating in breeding and improving grain crops, where it is one of the systems that can be relied upon to compare parental cultivars and select the best. Hybrids Due to the information that can be obtained from the first generation, the process of hybridization is an effective tool in the hands of plant breeders, as it gives the possibility of producing great genetic variation, and provides the opportunity to select new genotypes, wher the aim of hybridization between strains pure lines is to combine the good qualities desired in a hybrid. It can be used directly to produce other hybrids or synthetic cultivars.[4] . The first rice cultivar, IR8, was released in 1966. It was a modern, high-yielding rice cultivar at the time. Several genetic improvements were made to it in terms of shortening its growth period and improving the quality of the grain. Later, 42 cultivars of rice were released at the International Rice Research Institute. (IRRI). The yield of R8 and other early cultivars ranged between 9-10 tons/ha during the years 1969-1970. The production capacity of modern rice cultivars is 10 tons/ha[5] .

Although knowledge of the genetic and phenotypic correlations Lead to an important role for plant breeders in diagnosing the traits most closely related to the yield, weak knowledge of the interrelationships between different traits and the use of unilateral selection for field traits leads, as a result, to weak results, or to results being less than ideal. In plant breeding, it provides us with useful estimates in determining the components of a complex trait such as yield. However, it does not provide us with accurate information about the relative importance of the direct and indirect effects of each trait on yield. Therefore, path coefficient analysis is used to partition the genetic correlation coefficient between the dependent variable (yield) and the independent variables. (Studied traits) to direct

ISSN 2072-3857

and indirect effects, to derive and diagnose selection evidence to guide plant breeders in selection and hybridization programs [6] .studying the genetic parameters of traits, such as the heritability ratio, reveals the relative importance of the genetic variation on the total phenotypic variation, and thus the appropriate breeding method is used. The method of factorial mating proposed by the two scientists: Comstock and Robinson (1948 and 1952) is one of the methods of hybridization between strains or cultivars through which the best strains and genetic structures used as parents and the best hybrids resulting from that are determined.

The most important aims of this study can be summarized as follows:

1- The traits of eight local and Egyptian rice cultivars and their resulting hybrids are evaluated according to a factorial pairing design. Hybrid vigor estimation.Estimating the effects of the general combining ability of breeds and the general combining ability of hybrids. Estimating the components of phenotypic variation for different traits to identify the nature of their genetic action.Estimating heritability in its broad and narrow senses, and the average degree of dominance for the traits under study.

Materials and methods

The research was conducted at the rice research station in Al-Mishkhab / Al-Najaf Al-Ashraf for the years 2021 and 2022, which is 20 km south of the center of Al-Najaf Al-Ashraf province and located at latitude 31.48 north and longitude 44.29 east, at an altitude of 70 m above sea level, using eight genetic compositions of rice, which are four. Local cultivars (Amber 33, Yasmine,Al- Furat and Degla), which were obtained from the rice research station in Al-Mishkhab, and four Egyptian cultivars (Giza 201, Giza 178, Giza 179, and Basmati 1), which were obtained from the Arab Organization for Agricultural Development / Egypt. The research included the following steps:

Plowing the field soil with two perpendicular plows with a rotary plow, at a depth of 30 cm. Then it was smoothed with disc harrows and the soil was leveled with a leveling machine. After that, the field was divided into plot with a panel length of 3 m and a width of 1 m. Thus, the area of the experimental unit reached 3 m^2. The experimental soil was fertilized with P_2O_5 superphosphate fertilizer (150 kg/ha). It was added all at once before planting, and the planting was done manually on lines, with a distance of 10 cm between one line and another, with a seed rate of 35 kg per dunum. Nitrogen fertilization will be added in batches.

For the purpose of combating weeds, Isol pesticide was added at a spray rate of 50-100 grams per 100 liters of water after planting, using 100 liter containers for the purpose of combating weeds growing with rice, especially the weed. In addition to manual weeding whenever necessary, manual harvesting of the

ISSN 2072-3857

experimental units will be coundected when the plants reach physiological maturity.

Eight pure genotypes of rice (Table 1) were introduced into a crossbreeding program according to the factorial mating design proposed by researchers Comstock and Robinson (1948 and 1952).

The pure **strains** lines entered were divided into two groups. The first: used as female parents (Females), and their number is four types: (Amber 33, Yasmine, Al-Furat, and Dajla). The second: used as males, and there are four types: (Giza 201, Giza 178, Giza 179, and Basmati 1). The number of hybrids produced will be equal to 4 x 4 = 16 hybrids.

The hybrid is symbolized by two numbers representing its parents. The first number represents the female parent and the second number represents the female parent. For example, the hybrid: (1×6). This symbol means that strain number (6), which is (Giza 178), represents the female parent of this hybrid, and strain number (1), which It (Amber 33) represents the female parent of this hybrid, and the following table shows the method of multiplication to obtain 16 hybrids.

Table (1) Multiplication method and hybrid symbol

symbol	genotype	no.	Symbol	genotype	no.
3×5	♂) Giza 201 × Al-furat ♀ (	9	1×5	♂) Giza 201 × Amber 33 (♀	1
3×6	♂) Giza 178 × Al-furat (♀	10	1×6	♂) Giza 178 × Amber 33 (♀	2
3×7	♂) Giza 179 × Al-furat (♀	11	1×7	♂) Giza 179 × Amber 33 (♀	3
3×8	♂) Basmati × Al-furat (♀	12	1×8	♂) Basmati × Amber 33 (♀	4
4×5	♂) Giza 201 × dajla (♀	13	2×5	♂) Giza 201 × Yasmine (♀	5
4×6	♂) Giza 178 × dajla (♀	14	2×6	♂) Giza 178 × Yasmine (♀	6
4×7	♂) Giza 179 × dajla (♀	15	2×7	♂) Giza 179 × Yasmine (♀	7
4×8	♂) Basmati × dajla (♀	16	2×8	♂) Basmati × Yasmine (♀	8

Implementation of the experiment:

The eight genotypes were planted in the first year of 2021 at the rice research station in Al-Mishkhab / affiliated with the General Authority for Agricultural Research / Ministry of Agriculture, and pollination was controlled by taking random samples within the experimental units before the flowering stage and placing them in 7-kg anvils, three of each cultivar. They were transferred to the canopy near the experimental field, and the hybridization process was carried out between the local and Egyptian cultivars by removing the anthers from the female parents using forceps prepared for this purpose, as well as using a magnifying glass to facilitate the process of removing the anthers. Pollen grains were transferred from the female parents to the maternal lines, and the male and female

ISSN 2072-3857

inflorescences were covered with Poehlmen leaf bags.

Experimental design:

In the second year, 2022, the seeds of the parents and hybrids (sixteen individual hybrids + eight parents) were planted according to a completely randomized block design with three replicates. The experimental unit included three replicates. After preparing the field soil in terms of plowing, smoothing, amending, and dividing, the leveling was repeated in the presence of water to ensure the success of seedling growth. Movable, which is an important process in the shtal method. According to the planting dates on 6/21, the seeds of all cultivars were placed in cloth bags inside containers filled with clear water for a period of 48 hours, and the water was changed every 12 hours to ensure the abundance of dissolved oxygen for the seed embryos. After this process, the seeds were packaged by placing jute bags on them and covering them. For 24 hours for the purpose of stimulating germination (the appearance of the root and the petiole), after that, plastic dishes with dimensions (28 x ×58 x× 3) cm were prepared and filled with fine soil, and after moistening them to the point of saturation, the seeds were scattered for all cultivars. Then the placement process was carried out, where the dishes were placed on top of each other and each dish was covered. It was planted in an empty plate. Then I covered these plates stacked well on top of each other with a jute bag soaked in water to maintain permanent moisture for the seeds. They remained in this state for five days. Then I moved the plates to the nursery to obtain better growth of the seedlings. The plates were placed next to each other and covered with a light cloth to prevent damage to the seedlings. By birds, rodents and direct sunlight. The nursery was watered twice a day, with water being drained, and the nursery was kept moist to help the roots of the seedlings grow in the dishes. The dishes were left in the nursery until they were planted in the permanent field. The nursery was established near the experiment site for ease of transportation and not to harm the seedlings. Then the seedlings were transferred to the permanent field when they were 25 days old and planted as one seedling in the hole. The distance between one hole and another was 25 cm and between one line and another was 25 cm. The field was started to be watered using the traditional irrigation method to irrigate the (continuous) rice crop after manual transplanting. The bush was uprooted three times manually. The first weeding was carried out 10 days after planting, the second after 15 days of the first weeding, and the third after 15 days of the second weeding. The experiment was fertilized with the compound fertilizer (18-18-0) NP, in an amount of 400 kg ha-1 mixed with the soil. As for the urea fertilizer (46%) N was added in two equal batches, the first 10 days after planting, at a rate of 140 kg ha-1 for each batch, while the second was added a month after the first batch,

ISSN 2072-3857

and irrigation operations continued until the plants reached the stage of physiological maturity [7] .

Table 2: Some physical and chemical characteristics of the field soil in which the experiment was conducted

units		Agricultural season 2022	Traits	
Silty clay mixture	g.kg^{-1}	23.09	sand	Soil texture components
	g.kg^{-1}	41.27	Silt	
	g.kg^{-1}	35.64	Clay	
ppm		24.25	Nitrogen	
ppm		15.31	Phosphorus	
ppm		175.12	Potassium	
Ds.m^{-1}		3.24	EC electrical conductivity	
---		7.47	pH	

Studied traits:

1 - Number of days from planting to 50% flowering

2 - The number of days from planting to physiological maturity

3 - Plant height (cm): Measured for ten random plants at harvest

4 - Panicle length (cm): Measured for ten random panicle at harvest

5- The flag leaf length (cm).

6- Flag leaf area (cm^2): It will be calculated for ten random flag leaves, according to the following equation: Flag leaf area (cm^2) = leaf length x width (of the widest area) x 0.74 [8] .

statistical analysis

Data for the genotypes (parents and hybrids) and for the studied traits were analyzed according to a completely randomized block design using the analysis of variance method, and the least significant difference of 0.05 was used to diagnose statistical differences between the arithmetic means of the coefficients[9]

Genetic analysis

Second: The hybrid data were analyzed according to the method of the global mating system proposed by the scientists Comstock and Robinson (1948 and 1952) and the fixed model (Table 4).

For the purpose of conducting genetic studies, according to this system, the equation of the mathematical model is:

Hybrid vigor heterosis

Hybrid vigor was calculated in two ways:

Based on the average deviation of the first generation from the best parents

) as follows:

$$H = \overline{F}1 - H\,\overline{p}$$

Hybrid vigor was estimated for the two traits: the number of days from planting until 50% flowering, the number of days from planting until physiological maturity, the number of

ISSN 2072-3857

empty grains, the percentage of infertility, and the number of ineffective branches, on the basis of the deviation of the first generation from the lowest of the two parents, according to the following equation

$$H = \overline{F}1 - L\overline{p}$$

where:

$\overline{F}1$ =First generation hybrid rate

$H\overline{p}$ = =Higher parent rate

$L\overline{p}$ =Lowest rate of parents

Estimating public and private coalition capacity:

A- General capacity in the coalition : GCA(General combining ability)

It is the extent of the effect of the general ability in the coalition of female parents and female parents, as follows:

$$\hat{g}_i = \bar{y}_{i..} - \bar{y}_{...} \quad ; \quad \hat{g}_j = \bar{y}_{.j.} - \bar{y}_{...}$$

where:

$= \bar{y}_{i..}$ average parent (for traits)

$= \bar{y}.j.$ Average female parent) j traits(

$= \bar{y}_{...}$ Overall average (for the trait(

The t-test was used to determine the significance of the effect of general ability in the coalition, as: $t = \frac{\hat{g}_i}{SEgi}$

$$V(g_i) = \frac{2\sigma e^2}{r} \quad ;$$

$$SE(g_i) = \sqrt{\frac{2\sigma e^2}{r}}$$

B- The effect of special combining ability SCA in the coalition:

Estimate the effect of the special ability in the coalition for each hybrid according to the following rate:

$$\hat{S}_{ij} = \bar{y}_{ij.} - \bar{y}_{i..} - \bar{y}_{.j.} + \bar{y}_{...}$$

where:

$= \bar{y}_{ij.}$ Average hybrid) (ij) traits(

The t-test was used to determine the significance of the estimator's effect on the coalition, as:

$$t = \frac{\hat{S}_{ij}}{SE(S_{ij})}$$

Note that:

$$V(S_{ij}) = \frac{4\sigma e^2}{r} \quad ;$$

$$SE(S_{ij}) = \sqrt{\frac{4\sigma e^2}{r}}$$

10-3Contrast components:

The additional additive , dominant, and environmental variance were estimated based on the average expected variance (EMS) from the analysis method according to the factor pairwise system. Note that the additive variance was estimated in three cases:

The first: on the basis of female parents (Males)

$$\sigma^2 A_{asmale} = 2\sigma^2 m$$

Second: On the basis of female parents:

ISSN 2072-3857

$$\sigma^2 A_{as\ female} = 2\sigma^2 f$$

Third: Based on the rate of parents:

$$\sigma^2 A_{asaverage} = \frac{2\sigma^2 m + 2\sigma^2 f}{2} = \sigma^2 m +$$

The sovereign and environmental variance was calculated as follows: $\sigma^2 D = \sigma^2 MF$

$$\sigma^2 E = \frac{\sigma^2 e}{r}$$

The genetic and phenotypic variances were calculated through the following equations:

$$\sigma^2 G = \sigma^2 A + \sigma^2 D$$

$$\sigma^2 P = \sigma^2 G + \sigma^2 E$$

11-3Heritability and average degree of dominance:

Heritability:

The heritability peracentage was estimated in both senses: broad and narrow, by applying the following equations in three cases:

-1Based on parents (Male.(

-2On the basis of female parents.

-3Based on the rate.

According to the following equations:

$$h^2 bs = \frac{\sigma^2 G}{\sigma^2 P} \times 100 = \frac{\sigma^2 A + \sigma^2 D}{\sigma^2 A + \sigma^2 D + \sigma^2 E} \times 100$$

$$h^2 ns = \frac{\sigma^2 A}{\sigma^2 P} \times 100 = \frac{\sigma^2 A}{\sigma^2 A + \sigma^2 D + \sigma^2 E} \times 100$$

The limits of inheritance were adopted in the broad sense, according to what [9] stated, as follows:

Less than 40% low

From 40%-60% medium

More than 60% high.

The limits of inheritance in the narrow sense,

Less than 20% low

From 20%-50% medium

More than 50% high.

Average degree of sovereignty: (a) and was estimated from the following equation in three cases:

-1Based on parents (Male.(

-2Based on female parents.

3-Based on the average.

$$\bar{a} = \sqrt{\frac{2\sigma^2 D}{\sigma^2 A}}$$

When you are:

$0 = \bar{a}$ It indicates a lack of sovereignty.

$0 > \bar{a} > 1$ It indicates the presence of partial sovereignty.

$\bar{a}$ 1= It indicates the presence of complete sovereignty.

$\bar{a}$ 1< It indicates the existence of superior sovereignty.

RESULTS & DISCUSSION

The results of the analysis of variance table indicated that there were significant differences between the genotypes and all the studied traits,

ISSN 2072-3857

where shown in Table (3) and for the trait number of days from planting until 50% flowering to superiority of the 16H hybrid (Basmati x Tigris), where it was 113.33 days earlier in flowering, which did not differ significantly from the hybrids. (H14, H15, H9, H1) by giving them (114.0, 114.33, 140.67, 114.67) sequentially, while the H5 hybrid (Giza 201 The lowest number of days from planting to 50% flowering was 111.67 days, while the cultivars (Yasmine, Basmati, and Al-Furat) gave the highest number of days from planting to 50%, amounting to (123.67, 124.33, and 123.67 days) respectively. As for the trait of the number of days from planting to physiological maturity, hybridization was earlier. H11 (Basmati 158.0 days. As for plant height, the genotype H16 (Basmati x ×Tigris) excelled by giving the highest height of the hybrid, reaching 100.0 cm, while the hybrid H8 (Giza 179 x Yasmine) gave the lowest plant height, reaching 67.33 cm. As for the cultivars, the Ambar 33 cultivar excelled by giving it the highest plant height of 104.0 cm, while the shortest height of the Giza 179 cultivar reached 65.0 cm. As for the panicle length characteristic, the H14 hybrid (Giza 201 x Tigris) and the H2 hybrid (Giza 201 x Amber 33) excelled by giving them the highest panicle length of (25.73, 25.50) respectively. While the hybrid H15 (Giza 178 x Tigris) gave the lowest panicle length, which was 18.47 cm. As for the trait of leaf length, the hybrid H5 (Giza 201 x Yasmine) was excelled by 28.60 cm, while the hybrid H7 gave the lowest leaf length. The flag reached 22.20 cm. As for the cultivars, the Tigris cultivar excelled by giving it 30.93 cm, while the Giza 179 cultivar gave the lowest value, which was 21.40 cm. As for the flag leaf area, the hybrid H5 (Giza 201 x Jasmine) excelled by giving the highest flag leaf area of 27.06 cm2. While the hybrid H7 (Giza 178

ISSN 2072-3857

Table 3. Arithmetic means values for growth traits of rice crop for season 2022

Flag leaf area/cm2	Flag leaf length/cm	panicle length/cm	Plant height/cm	Number of days from planting to maturity	Number of days from planting up to 50%	traits
21.61	25.40	20.70	77.67	144.00	114.67	H 1
17.19	23.73	25.50	95.00	141.00	117.33	H 2
18.16	24.73	24.00	79.67	152.00	117.67	H 3
17.45	23.87	21.33	75./67	147.33	119.00	H 4
27.06	28.60	24.93	84.67	155.67	125.00	H 5
20.69	27.93	20.47	88.33	140.67	117.00	H 6
15.19	22.20	20.87	75.67	147.67	114.00	H 7
16.43	23.87	21.23	67.33	144.67	117.67	H 8
21.01	26.87	26.43	83.00	141.33	114.67	H 9
18.31	25.33	21.83	72.00	157.00	119.00	H 10
21.79	27.80	24.87	98.33	138.00	117.67	H 11
20.95	26.07	19.80	85.00	148.67	118.67	H 12
18.85	24.53	19.07	85.67	143.33	114.67	H 13
22.21	26.87	25.73	81.00	148.00	114.00	H 14
16.08	23.47	18.47	70.00	150.00	114.33	H 15
20.52	24.47	22.70	100.00	140.67	113.33	H 16
24.14	29.80	21.90	75.67	154.00	121.00	178G
17.40	21.40	19.47	65.00	135.00	111.67	179G
37.48	27.93	28.87	94.67	146.00	122.67	201G
26.16	26.87	26.37	89.00	158.00	123.67	B
26.56	26.40	22.30	76.00	139.33	124.67	Y
19.50	24.40	21.00	71.67	156.33	124.33	F
31.98	30.93	29.67	97.00	146.00	117.33	D
24.79	27.53	23.83	104.00	137.00	113.00	33A
2.958	3.130	1.403	4.946	3.215	2.294	LSD

Hybrid vigor

It is noted in Table (4) that there are significant differences in Hybrid vigor calculated on the basis of the content of the two parents, and that the highest value for Hybrid vigor in the negative direction reached -7.82% in the hybrid (6×4), indicating the effect of the superior dominance of genes in the direction of early flowering. However, some hybrids showed Also, positive hybrid strength reached a maximum of 11.94% in the hybrid (5×2).As for the trait of the number of days from planting until physiological maturity, the hybrid vigor in the negative direction reached its highest value, reaching -8.44% in the hybrid (6×1), while the hybrid vigor in the positive direction in the hybrid (5×2) reached the highest value, amounting to 15.31%.As for the plant height trait, it is noted that most of the hybrids gave negative values, with the

ISSN 2072-3857

exception of the hybrids (5×1), (6×1), (5×2), (6×2), and (7×3), which gave positive values, the highest of which was in the hybrid (6 x 1) reached 25.55%. These positive values given by most hybrids indicate the presence of hybrid abundance for this trait and that the trait falls under the non-additive influence of genes.As for the panicle length characteristic, all hybrids gave negative hybrid vigor, the highest being -37.75% in the (6×4) hybrid, with the exception of the (6×1) and (5×2) hybrids, which gave positive values, the highest reaching 16.44% in the (6×1) hybrid. Which indicates the existence of superior dominance of genes that control the inheritance of this trait. As for the leaf length traits, all hybrids showed negative hybrid vigor, with the exception of the hybrid (5×2) and (6×2), which gave the highest value of 14.48%, while the highest negative value reached -24.14% for the hybrid (7×4).

As for the area of the flag leaf, significant differences were found for Hybrid vigor, and that most of the hybrids gave negative values, reaching a maximum of 51.15% for the hybrids (6×3), while hybrids (5×2) and (6×2) gave positive values, reaching a maximum of (6.10%). For hybrids (6 x 2), these negative values indicate the effect of partial dominance of genes on the inheritance of the trait. [11]

Table 4. Hybrid vigor for growth characteristics traits of rice crop hybrids for the 2022 season

Flag leaf area/cm2	Flag leaf length/cm	panicle length/cm	Plant height/cm	Number of days from planting to maturity	Number of days from planting up to 50%	traits / Crosses
-18.64	-14.77	-7.17	2.19	3.35	-5.23	H 1
-28.80	-20.36	16.44	25.55	-8.44	-3.03	H 2
-43.22	-20.04	-19.10	-17.87	4.11	0.28	H 3
-29.61	-19.91	-10.49	-27.24	7.54	5.31	H 4
1.91	8.33	11.81	11.40	15.31	11.94	H 5
6.10	14.48	-2.54	23.26	4.20	4.78	H 6
-52.50	-28.23	-29.66	-21.99	9.38	2.09	H 7
-33.73	-13.32	-10.91	-35.26	7.16	5.37	H 8
-43.94	-3.82	-8.43	-12.32	1.44	-6.52	H 9
-51.15	-9.31	-24.36	-23.94	7.53	-2.99	H 10
-41.85	-10.13	-16.18	1.37	-5.48	0.28	H 11
-44.11	-6.68	-31.41	-18.27	8.52	5.01	H 12
-29.02	-8.68	-27.69	-3.75	2.87	-7.28	H 13
-15.12	0.00	-2.40	-8.99	-5.33	-7.82	H 14
-49.72	-24.14	-37.75	-27.84	2.74	-2.56	H 15
-21.57	-11.14	-13.91	-3.85	2.68	0.29	H 16
4.47	2.86	3.76	4.51	1.52	1.39	S.E

ISSN 2072-3857

Estimation of genetic parameters

Table (5) shows that there are significant differences for general and specific combining ability, which indicates the presence of both additive and non-additive effects of genes on this trait. It is clear from the table that the female parent (4) and female parent (7) showed the lowest values for general combining ability, amounting to (-2.70, -0.87). Thus, they can be used to improve the quality of early flowering, while the rest of the female parents and female parents gave positive values, thus taking a longer period to reach flowering, excelled female parent (2) by giving him the highest value for the general combining ability, amounting to 1.62. The general combining ability differed among them, as the hybrid (7×2) gave the highest value in the negative direction, amounting to -3.54, while the hybrid (5×2) gave the highest value in the positive direction, 6.12. Parents that gave the lowest value for general combining ability can be used in breeding and improvement programs for this trait. The additional variance (A) was 3.53. It is noted that the non-additive genetic variance of the genes was more influential than the additional variance, which led to the average degree of dominance being greater than the correct one (2.19), which indicates the existence of superior dominance of the genes that control the inheritance of the trait. The same table shows that the heritability peracentage in the broad sense was 84.14% and in the narrow sense was 24.67%. This low value also confirms that this trait is subject to the non-additive influence of genes, and based on these data, after hybridization is the most appropriate methods to improve the trait. [12].

ISSN 2072-3857

Table (5) General (GCA) and specific (SCA) combining ability, their variations, and some Genetic Parameters for the characteristic traits of the number of days from planting until 50% flowering of the rice crop.

The general combining ability of parents and specific of hybrid					
parents	SCA for cross				GCA for male
	5	6	7	8	
1	-2.958	0.125	1.375	1.458	0.375
2	6.125	-1.458	-3.542	-1.125	1.625
3	-3.292	1.458	1.042	0.792	0.708
4	0.125	-0.125	1.125	-1.125	-2.708
GCA for female	0.458	0.042	-0.875	0.375	
Se	Male	Female	male x female		
	1.2304	1.2304	1.7401		

Genetic Parameters					
σ^2GCA for male	3.350	H^2bs	84.145		
σ^2GCA for female	0.183	H^2ns	24.672		
σ^2SCA for m x f	8.518	A	2.196		
σ^2A in male	6.700	Genetic enhancement (EGM)	1.634		
σ^2A in female	0.367	Genetic improvement (EGM) as a percentage of the rate	1.399		
σ^2A	3.534				
σ^2SCA	8.518				
σ^2D	8.518				
σ^2G	12.051				
σ^2E	2.271				
σ^2P	14.322				

Table (6) shows the values of general and specific combining ability for traits of the number of days from planting until physiological maturity, as significant differences were found. It is clear from the table that the female parent (4) was superior by giving him the highest value for the general combining ability in the negative direction, amounting to -0.75, while the female parent (2) gave the highest value. It reached 0.91., the female parent (8) gave the highest value, amounting to 0.91 - while (7) gave the highest value in the negative direction, amounting to 0.66. The negative values for female parents and female parents indicate the possibility of improving the rice crop by early maturity. As for the special combining ability, the hybrid (7 × 3) gave the highest value in the negative direction, amounting to 8.91. Thus, it is possible to benefit from this hybrid by reducing the number of days it takes to reach maturity. As for the hybrid (6 × 3), it gave the highest value in the positive direction, amounting to 10.33. However, it takes a longer period to reach maturity, so it is possible to benefit from these hybrids that gave negative values towards improving this crop. The value of the additional variance was (0.37). The results indicate that the non-additional variance was greater than the

ISSN 2072-3857

additional variance, which made the average degree of dominance greater than the correct one. (6.09), which indicates the existence of superior dominance of the genes that control this trait

The heritability peracentage in the broad sense reached 93.23%, and in the narrow sense it was 0.71%. This low value indicates the non-additive effect of genes, and therefore hybridization is the appropriate way to improve this crop. [13]

Table (6) General (GCA) and specific (SCA) combining ability, their variations, and some Genetic Parameters for the characteristic of the number of days from planting until physiological maturity of the rice crop.

The general combining ability of parents and specific of hybrid					
Parents	SCA for cross				GCA for male
	5	6	7	8	
1	-1.917	-5.500	5.250	2.167	-0.167
2	8.667	-6.917	-0.167	-1.583	0.917
3	-4.750	10.333	-8.917	3.333	0.000
4	-2.000	2.083	3.833	-3.917	-0.750
GCA for female	-0.167	0.417	0.667	-0.917	
Se	male	Female	male x fe male		
	1.5429	1.5429	2.1820		

Genetic Parameters					
σ^2GCA for male	0.179	H^2bs	93.232		
σ^2GCA for female	0.198	H^2ns	0.715		
σ^2SCA for m x f	48.810	A	16.090		
σ^2A in male	0.359	Genetic enhancement (EGM)	0.091		
σ^2A in female	0.396	Genetic improvement (EGM) as a percentage of the rate	0.062		
σ^2A	0.377				
σ^2SCA	48.810				
σ^2D	48.810				
σ^2G	49.187				
σ^2E	3.571				
σ^2P	52.758				

Table (7) shows that there are significant differences for general and specific combining ability, where the female parent (3) excelled by giving him the highest value for general combining ability, amounting to (2.14), and the female parent (6) also excelled by giving her 1.64. Thus, we can benefit from them in improving this characteristic, as for the female parent (2) and the female parent. (7) They gave the lowest values of (-3.43 and -1.52), respectively. As for the special combining ability, the hybrid (8×4) was superior by giving it the highest value of 16.27, while the hybrid (6×3) gave the lowest value of the special combining ability of 14.22. The hybrids that gave positive values indicate the possibility of

ISSN 2072-3857

improving this trait. The same table also indicates that the additional variance was small, 7.00, compared to the genetic variance of 147.98, which indicates the presence of superior dominance, which led to an increase in the value of the average degree of dominance to 6.34.

The heritability percentage in the broad sense was 94.98%, while it was 4.49% in the narrow sense, which indicates the additional influence of genes (genetic), and thus hybridization is the best way to improve this trait.[14]

Table (7) General (GCA) and specific (SCA) combining ability and their variations and some Genetic Parameters for the plant height trait of rice crop

The general combining ability of parents and specific of hybrid					
Parents	SCA for cross				GCA for male
	5	6	7	8	
1	-4.646	11.354	-0.813	-5.896	-0.437
2	5.354	7.688	-1.813	-11.229	-3.438
3	-1.896	-14.229	15.271	0.854	2.146
4	1.188	-4.813	-12.646	16.271	1.729
GCA for female	0.313	1.646	-1.521	-0.438	
Se	Male	Female	male x fe male		
	2.2834	2.2834	3.2292		

Genetic Parameters					
σ^2GCA for male	5.882	H^2bs	94.980		
σ^2GCA for female	1.119	H^2ns	4.493		
σ^2SCA for m x f	140.980	A	6.346		
σ^2A in male	11.765	Genetic enhancement (EGM)	0.982		
σ^2A in female	2.237	Genetic improvement (EGM) as a percentage of the rate	1.191		
σ^2A	7.001				
σ^2SCA	140.980				
σ^2D	140.980				
σ^2G	147.981				
σ^2E	7.821				
σ^2P	155.802				

Table (8) indicates that there are significant differences in general and specific combining ability (Appendix 2), as the female parent (3) and female parent (6) gave the highest value for general combining ability, amounting to (0.86 - 1.01), respectively.It indicates the possibility of benefiting from them in improving this trait by increasing the length of the deltoid. As for the female parent (4) and female parent (8), they were given the lowest value, amounting to (-0.87, -1.10), respectively. As for the specific combining ability, the hybrid (5×3) was superior, giving the highest value of 2.78, while the hybrid (5×4) gave the lowest value of -2.83. Thus, it is possible to benefit from the hybrid that gave the highest positive values towards

ISSN 2072-3857

improving this trait.The additive variance was 1.40, while the genetic variance was 9.98, which indicates the influence of non-additional genes on this trait and the presence of superior dominance, which led to an increase in the value of the dominance score to 3.49.

The heritability peracentage in the broad sense was 93.93%, while it was 13.24% in the narrow sense, which confirms that this trait is subject to the non-additive influence of genes. [15].

Table (8) General (GCA) and specific (SCA) combining ability, their variations, and some Genetic Parameters for the rice crop's panicle length trait. 99,1.1

The general combining ability of parents and specific of hybrid					
parents	SCA for cross				GCA for male
	5	6	7	8	
1	-2.596	1.604	1.438	-0.446	0.512
2	2.646	-2.421	-0.688	0.462	-0.496
3	2.788	-2.412	1.954	-2.329	0.862
4	-2.838	3.229	-2.704	2.313	-0.879
GCA for female	0.412	1.013	-0.321	-1.104	
Se	male	Female	male x fe male		
	0.6552	0.6552	0.9267		

Genetic Parameters					
σ^2GCA for male	0.621	H^2bs	93.939		
σ^2GCA for female	0.785	H^2ns	13.242		
σ^2SCA for m x f	8.574	A	3.491		
σ^2A in male	1.243	Genetic enhancement (EGM)	0.755		
σ^2A in female	1.571	Genetic improvement (EGM) as a percentage of the rate	3.376		
σ^2A	1.407				
σ^2SCA	8.574				
σ^2D	8.574				
σ^2G	9.981				
σ^2E	0.644				
σ^2P	10.625				

Table (9) shows that there are significant differences in general and specific combining ability (Appendix 2), as the female parent (3) and female parent (5) excelled in general combining ability (0.99, 1.15) in succession, which indicates the possibility of these female parents getting acquainted with each other in the direction of improving the length of the flag leaf. The female parent (1) and female parent (7) gave values in the negative direction (-0.92, -0.80) respectively. Positive values for female parents and female parents indicate the possibility of improving this trait through cross-breeding between them. As for the specific combining ability, the hybrid (7×3) gave the highest value, amounting to 2.09, while the hybrid (7×2) gave the lowest value, amounting to 2.64. The value of the additional variance was 1.15, while the value of the genetic variance was 3.33, which indicates the

ISSN 2072-3857

non-additive effect of genes through the average degree of dominance being greater than the correct one, 1.93%, indicating the presence of superior dominance of genes. The percentage of heritability in the broad sense was 49.21%, while it was 17.08% in the narrow sense, which indicates the hereditary influence of genes. [16] .

Table (9) General (GCA) and specific (SCA) combining ability and their variations and some Genetic Parameters for the flag leaf length trait of rice crop

The general combining ability of parents and specific of hybrid					
parents	SCA for cross				GCA for male
	5	6	7	8	
1	-0.025	-1.308	1.108	0.225	-0.925
2	1.958	1.675	-2.642	-0.992	0.292
3	-0.642	-1.792	2.092	0.342	1.158
4	-1.292	1.425	-0.558	0.425	-0.525
GCA for female	0.992	0.608	-0.808	-0.792	
Se	Male	Female	male x fe male		
	1.5143	1.5143	2.1415		

Genetic Parameters					
σ^2GCA for male	0.566	H^2bs	49.212		
σ^2GCA for female	0.591	H^2ns	17.088		
σ^2SCA for m x f	2.176	A	1.939		
σ^2A in male	1.132	Genetic enhancement (EGM)	0.778		
σ^2A in female	1.182	Genetic improvement (EGM) as a percentage of the rate	3.069		
σ^2A	1.157				
σ^2SCA	2.176				
σ^2D	2.176				
σ^2G	3.333				
σ^2E	3.440				
σ^2P	6.772				

Table (10) shows that there are significant differences for general and specific combining ability. The female parent (3) and female parent (5) had the highest value for general combining ability by giving it (2.54, 0.92) respectively, while the female parent (1) and female parent (7) gave the lowest value for general combining ability, amounting to (-0.99, -1.78) respectively.

Positive values indicate the possibility of benefiting from female parents and female parents towards improving this trait by increasing the area of the flag leaf.

As for the special combining ability, the hybrid (5×2) was excelled, giving it the highest value of 4.68, while the hybrid (5×4) gave the lowest value for the special combining ability of 3.10.

It is possible to benefit from the hybrids that gave positive values in the direction of improving the trait of flag leaf area. As for the additional variance, it was less than the genetic variance, as it reached 3.45, which indicates the

ISSN 2072-3857

non-additive effect of genes in improving this trait, which was reflected in an increase in the average degree of dominance to greater than one, 2.18, and the presence of Superior dominance of genes.

The same table indicates values of the heritability rate in the broad sense, which amounted to 76.63% and in the narrow sense, 22.56%, which indicates the effect of genetic variation, which amounted to 11.73, and therefore hybridization is considered the most successful due to the effect of this trait.

Table (10): General (GCA) and specific (SCA) combining ability and their variations and some Genetic Parameters for the flag leaf area characteristic of rice crop

The general combining ability of parents and specific of hybrid					
parents	SCA for cross				GCA for male
	5	6	7	8	
1	0.467	-1.418	1.346	-0.395	-0.993
2	4.681	0.842	-2.864	-2.659	0.250
3	-2.044	-2.213	3.067	1.190	0.922
4	-3.104	2.788	-1.549	1.864	-0.179
GCA for female	2.540	0.005	-1.788	-0.757	
se	Male	Female	male x fe male		
	1.5444	1.5444	2.1841		

Genetic Parameters					
σ^2GCA for male	0.345	H^2bs	76.637		
σ^2GCA for female	3.110	H^2ns	22.562		
σ^2SCA for m x f	8.281	A	2.189		
σ^2A in male	0.691	Genetic enhancement (EGM)	1.545		
σ^2A in female	6.219	Genetic improvement (EGM) as a percentage of the rate	7.886		
σ^2A	3.455				
σ^2SCA	8.281				
σ^2D	8.281				
σ^2G	11.736				
σ^2E	3.578				
σ^2P	15.314				

References

[7] Al-Hassani, Laith Naeem Hassouni and Ammar Dahham Al-Maadidi. 2017. The effect of irrigation periods and organic fertilization on the growth and yield of two varieties of rice under the rice intensification system (SRT). Iraqi Journal of Agricultural Sciences. 48 (3): 823-840.

[9] Ali, F., I.A. Shah, Hidayat ur Rahman, M. Noor, Durrishahwar, M.Y. Khan, Ihteram Ullah and J.Yan. 2012. Heterosis for yield and agronomic

ISSN 2072-3857

attributes in diverse maize germplasm. AJCS 6(3):455-462.

[4] Al-Taweel, Muhammad Sobhi, Ahmed Abdel-Gawad, and Ahmed. 2012. Factorial taxation in wheat. Al-Rafidain Agriculture Journal, Magazine (40), Supplement (1).

[3] Central Bureau of Statistics, (2021). Crop and vegetable production for the year 2021. Directorate of Agricultural Statistics. The Ministry of Planning . Iraq - Baghdad.

[2] F.A.O.(2022). Food and Agriculture Organization of the Nations. Quarterly Bulletin Statistics, 11(3/4).

[1] FAOSTAT. 2021. grain production Worldwide by type., Food and Agricultural Organization of the United Nations. Available at: https://www.statista.com/statistics/263977.

Ganapati, R.K.; Rasul, M.G.; Sarker, U.; Singha, A.; Faruquee, M.2020. Gene action of yield and yield contributing traits of submergence tolerant rice (Oryza sativa L.) in Bangladesh. Bull. Nat. Res. Centre 2020, 44, 32–41. [CrossRef]

[11]Goff SA, Zhang Q .2013. Heterosis in elite hybrid rice: Speculation on the genetic and biochemical mechanisms. Curr Opin Plant Biol 16:221–227.

[5]Idris AE, Justin FJ, Dagash YM, and Abual A I. 2012. Genetic Variability and Inter Relationship between Yield and Yield Components in Some Rice Genotypes A. J.Exp. Agric;2(2):233-239.

[12] Mahmood, T., Turner, M., Stoddard, F.L. and Javed, M.A. (2004). Genetic analysis of quantitative traits in rice (Oryza sativa L.) exposed to salinity. Australian Journal of Agricultural Research, 55: 1173-1181.

[16] Najeeb, S., Zargar, M.A., Rather, A.G., Sheikh, F.A., Ahangar, M.A. and Rezvi, M.H. (2011). Combining ability study in rice (Oryza sativa L.) Under temperate conditions of Kashmir. Electronic Journal of Plant Breeding, 2(1): 31-40.

[8] Palaniswamy, K.M., and K.A. Gomez. 1971. Length-width method for estimating leaf area of rice. Agron. J. 66: 430-433.

Paschold A, et al. .2012. Complementation contributes to transcriptome complexity in maize (Zea mays L.) hybrids relative to their inbred parents. Genome Res 22:2445–2454.

[15] Roy, S.K. and Senapati, B.K. (2012). Combining ability anal-ysis for grain yield and quality characters in rice (Oryza sativa). Indian Journal of Agricultural Sciences, 82(4): al quality traits in rice (Oryza sativa L.). Journal of Applied and Natural Science, 8(1): 63-68.

ISSN 2072-3857

[14]Shyam, C.G., Chandrakar, P.K., Rastogi, N.K., Sharma, D. and Sarawgi, A. K. .2012. Combining ability analysis using CMS breeding system for developing hybrids in rice (Oryza sativa). Bangladesh J. Agril. Res. 37(4), 583-592.

[9] Steel, R.G., and J.H. Torrie. 1980. Principles and procedures of statistics. Mc Graw Hill Book Company. Inc USA.pp . 485.

[6] Taha, Ghada Abdullah (2007). Adopting the selection guide technique to improve the characteristics of grain yield and its components in roughage. Kirkuk University Journal - Scientific Studies (2)3: 52-66.

[13]Utharasu S .2007. Genetic analysis for yield and yield components involving in aerobic rice cultivars (*Oryza sativa* L.). M.Sc. (Ag.) Thesis, TNAU, Madurai. Unpubl.

ISSN 2072-3857