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ANALYSIS OF GENETIC PARAMETERS AND ESTIMATION OF OIL AND PROTEIN PERCENTAGE BY USING FULL DIALLEL CROSS IN MAIZE

Nagham M. Al-Azawi[1,2]*, Plyushchikov V.G.[2], Gadzhikurbanov Anvar[2]*, Sarra A. Bekuzarova[3] and Kozyrev A.Kh.[4]

[1]College of Agricultural Engineering Sciences, University of Baghdad, Iraq.
[2*]Peoples' Friendship University of Russia, RUDN University, Russia.
[3] Department of agriculture, plant growing and seed production, Mountain State Agrarian University, Vladikavkaz, Russia.
[4]Federal State Budgetary Educational Institution Higher Education, Gorsky State Agrarian University, Russia.

Abstract

Included four Inbred lines of maize in a program of hybridization (full diallel crossing system) namely (1. *W17-11*, 2. *N28*, 3. *AGR3* and 4. *AGR11*) On field of Voronezh in (2016, 2017). A comparison the objective was estimation of several genetic parameters for oil and protein content in maize. The genotypes was planted in Randomized complete block design with four replications. Significant differences were found among genotypes for oil and protein content. The results showed that the diallel hybrids (*W17-11×N28*), (*AGR3×AGR11*). Produced higher oil percentage (4.6%),while reciprocal hybrid (*N28×W17-11*) produced higher oil percentage (4.7%). The diallel hybrid (*W17-11×AGR3*) produced higher protein percentage (10.1%), while reciprocal hybrids (*N28×W17-11*), (*AGR3×N28*) produced higher protein percentage (9.6%). The higher positive hybrid vigour percentage for best parents for oil percentage (20.1%) for diallel hybrid (*W17-11×N28*) and (18.4)% for reciprocal hybrid (*N28×W17-11*). The higher positive hybrid vigour percentage for protein percentage (29.9%) for diallel hybrid (*N28×AGR3*) and (36.5%) for reciprocal hybrid (*AGR3×W17-11*). There is no significant in GCA and SCA for the other characters oil and protein. The average degree of dominance (ā) was zero for diallel hybrids for oil and protein percentage. The average degree of dominance (ā) for reciprocal hybrid was zero for protein percentage while more than one for oil percentage (1.5). The heritability percentage was low for broad and narrow sense for oil and protein percentage for diallel hybrids and reciprocal hybrids. Genetic variance dominance values σ^2D and genetic variance additive values σ^2A was low for characters for diallel hybrids and reciprocal hybrids. This research aims to study the effect of method full diallel cross increase in oil content and protein in the grain first-generation members of the F_1 community maize.

Key words: Inbred lines, full diallel cross, *protein content*, *oil content*, heterosis, heritability, *Zea mays.*

Introduction

There are many ways to improve maize depends most of them on the conduct of the election and vary according to the genetic material studied and the length of time it takes. Improving the quality of maize grain of the important objectives of plant breeders and particularly grain content of protein and oil, have been the work of oil to improve the protein began almost a hundred years and despite the use of maize grain as their primary source of energy they produce annually more than soy protein.

Recorded (Mihajlovic, M. 1984) that 80% of the corn protein resides in the endosperm grain and 20% in the embryo and 3-4% resides in the seed coat. While (Mihajlovic, M. and Piper, P., 1985). Pointed out when studying the seven of hybrids that about (87%-89%) of the protein present in grain endosperm and the majority of the oil is present in the embryo.

Indicated study (S.K. Temirbekova *et al*., 2019) that the percentage of protein in cereal crops, including wheat, is affected by environmental conditions. Pointed out (Sumittra, P. and Eppendorfer, W.H., 1988) to protein in the grain affected by environmental conditions and genetic composition as well. the oil content is much more related to the genotypes than the environment and is considered

***Author for correspondence :** E-mail: naghamalazawi@yahoo.com, gadzhikurbanov-ash@rudn.ru

a trait with high heritability. The effects of the genotype - environment interaction were only significant for grain yield, indicating a differentiated genotype performance in response to environmental changes. (Amir José Klein Werle *et al.,* 2014).

Studies have shown that maize plants in which the method is used (full diallel cross) which he means hybridization between Inbred lines and all possible combinations of them, Results from hybridization, hybrids group number varies different the number of parents whenever the number of parents has increased the number of the resulting hybrids. Method of cross-hybridization of the best methods of hybridization because of its effect on the chemical and quality components as well as to its usefulness in the evaluation of the genetic material and knowledge of the performance of different genetic structures in the resulting off spring from them. Confirmed studies concerned with the quality inherit qualities that many of controls inherited genetic knowledge and conduct and the nature of the act gene influential in important quality qualities in determining the best ways breeding and Improvement.

Cares about plant breeders hybridization for the purpose of study in hybrids which is usually accompanied by hybridization between Inbred lines or synthetic varieties, which differ from each other in composition and genetic variations of this increasingly greater genetic divergence (Genetic diversity) among breeds or varieties as it appears the first generation superiority and energetic. These differences increase the greater the genetic divergence superiority and energetic in the growth of this condition is called hybrid strongly positive (+Heterosis) and there is an inverse situation where heterosis negative. (-Heterosis).

Pointed (Haj Suleiman, 2006) to be a good way full-diallel cross to improve the protein content in maize grain, has proved it can improve grain yield and protein at the same time together to get to the level of 11-12% protein in a manner fully diallel cross. Most studies that have been applied on the open-pollination and self-pollination groups indicate that success in getting the highest percentage of heterosis be using genetic models of a broad-based (Baktash, F.Y and AL-Azawi, N.M., 2007).

Materials and Methods

Applied experience in two seasons, (2016, 2017). Was used four Inbred line of maize In full-diallel cross was conducting all agricultural operations of tillage and anti-aliasing filtering and weeding and hoeing Lori then fertilization fertilizer compound (NP 18:18) at a rate of 400\kg/h. When soil preparation added urea increased by 160\kg N/H. In two instalments, the first after 25\days of agriculture and the second a month after the first instalment. The field was sprayed pesticide (atrazine) concentration (80%) at a rate of 1kg/h, to combat bush after planting before germination and then fight the insect corn stalk borer (*Sesamia criteca*) by twice during the first growing season, when the arrival of the plant six leaf stage and the second after 20\ days of the first control.

Season 2016: In Summer 2016 planted the seeds of maize. A long the lines 5\m and the distance between them of 75\cm and between hills 25\cm. At the beginning of flowering, we are covered the ears in paper bags before the emergence of silking to avoid get open pollination.

The male inflorescences were packed the day before the process of pollination, After the launch of pollen conducted cross-hybridization between breeds both ways direct and inverse, recorded it (Griffing, B., 1956). According to the first method (Method 1) and the first model (Fixed Model 1), Shall be the number of genotypes produced equal to n^2, which included hybrids first generation F_1 experience (diallel hybrids and reciprocal hybrids) and their parents.

Season 2017: Carried out in this season comparison experiment that included planting the seeds of diallel, reciprocal hybrids and parent (Inbred line) in 2017. According to randomized complete block design with four replications.

The samples were analysed in laboratories college of Agriculture, University of Temeryazif, Oil content was estimated using Sucsulate device and the proportion of nitrogen using a device (Keldah l). Then it turned to nitrogen ratio of the proportion by multiplying the values in (4.75).

Statistical analysis was performed using statistical design of random randomized complete block (RCBD). Averages were compared using less significant difference LSD and the moral level of 5%.

Heterosis was estimated as a percentage compared with the average best parents (Shull, G.H., 1910). According to the equation:

$$H\% = \frac{F1 - HP}{HP} \times 100$$

Estimation of general combining ability for inbred lines and Specific combining ability for diallel hybrids and *reciprocal hybrids*

$$Yijk = \mu + \hat{g}i + \hat{g}j + \hat{S}ij + \hat{R}ij + eijk$$

Estimation effect of general combining ability ($\hat{g}$ *ii*) for inbred lines and Specific for diallel hybrids ($\hat{S}$ ij)

reciprocal hybrids ($\hat{R}$ij).

$$\hat{g}ii = 1/2p\,(xi.+x.i)\_1/p^2\,x..$$

$$\hat{S}ij = 1/2\,(xij + xji)\_1/2p\,(xi.+x.i + xj.+x.j) + 1/p^2\,x.$$

$$\hat{R}ij = 1/2\,(xij\_xji)$$

Estimation variance effect of general combining ability ($\sigma^2\hat{g}$ *ii)* and Specific ($\sigma^2\hat{S}$ ij) for diallel hybrids ($\sigma^2\hat{R}$ ij) and *reciprocal* hybrids (Singh, R.K. and B.D. Chaudary,1985).

$$\sigma^2\hat{g}ii = (\hat{g}ii)^2\_MSe/p^2$$

$$\sigma^2\,\hat{S}ii = (1/p\_2)\sum\hat{S}ij^2\_MSe\,(p^2-2p+2)/2p^2$$

$$\sigma^2\hat{R}ii = (1/p\_2)\sum\hat{R}ij^2 - MSe/2$$

As well as the proportion of heritability have been registered in the broad sense and narrow sense.

$$h^2b.s = \frac{\sigma^2G}{\sigma^2P} = \frac{\sigma^2A+\sigma^2D}{\sigma^2A+\sigma^2D+\sigma^2e}$$

$$h^2b.s-r = \frac{\sigma^2G}{\sigma^2P} + \frac{\sigma^2A+\sigma^2D-r}{\sigma^2A+\sigma^2D-r+\sigma^2e}$$

$$h^2n.s\ \frac{\sigma^2A}{\sigma^2P} = \frac{\sigma^2A}{\sigma^2A+\sigma^2D+\sigma^2e}$$

$$h^2n.s-r = \frac{\sigma^2A}{\sigma^2P} = \frac{\sigma^2A}{\sigma^2A+\sigma^2D-r+\sigma^2e}$$

It was estimated rate degree of dominance for each of the diallel hybrids a and reciprocal hybrids a-*r* was as follows:

$$\bar{a} = \sqrt{2\sigma^2D/\sigma^2A} = \sqrt{2\sigma^2Sca/2\sigma^2gca} = \sqrt{\sigma^2Sca/\sigma^2gca}$$

$$\bar{a} = \sqrt{2\sigma^2D-r/\sigma^2A} = \sqrt{2\sigma^2rca/2\sigma^2gca} = \sqrt{\sigma^2rca/\sigma^2gca}$$

Results and Discussion

Oil content

(Fig.1) Notes that the all inbreeds produced convergent rates to the percent of oil in the corn ranged between (3.7%-3%). Also recorded a diallel hybrids (*W17-11×AGR3*), (*AGR3×AGR114*). The highest rate of the proportion of oil was (4.6%), reciprocal hybrids

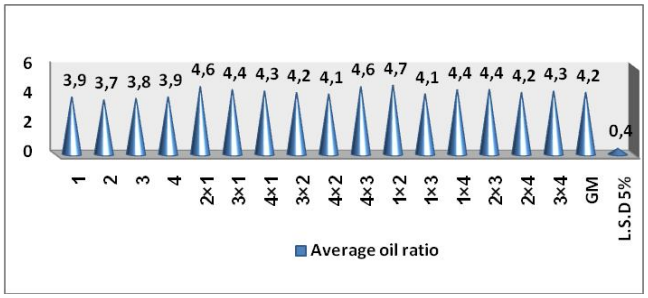

Fig. 1: Average oil ratio for parents, diallel and reciprocal hybrids of maize.

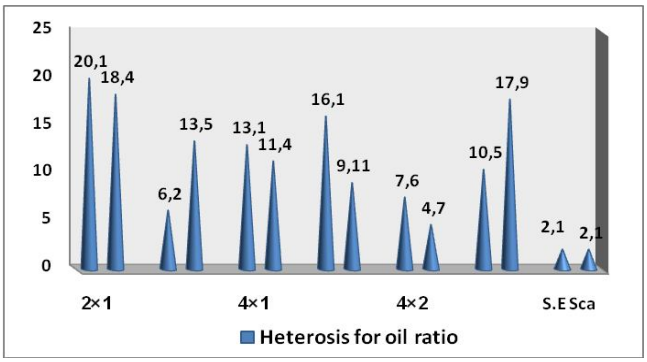

Fig. 2: Heterosis oil ratio for diallel and reciprocal hybrids of maize.

(*N28×W17-11*) have produced the highest rate of the proportion of oil was (4.7%). Were reflected the differences between the averages of parents and diallel hybrids on the heterosis, Notes from.

(Fig. 2) All that diallel hybrids and reciprocal hybrids showed a positive heterosis for the proportion of oil. The highest positive hybrid vigour ratio to a better parent (20.1%) for diallel hybrid (*W17-11×N28*) and (18.4%) for reciprocal hybrid (*N28×W17-11*). The values of the positive heterosis indicate to the effect of the over dominance to the best genes of parents towards the increase in the average of character with an additional effect of genes. Received (Al-Azawi, 2002; Gomaa, M.A. and A.M.A. Shaheen, 1994) positive and negative hybrid vigour which indicates an the effect of partial

Table 1: Estimate the effects of general combining ability ĝ ii and specific Ŝ ij and reciprocal R̂ij and its variation $\sigma^2\hat{g}$ii, $\sigma^2\hat{S}$ ij, $\sigma^2\hat{R}$ ij and the other parameters for oil ratio for inbred line, diallel hybrids and reciprocal hybrids of the maize.

Parents	ĝ ii	$\sigma^2\hat{g}$ii	$\sigma^2\hat{S}$ ij	$\sigma^2\hat{R}$ ij
W17-11	0.06	0.0	0.0	0.0
N28	-0.03	0.0	0.0	0.0
AGR3	-0.03	0.0	0.0	0.0
AGR11	0.00	0.0	0.0	0.0

Hybrids	Ŝ ij	**Diallel hybrids**	
W17-11 × N28	0.3	σ^2 *gca* σ^2 *Sca*	0.0
W17-11 × AGR3	0.0	h^2*n.s*	0.0
W17-11 × AGR11	0.0	h^2bs	0.8
N28 × AGR3	0.01	ā	0.0
N28 × AGR11	0.0	σ^2D	0.1
AGR3 × AGR11	0.2	σ^2A	0.0
Hybrids	R̂ ij	**Reciprocal hybrids**	
N28 ×W17-11	0.0	σ^2 *gca* σ^2 *Sca*	0.4
AGR3 × W17-11	- 0.1	h^2*n.s-r*	0.0
AGR11× W17-11	0.0	h^2*b.s-r*	0.1-
AGR3× N28	0.0	a-r	1.5
AGR11 × N28	0.0	σ^2*D- r*	0.0
AGR11× AGR3	-0.01		

dominance and high-inherited genes in character oil content.

Table 1, showed no significant difference in effect of general combining ability Specific and reciprocal. Notes from the study some of genetic parameters in the same table, That variability of dominance genes σ^2D Greater than the variability of the additional genes σ^2A each of diallel hybrids and reciprocal, Which shows that oil content character under the effect of over dominance of genes (Ali Abda Alkamel Abdullah, 1999). That oil content is under the effect of the additional genes, while (Sinobas, J. and I. Monteagudo, 1996) showed the importance of additional and non-additional effects on inheritance of character oil content in maize. The average degree of dominance (ā) zero, Which shows that inherited the character under the effect of the complete dominance of genes. The ratio of heritability in the broad sense and narrow to very low to the ratio oil.

Protein content

(Fig. 3) Notes that the Inbred (*AGR11*) produced the highest average of protein content in maize grain reached (8.0%) and the inbred (*N28*) produced the lowest average reached (7.2%). It also achieved the diallel hybrid (*W17-11×AGR3*3) the highest average ratio of the protein content reached (10.1%) and the reciprocal hybrids (*N28×W17-11*), (*AGR3×N28*) produced the highest average of protein reached (9.6%).

Were reflected the differences between the averages of parents and the diallel hybrid and reciprocal hybrids on the heterosis, Recalling (Fig. 4). That all the diallel hybrid and reciprocal hybrids showed a positive heterosis for the protein content, reached the highest ratio positive heterosis to the best parent (29.9%) for diallel hybrid (*N28×AGR3*) and (36.5%) for reciprocal hybrid (*AGR3×W17-11*).

Indicate the positive values for heterosis to effect of over dominance for genes best parents towards the increase in average character with an additional effect

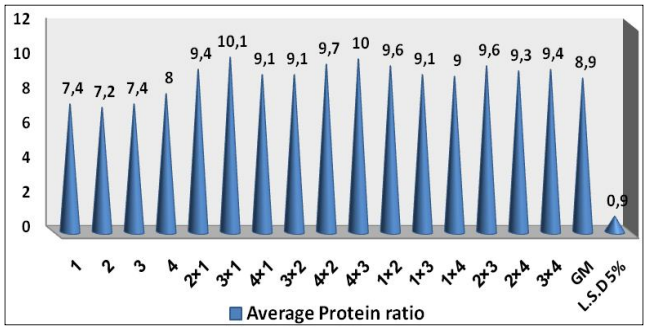

Fig. 3: Average protein ratio for parents (Diametrical values) and diallel hybrids (Values above diametrical) and reciprocal hybrids (Values under diametrical) of maize.

Table 2: Estimate the effects of general combining ability ĝ ii and specific ŝ ij and reciprocal r̂ij and its variation σ^2ĝii, σ^2ŝ ij, σ^2r̂ ij and the other parameters for protein ratio for inbred line, diallel hybrids and reciprocal hybrids of the maize crop.

Parents	ĝ ii	σ^2ĝii	σ^2ŝ ij	σ^2r̂ ij
W17-11	ĝ ii	0.0	0.4	0.0
N28	0.0	0.0	0.3	0.2
AGR3	-0.1	0.0	0.4	0.6
AGR11	0.1	0.0	0.1	0.2

Hybrids	ŝ ij	**Diallel hybrids**	
W17-11 × N28	0.7	σ^2*gca* σ^2*Sca*	0.0
W17-11 × AGR3	0.6	h^2*n.s*	0.0
W17-11 × AGR11	0.1	h^2bs	0.9
N28 × AGR3	0.4	ā	0.0
N28 × AGR11	0.1	σ^2D	1.7
AGR3 × AGR11	0.1	σ^2A	0.0
Hybrids	r̂ ij	**Reciprocal hybrids**	
N28 ×W17-11	0.6	σ^2*gca* σ^2*Sca*	0.0
AGR3 × W17-11	- 0.5	h^2*n.s-r*	0.0
AGR11× W17-11	-0.5	h^2*b.s-r*	0.4
AGR3× N28	0.2	a-r	0.0
AGR11 × N28	-0.7	σ^2*D- r*	0.1
AGR11× AGR3	-0.2		

of genes, (Al-baroudi, 1999) got the positive and negative heterosis for character protein content in maize, While (Sabljarevic, V., 1997; Wang, Z.H. *et al*., 1998) got the negative heterosis for protein content.

Shown in table 2, there is no significant differences in effect of general combining ability, specific and reciprocal. Notes from the study Some of genetic parameters in the same table that the dominance variation of genes σ^2D bigger than the additional variation of genes σ^2A each of the diallel hybrid and reciprocal hybrids. Was rate degree of dominance (ā) zero, Which shows that inherited the character under the effect of the complete dominance of genes.

The proportion of heritability in the broad sense and narrow to very low for protein content**.**

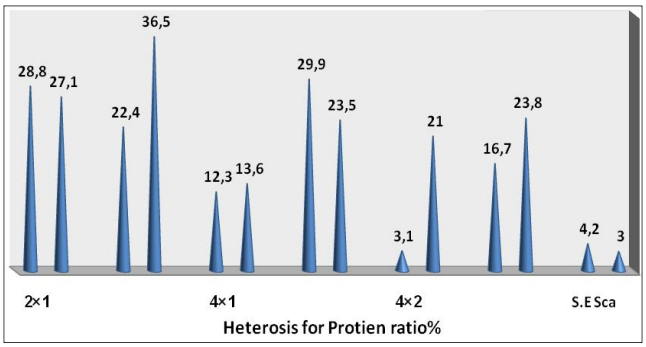

Fig. 4: Heterosis for protein ratio for diallel hybrids (and reciprocal hybridsof maize.

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