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NATURE OF INHERITANCE OF RESESTANCE TO LEAF AND YELLOW RUSTS, KERNEL WEIGHT AND GRAIN YIELD IN WHEAT.

El- Diasty, Z. M*; M. S. Hamada; S. M. Hammad***and M.M. Yasin*****

*** Genet. Dept., Fac.of Agriculture, Mansoura University**

**** Genet. Dept. Fac.of Agriculture (Damietta) Mansoura University**

***** Wheat Research Dept., Field Crops Res. Inst., Agric. Res. Center.**

ABSTRACT

In this investigation , four wheat cultivars namely Giza 163 , Sakha 94 , Giza 168 and Sakha 69 .These varieties were crossed to each other to obtain three crosses . The obtained crosses were : Cross1 (Sakha 69 * Giza 163) , Cross 2 (Sakha 94 * Giza 168) ,and Cross 3 (Sakha 69 * Sakha 94) ,

Six populations, P_1, P_2, F_1, F_2, BC_1 and BC_2 were obtained for each cross through the three growing seasons 2004 /2005, 2005 /2006 and 2006 /2007 at Sakha Agricultural Research Station , Agriculture Research Center (ARC.), Egypt.

The results indicate that the two parents of each crosses were significantly differed in most cases . The parental cultivar Sakha 94 gave the highest kernels weight (k .w.) . In addition the two crosses 2 and 3 exceeded the better parent (Sakha 94) indicating the presence of over dominance for that traits . Similar results obtained for Grain yield / plant (G.Y. / P) . The results also reveald that the additive variance mainly controlled the inheritance of (G.Y. / P) .

The results also illustrated that resistance of leaf rust and yellow rusts is mainly due to additive variance although dominance variance could not be neglected . The six parameter model was adequacy to explain the type of gene action controlling the studied characters .

INTRODUCTION

Wheat is considered as the major food crop throughout the world., It is also, the most strategic grain crop in Egypt. National wheat production is insufficient to meet local consumption. In Egypt the domestic wheat production is about 8 million tons produced from 2.7 million fad., while imports totaled about six million tons.

It is not feasible to increase the area cultivated to wheat. The increasing production per unit area appears to be the only possible mean of reducing the wheat gap. The required yield increases may be achieved by improved cultural practices and or development of new high yielding cvs.

Wheat production in Egypt is seriously threatened by a great loss due to many diseases, particularly the two rusts, (stripe rust caused by *Puccinia striiformis* and leaf rust caused by *puccinia reccondita*) .

Wheat resistance to rusts has been documented to be a simple inherited trait governed by one, two or a few number of major gene pairs (Shehab El-Din and Abd El-Latif 1996). On the other hand , other studies proved that it is a quantitative character and controlled by many pairs of gene, as well as environmental conditions (Mahgoub 2001 and Hammad 2003). However, additive gene action was more important in rust studies

(Mahgoub 2001 and Menshawy and Najeeb 2004). Moreover, estimated broad and narrow sense heritabilities of resistance trait were generally high in magnitude (Zhang *et al.* 2001 and Menshawy and Youssef, 2004).

The present research was carried out to investigate the mode of inheritance for strip and leaf rusts, kernel weight and grain yield / plant, also, to estimate types of gene action for the three wheat crosses.

MATERIALS AND METHODS

This investigation was conducted at the Experimental Farm of Sakha Agricultural Research Station, Agricultural Research Center (ARC), Egypt.

In the growing season of 2004/2005, four parental wheat cultivars i.e., Giza 163, Sakha69, Giza 168, and Sakha 94 were sown to crossed each other produce the following three crosses.These crosses were : Cross1 Sakha 69 × Giza 163 (susceptible × susceptible), Cross2 Giza 168 × Sakha 94 (resistance × resistance) and Cross3 Sakha 69 × Sakha 94 (susceptible × resistance). The Genotypes, origin and pedigree of the parental genotypes and their reaction to yellow and leaf rusts are presented in Table 1.

In the second season 2005/2006, the parents and the three obtained F_1 crosses hybrid seeds were sown to produce the F_2 and to be crossed to their two respective parents to obtain (BC_1 and BC_2).

In the third growing season, all six generations of each cross (the two parents, F_1, F_2, BC_1 and BC_2) were evaluated,using a randomized complete blocks design with three replications. The spaces between rows were 25cm, while it was 20cm between plants. Each plot consisted of 15 rows ($1P_1$, $1P_2$, $1F_1$, $2BC_1$, $2BC_2$ and $8F_2$). In basid two border rows. The experiment was surrounded by wheat cultivars highly susceptible to rusts as a spreader. All recommended culture practices were applied at the proper time.

Table 1: Genotypes, pedigree and origin as well as their reaction to yellow and leaf of the studied bread wheat genotypes.

Genotypes	pedigree	Origin	Reaction to rusts YR	LR
Giza 163	*T. aestivunm* / Bon // Cno / 7c CM33009 –F-15M-4Y-2M-1M-1M-1Y-0M	EGYPT	S	S
Sakha 94	Opata / Rayon // Kauz CMBW 90Y3180 -0TOPM-3Y-010M-10M-010Y-6M-0S	EGYPT	R	R
Giza 168	MRL / BUC // SERI CM93046-8M-0Y-OM-2Y-0P	EGYPT	R	R
Sakha 69	Inia/RL4220//7C/Yr"S" CM15430-2S- CM15430-2S-6S-0S-0S	EGYPT	S	S

YR = yellow rust
LR = leaf rust
R = resistant
and S = susceptible

Data were collected from guarded plants in each row. The studied characters were : Yellow and leaf rusts reaction, kernel weight(K.W.) and grain yield/plant(G.Y./ P).

Rust data were recorded under field condition at Sakha Agricultural Research Station the a hot spot to rust diseases, according to the scale of Stubbes *et al.* (1986). In this method: resistance, moderately resistance, intermediate, moderately susceptible and susceptible field responses were symbolized as R, MR, M, MS and S, respectively. For the quantitative analysis, field response was converted into an average coefficient of the infection according to the methods of Stubbes *et al.* (1986) and (Shehab El-Din and Abdel-Latif,1996). In this methods, an average coefficient of infection could be calculated by

multiplying infection severity by assigned constant values namely, 0.05, 0.1, 0.2, 0.4, 0.6, 0.8, and 1 for 0, 0, R, MR, M, MS and S infection types, respectively.

T test was used to test the significance of the differences between the two parents in each cross. Moreover, the F ratio was calculated to test the significance of genetic variance among F_2 plants according to Allard (1960) as follows:

$$F = \frac{\text{Variance of } F_2}{\text{Variance of E}}$$ where,

$$VE = [VF_1 + VP_1 + VP_2] / 3$$

Since F ratio was significant, Gamble's procedure(1992) was used to estimate the components of genetic variance. Meanwhile, when the F ratio was in significant, it would be an indication, that the variation among the F_2 generations were mainly due to the environmental effects.

The population means and variance were used to estimate the type of gene action. The collected data were further subjected to the following biometrical analysis. The scaling tests A, B and C were performed for all studied characters in the three crosses to study the adequacy of the three-parameters (nonepistatic) model according to Mather (1949). The significance of any of the three testes indicates the presence of nonallelic interaction. The estimates of gene effects i.e., additive (a), dominance (d), additive x additive (aa), additive x dominance (ad) and dominance x dominance (dd) were obtained using the digenic epistatic model (Gamble 1962). The standard errors of a, d, aa, ad, and dd are worked out by taking the square rote of respective variance. t-values were calculated by dividing the effects of a, d, aa, ad, and dd by their respective standard error.

Heterosis was expressed as the deviation of F_1 generation mean from the better-parent value.

Average degree of dominance = $(H/D)^{0.5}$

Heritability in broad and narrow sense were calculated according to Mather and Jinks (1982).

The expected genetic gain resulting from selection in a character (GS%) was computed by the formula reported by Allard (1960).

RESULTS AND DISCUSSION

The mean values of the six populations, t-test for the differences between parents of each cross, and F-test for the significance of genetic variance among F_2 plants of the three crosses are shown in Table 2. The results indicated that the two parents of each cross were significantly different in most cases in the three studied crosses. Moreover F-test for the variance showed that the F_2 plants of each of the three crosses were genetically different. These differences indicated that a considerable amount of genetic variations were existed among the parents used in this study.

Regarding kernel weight traits, the results indicated that the parental variety Sakha 94 produced the heaviest kernel. In crosses 2 and 3, the F_1 mean values were higher than their better parents values, suggesting the presence of over–dominance. On the other hand, in crosses 1, the F_1 mean value was less than that of the better parent. This result indicated the presences of partial dominance for higher parent. The F_2, Bc_1 and Bc_2 means were less than that of F_1 (in crosses 2 and 3), indicating the importance of the non-additive component.

Table 2: The calculated mean values of the six populations, the t-test of differences between parents and F-test for significance of genetic variance among F_2 plants of the three crosses.

Trait	Cross	P_1	P_2	F_1	F_2	BC_1	BC_2	t	f
K.W.	1	3.88	3.20	3.55	4.11	3.87	3.59	**	**
	2	4.65	4.90	4.93	4.19	4.68	4.77	ns	**
	3	3.88	4.90	5.06	4.71	4.59	4.79	**	**
GY(gm)	1	39.54	14.16	20.46	25.73	21.92	19.24	**	**
	2	44.36	48.90	44.57	40.72	38.35	41.32	**	**
	3	39.54	48.90	49.72	43.27	32.44	41.82	**	**
Yellow Rust	1	76.67	93.33	76.67	52.51	53.22	47.79	**	**
	2	0.01	0.04	0.01	0.09	0.03	0.03	ns	**
	3	76.67	0.04	3.20	10.46	21.89	2.52	**	**
Leaf Rust	1	0.01	0.01	0.01	0.25	0.18	0.14	ns	**
	2	1.60	1.13	0.40	1.08	0.47	0.65	ns	**
	3	0.01	1.13	63.33	28.45	36.18	16.09	**	**

Cross 1 = Giza 163 X Sakha 69, Cross 2 = Giza 168X Giza 94 and Cross 3 = Sakha 69X Sakha 94

***, ** = Significant at 0.05 and 0.01 levels of probability, respectively.**

The results reveald that the parental cultivar Sakha 94 gave the highest grain yield /plant (48.90 g) while, Sakha 69 produced the lowest one (14.16 g). The unexpected result of grain yield of the cultivar Sakha 69 might be attributed to its higher susceptililty reaction to stripe and leaf rusts. F_1 mean values were higher than the better parent in crosses 3, indicating over–dominance while, it was less than the better parent in cross 1 and 2 revealing the presence of additive effect in the inheritance of the trait. The means of all backcrosses tended to be toward their respective recurrent parents, reflecting the role of additive and epistasis gene effects.

The mean values of strip rust average coefficient of infection (ACI) presented in Table 2 revealed that the differences between the two susceptible parents of cross 1, Giza 163 (low disease severity) / Sakha 69 (high disease severity), were highly significant due to differences in F_1 was close to the low disease severity parent, indicating almost complete dominance for low disease severity in the crosses 1 and 2. In cross 3, the two parents Sakha 69 and Sakha 94 were different in resistance for stripe rust; F_1 mean values were close to the resistant parent (Sakha 94), indicating that the direction of dominance was towards resistance.

The ACI values for leaf rust in cross 2, between Giza 168 (resistance) and Sakha 94 (resistance) illustrated that F_2 plants were genetically different, despite of insignificant mean values of the two parents. The F_1 was less than the better parent. This finding indicated almost over dominance for resistance. The two parents of cross 1 (Giza 163 and Sakha 69), one parent of cross 3 (Sakha 69), and their derivative generations F_1, F_2, BC_1 and BC_2 were covered by stripe rust pustules and consequently leaf rust reaction could not be recorded.

Scaling tests:

The A and B scaling tests provide an evidence for the presence of i (additive x additive), j (additive x dominance) and l (dominance x dominance) gene interaction. The C scaling test provides test for l (dominance x dominance) epistasis. The results are presented in Table 3 showed significant estimates of A , B and C Scaling tests for most studded character in the three crosses. The result indicated the adequacy of the six-parameters model to explain the type of gene action controlling most characters. A,B and C scaling tests were non significant for leaf rust in cross 2, indicating the adequacy of the three-parameter model to explain the type of gene action in this cross. Aglan (2003) and Hammad (2003) reported the presence of epistasis for rusts disease and grain yield in most cases.

Table 3: Scaling tests (A, B, and C) for the , studied characters in the three wheat crosses.

Trait	Cross	A	B	C
K.W.	1	0.31	0.43	2.26**
	2	-0.21	-0.29	-2.26**
	3	0.23	-0.38*	-0.08
GY(gm)	1	-9.23**	3.85	15.20**
	2	-12.22	-10.84*	-19.51**
	3	-24.38	-14.98**	-14.79*
Yellow Rust	1	-43.55**	-74.43**	-109.94**
	2	0.04	0.01	0.31*
	3	-36.09**	1.80	-41.25*
Leaf Rust	1	0.34**	0.26**	0.96**
	2	-1.07	-0.23	0.78
	3	8.92	-32.28**	-14.11

Cross 1 = Giza 163 X Sakha 69, Cross 2 = Giza 168X Giza 94 and Cross 3 = Sakha 69X Sakha 94

***, ** = Significant at 0.05 and 0.01 levels of probability, respectively**

Types of gene action:

Types of gene action for the studied characters in the three crosses are presented in Table 4. The additive, dominance and epiestatic gene effects were found to be important in controlling the inheritance of kernel weight. Additive, dominance, and additive x additive type of epistasis were more important in controlling kernel weight in crosses 1. These results supported by those obtained from the narrow sense heritability. Thus, phenotypic selection would be an effective procedure for improving this character. Dominance and epistatic gene effects were important in the inheritance of grain yield in cross 1 while, dominance x dominance interaction was significant in the crosses crosses 2 and 3.

Table 4: Types of gene action for four studied characters in the three wheat crosses .

Trait	Cross	m	a	d	aa	ad	dd
K.W	1	4.11**	0.28*	-1.52**	01.52**	-0.06	0.78
	2	4.19**	-0.09	2.08**	2.12**	0.04	-1.62*
	3	4.71**	-0.21	0.61	-0.06	0.30*	0.21
G.Y/ P(gm)	1	25.73**	2.68	-23.50**	-20.58**	-6.54**	25.96**
	2	40.72**	2.96	-5.60	-3.54	-0.69	26.60*
	3	43.27**	-9.38	-19.0	-24.57	-4.70	63.94**
yellow Rust	1	52.51**	5.44**	-14.70**	-8.04	15.44**	126.01**
	2	0.09**	0.00	-0.27	-0.26	0.01	0.22
	3	10.46**	19.37**	-28.19**	6.96	-18.95**	27.32**
Leaf Rust	2	1.08**	-0.19	-3.05	-	-	-

Cross 1 = Giza 163 X Sakha 69, Cross 2 = Giza 168X Giza 94 and Cross 3 = Sakha 69X Sakha 94
***, ** = Significant at 0.05 and 0.01 levels of probability, respectively**

The results revealed that the obtained mean effect parameter (m), which reflect the contribution of overall mean (additive) plus the locus effects (dominance) found to be important in the inheritance of resistance to in strip rust. Additive, dominance, additive x dominance and dominance x dominance gene effects were also important in the inheritance of strip rust in crosses 1 and 3. These results were in general agreement with those obtained by Darwish and Ashoush (2003), Hagras (1999) and Ragab (2005).

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صفة المقاومة للصدأ الأصفر وصدا الأوراق ووزن ومحصول الحبوب في القمح طبيعة توارث

زكريا محمد الديسطى* ، محمد سعد حمادة ، سعيد محمد حماد*** و محمد مصطفى يس*****

* قسم الوراثة – كلية الزراعة – جامعة المنصورة
** قسم الوراثة – كلية الزراعة بدمياط – جامعة المنصورة
*** قسم بحوث القمح – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

استخدم في هذا البحث اربعة أصناف من قمح الخبز. هذه الأصناف هي : سخا ٦٩ , جيزة ١٦٣ , سخا ٩٤ , جيزة ١٦٨ . تم التهجين بين هذه الأصناف الاربعه للحصول على ثلاثة هجن هي : (جيزة ١٦٣ * سخا ٦٩) , (سخا ٩٤ * جيزة ١٦٨) , (سخا ٦٩ * سخا ٩٤) لكل هجين تم الحصول على الأب الأول والأب الثاني والجيل الأول والهجين الرجعي الأول والهجين الرجعى التانى والجيل التانى التي تم تقييمها في موسم نمو ٢٠٠٦/٢٠٠٧ في محطة البحوث الزراعية بسخا.

أظهرت النتائج أن الآباء لكل هجين اختلفا اختلافا معنويا في معظم الصفات محل الدراسة . وكان الأب سخا ٩٤ هو الأفضل لوزن الحبوب / نبات وقد كان الهجينان ٢و٣ أعلى من الأب الأفضل مما يشير إلى وجود سيادة فائقة لهذه الصفة ,وقد أظهرت النتائج أيضا أن التباين المضيف هو الذي يتحكم بصفه رئيسيه في وراثة صفة محصول الحبوب .

وقد أظهرت النتائج أيضا أن صفتي المقاومة لكل من الصدأ الأصفر وصدا الورقة يحكمهما التباين التجميعي وان كان التباين السيادي لايمكن إغفاله . وقد كان استخدام تحليل العشائر الستة مناسبا لدراسة طبيعة فعل الجين للصفات التي تم دراستها .