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QUANTITATIVE STUDIES ON WHEAT RESISTANCE TO STRIPE RUST CAUSED BY *PUCCINIA STRIIFORMIS TRITICI*

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ABSTRACT

The Present investigation was carried out at Sakha Agric. Res . Sta. from 1996/97 to 1998/1999 seasons to study the inheritance of wheat resistance to stripe rust caused by *Puccinia Striiformis tritici* at adult stage , under field conditions on quantitative basis .

Moreover the results of the six populations ; P_1, P_2, F_1, F_2, Bc_1 and Bc_2 for the three crosses ; Sids 8 x Sakha 61, Sids 8 x Vee # 5 “s” / Bow “s” and Sids 8 x Kinglet proved that heritability values in broad and narrow senses were high in cross 1 (58.26 and 82.32%) and cross 3 (80.6 and 78.04 %) where these values for cross 2 were 70.26 and 62.61 % , respectively.

The obtained results revealed that degrees of dominance for the F_1 (h_1) were –0.91, -0.71 and 0.80 while they were –0.68 , -2.08 and –1.71 for the F_2 (h_2) in the three crosses, respectively , indicating partial dominance for resistance in both F_1 and F_2 populations in all crosses .

INTRODUCTION

Stripe rust caused by *Puccinia striiformis tritici west*, is the most destructive disease for wheat (*Triticum aestivum L*.) in Egypt as well as in many regions of the world. The disease is mainly controlled by the use of resistant cultivars. However , disease resistance has been known to be a simple inherited character controlled by one major gene since the time of Biffen (1905). Known, many outhers confirmed this conclusion and indicated that plant reaction for the pathogen is a simple inherited character affected by one, two or three major genes (Milus and Line, 1986 a; Griffery and Allan , 1988; Dubin *et al* 1989;Shehab El-Din 1986 and Abd El- Latif *et al*,1995) However resistance was dominant over susceptibility in most cases and vise versa in others (Milus and Line, 1986 b ; Pamela *et al*, 1991;Chen *et al*, 1995; Kema *et al*, 1995; Abd El-Latif *et al* 1995 and Shehab El-Din *et al* 1996 On the other hand several investigators proved that resistance is a quantitative character governed by many genes as well as environmental conditions (Shehab El-Din , 1986; Shehab El-Din *et al*, 1991 a and b and Chen *et al* . 1995). Moreover, estimated values of broad and narrow sense heritabilities for resistance were generally high . However, the role of additive gene action was very important in many studies while dominance and / or epistasis were more pronounced in others (Shehab El-Din *et al* 1991 b; Chen *et al*. ,1995 b and Shehab El-Din and Abd El- Latif, 1996).

This research aimed to study the genetic behaviour of stripe rust resistance in four wheat cultivars on a quantitative basis.

MATERIALS AND METHODS

Four bread cultivars namely , the Egyptian commercial Sakha 61 (resistant) and Sids 8 (susceptible) as well as the two lines vee # 5 “s” / Bow “s” (susceptible) and kinglet (intermediate) were selected to represent a wide range of variability in reaction to yellow rust pothogen. These parents were sown at Sakha Agric. Research Station during 1996/1997 wheat growing season in six rows each . Three crosses were made among these parents to represent the following categories:

I-Sids 8 x Sakha 61 (susceptible x Resistant)
II-Sids 8 x Vee #5 “s” / Bow “s” (susceptible x suceptible)
III-Sids 8 x Kinglet (susceptible x Intermediate)

In 1997/1998 season, part of the three F_1‘s was backcrossed to their respective parents, while, the other part was left to produce theF_2 seeds.In1998/1999 season , the final comprehensive experiment was conducted in a completely randomized block design with three replicates . Each replicate consists of 1,1,1,6,2and 2 rows for P_1, P_2, F_1, F_2, Bc1and Bc2, respectively.

These rows were 4 m long and 30 cm apart. Seeds within rows spaced 20 cm, therefore, each row was sown with 20 seeds and the usual cultural practices were applied .

The experiment was surrounded 3 m width spreader grown to highly susceptible wheat cvs to stripe rust i.e. Sakha 92, Giza 163, Gemmeiza 1.etc. The spreader was subjected to an artificial inoculation with stripe rust inoculum using the method of Tervet and Cassel (1951) , in which fresh uredeniospores were mixed with talcum powder at the rate of 1:20. The inoculation was carried out soon after sun set in the second week of January . In addition , the region was subjected to severe waves of winds that carried stripe rust uredeniospores. So, it was considered as a stripe rust epidemic. Moreover, infection types were recorded according to the scale adopted by Chen and Line , (1999). The ordinary cultural practicas were implemented to the experiment during the two seasone.

The yellow rust infection types were recorded according to the scale of Stubbes *et al*. (1986), in which R, MR, M, MS and S are symbolized for i.e. resistant ; moderately resistant, intermediate, moderately susceptible and susceptible , sequently.

The yellow rust reaction frequency distribution was performed for the Six populations of the three crosses at heading and anthesis stages under field conditions .

For the quantitative analysis field response was converted into an average coefficient of infection according to the method of Stubbes *et al*, (1986). In this method, an average coefficient of infection could be calculated by multiplying infection severity by an assigned constant value namely , 0.2, 0.4, 0.6, 0.8 and 1 for R, MR, M, MS and S infection types , in sequence .

Moreover, the genetic analysis was made using the formulae of Peter and Frey (1966). The degree of dominance symbolized as h_1 and h_2 for F_1 and F_2 respectively, were calculated using these two formula.

$$h_1 = (X F_1 – X Mp) / D \text{ and } h_2 = (X F_2 – X Mp)/D$$

Where : D = X hp – X Mp and X F_1, X F_2 and X hp are the means of F_1, F_2 and the higher parent, respectively , while XMp = nid parent value.

Moreover, the different types of gene action were measured according to the method adopted by Gamble (1962)

Heritability in broad sense was calculated by the formule of Lush (1949), while, the heritability in narrow sense was estimated according to the formula developed by Warner (1952).

RESULTS AND DISCUSSION

The yellow rust infection type frequency distributions and phenotypic classes of the parents , F_1, F_2, Bc_1 and Bc_2 populations of the three crosses i.e. Sids 8 x Sakha 61, Sids 8 x Vee #5 “s” / Bow “s” and Sids 8 / Kinglet inoculated with stripe rust (P. *Striiformis tritici)* are shown in Table (1).

Sids 8, Sakha 61, Vee # “s” / Bow “s” and Kinglet infection types ranged from 30 S to 40S , 10R to 20R , 20S to 30S and 10M to 20 M respectively. The three F_1’s ranged from 10 R to 20 R, 20S to 30 S and 10MS to 20 MS indicating that resistance was dominant over susceptibility in crosses 1 and 3 and that low disease severity was dominant in cross2.

The means and variances of coefficient of infection for the six populations ; P_1, P_2, F_1, F_2, Bc_1 and Bc_2 are given in Table (2). Means of infection types for Sids 8 were high and ranged from 36.33 to 38.33 . Meanwhile, for Sakha 61, Vee # 5 “s” / Bow “s” and Kinglet these values were 2.60 , 11.25 and 9.93 in the three crosses, respectively . Moreover, F_1 mean value in the first cross was very close to the resistant parent (2.86), while in the other two crosses, these values (16.25 and 12.74)were lower than those of the mid-parent estimates (24.61 and 24.13) indicating the presence of partial dominance for resistance over susceptibility.

Partial dominance also could be concluded from the estimates of h_1 and h_2 degrees of dominance for both F_1 and F_2 presented in Table (3). However, h_1 values were –0.91, -0.71 and –0.80 while the h_2 values were –0.68 , -2.08 and –1.71 , for the three crosses , respectively. Negative values of h_1 and h_2 reflect the presence of the partial dominance of resistance over susceptibility and support the results obtained from the F_1 means.

The role of different types of gene action was pronounced in all crosses (Table3). However, these effects could not reach the significancy except for the additive component in the first cross.

Heritability values in broad and narrow senses, for yellow rust infection type are given in Table (3). Generaly estimates of heritability in broad sense were 0.85, 0.70 and 0.80 and in narrow sense the estimates were 0.82, 0.62 and 0.78 in the three crosses, respectively.

These conclusions are in agreement with the findings of Shehab El-Din et. al, 1999; Abd El-Latif et. al, 1995; Shehab El-Din (1986) and Shehab El-Din and Abd El-Latif , 1996. Furthermore heritability values in broad sense are being high revealing that most of the phenotypic variability was due to genetic effects . Whereas, obtained high and / or intermediate heritability

estimate in narrow sense indicate the importance of both additive and dominance gene action in the expression of this trait .

This means that selection for rust resistance may be useful in the early generations but would be more effective if postponed to the late ones.

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دراسات وراثية على مقاومة القمح لمرض الصدأ الأصفر المتسبب عن الفطر *Puccinia Striiformis tritici*

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أجرى هذا البحث فى محطة البحوث الزراعية بسخا فى الفترة من 97/96 حتى 99/98 لدراسة وراثة صفة مقاومة القمح لمرض الصدأ الأصفر (المخطط) المتسبب عن الفطر Puccinia Striiformis tritici فى طور النبات الكامل تحت ظروف الحقل. وقد أوضحت النتائج المتحصل عليها من الستة عشائر (الابوين – الجيل الأول – الجيل الثانى – الهجين الرجعى الأول والثانى) لثلاثة هجن بين الصنف سدس 8 وكلا من الصنف سخا 61 والسلالة "Vee # 5"s / Bow "s والسلالة Kinglet أن متوسط الجيل الأول فى الهجن الأول كان قريباً من قيمة الأب الثانى (المقاوم) مما يدل على أن هناك سيادة شبه كاملة للمقاومة بينما فى الهجين الثانى والثالث كانت هذه السيادة جزئية – وبتقدير درجة السيادة فى الجيل الأول والثانى أتضح أنها كانت عالية مما أكد وجود سيادة جزئية فى كل من الجيل الأول والثانى . كما أوضحت النتائج أن كلا من الفعل المضيف والسيادة والتفاعل بينهما له تأثيرات على صفة المقاومة – كما أتضح أن المعامل الوراثي بمعناه الواسع والضيق كان عاليا فى الهجين الأول والثالث بينما كان متوسطا فى الهجين الثانى مما يدل على أن صفة المقاومة صفه وراثية وأن إنتخاب التراكيب الوراثية المقاومة للصدأ الأصفر فى الأجيال الانعزالية المبكرة قد يكون مفيدا ولكن تأخير هذا الانتخاب الى الأجيال المتقدمة هو الأفضل.

Table (1) Yellow rust Infection type frequency distribution and phenotypes of parents, F_1 , F_2, Bc_1 and Bc_2 populations of three wheat crosses inoculated with stripe rust (*Puccini astriiformis tritici)* under field conditions .

Cross	No of plants	10R	20 R	10MR	20MR	10M	20M	10MS	20MS	10S	20S	30S	40S
Sids 8 x Sakha 61													
P_1	30											11	19
P_2	30	21	9										
F_1	35	20	15										
F_2	175	5	8	7	20	12	18	10	15	35	28	17	
Bc_1	90								8	45	28	7	2
Bc_2	90					25	22	28	15				
Sids8xVee #5"s"/Bow"s"													
P_1	28											10	18
P_2	30										25	5	
F_1	32										12	20	
F_2	180			22	20	16	25	23	20	21	19	8	6
Bc_1	90					10	20	19	10	8	15	8	
Bc_2	88					15	16	14	12	18	10	7	
Sids 8 /Kinglet													
P_1	30											5	25
P_2	29					10	19						
F_1	27							11	16				
F_2	188			10	38	35	27	15	12	17	18	10	6
Bc_1	89				6	8	21	14	12	6	12	10	
Bc_2	88					8	14	17	21	15	10	3	

Table (2) : Means and variances for six populations of three wheat crosses inoculated with stripe rust *(puccinia striiformis tritici)* under field conditions .

Cross	P_1	P_2	MP	F_1	F_2	Bc_1	Bc_2
Sids 8x Sakha 61 X	36.33±0.88	2.60±0.17	18.82	2.86±0.17	12.90±0.57	16.03±0.77	9.76±0.37
Sz	23.22	0.84		0.98	56.62	54.02	12.61
Sids 8x vee#5"2" /Bow"s" X	36.43±0.92	11.25±0.60	24.61	16.25±0.86	12.32±0.59	13.69±0.72	12.78±0.69
Sz	22.96	10.94		23.44	64.27	46.13	42.17
Sids 8 / kinglet X	38.33±0.68	9.93±0.53	24.13	12.74±0.76	12.02±0.59	14.07±0.75	12.82±0.57
sz	13.89	8.13	-	15.45	64.38	50.02	28.50

Table (3): Degrees of dominance , for F1 and F2, gene action and heritability estimates for three wheat crosses incoulated with stripe rust (*P. striiformis tritici*) under field conditions.

Cross	H_1	H_2	a	d	aa	ad	dd	% heritability	
								Broad	Narrow
Sids8 x Sakha 61	-0.91	-0.68	**6.27	-16.63	-0.02	6.27	-6.91	85.26	82.32
Sids8 x vee#5"2" /Bow"s"	-0.71	-2.08	0.91	-3.93	3.66	0.91	23.58	70.26	62.61
Sids8 / kinglet	-0.80	-1.71	1.25	-5.69	5.60	1.25	14.26	80.6	78.04