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DIALLEL ANALYSIS OF YELLOW MAIZE FOR RESISTANCE TO LEAF BLIGHT (*HELMINTHOSPORIUM TURCICUM* PASS.) DISEASE AND SOME YIELDING TRAITS UNDER ARTIFICIAL AND NATURAL INFECTION

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ABSTRACT

Eight maize inbred lines were crossed in a half diallel cross system to obtain 28 single crosses in 2002 season and evaluated plus the eight parents under two experiments (artificial infection and natural infection). The two experiments were carried out at Sakha Agriculture Research Station in 2003 season for yield/plant, ear length and percentage of resistance to leaf blight disease Under natural infection experiment, GCA and SCA means squares were highly significant for all traits except resistance to leaf blight disease. Therefor , these genotypes must be tested under artificial infection to appear their ability for resistance to leaf blight disease. Non-additive type of gene action was more important than additive type of gene action in the inheritance for all studied traits under artificial and natural infection conditions. The best inbred lines for GCA effects under artificial infection were SK-7266 for grain yield/plant, SK-6241 for ear length and Gm-1004 for resistance to leaf blight disease. While, the best GCA effects under natural infection were SK-9074 and SK-9108 for grain yield/plant and SK-9108 for ear length. Under artificial infection, resistance of leaf blight disease ranged from 71.5% for cross SK-6241 x SK-9108 to 100% for cross SK-6241 X SK-7266.The cross SK-9108 x SK-9115 exhibited desirable SCA effects for grain yield/plant and resistance to leaf blight disease under artificial infection, also. Moreovér, the cross SK-7266 x SK-9108 had the highest SCA effects for grain yield/plant and ear length under natural infection. Over the mean of grain yield/plant under artificial infection reduced with relative 4% compared to natural infection. The cross SK-7266 x SK-9108 was the best cross for grain yield/plant under artificial and natural infection. While, the cross SK-6241 x SK-7266 had higher resistance to leaf blight under artificial and natural infection.

Keywords: Zea mays, maize, corn, *Helminthosporium turcicum*, leaf blight, Disease resistance, Gene action, combining ability.

INTRODUCTION

It is known that leaf blight disease caused by *Helminthoporium sp.* is a wide spread disease affecting maize plants (*Zea mays* L.) in humid areas with moderate climatic temperature. This disease causes a serious reduction in plant yield and may cause death of adult plants. It can cause significant loss in grain yield by 24.49, 30 and 49.1% estimated by Sharma and Mishra (1988), Gouda (1996) and Tefferi et al., (1996), respectively. Some investigators studied resistance to *H. turcicum* in different maize genetic materials, under the stress of artificial infestation at different growth stages. Raymundo and Hooker (1982) and Sultan (1984).concluded that this resistance depended on high sensitivity in some foreign inbreds, clear signs of monogenic resistance in other and the presented of medium resistance in certain domestic inbreds. On the other hand, resistance response of single

crosses seed may be due to either parental effect or complementary effect of the resistance of both parents.

Maize plants may be infected by leaf blight disease at any stage, but usually during an thesis or post-an thesis. Lesions on susceptible plants are formed first on the lowest leaves and as season progresses, move up wards. Lesions may stage or be so numerous that entire leaf or plant dies (Sangam,1991).

Type of gene action of maize resistance to leaf blight disease in Egypt is necessary for planning the most appropriate and effective breeding program to improve this trait. However, it has been reported that the additive, dominance and epistatic gene actions were responsible for inheritance of this disease by analysis of generation means with a major importance of additive gene action (EL-Menshawy,1986). Also, disease resistance planting adapted, disease resistant hybrids (single and three way crosses) is one of the most important and efficient means of control. Although no variety is resistant or tolerant to all disease , but up to date, there is some single crosses are resistant or highly tolerant to several major disease, specially leaf blight disease as showen in this study. The aime of this study can be summarized as showen:-

1- Estimation G.C.A and S.C.A for the studied genotypes for grain yield/plant, ear length and resistance of leaf blight disease.

2- To identify the best parents and crosses to be used in maize breeding program

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MATERIALS AND METHODS

Isolation and identification of the causal organism:

Infected maize leaves were carefully washed in tap water, small pieces showing blight symptoms were cut and dipped in 0.2% mercuric chloride for half to one minute, allowed to pass through a series of distilled sterile water and dried thereafter on sterilized filter paper, and transferred into Petri-plates containing PDA medium. The inoculated plated were incubated at 27 to 30°C for 7 to 10 days, to get adequate fungal growth. The resulted fungal isolate, were microscopically examined and purified using the single spore and/or hyphal tip techniques. The obtained fungus was identified by staff number of Fungal Taxonomy, institute of plant pathology (ARG) Giza, Egypt.

Preparation of inoculum:

Spore suspension was prepared from 2 to 4 weeks old pure cultures grown on PDA in Petri-plates at 28°C. Distilled sterile water was added to each plate fungal. Growth was scrapped with the aid of a sterile scraped to release the conidia and/or mycelia fragments of the tested fungus. Spore suspension was adjusted to the concentration of 10000 conidia/ml and used for spray of maize genetic materials after 70 to 70 days of sowing as adopted by Gouda (1996). . Data were recorded at 90 days after sowing using the modified scale of Elliott and Jenkins (1946) for estimating *H.Turcicum* infection on maize plants

Eight maize inbred lines i.e. L-121, Gm-1004, SK-6241, SK7-266,SK-8249,SK-9074,SK-9108 and SK-9115 were used in this investigation. All possible combinations, with out reciprocal, were made between the eight parents to obtaine 28 F_1 crosses in 2002 season. The 28 single crosses plus eight parents were grown under two separately experiments (the first under artificial infection while the second under natural infection conditions) in 2003 season at Sakha Agricultural Research Station. A Randomized Complete Blocks Design, with two replicates were used in the two experiments. The plot size was one row, 2 m long and 80 cm apart and 20 cm between hill. Each row consisted of 11 hills with three kernels are seeded per hill. The plants were thinned to one healthy plant per hill. All agricultural practices were applied and the reading were taken for grain yield/plant, adjusted to 15.5% moisture, ear length and resistant of leaf blight disease for two experiments. The genetic analysis for the diallel crosses was computed according to, procedure developed by Griffing (1956), Method-2, Model-1 for all studied traits.

RESULTS AND DISCUSSION

Highly significant differences were found among genotypes for most studied traits under artificial and natural infection except leaf blight resistance trait under natural infection as shown in Table (1), indicating a large amount of variability among studied genotypes for grain yield/plant, ear length and leaf blight resistance. Therefore, these genotypes must be tested under artificial infection to leaf blight. Also, mean squares due to general GCA and specific SCA combining ability were highly significant for most studied traits under artificial and natural infection except leaf blight resistance under natural infection, indicating that both additive and non-additive genetic variance were important in the inheritance of these traits.These results are in agreement with thoses obtained by Hooker (1978), Sharma et al., (1987), Gowda et al., (1993), Takamiya and Send (2000) and El-Kheshin (2002). While, variance due to specific combining ability was more important than variance due to general combining ability in the inheritance of all traits under artificial and natural infection. This was indicated through the ratio of GCA/SCA mean squares, where it was less than unity for all studied traits in this respect. This means that non-additive genetic effects (dominance and epistatic effects) were played the major role in the inheritance of these traits. Therefore, these genotypes must be tested under artificial infection condition to evaluate the ability of each genotypes for high yielding and resistance to leaf blight disease and it could be recommended to use these genotypes in maize breeding program at north and middle delta region.

Table (2) shows mean performance of eight inbred lines for three studied traits. In relation to artificial infection, inbred line SK-9115 exhibited the highest value (190.05 gm) for yield/plant while the lowest value (32.31 gm) was produced by inbred line L-121 with an average of 135.53 gm. the inbred line SK-6241 gave the highest length of ear by value 11.6 cm while the lowest value was 6.2 cm by inbred line SK-8249 with an average of 9.15 cm. Generally, most of the inbred lines exhibited highly resistance to leaf blight

disease and it ranged from 75% for inbred line SK-6241 (moderately resistant) to 97.5% for inbred line Gm-1004(highly resistant). These results indicated that these inbred lines could be used to produce a new resistance hybrids in maize breeding programs. On the other hand, under natural infection experiment, the inbred line SK-9074 gave the highest value (204.53 gm) for grain yield/plant, while the inbred line L-121 gave the lowest value (46.32gm) with an average of (152.47gm).For the ear length trait, the inbred line SK-6241 gave the highest value (14.75cm) meanwhile, the inbred line SK-7266 gave the lowest value (9.0cm) with an average of (12.42 cm). The values of leaf blight resistance ranged from 86% for inbred line SK-7266 (moderately resistant) to 100% for inbred line SK-9115 (highly resistant) with an average of 95.75%. As general, the results showed higher values of means under natural infection compared to artificial infection for the studied traits.

The mean performance of crosses for all studied traits are shown in Table (3). Under (artificial infection) the grain yield/plant ranged from 102.14 gm/plant for cross (Gm-1004 x SK-7266) to 220.82 gm/plant for cross (SK-7266 x SK-9108) with an average of 162.04 gm/plant. Moreover, some crosses gave highest values such as (SK-7266 x SK-9115) 201.37 gm/plant, (SK-9108 x SK-9115) 198.48 gm/plant, (SK-9074 x SK-9108) 197.73 gm/plant, (SK-6241 x SK-9108) 196.52 gm/plant and (SK-624 x SK-9115) 195.50 gm/plant. These crosses could be used in improving grain yield of maize. For ear length, means of crosses ranged from 10.8 cm (Gm-1004 x SK-7266) to 18.2 cm (SK-6241 x SK-9108) with an average of 15.22 cm. For leaf blight resistance, the crosses as general exhibited different degrees of resistant, where the values ranged from 71.5% (SK-6241 x SK-9108) moderately susceptible to 100% (SK-6241 x SK-7266) highly resistant with an average of 91.57%. These results indicated that these crosses in this study having highly resistance for leaf blight disease and it could be contributed in maize breeding programme. While, under natural infection hand and mean performance for grain yield/plant ranged from 119.39 gm/plant (SK-8249 x SK-9115) to 290.6 gm/plant (SK-7266 x SK-9108) with an average 168.52 gm/plant. Moreover, some crosses gave highest values such as (L-121 x Gm-1004) 201.29 gm/plant, (L-121 x SK-9074) 204.53 gm/plant and (SK-8249 x SK-9108) 210.6 gm/plant. These crosses are considered promising genotypes and can be used in breeding maize programme. For ear length, the values of means ranged from 15.5 cm (SK-8249 xSK-9074) to 21.2 cm (Gm-1004 x SK-9108) with an average of 18.29 cm. For leaf blight resistance, no differences between crosses for resistant to leaf blight, where the values ranged from 84% for the cross (SK-8249 x SK-9108) (moderately resistant) to 100% for crosses (L-121 x SK-9115), (SK-6241 x SK-8249) and (SK-6241 x SK-9074) highly resistance with an average of 95.71%. Similar results were obtained by Cosmin et al., (1987) and Shmara et al.,(1987). As general, 15 crosses are considered of (highly resistant), where ranged from 95% to 100%, 4 crosses are resistant ranged from 92.5% to 93.5%, 8 crosses are moderately ranged from 78% to 87.5% and one cross is moderately susceptible 71.5% according to the modified scale of Elliott and Jenkins (1946) indicating that majority of these single crosses nearly 23 single

crosses are considered fruitful promising hybrids to contribute in maize breeding program.

General combining ability effects of eight inbred lines under artificial and natural infection are shown in Table (4). The inbred line SK-7266 exhibited the highest positive and significant GCA effects for grain yield/plant, the inbred line SK-6241 gave the highest positive and significant GCA effects for ear length while, the inbred line Gm-1004 exhibited the highest positive and significant GCA effects for resistance to leaf blight disease under artificial infection. While, under natural infection, the inbred line SK-9108 exhibited the highest positive and significant GCA effects for grain yield/plant and ear length. While, the remaining inbred lines did not appear significant differences under natural infection for the studied traits. Therefor , it must be test these genotypes under artificial infection to appear their ability to resistance this disease.

Specific combining ability effects of 28 crosses under artificial and natural infection are shown in Table (5). Under artificial infection, eight crosses exhibited positive and highly significant SCA effects, two crosses exhibited positive and significant effects for grain yield/plant. Six crosses exhibited positive and highly significant SCA effects, three crosses exhibited positive and significant SCA effects for ear length. Two crosses exhibited positive and significant SCA effects. Moreover, the cross SK-6241 x SK-9108 exhibited higher positive and significant SCA effects for grain yield/plant, ear length and resistant to leaf blight disease . Under natural infection, ten crosses exhibited the highest positive and significant SCA effects, two crosses gave positive and significant SCA effects for grain yield/plant. Three crosses gave the highest positive and significant SCA effects, four crosses exhibited positive and significant SCA effects for ear length. For resistance to leaf blight disease, no significant differences among crosses for SCA effects, indicating that these crosses must be testing under artificial infection to evaluate their ability to resistant to leaf blight disease.

Table (1): Analysis of variance of eight parents and their crosses under artificial and natural infection and reaction for leaf blight disease and some other traits.

S.O.V	d.f	Artificial infection			Natural infection		
		Yield/plant	Ear length	L.B.R.	Yield/plant	Ear length	L.B.R
Reps	1	254.4	14.76	234.72	83.45	7.54	32.00
Genotype	35	5654.1**	17.13**	140.26**	6813.30**	17.10*	38.84^{NS}
GCA	7	2153.8**	5.73*	170.09**	2604.93**	10.13**	30.10^{NS}
SCA	28	6529.13**	19.98**	132.80**	7865.4**	18.84*	41.03^{NS}
Error	35	629.8	2.31	46.78	270.11	2.84	30.31
$\bar{x}$		141.35	13.87	90.11	141.55	16.98	95.72
C.V%		17.75	10.95	7.59	11.61	9.92	5.75
GCA/SCA		0.030	0.024	0.134	0.032	0.05	0.058

*,** significant at 0.05 and 0.01 levels of probability, respectively.

Table (2): Means of eight inbred lines for resistant of leaf blight disease and some other traits under artificial and natural infection.

Parents	Artificial infection			Natural infection		
	Yield/plant	Ear length	L.B.R.%	Yield/plant	Ear length	L.B.R.%
L-121	32.31	10.5	97	46.32	13.70	97
Gm-1004	124.71	9.0	97.5	201.29	12.70	95
SK-6241	162.00	11.6	75	160.19	14.75	97
SK-7266	125.26	8.1	85	134.64	9.00	86
SK-8249	178.63	6.2	77.5	119.62	12.90	98.5
SK-9074	151.44	10.2	78	204.53	13.90	95
SK-9108	119.83	9.3	93.5	174.55	12.40	97.5
SK-9115	190.05	8.3	93.5	178.62	10.00	100
$\bar{x}$	135.53	9.15	87.13	152.47	12.42	95.75
L.S.D 0.05	49.19	1.52	13.4	32.21	3.05	10.80
0.01	64.75	2.00	17.65	42.40	4.01	14.21

Table (3): Mean of 28 single crosses for leaf blight resistance and some other traits under artificial and natural infection conditions.

Crosses	Artificial infection			Natural infection		
	Yield/plant	Ear length	L.B.R.%	Yield/plant	Ear length	L.B.R.%
L-121xGm-1004	124.71	14.9	98.5	201.29	18.4	97.5
xSK-6241	162.00	14.8	95.0	160.19	17.5	96.0
xSK-7266	125.26	15.7	96.0	134.64	18.6	98.5
xSK-8249	178.63	14.5	92.5	119.62	16.9	97.5
xSK-9074	151.41	13.6	98.5	204.53	17.3	96.0
xSK-9108	119.83	15.2	85.0	174.55	19.9	93.5
xSK-9115	140.05	15.5	93.5	178.62	19.6	100
Gm-1004xSK-6241	153.57	15.5	97.5	154.11	17.9	97.0
xSK-7266	102.14	10.8	93.5	163.74	17.0	97.0
xSK-8249	145.57	16.4	95.0	131.7	18.3	96.0
xSK-9074	186.05	14.7	97.0	134.44	16.7	97
xSK-9108	154.06	17.2	97.0	188.55	21.2	97.5
xSK-9115	157.65	16.4	78.0	178.62	17.6	97.0
SK-6241xSK-7266	160.73	16.4	100	140.44	18.5	97.0
xSK-8249	160.61	14.1	92.5	133.00	17.8	100
xSK-9074	185.06	15.1	96.0	182.42	17.6	100
xSK-9108	196.52	18.2	71.5	184.42	20.8	97.5
xSK-9115	195.50	16.2	97.0	192.85	19.9	97.5
SK-7266xSK-8249	158.35	15.5	97.5	141.56	16.7	97.0
xSK-9074	157.37	14.6	96.0	194.33	18.3	96.0
xSK-9108	220.82	14.7	78.0	290.6	20.7	98.5
xSK-9115	201.37	15.6	86.0	155.90	16.4	86.0
SK-8249xSK-9074	156.05	13.2	78.0	140.01	15.5	97.5
xSK-9108	152.18	15.3	87.5	210.60	19.5	84.0
xSK-9115	147.24	16.2	87.5	119.39	16.4	86.5
SK-9074xSK-9108	197.73	16.4	87.5	168.54	19.3	85.0
xSK-9115	148.77	14.2	96.0	174.51	18.4	98.5
SK-9108xSK-9115	198.48	15.2	96.0	165.26	19.4	98.5
$\bar{x}$	162.04	15.22	91.57	168.52	18.29	95.71
L.S.D 0.05	49.19	1.52	13.4	32.21	3.05	10.80
0.01	64.75	2.00	17.65	42.40	4.01	14.21

Table (4):General combining ability effects of eight inbred lines under artificial and natural infection.

Parents	Artificial infection			Natural infection		
	Yield/plant	Ear length	L.B.R.	Yield/plant	Ear length	L.B.R.
L-121	-15.57**	0.037	-3.4*	-0.789	0.266	0.150
Gm-1004	-13.26*	-0.092	4.40**	-5.181	-0.044	1.00
SK-6241	7.05	0.867**	1.45	2.328	0.666	1.00
SK-7266	15 44**	-0.533	2.05	2.230	-0.864*	0.900
SK-8249	0.69	-0.723	0 05	-20 731**	-0.594	0.500
SK-9074	-1.34	-0.263	-1.50	8.075*	-0.194	-1.200
SK-9108	6.73	0.598	-4.30**	18 865**	1.276**	-2.450*
SK-9115	0.26	0.107	1.25	-4.798	-0 514	0.100
L.S D 0 05	10.30	0.62	2.80	6.74	0.69	2.25
0.01	13.54	0.82	3.69	8 87	0.91	2.97

*,** significant at 0.05 and 0.01 levels of probability, respectively.

Table (5): Specific combining ability effects of 28 crosses under artificial and natural infection.

Crosses	Artificial infection			Natural infection		
	Yield/plant	Ear length	L.B.R.	Yield/plant	Ear length	L.B.R.
L-121xGm-1004	12.181	1.086	6.389	65.705**	1.096	-1.872
xSK-6241	29.172	0.026	-13.161**	17.101	-0.410	0.128
xSK-7266	-15.968	2.326*	-3.76	-8.350	2.216*	-10.772**
xSK-8249	52.157**	1.316	-10.261*	-0.416	0.246	2.128
xSK-9074	26.962	-0.044	-7.711	55.689**	0.246	0.328
xSK-9108	-12.687	0.696	-4.411	14.920	1.376	4.078
xSK-9115	64.002**	1.486	5.539	42.652**	2.866**	4.028
Gm-1004xSK-6241	18.435	0.856	-0.961	15.410	0.296	-1.722
xSK-7266	-14.387	-2.444*	-0.561	25.144*	0.926	0.878
xSK-8249	16.783	3.346**	-2.061	16.065	1.956	0.278
xSK-9074	59.291**	1.186	5.489	-10.010	-0.044	0.478
xSK-9108	19.228	2.826**	-5.211	33.405**	2.986**	0.772
xSK-9115	28.809	2.516**	-2.261	9.589	1.176	3.178
SK-6241xSK-7266	-3.110	2.196*	-0.111	-5.671	1.176	-0.622
xSK-8249	11.521	0.086	3.389	9.855	0.746	-1.222
xSK-9074	37.991*	0.626	6.939	30.467**	0.146	1.478
xSK-9108	41.389*	2.866**	9.739*	21.856*	1.876	3.228
xSK-9115	46.837**	1.356	-14.811**	53.771**	2.766*	0.178
SK-7266xSK-8249	0.866	2.886**	0.289	18.512	1.176	2.878
xSK-9074	15.416	1.526	5.339	42.477**	2.376*	4.578
xSK-9108	57.297**	0.766	-16.361**	127.956**	3.306**	3.328
xSK-9115	44.316**	2.156*	3.589	16.916	0.796	0.778
SK-8249xSK-9074	15.297	0.316	7.339	11.111	-0.694	0.978
xSK-9108	3.399	1.556	-7.861	70.915**	1.876	4.728
xSK-9115	4.934	2.946**	-5.411	3.364	0.526	-10.322
SK-9074xSK-9108	50.972**	2.196*	3 189	0 025	1.236	-8.072
xSK-9115	8 130	0.486	-2.361	29.681**	2.126*	-8.122
SK-9108xSK-9115	50.130**	0.626	8.939*	9.638	1.656	5.128
L.S.D 0.05	31.54	1.91	8 60	20.65	2.12	6.92
0.01	41.51	2.51	11.31	27.19	2.79	9.11

*,** significant at 0.05 and 0.01 levels of probability, respectively.

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التحليل الوراثى للهجن التبادلية للذرة الصفراء لمقاومة مرض تبقع الأوراق وبعض الصفات المحصولية الأخرىتحت ظروف العدوى الصناعي والطبيعي

محمد حسن على إبراهيم
مركز البحوث الزراعية – معهد المحاصيل الحقلية – قسم بحوث الذرة الشامية

تم عمل الهجن الممكنة بين ثمانية سلالات صفراء جديدة من الذرة الشامية بنظام التهجين الدوري الغير كامل (الدياليل) وذلك بمحطة البحوث الزراعية بسخا فى الموسم الزراعي ٢٠٠٢م.

تم تقييم السلالات والهجن الناتجة منها تحت ظروف تجربتين للعدوى الصناعي والطبيعي لمرض تبقع الأوراق فى الذرة الشامية.

- اظهر التباين لكل من القدرة العامة والخاصة على التالف فروقا معنويا لكل الصفات المدروسة ما عدا صفة المقاومة لمرض تبقع الأوراق تحت ظروف العدوى الطبيعي.

- اظهر الفعل الوراثى الغير مضيف أكثر أهمية لوراثة صفة المقاومة لمرض تبقع الأوراق لكل الصفات المدروسة تحت ظروف العدوى الصناعي والطبيعي.

- أظهرت السلالة سخا-٧٢٦٦ تأثيرات عالية للقدرة العامة على التالف لصفة محصول الحبوب للنبات، السلالة سخا-٦٢٤١ لطول الكوز وأيضا السلالة جميزة-١٠٠٤ لصفة مقاومة مرض تبقع الأوراق تحت ظروف العدوى الصناعي. بينما تحت ظروف العدوى الطبيعي أظهرت السلالة سخا-٩٠٧٤ والسلالة سخا-٩١٠٨ أفضل التأثيرات الموجبة والمعنوية لتأثيرات القدرة العامة لصفة المحصول والسلالة سخا-٩١٠٨ لصفة طول الكوز.

- تراوحت نسبة المقاومة لمرض تبقع الأوراق من ٧١,٥% للهجين سخا-٦٢٤١ x سخا-٩١٠٨ الى ١٠٠% للهجين سخا-٦٢٤١ x سخا-٧٢٦٦ .

- كانت الهجن سخا-٦٢٤١ x سخا-٩١٠٨ – سخا-٩١٠٨ x سخا-٩١١٥ أفضل الهجن لتأثيرات القدرة الخاصة على التالف لصفة محصول الحبوب للنبات بينما كان الهجين سخا -٧٢٦٦ x سخا-٩١٠٨ أفضل الهجن لتأثيرات القدرة الخاصة على الانتلاف لصفة محصول حبوب النبات وطول الكوز تحت الظروف الطبيعية بينما كان الهجين سخا-٧٢٦٦ x سخا-٩١٠٨ أفضل الهجن بالنسبة لمحصول حبوب النبات.

- كانت نسبة النقص فى المحصول تحت ظروف العدوى الصناعي تقدر بـ٤% مقارنة بالمحصول تحت ظروف العدوى الطبيعي.

- اظهر الهجين سخا-٦٢٤١ x سخا-٧٢٦٦ مقاومة عالية لمرض تبقع الأوراق تحت كل من ظروف العدوى الصناعي والطبيعي ويمكن الاستفادة بهذه الهجن فى برنامج التربية للذرة الشامية.