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INFLUENCES OF PLANT DENSITY ON COMMON SMUT RESISTANCE UNDER ARTIFICIAL AND NATURAL INFECTION IN MAIZE.

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ABSTRACT

Climatic condition around the plant greatly affected by differ plant density, since the high plant density could increase relative humidity around the plants and increase the smut incidence in maize plants. The present study reported that, increasing plant density from 20.000 to 30.000 plants/fed. Significantly decreased the yield, ear length and increased percent of infection by the disease .In the reverse, the disease index was increased by decreasing plant density. The optimum plant density which gave the highest yield, the longest ear and moderately infection by the smut disease was 20.000 plants /fed. Moreover, the single crosses 107, bashaier –13 gave the lowest rate of infection percent and disease index comparing with other tested caultivars. The open pollinated variety G-2 and Bush gave the highest rate of susceptibility infection percent and disease index. The results revealed that resistant to common smut deferred significantly from one year to another, meanwhile the disease index not varied in the two years.

INTRODUCTION

The aim of this study was to assess the influence of plant density on the resistant to smut disease under artificial and natural infection on some maize cultivars. *Ustilago maydis* (DC) Cda caused organism of common smut disease of maize infects all tissues of its host plant. . The fungus normally uses three points of entry; leaf whorls, the intersperses between young leaves, and leaf sheaths (urech 1972). Galls of different morphological types can be produced by artificial inoculation of 30 days old maize plants .The hypodermic injection technique was the most effective in inducing disease symptoms (Raymal 1975, and Pope and Maccarter 1992).Shurtleff (1980)and Maysa Moursy *et al*. (1998) found that breeding for smut resistance must be done continuously in view of fact that there are many and changing physiologic farms of the pathogen (*U.maydis*). The estimation of maize grain yield losses in plants were infected by *U.maydis* depended on number, diameter and location of smut galls as was reported by El-Kafrawy (1989) .Kostandi and Geisler (1989) stated also that, loss in maize grain yield associated with smut galls on ear ,stem and tassel were 57.1%, 24.3%and 9.3%, respectively. Climatic condition greatly affected smut infection. They also added that relative yield was highest for resistant maize hybrids to smut infection, and lowest for susceptible ones. Kostandi and Soliman (1991) concluded that infection of maize with common smut reduced yield per plant from 5 up to 93%. Infection with one gall above the ear drastically affected the yield than infection with one or more galls bellow the ear. Climatic condition around the plant greatly affected by differing plant density. Wilcoxson (1975) showed that maize smut was less prevalent on five

different hybrids and inbred lines when plant population were maintained at 18000 (or more) plant /acre. Ragab *et al.* (1984), El-Kafrawy (1989) and Kostandi (1992) stated that low plant density (20.000 plant/fed.) could increase smut incidence in maize plants .In the reverse, El-Assiuty *et al*, (1990) showed that infection of maize with common smut were increased by increasing plant density up to 30.000 plants/fed. Moreover, Shalaby *et al.* (1994) and Tolba (1996) showed that maize grain yield and grain quality were significantly decreased as plant density was increased from 48.000 up to 96.000 plants /ha. They also added that, the optimum plant density which gave low degree of infection by smut and high production of grain yield was 24.000 plants /fed.

MATERIALS AND METHODS

The experiment was carried out at Sakha Research Station during the two season of 1999 and 2000 to determine the reaction of six maize cultivars i.e. S.C. 107, S.C. 120, S.C. 122, S.C. bashaier–13, Gize-2 and Balady (Boch) to common smut resistance under two plant density. Each experiment was arranged in split plot design with three replications. The main plot included two-plant densities i.e 20,000 and 30,000 plant/fed and six maize cultivars, sub plot involved the two common smut infection. Plot size was 4 rows, 6m long, 80 cm apart. The two inner rows per each plot were used to artificial and infection as follow all plants of the first row were inoculated by suspension of smut teloiospores, the second row was inoculated by distillated water. The experiment was carried out under artificial and natural infection, infected plants were recorded after 100days of sowing and expressed as healthy plant were percentage. Disease severity was classified into classes according to size of gall, and disease index (DI) was estimated .At harvest, the ear and grain yield was estimated as arab /fed. for each treatment .

Isolation and preparation of inoculation:

Free teloiospores of tested fungus were soaked in 1.5% copper sulphate solution for 24 hours at the rate of 0.5 gram teliospore powder per liter in 250 ml chrlemmayer flasks. Flasks were shaken from time to time for enough mixing during treatment. A loopfalls of spore suspension was streaked on potato dextrose agar (PDA) plates and inoculated at 30 ^{0}C for 10 – 15 days till the formation of visible and considerable colonies (Khalil, 1973).

Suspension of sporidia was prepared from 10 days old cultures grown on PDA in petri plates at 30 ^{0}C. Distilled sterile water (10 ml) was added to each plate. Growth was scrapped with the aid a sterile scrapped for release the sporidia. Spore suspension of 10 plates were complied and them, filtered through cheese cloth to get rid of agar particles. The suspension was completed to 500 ml using a sterile water. Spore suspension was adjusted to the concentration of 10^4 spore/ml.

Inoculation technique:

Sporidial suspension was injected by hypodermic needle into 45 – 50 days old plants at about 20 – 25 cm above the ground at the rate of 2 ml/plant. The sterile water was used for injection of control treatment, as adopted by Khalil (1973)

Disease reading were recorded after 100 days of sowing and expressed as percentage of healthy plants. Disease severity was classified into eight classes according to size of each gall and disease index (DI) computed as out line as Khalil (1973) as follows:

$$DI = \frac{NPCxCA}{NIPxMSC}$$

Where:

NPC = No. of plants in class rate

CA = class rate

NIP = No. of included plants

MSC = Maximum severity class rate

And modified decease rate which was suggested later on as :

0 = No. Infection

1 = Galls less than 1 cm in diameter

2 = 1 to less than 2 cm

3 = Galls to less than 3 cm

4 = Galls 3 less than 4 cm

5 = Galls 4 less than 5 cm

6 = Galls 5 to less than 6 cm

7 = Galls 6 to less than 7 cm and

8 = Galls 7 cm and more the ear length and finally, at harvest, the yield was estimated as ard/fed. for each cultivar. Effect of different plant densities on the incidence of maize common smut disease.

RESULTS AND DISCUSSION

Table (1) shows the combined analysis for grain yield, ear length, disease index and percentage of resistant to common smut disease over all the two years 1999 and 2000. The results indicated that the highly significant between varieties for all studied traits, significant difference obtained between natural and artificial infection for all traits and between the two plant densities for ear length and resistance to common smut disease. The interaction of (varieties x density), (years x infection) , (densities x infection) and (varieties x infection) were significant specially for disease index and resistant to common smut disease. These results indicated that the disease index and resistance to common smut deferred significantly from one year to another and from 20,000 and 30,000 plants/fed. and from one variety to another as expected.

Table (2) revealed the decreasing the yield, ear length and resistance to common smut as well as the plant density increased. While, the disease index increased with increasing the plant density.

Table (1): combined analysis for grain yield, ear length, disease index and percentage of resistance to common smut disease over all the two years 1999 and 2000.

Sources	D.F	Yield (ard/fed)	Ear length	Disease Index	Resistance percentage
Years Y	1	278.108	26.095	0.220	478.9
Error	4	40.938	6.289	23.354	248.8
Densities D	1	12.865	449.79**	11.554	2955.6**
Y x D	1	5.652	0.008	37.159	134.77
Varieties V	5	707.786**	122.140**	3680.6**	2936.0**
Y x V	5	79.632**	4.562**	26.245	63.343
D x V	5	10.256	6.504**	104.892**	275.60**
Y x D x V	5	8.119	1.004	13.994	68.149
Error	44	13.907	0.899	26.069	62.849
Infection E	1	3013.7**	14.377**	15425.0**	53494.6**
Y x E	1	279.78**	1.156	117.23	586.08**
D x E	1	46.151*	0.391	1357.6**	2455.78**
Y x D x E	1	12.082	3.578	78.485	53.229
V x E	5	121.893**	0.738	177.997**	1820.0**
Y x V x E	5	36.960**	1.762	32.639	36.172
D x V x E	5	3.118	1.290	62.451	99.082
Y x D x V x E	5	2.212	0.808	17.765	127.887
Error	48	9.215	1.164	25.838	72.848
C.V %		16.78	5.59	23.05	11.47

Table (2): Mean performance for grain yield, ear length, disease index and percentage of resistance to common smut over all environments.

Sources	Yield (Ard/fed)	Ear length	Disease index	Resistant percentage
Year 1999	16.696	18.878	22.093	76.205
Year 2000	19.475	19.729	22.015	72.558
Density 20,000	18.384	21.071	22.337	78.912
Density 30,000	17.787	17.536	21.771	69.851
S.C. 107	15.211	19.383	9.410	83.225
S.C. 120	20.057	20.642	25.548	71.070
S.C. 122	23.249	20.446	16.728	75.079
S.C. Bashaier	23.667	21.125	9.498	90.332
Giza-2	16.976	19.283	30.917	66.582
Boch	9.353	14.942	40.224	60.002
L.S.D. 0.05	2.16	0.55	2.96	4.59
Infection	13.511	18.987	32.404	55.108
Natural	22.660	19.619	11.704	93.656

The mean of varieties for grain yield ranged from 9.353 ard/fed for Boch variety, to 23.667 ard/fed. for S.C. Baschaier-13, disease index ranged

from 9.410 for S.C. 107 to 40.224 for Boch variety and resistant to common smut ranged fron 60.00% for Boch variety to 90.33% for S.C. Baschaier –13. The optimum plant density which produce the highest level of grain yield with moderate level of infected by smut was 20,000 plant/fed. This disagree with finding of El-Kafrawy 1989 who reported that, no significant differences in smut disease reaction were observed between the different maize plant densities (i.e. 20,000 and 30,000 plant / fed. On the other hand, this study supported the finding by El-Assuity *et al*. (1990), Shalaby *et al.* (1994) and Tolba (1996) who found that maize infection by *U. maydis* increased by increasing plant density up to 30,000 plant / fed. The great grain losses due to the highest degree of disease severity.

Table (3) shows the interaction between densities and varieties for resistance to common smut and disease index. The percent of resistance to common smut was high under low density for all tested cultivars except S.C. 107. The single crosses Baschaier-13 and 107 were the highest resistant percent compared with other cultivars under both of 20,000 and 30,000 plant / Fed. .The disease index was high under the low density for all cultivars except S.C 122.

Table (4) shows the interaction between infection by common smut and each of years, plant densities and varieties for resistance to common smut and disease index. The results revealed that resistant to common smut differed significantly from one year to another, meanwhile the disease index did not varied in the two years. The percent of resistance to common smut were high under low density (20.000 plants /fed.) under artificial and natural infection. Disease index was high at 20.000 plant /fed. under artificial infection compared with 30.000 plant /Fed., the reverse observed under natural infection. These results are in accordance with those obtained by El-Assuity *et al.* (1990), Shalaby *et al.* (1994) and Tolba (1996). The resistance to common smut ranged from 32.262% for boch variety to 81.882 for S.C. bashaier whoever, disease index ranged from 16.94 for S.C. bashaier to 53.07 for boch variety under artificial infection. Meanwhile, The resistance to common smut varied from 87.74% for boch variety to 98.78% for bashaier–13, whoever, disease index ranged from 0.982 for S.C. 107 to 27.371 for boch variety under natural infection.

Table (3): Mean of interaction between densities and varieties for resistance to common smut and disease index.

	Resistance %		Disease index	
	D-1	D-2	D-1	D-2
S.C. 107	81.688	84.763	10.132	8.689
S.C. 120	77.122	65.017	25.768	25.328
S.C. 122	80.630	69.528	13.337	20.118
S.C. Bashaier	93.448	87.215	9.367	9.629
Giza-2	72.352	60.813	32.317	29.517
Boch	68.234	51.770	43.103	37.344

Table (4): means of interaction between infection by common smut and years, plant densities and varieties for resistance to common smut and disease index.

Infection			Resistance%	Disease index
Artificial	Years	1999	54.917	31.541
		2000	55.301	33.267
Natural		1999	97.497	12.646
		2000	89.815	10.763
Artificial	Densities	20.000	63.768	35.758
		30.000	46.447	29.050
Natural		20.000	94.057	8.917
		30.000	93.255	14.492
Artificial	Varieties	S.C .107	75.015	17.839
		S.C. 120	46.227	39.794
		S.C. 122	53.618	25.228
		S.C. Bashaier	81.882	16.941
		Giza-2	41.642	41.545
		Balady (boch)	32.262	53.077
Natural		S.C .107	91.436	.982
		S.C. 120	95.913	11.302
		S.C. 122	96.54	8.227
		S.C. Bashaier	98.781	2.055
		Giza-2	91.523	20.289
		Balady (boch)	87.742	27.371

REFERENCES

El-Assuity, E.M.; A.M. El-Kafrawy; M.M. Diab and M.M. Khalifa (1990). Common smut of maize: Yield losses and disease control. Egypt. J. Appl. Sci., 5(8): 895-902.

El-Kafrawy, A.M. (1989). Studies on the common smut of maize with special emphasis of the chemical control of the disease. Ph. D. Thesis Fac. Agric., Mansoura Univ., Egypt.

Khalil, F.A. (1973). Studies on common smut of maize caused by *Ustilago maydis* (DC) Cda. M. Sc. Thesis, Fac. Agric., Cairo University.

Kostandi, F. Sofi (1992). Smut incidence and yield losses of corn cultivars under different plant population densities. J. of Agric. and Crop Sci., 168 (3): 201-207.

Kostandi, F. Sofi and G. Geisler (1989). Maize smut induced by *Ustilago maydis* (DC) Cda. Specific effect of common smut intensity and location of galls on yield losses. J. of Agronomy and Crop Sci., 163 (1): 62-68.

Kostandi, F. Sofi and M.F Soliman (1991). The significance of NPK fertilizers on yield and smut incidence of corn. J. of Agron. and Crop Sci., 167 (4): 269-276.

Maysa Moursy, A.; I.M. Mansour and H.Y. El-Sherbiny (1998). Variation in *Ustilago maydis the*_cause of common smut of maize. Minufya J. Agric. Res., 13(3): 1407-1423.

Pope, D.D. and S.M. Maccarter (1992). Evaluation of inoculation methods for inducing common smut on corn ears. Phytopathology, 82(9): 650-955.

Ragab, M.M.; F.A. Khalil and Zeinab M. Fahmy 1984). Effect of cultural practices on the control of maize common smut caused by *Ustilago maydis* (D.C.) Cda. Bull. Fac. Agric., Cairo Univ., 36(1): 563-574.

Raymal, G. (1975). Um technique de contamination artificial du par *Ustilago maydis* (D.C..) Carda. Ann Phytopathology, 6(3): 353-358.

Shalaby, A.A.; M.A. Gommaa; F.I. Radwan and R.A. Gaafar (1994). Response of maize to increasing levels of nitrogen fertilization and plant population. J. Agric. Res., Tanta Univ., 20(1): 25-36.

Shurtleff, M.C. (1980). Compendium of corn disease. 2ndeddition, the disease Compendia Series Publishes by the American Phytopath. Socity.

Tolba, S.A.E. (1996). Studies on common smut of maize in Egypt caused by *Ustilago maydis* (D.C.) Cda. Ph. D. Thesis, Fac. Agric. Kafer El-Sheikh, Tanta Univ., Egypt.

Urech, P.A. (1972). Investigation of the corn smut by *Ustilago maydis* phytopathol., 73(1): 1-26.

Wilcoxson, R.D. (1975). The relation-ship between corn plant population and smut disease. Plant Dis. Res., 59(8): 678-680.

تأثير الكثافة النباتية على مقاومة التفحم العادى تحت العدوى الصناعية والطبيعية فى الذرة الشامية

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معهد المحاصيل الحقلية - مركز البحوث الزراعية

أجريت هذه الدراسة فى محطة البحوث الزراعية بسخا موسمى ١٩٩٩ و ٢٠٠٠ على ستة أصناف من الذرة الشامية لدراسة المقاومة لمرض التفحم وبعض الصفات المحصولية تحت كثافتين (٢٠,٠٠٠ , ٣٠,٠٠٠ نبات/فدان) تحت ظروف العدوى الصناعية والعدوى الطبيعية.

وأظهرت النتائج ما يلى:

* - تتأثر الظروف المناخية حول النباتات باختلاف الكثافة النباتية حيث أن الكثافة النباتية العالية يمكن ان تؤدى الى زيادة الرطوبة النسبية حول النباتات وينتج عن ذلك زيادة فى مرض التفحم فى نباتات الذرة.
* - أوضحت الدراسة الحالية أن زيادة الكثافة النباتية من ٢٠,٠٠٠ إلى ٣٠,٠٠٠ نبات/فدان أدت الى انخفاض المحصول معنويا وصفة طول الكوز وزيادة النسبة المئوية للإصابة بمرض التفحم٠
* - أوضحت الدراسة أن الشدة المرضية تزداد بانخفاض الكثافة النباتية .
* - الكثافة النباتية المثلى التى تعطى محصول عالى من الحبوب و طول الكوز ودرجة متوسطة من الإصابة بالتفحم هى ٢٠,٠٠٠ نبات/فدان.
* - أوضحت الدراسة أن الهجن الفردية ١٠٧ و بشاير-١٣ أعطت أقل درجة فى نسبة الإصابة وكذلك فى الشدة المرضية مقارنة مع الهجن الفردية الأخرى المختبرة.
* - كذلك فان الأصناف المفتوحة التلقيح جيزة-٢ وبوش أعطت أعلى درجة إصابة بمرض التفحم والشدة المرضية.