COMBINED EFFECT OF MANURE- NITROGEN FERTILIZATION ON MAIZE HYBRID (10) TO INSECT INFESTATION IN RELATION TO PHYSICAL AND CHEMICAL GRAIN CHARACTERS

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Abstract

Laboratory experiments were carried out to study the degree of insect infestation by *Sitophilus oryzae* L. on maize grains (Hybrid 10) treated in the field with organo-fertilizer (farm- yard manure at zero and 20 m3/Fed.) under three levels of nitrogen fertilization (45, 90 and 135 kg/Fed.). Results showed that the degree of infestation and the mean of emerged adults of *S. oryzae* were greatly affected by the tested fertilization treatments of Hybrid 10 maize. Data also, showed that the treatment with nitrogen fertilizer alone gave a susceptible hybrid to insect infestation whereas, the combination between the high levels of nitrogen (135 kg/Fed.) and 20m3/Fed manure, gave Hybrid 10 more tolerant for infestation and with less weight loss. Relationship between some chemical and physical characters of Hybrid 10 and its *resistance to* insect infestation was also studied. Such characteristics were obviously affected as a result of tested levels of Nitrogen fertilization as well as its combination with manure. On the other hand, some physical characteristics were variously affected by insect infestation, i.e. weight of 100 grain, grain volume, ash % endosperm %, germ % and hull %. Most of chemical composition of tested treatment (except total carbohydrate) were increased by increasing the fertilization i.e. amylose %, protein %, ash, oil %, and fibers. Finally, crude fiber and its fractions in the tested hybrid affected the degree of insect infestation and should be taken in consideration during breeding programs to select a line with high yield, high quality, more resistant to insect attack and characterized with low degree of deterioration after storage.

Key Words: Maize hybrid, manure, nitrogen fertilizers, physical, chemical grain characters and S. oryzae.

INTRODUCTION

Maize plant is considered as one of the most cereal crops used in human consumption, animal feeding, starch industry and oil production. In Egypt, it is very important to increase maize production to cover the gab between production and consumption. This can be achieved through improving of production procedures and increasing cultivation area by the extension in newly reclaimed areas. Nitrogen fertilizer application was shown as one of the reliable factors to get more increase production and quality, Ahmed (1990). Researchers studied the nutritional

requirements of corn, and found that the chemical composition and technological characters responded to both different levels of fertilizers and its kind (Madkour *et al* 1987). One of the interesting problems for practical breeding of maize corn is to explore the possibility of combining chemical and physical traits which contribute to high grain production with best grain quality and more resistant to insect attack during storage. Stored maize grains are attacked by both Coleopterous and Lepidopterous pests. The rice weevil, *S. oryzae* is one of the most destructive insect pests of corn in the field and in storage. The rice weevil causes tremendous losses annually. Losses in stored grain are caused by both adult and larval feeding. Larval activity occurs only within the grain.

Rice weevil, *S. oryzae* is a good flier and ranks as a primary insect pest because of its ability to infest sound grain in the field and storage. It is likely that maize varieties or hybrids are varying in susceptibility to *S. oryzae* Karan *et al* (1973) recorded that the relative resistant to *S. oryzae* was due to the hardness of the grains, and added that uric acid and free fat acidity were found to be directly correlated with the infestation . Little information are known about the relationship between chemical composition of maize corn and resistance to insect infestation, therefore, the present investigation was undertaken to determine the relationship between some grain chemical fractions and physical grain traits of maize crop (Hybrid 10) and its resistance to insect infestation by *S. oryzae* Khokhar and Gupta (1974 and 1975) recorded that high protein content and high grain moisture were linked to susceptibility corrected with resistant .

Also the information gained from this study could be utilized for avoiding the miss or overuse of different fertilizers which would produce more susceptible corn hybrids to insect infestation during its storage. The goals of the present work were to study effect of different levels of both nitrogen and manure fertilizers applied to a maize crop variety (Hybrid 10) in the field on degree of infestation with *S. oryzae* in laboratory.

MATERIALS AND METHODS

1- Experimental insects

The experimental insect was *S. oryzae*, was obtained from an infested corn grain sample and reared in laboratory in Plant Protection Research Institute, on a commercial corn variety. The used grains were previously frozen in a deep freezer for 2 weeks to eliminate any possible hidden infestation. The newly emerged adults were used in this study.

2- Susceptibility to insect infestation

Maize corn Hybrid 10 used in the present work was obtained from the field crops Research Institute ARC, Egypt. Sound maize grains of Hybrid 10 were selected for this study as follows: Three replicates of 30 gm each were weighed from each treatment and placed in a separate glass jar. Each jar was infested by 15 pairs of newly emerged adults, covered with muslin and secured by rubber bands, three similar replicates left without infestation as control and placed with infested jars in dark incubators at 28± 2 °C and 70± 5% RH.

The parent's insects left to oviposit for 2 weeks, then removed and discarded. After about month, the glass jars were examined every day for observing the start date of adult emergence for determining duration of the development as well as number of the emerged offspring.

3- Weight losses associated with insect infestation

Quantitative losses arising from the feeding of both adult and immature stages of *S. oryzae* L. on maize grains (Hybrid 10) were assessed by weight difference of both infested and control grains.

4- Susceptibility index of Hybrid 10 treatments

Howe (1971) and Fam (1985) proposed an index for assessing the suitability of an environment or medium for insect development. The index is expressed log S/T, where: S = percentage of adult survival (= % adult emergence) and T = Mean developmental period (days).

5- Preparation of infested corn grains for studying chemical and physical characteristics

Two groups of infestation experiments were conducted to study effect of various treatments on growth of the immature stages of the test insect as follows:

a - Samples of 20 gm of sound maize grains in small glass jars were infested each with 15 pairs of newly emerged adults. Twenty four hours later, the insects were removed. The grains having egg plugs were left two weeks time to obtain larvae within the grains (15 days of eggs laying).

b- Other similar samples infested with the insects were left up until emergence of adult offspring.

The two previous groups are carried out to study physical grain characteristics as well as its chemical fractions and the relationship between them and insect infestation by the test insect.

6- Physical characteristics, Chemical composition and fraction of grain

Grain characters i.e. 100-grain weight, grains volume were determined by (Ibrahim, 1975), grain fraction, i.e. endosperm, germ and hull were also determined

(Hussein, 1981). Amylose was determined (Juliano, 1976), crude protein, ash, fiber and oil were chemically analyzed (A.O.A.C., 1980).

The obtained data were statistically analyzed by Fisher (1970).LSD (Least squares differences) test was used to compare the significant differences between means of treatment (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

1-Susceptibility of tested maize hybrid to insect infestation

Results in table (1) indicated that there was a clear significant effect on the mean number of offspring of *S. oryzae* L., susceptibility index(SI) and weight loss(%) as a result of different levels of nitrogen fertilization alone or in combination with manure fertilizer. Such findings show that the level and the kind of fertilizer had some effect on the all tested biological parameters of the target insect pest.

Data also showed that the treatments with nitrogen fertilizer alone resulted in susceptible maize hybrid. The mean offspring of *S. oryzae* L. from N_1 level (45 kg/Fed.) was the highest among the tested levels, it produced a susceptible hybrid with susceptibility index of 3.91. Moreover, when the manure fertilizer was combined with nitrogen, the mean *number* of offspring of *S. oryzae* L. as well as susceptibility index of the hybrid was decreased. At the highest level of both nitrogen and manure, Hybrid 10 was more tolerant for insect infestation (SI was 2.17) than the others levels.

With regard to weight loss (%) (Table 1), the highest mean weight losses was recorded in N_1 level (45 kg/Fed and without manure (4.6%) followed by the treatment at N_2 level (3.8%). From these results, it is obvious that nitrogen fertilizer alone at the three tested levels gave the highest susceptible maize hybrid, whereas, the application of the two used fertilizers produced lower values of offspring, SI and Minimal percentages of weight loss which marked (2.08, 0.33 and 0.1% respectively). this means the hybrid 10 a least susceptible to *S. oryzae* L. infestation.

These results are in agreement with those obtained by Zein and Abo-Arab (2000) who found *that* susceptibility of *S. oryzae* L. and *Rhizopertha dominica* was affected by different levels of nitrogen fertilization. Also, Mahgoub (1987) proved that maize varieties have a different susceptibility levels to *S oryzae*.

Table(2) Showed the physical characteristics, i.e., weight of 100 kernels, kernel volume, endosperm, germ and hull ratio of maize grains (hybrid 10). From data, weight of 100 kernels increased significantly by increasing the level of nitrogen fertilization and decreased after insect infestation. The same trend was observed in the kernel volume and endosperm (%). These results were in agreement with Nofal and Sleem *(2003)* who noticed that increasing in grain weight was associated with

and Sleem *(2003)* who noticed that increasing in grain weight was associated with grain volume, such association may be due to the rate of dry matter accumulation of the grains. On the other hand, germ ratio showed a significant decrease by increasing the level of nitrogen and non-significant decrease was shown by infestation except at 135kg N/Fed. On the other hand, hull ratio was insignificantly decreased in sound grains, but significantly decreased due to insect infestation.

These findings are in agreement with those obtained by Faisal *et al.*(1995**)** who stated that increasing nitrogen fertilizer from 45 to 135 kg/Fed decreased grain fraction in terms of hull and germ. A negative correlation coefficient was found between endosperm and hull %.

Manure fertilization resulted in an increasing in 100-kernels weight, kernel volume and grain fraction compared with nitrogen fertilization only. For that, manure fertilization improved physical characteristics of infested maize grain, as well as, nitrogen fertilization.

Table (3) showed the relationship between chemical characteristics of maize hybrid 10 (as affected by manure and nitrogen fertilization) and insect infestation.

Results in Table (3) indicated that amylose and protein in sound grains significantly increased by increasing nitrogen fertilizer from 45 to 135 kg/Fed, the same trend was observed due to manure fertilization (20 m^3/Fed). The results showed also that the insect infestation decreased amylose and protein ratio compared with the sound grain. There was a gradual slightly increase in ash content by increasing nitrogen, manure fertilization and insect infestation. Concerning oil content, a slight increase was shown due to nitrogen and manure fertilization, but its values decreased by insect infestation. On the other hand, fiber content increased by increasing nitrogen and manure fertilization and also insect infestation caused an increasing. The crude fiber affected by insect infestation, this may be explained by the fact that crude fiber increased hardness and tough of the seed coat, thus the seed coat resist larvae penetration and decreased the degree of insect infestation El-Aidy *et al.*,(1995). These findings are in full agreement with Mahgoub and Khalifa (1993*)* who proposed that hard seed coat resist larvae penetration.

Significant decreases were shown in total carbohydrates content due to nitrogen fertilization only and combined with manure fertilization, the same trend was observed due to insect infestation.

Generally, it could be concluded that all chemical composition of treatments (except total carbohydrates) were increased by increasing nitrogen and manure fertilization which improved the chemical characteristic of infested grains.

These findings are in agreement with Delvin *1996*, who proved that increasing nitrogen encouraged protein synthesis and its partitioning and accumulation in maize grain.

Similar results were obtained by Ahmed *(1990)* and Amin *(1994)*. Also, Nofal *et al. (2003)* reported that percent of ash, protein and total carbohydrate were affected by the addition of 20 m^3/Fed from yard manure significantly affected oil and carotene content of maize grain.

Table 1. Effect of nitrogen fertilizer and/or farmyard manure on maize hybrid 10 susceptibility to *Sitophilus oryzae* infestation.

Manure (m^3/Fed)	Nitrogen (kg/Fed)	Offspring No.± SE	MDP (days)	SI	Weight loss (%)
0	45	23.75 ± 3. 24 a	35.00 ± 1.49 a	3.91±0.15 a**	4.55± 0.26 a
	90	24.75 ±5. 61 a	37.75 ± 2.11 a	3.44±0.34 ab	3.78 ± 0.11 ab
	135	20.0 ± 2.94 a	38.25 ± 0.68 a	3.07±.0.39 b	3.00± 0.54b
	LSD at 5%	N.S	N.S	0.723	0.833
20	45	8.75 ± 0.99 a	36.75 ± 0.73b	2.68±0.13 ab	2.08± 0.22 a
	90	11.50± 1.22 a	36.75± 2.34b	2.89±0.14 a	0.33±0.15b
	135	11.50 ± 1.68 a	46.25 ± 3.43a	2.17 ±0.57*b	0.15± 0.04b
	LSD at 5%	N.S	5.548	0.404	0.408

MDP= Mean developmental period (days), SI=susceptibility index, *=Tolerant hybrid and **=Susceptible hybrid. Means with the same letters in a column are not significantly different.

Table 2. Physical grain characteristics and grain fractions of the corn meal variety (Hybrid10) as affected by nitrogen, manure fertilization and insect infestation by *S. oryzae*.

Manure rate M^3/Fed	Nitrogen rate (Kg/Fed)	Physical characteristics and insect infestation														
		Weight of 100 kernel (g)			Kernel volume (cm^3)			Endosperm %			Germ %			Hull %		
		S*	L**	A***	S*	L**	A***	S*	L**	A***	S*	L**	A***	S*	L**	A***
0	45	27.50c ±0.03	26.35c ±0.23	25.15b ±0.38	22.66c ±0.04	21.47b ±0.17	20.11c ±0.09	81.87c ±0.03	81.54b ±0.06	79.06c ±0.05	10.16a ±0.06	10.81a ±0.10	11.02a ±0.05	6.08a ±0.01	7.61b ±0.01	8.70a ±0.05
	90	29.45b ±0. 09	27.85b ±0.17	25.80b ±0.11	25.11b ±0.16	25.09a ±0.09	21.50b ±0.06	82.69b ±0.06	81.56b ±0.08	79.28b ±0.01	9.32b ±0.06	10.31a ±0.05	11.05a ±0.38	6.06a ±0.05	7.22a ±0.05	8.16b ±0.15
	135	33.73a ±0.58	31.55a ±0.40	31.45a ±0.31	28.39a ±0.31	25.93a ±0.35	25.11a ±0.35	84.77a ±0.05	83.64a ±0.09	79.46a ±0.02	7.84c ±0.05	8.96c ±0.06	9.45b ±0.03	6.02a ±0.10	7.03a ±0.10	8.10b ±0.10
L.S.D. at 5%		1.14	0.74	1.00	0.75	0.01	0.95	0.24	0.20	0.12	0.20	0.26	0.20	0.15	0.23	0.39
20	45	28.25c ±0.57	27.05c ±0.06	26.48c ±0.29	25.42c ±0.33	22.33c ±0.30	22.06b ±0.35	82.39c ±0.06	82.15c ±0.06	80.74c ±0.06	11.52a ±0.06	11.44a ±0.12	12.83a ±0.01	7.08a ±0.07	7.74a ±0.07	9.73a ±0.07
	90	29.75b ±0.59	29.53b ±0.09	28.85b ±0.32	26.36b ±0.11	25.50b ±0.34	22.18b ±0.29	83.40b ±0.08	82.46b ±0.06	81.85b ±0.05	9.33b ±0.12	10.88b ±0.06	12.55a ±0.03	7.03a ±0.02	7.39a ±0.02	8.68b ±0.08
	135	34.15a ±0.58	34.00a ±0.34	32.80a ±0.37	29.12a ±0.07	27.56a ±0.21	25.26a ±0.13	85.64a ±0.07	83.89a ±0.06	82.59a ±0.07	7.26c ±0.07	9.88c ±0.09	11.82b ±0.09	6.48b ±0.01	7.02a ±0.01	8.23c ±0.04
L.S.D. at 5%		1.17	0.72	2.01	0.72	0.81	0.71	0.17	0.26	0.20	0.31	0.33	0.78	0.23	0.15	0.22

S*= Sound grain L** = Infested seeds with larvae A***= Grains after adult emergence
Means within the same column under the same manure rate, with the same letters are not significantly different.

Table 3. Effect of manure, nitrogen fertilization and insect infestation by *S. oryzae* of maize Hybrid 10 on chemical grain characteristics.

Manure rate M^3/Fed	Nitrogen rate (Kg/Fed)	Chemical characteristics and insect infestation																	
		Amylose%			Protein%			Ash%			Oil%			Fiber%			T.C.****		
		S*	L**	A***	S*	L**	A***	S*	L**	A***	S*	L**	A***	S*	L**	A***	S*	L**	A***
0	45	34.10c ±0.06	29.28a ±0.03	18.55a ±0.01	8.27c ±0.02	7.66c ±0.08	6.66c ±0.07	1.50a ±0.06	1.52a ±0.04	1.63b ±0.04	3.24b ±0.08	3.18a ±0.01	2.90a ±0.01	2.19b ±0.01	3.04c ±0.02	3.84a ±0.09	84.80a ±0.08	84.60a ±0.14	84.97a ±0.21
	90	34.97b ±0.10	27.73b ±0.02	15.39b ±0.01	9.37b ±0.02	8.39b ±0.02	7.35b ±0.02	1.54a ±0.08	1.55a ±0.01	1.64b ±0.03	3.38b ±0.01	3.22a ±0.01	3.00a ±0.11	2.23b ±0.02	3.22b ±0.01	3.96a ±0.02	83.48b ±0.09	83.62b ±0.15	84.05b ±0.34
	135	35.21a ±0.01	26.42c ±0.04	13.83c ±0.01	9.56a ±0.08	9.24a ±0.03	8.69a ±0.06	1.55a ±0.00	1.57a ±0.08	1.77a ±0.02	3.54a ±0.08	3.30a ±0.10	3.05a ±0.06	2.72a ±0.05	3.39a ±0.02	4.00a ±0.12	82.63c ±0.12	82.50c ±0.16	82.49c ±0.25
L.S.D. at 5%		0.23	0.03	0.11	0.17	0.18	0.20	0.20	0.19	0.11	0.17	0.21	0.26	0.01	0.06	0.30	0.34	0.52	0.95
20	45	34.62c ±0.01	32.37a ±0.03	30.35a ±0.01	8.49c ±0.01	8.43c ±0.04	7.68c ±0.06	1.57a ±0.08	1.63a ±0.04	1.83a ±0.04	3.42c ±0.04	3.26c ±0.02	3.19a ±0.03	2.35b ±0.02	2.92c ±0.10	4.00c ±0.03	84.17a ±0.14	83.76a ±0.20	83.30a ±0.17
	90	34.71b ±0.01	29.73b ±0.02	18.43b ±0.01	9.31b ±0.01	9.23b ±0.01	8.13b ±0.01	1.65a ±0.08	1.71a ±0.20	1.85a ±0..3	3.66b ±0.07	3.36b ±0.02	3.21a ±0.01	2.50b ±0.06	3.38b ±0.01	4.31b ±0.01	82.88b ±0.19	82.32a ±0.17	82.50b ±0.03
	135	35.63a ±0.01	24.39c ±0.01	15.51c ±0.02	10.48a ±0.07	9.57a ±0.08	9.54a ±0.08	1.66a ±0.07	1.79a ±0.01	1.87a ±0.02	3.90a ±0.06	3.43a ±0.02	3.24a ±0.01	2.90a ±0.06	3.98a ±0.01	4.45a ±0.01	81.06c ±0.25	81.23a ±0.06	80.90c ±0.12
L.S.D. at 5%		0.04	0.04	0.07	0.14	0.18	0.21	0.27	0.42	0.11	0.20	0.06	0.07	0.17	0.21	0.06	0.69	0.54	0.41

S*= Sound grain L** = Infested seeds with larvae A***= Grains after adult emergence
T.C.**** = Total carbohydrates were calculated by difference.
Means within the same column under the same manure rate, with the same letters are not significantly different.

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التأثير المشترك للتسميد العضوى والنيتروجيني لهجين الذرة ١٠ على مقاومة تحملة الإصابة الحشرية وعلاقته بخصائص الحبوب الطبيعية والكيميائية

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أجريت تجارب معملية لدراسة درجة الإصابة الحشرية بسوسة الأرز لحبوب صنف الذرة الشامية (هجين ١٠) ، والذي سبق معاملته فى الحقل بالتسميد البلدي العضوى (٢٠م٣/فدان) مع ثلاثة مستويات مختلفة من التسميد النتروجينى (٤٥ ، ٩٠ ، ١٣٥ كجم/فدان) وعلاقتها ببعض خصائص الحبوب الطبيعية والكيميائية.

أوضحت النتائج وجود إختلافات معنوية في كل من متوسط نسبة خروج الحشرات وقيم دليل الحساسية وكذلك النسبة المئوية للفقد في وزن الحبوب(بينما لم تتاثرفترة تطور الحشرات) عند مستويات التسميد المختلفة ، كذلك أتضح أن التسميد النتروجينى بمفرده بمستوياته المختلفة قد أعطى هجين ذو حبوب حساسة للإصابة الحشرية . بينما التأثير المشترك لكل من التسميد النتروجينى بمستوياته الثلاثة مع التسميد العضوى قد أنتج حبوب ذاتدرجة من التحمل للاصابة الحشرية ، كما قللت هذه المعاملات نسبة الفاقد في وزن الحبوب .

ـ أظهرت دراسة العلاقة بين بعض الصفات الطبيعية والكيمائية لحبوب الذرة السليمة والمصابة باليرقات والحشرات الكاملة لسوسة الأرز، أن الخصائص الطبيعية(وزن الـ١٠٠ حبة ، حجم الحبوب ، نسبة الرماد ، نسبة الأندوسبرم ، نسبة الجنين ، و نسبة القشور) قد تأثرت بكل من الإصابة الحشرية ولم تتأثر بمعاملات التسميد النيتروجيني المختلفة.

– لوحظ أن بعض الخصائص الكيمائية (نسبة الأميلوز ، نسبة البروتين ، نسبة الرماد ، نسبة الزيوت وكذلك نسبة الالياف) قد تأثرت معنويا فقط بمعاملات التسميد المختلفة ودرجة الإصابة الحشرية ، بينما لوحظ عدم تأثر الحبوب السليمة بالمستويات المختلفة من التسميد النيتروجيني، وتمثل الألياف عاملا هاما فى الإصابة الحشرية حيث يضع المربون فى إعتبارهم دائما إختيار صنف ذو صفات زراعية مرغوبة وقياسية الى جانب أن يكون ذو تحمل وراثى للإصابة الحشرية ولا يحدث له تدهور أثناء تخزين حبوبه نتيجة الإصابة بحشرات المخازن.