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Effect of different maize plant varieties on the main piercing-sucking insect pests attacking maize plants

EL-Kady, H. A.*; S. S. Awadalla **; T. E. Ata* and M. A. M. Hegab[1]*
*Economic Entomology Dept., Fac. Agric., Damietta Univ.
** Economic Entomology Dept., Fac. Agric., Mansoura Univ.
[1]Corresponding author*: *mohmoudhegab@du.edu.eg*

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ABSTRACT

This study was carried out to survey the major piercing-sucking insect species on maize plants and to examine the effect of maize varieties and their chemical composition on population density of aphid, leafhopper and planthopper species in Zagazig district, Sharkia Governorate, Egypt during 2020 and 2021 seasons. The aforementioned homopterous species were collected from maize varieties by using different sampling methods. Results showed that aphid species infested maize plants were *Rhopalosiphum maidis*, *R. padi*, *Aphis gossypii*, while the leafhopper: *Empoasca decipiens*, *E. decedents*, *Cicadellina china*, *C. bipunctella zea* and *Balclutha hortensis* and planthopper insects, *Sogatella vibix* and *S. frucifera* were also collected. Maize varieties had effect on the population density of the major piercing-sucking insect species. Signal white 2030 variety hosted the lowest mean number of insects, while Signal white 131 hosted the largest number of homopterous insects. Results of chemical analysis of all tested maize plant varieties showed a positive relationship between each of protein and carbohydrate contents and aphid, leafhopper and planthopper populations, while a negative relationship between pH values and hompoterous insect populations and maize yield were obtained.

INTRODUCTION

The piercing-sucking insects such as aphids, leafhoppers and planthoppers are consider serious insects of gramineous crops. Several studies confirmed the role of these insect species in transmitting plant diseases **(Maramorosch, 1969; Harris and Maramorosch, 1977, 1980; Hegab, 1980 and El-Defrawi et al., 2000.** Further, these insect species were reported and monitored in many fields of Egypt **(Hegab et al., 1987; Hashem, 2005 and El-Zohairy and Ola–Hegab, 2008)** with more details were obtained from their study on field crops. However, there is a great shortage regarding their populations on gramineous plants. The agricultural practices in gramineous field crops such as various plant varieties, are considered essential elements for integrated pest management (IPM) for the various insect pests particulary the piercing –sucking insect pests **(Ola -Hegab, 2001, Awadalla et al. 2013).** The main of this study is to survey aphid, leafhopper and planthopper insect species on maize plants and to examine the effect of maize varieties and their chemical composition on population density of the piercing-sucking insects.

MATERIALS AND METHODS

The effect of maize varieties on the population density of the major piercing-sucking insects in Zagazig district, Sharkia Governorate, Egypt was examined during 2020 and 2021 seasons. Four maize varieties (Single white 2030, Single white 30 k 8, Single white 30 k 9 and Single white 131) were used in this experiment. The experimental area was 600 m2 which spilt into four plots (150 m2/plot). Each variety was sown in each plot. Each variety replicated three times and every replicate was 50 m2 and the replicates arranged in completely randomized design. Seeds of each variety were sown during mid of May (the recommended date) for two successive seasons (2020 and 2021). Each plot consisted of (10 meters wide and 5 meters long). The space between holes was 20-30 cm. The normal agricultural practices were followed without using any pesticide treatments.

Three sample methods were followed to examine the effect of maize varieties on the population density of the major piercing-sucking insects as follows:

Weekly samples of (10 leaves and 5 tassels) were taken randomly from 5 plants during the period from mid of June to end of September during 2020 and 2021 seasons. The plant samples were kept in paper bags and examined in the

laboratory. For this purpose, a simple apparatus composited of a wooden desk with a white card board paper that divided into 4 cm2. A part column put in the bottom on which a glass plate was fixed and the top surface of the plate was allowed to be wetted with few droplets of water to impede the movement of collected insect pests **(Hegab et al., 1987).** Then, the plants were carefully wiped on the plate using a small brush in each column. The samples were examined in the laboratory and the total number of insects were preserved in 70% ethyl- alcohol and recorded by using stereo-microscope and a hand lens (5 X). Specimens of collected insects were identified according to **Habib (1961); Szelegiewiez (1977) and Blackman and Eastop (2000).**

Weekly samples of 50 double strokes were taken by sweeping net (35 cm in diam. and 60 cm in dep.) were taken at random during maize growing season in 2020 and 2021 seasons. Specimens of collected insect pests were killed by cyanide. The sorted insect species were identified and recorded according to the work of **Herakly (1980) and Hegab et al. (1987).** In each sample, the collected insects were kept in paper bags and then transferred to the laboratory for further inspection and counting.

Yellow paper boards of 10 × 20 cm. coated with sticky material and hung on wood rods varied according to the height of plants through the period of sampling. The traps levels were always kept over plant surface with 20-30 cm. six traps of yellow sticky board traps were used in this investigation. Counts of the main piercing-sucking insect pests captured were recorded according to **Herakly (1980) and Hegab et al. (1987 and 1988).** Sampling began when the maize plants were about one month in age and continued in weekly intervals during the whole growing season. The crop yield for replicate was also estimated.

Chemical analysis of the total protein and carbohydrate contents, and pH values in maize varieties was performed in the central lab belonging to Faculty of Agriculture, Zagazig University.

The effect of different maize varieties and their chemical composition on population density of the major insect species (aphid, leafhoppers and planthoppers) that inhibiting maize plants along with the obtained yield quantities were statistically analyzed according to **Little and Hills (1975).**

Statistical analysis: Statistical analysis of the data was performed using version 6.303 of a computer program Costat (2005). Statistically significant differences between means were compared using analysis of variance (ANOVA) with the least significant difference (LSD) at a probability of 0.05.

RESULTS AND DISCUSSION

3.1. Survey and relative occurrence of the main piercing – sucking insects infesting different maize plant varieties:

The present data in Table (1) showed the total number and the relative occurrence of the main piercing–sucking insects (aphid, leafhopper and planthopper) infested maize plants during the two successive seasons 2020 and 2021 in Zagazig district, Sharkia, Governorate.

The aphids *Rhopalosiphum maidis* recorded the highest total numbers and relative occurrence which represented by 4968 individuals (32.29%) and 3564 individuals (27.73%) during 2020 and 2021 seasons, respectively. Also, it is clear that the highest leafhopper insects population occurred by *Empoasca decipiens* on maize plants and presented by 1584 individuals, relative occurrence (10.30%) and 1068 individuals, relative occurrence (8.31%) during the two successive seasons 2020 and 2021, respectively. While, the planthopper *Sogatella frucifera* came in the last category and had the lowest total number and relative density during the aforementioned seasons and represented by 732 individuals, relative density (4.76%) and 840 individuals, relative density (6.54%), respectively.

It is worth to mention that aphid insects *R. maidis, R. padi* and leafhopper *E. decipiens, E. decedens, C. chinai* and *B. hortensis* recorded the highest total number of the main piercing-sucking insects during 2020 and 2021 seasons. The present results are in agreement with those obtained by **Hashem and Abdel- Samed(2011), El-Defrawi et al. (2000), El-Gindy (2002), Abdel- Samed and Al-Habashy (2013), Nora –Elmashaly (2013), Awadalla et al.(2017), Mohsena-Mansour, (2017) and Alaa- Elshyeb (2020).** They mentioned that different aphid, leafhopper and planthopper insect species were collected from some field and vegetable crops and the host plants had a great effect on incidence of piercing-sucking insects.

3.2. Effect of different varieties

The influence of maize varieties on the occurrence of main piercing –sucking insects attacking different maize plant varieties under the field conditions of Zagazig district, was studied during two successive growing seasons, 2020 and 2021.

3.2.1. Aphid species (Aphididae: Homoptera)

Data given in Tables (2 and 3) showed that the intensity of *R. maidis* infestation in 2020 and 2021 seasons, measured as mean number of insects could be arranged in the two seasons in descending order as follows; Single white 131 (639, 393 individuals), Single white 30 k 9 (573, 364 individuals), Single white 30 k 8 (489, 332 individuals) and Single white 2030 (414, 297 individuals), in the two investigated seasons 2020/2021, respectively. Data in Table, (2 and 3) pointed out that Single white 2030 recorded the lowest number of *R. padi* (300, 226 individuals) in 2020 and 2021 seasons, respectively. while the variety Single white 131 appeared to be the most susceptible maize variety (502, 326 individuals) in the two successive seasons, respectively.

Results given in Table, (2 and 3) revealed that in the two seasons of study, variety Single white 2030 proved to be the least susceptible host plant for *A. gossypii* infestation, (114 and 92 individuals) for 2020 and 2021 seasons, respectively. While the variety Single white 131 appeared to be the most susceptible maize variety, (189 and 196 individuals) for the first and second seasons, respectively.

3.2.2. Leafhopper species (Cicadellidae: Homoptera)

As seen from Table, (2 and 3) *E. decipiens* infestation on the four tested maize cultivates were statistically high significant during 2020 and 2021 seasons. The most susceptible cultivar was Single white 131 (189 and 198 individuals),while the least susceptible cultivar was Single white 2030 (132 and 89 individuals) during 2020 and 2021seasons, respectively.

Results given in Table, (2 and 3) revealed that the differences between mean numbers of *E. decedens* on the four tested maize varieties were statistically high significant for the two seasons of study. It was obvious that, variety Single white 2030 proved to be the least susceptible host plant for *E. decedens* infestation, (96 and 84 individuals) for 2020 and 2021seasons, respectively. While the variety Single white 131 appeared to be the most susceptible maize variety (174 and 185 individuals) for the two seasons, respectively.

Data presented in Table, (2 and 3) showed that the most susceptible cultivar for *C. chinai* was Single white 131 (170 and 177 individuals) , while the least susceptible cultivar was Single white 2030 (82 and 75 individuals) during 2020 and 2021 seasons, respectively.

As seen from Table (2 and 3) *B. hortensis* infestation on the four tested maize cultivars were highly significant during 2020 and 2021 seasons. The least susceptible cultivar was Single white 2030 (84 and 81 individuals) during 2020 and 2021 seasons, respectively. While the most susceptible cultivar was Single white 131 (164 and 186 individuals) during the first and second seasons, respectively.

Results given in Table, (2 and 3) revealed that variety Single white 2030 proved to be the least susceptible host plant for *C. bipunctella zeae* infestation, (68 and 73 individuals) for 2020 and 2021 seasons, respectively. While the variety Single white 131 appeared to be the most susceptible maize variety (152 and 174 individuals) for the two seasons, respectively.

3.2.3. Planthopper species (Delphacidae: Homoptera)

Data given in Table, (2 and 3) indicated that variety Single white 2030,was the least susceptible host plant for *S. vibix* infestation (61 and73 individuals), while the variety Single white 131 appeared to be the most susceptible maize variety (136 and 170 individuals) during 2020 and 2021 seasons, respectively.

Results given in Table, (2 and 3) showed that variety Single white 2030 proved to be the least susceptible host plant for *S. frucifera* infestation (63 and 70 individuals), while the variety Single white 131 appeared to be the most susceptible maize variety (148 and 126 individuals) during 2020 and 2021 seasons, respectively.

It is worth to mention that Single white 2030 variety harboured the lowest mean number of aphids, leafhoppers and planthoppers, while, the infestation increased on Single white 30k8, Single white k9 and it was the highest on variety Single white 131.

Generally, it is obvious that all the tested maize varieties were highly infested in the first season than the second Tables (2 and 3), this may be due to the differences in environmental factors e.g. weather factors and natural enemies prevailing in the second season of investigation.

Statistical analysis revealed that, a highly significantly differences were obtained between the different maize varieties for each aphid, leafhopper and planthopper species and for each season.

Regarding to the influence of maize varieties on maize yield, data presented in Table, (2 and 3) showed that varieties, Single white 2030 yielded the highest mean of 43.3 and 42.5 kg/plot in 2020 and 2021 seasons, respectively. followed by Single white 30k8 variety yielded mean of 39.66 and 40.50 kg/plot in the two seasons, respectively. While the variety of Single white 131 yielded the lowest mean of 33.33 and 34.33 kg/plot in 2020 and 2021 seasons, respectively.

These findings are in consistent with those of **Hashem (1997), Ola-Hegab (2001), El -Gindy (2002), Youssef (2006), Awadalla et al. (2013 and 2014) Nora–Elmashaly (2013), Hegab (2015), Awadalla et al. (2017 and 2019), Mohsena-Mansour, (2017) and Alaa- Elshyeb (2020).** They mentioned that host plant varieties had a high impact on population of piercing-sucking insects .

3.3. Relationship between chemical composition of maize varieties and population density of major piercing – sucking insect pests.

The chemical contents of maize varieties are presented in Table (4). The mean number of the major piercing–sucking insect pests (aphid, leafhopper and planthopper insects) and crop yield was affected by the chemical composition of different maize varieties (Table 4).

Generaly, it is evident that chemical analysis of the tested maize varieties pointed out that the total number of main piercing-sucking insects infesting maize plants (aphid, leafhopper and planthopper insects) were positively related with the total of protien and carbhydrate contents of the different tested maize varieties, while it was negatively related with the pH values of different maize varieties and also with quantity of yield (Table 4). These findings are in consistent with those of **Ola-Hegab (2001), El -Gindy (2002), Hashem (2005), Youssef (2006), Awadalla et al. (2013), Hegab (2015), Shalaby et al. (2012), Awadalla et al. (2017), Mohsena-Mansour (2017) and Alaa- Elshyeb (2020).** They reported that chemical contents of host plants had a great effect on population of piercing-sucking insects.

CONCLUSION

These results indicated that maize varieties had effect on the population density of the major piercing-sucking insect species. Signal white 2030 variety hosted the lowest mean number of insects, while signal white 131 hosted the largest number of homopterous insects. Various plant varieties are considered essential elements for integrated pest management (IPM) for the various insect pests particularly the piercing –sucking insect pests Results of chemical analysis of all tested maize plant varieties showed a positive

relationship between each of protein and carbohydrate contents and aphid, leafhopper and planthopper populations, while a negative relationship between pH values and homopterous insect populations.

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This research didn't receive any funding.

CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

EL-Kady, H. A.; S. S. Awadalla; T. E. Ata and M. A. M. Hegab wrote the manuscript. All authors checked and confirmed the final revised manuscript.

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Table 1. The total numbers and the relative densities of the main piercing– sucking insects infesting maize plants in sowing date (Mid of May) during the two successive

Insects species	2020 Season		2021 Season	
	Total number	Relative density %	Total number	Relative density %
Rhopalosiphum maidis	4968	32.29	3564	27.73
Rhopalosiphum padi	3600	23.40	2712	21.10
Aphis gossypii	1368	8.89	1104	8.59
Empoasca decipiens	1584	10.30	1068	8.31
Empoasca decedens	1152	7.49	1008	7.84
Cicadellina chinai	984	6.40	900	7.00
Cicadellina bipunctella	816	5.30	876	6.82
Balclutha hortensis	1008	6.55	972	7.56
Sogatella vibix	756	4.91	876	6.82
Sogatella furcifera	732	4.76	840	6.54
Total	15384	100	12852	100

Table 2. Effect of maize varieties on the mean number of the major piercing- sucking insect pests during the first season 2020.

Varieties / Insect species	Mean number				F.	LSD 0,05
	Single white 2030	Single white 30K8	Single white 30k9	Single white 131		
Rhopalosiphum maidis	414 ^{d}	489 ^{c}	573 ^{b}	639 ^{a}	265.39**	6.94
Rhopalosiphum padi	300 ^{d}	352 ^{c}	439 ^{b}	502 ^{a}	76.70**	11.83
Aphis gossypii	114 ^{d}	138 ^{c}	162 ^{b}	189 ^{a}	23.27**	8.75
Empoasca decipiens	132 ^{d}	156 ^{c}	185 ^{b}	206 ^{a}	129.24**	3.31
Empoasca decedens	96 ^{d}	118 ^{c}	142 ^{b}	174 ^{a}	70.92**	5.06
Cicadulina chinai	82 ^{d}	103 ^{c}	126 ^{b}	170 ^{a}	68.26**	5.19
Cicadulina bipunctella	68 ^{d}	92 ^{c}	120 ^{b}	152 ^{a}	196.63**	3.41
Balclutha hortensis	84 ^{d}	106 ^{c}	126 ^{b}	164 ^{a}	154.90**	4.12
Sogatella furcifera	63 ^{d}	87 ^{c}	118 ^{b}	148 ^{a}	225.32**	2.51
Sogatella vibix	61 ^{d}	86 ^{c}	112 ^{b}	136 ^{a}	99.60**	3.71
Yield kg. /Plot	43.3 ^{a}	39.66 ^{b}	36.5 ^{c}	33.33 ^{d}	62.48**	0.548

Mean followed by the same letter are not significantly different (P= 0.05; Duncan multiple range test) Duncan, 1955.

Table 3. Effect of maize varieties on the mean number of the main piercing- sucking insect pests during the second season 2021.

Varieties / Insect species	Mean number				F.	LSD 0,05
	Single white 2030	Single white 30K8	Single white 30k9	Single white 131		
Rhopalosiphum maidis	297 [d]	332 [c]	364 [b]	393 [a]	104.14**	4.67
Rhopalosiphum padi	226 [d]	258 [c]	289 [b]	326 [a]	129.1**	1.37
Aphis gossypii	92 [d]	126 [c]	162 [b]	196 [a]	550.55**	2.20
Empoasca decipiens	89 [d]	129 [c]	166 [b]	198 [a]	344.99*	2.92
Empoasca decedens	84 [d]	120 [c]	151 [b]	185 [a]	421.28**	2.42
Cicadulina chinai	75 [d]	111 [c]	144 [b]	177 [a]	232.27**	3.31
Cicadulina bipunctella	73 [d]	106 [c]	141 [b]	174 [a]	251.12**	3.17
Balclutha hortensis	81 [d]	116 [c]	152 [b]	186 [a]	448.05**	2.46
Sogatella furcifera	70 [d]	105 [c]	136 [b]	126 [a]	222.72**	3.06
Sogatella vibix	73 [d]	108 [c]	142 [b]	170 [a]	222.94**	3.24
Yield kg /Plot	42.5 [a]	40.50 [b]	37.50 [c]	34.33 [d]	123.03**	0.326

Mean followed by the same letter are not significantly different (P= 0.05; Duncan multiple range test) Duncan, 1955.

Table 4. Effect of chemical constituents (protein, carbohydrate, pH value, K, Ca and P) of different maize varieties on population density of the major piercing–sucking insect pests at Zagazig, Sharkia Governorate during 2021 season.

Maize varieties	Protein %	Carbohyd-rate %	pH	K %	Ca %	P %	Mean number of aphid insects	Mean number of leafhopper insects	Mean number of planthopper insects
Single white 2030	**14.98 [d]**	**41.16 [d]**	**4.98 [a]**	**2.96**	**2.87**	**0.94**	**615 [d]**	**402 [d]**	**143 [d]**
Single white 30K8	**15.55 [c]**	**43.88 [c]**	**4.65 [b]**	**3.28**	**2.72**	**0.77**	**716 [c]**	**582 [c]**	**213 [c]**
Single white 30k9	**16.75 [b]**	**47.68 [b]**	**4.32 [c]**	**3.52**	**2.50**	**0.62**	**815 [b]**	**754 [b]**	**278 [b]**
Single white 131	**17.25 [a]**	**49.81 [a]**	**4.12 [d]**	**3.75**	**2.32**	**0.46**	**915 [a]**	**920 [a]**	**296 [a]**
F.	**69.50****	**56.62****	**7.58***	**4.27**	**4.67**	**3.30**	**261.26****	**337.74****	**334.19****
L.S.D. 0.05	**0.4542**	**0.1798**	**0.1887**	**0.853**	**0.672**	**0.581**	**6.77**	**12.64**	**4.64**

Mean followed by the same letter are not significantly different (P= 0.05; Duncan multiple range test) Duncan, 1955.

تأثير الإصابة بالحشرات الثاقبة الماصة على بعض أصناف الذرة المختلفة

أ.د/ حافظ عبد الرحمن القاضي *، أ.د/ سمير صالح عوض الله،أ.م. د/ طارق السيد عطا* و محمود على مرسى حجاب***

***قسم الحشرات الاقتصادية- كلية الزراعة – جامعة دمياط**

****قسم الحشرات الاقتصادية -كلية الزراعة- جامعة المنصورة**

أجريت تلك الدراسة لتقييم قابلية أربعة أصناف من الذرة وهي فردى ٢٠٣٠، فردى٣٠ ك ٨، فردى ٣٠ ك ٩ وكذلك فردى ١٣١ للإصابة بحشرات المنَ ونطاطات الأوراق وكذلك نطاطات النباتات في منطقة الزقازيق محافظة الشرقية خلال موسمي ٢٠٢٠ و٢٠٢١ ولقد أظهرت النتائج حصر لجميع أنواع المن وهى: *R. maidis, R. padi, A. gossypii* وأنواع نطاطات الأوراق وهى:*E. decipiens, E. decedens, C. chinai, C. bipunctella, B. hortensis*

وكذلك نطاطات النباتات وهى: *S. furcifer* و *S. vibix* وقد أوضحت النتائج أيضا أن الصنف فردى ٢٠٣٠ هو أقل الأصناف قابلية للإصابة بجميع الأنواع السابق ذكرها يلي ذلك الصنف فردى ٣٠ ك ٨ ثم الصنف فردى ٣٠ ك ٩ وأن الصنف فردى ١٣١ هو أعلى الأصناف وأكثرها قابلية للإصابة. كما أوضحت النتائج أيضا أنه توجد علاقة بين التركيب الكيميائي للأصناف المختلفة حيث أثبتت النتائج أنه يوجد ارتباط موجب بين نسبة محتوى كلاً من البروتين والكربوهيدرات في العصارة النباتية للعائل النباتي وشدة الإصابة (تعداد الحشرات) على حين أن هناك ارتباط سالب بين قيمة pH للعصارة النباتية للعائل النباتي وتعداد الحشرات.

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