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DISTRIBUTION OF EUROPEAN CORN BORER LARVAE WITHIN – MAIZE PLANTS OF SOME SINGLE CROSS HYBRIDS

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ABSTRACT

The field experiments were conducted at Gemmeiza Agricultural Research Station to study the European corn borer (ECB) ,*Ostrinia nubilalis* (Hbn.)distribution within plants of seven maize singie cross hybrids . Stalk damage , as indicated by cavity length and grain yield reductions were also estimated .To attempt this work, an artificial infestation was done when the plants aged 45 days . The obtained data revealed that the majority of larvae fed mainly on plant leaves and more than 97% died within 6 days after egg hatching . Larval distribution on tassels and ears depends only on maize plant development stages , so it differs from cultivar to another . Few larvae (2.1%) started to bore into internodes through 9 days of egg hatching and increased gradually to 94.2 % after 35 days . Most of larvae on leaves and in internodes tended to distribute in the middle part of plant (around ear zone) with highly aggregation especially in the first instars . The damage in stems , as indicated by cavity length differed according to the hybrid and reached maximum at the blister stage of development (plants aged 63-80 days) . Single cross hybrids 124 , sc122 and sc155 seemed to be more susceptible to the ECB infestation , more larvae and more damage to stems and grain yield (20.4 – 24.8 %) . The other hybrids were the least susceptible to the infestation , more than 95 % as larval mortality within 3 days after egg hatching and the least stalk damage and grain yield reduction (9.5 – 13.1%).

INTRODUCTION

The European corn borer (ECB) , *Ostrinia nubilalis* (Hubner) is a major pest of maize in Egypt (Isa&Awadallah , 1975 and Tantawi , 1981) . The first and second larval instars feed mainly upon the surface of maize leaf , sheath , collar , husk and ear shoots . The 4th instar starts to bore into the stems excavating long tunnels and a differential larval distribution was recorded on maize plants according to infestation date (Hosny & El-Saadany 1967 and Guthrie *et al.* 1969 and 1970) . Labatte and Got 1993 indicated that larval distribution in the tassels and ears was influenced mainly by corn development . Dean Barry and Morlee Mends 1991 studied orientation of ECB larvae within maize plant and concluded that larval survival influenced by plant susceptibility and environment (season) . Also the number of surviving borers per plant affected orientation and more larvae were found around the ear zone in resistant plants and less than 10% of the borers were above this zone , when plants were infested during anthesis .The larval survival and consequently corn variety resistance differed according to larval feeding sites (Guthrie *et al* ., 1980) . Many researchers have attempted to quantify the relationship between infestation level and corn yield reduction ; Guthrie *et al.* 1975 reported 11.4 to 34.8% grain yield reduction for some

maize single crosses corresponding to different levels of larval survival . Sherif and Lutfallah 1991 stated yield reduction ranged between 15.7 to 73.3 % for different infestation rates in maize ears . Studies on the relationship between *O. nubilalis* infestation and yield losses have been restricted to searching for the infestation characteristics that are best correlated with losses , such as number of larvae or holes at harvest (Calvin *et al.* 1988,and Metwally & Shehata 1999) . Such models explain only a small part of yield loss variability (11- 45 %) according to Sparks *et al* . 1967 and thus can not provide accurate predictions of losses . They explained their results by the influence on yield losses of infestation date , within plant distribution of damage , corn variety and environmental conditions . A lake of specific and detailed information about some aspects of ECB behavior on maize plant varieties , combined with the various interpretation of yield losses, leaves this research to be conducted . This article deals with ECB larval survival, within – plant distribution, appearance of cavity and cavity length in some maize single crosses in relation to yield losses .

MATERIALS AND METHODS

To evaluate distribution of ECB larvae on / in the plant and cavities in seven maize single crosses (sc) and consequently yield reduction , an experiment was conducted at Gemmeiza Agricultural Research Station in 2001 season. The single crosses of maize; sc10, sc122 , sc123 , sc124 , sc129 , sc155 and sc161 were sown in the recommended date , May 26th in plots of 4 rows . Each row (6 m. length and 0.8 m apart) concluded 25 plants distributed as 25 cm. between each other .According to technique of Guthrie *et al.* 1971 and Awadallah *et al.* 1982 an artificial infestation was done , 45 days after sowing , with 9 black head egg – masses (approximately 180 eggs)for each plant in the two central rows in each plot . The first row plants were specialized for studying larval distribution whereas the others of the second row were specialized for estimating the grain yield . Three plants , from the first row , were randomly chosen in each plot at 3 , 6 , 9 , 12 , 18 and 35 days after egg hatching to record position and cavity length of larvae .To calculate the yield reduction, all ears from the second infested and uninfested rows in each plot were separately collected, dried, weighed, shelled and corrected to 15.5 % moisture content of grain yield . At harvest, ten plants were randomly chosen from each of the infested and uninfested rows in each plot to record number of holes per 100 internodes. This experiment was repeated again with all of the same treatments and replicates in 2002 season and all data obtained were statistically analyzed according to Steel and Torrie (1980) .

RESULTS AND DISCUSSION

Survival and establishment of *O. nubilalis* larvae and pupae on seven maize single cross hybrids , after 3 , 6 , 9 , 12 , 18 and 35 days of the artificial infestation , are shown in Table 1. Mean number of larvae and pupae was significantly lower on sc 123 and sc 161 (7.3 and 8.7 , respectively)

than on sc 124 and sc 122 (16.7 and 15.9 , respectively) . This mean was 11.2 , 12.2 and 14.3 larvae in case of sc 10 , sc 129 and sc 155 , respectively . Rate of larval mortality was great (97.2%) within the first 6 days after infestation . Thereafter no appreciable decrease was noticed in number of larvae (98.5-98.9 %) . The highest larval mortality occurred on sc 123 and sc 161 (95.6 and 95.3 %) whereas the lowest was recorded on sc 122 and sc 124 (92 and 92.7 %) within the first 3 days after infestation . These findings agree with those obtained by Guthrie et al 1970 who recorded more than 95% of larval mortality on resistant maize lines within 3 days after egg hatching .

Regardless of cultivars , number of alive larvae and pupae (calculated for 100 plants) in or on different sites of the maize plant are illustrated in Table 2 .The majority of larvae (100%) were found on the leaves after 3 days of infestation and decreased gradually to 60.9%, 12 days after infestation . By appearance of a perceptible tassel stage , at plant age of 51 days after sown, some of larvae (2.9%) were found on the tassels and increased to 22.8% when the plants aged 57 days and number of tassels increased . The larvae nearly disappeared on tassels (2.3) when the plants aged 80 days. Distribution of larvae on the ears was recorded as 7.9 % when the plants aged 63 days, decreased to 3.5% at 80 days old . About 2.1% of larval population was found in the internodes after the infestation with 9 days, increased to 77.7% after 18 days and the highest proportion (94.2 %) was recorded after 35 days of this infestation . Similar observations were reported by Isa *et al.* 1969 and Labatte and Got , 1993 .

Table 1. Mean number of ECB larvae and pupae per 3 plants of seven maize single cross hybrids after the artificial infestation .

Hybrid	Days after infestation						Mean
	3	6	9	12	18	35	
Sc 10	28.6 cd	17.3 h	6.6	5.3	4.6	4.5	11.2c
Sc 122	42.9 a	18.6 gh	8.6	8.9	8.3	7.9	15.9a
Sc 123	23.9 f	7.3 l	4.6	3.3	2.6	1.9	7.3e
Sc 124	39.6 b	20.3 g	11.3	10.6	9.3	8.3	16.7a
Sc 129	26.9 de	14.3 i	9.3	8.3	8.3	5.9	12.2c
Sc 155	30.5 c	18.9 gh	10.9	8.6	8.6	8.3	14.3b
Sc 161	25.3 ef	6.6 l	5.3	5.3	4.9	4.6	8.7d
Mean	31.1a	14.8b	8.2c	7.2cd	6.7de	5.9e	
Mortality%	94.2	97.2	98.5	98.7	98.8	98.9	

*** The original number of larvae was about 540 .**

The different corn hybrids exhibit a variation in the emergence time of their tassels , a high proportion of sc124 and sc122 plants reached to a perceptible tassel stage after about 54 days from planting . So they attract more larvae ; 133.3 and 100 /100 plants , respectively , Table (3). On the other side , decreasing of tassel numbers in the rest cultivars increased probability of larval occurrence on the leaves and exposed the larvae for death through 9 days of infestation . These data may partially interpret some reasons of the susceptibility of sc 124 and sc 122 to ECB infestation .

Table 2. Interorgan distribution of ECB larvae and pupae per 100 plants in or on different sites of maize plant after the artificial infestation .

	Site		Days after infestation			
	3	6	9	12	18	35
Leaf	1043 (100%)	473 (97.1%)	208.6 (77.4%)	143 (60.9%)	0.0	0.0
Tassel	–	14.3 (2.9%)	55.3 (20.5%)	53.7 (22.8%)	31.7 (14.4%)	4.7 (2.3%)
Ear	–	–	–	–	17.3 (7.9%)	7.3 (3.5%)
Internode	0.0	0.0	5.7 (2.1%)	38.3 (16.3%)	171 (77.7%)	194.7 (94.2%)
Total	1043	487.3	269.6	235	220	206.7
Age of plant (days)	48	51	54	57	63	80

*Number between brackets represents percentage of larvae on or in plant sits

When the infested plant leaves were divided into three levels ; the bottom (4 Leaves) , the middle (5 Leaves) and the top (4 leaves) , the highest number of larvae (68.7 %) were found on the middle part leaves whereas the lowest (7.3 %) was observed on the bottom part ones, (Table 4) . The high proportion of larvae (81.6%) on the middle part , after 3 days of the infestation was markedly reduced to (35..4%) after 12 days of the infestation . It generally increased on the top leaves from 12.9 to 31.0 % and on those of bottom levels from 5.5 to 33.6 % .

Table 3. Mean number of ECB larvae and pupae on the tassels (per 100 plants) of seven maize single cross hybrids after the infestation .

Plant age (days)	Days after Infestation	Hybrid						
		Sc 10	Sc 122	Sc 123	Sc 124	Sc 129	Sc 155	Sc 161
51	6	11	0.0	-	66.7	-	22	-
54	9	44.3	100	0.0	133.3	33.3	33.3	44.3
57	12	22	66.3	22	77.7	111	44.3	33.3
63	18	22	33.3	22	22	66.3	44.3	11
80	35	11	0.0	0.0	0.0	0.0	22	0.0
Mean		22.1	39.9	8.8	59.9	42.1	33.2	17.7

These results indicated that the small larvae have a high tendency to aggregate ,and that aggregation becomes less pronounced as larvae mature (Shelton *et al.*, 1986). The highest number was found on the eighth leaf followed by the seventh and ninth leaves , 93.1 , 69.8 and 67.7 larvae respectively.However , the frequency of larval occurrence decreased dramatically on the leaves as the distance from the eighth leaf increased.
Table 5. shows ECB distribution within the stem after the artificial infestation . While more larvae (57.6 %) were found around the ear zone in the middle part of the plant , followed by the bottom part (39.6 %) , less than 3 % of larvae were found above the ear zone (top strata) . As the season progressed , a considerable number of larvae tended to bore into the bottom internodes to hybernate . The highest mean numbers of larvae (18.8 and 15.6) were observed in the ninth and eighth internodes respectively (Dean Barry and Morlee Mends - Cole 1991) .

Table 4. Vertical distribution of ECB larvae (per 100 plants) on maize plant leaves after an artificial infestation .

Level	Leaf no.	Days after infestation				Mean
		3	6	9	12	
Bottom	1	0.0	3	17	17	9.3ef
	2	1.3	1.3	7.7	4.7	3.8g
	3	18.3	0.0	1.3	9.3	7.2fg
	4	37.7	0.0	0.0	17	13.7e
Total (%)		57.3 (5.5)	4.3 (0.9)	26 (12.5)	48 (33.6)	34 (7.3)
Middle	5	104	8.3	21.7	10.7	36.2d
	6	172.7	25	4.7	12.3	53.7c
	7	199.3	59.3	15.7	4.7	69.8b
	8	231.3	96	39	6	93.1a
	9	142.7	80	31.3	17	67.7b
Total (%)		850 (81.6)	268.6 (56.6)	112.4 (53.8)	50.7 (35.4)	320.5 (68.7)
Top	10	87	76	33	20	54c
	11	42.7	74	26.7	18	40.4d
	12	47	29.7	9.3	6.3	12.5e
	13	0.0	21.7	1.3	0.0	5.8fg
Total (%)		134.4 (12.9)	201.4 (42.5)	70.3 (33.7)	44.3 (31)	112.7 (24)
General total		1041.7	474.3	208.7	143	466.7
General mean		80.1a	36.5b	16c	11d	

Table 5. Distribution of ECB larvae and pupae per 100 plants in internodes after the artificial infestation .

Level	Internode No.	Days after infestation				Mean
		9	12	18	35	
Bottom	3	0.0	0.0	12.7	17.3	7.5e
	4	0.0	11	14	28.3	13.3c
	5	0.0	3	12.7	22	9.4d
	6	0.0	3	22	15.7	10.2d
Total (%)		0.0	17 (44.3)	61.4 (35.9)	83.3 (42.8)	40.4 (39.6)
Middle	7	1.3	4.7	20.3	11	9.3d
	8	1.3	7.7	17.3	36.6	15.6b
	9	3	7.7	34.7	30	18.8a
	10	0.0	1.3	11	14	6.6e
	11	0.0	0.0	19	9.3	7.1e
	12	0.0	0.0	1.3	4.7	1.5f
Total (%)		5.6 (100)	21.4 (55.7)	103.6 (60.6)	105.3 (54.1)	58.9 (57.6)
Top	13	0.0	0.0	0.0	4.7	1.2fg
	14	0.0	0.0	0.0	1.3	0.3fg
	15	0.0	0.0	0.0	0.0	0.0g
	16	0.0	0.0	3	0.0	0.7fg
	17	0.0	0.0	3	0.0	0.7fg
Total (%)		0.0	0.0	6 (3.5)	6 (3.1)	2.9 (2.8)
General total		5.6	38.4	171	194.6	102.2
General mean		0.4d	2.6c	11.4b	13a	

There were significant differences in stalk damage among cultivars as indicated by cavity length , Table 6 . The greatest damage occurred in the plants aged 60 – 80 days approximately synchronyzed with the blister stage of maize plant development and also resulted from the highest number of larvae harbored at this stage (Table 5) (Labatt and Got ,1991) . The variation in mean cavity length indicated a low stalk damage in sc 123 and sc 161 ; 5.8 and 7.8 cm. , respectively . On the other side an extensive damage was recorded in sc 124 , sc 122 and sc 155 ; 21.3 , 17.8 and 16.4 cm. , respectively .

Grain yield reduction percentages and number of holes /100 internodes in the tested cultivars in 2001 and 2002 seasons are illustrated in Table 7 . While , mean number of holes ranged from 47.1 (sc 123) to 83.2 (sc155) under the artificial infestation conditions , it ranged 11.1 (sc123) and 23.8 (sc 122) only under the natural infestation . As for grain reduction percentages they were in parallel with increasing of holes ; 19.5 % in case of sc 123 and 24.8 % in case of sc 155 .

Table 6. Mean cavity length (cm .) per 3 plants of seven maize ultivars after the artificial infestation .

Cultivar	Days after infestation				Mean
	9	12	18	35	
Sc 10	2.6	0.3	25.0	23.3	12.8 abc
Sc 122	0.3	2.7	37.3	31.0	17.8 a
Sc 123	0.0	0.9	11.3	11.0	5.8 c
Sc 124	3.0	6.0	34.3	42.0	21.3 a
Sc 129	1.0	3.3	24.3	26.6	13.8 abc
Sc 155	0.0	1.9	22.0	41.6	16.4 ab
Sc 161	0.3	1.0	15.0	15.0	7.8 bc
Mean	1.03 b	2.3 b	24.2 a	27.2 a	
Plant age	54	57	63	80	

Table 7. Grain yield reductions % and number of holes / 100 internodes for seven maize cultivars in 2001 and 2002 .

Cultivar	No. of holes						Yield reduction %		
	Artificial infestation			Natural infestation					
	2001	2002	mean	2001	2002	mean	2001	2002	Mean
Sc 10	60.0 b	56.4 c	58.2	15.8 bc	12.6 cd	14.2	9.3 b	14.9 cd	12.1
Sc 122	70.3 a	93.3 a	81.8	23.7 a	23.9 a	23.8	20.9 a	20.0 b	20.4
Sc 123	50.2 b	44.1 d	47.1	11.9 c	10.2 d	11.1	8.6 b	10.4 e	9.5
Sc 124	64.4 a	94.2 a	79.3	14.5 bc	15.6 bc	15.1	23.8 a	20.0 b	21.9
Sc 129	47.9 b	69.6 b	58.7	20.9 ab	12.7 cd	16.8	8.8 b	17.4 bc	13.1
Sc 155	67.2 a	99.3 a	83.2	20.6 ab	18.8 b	19.7	24.6 a	25.0 a	24.8
Sc 161	57.0 ab	53.1 c	55.1	15.7 bc	10.6 d	13.1	6.9 b	12.7 de	9.8
Mean	59.6	72.9		17.6	14.9		14.7	17.2	

Generally , it could be concluded that the yield losses caused by ECB larvae depend mainly on larval survival , extent of cavity , timing of tunnelling and their within plant distribution . Also , it could classify the tested hybrids to two groups according to the reduction in their yield . The first concluded the lower sensitive hybrids to the ECB infestation (9.5 – 13.1 % reduction) as sc 123 , 161 , 10 and sc 129 . The second group had the higher sensitive ones (20.4 – 24.8 % reduction) as sc 122 , 124 and sc155 . In the same time , the first group hybrids harbored lesser number of larvae (7.3 - 12.2) and shorter tunnels (5.8 – 13.8 cm) when compared with 14.3 – 16.7 larvae and 16.4 – 21.3 cm. In the hybrids of the second group .

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توزيع يرقات حفار ساق الذرة الأوربي داخل نباتات بعض الهجن الفرديـــة للـــذرة الشامية

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وبواقع تسعة لطع من بيض الحشرة (فى عمر الرأس السوداء . أوضحت النتائج أن اليرقات الصغيرة تتغذى أساسا على أوراق النبات خلال ١٢ يوما من فقس البيض وأن اكثر من ٩٧% منها قد مات خلال الستة أيام الأولى مـــن الفقـــس . اعتمد توزيع اليرقات على السنابل والكيزان على مراحل تطور نبات الذرة لذلك أختلف توزيعها من صنف لآخر ،بـــدأت نسبة ضئيلة من هذه اليرقات (٢,١%) في الحفر إلى داخل النبات بعد ٩ أيام من الفقس ثم إزدادت إلى ٩٤,٢% بعـــد ٣٥ يوم منه ، ازدادت اعداد اليرقات خاصة في الأعمار الأولى سواء على الأوراق أو داخل العقل الموجودة في منطقة وسط النبات (حول منطقة الكوز) .حدث معظم الضرر للسيقان في مرحلة رص الحبوب (عمر النبات من ٦٣ _ ٨٠ يوم) واختلف شدة الضرر من صنف لآخر حيث كانت الهجن الفردية ١٢٤،١٢٢،١٥٥ اكثر حساسية للإصابة بالحشـــرة و سجل عليها اكبر عدد من اليرقات الحية الذى نتج عنه ضرر كبير للسيقان وفقد ملحوظ في محصول الحبـــوب (٢٠,٤– ٢٤,٨%)بينما كانت بقية الهجن الأخرى أقل حساسية للإصابة حيث تسببت في موت اكثر مـــن ٩٥% مـــن اليرقـــات وبالتالى كان الضرر للسيقان قليل و الفقد في محصول الحبوب بسيط (٩,٥–١٢,١%) .