RELATIVE SUSCEPTIBILITY OF SOME NEW PROMISING SUGARCANE VARIETIES TO THE PINK BORER, *SESAMIA CRETICA* LEDERER AND THE PURPLE- LINED BORER, *CHILO AGAMEMNON* BLEZYNSKI

By **MOHAMED A. EID[1]; HAMDY A. ELSHABRAWY[1]; MOHAMED F. MAAREG[2] AND RAMY S. YAKOUB[2]**

[1]Department of Economic Entomology and Pesticides, Faculty of Agriculture, Cairo University, Giza, Egypt.

[2]Sugar Crops Research Institute, Agriculture Research Center, Giza, Egypt.

(Received 25-12-2005)

INTRODUCTION

Sugarcane (*Saccharium* spp.) is the main field crop for white sugar production in Egypt and about 69 countries in tropical and subtropical regions of the world (Humbert, 1968). For sugar production, sugarcane grow successfully in 250 thousand feddans in both middle Egypt (El-Minia governorate) and upper Egypt (Sohag, Quena and Asswan governorates), where, the total amount of sugar (about one millon tons) produced from sugarcane represent about 70 and 50 % of the total annual sugar production and consumption, respectively.

Sugarcane is severely attacked by two species of Lepidoptera. Larvae of the pink borer (PB), *Sesamia cretica* Lederer (Noctuidae, Lepidoptera) represents potential threat to sugarcane grown in upper and middle Egypt. It has been historically categorized as a shoot borer which enters shoots at ground level, eat young tissue and destroy the growing-point, thereby, causing the formation of characteristic "dead hearts". The damage caused by *Sesamia* depends on the ability of affected plants to compensate for "dead hearts" by producing new shoots (tillers).The second species is the purple-lined borer (PLB), *Chilo agamemnon* Blezynski (Pyralidae, Lepidoptera). It is the most destructive and potentially chronic species that attacks sugarcane. It is a pest on graminaceous crops in tropical and subtropical regions and chiefly attacks corn, sugarcane and rice (El-Sherif , 1962).

Fletcher (1910) was the first to record it from Egypt under the synonym *C. simplex* Butl. Willcocks (1925) believed that *Chilo* sp. had been imported to Egypt in some sugarcane sets or straw packings from Japan.

Borer infestation causes reduction in cane weight due to internodes damage, in addition larval tunnel in the cane cause stalk breakage and lodging. Moreover, the larval entrance and moth holes offer entry points for red rot (Reagan and Flynn, 1985). Damage of this type of pathogens severly depends on the incidence of these pests, as well as on varietal susceptibility. The borer infestation and accompanied diseases complex cause serious deterioration in the quality and quantity of juice extract for sugar production and hence drastic threat to the sugar industry.

Numerous reports are listed in the literature on observed differences among sugarcane varieties injury by stalk borer, whereas, screening for new resistant varieties is of paramount importance to both cane grower and industry. In this connection, three main types of sugarcane resistance to stalk borers have been postulated by Mathes and Charpentier (1969). These types include: 1- Unattractiveness of host-plant to moths for egg deposition.

2- Plant characters unfavorable for establishment of borers in the plant, which inhibit or render borer development. 3- Tolerance or the ability to yield well inspite of a high infestation.

Meantime, varietal resistance has already played a fital role in reducing the use of insecticide and consequantly environmental pollution.

The present study was initiated to evaluate the relative susceptibility and/or resistance of six new promising sugarcane varieties to the two borers attack in plant cane and first ratoon under natural conditions of Sohag governorate.

MATERIAL AND METHODS

Six new promising sugar cane varieties i.e. Giza (G) 84-47, 85-37, 95-21, 95-21, Farmosa (F) 161 and PH (Philippine) 8013 in addition to the major commercial variety Giza-Taiwan (GT) 54-9 (occupied about 95 % of the total sugarcane area). Varieties were planted in Shandaweel Agricultural Research Station, Sohag governorate, Upper Egypt during the two successive seasons, 2000/2001 and 2001/2002, as plant cane and first ratoon, respectively. To evaluate their sensitivity under natural infestation (without insect control program) by the shoot borer or pink borer (PB), *S. cretica* and the stalk borer or purple-lined borer (PLB), *C. agamemnon.*

Varieties were planted in Febreuary 20, 2000 (summer sowing) in a randomized complete block design with twelve replicates (8 replicates for current samples and 4 replicates for yield and yield components). The individual plot size was 42 m^2 (= 1/100 Feddan) (6 ridges 7 m long and one meter apart). The plantation was carried out using a fixed number of eye-buds (84 eye-buds three in each cutting) in each ridge (7 long) for each variety. The package of recommended cultural practices for plant cane and 1st ratoon were adopted informally when needed. Application of insecticides was excluded.

Harvest was carried out in March 15, for two seasons 2001 and 2002 for plant cane and 1st ratoon, respectively (worth to mention that harvest date of plant cane was considered as the beginning of the new ratoon crop or approximately the sowing date of the ratoon crop).

Evaluation of susceptibility of sugarcane varieties to borer infestation:

Shoot Borer or Pink Borer (PB), *S. cretica*:

Dead hearts were surveyed for each variety from four replicates at 15 days intervals from March 21 to June 4, 2001 and from March 30 to June 29, 2001 for plant cane and 1st ratoon, respectively. The percentage of dead hearts was counted according to the following equation:

Dead heart % = No. of dead heart × 100/No. of plants

Stalk Borer or Purple-Lined Borer (PLB), C. agamemnon:

Samples of 100 stalks were taken randomly from the four middle rows of four replicates for each variety from July 15 and every month intervals up to harvest time at March 15, 2001 and 2002 for both plant cane and 1st ratoon, respectively. Cane stalks were stripped, cleaned and examined for various noticeable sign infestation with *C. agamemnon* using the following formula according to Mendes *et al* (1980):

a. Percentage of bored stalks (infestation incidence) = No.of bored stalks × 100/No. of examined stalks.

b. Percentage of bored joints (infestation intensity) = No. of infested joints ×100/No. of examined joints.

c. Percentage of girdled stalks = No. of girdled stalks × 100/No. of examined stalks.

d. Percentage of breakage stalks = No. of breakage stalks × 100/No. of examined stalks.

At harvest time:

e. Mean No. of holes/stalk = No. of holes/No. of examined stalks.

f. Mean No. of holes/joint = No. of holes/No. of examined joints.

g. Mean No. of holes/infested joints = No. of holes/No. of examined infested joints.

RESULTS AND DISCUSSION

Evaluation of susceptibility of sugarcane varieties to borer infestation:

Shoot Borer or Pink Borer (PB), *S. cretica*:

The obtained results (Table 1) show that, the varieties differed significantly in their susceptibility to shoot borer measured as dead hearts in both plant cane and 1st ratoon as well. Moreover, G 95-19 was the most susceptible variety to *Sesamia* attack recording the highest dead hearts in all sampling dates and their average recorded 10.84% and 10.69% in plant cane and 1st ratoon, respectively, followed by G 95-21 variety (9.31 and 8.83%). On the contrary, the most tolerant varieties to PB attack were in plant cane G 85-37 and PH8013 varieties and in the 1st ratoon PH8013 and G 84-47 varieties which exhibited the lowest dead hearts percentage recording 5.95% and 5.98% in plant cane and 5.10 and 5.20% in the first ratoon. Meantime, GT 54-9 and F161 varieties were moderately affected by shoot borer in both plant cane and 1st ratoon recording intermediate dead heart values. Similar results are reviewed by Hensley *et al* (1967), Kyle (1968), Lim and Pan (1977), Abu-Dooh (1980 and 1988), Bessin and Reagan (1993) and Eskandar (1996).

Worth to mention that in both plant cane and 1st ratoon the new promising varieties G 84-47, G 85-37, F161 and PH8013 were the most tolerant varieties to shoot borer attack, which recorded less dead heart than the commercial variety (GT 54-9).

Also, the average data manifested that, plant cane was more sensitive to shoot borer damage than 1st ratoon. Average of dead hearts percentage amounted 7.52% and 7.04 for plant cane and 1st ratoon, respectively. Similar conclusion was observed by Abu-Dooh (1980 and 1988) and Eskandar (1996). While, early studies by Avasthy *et al.* (1969) showed that the shoots of both plant cane and ratoon crops are equally liable to shoot borer attack.

Stalk Borer or Purple-Lined Borer (PLB)), *C. agamemnon*:

Various noticeable signs of infestation were taken in consideration as measures and exact figures for estimating the main damage of PLB. These measures will be discussed as follows for both plant (virgin) cane and first ratoon canes:

TABLE (I)

Percentage of dead hearts in sugarcane varieties resulted from infestation by shoot borer (PB), *Sesmia cretica*

Varieties	GT 54-9	G 84-47	G 85-37	G 95-19	G 95-21	F161	PH8013	Average
Plant cane	7.07	6.12	5.95	10.84	9.31	7.40	5.98	7.52
First ratoon	7.04	5.20	6.25	10.69	8.83	6.16	5.10	7.04

TABLE (II)

Percentage of bored stalk, bored joints, girdled stalk and breakage stalk in sugarcane varieties resulted from*Chilo agamemnon* infestation.

Sugarcane varieties	**bored stalk %**		**bored joints%**		**girdled stalk%**		**breakage stalk%**	
	Plant cane	**First ratoon**	**Plant cane**	**First ratoon**	**Plant cane**	**First ratoon**	**Plant cane**	**First ratoon**
GT 54-9	78.22	71.69	13.69	14.71	17.25	17.47	10.30	11.25
G 84-47	64.50	70.03	10.15	12.30	14.61	14.36	6.10	7.13
G 85-37	71.47	57.86	12.26	11.93	12.97	12.86	6.75	9.46
G 95-19	78.39	74.86	15.64	16.22	15.47	16.61	9.75	12.71
G 95-21	70.64	63.61	13.93	14.44	16.56	18.56	6.25	9.58
F161	68.72	57.83	11.18	11.74	12.11	14.44	6.90	9.46
PH8013	73.14	69.86	11.90	12.57	12.75	13.11	5.60	9.63
Average	72.15	66.54	12.68	13.42	14.53	15.34	7.38	9.89

Bored stalk percentage (infestation incidence %):

Data in Table (2) indicate that, bored stalks percentage in both plant cane and 1st ratoon significantly differed among varieties. In plant cane G 95-19 and GT 54-9 (the commercial cane variety) varieties exhibited the highest bored stalk percentage recording 78.39 and 78.22%, respectively. The variety next in order in its sensitivity to PLB attack was PH8013 (73.14%), the same trend was also observed in the 1st ratoon.

On the other hand, G 84-47 was the most tolerant variety in plant cane recording the lowest bored stalk% (64.50%), while, in the 1st ratoon it was G 85-37 variety (57.86%) followed by F161 (57.83%). G 95-21, F161 and PH8013 in plant cane and G 95-21 in the 1st ratoon could be classified as moderate in their resistance to stalk borer attack. Based on, data of both plant cane and 1st ratoon all the new promising varieties were less attacked by PLB than the commercial variety GT 54-9 except G 95-19 variety. No variety appeared to be immune towards PLB infestation.

In general, the obtained results are in accordance with those reviewed by Issa (1979), Abu-Dooh (1980 and 1988), Gaber *et al.* (1981a and b), Padmanabhan *et al.* (1990), Borah (1993), Embaby (1996), Jena and Patnaik (1996a and b) who found that the relative susceptibility to *C. agamemnon* infestation measured as bored stalk percentage differed greatly among cane varieties.

Data also show that the plant cane suffered more bored stalks % (72.15) than the first ratoon (66.54%). These findings are partly in line with those obtained by Abu-Dooh (1988), Maareg *et al.* (1993), Eskandar (1996) and Mahmoud (2000).

Bored joints percentage (Infestation intensity):

The data (Table 2) show that the used varieties significantly differed in their susceptibility to borer attack measured as bored joints percentage in both plant cane and 1st ratoon. G 95-19 seemed to be the most susceptible variety to borer attack recording the highest bored joints in both plant cane (15.64%) and 1st ratoon (16.22%), followed by GT 54-9 (14.71%) and G 95-21 (14.44%) varieties in the 1st ratoon only without significant differences. On the other hand, G 84-47 (in plant cane) and G 85-37 (in 1st ratoon) were the least infested varieties attacked by PLB followed by F161 variety. Other varieties were located between these limits and recorded intermediate bored joints % values such as GT 54-9, G 85-37, G 95-21 and PH8013 in plant cane and G 84-47 and PH8013 in the first ratoon could be grouped as moderate in their susceptibility to PLB attack.

Worth to mention that no one of the new promising varieties tested under this study is able to escape from borer (PLB) attack, meantime all varieties in both plant cane and 1st ratoon were less infested by stalk borer than GT 54-9 the main commercial variety except G 95-19 variety which recorded the highest bored joints % in both season. Similar findings are reported by Hassnein and El-Naggar (1971a and b), Negm (1978), Williams *et al.* (1979), Abu-Dooh (1980 and 1988) and Eskandar (1996) who reported that no commercial sugarcane variety being grown in Egypt is able to escape economically from stalk borer infestation damage during the crop season. They added that screening for new promising commercial tolerant varieties is of paramount importance to both sugar cane growers and manufacturers.

The 1st ratoon was more susceptible to borer attack (13.42%) than plant cane (12.68%). Similar results are reviewed by Waiyaki (1971), Issa (1979), Abu-Dooh (1980 and 1988), Embaby (1996), Eskandar (1996), Mahmoud (2000) and Ali *et al.* (2001).

Girdled stalks percentage:

Girdled stalks percentage differed significantly among the varieties in both plant cane and 1st ratoon (Table 2). GT 54-9 (the commercial cane variety), G 95-21 and G 95-19 (from the new candidate varieties to commercial plantation) exhibited the highest percentage of girdled stalks in both plant cane and 1st ratoon. The girdled stalk% of these three varieties recorded 17.25, 16.56 and 15.47% in plant cane, respectively corresponding to 17.47, 18.56 and 16.61% in the 1st ratoon. This indicates that these varieties were the most susceptible (least tolerant) varieties among the other used varieties in both plant cane and 1st ratoon to stalk borer attack. On the contrary, the most tolerant varieties (least susceptible) in plant cane was F161 followed by PH8013, while, in the 1st ratoon PH8013 followed by G 85-37 which recorded the lowest percentage of girdled stalks.

Furthermore, G 84-47 in both plant cane and 1st ratoon, however, G 85-37 in plant cane only and F161 in the 1st ratoon only were moderate in their sensitivity to stalk borer attack. These results are in agreement with those reported by Abu-Dooh (1988), Maareg *et al* (1993) and Eskandar (1996) who found that girdled stalks percentage markedly differed among sugarcane varieties and GT 54-9 variety showed a great sensitivity to girdled stem infestation.

The sensitivity to PLB attack measured as % girdled stalks was higher in the 1st ratoon (15.34%) than those of plant cane (14.53%). These results are affirmed

by those of Abu-Dooh (1988) and Eskandar (1996), whereas, they are on contrary with those of Mahmoud (2000).

Breakage stalks percentage:

Data in Table (2) clarify that, the sign of infestation expressed as breakage stalk percentage significantly varied among the used varieties in both plant cane and 1st ratoon. GT 54-9 and G 95-19 seemed to be the most susceptible varieties, which exhibited the highest breakage stalks %.

Accordingly, the other varieties such as G 84-47, G 85-37, G 95-21, F161 and PH8013 in both plant cane and 1st ratoon seemed to be less affected by PLB damage recording lower and nearly the same breakage stalks percentage in both plant cane and the 1st ratoon .The obtained results are in harmony with those of Embaby (1996). A perusal of the obtained data clarify that, in plant cane all the six new promising varieties were less affected by PLB damage than GT 54-9 (the commercial variety). The same trend was observed in the 1st ratoon with the exception of G 95-19 variety.

The average of breakage stalks percentage of 1st ratoon was higher than that of plant cane where, it recorded 7.38% and 9.89% for plant cane and 1st ratoon, respectively. These results are in contradection with those of Mahmoud (2000) who found that plant cane recorded the maximum breakage stalk percentage followed by the 1st ratoon.

At Harvest time:

Number of holes/stalk:

Significant differences in number of holes/stalk among the tested varieties over and within both plant cane and 1st ratoon have been detected (Table3). Averaged data clear that, G 95-19 was the least tolerant variety (high susceptible) recording the highest number of holes/stalk (6.78), while the varieties G 95-21 (4.64), GT 54-9 (4.38) and PH8013 (3.86) were moderate in their resistance. On the other hand, the varieties G 85-37, F161 and G 84-47 seemed to be the most tolerant varieties (less susceptible) which recorded the lowest number of holes/stalk (2.88, 2.74 and 2.72, respectively).

Similar results were recorded previously for percentage of bored cane stalks and bored joints criteria. The sensitivity of the tested varieties within plant cane and 1st ratoon showed similar trend as mentioned above, where, G 95-19, G 95-21 and GT 54-9 recorded the highest number of holes per stalk in both plant cane

and 1st ratoon or with other orders, the susceptibility of these three varieties was the same in both plant cane and 1st ratoon. Furthermore, the sensitivity of G 85-37 and PH8013 in terms of number of holes/stalk were higher in plant cane than 1st ratoon. However, G 84-47 and F161 had a vise versa trend. Meantime, F161 was the most tolerant variety in plant cane than 1st ratoon. In general, data in clearly indicate that plant cane suffered more number of holes/stalk (4.16) than those of 1st ratoon (3.83). The obtained results are completely in line with those of Mahmoud (2000) who found that the maximum number of holes was observed on plant cane and the minimum was of the 1st ratoon.

Number of holes/joint:

The results in Table (3) reveal significant differences between the used varieties in plant cane, 1st ratoon and mean over both crops, respectively. Mean data (over plant cane and 1st ratoon) indicated that number of holes/joint ranged between 0.14 (G 84-47) and 0.40 (G 95-19). Cane variety G 84-47 exhibited the lowest number of holes per joint (0.14) followed by G 85-37 (0.16) and F161 (0.17), However, GT 54-9 (0.22) and PH8013 (0.21) were moderate varieties in respect to this trait. On the other hand, G 95-19 variety was the highest infested variety (0.40).

Moreover, Data showed that the susceptibility of the used cane varieties to borer attack, measured by number of holes per internodes, was different according to plant crop. Similar results were obtained by Abu-Dooh (1988), Maareg *et al* (1993) and Eskandar (1996).

In general, G 95-19 exhibited the highest number of holes/joint (0.44 and 0.36) in both plant cane and 1st ratoon, respectively while, the lowest one (0.12) was of G 84-47 in plant cane and of G 85-37 (0.14) and G 84-47 (0.15) varieties in the 1st ratoon . The number of holes/joint was higher (0.24) in plant cane than those of 1st ratoon (0.21). Such effects give evidence that plant cane was most susceptible to borer damage than the 1st ratoon. Meantime, these results are re-affirmed by the previous results of bored stalks and bored joints percentages. Some findings coincide with current results and some others disagree with them. El-Naggar (1968) and Kira and El-Sherif (1973 a and b) reported that plant cane is more susceptible to infestation than ratoons. On the other hand, Abu-Dooh (1988), Maareg *et al* (1993) and Eskandar (1996) claimed that plant canes were less susceptible than ratoons.

Number of holes/infested joint:

Average data (over plant cane and 1st ratoon) in Table (3) clarify that, number of holes/infested joint significantly differed among the varieties.The highest

TABLE (III)

Mean Number of Holes/Stalk, Mean Number of Holes/Joint and Mean Number of Holes/infested Joints in plant cane (2000/01) and first ratoon (2001/02) of the seven tested sugarcane varieties due to *Chilo agamemnon* infestation.

Sugarcane varieties	Mean Number of Holes/Stalks			Mean Number of Holes/Joint			Mean Number of Holes/infested Joints		
	Plant cane	First ratoon	Mean	Plant cane	First ratoon	Mean	Plant cane	First ratoon	Mean
GT 54-9	4.29	4.46	4.38	0.21	0.22	0.22	1.49	1.56	1.53
G 84-47	2.37	3.06	2.72	0.12	0.15	0.14	1.04	1.28	1.16
G 85-37	3.18	2.58	2.88	0.17	0.14	0.16	1.34	1.20	1.27
G 95-19	7.44	6.11	6.78	0.44	0.36	0.40	2.69	2.52	2.61
G 95-21	5.23	4.05	4.64	0.33	0.25	0.29	2.40	1.96	2.18
F161	2.59	2.88	2.74	0.16	0.18	0.17	1.38	1.54	1.46
PH8013	4.02	3.70	3.86	0.22	0.20	0.21	1.61	1.60	1.61
Mean	4.16	3.83	4.00	0.24	0.21	0.23	1.71	1.67	1.69
L.S.D. at 0.05	0.285	0.313		0.016	0.019		0.209	0.159	

number of holes/infested joint was recorded in G 95-19 variety (2.61) followed by G 95-21 variety (2.18). The varieties next in order were PH8013, GT 54-9 and F161 which recorded 1.61, 1.53 and 1.46 holes/infested joint, respectively. On the other hand, G 84-47 variety exhibited the lowest holes per infested joint (1.16) followed by G 85-37 (1.27). Data also show that, number of holes/infested joint was significantly differed among the tested varieties in both plant cane and 1st ratoon.

Furthermore, G 85-37, G 95-19 and G 95-21 exhibited higher number of holes/infested joint in plant cane than the 1st ratoon. On the other hand, the same trait of GT 54-9, G 84-47 and F161 was higher in the 1st ratoon than plant cane. Also, number of holes/infested joint for PH8013 was nearly the same (1.61 and 1.60) in plant cane and 1st ratoon, respectively. Such results in general give evidence that the varieties perform inconsistently with respect to this trait in plant cane and 1st ratoon except PH8013, where, its behaviour against borer effect was the same in both plant cane and 1st ratoon.Insignificant differences was found between plant cane and the 1st ratoon in regard to number of holes/infested joint.

SUMMARY

Six new promising sugar cane varieties were used to evaluate their relative susceptibility to shoot borer pink borer (PB), *S. cretica* and stalk borer the purple lined borer (PLB), *C. agamemnon* in both plant cane and 1st ratoon. All the promising varieties except G 95-19 and G 95-21 were relatively highly tolerant to PB recording less dead hearts % than GT 54-9 (the major commercial variety). The plant cane was more sensitive to shoot borer than 1st ratoon.

The sensitivity of the tested cane varieties differed significantly against PLB attack measured as bored stalk and bored joints percentage. Nothing of the tested varieties is immune to PLB infestation, meantime, all the new varieties showed relative higher degree of tolerant to stalk borer attack except G 95-19 than the commercial variety GT 54-9. The 1st ratoon was more susceptible to stalk borer attack than the plant cane. When the sensitivity was measured as girdled stalks percentage , the 1st ratoon was more sensitive than plant cane. Girdled stalks percentage positively but insignificantly correlated with borer stalks %, while, it correlated positively but significantly with bored joints %.

Breakage stalks percentage as a measurment of the sensitivity reveal that, GT 54-9 and G 95-19 were the most susceptible varieties which exhibited the highest breakage stalks %, while, the other new promising varieties were relatively

more tolerant. No. of holes/stalk, No. of holes/joint and No. of holes/infested joint significantly differed amongst the used varieties in both plant cane and 1st ratoon.

Varieties could be classified according to its susceptibility as follows: high susceptible G 95-19, moderate susceptible GT 54-9, G 95-21, F161 and PH8013 and low susceptible G 84-47 and G 85-37.

REFERENCES

ABU-DOOH, A. M. (1980): Varietal resistance of certain sugarcane varieties to infestation by sugarcane borers. *(Unpublished M. Sc. Thesis, Assiut Univ., Egypt,101pp).*

ABU-DOOH, A. M. (1988): Relationship between sugarcane varieties and their insect pests in Upper Egypt. *(Unpublished Ph. D. Thesis, Assiut Univ., Egypt. 130 pp).*

ALI, M.K.; S. M. ALLAM; A. A. ABAZIAD; and M. G. BESHAY (2001): Effect of stalk borer intensity *Chilo agamemnon* (PLB) on juice quality of three sugar cane varieties. *(Egypt J. Appl. Sci., 16 (1): 99-110).*

AVASTHY, P. N; T. N. KRISHNAMUTHY; and K. ANATHANARAYANA (1969): Factors affecting shoot borer in sugarcane. *(World Crops Proc. ISSCT., 13: 1285-1291).*

BESSIN, R. T.; and T. E. REAGAN (1993): Cultivar resistance and arthropod predation of sugarcane borer (Lepidoptera: Pyralidae): effect incidence of dead hearts in Louisiana sugarcane. *(J. Econ. Entomol., 86(3): 929-932).*

BORAH, B. K. (1993): Response of certain sugarcane varieties to plassey borer, *Chilo tumidicostalis* Hmpsn. *(Assam. Ind. Sug., 43 (6): 363-364).*

EL-NAGGAR, M. Z. (1968): Studies on sugarcane borer in Upper Egypt. *(Unpublished M.Sc. Thesis, Assiut Univ., Egypt, 244 pp).*

EL-SHERIF, S. I. (1962): Studies on the corn borers in Alexandria district, Egypt, *Chilo agamemnon* Wilk. (Lepidoptera: Crambidae), *Pyrausta nubilalis* Hbn. (Lepidoptera: Pyraustidae), and *Sesamia cretica* Led. (Lepidoptera: Noctuidae). *(Unpublished M.Sc. Thesis, Alexandria Univ., Egypt, 199 pp).*

EMBABY, M. M. (1996): Ecological and biological approaches in an attempt to face the problem of the purple lined borer, *Chilo agamemnon* Blez. in the

sugarcane production areas of Egypt. *(Unpublished Ph. D. Thesis, El-Minia Univ., Egypt, 176 pp).*

ESKANDAR, R. A. (1996): Evaluation of some sugarcane genotypes for infestation with some animal and insect pests. *(Unpublished M. Sc. Thesis., Zagazig Univ., Egypt, 174 pp).*

FLETCHER, F. (1910): Notes on Egyptian insects in Egypt. *(2nd Edition, Cairo. c.f. S.I. El- Sherif, 1962).*

GABER, A. A.; H. A. MESBAH; A. H. NOUR; and M. A. ABD EL-RASSOL (1981a): Correlation between yield and some morphological, physiological, chemical characters and borers infestations in thirty four varieties of some sugarcane at Alexandria. *(Agric. Res. Rev., 59(8): 99-12).*

GABER, A. A.; M. A. EL-MANHALY and A. H. NOUR (1981b): Relationship between number of tillers, sugar content and levels of borers infestation of some sugarcane varieties. *(Agric. Res. Rev., 59: 113-126).*

HASSANEIN, M. H.; and M. Z. EL-NAGGAR (1971a): The effect of planting dates and different crops of sugarcane on the infestation of the stalk borer, *Sesamia*

cretica Led., in Egypt. *(Bull. Ent. Soc.Egypte, 55: 403-408).*

HASSANEIN, M. H.; and M. Z. EL-NAGGAR (1971b): Susceptibility of certain sugarcane plant varieties to borers infestation in Egypt. *(Bull. Ent. Soc.Egypte, 55: 427-439).*

HENSLEY, S. D.; E. J. CONCIENNE; and GRADUATE ASSISTANT (1967): Summary of research in 1966 on sugarcane insects. *(Agri. and Mechanical College, Louisiana Agric. Exp. Sta. 8 p).*

HUMBERT, R. P. (1968): The growing of sugarcane. *(2nd Ed. Elsevier, Publ., Co. New York, 280 pp).*

ISSA, A. L. (1979): Studies on sugarcane borers in Egypt. *(Final Report of Proj. No. 480, PG-EG-147: 4-7).*

JENA, B. C.; and N. C. PATNAIK (1996 a): Performance of sugarcane varieties to stalk borer infestation. *(Cooperative sugar, 27(5): 335-339).*

JENA, B. C.; and N. C. PATNAIK (1996 b): Research note on the extant of weight loss in sugarcane varieties due to stalk borer. *(Cooperative Sugar, 27(10): 749-750).*

KIRA, M. T.; and H. F. EL-SHERIF (1973 a): Estimation of losses in cane and sugar yields caused by infestation of *Chilo agamemnon* Bles. *(Bull. Ent. Soc.Egypte, 57: 271-277).*

KIRA, M. T.; and H. F. EL-SHERIF (1973 b): Fluctuation in *Chilo agamemnon* Bles. population and its annual number of generations in sugarcane fields in Egypt. *(Ibid., 57: 211-218).*

KYLE, M. L. (1968): The effect of varietial resistance in sugarcane on biology of *Diatraea saccharalis* (F.). *(Ph.D. Thesis, Louisiana State Univ. Libr. 83pp).*

LIM, G. T.; and Y. S. PAN (1977): A study of ovipositional preference of sugarcane moth borer *Tetramoera schistaceana* Snell. *(Proc. ISSCT, 16: 593-602).*

MAAREG, M. F.; A. M. ABU-DOOH; and A. M. EBIEDA (1993): Varietal resistance to purple – lined borer *Chilo agamemnon* Bles. and relative differential yield loss of certain local sugarcane varieties in Egypt. *Annals of Agric. Sci., Moshtohor, 31(1):* 517-527.

MAHMOUD, H. H. (2000): Ecological and control studies on the lesser sugar-cane borer *Chilo agamemnon* Bles. (Lepidoptera: Pyralidae) in sugar cane fields. *(Unpublished M. Sc. Thesis, Cairo Univ., Egypt, 70 pp).*

MATHES, R. N.; and L. J. CHARPENTIER (1969): Varietal resistance in sugarcane to talk moth borer. *(p. 175-188 in. J.R. Williams; J.R. Metcafe; R.W. Mungemery and R. Mathes, (eds.) Pests of sugarcane (Book). Emsterdam Elsevier Publ. Co. London and New York: 868 pp).*

MENDES, A. C.; P. S. BOTELHO; and N. MACEDO (1980): Correlation between the intensity of infestation and population index of the sugarcane borer, *Diatraea saccharalis* (Fabr.). *(Proc. ISSCT, 17, Bull. 8).*

NEGM, A. A. (1978): Population management of the lepidopterous stalk borer complex indigenous to Egyptian sugarcane agroecosystem. *(A Potential P. L. 480 Res. Proj. Assuit Univ., Plant Protection Dept., 10 p).*

PADMANABHAN, M. D.; J. RAJA; and S. RAJASEKARAN (1990): Evaluation of new early season sugarcane clones for resistance to pests of sugarcane. *(Indian Sug., 40(1): 33-34).*

REAGAN, T. E. and J. L. FLYNN (1985): Insect pest management of sweet sorghum in sugarcane production systems of Louisiana: problems and integration. *(Biomass energy Development, Plenum, New York).*

WAIYAKI, J. H. (1971): The ecology of *Eldana saccharina* Wlk. and associated loss in cane yield at Arusha-Chini, Mahi, Tanzania. *(Proc. ISSCT Fourteenth Cong., New Orleans, Louisiana, 5 pp).*

WILLCOCKS, F. C. (1925): The insects and related pests of Egypt. *(Vol. II. c.f. El- Sherif, 1962).*

WILLIAMS, H. A.; A. G. ALY; A. SABER; and A. G. MORCOS (1979): Screening of the breeding materials for resistance to sugarcane borers. *(Proc. Egypt. Agri. Res. Center Cong.: 59 pp).*