

RICE STEM BORER, *Chilo agamemnon* POPULATION FLUCTUATION AND RICE VARIETAL RESISTANCE

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ABSTRACT

Rice, *Oryza sativa* L. is a vital food crop for more half of the global population. Unfortunately, it is subjected to attacks of several insect pests, from which is the rice stem borer, *Chilo agamemnon* Bles, the key insect pest species in Egypt. Monitoring population fluctuation of the insect during 2013 and 2014 rice seasons revealed the peaks of immature stages, as well as dead heart and white symptoms. In both seasons, the larvae exhibited three peaks of abundance, with high population density during August and September. The same trend, two peaks of abundance, was recorded for dead hearts. High population densities of white heads were detected in August and September with distinct peaks by late August and late September. Evaluation of varietal resistance to the borer revealed that Egyptian Jasmine cultivar was susceptible to *C. agamemnon*, while three cultivars were moderately susceptible; Giza 178, Giza 181 and Giza 182. Both Sakha 101 and Sakha 104 proved to be resistant to the borer throughout the three seasons. Six cultivars exhibited moderate resistance; Giza 177, Giza 179, Sakha 102, Sakha 103, Sakha 105 and Sakha 106.

INTRODUCTION

Rice (*Oryza sativa*, L.) is one of the most important food crops all over the world, providing food for more half of the global population (FAO, 2004). It is a key source of employment and income for rural people who live in developing countries. Rice is grown on over 150 million hectares in more than 110 countries, and occupies one fifth of the world crop land under cereals (Leonard and Rwegasira, 2015).

The rice plants are subjected to attacks of more than 100 insect species, but only twenty of which can cause economic damage. In Egypt, the rice stem borer, *Chilo agamemnon* Bles. is the key insect pest. This insect infests rice stems during vegetative stage resulting in "dead heart" symptom, and resulting in "white head" symptom during reproductive stage. The latter symptom is directly and negatively affect the rice yield, as the plants can compensate for the damage during vegetative stage, but can not during reproductive stage.

From the main components of insect pest management are insect monitoring, and host-plant resistance. Monitoring insect pest population fluctuation is very important for decision makers to apply control measures at proper time (Hugar *et al.*, 2014). Because the excessive applications of insecticides result in many problems in the environment, natural balance and

human-being health, it has been necessary to enhance the role of host plant resistance (Pandy and Choubey, 2012).

The current study was conducted at the experimental farm of Sakha Agricultural Research Station during three successive rice seasons; 2013, 2014 and 2015. Population fluctuations of the rice stem borer, *Chilo agamemnon* Bles were monitored throughout the rice season, and susceptibility of twelve rice cultivars to the borer infestation was evaluated.

MATERIALS AND METHODS

1. Population fluctuation of rice stem borer, *Chilo agamemnon* Bles in rice fields:

The rice cultivar Giza 178 was sown in well-prepared nursery (as recommended) on the fifth of May in 2013 and 2014 seasons. One month after sowing, the rice seedlings were transported to the permanent field, and transplanted as 2-3 seedlings/hill at spacing of 20 x 20 cm between rows and hills as recommended. Normal cultural practices were adopted, but without pesticides. Ten days after transplanting, samples of rice plants were cut at the soil surface, and examined for different stages of the *C. agamemnon*. Weekly samples were taken, as 1000 rice tillers (about 40-50 hills) per sample. The rice plants were dissected and insect immature stages were counted and recorded. In addition, numbers of tillers having dead heart or white head symptoms were counted and percentages of both symptoms were calculated.

2. Varietal resistance to rice stem borer, *Chilo agamemnon* Bles.

Twelve rice cultivars (Table 2), released and cultivated by rice growers, were obtained from seed companies, and sown in the nursery as recommended on the fifth of May in 2013 and 2014 rice seasons. One month after sowing, rice seedlings were transplanted as previously mentioned with studying the population fluctuation. For assessing dead heart, samples (1000 tillers) were taken randomly 30-40 days after rice transplanting (depending on cultivar duration) and plant, having dead heart or white head symptoms were counted. Thus, percentages of both symptoms were calculated according to the scale of RRTC (2012), the rice cultivars were categorized into resistant (0-<3% white heads), moderately resistant (3-<6), moderately susceptible (6-<9), susceptible (9-<12) and highly susceptible (>12% white heads).

RESULTS AND DISCUSSION

1. Population fluctuation of rice stem borer, *Chilo agamemnon* Bles in rice fields:

Data presented in Table (1) show the population fluctuations of larvae and pupae of the rice stem borer, *C. agamemnon* in rice fields of Giza 178. This cultivar was selected for the current study as it was categorized as a susceptible cultivar to the rice stem borer, according to RRTC (2012). In 2013 rice season (Table 1), the larval population density was low during June and gradually increased throughout July, to reach a peak of 13 borer

larvae/1000 rice tillers on the 3rd of August. Another larval peak was detected by late August and early September; 23-25 larvae/1000 tillers. In general, the borer larvae were of high population density during September. However, these larvae are physiologically go into hibernation late in the season (Sherif, 1996).

The pupal population density was mostly low throughout the rice season, with only two small peaks of abundance; the first on 27th of July (7 pupae/1000 tillers), and the second on 7th of September (10 pupae). As for dead hearts, the symptom of damage appearing during the vegetative stage, they were very low during June (0-3 dead hearts/1000 rice tillers), medium during July (6-10 dead hearts), and relatively high during August, which coincides with the maximum tillering stage of Giza 178 rice cultivar (Anonymous 2012). Results revealed the occurrence of two peaks of dead heart; 10 and 23 dead hearts/1000 tillers on 13th of July, and on 17th of August, respectively. The white head appeared by early August with 11 white heads/1000 rice tillers, and progressively increased in density to exhibit a big peak on 31st of August (120 white heads/1000 tillers) and another peak of abundance (100 white heads/100 rice tillers) on 21st of September.

Table (1): Population fluctuation of rice stem borer, *C. agamemnon* infestation in rice fields during 2013 rice season, Sakha Agricultural Research Station, Giza 178 cultivar

Date of examination	Per 1000 rice tillers			
	Larva	Pupa	Dead Heart	White Head
June 15	0	0	0	0
22	1	0	2	0
29	3	1	3	0
July 6	6	5	6	0
13	2	0	10	0
20	9	4	7	0
27	10	7	8	0
August 3	13	3	5	11
10	4	2	5	17
17	7	2	23	28
24	9	3	11	71
31	25	4	9	120
September 7	23	10	0	85
14	18	0	0	89
21	20	0	0	100
Average/1000rice tillers	10.00	2.73	5.93	34.73

In 2014 rice season (Table 2), the larval population density was obviously higher than that of the former season. However, three peaks of larval occurrence were recorded; 17, 35 and 62 larvae/1000 rice tillers on 29th of July, 26th of August and 23rd of September. The pupae appeared in two peaks of occurrence; 7 and 9 pupae/1000 tillers on 22nd of July and on 5th of August. Also, the dead heart symptom exhibited two peaks of occurrence; 12

and 25 individuals/1000 tillers on 15th of July, and on 12th of August. As for the infestation by white heads, the infestation was maximum (135 white heads/1000 rice tillers) on 2nd of September and 96 white heads on 23rd of September. Population fluctuation of different rice stem borer species were monitored by several investigators; e.g. Kabran and Chen (2007) and Sommro *et al.* (2013)

Table (2): Population fluctuation of rice stem borer, *Chilo agamemnon* infestation in rice fields during 2014 rice season, Sakha Agricultural Research Station, Giza 178 cultivar

Date of examination	Per 1000 rice tillers			
	Larva	Pupa	Dead Heart	White Head
June 17	0	0	0	0
24	0	0	5	0
July 1	1	2	3	0
8	8	4	4	0
15	9	6	12	0
22	11	7	7	0
29	17	3	8	0
August 5	11	9	5	0
12	12	6	25	7
19	23	5	20	31
26	358	4	4	40
September 2	22	3	0	135
9	33	0	0	90
16	41	0	0	87
23	62	0	0	96
Average/1000rice tillers	19.00	3.27	6.20	32.40

Comparison between the results of both seasons, it is evident that most of infestation criteria were higher in the second season than in the first one.

2. Varietal resistance to rice stem borer, *C. Agamemnon*:

Based on dead hearts:

Data presented in Table (3) show the susceptibility of 12 rice cultivars to rice stem borer, *C. agamemnon*, expressed as dead hearts for three successive seasons; 2013, 2014 and 2015. The overall average revealed that ten cultivars had low dead heart percentages ranging between 0.17% (Sakha 104) and 2.78% (Giza 181). The two cultivars; Giza 178 and Egyptian Jasmine suffered the highest levels of infestation; 4.23 and 5.55%, respectively. Also, both Giza 178 and Egyptian jasmine proved to be the highest susceptible cultivars through the three years of study; 4.33, 3.19 and 5.16% for the former cultivar and 4.15, 5.13 and 7.18% for the latter one, respectively.

Table (3): Susceptibility of rice cultivars to rice stem borer, *C. agamemnon* infestation, expressed as dead hearts Sakha Agricultural Research Station.

Cultivar	Type	Dead heart %			
		2013	2014	2015	Average
Giza 177	Japonica	1.21 b	1.36 b	2.15 b	1.57
Giza 178	Indica x Japonica	4.33 c	3.19 c	5.16 c	4.23
Giza 179	Indica x Japonica	2.70 bc	3.11 c	1.18 a	2.33
Sakha 101	Japonica	0.99 a	0.15 a	0.18 a	0.44
Sakha 102	Japonica	1.33 b	1.50 b	2.09 b	1.64
Sakha 103	Japonica	1.44 b	2.00 bc	0.96 a	1.47
Sakha 104	Japonica	0.11 a	0.16 a	0.25 a	0.17
Sakha 105	Japonica	1.19 b	1.14 b	0.66 a	1.00
Sakha 106	Japonica	2.05 bc	1.60 b	3.22 bc	2.29
Giza 181	Indica	4.25 c	1.90 bc	2.18 b	2.78
Giza 182	Indica	1.25 b	1.36 b	2.17 b	1.59
Egyptian jasmine	Indica	4.15 c	5.31 c	7.18 c	5.55

Based on white heads:

Data presented in Table (4) show the susceptibility of 12 rice cultivars, expressed as white head during three successive rice seasons. Average of the three years show that the lowest susceptible cultivar was Sakha 101, with only 1.35% while head followed by Sakha 104 with 2.63%. The highly infested cultivars were Giza 178, Giza 181 and Egyptian jasmine with 8.67, 8.70 and 10.73% white head%, respectively. The remaining cultivars exhibited moderate susceptibility to the rice stem borer. From abovementioned data of dead hearts and white heads, it could be reported that rice cultivars expressed their reactions to rice stem borer infestation clearly in the reproductive stage, expressed as white heads. In addition, rice cultivars of japonica type were more resistant or tolerant to the borer infestation than were cultivars of indica type.

Table (4): Susceptibility of rice cultivars to rice stem borer, *C. agamemnon* infestation, expressed as white heads Sakha Agricultural Research Station.

Cultivar	Type	White heads % [^]				Category
		2013	2014	2015	Average	
Giza 177	Japonica	3.25 b	4.29 b	3.28 b	3.61	Moderately resistant
Giza 178	Indica x Japonica	7.01 c	9.30 d	9.70 d	8.67	Moderately susceptible
Giza 179	Indica x Japonica	4.12 b	5.12 c	4.66 b	4.89	Moderately resistant
Sakha 101	Japonica	1.56 a	1.20 a	1.28 a	1.35	Resistant
Sakha 102	Japonica	4.11 b	4.60 b	5.12 bc	4.61	Moderately resistant
Sakha 103	Japonica	4.05 b	5.11 c	6.08 c	5.08	Moderately resistant
Sakha 104	Japonica	3.02 ab	2.80 a	2.07 a	2.63	Resistant
Sakha 105	Japonica	3.50 b	3.77 b	5.12 bc	4.13	Moderately resistant
Sakha 106	Japonica	3.60 b	4.89 bc	5.16 bc	4.55	Moderately resistant
Giza 181	Indica	6.91 c	9.11 d	10.07 de	8.70	Moderately susceptible
Giza 182	Indica	6.90 c	8.12 d	7.05 c	7.36	Moderately susceptible
Egyptian jasmine	Indica	7.20 c	12.60 e	12.39 de	10.73	Susceptible

These results are in agreement with those of El-Habashy *et al.* (2015) who reported that Sakha 101 was the least infested cultivar, while Egyptian jasmine was the highest infested cultivar. According to RRTC report (2012), rice genotypes with white heads less than 7% are considered tolerant to the rice stem borer infestation.

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تقلبات تعداد ثاقبة ساق الأرز *Chilo agamemnon* Bles والمقاومة الصنفية للحشرة

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الأرز محصول غذائي حيوى لحوالى نصف سكان الكرة الأرضية. يهاجم المحصول بالعديد من الآفات الحشرية ، والتي من أهمها ثاقبة ساق الأرز *Chilo agamemnon* Bles. تمت مراقبة تقلبات تعداد الحشرة خلال موسمي ٢٠١٣ ، ٢٠١٤ لتسجيل أعداد الأطوار غير الكاملة ، ومظهر القلب الميت والسنابل البيضاء. ظهرت ثلاث ذروات لليرقات خلال كل موسم ، وكانت الأعداد أكثر كثافة خلال أغسطس وسبتمبر. وتم تسجيل نفس العدد من الذروات لمظهر القلب الميت. كانت كثافة الإصابة بالسنابل البيضاء عالية مع نهاية شهرى أغسطس وسبتمبر. تم اختبار حساسية إثني عشر صنفا للإصابة بالثاقبة ، وكان الصنفان سخا ١٠١ ، وسخا ١٠٤ أعلى الأصناف مقاومة للحشرة ، بينما كان الصنفان جيزة ١٧٨ ، وباسمين مصرى أكثر الأصناف إصابة بالثاقبة.