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EFFECT OF RICE LEAFMINER INFESTATION ON RICE YIELD, AND CORRELATION BETWEEN LEAF PLANT CHEMICAL COMPONENTS AND INSECT SEVERITY

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ABSTRACT

Rice leafminer, *Hydrellia prosternalis* Deem. is one of important rice insects, as it causes economic yield losses, particularly in late-sown rice plantations. The current study was undertaken in 2010 rice season to monitor the population fluctuations of this insect pest. The losses resulting from the pest, in different rice plantations, were evaluated. Also, the correlations among some chemical components of rice plants and severity of the insect infestation were computed. The insect adult activity, monitored by water aluminum pan traps, exhibited five peaks from May up to September. The highest two peaks were detected during the second half of July. Yield losses due to this insect pest were negligible in rice plantations sown during the recommended duration; the first half of May. High yield losses were evaluated in rice plantations sown by late May or early June; with values of losses ranging between 21.99 and 25.24 %. Chemical analysis of rice leaves revealed a negative correlation between rice infestation by *H. prosternalis* and each of silica (r = - 0.605**), nitrogen (r = - 0.340) and potassium (- 0.198). However, the correlation between insect infestation and phosphorus content in rice leaves was insignificantly positive. This study show the importance of avoidance of sowing rice late in the season, otherwise chemical insecticides may be required to control the insect. The collaboration between rice breeders and entomologists is required to develop rice varieties with high silica content to reduce the infestation by *H. prosternalis* in rice plants.

INTRODUCTION

Rice leafminers, *Hydrellia* spp. are important insect pests in rice cultivations in different countries. In Egypt, *H. prosternalis* has become an important insect pest, particularly in late sown rice (El-Habashy 2003).

This insect pest lays single eggs, hatch to larvae that bore in the leaves feeding on mesophyl layer, accordingly, white longitudinal lines appear as the main symptom of the insect infestation. El-Habashy (2003) estimated the losses in rice yield due to this insect as 14.15 and 18.22 % in rice sown by late May or early June. In contrast, Viajante and Heinrichs (1985) recorded 82 % damaged leaves due to *H. philippina*, but they clarified that the grain yields of tested cultivars have not been reduced. Pantoja *et al* (1993) reached the same conclusion concerning *H. wirthi.* Granger (1992) demonstrated that rice plants can tolerate and compensate for *Hydrellia* sp damage at levels of leaf clipping at 0, 25, 75 and 100 % when clipping occurs between 21 and 63 days after sowing, and he indicated the insect does not normally infest rice at later stages. Zhengxiang and Hua (1996) estimated the economic threshold level of *H. sasakii* as 4.6 eggs or 3.74 damaged plants per hill. In contrast, Castro *et al* (2007) estimated high damage in rice plantations due to *H. wirthi*, and consequently, considerable yield losses occurred.

To manage insects, monitoring the population fluctuations has become an integral part to use integrated insect management system. Aluminum water floating traps have been used to monitor the insect adults (El-Habashy, 1997). Bharathi *et al* (2002) improved the capability of floating traps in attractiveness of *H. philippina* adults using traps baited with banana, vinegar, soybean hydrolysate, and palm oil. These baited traps were found to be a good index of the insect pest fluctuations.

Despite several control methods (including cultural practices) have been adopted against this rice leafminer, Karthikeyan and Jacob (2010) used the bacteria, *Pseudomonas flourescens* and the nematode, *Heterohabditis indica* to control *Hydrellia philippina.*

The current investigation was conducted to monitor the population fluctuations of *Hydrellia prosternalis* in rice fields. Levels of insect infestation, and resulting yield losses in early and late rice plantations were evaluated. The levels of infestation as influenced by some chemical components of rice leaves were studied.

MATERIALS AND METHODS

Monitoring population fluctuations of *Hydrellia prosternalis*:

Aluminum water pan traps were used to monitor the population fluctuations of the rice leafminer, *H. prosternalis* in rice plots by late May up to early September, 2010. The pan (20 cm diameter, with an edge of 3 cm height) contained water to about 2.5 cm height, and the water was provided with 5 ml of Tween 80 as a detergent to remove water surface tension, and deprive the insect adults from walking on water, and thus the insect sink in the trap, instead of escape. The trap was also provided with few drops of formalin to avoid the decay of tissues of trapped insects. Three experimental plots (100 m^2 each) were assigned for insect monitoring, and one trap was fixed in the center of each plot. Every 3-4 days, the catch of the trap was obtained by screening the contents of the trap through a fine wire screen to exclude the captured insects. The obtained insects were transferred to the laboratory, and examined using a binocular microscope to exclude the adults of *H. prosternalis*. The adults were counted, and the figure of population fluctuations was drawn.

Effect of date of rice sowing and chemical control on rice yield:

In 2010 and 2011 rice seasons, plots were sown on four successive dates; May 1st, May 10th and May 20th and June 1st. Transplanting was conducted one month after sowing. Sakha 101 rice cultivar was sown in both seasons, while sakha 105 was sown in 2011 rice season only. Each plot measured 200 m^2, that was divided into two equal parts. In each cultivation, one part was sprayed with fenitrothion (Sumithion 50 EC) at a rate of 250 ml / fed, to control rice leafminer, one week after transplanting, while the second part was left untreated. Twenty days after transplanting, all rice plots were examined to count number of infested leaves and number of insect mines per

100 rice leaves. At harvest, rice yield of 4 m^2 / plot was weighed, and adjusted as yield per feddan. Reductions in insect damage parameters, and rice yield were computed by comparing data collected from treated and untreated plots.

Rice infestation by *Hydrellia prosternalis* as influenced by chemical components of rice leaves:

Some chemical components of rice cultivars; Giza 177, Giza 178, Sakha 101, Sakha 102, Sakha 103, Egyptian Yasmin and the rice line GZ 5121-5-2-1 were assessed in the leaves. The considered elements were silica, nitrogen, potassium and phosphorus. About 100 leaves of each entry were oven dried at 70 ^{O}C for 48 hours, and finely crushed. According to Van der Vorm (1987), silica percentages were assessed. Total nitrogen was determined in a sample of finely crushed leaves by micro Kjeldahl method (Jackson 1967). From each entry, phosphorus percentage in a sample of 2 g of crushed leaves was taken to be determined colourimetrically by ascorbic acid, according to Olsen and Dean (1965). In another sample of finely crushed leaves, potassium percentage was assessed by flame photometer as described by Jackson (1967). Coefficient correlation values among insect infestation parameters and percentage of each element were computed.

RESULTS AND DISCUSSION

Monitoring population fluctuations of *Hydrellia prosternalis*:

Data illustrated in Fig. (1) show the population fluctuations of the rice leafminer, *H. prosternalis* adults in rice field, throughout the period from late May up to early October, 2010. Adults of rice leafminer were not obtained in the aluminum water pan traps up to 14 May. Very few adults were trapped on 17 May, and the numbers increased gradually to exhibit an obvious peak of 1750 adults / 4 traps on 3 July. The numbers decreased gradually till 14 July (750 adults), but the second peak (2120 adults / 4 traps) was attained on 17 July. However, the highest peak (2200 adults / 4 traps) was detected on 31 July. In general, the insect population tended to decline towards the end of season, but two small peaks could be observed; one on 24 August (250 adults), and another one on 14 September (133 adults). Thus, five peaks of rice leafminer adult activity were detected, with the highest ones by the second half of July. Clearly, the numbers of the insect adults were few in June and in the second half of September. These results are almost agree with the findings of Sherif and Bastawisi (1997) who defined the peaks of this insect on first of July, third-fourth week of July, and third week of September. Several authors, in different locations, have monitored the population fluctuations of *Hydrellia* spp in rice fields. Bharathi *et al* (2002) concluded that the water floating traps baited with banana pulps, vinegar and palm oil were efficient in attracting *H. philippina* adults.

Figure (1): Population fluctuations of rice leafminer, *Hydrellia. Prosternalis* during 2010 season at Kafr El-Sheikh region

Effect of date of rice sowing and chemical control on rice yield:

Data presented in Table (1) show that infested leaves of Sakha 101 cultivar in 2010 season were reduced by 71.77, 16.01, 11.32 and 17.45 % due to use insecticides to protect the plants against the insect infestation in plantations of May 1, 10, 20 and June 1, respectively. The corresponding values of number of mines per 100 leaves were 72.07, 36.95, 48.37 and 30.80 %. However, the losses in yield due to this insect were 7.43, 6.94, 15.58 and 24.17 % for the first, seconed, third and fourth plantation, respectively. In 2011 season, the same cultivar gave results of the same trend. The losses in Sakha 105 cultivar, due to *H. prosternalis* infestation were lowest (3.89 %) in the first plantation, but highest (27.05) in the third plantation. From the results of both cultivars in both seasons, it could be concluded that sowing rice early; up to 10 May can produce well-grown plants, and gives the plants a chance to escape the leafminer infestation, otherwise insecticides should be applied.

Granger (1992) reported that the rice plants can compensate for high levels of clipping if the simulated infestation occurred up to 63 days after sowing. The results of the current study are in agreement with those of Castro *et al* (2007) who estimated high damage in rice plantations due to *H. wirthi*, and assured that considerable yield losses occur.

1

Rice infestation by *Hydrellia prosternalis* as influenced by chemical components of rice leaves

Data presented in Table (2) show that the higher damaged entries were Giza 178, Sakha 103 and GZ 5121-5-2-1. These entries had 336, 334 and 344 mines / 100 rice leaves, and 78, 80 and 82 % infested leaves, respectively. By contrast, the lower damaged entries were Giza 177, Sakha 101, Sakha 102 and Egyptian Yasmine. They only suffered 141, 172, 126 and 123 mines/100 leaves, and 54, 50, 57 and 64 % infested leaves, respectively.

Table (2): Relationship between chemical components of rice leaves and damage caused by *Hydrellia prosternalis* on 7 entries during 2011 season at Kafr El-Sheikh region

No.	Entry	Mines / 100 leaves	Infested leaves %	%			
				Silica	Nitrogen	Potassium	Phosphorus
1	Giza 177	141	54	4.48	2.51	3.78	0.077
2	Giza 178	336	78	3.44	1.89	4.27	0.068
3	Sakha 101	172	60	3.60	2.15	4.01	0.068
4	Sakha 102	126	57	4.46	1.98	3.08	0.066
5	Sakha 103	334	80	3.45	1.94	3.24	0.070
6	Egyptian Yasmin	123	64	3.22	1.92	3.56	0.009
7	GZ 5121-5-2-1	344	82	3.04	1.80	2.59	0.082

Statistical analysis (Table 3) revealed highly significant negative correlations between silica percentages of rice leaves and each of mines /100 leaves (r = 0.605 **) and infested leaf percentage (r = 0.578 **). Mishra and Mishra (1992) reported negative correlation between silica content in rice plants and leafhopper, *Sogatella furcifera* infestation. Salem and Saxena (1992) indicated into adverse effect of silica on *S. furcifera* biology, as the food intake and its assimilation, insect growth, adult longevity, female fecundity and insect population size were reduced when the leafhopper was fed on rice entries having high silica contents. Soliman *et al* (1997) proved that feeding of *Hydrellia prosternalis* upon rice entries of low silica content resulted in higher damage to rice leaves as compared with feeding upon rice entries with high silica content.

Nitrogen contents of rice leaves (Table 3) had also negative correlations with mines/100 leaves (r = -0.340) and with infested leaves (r = -0.491*). This is not in agreement with the result of Mehta and Sharma (1997) who observed that pea genotypes having high contents of total free amino acids were more susceptible to the agromyzid leafminer, *Chromatomyia horticola* than genotypes having low amino acid contents. Potassium percentages negatively, but insignificant, correlated with both parameters of rice leafminer infestation. However, phosphorus correlated positively, but also insignificant, with rice leafminer infestation.

Table (3): Correlation coefficient values between damaged rice leaves by *Hydrellia prosternalis* and some chemical components of rice leaves during 2011 season at Kafr El-Sheikh region

Parameter	"r value"
Mines / 100 rice leaves x silica %	-0.605**
Infested leaves / 100 rice leaves x silica %	-0.578**
Mines / 100 rice leaves x nitrogen %	-0.340
Infested leaves / 100 rice leaves x nitrogen %	-0.491*
Mines / 100 rice leaves x potassium %	-0.198
Infested leaves / 100 rice leaves x potassium %	-0.214
Mines / 100 rice leaves x phosphorus %	0.254
Infested leaves / 100 rice leaves x phosphorus %	0.221

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تأثير الإصابة بصانعة أنفاق أوراق الأرز على المحصول والعلاقة بين المحتوى الكيميائى لأوراق النبات وشدة الإصابة بالحشرة

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تعتبر صانعة أنفاق أوراق الأرز *Hydrellia prosternalis* Deeming أحد أهم آفات الأرز الحشرية التى تسبب خسائر اقتصادية للمحصول خصوصا فى الزراعات المتأخرة. أجريت الدراسة الحالية خلال موسمى 2010 ، 2011 لدراسة التذبذبات الموسمية لهذه الحشرة خلال موسم زراعة الأرز ابتداءا من آخر مايو وحتى الأسبوع الأول من أكتوبر ، وكذلك لتقدير الخسائر الناتجة عنها تحت ظروف مواعيد زراعة مختلفة بالإضافة إلى دراسة العلاقة بين بعض العناصر الكيماوية المتواجدة بنبات الأرز وشدة الإصابة بهذه الحشرة. تمت دراسة نشاط الحشرة لمتابعة تقلبات تعدادها عن طريق استخدام المصائد المائية الطافية وتم تسجيل خمس ذروات لهذه الحشرة ، أعلاها ذروتان خلال النصف الثانى من شهر يوليو. لوحظ أن الخسائر فى محصول الأرز والناتجة عن هذه الحشرة كانت بسيطة فى الزراعات المبكرة فى المواعيد الموصى بها خلال

النصف الأول من شهر مايو بينما سجلت خسائر اقتصادية عالية فى الزراعات المتأخرة فى آخر مايو وأول يونيو بمتوسط من 21.99 إلى 25.24 %. أوضحت التحاليل الكيماوية لأوراق الأرز أن هناك علاقة سالبة بين كل من نسبة السيليكا (r = - 0.605**) والنتروجين(r = - 0.340) والبوتاسيوم (r = – 0.198) وعدد الأنفاق الناتجة عن الإصابة بهذه الحشرة، بينما كانت العلاقة بين نسبة الفوسفور وعدد الأنفاق موجبة ولكنها غير معنوية. وتوضح هذه الدراسة أهمية تجنب زراعة الأرز فى مواعيد متأخرة عن المواعيد الموصى بها وإلا سيضطر المزارعون لاستخدام المبيدات الحشرية لمكافحة هذه الحشرة كما يمكن التوصية بالتعاون بين مربى النبات والمشتغلين بمكافحة الحشرات لإنتاج أصناف أرز تزداد بها نسبة السيليكا، نظرا لما لها من دور فعال فى خفض نسبة الإصابة بهذه الحشرة.

قام بتحكيم البحث

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Table (1): Rice yield as affected by date of sowing and chemical control against *Hydrellia prosternalis* during seasons 2010 and 2011 at Kafr El-Sheikh region

Date of Sowing	Infested leaves / 100 leaves			No. mines / 100 leaves			Yield (t/fed)		
	Protected	Unprotected	Reduction %	Protected	Unprotected	Reduction %	Protected	Unprotected	Reduction %
Sakha 101 / 2010 season									
May 1	3.50	28.62	71.17	3.33	27.33	72.07	4.98	4.61	7.43
10	10.33	26.87	16.01	7.22	33.90	36.95	4.32	4.02	6.94
20	25.89	55.20	11.32	27.18	158.66	48.37	3.98	3.36	15.58
June 1	26.70	73.28	17.45	48.70	198.70	30.80	3.93	2.98	24.17
(I) Sakha 101 / 2011 season									
May 1	1.99	22.82	10.47	6.22	22.63	26.38	4.22	3.98	5.69
10	8.43	33.93	30.25	10.15	47.60	36.90	4.06	3.87	4.68
20	26.55	69.40	16.14	49.95	185.50	27.14	3.90	2.99	23.33
June 1	29.45	73.68	15.02	55.90	215.67	28.58	3.67	2.51	31.61
(II) Sakha 105 / 2011 season									
May 1	1.75	17.77	91.54	5.41	18.33	23.88	5.40	5.19	3.89
10	15.36	46.60	20.34	39.70	143.82	26.23	3.84	3.35	12.76
20	28.73	77.82	17.09	61.70	206.84	23.52	3.66	2.67	27.05
June 1	27.50	62.75	12.82	58.66	190.20	22.42	3.31	2.65	19.94