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ECOLOGY AND BIOCONTROL STUDY ON THE WHITE GRUBS, PENTODON BISPINOSUS INFESTING STRAWBERRY ROOTS

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ABSTRACT: An ecological study was conducted to elucidate the peaks of the white grubs' larvae infesting strawberry roots along one year from May 2020 to April 2021. Furthermore, feeding and control study was applied under laboratory conditions. Results revealed that May and September months recorded 20 larvae per root of strawberry plant as the highest numbers of larvae under 17-38°C and 32-61 RH%. The larvae of the Pentodon bispinosus were reared on three vegetable roots; however, the grubs have a wide range of host families. The larvae of the P. bispinosus prefer the roots of the Strawberry plants recording the highest weights as 7 ± 0.6 g roots/day. Bio-insecticides were tested to determine the most effective agents against white grubs, from the results, the third stage of grubs have resistance against Abamectin 3.6 % and Chitosan. Abamectin 3.6% EC recorded 30% reduction in larvae population after 3 days of treatment decreased to 10% after 30 days, on contrary, Chitosan recorded zero reduction.

Key words: White grubs, Biocontrol, rearing diet, Scarabaeidae, hard black beetle

INTRODUCTION

Strawberry (Fragaria ananassa) is an economic crop in Egypt, and greatly increased over the last ten years, due to longer growing seasons, readily available labor and relatively low cost and vicinity to large national or export markets. The production of strawberry rises from 70,000 million ton in 2000 to 464,000 million ton in 2019, with an increase of fresh export from 338 ton in 2000 to 36,000 million ton in 2019, and from 15,000 million ton in 2009 to 140,000 million ton as individually quick frozen (UNITC, 2019) (GOEIC, 2020). The Ministry of Agriculture and Land Reclamation in Egypt reported that Egypt ranked first in exporting frozen strawberries all over the world from 2019 till now, the exports of strawberry ranked the eighth between the most important crops to export the governorates of Qaliobia, Beheira, Ismailia, and Sharkia are the most interested in cultivating strawberries.

The white grub, Pentodon bispinosus Kuster, 1852 (Coleoptera: Scarabaeidae) become one of the major pests that reduces the crop of strawberry production. White grub larvae are polyphagous (Abd-Rabou and Saadia, 2006). The larvae of hard back beetle feed on the organic manure wastes in the soil especially sand soil near the surface and under the vegetable roots and its feeding causes fast dry to the plant causing great losses. White grubs are difficult to control duo to its habits of living and the hardness of its body (Devi, 2019). Polyethylene mulched growing system displayed the plants to the root feeding weevils (Cross et al., 2001).

Systemic pesticides used against white grubs have direct and indirect objectionable effects on other organisms

in the ecosystem (Choudhury et al., 2020) against the beneficial predators as coccinellid beetles, predatory mites, and hymenopteran parasitoids, in addition to the increase of the environmental pollution (Abd El-Salam et al., 2013; Parra, 2014; Lee et al., 2017; Tappert et al., 2017; Skouras et al., 2019).

The application of insecticides against white grubs has two strategies (preventative and curative). The first strategy requires insecticides with late residual activity in the soil before a potential problem (2-3 months before hatching), and these insecticides should not be harmful to any ecosystem organisms or the environment. The curative process starts after egg hatching, and the larvae have made a little damage in mid-August. The preventative strategy is more effective than the curative (Potter and Potter, 1999).

Rani et al., 2021 reared grubs to study the biology of white grubs, the neonates (at the first day of hatching) moved individually on live roots of (7-10 days maize in sandy soil in pots) moisture adequate weekly to avoid food, environmental stress, and cannibalism, The newly hatched grubs feed on decaying organic matter and then on the host plant roots.

Recently, Abd El-Salam, 2019 showed that Imidacloprid had the highest lethal impact against white grubs followed by Bio-catch, while Nimbecidine showed the lowest impact after twice applications.

From the previous review, this study was conducted to study the ecology of Pentodon bispinosus under field conditions, as well as to study the food preference of the beetle under laboratory conditions, and to evaluate the efficacy of some bio insecticides against the white grub, Pentodon bispinosus,

MATERIALS AND METHODS

Tested insect:

The larvae of the white grub, Pentodon bispinosus (Fig. 1) were collected from different farms located in Badr center, El Beheira Governorate, Egypt, and reared under laboratory conditions which served as a source to conduct feeding and toxicological studies. Collected larvae were reared in glass boxes 30x 30x25 cm filled with sand and support with food and water as needed.

(a) **(b)**

Fig. (1): (a) the adult (b) larva of the hard back beetle, Pentodon bispinosus

Field experiment:

An ecological study was conducted during the 2020/2021 months to determine the peaks of the population of the white grubs on strawberry. Samples were weekly collected along the period from May 2020 to April 2021 by digging under the strawberry plants and the percentage of the infested plants and the numbers of larvae under every root plant were recorded as numbers per root.

Laboratory experiments:

Food ability experiment:

The 3rd instar larvae of the white grub, P. bispinosus were reared, during March month to study the food preference of arugula, carrot, strawberry, where one larva was provided with food , replicated three times for each kind of food , observed till pupal stage. Food and water was added as needed and the weight of each was determined.

The grubs were observed by digging in the sand, collected, and identified in the laboratory by the identification key of Scarabaeidae larvae (López-García, 2015). Larvae were separated each one put in a 250 ml glass jar filled with sandy soil. Larvae were provided daily with tested plant roots till the larvae reach the pupal stage. The consumed root weight was calculated by subtracts the weight after feeding from the pre-weighted plant roots.

Control study:

To study the effect of Chitosan and Abamectin against 3rd instar larvae of the white grub, *Pentodon bispinosus*, five larvae were potted in 250 ml glass jar filled with sand soil treated with the recommended dose of each material. Treatments were replicated five times, and the jars were examined daily to determine the reduction percentage of each treatment.

Tested insecticides:

Chitosan:

Chitosan is a versatile biopolymer that Is Nontoxic, is a sugar obtained from the hard outer skeleton of shellfish, including crab, lobster, and shrimp, and was applied at the rate of 3 liter/ feddan.

Abamectin:

Abamectin (3.6% EC) is an insecticide used widely, is one from the family of Avermectin and is one of the avermitilis family (natural product of soil dwelling (actinomycete Streptomyces), was applied at the rate of 3 liter/ feddan.

Temperature and relative humidity:

Temperature and relative humidity were noted daily during the study and weekly averages were calculated (Table 1).

Statistical analysis:

Data were subjected to the analysis of variance test (ANOVA) as randomized complete blocks design. The least significant differences (LSD) at the 5% level were determined using a computer program (CoStat, 2008) and Duncan's Multiple Range testes and LSD 5% values were used to compare the average mean numbers. Reduction percentages were counted according to Abbott's formula.

Increase or decrease % =

Control – treatment / Control x 1009

Table (1): Average numbers of air temperature and the relative humidity along year months

Month	C°	C°	RH%	Month	C°	C°	RH%
May 2020	36	17	46	Nov. 2020	26	17	58
	37	17	44		26	16	59
	43	20	32		24	13	63
	31	17	48		24	14	69
Jun. 2020	37	17	45	Dec. 2020	23	13	49
	39	20	37		27	11	44
	42	21	45		27	12	58
	40	22	48		22	10	75
Jul. 2020	36	22	51		22	10	78
	37	24	51	Jan. 2021	19	08	52
	36	23	57		18	08	59
	36	23	60		21	10	63
	37	23	58		17	06	56
Aug. 2020	38	24	52		19	06	57
	36	19	57	Feb. 2021	22	09	54
	37	24	58		24	09	60
	36	24	56		20	10	66
Sept. 2020	38	25	61		26	09	51
	37	25	61	Mar. 2021	26	11	50
	37	23	60		30	12	72
	35	23	58		26	10	59
	38	22	55		28	10	48
Oct. 2020	37	21	60	Apr. 2021	34	13	35
	32	19	58		31	14	53
	33	20	61		28	14	55
	29	20	64		34	15	48
					32	16	46

RESULTS AND DISCUSSION

1-Seasonal fluctuations of the white grub of *P. bispinosus* infesting strawberry roots along 2020- 2021 months at El Beheira Governorate:

The obtained results in Table (2) indicated that the larvae prefer the mild climate (17-38°C and 32-61 RH%) where the larvae has the most dispertion in May and September followed by April and October.

2-Rearing white grubs, Pentodon bispinosus:

The obtained results in Table (3) showed that the grubs have a wide range of host families (Brassicaceae, Apiaceae, and Rosaceae) as it successfully reared on arugula, carrot, and strawberry, respectively, but it greatly prefers the roots of the strawberry plants among the tested plants.

3-The effect of Chitosan and Abamectin against white grubs, P. bispinosus:

The data of Table (4) showed that the third stage of the larvae of white grubs, Pentodon bispinosus have resistance against Chitosan and Abamectin 3.6% EC with the recommended dose, although the Abamectin recorded 30% reduction in the population of the pest but this is not enough to reduce the damage happened.

Table (2): Average numbers of the white grub, Pentodon bispinosus larvae /strawberry plant along year months

month	2020								2021			
	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
	average numbers of larvae /10 plant root											
Rep. 1	20	10	5	6	20	15	10	2	0	0	3	15
Rep. 2	18	10	4	5	17	12	12	2	0	0	3	17
Rep. 3	22	10	6	4	23	18	8	2	0	0	3	13
Mean	20a	10c	5 d	5 d	20a	15b	10c	2 ef	0 f	0 f	3 de	15b
LSD5%	2.75											

mean values followed by the same letter(s) are not significantly different by (P=0.05) according to Duncan's multiple range test.

Table (3): The ability of Pentodon bispinosus to eat

Plant roots	grams/ day / larva
Arugula, *Eruca sativa*	2 ± 0.13
Carrot, *Daucus carota*	5 ± 0.32
Strawberry, *Fragaria x ananassa*	7 ± 0.60

Table (4): Reduction % of the white grub, Pentodon bispinosus

Days after application	Reduction %		
	Chitosan	Abamectin3.6% EC	Control
1 day	0	0	0
3 days	0	30	0
7 days	0	0	0
10 days	0	0	0
20 days	0	0	0
30 days	0	10	0
Total	0	40	0

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دراسة ايكولوجية ومكافحة حيوية على يرقات الجعل ذو الظهر الجامد التى تصيب جذور الفراولة

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أجريت دراسة بيئية على حشرة الجعل ذو الظهر الجامد لتحديد أوقات نشاط الحشرة خلال العام وخاصة خلال موسم الفراولة وأوضحت النتائج أن أعلى تعداد تم تسجيله للحشرة كان في شهري مايو وسبتمبر حيث تم تسجيل 20 يرقة / 10 جذور نباتات تلاهما أبريل وأكتوبر وسجلا 15 يرقة/ 10 جذور من نباتات الفراولة.

تم عمل تجربة معملية لقياس فاعلية مبيدي الشيتوزان والأبامكتين بتركيز 3 لتر للفدان مستخدمة لمكافحة يرقات الجعل ذو االظهر الجامد وأظهرت النتائج مقاومة العمر اليرقي الرابع للمبيدين حيث لم يسجل الشيتوزان أي معدلات موت طوال فترة التجربة ، وسجل الأبامكتين نسبة موت بلغت 30٪ بعد ثلاثة أيام من المعاملة وسجل 10٪ بعد شهر من المعاملة بإجمالي 40٪ .

كذلك أجريت دراسة على قابلية اليرقات للتغذية على بعض جذور نباتات العائلة الصليبية والعائلة الخيمية والعائلة الوردية وهى جذور نبات الجرجير والجزر والفراولة على التوالى ، حيث فضلت اليرقات جذور الفراولة عن كلاً من جذور الجزر وجذور الجرير وكان معدل استهلاك اليرقات من جذور الفراولة هو الأعلى تليه جذور الجزر ثم جذور الجرجير.

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