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Efficacy of Some Insecticides against White Grub, *Pentodon algerinum* on Sugar Beet

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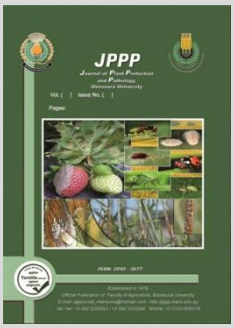

ABSTRACT

Two field investigations were conducted at the Ten Thousand Region, Behaira governorate, Egypt in 2022/23 and 2023/24 seasons to assess the impact of some insecticides against the white grub larvae on sugar beet plants as well as to estimate both yield and quality components. The experimental design was a randomized complete block design (RCBD) with three replicates and nine treatments including four organophosphate insecticides (Meritan® 10% GR, Mocap® 10% GR, Extra cap® 10% GR and Nema gold® 10% GR), two carbamate insecticides (Viva® 24% SL and Mesurol® 2% RB), entomopathogenic fungi (Care protector® 2% WP) and Egyperl as a carrier material, in addition to the untreated control. Results showed that Meritan® 10% GR achieved the highest reduction percentage of white grub larvae/ 10 plants during both seasons and equaled with Nema gold® 10% GR, Mocap® 10% GR and Extra cap® 10 % GR, followed by Viva® 24% SL without significant differences. On the other hand, Mesurol® 2% RB and Care protector® 2% WP produced the least reduction percentages followed by Egyperl, and untreated control treatment came in the final rank. The treatments, Meritan®10% GR, Mocap® 10% GR, and Extra cap® 10% GR demonstrated the best results regarding both yield and quality characteristics, while the lowest results were associated with Egyperl and Viva® 24% SL, which were less effective compared to the untreated control group.

Keywords: *Beta vulgaris*, White grub, *Pentodon bispinosus*, Entomopathogenic fungi and Pesticides.

INTRODUCTION

White grub, *Pentodon algerinum* (Fuessly) (Coleoptera: Scarabaeidae) is a destructive soil pest that feeds on plant roots at the early stages directly after germination and can cause economic damage (Chandel *et al.*, 2021). For the first time, the occurrence of white grub infestation was reported in Egypt on sugarcane (Abd-Rabou and Abd-El-Samea, 2006). White grub species has an annual life cycle with adults emerging in summer to lay eggs in the soil among the roots of the host plants (Potter, 1998). The grubs feed on plant roots and on the organic manure wastes in the soil especially sandy soil near the surface and under the vegetable roots and its feeding causes fast dry to the plant causing great losses, while the adult beetle can feed on plant tissues/foliage as well as cause defoliation of plants (Katumanyane *et al.*, 2023). White grub feeding activity not only affect yield but also cause secondary microbial infections through the damaged plant cuticle (Smith *et al.*, 1995 and Miller *et al.*, 1999). According to Abd-Rabou and Abd-El-Samea (2006), the white grub is considered a major pest due to the drastic effects of this pest species.

The control process of white grub larvae is so complicated due to many reasons such as their habits of living in the soil, the hardness of its body and it considered polyphagous insect (Abd-Rabou and Abd-El-Samea, 2006 and Devi, 2019). Chemical control of white grubs is commonly perceived as fast and effective; however, research suggests that biological control agents, such as entomopathogenic fungi, can be equally or even more effective in managing white grub infestations in crops like sugarcane (Visalakshi *et al.*, 2023 and Riazuddin and Singh, 2024). Application of chemical insecticides has been the main method of defense against damage by white grubs. Insecticides are usually applied by late July or August after oviposition ends and the bulk of the population is in the first or early second instar stage. This is preferred before damage becomes apparent. The efficacy of most insecticides declines when larvae reach the third instar (Grewal *et al.*, 2004). *Beauveria bassiana* and *Metarhizium anisopliae* have great importance in the management of white grubs. Manisegaran *et al.* (2011) reported that *Metarhizium anisopliae* recorded 92% mortality in grubs resulting in higher cane yield. Perlite is a highly absorbent amorphous volcanic alumina-silicate rock material (Teas *et al.*, 2001 and Maxim *et al.*, 2014) that is commonly used as a soil additive to conserve water, reducing irrigation requirements in some cases (Al-Shammari *et al.*, 2018), and has been linked to improved plant growth (Alinia *et al.*, 2009).

The present study aimed to investigate the effect of some insecticides as well as entomopathogensa gainst white grub larvae on sugar beet plants, as well as to estimate the yield and quality components.

MATERIALS AND METHODS

1. Experimental design

Two field investigations were conducted at the Ten Thousand Region, Behaira governorate, Egypt (30°47´40´´N latitude and 30°4´58´´E longitude) during 2022/23 and 2023/24 seasons to assess the impact of some insecticides against the white grub larvae on sugar beet

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plants. The experiment comprised 27 plots (7 m × 12.5 m each), each plot consisted of 10 rows, 12.5 m long and 50 cm width, and the experimental design was a randomized complete block design (RCBD) with three replicates. Sugar beet seeds (Hussam cv.) were planted in the experimental plots by hand planter on the 20th and 22nd of October in the first and second seasons, respectively.

Tested insecticides

Nine treatments; including four organophosphates (Meritan® 10% GR, Mocap® 10% GR, Extra cap® 10% GR and Nema gold® 10% GR), two carbamates (Viva® 24% SL and Mesurol® 2% RB), entomopathogenic fungi (Care protector® 2% WP) and agricultural perlite as a carrier material (Egyperl), in addition to the untreated control as indicated in Table 1. The insecticides (Viva® 24% SL and Care protector® 2% WP) were mixed with the carrier (Egyperl), while the other treatments were mixed with a suitable amount of sand and incorporated among the sugar beet rows before irrigation.

Table 1. Insecticides evaluated against white grub, *Pentodon algerinum*.

Chemical group	Active ingredient	Trade name	Application dose/feddan	Company
Organophosphate	Ethoprophos	Meritan® 10% GR	8 kg	Imported by AGROCHEM
		Mocap® 10% GR	8 kg	Produced by Amvac Chemical Corporatio and imported by MayTrade
		Extra cap® 10% GR	8 kg	Produced by Zibo Zhoucun Suifeng Pesticide & Chemical Limited Corporatio and imported by Agres company for import, export and agricultural services.
		Nema gold® 10% GR	8 kg	Produced by Jiangsu Fengshan Group Co., Ltd and imported by Elezz Group For Import Export & Trading Agencies
Carbamate	Oxamyl	Viva® 24% SL	2.5 l	Produced by United kingdom and imported by Abu Ghanima Group
	Methiocarb	Mesurol® 2% RB	4 kg	Produced by Bayer and imported by Cairo Chemical Company
Entomopathogenic fungi	*Beauveria bassiana* + *Metarhizium anisopliae*	Care protector® 2% WP	1.5 Kg	Produced by Jafgreen Company, Germany and imported by Pharmaceutica for Chemicals and Pharmaceuticals Company
Agricultural perlite	-	Egyperl	10 kg	Produced and imported by the Egyptian Co. for Manufacturing Perlite

GR= Granules, SL= Soluble concentrate, RB= Baits (ready for use), and WP = Wettable Powder

3. Sampling technique

To count the white grub larvae per 10 plants, sugar beet plants were taken randomly from each plot before treatment and 35 days after application. Reduction percentage of the white grub larvae = (Number of white grub larvae in control - Number of white grub larvae in treatment/Number of white grub larvae in control) ×100 (Guo *et al.*, 2013).

4. Sugar beet yield and quality characteristics

At harvest, all plants in each plot (87.5 m^2) were harvested and weighed to assess yield parameters; root yield, top yield, biological yield (root yield + top yield), and sugar yield, which converted to ton per feddan (4200 m^2). Furthermore, the quality characteristics i.e. total soluble solids (TSS %), purity % and sucrose % were estimated in juice of fresh roots using hand refractometer according to Me Ginnis (1982).

Total soluble solid percentage (TSS %) =

Sucrose (Su %) / Purity (Pu %)

5. Statistical analysis

Data were subjected to analysis of variance (ANOVA) and "F" test. To compare changes across treatments, a computer program (Costat software, 1988) was used to calculate the least significant differences (L.S.D) at the 0.05 level, and means were compared according to Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Results

Efficacy of the tested insecticides against white grub larvae

Data listed in Table (2) demonstrated that the mean number of white grub larvae per 10 plants declined significantly after 35 days of insecticidal treatments compared with untreated control in 2022-2023 and 2023-2024 seasons. Meritan® 10% GR produced the highest reduction (72.39 and 73.13%) /10 plants during the two investigated seasons, respectively, and was equal to Nema gold® 10% GR, Mocap® 10% GR, and Extra cap® 10% GR with reduction percentages of 68.98, 65.56, and 62.05% in the first season, and 73.13, 69.20, and 65.40% in the second season, respectively.

Table 2. Efficacy of tested insecticides against the white grub larvae.

Material	1st Season (2022/23)		2nd Season (2023/24)	
	No. of white grub larvae/ 10 plants after 35 days	Reduction %	No. of white grub larvae/ 10 plants after 35 days	Reduction %
Meritan® 10% GR	2.67^{c*}	72.39^{a}	2.33^{d}	73.13^{a}
Mocap® 10% GR	3.33^{c}	65.56^{ab}	2.67^{d}	69.20^{ab}
Extra cap® 10% GR	3.67^{c}	62.05^{ab}	3.00^{cd}	65.40^{ab}
Nema gold® 10% GR	3.00^{c}	68.98^{b}	2.33^{d}	73.13^{a}
Viva® 24% SL	4.00^{c}	58.63^{b}	3.33^{bcd}	61.59^{b}
Mesurol® 2% RB	6.33^{b}	34.54^{c}	5.00^{b}	42.33^{c}
Care protector® 2% WP	6.67^{b}	31.02^{c}	4.67^{bc}	46.14^{c}
Egyperl	10.00^{a}	0.00^{d}	8.67^{a}	0.00^{d}
Untreated control	9.67^{a}	0.00^{d}	8.67^{a}	0.00^{d}
$LSD_{0.05}$	2.21	12.07	1.75	10.٧1

*** Means followed by the same letter (s) in each column are not significantly different**

Viva® 24% SL came in the second rank with the reductions of 58.63 and 61.59%, in the 1st and 2nd seasons, respectively with significant differences. On the other hand, Mesurol® 2% RB and Care protector® 2% WP produced the least reductions of white grub larvae with 34.54 and 31.02% in the first season, and 42.33 and 46.14% in the second season, respectively, without significant variations, followed by Egyperl and untreated control treatment that came in the final rank.

Sugar beet yield and quality characteristics

Data in Tables 3 and 4 show the effect of the tested insecticides on root yield, top yield, biological yield and sugar yield as well as quality characteristics (TSS %, sucrose % and purity %) in both seasons. Treating sugar beet plants with some insecticides had no significant effects on the majority of yield and quality characteristics. Almost all insecticides, including Meritan®, Mocap®, Extra cap®, produced the highest yield and quality characteristics. The results showed that Extra cap® and Nema gold®, performed the highest yield and quality characteristics compared to the other treatments, however, Egyperl and Viva® gave low yield and quality compared to untreated control. Meritan® treatment achieved the highest root yield (30.50 and 29.57 ton/fed.), top yield (5.04 and 3.97 ton/fed.), biological yield (35.54 and 33.54 ton/fed.) and sugar yield (5.29 and 542ton/fed.), in both seasons, respectively followed by Mocap®, Extra cap®, and others. On the other hand, Nema gold® treatment induced the highest TSS % (22.00 and 21.33%), sucrose (19.00 and 18.67%) and purity (86.36 and 87.52%) in the first and second seasons, respectively. However, the treatments of Egyperl and Viva® gave the lowest yield and quality characteristics in both seasons.

Table 3. Effect of the tested insecticides on sugar beet yield and quality characteristics during 2022/23 season.

Material	Yield character (ton/fed.)				Quality character (%)		
	Root yield	Top yield	Biological yield	Sugar yield	TSS	Sucrose	Purity
Meritan® 10% GR	30.50^{a*}	5.04^{a}	35.54^{a}	5.29^{b}	21.67^{ab}	17.33^{cd}	80.01^{c}
Mocap® 10% GR	30.25^{a}	4.93^{ab}	35.18^{a}	5.35^{b}	22.00^{a}	17.67^{bc}	80.30^{c}
Extra cap® 10% GR	30.41^{a}	5.22^{a}	35.63^{a}	5.68^{a}	21.00^{bc}	18.67^{a}	88.89^{a}
Nema gold® 10% GR	29.77^{ab}	5.10^{a}	34.87^{a}	5.66^{a}	22.00^{a}	19.00^{a}	86.36^{ab}
Viva® 24% SL	28.66^{cd}	4.99^{a}	33.65^{b}	4.87^{c}	19.67^{de}	17.00^{d}	86.49^{ab}
Mesurol® 2% RB	29.05^{bc}	4.55^{c}	33.60^{b}	5.23^{b}	22.00^{a}	18.00^{b}	81.82^{bc}
Care protector® 2% WP	28.86^{cd}	4.66^{bc}	33.51^{bc}	5.19^{b}	20.33^{cd}	18.00^{b}	88.72^{a}
Egyperl	28.18^{d}	4.42^{c}	32.60^{c}	4.79^{c}	19.00^{e}	17.00^{d}	89.64^{a}
Untreated control	28.67^{cd}	4.50^{c}	33.17^{bc}	4.87^{c}	19.00^{e}	17.00^{d}	89.47^{a}
$LSD_{0.05}$	0.79	0.31	0.95	0.27	1.00	0.60	5.00

*** Means followed by the same letter (s) in each column are not significantly different**

Table 4. Effect of the tested insecticides on yield and quality characteristics during 2023/24 season.

Material	Yield character (ton/fed)				Quality character (%)		
	Root yield	Top yield	Biological yield	Sugar yield	TSS	Sucrose	Purity
Meritan® 10% GR	29.57^{a*}	3.97^{abc}	33.54^{a}	5.42^{ab}	21.67^{a}	18.33^{bcd}	84.63^{d}
Mocap® 10% GR	29.64^{a}	3.92^{abc}	33.56^{a}	5.63^{a}	22.00^{a}	19.00^{ab}	86.36^{cd}
Extra cap® 10% GR	29.46^{a}	4.20^{a}	33.66^{a}	5.70^{a}	22.00^{a}	19.33^{a}	87.88^{abc}
Nema gold® 10% GR	29.59^{a}	4.07^{ab}	33.66^{a}	5.53^{ab}	21.33^{ab}	18.67^{abc}	87.52^{abcd}
Viva® 24% SL	28.74^{b}	3.99^{ab}	32.74^{b}	4.98^{cde}	19.33^{d}	17.33^{e}	89.65^{ab}
Mesurol® 2% RB	28.67^{bc}	3.75^{bcd}	32.42^{b}	5.26^{bc}	20.33^{bcd}	18.33^{bcd}	90.16^{a}
Care protector® 2% WP	28.33^{c}	3.75^{bcd}	32.09^{b}	5.10^{cd}	21.00^{abc}	18.00^{cde}	85.71^{cd}
Egyperl	27.58^{d}	3.48^{d}	31.06^{c}	4.78^{e}	20.00^{cd}	17.33^{e}	86.73^{bcd}
Untreated control	27.70^{d}	3.65^{cd}	31.36^{c}	4.89^{de}	20.00^{cd}	17.67^{de}	88.40^{abc}
$LSD_{0.05}$	0.41	0.32	0.67	0.30	1.04	0.87	0.05

*** Means followed by the same letter (s) in each column are not significantly different**

Discussion

According to the current findings, white grub, *Pentodon algerinum* (Fuessly) (Coleoptera: Scarabaeidae) infestation reduced yield and quality of sugar beet. So, control of this insect pest can lead to increases in the yield and quality characteristics (Ibrahim, 2010). This was supported by the results obtained from the current study, as the tested insecticides, in general, led to improving the productivity and quality of the sugar beet crop. The application method and timing are critical; soil-applied insecticides have a higher effectiveness to ensure direct contact with grubs in their habitats (Jakhar *et al.*, 2020). However, environmental factors such as soil moisture and temperature can affect the degradation of these chemicals, thereby influencing their effectiveness (Patel *et al.*, 2020). Accordingly, the soil-application of the insecticides in the granular form enhances the long-lasting effect of the insecticides to protect sugar beet plants. Application should be applied after planting and just before irrigation to obtain a preventive control for the seedlings and to inhibit the grub multiplication. Insecticide trials using aldicarb, chlopyrifos, carbosulfan, isozofos, and ethoprophos reduced the number of white grubs in the soil (Carnegie, 1974). Therefore, Meritan® 10% GR produced the highest reduction percentage of white grubs/10 plant during the two investigated seasons, equaled with Nema gold® 10% GR, Mocap® 10% GR and Extra cap® 10% GR in the 1st and 2nd season without significant differences compared with untreated control. Because Perlite is a highly absorbent material (Teas *et al.*, 2001), it is commonly used as a soil additive to conserve water, reducing irrigation requirements in some cases (Al-Shammari *et al.*, 2018), and it has been linked to improved plant growth (Aliniaeifard *et al.*, 2009). This advantage was used to preserve insecticides for an extended period of time without breaking or washing into the soil. It is also critical to maintain nutrients and deliver

them to the plant, which has resulted in increased production and quality in the sugar beet crop. Overall, it's reflected in improving the sugar beet quantity and quality in the end, either directly or indirectly.

CONCLUSION

The results of insecticides against the white grub larvae showed that Meritan® 10% GR, Mocap® 10% GR, Extra cap® 10% GR and Nema gold® 10% GR followed by Viva® 24% SL were the best chemical control treatments. The tested version of these pesticides produced the highest average number of dead white grubs when compared to the other insecticides. In order to minimize infestation levels and maximize productivity and quality, this pest should be managed using an integrated strategy that combines viable pest management methods such as agricultural, bio-control, physical, mechanical, and chemical control.

Ethics approval and consent to participate

The authors don't conduct any human or animal experiments for this publication.

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Declaration of Competing Interest

The authors have no known financial interests or personal ties that might have influenced the work presented in this publication.

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فاعلية بعض المبيدات الحشرية ضد الجعل على بنجر السكر

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الملخص

أجريت تجربتان حقليتان بمنطقة (العشرة آلاف) محافظة البحيرة، مصر خلال الموسمين ٢٠٢٢/٢٠٢٣ و ٢٠٢٣/٢٠٢٤ لتقييم تأثير بعض المبيدات الحشرية ضد يرقات الجعل(Coleoptera: Scarabaeidae) *Pentodon algerinum* (Fuessly) على نباتات بنجر السكر وكذلك تقدير صفات المحصول والجودة. كان التصميم التجريبى المتبع هو قطاعات كاملة العشوائية بثلاث مكررات وتمت المعاملة بتسع مواد تشمل أربعة مبيدات حشرية من مجموعة أورجانوفوسفيت (الميريتان١٠٪، موكاب ١٠٪، اكسترا كاب ١٠٪ ونيماجولد١٠٪) ومبيدين حشريين من مجموعة كربامبت (فيفا ٢٤٪ و ميصرول ٢٪) والفطر الممرض للحشرات (كير بروتكتور ٢٪) و إجبيرايل كمادة حاملة بالإضافة إلى الكنترول (غير معامل). أوضحت النتائج أن مبيد الميريتان ١٠٪ حقق أعلى نسبة خفض ليرقات الجعل لكل ١٠ نباتات خلال الموسمين وتساوى مع نيماجولد ١٠٪، موكاب ١٠٪، اكسترا كاب ١٠٪ ويلية فيفا ٢٤٪ بدون فروق معنوية. وفى المقابل أعطى ميصرول ٢٪ و كير بروتكتور ٢٪ أقل نسبة خفض يليها معاملة إجبيرايل والكنترول التى جاءت فى نهاية الترتيب. أعطت معاملات الميريتان ، موكاب واكسترا كاب أفضل النتائج فى كلا الموسمين لصفات المحصول والجودة. بينما تحققت أقل النتائج بمواد إجبيرايل وفيفا والتى كانت أقل فاعلية مقارنة بمجموعة الكنترول غير المعامل.