EFFICIENCY OF THREE NATURAL PRODUCTS FOR CONTROLING DESERT LOCUST, SCHISTOCERCA GREGARIA (FORSK.) (ORTHOPTERA: ACRIDIDAE) [5]

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ABSTRACT

Desert locust, Schistocerca gregaria is serious agricultural pest that cause considerable damage to food crops and pasture grasses, particularly during outbreaks.

In this study, laboratory trials and field trials were carried out at different periods in some places in Egypt considered as favorable breeding sites to test its efficacy on the target pests under the Egyptian Agro-Ecosystem to evaluate the performance of three natural products as bio-insecticides, actinomycetes-bacteria, Saccharopolyspora spinosa (Spinosad, Tracer 24%SC), fungus, Metarhizium anisopliae var. acridium (Green Muscle), and Bacillus thuringiensis-bacteria (Protecto 9.4%WP).

Results of laboratory trials revealed that, actinomycetes (Spinosad, Tracer 24%SC) was successful as bio-agent to control both locusts and grasshoppers. Also, fungus M. anisopliae var. acridium (Green Muscle) is promising for locust and grasshoppers control. While the obtained results demonstrated B. thuringiensis (Protecto 9.4%WP) was not effective on the desert locust, S. gregaria or the grasshoppers.

In the field, (Spinosad, Tracer 24%SC) at concentration of 65ml/100L caused 75% mortality among S. gregaria nymphs after 24hr., reached its maximum effect (100%) mortality after 48hr. under the Egyptian conditions, while fungus M. anisopliae var. acridium (Green Muscle®) was very slow acting as a bio-control agent when applied against S. gregaria and some acridid pests, but it was safe to non-target organisms and mammals. 50g/ha

dose (diluted in diesel) resulted in an optimal mortality of locusts during 21 days, followed by 50g/ha dose (diluted in vegetable oil), respectively.
Key words: Acrididae, Locust, Schistocerca gregaria, Biological Control. Metarhizium anisopliae var. acridium, Green Muscle, Spinosad, Bacillus thuringiensis

INTRODUCTION

The insect pests which belong to family "Acrididae" specially the desert locust, Schistocerca gregaria (Forsk.) and several species of grasshoppers are consider the most serious pests around the world. Locusts can cause considerable economic problems on affected countries and so on grasshoppers on the regional levels (Bullen 1970). So indicated that, instead of waiting for Schistocerca gregaria outbreaks to occur, preventive action against this pest must be taken to prevent its damage (Krall 1995).

The principal aim of strategies for locust controls were designed on: a) reduce the size of the total population of insects, not only to attack insects on crops by insecticides. where that, is the only way now to achieve crop protection and prevent the damages; b) prevent of any plagues may forming by controlling of bands and swarms in affected areas (Steedman, 1990).

The numerous of pesticides used for control during upsurges and plagues caused environmental risks and affected non-target organisms. Due to the environmental and pest-resistance problems associated with chemical pesticides, now there is an increasing interest for the exploitation of biological control agents, available as commercial products or those still under development. Consequently, the environmental pollution by chemical pesticides such as; toxicity to non-target organisms (Tingle, 1996) and humans (Pretty, 1996) has led to new strategies and development of

environmental friendly alternatives to control locusts and grasshoppers based on microbial control agents (Johnson and Goettel, 1993; Lomer et al., 2001 and Lange, 2005).

At last years the quality of the environment has become a major issue. Many chemicals (pesticides) previously accepted for locust control at national and international levels would not survive the rigorous environmental testing required of modern insecticides. Detailed field assessments are urgently needed to ascertain the impact of all insecticides.

So, the present study is an attempt through laboratory and field trails to evaluate the efficacy of bio-insecticide produces such as a actinomycetes-bacteria (Spinosad, Tracer 24%SC), fungus, M. anisopliae var. acridium (Green Muscle) and Bacteria, B. thuringiensis (Protecto 9.4%WP) against desert locust, S. gregaria under the Egyptian environment conditions.

MATERIALS AND METHODS

1.1. Experimental insects: During December 2014, locusts preliminary surveys were carried out several times in some places which are considered favorable breeding sites for the desert locust. Such sites may expect to have risks after rains fell during October and November 2014. Small-scale breeding occurred in some places along both sides of Lake Nasser (South of Aswan City) and Abu-Ramad region (Red Sea Coast, near Elba Mountains and Egyptian-Sudanese border) some of desert locust insects and 4th nymphal instars were collected as a parents and kept under gregarious and crowded conditions in cages in the breading room at the Egyptian Locust and Grasshopper Research Dep., Plant Protection Research Institute, following the technique described by Hunter, 1961.

Desert locust, S. gregaria 4th nymphal instars and adults were used in the laboratory bioassay of the natural products, actinomycetes (Spinosad, Tracer 24%SC), fungus, M. anisopliae var. acridium (Green Muscle), and B. thuringiensis (Protecto 9.4%WP).

1.2. Laboratory Bioassay: Spinosad (Tracer 24%SC) and B. thuringiensis (Protecto 9.4%WP) were bought as a commercial products, but M. anisopliae var. acridium (Green Muscle) it was kindly provided by the General Department for Locusts and Agro-Aviation Affairs, Egyptian Ministry of Agriculture in co-operation with FAO from the Biological Control Products of South Africa (Pty) Ltd.

This products used to evaluate the biological control against the desert locust, S. gregaria.

Preliminary tests were carried out in the laboratory to determine the dose effect of Spinosad, M. anisopliae var. acridium, and B. thuringiensis on 4th instars and adults of desert locust, S. gregaria. Several concentrations were used of each product, in each concentration 3 replicates were used, each replicate consists of 20 insects. Insects were fed on dipped leaves of (clover/maize) in the different concentrations of Spinosad, Metarhizium and Bacillus. After dipping the leaves for five minutes, the treated leaves were allowed to dry before offering to the insects. After feeding for 24 hours on the treated leaves, normal diet was offered and insects were examined daily for mortality or survive and data recoded.

Spinosad (Tracer 24%SC) concentrations were 35, 45, 65ml/100L water, while concentrations of Metarhizium (Green Muscle) were 25gm, 50gm (diluted of oil), 25gm, 50gm (diluted of Diesel) and concentrations of Bacillus (Protecto 9.4%WP) were 50, 100, 150, 200, 250, 300ml/100L water.

2. Field trail: in the field spinosad (Tracer 24% SC) at 65ml/100L water, Green Muscle 50gr. /ha. Were used. Three blots were determined each blot (1050m2) by using microner AU 8000.

3. Statistical analysis: Data were analyzed by analysis of variance (ANOVA) means, within row, bearing different subscripts are significantly different ($P<0.05$).

RESULTS AND DISCUSSION

1) Laboratory trail: In this trial, Spinosad concentrations used against desert locust were 35, 45 and 65ml/100L water.

Table (1) shows the mortality percentages of desert locust individuals after treatments with spinosad. It is clear that, spinosad at the highest concentration (65 ml/100L water) was almost similar to the chemical pesticide in its effectiveness against desert locust. Where spinosad at high concentration caused 75% after 24hr. then 85% after 36hr. and 95% after 42hr., and finally reached 100% after 48hr.

Table (2) shows the effect of Green Muscle® on mortality percentage of locust. Data in this table indicate that the efficacy percentages of the fungus on locust population were 8.4, 41.2 and 60.8% post treatment with 25g/ha diluted in vegetable oil and were 14.7, 54.2 and 77.3% after treatment with

25g/ha diluted in diesel, in the 1st, 2nd and 3rd weeks post treatment, respectively.

Meanwhile, the efficacy percentages were 19.2, 58.6 and 86.5 % after treatment with 50g/ha diluted with vegetable oil and were 24.7, 65.2 and 94.4% after treatment with 50g/ha diluted in diesel in the 1st, 2nd and 3rd weeks post treatment, respectively. Highest mortality was recorded for desert locust nymphs.

Table (1): Efficacy of S. spinosa (Spinosad-Tracer 24%SC) against desert locust, Schistocerca gregaria under laboratory condition.

Stage	Con.	Mortality Percentage % after:			
		12 day	24 day	36 day	48 day
4th Nymphal instar	35%	20	30	45	65
	45%	35	55	60	75
	65%	40	75	85	100
	control	0	0	0	0
Adult	35%	16	26	42	63
	45%	31	49	55	69
	65%	38	70	80	96
	control	0	0	0	0

Table (2): Efficacy of M. anisopliae var. acridium (Green Muscle®) against desert locust, Schistocerca gregaria under laboratory condition.

Stage	Con.	Mortality Percentage % after:		
		1stweek	2ndweek	3rdweek
4th Nymphal instar	25g V. Oil diluted	8.4	41.2	60.8
	25g Diesel diluted	14.7	54.2	77.35
	50g V. Oil diluted	19.2	58.6	86.5
	50g Diesel diluted	24.7	65.2	94.4
	Control	0	10	15
Adult	25g V. Oil diluted	7	39	55.5
	25g Diesel diluted	13.2	51.8	74.9
	50g V. Oil diluted	17.1	52.8	83.7
	50g Diesel diluted	23.0	62.0	91.6
	Control	0	7	11

2. Field trail: Table (3) shows spinosad (Tracer 24%SC) at concentration of 65ml/100L caused 70% mortality among S. gregaria nymphs after 24hr., that reached 95% after 48hr. So, Spinosad proved that it successful bio insecticide for locust.

Also, the fungus M. anisopliae var. acridium (Green Muscle) at concentration 50g/ha. Diluted in diesel oil and vegetable oil caused 81 and 89 % after 21 days of treatment. While, the laboratory tests of B. thuringiensis (Protecto 9.4%WP) showed that, there is no any significant effects against locusts.

Table (3): Efficacy of S. spinosa (Spinosad-Tracer 24%SC) and Green muscle against desert locust, Schistocerca gregaria in Sharq El-Owainat region during Marsh 2015.

Treatment	Green Muscle						Spinosad 65ml/100L				Control
	50g V. Oil diluted			50g Diesel diluted							
Period	1st week	2nd week	3rd week	1st week	2nd week	3rd week	12 day	24 day	36 day	48 day	
Mortality Percentage %	16	45	75	20	55	82	35	64	75	89	0

Fungal growth on cadavers of insects was evident in the treatments with (Green Muscle®). 50g/ha occurred amongst days 12-13 onwards, while with 25g/ha, it occurred amongst days 15-16 onwards in all cages. Moreover, numbers of dead infected increase slowly and the majorities of the treated locust were much less active than the untreated ones (control treatment).

Analysis of variances of the obtained data showed significant differences among all treatments. Lowest mean of insects number affected was in all treatments with 25g/ha diluted i vegetable oil. While, highest one was in all treatments of 50g/ha diluted in diesel. The data convergent approximately in most of the treatments with 25g/ha diluted in diesel and the treatments of 50g/ha diluted in vegetable oil.

The results showed also that, 50g/ha dose (diluted in diesel) of M. anisopliae var. acridium (Green Muscle®) resulted in an optimal mortality of locust under the cages during 3rd week (21 days), followed by 50g/ha dose (diluted in vegetable oil), respectively. From the economical point of view, use of diesel for dilution may be more practical than vegetable oil.

Also. the efficacy of M. anisopliae var. acridium may be greater against nymphal instars (smaller size) than the adult insects (biger size) and may be related to increased susceptibility to the pathogen. Likewise, the effect of the fungus was also greater against young nymphal instars than the older ones.

The efficacy of M. anisopliae var. acridium , in all treatments, indicated that it is a specific bio-pesticide for controlling Acrididae pests but it seems to be slow acting as a bio-agent unlike chemical pesticides.

The pests may be infected by: 1) Direct impact, by droplets; 2) Secondary pickup, from vegetation and soil; 3) Horizontal transmission, by recycling the spores produced on infected cadavers.

At field application rates, M. anisopliae var. acridium is considered safe to non–target Hymenoptera, Coleoptera and Homoptera species (Prior and Streett, 1997), and to mammals (El–Kadi et al., 1993 and Zimmermann, 1993). The fungus can be mass produced relatively easily on artificial solid substrates and when formulated in oil, can be applied under a wide range of environmental conditions using commonly available pesticide application equipment (Bateman, 1997; Bateman et al., 1998 and Langewald et al., 1997, 1999). There was no side effect of the diesel use as dilutes on viability of fungus spores, it is useful to increase the efficacy impact on the insect.

Accordingly, Green Muscle® can be useful for developing different elements of an IPM strategy, both optimizing time and place of treatment, and combining or replacing the use of chemical insecticides with the use of the fungal control agent M. anisopliae var. acridium is hypothesized to be most effective as a preventive measure whereas chemical insecticides will be most effective in curative treatments.

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كفاءة ثلاث منتجات لمكافحة الجراد الصحراوى (مستقيمة الأجنحة: اكريدى)

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المستخلص

يعتبر الجراد الصحراوى Schistocerca gregaria (Forsk) من أخطر الآفات الحشرية وأكثرها تدميراً للمحاصيل الزراعية ولاسيما فى مناطق إنتشاره المحصورة بين خطى عرض ١٠، ٤٠ شمال خط الإستواء وقد تعرضت جمهورية مصر العربية خلال السنوات الأخيرة (٢٠٠٤/٢٠٠٥، ٢٠١٢/٢٠١٣) لعدة هجمات شرسة من الجراد الصحراوى، والتى تمت مكافحتها بعد عناءٍ شديد، وباستخدام كمية كبيرة من المبيدات الكيميائية، أدت إلى تلويث البيئة بشكل هائل وبصورة قد تظهر آثارها المدمرة على مكونات البيئة خلال السنوات القليلة القادمة.

تم إجراء التجارب العملية والمعملية للبحث عن وسائل بديلة أو طرق جديدة وغير تقليدية للمكافحة ولإحداث تغيير جوهرى فى استراتيجيات مكافحة الجراد باستخدام تقنيات ومواد بديلة عن المبيدات الكيميائية الضارة بمكونات البيئة، بعناصر أخرى تكون صديقة للبيئة وغير ضارة بمكوناتها المختلفة. تتلائم مع ظروف البيئات المصرية بما يحافظ عليها ويساعد على إستثمارها والإنتفاع منها كالتالى:

أولاً: دراسة أو تقويم تأثير منتجات أيض بكتريا الأكتينومايسيتس Saccharopolyspora spinosa على حوريات والحشرات الكاملة للجراد الصحراوى.

ثانياً: دراسة أو تقويم تأثير فطر Metarhizium anisopliae var. acridium فى مكافحة حوريات والحشرات الكاملة للجراد الصحراوى.

ثالثاً: دراسة أو تقويم تأثير بكتريا Bacillus thuringiensis على حوريات والحشرات الكاملة للجراد الصحراوى.

تحديد واختيار أيٍ من المعاملات السابقة هى الأمثل والأفضل للتطبيق وبأى جرعة.

وجد أن B. Thuringiensis لم يكن مؤثر في الجرادالصحراوي، بينما كان نتائج تأثير فطر Metarhizium anisopliae var. acridium (Green Muscle*) تحت الظروف المصرية تأثير بطيئ جداً ولكنه أمناً بيئياً، بينما تأثير المنتج الأيضي لبكتيريا Saccharopolyspora spinose (Spinosad, Tracer 24%SC) تسبب في موت ٧٥% من الجراد الصحراوي بعد ٢٤ ساعة، والتأثير الأعلى ١٠٠% بعد ٤٨ ساعة، ولهذا ينصح به للمقاومة البيولوجية للجراد.