Egypt. J. Plant Prot. Res. Inst. (2020), 3 (1): 486 - 492

وزارة الزراعة واستصلاح الأراضي
Ministry of Agriculture and Land Reclamation
مركز البحوث الزراعية
Agricultural Research Center

Egyptian Journal of Plant

Protection Research Institute

www.ejppri.eg.net

Effect of jojoba and moringa essential oils and cascade on grasshoppers in the field

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ARTICLE INFO

Article History
Received: 17/ 2/ 2020
Accepted: 30/ 3/2020

Keywords
Grasshoppers, Acrididae, essential oils , moringa , jojopa, cascade (IGR), mortality, trehalase, chitinase and protease.

Abstract:

Efficacy of moringa and jojopa essential oils and cascade was tested against 3rd, 4th and 5th nymphal instars of different species of grasshoppers at El-Baharia Oasis (western desert of Egypt) by using Ulva sprayer (ULVA+). Mortality percentages were calculated after 2, 4, 6, 8, 10 and 12 days post treatment. The results indicated that the mortality percentages of grasshoppers were 96, 65 and 87% by moringa, jojopa and cascade, respectively after 12 days post treatment. The effects of moringa, jojopa and cascade on trehalase, chitinase and protease activities were tested in haemolymph of some nymphal instars of grasshoppers. There was insignificant difference activity between moringa and control after 2 days. Also the difference in chitinase activity was insignificant between moringa and control after 2 and 4 days, while decreased significantly after 6 days from treatment. In cascade and jojopa increased also after all periods after treatment. The difference in protease activity was insignificant between moringa and control after 2 days while caused increase significant between jojopa and control after 4 and 6 days after treatment. There was no significant difference after 2 days but increased inactive significantly after 4 and 6 days compared with control. In cascade increased significantly after 2, 4 and 6 days after treatment. The efficacy of moringa and jojopa essential oils and cascade in all treatments can be useful for development safe elements for an IPM strategy to grasshoppers.

Introduction

Several species of grasshoppers such as; *Euprepocnemis plorans plorans*, *Heteracris annulosa*, *Acrotylus insubricus*, *Chrotogonus homalodemis*, *Acrididella nasuta*, *Catantops axillaris* and *Aiolopus strepens* are considered among the most dangerous pests that attack the agricultural crops in Egypt and many parts of the world. Also, locust and grasshopper generally have very high reproductive rates and are able to respond to unfavourable climatic conditions with rapid population increase. The most economic species that caused a serious damage is the berseem grasshopper, *E. plorans plorans* and *H. annulosa.*These species cause 95% damage to crops of the El-Farafra Oasis at the new valley, El-Baharia Oasis and Nile Delta (Abdel-Fattah, 2002). Field trials showed the efficacy of some chemical insecticide formulations, the bioinsecticide *Metarhizium anisopliae* var. *acridum* and anti-moulting agent atabrone against different species of grasshoppers at El-Baharia Oasis western desert of Egypt by micron Ulva sprayer (Ulva+) (Abdel-Fattah and Abdel-Lattef, 2013). The biochemical effects of neem and cascade on the mortality percentages, malformations and some biochemical changes were studied by (Soltan, 2014). In Egypt, toxicity of two chemical insecticides (chlorpyrifos, es-fenvalerate); a bioinsecticide (protecto); an IGR (lufenuron) and jojoba oil against 2^{nd} and 4^{th} instar of larvae of *Spodoptera littoralis* and their effect on some biological characters and fecundity were studied on 4^{th} instar larvae (Gaaboub *et al*., 2012). Jojoba oil is suggested as a safe product with a potential for use as a bioinsecticide in integrated pest management especially in urban localities where use of chemical insecticides are discouraged (Abdel-Razik and Mahmoud, 2017). Jojoba, *Simmondsia chinensis* L. is native to south western the desert, United States and northern Mexico. It is also grown in Australia, Brazil, Argentina and some Middle East countries. Jojoba has become an attractive alternative crop because of the promising commercial applications for its seed oil in cosmetics. Many countries are looking toward developing jojoba culture to solve overproduction and low price for their food and other traditional crops (Ayerza, 1996). Antifeedant and protection activity percentage were increased by increasing the concentration. The highest mortality percentage (100%) of *Schistocerca gregaria* (Forsskål) (Orthoptera: Acrididae) nymphs was recorded at 10% jojoba oil (Halawa *et al*., 2007).

The Drumstick tree *Moringa oleifera* (Lamk.) belongs to Moringaceae family commonly called miracle tree. It is an important vegetable crop and is a fast growing, drought resistant tree, native to the southern foothills of the Himalyas in North western India. It is the most widely distributed species (Sontag, 1982). Dimetry *et al*. (2017) studied *M. oleifera* leaves that decreased the weight gain significantly in the treated individuals of *S. littoralis* in comparison with the control. The relative consumption index (CI) increased in case of treated leaves in comparison with the control ones. Flufenoxuron (Cascade) is classified in the chitin syntheses inhibitors (CSIs), it caused some toxic effects on larvae of insect species (Bakr *et al*., 2010).

Therefore, the present work aims at throwing some light on the toxicity, and enzyme activities of grasshoppers due to using two botanical oils, I G R (Cascade) in the field at El-Baharia Oasis western desert of Egypt.

Materials and methods

During the seasons 2017 and 2018 many ecological surveys were carried out to evaluate the major insect pests of family Acrididae prevailing at El-Baharia Oasis western desert of Egypt. It was found that the grasshoppers, *E. plorans plorans, H. annulosa, A. insubricus, Ch. Homalodemis, A. nasuta, C.* axillaris and *A. strepens* and the local locust *Anacredium aegyptium* were existed in this area. Among these pests, the berseem grasshopper, *H. annulosa* was the most dominat. A suitable infested area characterized by high population tested nymphs were 3^{rd}, 4^{th} and 5^{th} instars only.

1. Essential oils:

1.1. Jojoba oil and *Moringa oleifera*: (plant oil is formulated as EC) produced by Egyptian Natural oil Co. used at the rate of 1.2 liter/ ha.

1.2. Cascade 10% EC (Flufenoxuron) 1.5 liter/ ha. Its chemical name is: 1-{4-(2-chloro-α, α, α,-trifluoro-p-tolyloxy)-2-fluorophenyl}-3-fluorophenyl}-3-(2,6-difluorobenzoyl) urea.

2. Experimental design:

A field cultivated by alfalfa (*Medicago sativa*) in sandy loam soil, highly infested with different grasshoppers , mixed with few local locusts at the region of western desert El-Baharia Oasis was chosen in August 2019. The field was divided to plots of (35x20) = 700 m^2 each the plots were isolated by a wide belt of 10x25m= 250 m^2. Five plots were allocated randomly for each treatment. Plots laying up wind of treatment were used as a control. The untreated cheek plot was sprayed with water only. Each treatment as well as the control was represented by five replicates (cages) 0.5m x 0.5m. The cages were put in the treated plots. The insects were collected randomly from the same treatment of the pesticides after application directly by using sweep-net and introduced to the cages. The insects were kept in cages and fed with treated plants (alfalfa) from the same plot. Unfortunately, the sweeping net didn't catch any individual of locust after treatment, so, locust results were not mentioned in the tables, however, by observation after treatments, and there was no alive individual. Mortality counts were calculated after 2, 4, 6, 8, 10 and 12 days post treatment but collected haemolymph after 2, 4 and 6 days post treatment to biochemical analysis. A suitable infested area characterized by high population density of grasshoppers (more than 30 insects/m^2) was selected. The tested nymphs were 3^{rd}, 4^{th} and 5^{th} instars only (Abdel-Fattah *et al*., 2012).

Sprayer used: The micron Ulva (ULVA+),Nozzle: Red nozzle to treatments EC. Red nozzle calibrated 90 ml water/min., Spraying height: 0.5 m above the plants.,Walking speed: 40m/min = 2.4 km/hr., Swath width:3m according to wind velocity.,Weather conditions at applications: Wind: 4–6 m/sec, measured by anemometer and Temperature: 33ºC ± 2 °C, the sun rose clearly.

The spraying was done between 07 and 10 am in morning. Daily routine works includes removing the previous uneaten food, faeces and dead nymphs and counting the living insects before introducing the fresh food were conducted.

2.1.Collection of haemlymph: according to the technique was followed as described **by** (Amin, 1998).

2.2. Determination of trehalase activity: Trehalase was determined according to the method described by Ishaaya and Swiriski (1976).

2.3. Determination of chitinase activity: Chitinase was determined according to the method described by **Bade and Stinson (1981).**

2.4. Determination of Protease activity: Protease was determined according to the method described by Gatehouse *et al*. (1999).

3. Statistical analysis: Data were subjected to analysis of variance (ANOVA), and Duncan's multiple range test to differentiate between the means at $P<0.05$, using SAS program **(**SAS, 1995).

Results and discussion

The effect of jojoba, moringa and essential oils and cascade were tested under field conditions against 3^{rd}, 4^{th} and 5^{th} different nymphal instars of the grasshoppers by using ULVA+ spraying equipment after 2, 4, 6, 8, 10 and 12 days post treatment. The efficacy of tested essential oils and cascade was calculated by using equation as follow:

Efficacy% = dead treatment% - dead check% / 100- dead check%

Data in Table (1) show the efficacy of jojoba and moringa, essential oils and cascade against nymphal instars of grasshoppers after 2, 4, 6, 8, 10 and 12 days post treatment. Results showed that there is no mortality in the check (untreated after 2, 4, 6, 8, 10 and 12 days). Data cleared that the mortality percentages of nymphal instars of grasshoppers were (Jojoba 96%, moringa 65% and cascade 87%) after 12 days post treatment. The present results in this concern agreed with Aaboub *et al.* (2012) studied the toxicity of two chemical insecticides (chlorpyrifos, es-fenvalerate); a bioinsecticide (protecto); an IGR (lufenuron) and jojoba oil against 2nd and 4th of instar larvae S. littoralis and their effect on some biological characters and fecundity and found that Es-fenvalerate proved to be the most effective insecticide against 2nd and 4th instar larvae of *Spodoptera littoralis* (Boisd.) (Lepidoptera:Noctuidae) after 24 hrs, followed by chlorpyrifos, lufenuron, jojoba oil and protecto. The highest mortality percentage (100%) of S. gregaria nymphs was recorded at 10% jojoba oil. Abd El-Rahman (2003) mentioned that jojoba oil caused 83.8 and 90.8% mortality against *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae). larvae at 0.5 and 1% respectively. In the same subject, Salem *et al.* (2003) revealed that jojoba oil formulation was the potent agent against both white fly and leafhopper species where the LC50 was 5.4% for *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) and 6.4% for *Empoasca decipiens* Paoli (Hemiptera: Cicadellidae), respectively. Abdel-Razik and Mahmoud (2017) showed that 2nd or 4th instar larvae of cotton leafworm, *S. littoralis* exposed to jojoba extract for 24 hrs were greatly suffered from toxic effects which give good evidence for using jojoba as an element for the integrated management of insects. The variable toxicity may be due to the constituents of each oil and disturbance or the hormonal regulations (Al-Sharook *et al*., 1991), 200 species of plants, which produce chemicals substances able to act against insects, are known. The substances can have poisonous and repellent effects and can work as phagorestrainer ovicide and can affect the insect's hormonal system. Moreover, a great number of essential oils can reduce the reproduction system of several insects and they can also hinder the growth, the development and the reproduction of some herbivore insects (Partes *et al*., 2000). Dimetry *et al.* (2017) studied that the acceptability and anti-feedant effect of *M. oleifera* leaves as host plant towards the cotton leaf worm *S. littoralis*. The obtained results showed highly significant anti-feedant effects of *M. oleifera* leaves towards studied instars in comparison with castor oil leaves as a control. Also, the percentage mortality of the larvae was very high and those of the 1^{st} instar larvae failed to complete one generation and all of them died during 2^{nd} and 3^{rd} instars. The present results agree with those findings by several CSIs against the same Acrididae species, *S. gregaria*, such as Diflubenzuron which interfered with the chitin synthesis during the nymphal ecdysis to the last instar causing some mortalities (Taha and El-Gammal, 1985) and the mortal power of cascade Flufenoxuron depending on the developmental nymphal instar under treatment or its physiological age (Soltan, 2014).

Table (1): Mortality percentage of jojoba, moringa and cascade against nymphal instars of the grasshoppers, after 2, 4, 6, 8, 10 and 12 days post treatment in the field.

Days after treatment	Jojoba	Moringa	Cascade mortality %	Control mortality %
2nd	10	5	0	0
4th	30	19	22	0
6th	49	38	39	0
8th	68	46	51	0
10th	83	59	72	0
12th	96	65	87	0

Some biochemical effects (Trehalase, Chitinase and Protease) activities after treatment by jojoba, moringa and cascade on nymphal some instars of grasshoppers in the field:

Data in Table (2) showed that, The effect of jojoba, moringa and cascade on trehalase, chitinase and protease activities of haemolymph to nymphal instars of grasshoppers. Data in Table (2) showed that, jojoba highly significant increased trehalase activity after 2, 4 and 6 days compared to control. The trehalse activity difference was insignificant between moringa and control after 2 days while caused significant increase after 4 and 6 days from treatment. In cascade significant increased after 2, 4 and 6 days compared to control was observed. On the other hand Jojoba increased the chitinase activity significantly and cascade showed highly increase on chitinase activity after 2, 4 and 6 days after treatment compared with control but moringa caused significant increase in chitinase activity after 2 and 4 days but decreased after 6 days compared with control. While jojopa induced insignificant difference in activity in protease after 2 days but highly increased after 4 and 6 days compared with control. Also moringa caused insignificant difference after 2 days from treatment but induced highly significant increase compared with control after 4 and 6 days. While cascade increased protease activity significantly after 2, 4 and 6 days from treatment compared with control. These results agree with Tanani *et al.,* (2012) showed that the treatment of newly molted 5th instar of the *S. gregaria* by through fresh plant IGR tebufenozide caused statistically significant increase in trehalase activity after 4 days. Soltan (2014) observed that the difference trehalase activity of desert locust was insignificant between neem and control after 2 days while increased significantly after 4 and 6 days from treatment, but cascade and mixuture (Neem and cascade) increased after 2, 4 and 6 days. Trehalase is activated for the production of glucose needed for chitin build-up in the newly synthesized cuticle; it is generally present in large amounts in the haemolymph of most insects and its activity might be an indicator of energy reserves resulting from availability of carbohydrate nutrient (Wyatt, 1967). Ecdysis is initiated by apolysis the process that separates epidermal cells from the old cuticle by molting fluid secretion and ecdysal membrane formation. The molting fluid contains protease and chitinase, enzymes that digest the main constitution of old endocuticle (Reynolds and Samuels, 1996). Accordingly mortality percentage and changes in enzymes activities of the insects was greatly affected. Thus, it could be concluded that essential oils of jojoba and moringa and cascade could be use as an effective natural products to be included in the integrated pest management program of grasshoppers in the field.

Table (2): The effect of jojoba, moringa and cascade on trehalase , chitinase and Protease activity of nymphal instars grasshoppers.

Enzymes	**Trehalase (µg glucose released/min./gm fresh weight)**			**Chitinase (µg NAGAx10^3/min./gm fresh weight)**			**Protease (µmol/min./mg protein)**		
Days after treat.	**2**	**4**	**6**	**2**	**4**	**6**	**2**	**4**	**6**
Jojoba	600^a	445^a	417^a	509^b	849^b	979^b	5.2^b	14.1^a	17.51^b
Moringa	421^c	425^c	362^c	440^c	346^c	261^d	5.81^b	16.1^a	18.65^a
Cascade	527^b	399^b	321^c	577^a	1284^a	1843^a	8.22^a	12.42^b	14.75^c
control	410^c	330^d	273^d	451^c	335^c	318^c	5.11^b	7.5^c	9.28^d
LSD	68.89	72.33	79.55	588.4	615.2	679.1	4.05	4.12	4.68

Measurement of distance between individual distributions ($P<0.05$).
Means with the same letter are not significantly different.

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