Acta Phytopathologica et Entomologica Hungarica 52 (1), pp. 107–110 (2017)
DOI: 10.1556/038.52.2017.001
First published online February 10, 2017

Studying the Efficacy of Fipronil (GR 0.2%) against European Mole Cricket, *Gryllotalpa gryllotalpa* (Orthoptera: Gryllotalpidae)

M. JAVADZADEH [1]*, M. TAGHIZADEH[2] and A. HOSSEINI-GHARALARI[1]

[1]Agricultural Entomology Research Department, Iranian Research Institute of Plant Protection, Agricultural Research, Education and Extension Organization (AREEO), Yaman St., Chamran Hwy., Tehran, Iran
[2]Agricultural and Natural Resources Research Center of Ardabil Province, Agricultural Research, Education and Extension Organization (AREEO), Moghan, Ardabil, Iran.

(Received: 22 August 2016; accepted: 07 September 2016)

The European Mole Cricket, *Gryllotalpa gryllotalpa* (Orthoptera: Gryllotalpidae), is a key pest of several crops in different regions of the world, damaging seedlings, roots and tubers. The efficacy of fipronil (Regent ® GR 0.2%) @ 2, 2.5 and 3 g/m^2 along with toxic bait of carbaryl (EC 85%)@ 20 g/m^2 were assessed against this pest in the field based on a completely randomized block design. Based on Henderson-Tilton formula, on the third day after treatment, the efficacy of fipronil @ 2, 2.5 and 3 g/m^2 and carbaryl bait was 16%, 30%, 47% and 53%, respectively; while on the third day after treatment, the efficacy was 22%, 48%, 64% and 81%, respectively. At present, carbaryl application is banned in Iran; therefore, fipronil can be a suitable substitute for this insecticide.

Keywords: European Mole Cricket, *Gryllotalpa*, fipronil, carbaryl, bait.

The European Mole Cricket, *Gryllotalpa gryllotalpa* (Orthoptera: Gryllotalpidae), is a key pest of several crops in different regions of the world. Mole crickets are omnivorous and feed on different species of plants and also on other insects. Some of the plants and crops that are injured are beet, cabbage, cantaloupe, carrot, cauliflower, collard, eggplant, kale, lettuce, onion, pepper, potato, spinach, sweet potato, tomato, peanut, strawberries, sugar cane and tobacco (Matheny, 1981; Matheny et al., 1981; Walker and Ngo, 1982; Schuster and Price, 1992). The crickets usually damage seedlings, feeding aboveground on foliage or stem tissue, and in the soil on roots and tubers. Girdling of the stems of seedling plants at the soil surface is a common form of injury, though young plants are sometimes severed and pulled belowground to be consumed. Additional injury to small plants is caused by soil surface tunneling, which may dislodge seedlings or cause them to desiccate. Female can lay up to 100 eggs (Hayslip, 1943). There are 8 to 10 nymphal instars (Hudson, 1987). Nymphs and adults create tunnels within the upper 20 cm of soil. When the soil is moist and warm they tunnel just beneath the surface, but at cool conditions, they go deeper. They come to the surface to forage during the evening, usually

* Corresponding author; e-mail: mehranjd@yahoo.com

appearing shortly after dusk if the weather is favorable. Complete information on biology and classification of mole crickets can be found in the works of Worsham and Reed (1912); Thomas (1928); Hayslip (1943); Walker (1985) and Nickle and Castner (1984).

Liquid and granular formulations of insecticides are commonly applied to the soil to suppress mole crickets. In some cases, insecticide application should be followed by irrigation because the insecticide must enter into the root zone of the plants to be most effective, but this is an insecticide-specific requirement so the insecticide label should be read carefully for application directions. Bait formulations are also useful. Various baits have proven effective, but most contain wheat bran, cottonseed meal, or some other grain product plus 2-5% toxicant. Addition of 5 to 15% water and 2 to 5% molasses to the grain-toxicant mixture are sometimes recommended (Thomas 1928; Walker, 1985). Mole crickets feed at night so baits should be applied in the early evening.

The goal of this research was to study the efficacy of fipronil (Regent® GR 0.2%) against *G. gryllotalpa* in the field. As carbaryl application has been banned since 2010, there was a need for suggesting a suitable candidate for this insecticide. Fipronil is a broad use insecticide that belongs to the phenylpyrazole chemical family. It disrupts the insect central nervous system by blocking GABA-gated chloride channels and glutamate-gated chloride (GluCl) channels, resulting in central nervous system toxicity. This causes hyperexcitation of contaminated insects' nerves and muscles. It is effective on contact or ingestion. Fipronil is used to control ants, beetles, cockroaches, fleas, ticks, termites, mole crickets, thrips, rootworms, weevils, and other insects. Fipronil sticks tightly to soil and does not mix very well with water. Therefore, it does not move much in the soil and is not expected to leach into groundwater.

Materials and Methods

The research was conducted based on a completely randomized block design with 5 treatments and 5 replications during 2007 in Moghan (Ardabil, Iran). Treatments were 1) fipronil (GR 0.2%) @ 2 g/m^2, 2) fipronil (GR 0.2%) @ 2.5 g/m^2, 3) fipronil (GR 0.2%) @ 3 g/m^2, 4) toxic bait of carbaryl (EC 85%) @ 20 g/m^2 and 5) control (no-spray treatment). In order to prepare the toxic bait, 1.5 g of carbaryl (EC 85%) was added to 15 ml of water which was followed by mixing with 85 g of wheat bran. The treatments were applied in a 2 ha melon field ('Atashi' variety) in March 2007. Each plot was ca. 800 m^2 with 2 m border for each plot. The number of tunnels was recorded one day before treatment. The field was irrigated 2 days after treatment and on the third day after treatment, the number of tunnels was recorded. On the sixth day after treatment, the field was irrigated, and the next day, the number of tunnels was recorded. The efficacy of treatments was estimated based on the Henderson-Tilton formula (Henderson and Tilton, 1955):

$$\text{Efficacy}\% = 100 \times [1 - (Ta \times Cb)/(Tb \times Ca)]$$

where, *Ta* is the number of tunnels in treated plot after treatment, *Cb* is the number of tunnels in control plot before treatment, *Tb* is the number of tunnels in treated plot

before treatment, and *Ca* is the number of tunnels in control plot after treatment. This method is based on Hudson (1989) which suggests that the best method for sampling *G. gryllotalpa* population is counting the tunnels.

Data were analyzed using procedures of SAS (SAS Institute Inc., 2002). The normality of the untransformed and transformed data and also normality of residuals after analysis of variance were checked using stem-leaf and normal probability plots. Homoscedasticity was checked by observing graphical distribution plots of variance by mean (PROC PLOT). A General Linear Model (PROC GLM) was used to compare the efficacy of the treatments as well as the number of insects at different growth stages in the treatments (α=0.05). Comparisons between the treatments were made using the Tukey test, where analysis of variance showed significant differences among means.

Results and Discussion

The analysis of variance showed that there was a significant difference among treatments on the third ($F_{3,12} = 17.16$, $P = 0.0001$) and fourth ($F_{3,12} = 24.22$, $P < 0.0001$) day after the application. In both dates, the highest efficacy was observed in carbaryl followed by fipronil @ 3 g/m^2. The mortality rates between carbaryl and fipronil @ 3 g/m^2 was not significantly different based on Tukey test (Table 1). In all treatments, the efficacy was higher on the seventh day after application compared to the third day after application. The fipronil insecticide at 2 g/m^2 and 2.5 g/m^2 did not show acceptable control against European Mole Cricket. Each 0.5 g increase in application rate of fipronil, resulted in ca. 20% more mortality rate. Therefore, in future research, it is recommended to test the efficacy of fipronil at a rate of 3.5 and 4 g/m^2, in order to reach an efficacy ca. 80% or higher. At present, carbaryl application is banned in Iran; therefore, fipronil can be a suitable substitute for this insecticide. Ibrahim Sanaa (2001) reports that weekly application of azadirachtin (5 ml of extract / 50 ml of water mixed with 25 g of crushed maize) during four consecutive weeks significantly reduced the Mole Cricket tunnels up to 98%. In future research, efficacy of azadirachtin can be compared with fipronil. As fipronil residues tend to stay in the upper 15 cm of soil and exhibit low potential to leach to groundwater (New Pesticide Fact Sheet, 1996), it is more suitable for controlling pests that reside

Table 1

Mean (±SE) efficacy of different insecticides applied against European Mole Cricket, *Gryllotalpa gryllotalpa* (Orthoptera: Gryllotalpidae) in melon field at Moghan (Ardabil, Iran) in 2007

Treatments	Mean (± SE) efficacy on the third day after application	Mean (± SE) efficacy on the seventh day after application
fipronil (GR 0.2%) @ 2 g/m^2	15.95 ± 2.24 c	22.10 ± 2.62 c
fipronil (GR 0.2%) @ 2.5 g/m^2	30.30 ± 5.40 bc	48.36 ± 8.68 bc
fipronil (GR 0.2%) @ 3 g/m^2	46.53 ± 6.88 ab	64.43 ± 7.57 ab
carbaryl (EC 85%)@ 20 g/m^2	53.00 ± 5.73 a	80.72 ± 5.60 a

in the upper part of the soil such as Mole Crickets and Grape Vine Cicada, *Psalmocharias alhageos* (Homoptera: Cicadidae). Moreover, in aquatic environments, fipronil residues rapidly move from the water to the sediment with over 95% of the residues being found in or on the sediments within one week of application (Bobe et al., 1998).

Compliance with ethical standards:

Funding: This study was not funded by any organization.
Conflict of Interest: All authors declare that they no conflict of interest.
Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Literature

Bobe, A., Cooper, J. F., Coste, C. M. and Muller, M. A. (1998): Behaviour of fipronil in soil under Sahelian plain field conditions. Pestic. Sci., 52, 275–281.

Hayslip, N. C. (1943): Notes on biological studies of mole crickets at plant city, Florida. Florida Entomologist 26, 33–46.

Henderson, C. F. and Tilton, E. W. (1955): Tests with acaricides against the brown wheat mite. J. Econ. Entomol. 48, 157–161.

Hudson, W. G. (1987): Variability in development of *Scapteriscus acletus* (Orthoptera: Gryllotalpidae). Florida Entomologist 70, 403–404.

Hudson, W. G. (1989): Field sampling and population estimation of the tawny mole cricket (Orthoptera: Gryllotalpidae). Florida Entomologist 72, 337–343.

Ibrahim Sanaa, A. M. (2001): Antifeedant and molt disruption effects of Azadirachtin on mole crickets. Plant Protection Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt.

Matheny, Jr. E. L. (1981): Contrasting feeding habits of pest mole cricket species. J. Econ. Entomol. 74, 444–445.

Matheny, Jr. E. L., Tsedeke, A. and Smittle, B. J. (1981): Feeding response of mole cricket nymphs (Orthoptera: Gryllotalpidae: *Scapteriscus*) to radiolabeled grasses with and without alternative foods available. J. Georgia Entomol. Soc. 16, 492–495.

New Pesticide Fact Sheet (1996): US EPA, Office of Prevention, Pesticides and Toxic Substances, Washington DC, 20460, EPA-737-F-96-005. http://www.epa.gov/fedrgstr/EPA-PEST/199...ay-12/pr-736DIR/Facts/Factsheet.txt.html

Nickle, D. A. and Castner, J. L. (1984): Introduced species of mole crickets in the United States, Puerto Rico, and the Virgin Islands (Orthoptera: Gryllotalpidae). Ann. Entomol. Soc. of America 77, 450–465.

SAS Institute Inc. (2002): SAS/STAT user's guide. Version 9.1. SAS Institute Inc., Cary, North Carolina.

Schuster, D. J. and Price, J. F. (1992): Seedling feeding damage and preference of *Scapteriscus* spp. mole crickets (Orthoptera: Gryllotalpidae) associated with horticultural crops in west-central Florida. Florida Entomologist 75, 115–119.

Thomas, W. A. (1928): The Porto Rican mole cricket. USDA Farmers' Bulletin 1561. 8 p.

Walker, T. J. (ed.). (1985): Mole crickets in Florida. Florida Agricultural Experiment Station Bulletin 846. 54 p.

Walker, T. J. and Ngo, D. (1982): Mole crickets and pasture grasses: damage by *Scapteriscus vicinus*, but not by *S. acletus* (Orthoptera: Gryllotalpidae). Florida Entomologist 65, 300–306.

Worsham, E. L. and Reed, W. V. (1912): The mole cricket (*Scapteriscus didactylus* Latr.). Georgia Agricultural Experiment Station Bulletin 101. 263 p.