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Effect of *Ferula assafoetida* essential oil in controlling the black bean aphid

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Abstract

In order to evaluate the effect of different levels of *Ferula asafoetida* essential oil on controlling the black bean aphid a research was done in a completely random model with four replications, in 2012. Treatments were consisted of essential oils of assafoetida leaf and seeds in levels of (0, 100, 200, 300, 400 and 500 microliter per mL). This plant was collected from rangelands of Eastern Dena (Kakan) and their essential oils were extracted after drying and grinding by distillation method using Clevenger apparatus. The test was conducted in temperature of 25±1 ° C and a relative humidity of 60±10% (16 hours in darkness and 8 hours in lightness) using Topical test. The results showed that all essential oils had significant effect on the death rate of black bean aphid in level of 1% compared to the control. The highest death rate of black bean aphid was obtained in treatment of 500 microliter per mL of asafoetida leaf and seed essential oil. The minimal losses of black bean aphid were observed in treatment of control. Due to the high insecticidal property, the essential oil of this plant can be recommended as a low-risk insecticide for controlling the black bean aphid.

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Introduction

Pest damages in countries which don't have an advanced technology for planting, harvesting and storing are about 10% to 40% of the product. This important in some rural areas of Iran is sometimes up to 80% due to traditional and primary agriculture and warehouses (Motavalian, 2007).

These pesticides, which are designed to kill the organisms, are a serious threat for human health. According to the declaration of Cancer National Institute, 30% of insecticides, 60% of herbicides and 90% of fungicides are carcinogenic. This is just one of negative side effects of these substances, because chemicals can also damage the nervous and hormonal systems; among these, children are more vulnerable than adults against agricultural pesticides (Alichi, 1997; Motavalian, 2001).

Based on the obtained results, per capita consumption of pesticides in Iran is 400 g per each person. Also, the rate of using chemical fertilizer has been increased from 2.5 to 3.5 million tons in past 10 years. In current agriculture, more than 300 types of dangerous chemical compounds such as pesticides, herbicides and chemical fertilizers are used to control the pests, insects and fertilizing the soil. In addition to contaminating ground waters and air, remainders of these substances will be absorbed in plants and trees and a part of it is precipitated in agricultural products such as fruits and vegetables and will be transferred to the human body while consuming (Bagheri Zenoz, 1996; Alichi, 1997; Motavalian, 2001).

One of the potential sources for producing new pesticides is the substances produced by plants. The essential oils extracted from plants are usually decomposed in the environment earlier, so they have lower toxicity for humans and other mammals and have lower harmful effects on the environment (Modarres Najaf Abadi *et al.,* 2006).

Unfortunately, given that 1.2% of the world's agricultural lands are located in Iran, but 3% of the world's pesticides are also used in Iran which is posed as a serious threat.

Asafoetida is a plant of monocarp apiaceous, herbaceous, long life-time, straight and fleshy and relatively thick root, strong and tough and fibrous stem family. In wild habitats and natural environments, in first five years this plant has only a few leaves which is placed on the ground; eventually, a straight and fleshy stem comes out of these leaves which usually have a dusty appearance. The height of these stems is sometimes more than 2 meters (figure 1). The latex obtained from cutting or natural or artificial wound in the collar zone of Asafoetida (junction of the stem to the ground floor) is also called Asafoetida. It has a spicy sulfur smell like fetid and unbearable garlic odor with nasty taste. Despite its widespread usage, there has been no report about its adverse effects or possible risks so far.

Essential oil of Asafoetida is mainly used as flavoring in food industry specially in producing different types of sauces. Asafoetida gum was former the conventional spice of Romans and now a days, it is widely used in India as spice in making variety of foods, fish, vegetables and different sauces.

A desirable type of Assafoetida consists of 62% resin, 25% gum, 3% to 7% essence, 1.28% free ferulic acid and very low amount of vanillin. If it's' resin be under the effect of the ether, it will have a sediment which is a saresinotannol. Almost all of the Asafoetida gums contain the compounds of di, tri, tetra sulfide, Coumarin derivatives, Foetidin, Kamolonfrol, Episamarcandin, Umbelliperenin and conferlol.

Black bean aphid exists in many parts of the country and it is a polyphagous pest and in addition to broad beans, it also exists on beets, peas, beans, potatoes, boxwood and ... it attacks to about 50 plant species in Iran and to more than 200 plant species in the world. It is the carrier of more than 50 types of plant diseases. The pest damage is in form of complexity, yellowing and shortening of plants and stops the growing; therefore, it reduces the quality and quantity

of products (figure 2). The pest damage is combined with honeydew secretion. Reproduction of this insect is high in arid regions and the family of grains is known as the main host of this insect. It also damages other ornamental plants such as roses, chrysanthemum and other vegetables such as tomatoes, vegetables, squash and cucumber. Black bean aphid is also called the black beet aphid due to the severity of its outbreak in beet farms of Shiraz, Khorasan, Ardebil, Karaj and Hamadan (Shisheh Bor, 2001). Black bean aphid damages the bean severely in the early stages of growth and spreads the yellow mosaic disease on the bean by transmitting the virus indirectly. Air pollution can also increase the pests of black bean aphid (Dohmen *et al*., 1984).

The hosts of this pest are broad beans, chickpeas, beans, poppies, beets, spinach, boxwoods and weeds such as Solanum nigrum, Glycyrrhiza glabra, Rumex sp and Acroptilon repens L. This pest has more than 200 hosts in the world (Esmaeeli *et al.,* 2003). Mosaddegh and Kachili consider the beets, beans, broad beans, potatoes, safflowers, poppies, spinach, chards, oxalis, pumpkins, hemps and many other crops in Khuzestan as the hosts of the pest (Mosadegh and Kachili, 2002).

This insect is also the vector of 50 viral diseases such as beet mosaic virus and bean mosaic virus (Shisheh Bor, 2001). This pest is the vector of some viral diseases from poty group of viruses which their most important is the virus y of potato (Mosalla Nezhad *et al*, 2002).

Black bean aphid is one of important pests in bean farms and attacks to different types of beans. Research results show that feeding of this aphid delays the growth of different plants and reduce the dry weight of the plant aerial organs (Hailk and Gafar, 2007). A research conducted in Egypt was about reducing the rate of damages by black bean aphid on 5364 genotypes of bean. It was found that only 64 genotypes had the lowest rate of damage by pests that 2 digits of Rebya 40 and Giza 402 had the best conditions in 2 consecutive years. It has been observed that the plant is stricken with high complexity and has bad shape due to high compression of aphids on weeds or harvest and the aphid compression on the host is in compressed form (Weigand *etal.,* 1994).

Antibacterial properties of essential oils and resins were known highly by Egyptians about 3000 years before BC. They used these substances in embalmment of their death people. Essential oils are aromatic compounds which are found in different organs of plants. Generally, they are colorless, especially when they are fresh (Bekhradi, 2006).

The most important use of herbs with essential oils is to make perfumes. Essential oils are also used in medicines, industry, food and cosmetics. Many essential oils have antiseptic properties. Herbal insecticides such as essential oils are appropriate alternative for pesticides which insects are resistant towards them. Essential oils have a broad range of efficiency and are used against different pests (Isman, 2000). There is a kind of Artemisia called verlotrum.L which has repellency and anti-nutritional effects on Tribolium confusum (Negahban and Moharami Pour, 2007). Researches indicated that besides making losses in population of pests, eucalyptus and mint have great effect on the rate of hatching and departure of next generation pests (Yazdani, 1998; Modarres Najaf Abadi *et al.,* 2006).

In this study, we have tried to investigate the effect of the essential oil of asafoetida leaf and seeds on controlling the black bean aphid which is an important pest in different agricultural products.

Methods and materials

Research Location

In 2012, a research was done in laboratory of University of Medical Science in Yasuj in order to investigate the effect of different levels of *Ferula asafoetida* essential oil on controlling black bean aphid. The desired of *Ferula asafoetida* was collected from eastern Dena rangelands (Kakan) with geographical coordinates of 30 degrees and 41

minutes north latitude, 51 degrees and 46 minute east of the Greenwich meridian and at an altitude of 2,300 meters above the sea level in Boyer Ahmad city.

Time of collecting samples

asafoetida leaves and seeds were collected from grasslands of eastern Dena (Kakan) in second half of April 2012, in several different occasions. Black bean aphid was also collected from grain fields of Kakan region.

Methods of taking essential oil

All collected samples were dried in appropriate shade and ventilation condition. To take the essential oil, roughage branches of dried herbs were removed and leaves and seeds of dried herbs were changed to the form of powder using electric mill.

Each time 100 g powder was poured in a calibrated flask; first it was soaked with distilled water and after connecting to the Clevenger apparatus, 150 cc of water was added to perform the operation of taking essential oil. The collected oils were kept in dark sterile glassy containers in refrigerating condition.

Experimental treatments

This experiment was conducted in form of statistical model completely randomized. Treatments were consisted of essential oil of *ferula asafoetida* leaves and seeds in levels of 0, 100, 200, 300, 400 and 500 microliter per mL.

Experimental Method

This test was done based on the method of Rahman and Schmidt (1999) and Keita (2000) in glassy containers with bonnet. Required values of testing densities (0, 100, 200, 300, 400 and 500) were prepared using micropipette. Then, the prepared densities were poured in a piece of filter paper; next, the filter paper was put in a bonnet of glassy container (petri dish). The black bean aphid was transferred to the container after 20 minutes. After that, the samples were put in appropriate thermal condition between 25±1 and relative humidity of 60±10 percent for 16 hours in dark place and 8 hours in light place (in control treatment or zero density, pure water was used and in other treatments, the used essential oil was prepared in different densities). The results of different treatments based on density of the essential oil and also the type of organ used in this test were investigated (after 24 hours, the number of dead insects in containers of treatment and control were counted) and the percent of insects mortality was studied.

Statistical analysis

After collecting data using SAS statistical software, the analysis of variance and comparing the means was conducted with Duncan's multiple range tests in one percent probability level. Also, EXCEL software was used to draw the graphs.

Results

Essential oil of Asafoetida leaf

Based on the results of the table of variance analysis, there was a significant difference at probability level of 1% in case of the effect of asafoetida leaf essential oil on death rate of black bean aphid (table 1).

Table 1. Analyze variance of data squares of asafoetida leaf essential oil on death rate of black bean aphid.

Change sources	Degree of freedom	Mean-square
		Number of losses
Repetition	3	9.04*
Essential oil of asafoetida leaf	5	78.841**
Error	15	3.452
Percentage of variation coefficient (%CV)		20.45

* and **: significant at the 5 and 1% levels of probability, respectively.

Table 2. Analyze variance of data squares of asafoetida Seed essential oil on death rate of black bean aphid

Change sources	Degree of freedom	Mean-square
		Number of losses
Repetition	3	0.819*
Essential oil of asafoetida Seed	5	79.741**
Error	15	3.452
Percentage of variation coefficient (%CV)		19.13

* and **: significant at the 5 and 1% levels of probability, respectively.

Fig. 1. *Ferula assafoetida.*

Fig. 2. (a,b) Damage of black bean aphid in beans farm, colony of black bean aphid.

The results of comparing the means using Duncan's test showed that there was a significant difference between different levels of essential oil Asafoetida leaf and control in case of black bean aphids death. The highest death rate of black bean aphid (12.75) was related to the treatments of 400 and 500 microliter per mL in essential oil of Asafoetida leaf and the lowest death rate of black bean aphid (1.25) was related to the control treatment (no use of essential oil of Asafoetida leaf) (figure 3).

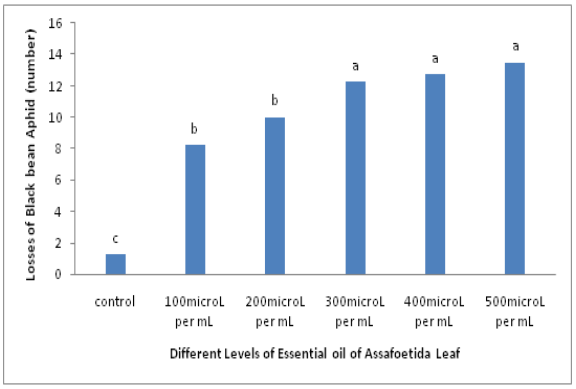

Fig. 3. The effect of different levels of essential oil of Asafoetida leaf on death rate of black bean aphid.

Asafoetida seed oil

The results of the analysis of variance indicated a significant difference at probability level of 1% in case of the effect of Asafoetida leaf essential oil on death rate of black bean aphid (table 2).

The results of comparing the means with Duncan's test indicated that there was a significant difference between different levels of essential oil of Asafoetida seed with control in case of death rate in black bean aphid; it was so that the highest death rate of black bean aphid (13.5) was related to the treatment of 500 microliter per mL of Asafoetida seed essential oil and the lowest death rate of black bean aphid (1.5) was related to treatment of control (not use of Asafoetida seed essential oil) (figure 4).

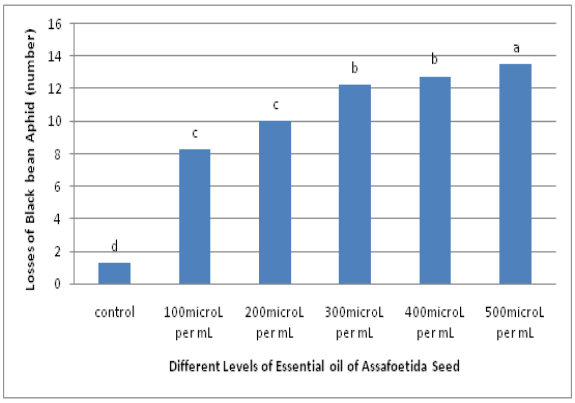

Fig. 4. Effect of different levels of seed essential oil of Asafoetida on death rate of black bean aphid.

Conclusion

The results of the analysis of variance showed that treatment of essential oil of Asafoetida leaf and seed had significant effect on death rate of black bean aphid at probability level of 1%. According to the obtained results, the highest rate of losses was related to the treatment of 500 microliter per mL (13.5) of Asafoetida seed essential oil. Findings of the experiment indicated that the rate of losses of black bean aphid had the lowest amount in all experiments in control treatment (no use of Asafoetida leaf and seed essential oil). According to the results of this research, the densities of 300 microliters of leaf essential oil and 500 microliters of Asafoetida seed essential oil is recommended in order to increase the death rate of black bean aphid. It is also suggested to investigate the effect of these natural products in farm environment on controlling the black bean aphids.

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