Natural parasitism of the diamondback moth, Plutella xylostella (L.) (Lep.: Plutellidae) by a larval parasitoid wasp, Diadegma anurum on different cauliflower cultivars

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Natural parasitism of the diamondback moth, *Plutella xylostella* (L.) (Lep.: Plutellidae) by a larval parasitoid wasp, *Diadegma anurum* on different cauliflower cultivars

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The diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae), is the most serious pest of cauliflower fields in central Iran and its control is primarily based on pesticide sprays. Over the past years, a number of new pesticide compounds were introduced onto the market and some of them may cause adverse effects on natural populations of parasitoids associated with DBM. Excessive use of insecticides against the pest did not produce satisfactory results but has caused concerns about environmental pollution and increased pest resistance to chemicals. This research aims to study natural parasitism of pest on different cauliflower cultivars in the fields of south of Tehran. Dominant species of parasitoids include *Diadegma anurum*, *Cotesia plutellae* and *Oomyzus sokolowskii*. The highest parasitism rate was observed by *D. anurum* that was recorded on Buris cultivar (19.92 ± 1.06) and White cloud cultivar (16.20 ± 1.49) and the lowest parasitism rate was observed on Snow crown cultivar (3.42) and SG cultivar (5.00) during the season.

**Keywords:** *Plutella xylostella*; parasitism rate; *Diadegma anurum*; cauliflower cultivars; Tehran

Introduction

Cauliflower is a variety (*Brassica oleracea* var. *botrytis*) of the cruciferous family (*Brassicaceae* = *Cruciferae*). Plants of this family have high economic value and are used as a source of oil, medicine, animal feed, green manure and ornamental plants (Talekar & Shelton 1993). The diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae), is the most serious pest of cauliflower fields in central Iran. The first instar sometimes feeds in the spongy plant tissue beneath the leaf surface forming shallow mines that appear as numerous white marks. The larvae are surface feeders in all subsequent stages. These larvae feed on the lower leaf surface 62–78% of the time, chewing irregular patches in the leaves (Harcourt 1986). On some leaves, the larvae feed on all but the upper epidermis creating a “windowing” effect. The last stage larva is a voracious feeder; it causes more injury than the first three larval instars (Harcourt 1986; Mitchell et al. 1997). Since the early 1990s and over the past years, a number of new pesticide compounds have been introduced to the market: some of them causing

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adverse effects on natural populations of parasitoids associated with DBM (Cheng et al. 1990; Zu-hua et al. 2004; Naveed 2005). It has shown resistance to a large number of chemical insecticides that are used against it. From the important regions of cabbage implant of the world have been many reports about resistance of the DBM to consumable insecticides (Sun et al. 1978; Altmann 1988; Hama 1992; Mota-Sanchez et al. 2002). It seems that other management programmes are essential to control this pest; including a management programme for pest control using resistant cultivars. The use of resistant cultivars is one of the effective methods for controlling pests in different crops. The use of resistant cultivars has many advantages in integrated pest management. Resistant cultivars reduce pest damage with the least cost for farmers (Reagan et al. 1997). Resistant cultivars due to resistance mechanism type could affect pest population in the short or long term and despite the existence of pest, yield reduction is not found in the product (Nouri-Ghanblani et al. 1995). Cruciferae plants have different susceptibility to the DBM. That can be one of the reasons for the presence of wax on leaf surface. Kohlrabi and turnip are two of the resistant Cruciferae to this pest (Eigenbrode & Trumble 1994; Eigenbrode et al. 1995; Capinera 2001). Presence of wax on smooth and shiny leaves has caused rejection of these plants by neonate larvae. Larva in this type of plant tissue expends more time on searching and less time on feeding. This cultivars improved the mobility of some of the predators that have not well move in ordinary crucifer crops (Eigenbrode & Trumble 1994; Eigenbrode et al. 1995). Percentage of parasitism by *Diadegma insulare* was conducted on different canola cultivars in laboratory conditions. The results showed that there is significant difference between parasitism rate on different cultivars and it was variable from 27 to 60%. Different canola cultivars have different effects on the longevity, adult weight and weight of pupa silk of this parasitoid (Sarfraz et al. 2008).

As indiscriminate use of chemical insecticides will result in resistance incidence in pest, also other control management factors, including the use of resistant cultivars and protection of natural enemies, will find a prominent role. Use of resistant cultivars will affect the pest parasitoids in addition to reducing the pest population. Use of resistant cultivars will lead to the reduction of pest populations and increase the efficiency of parasitoids. Due to importance of constituencies, present study was conducted for the first time on different cauliflower cultivars and provides a management programme solution.

**Materials and methods**

Fluctuations of parasitism of DBM was tested in the field during 2011 in terms of natural pollution at the Shahed University research field (south of Tehran) on the eight cauliflower cultivars (including Smilla, Snow mystique, White cloud, Buris, Galiblanka, Snow crown, SG and Tokita). An experiment was carried out in randomised complete block design with five replications. Twenty-five plants per plot were cultivated. Each plant was presumed as a sampling unit and sample size was determined as two host plants in each plot for each sampling time. The plants that had larvae were selected and were presumed as a sampling unit and healthy plants (zero larvae number) were not. Sampling was carried out every 10 days. All larvae and pupae were collected during the season and cut pieces of host plant were transported to the growth chamber at 25 ± 2 °C and 65±5% RH and 16:8 L:D. Larvae related to each plant and each cultivar was placed in clear plastic containers (5 × 20 × 10 cm) which contained the leaf of each cultivar, separately. For survival of the leaves, the ends of the leaves were placed in wet
cotton. The leaves were replaced once every two or three days with fresh leaves. DBM pupa was placed inside the test tube (1 × 10 cm) and was kept until appearance of adults or parasitoids.

Statistical analyses
Analyses of variance for a completely randomised block design were performed to test the differences between treatments, and means were compared at the 5% level of significance using the Duncan studentised range test (Littell et al. 2002; SAS Institute 2004). For analysis and mean comparison, mean of different developmental stages in each sampling date was considered as a replicate. Correlation (Linear Regression) was used to detect the relationship between pest density and percentage of parasitism.

Results

Fluctuations of parasitism of DBM by Diadegma anurum on different cauliflower cultivars
Fluctuations of percentage of parasitism by *D. anurum* on different cauliflower cultivars are shown in Figure 1. As is observed in this figure, percentage of parasitism was highest on White cloud (21.66 ± 7.87) and Buris cultivars (21.66 ± 11.66) in the beginning of season. At the same time, the lowest percentage of parasitism was observed on Galiblaneka and Snow crown cultivars and parasitoid activity was not observed on these cultivars on 20 August. The highest parasitism rate was observed on all cultivars on 31 October. In this time, percentage of parasitism was highest on Buris cultivar (23.28 ± 8.21) and it

![Figure 1](image-url)
was lowest on Snow crown cultivar (7.50 ± 5.33). The highest percentage of parasitism was observed on Buris (19.92 ± 1.06) and White cloud cultivars (16.20 ± 1.49) during the season. The lowest percentage of parasitism was observed on Snow crown (3.42 ± 0.96) and SG cultivars (5.00 ± 0.99) during the season.

**Comparison of parasitism of DBM on different cauliflower cultivars at the time of the parasitoid peak activity**

The statistical comparison of percentage of parasitism of DBM on different cauliflower cultivars at the end of season is shown in Table 2. There is significant difference between percentage of parasitism on different cultivars ($p < 0.05$) (Table 1). The highest parasitism was observed on Buris (19.70 ± 1.06 Aa) and White cloud cultivars (15.71 ± 1.49). Snow crown (2.28 ± 0.962.28 ± 0.96) and SG (4.06 ± 0.99) had lower percentage of parasitism.

**Relationship between pest density and parasitism of D. unurum on different cauliflower cultivars**

Relationship between pest density and percentage of parasitism of *D. unurum* on different cauliflower cultivars during the season is shown in Figure 2. Snow mystique cultivar despite had lower pest density of the DBM (2.37 ± 0.15) and had percent parasitism (19.92 ± 2.57) more than other cultivars. Difference between percent parasitism and pest density on White cloud and Tokita cultivars was more than other cultivars. Difference between percent parasitism and pest density was lower in other cultivars. Despite there

<table>
<thead>
<tr>
<th>Table 1. Results of data analysis of parasitism rate (%) of DBM by <em>D. anurum</em> on cauliflower cultivars.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Cultivar</td>
</tr>
<tr>
<td>Error</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

**Significant at 1% probability level.***
<table>
<thead>
<tr>
<th>Table 2. Comparison mean (± SE) of parasitism rate (%) of DBM by <em>D. anurum</em> on cauliflower cultivars.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivars</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Smilla</td>
</tr>
<tr>
<td>Snow mystique</td>
</tr>
<tr>
<td>White cloud</td>
</tr>
<tr>
<td>Buris</td>
</tr>
<tr>
<td>Galiblanaka</td>
</tr>
<tr>
<td>Snow crown</td>
</tr>
<tr>
<td>SG</td>
</tr>
<tr>
<td>Tokita</td>
</tr>
</tbody>
</table>

The means followed by the same small letter within a same column of each development stage are not significantly different between different host plants ($p < 0.01$; Duncan).
being not many differences between percent parasitism and pest density on Smilla and Snow mystique cultivars, pest density on this cultivar was more than other cultivars.

Regression between density of DBM and parasitism rate on different cultivars

Regression relationship between pest density on each cultivar and parasitism rate by parasitoids of DBM in different cultivar has shown that behaviour of this parasitoids has particular dependence to DBM density. The significant difference between DBM density and parasitism rate shows that there is relationship between DBM density and parasitism rate in each cultivar. Since the $R^2$ has little value, this model is not a good representative for the reaction type of parasitoid to pest density. Possibly, other factors except pest density have been effective on parasitoid activity. But Since $R^2$ has high value, this model can well explain this relationship. Slope of regression line is negative in the relationship between density and parasitism rate; which shows that there is an inverse relationship between density and percentage of parasitism.

According to Table 3, there are nosignificant differences in regression between DBM density and parasitism rate of $D. unurum$ in different cultivars ($p < 0.05$).

Discussion

Results of this research showed that percentage of parasitism of DBM was different on different cauliflower cultivars during the season. The highest parasitism was observed on White cloud and Buris cultivars. On the other hand, the lowest parasitism occurred on Snow crown and SG cultivars. Also, the highest percentage of parasitism was observed on different cultivars at the end of season. In addition, statistical comparison of parasitism at the time of the parasitoid peak activity showed that parasitism on Buris...
and White cloud cultivars was more than other cultivars and there was significant difference between different cultivars despite the higher density of pest on Smilla and Snow mystique cultivars; the highest percentage of parasitism was not observed on these cultivars. So, these two cultivars were not suitable for parasitoid activity of DBM. Golizadeh (2008) (in Karaj-Tehran) and Hasanshahi (2012) (in Tehran) reported that *D. unurum* has the highest percentage of parasitism and *O. sokolowskii* has the lowest percentage of parasitism in between three species of parasitoids of DBM. Afniizadeh, Karimzadeh, Broad et al. (2010) studies in Karaj showed that *C. plutellae* with 54% and *D. semiclausum* with 34% abundance are dominant species among different parasitoids. Afniizadeh, Karimzadeh, Shojai et al. (2010) studied percentage of parasitism of DBM on cauliflower and savoy cabbage cultivars that this review showed that percentage of parasitism on savoy cabbage cultivar (42%) was higher than cauliflower cultivar (34%). Bozorg-Amirkalaee et al. (2010) studied parasitoid activity of DBM on different cauliflower cultivars. In this review, percentage of parasitism was shown significantly more on Hyola401, Option500, Adder, Ebonite and Opera cultivars and percentage of parasitism was shown significantly less on Hyola308, PF/7045/91, Elvis, Hyola60 and Jewel cultivars. Hasanshahi et al. (2013) studied density of DBM on different cauliflower cultivars; the results showed that the Buris and Snow crown cultivars had the lowest infestation and had a kind of resistance to pest. Effect of eight cauliflower cultivars on biological parameters of the cabbage aphid, *Brevicoryne brassicae* (L.) (Hem: Aphididae), was reviewed in controlled condition. The results showed that using cauliflower cultivars affected the adult biological parameters (Jahan et al. 2013a). Askarianzadeh et al. (2013) studied the density of DBM on different canola cultivars. Jahan et al. (2013b) studied density of *B. brassicae* (L.) (Hom.: Aphididae) and its parasitoid *Diaeretiella rapae* on different cauliflower cultivars; and this review showed that using of Smilla, Buris and SG cultivars probably increases the efficiency of *D. rapae* in the control of the *B. brassica* (L.). In our study, plant resistance changed with plant phenology. Other studies also show that plant resistance changes with plant phenology and effectiveness on biological parameters of insect (Jahan et al. 2013a; Esmaeili-Vardanjani et al. 2013).

**Acknowledgements**

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<table>
<thead>
<tr>
<th>Cultivar</th>
<th>$R^2$ ($F$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smilla</td>
<td>0.31 (4.59)$^{**}$</td>
</tr>
<tr>
<td>Snow mystique</td>
<td>0.03 (0.26)$^{ns}$</td>
</tr>
<tr>
<td>White cloud</td>
<td>0.01 (0.02)$^{ns}$</td>
</tr>
<tr>
<td>Buris</td>
<td>0.03 (0.25)$^{ns}$</td>
</tr>
<tr>
<td>Galiblanka</td>
<td>0.37 (4.91)$^{**}$</td>
</tr>
<tr>
<td>Snow crown</td>
<td>0.35 (3.83)$^{**}$</td>
</tr>
<tr>
<td>SG</td>
<td>0.09 (0.72)$^{ns}$</td>
</tr>
<tr>
<td>Tokita</td>
<td>0.04 (0.34)$^{ns}$</td>
</tr>
</tbody>
</table>

$^{**}$Significant at 1% probability level.  
$^{*}$Significant at 5% probability level.  
$^{ns}$Non-significant.
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Hasanshahi G. 2012. Natural parasitism of the diamondback Moth, Plutella xylostella (L.) (Lep.: Plutellidae) in the cauliflower fields of the South of Tehran. [Thesis Submitted in Partial Fulfillment of the Requirements for the degree of Master of Science]. Agricultural Entomology Department of Plant Protection Shahed University; p. 133.


