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Full Length Research Paper

A survey on pest insect fauna of safflower fields in the Iranian Province of Kohgiloyeh and Boyerahmad

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Safflower (*Carthamus tinctorius* L.) is an important oilseed crop and an essential component of cropping systems in the dry regions and marginal areas of the world. Since the identification of insect pests and their natural enemies is one of the most efficient methods for pest management, an attempt was made to investigate insect fauna in safflower fields of Kohgiloyeh and Boyerahmad Provinces, Iran. To accomplish this, three main cultivation regions were selected and insect pests and their natural enemies were surveyed and collected according to the plant phenology during 2008 to 2009. To sample different techniques, such as sweeping, sticky yellow traps, bait traps and rearing of adult insects, were used. Pest insect fauna was as follows: 1) Pest insects feeding inside the flower heads (bolls) and their natural enemies: *Acanthiophilus helianthi*, *Chaetorellia carthami*, *Trellia luteola* (Tephritidae), *Antistrophoplex conthurnatus*, *Microdontomenu annulatus* (Torymidae), *Bracon hebetor*, *Bracon luteator* (Braconidae); unidentified specimen (Ichneumonidae), *Pronotalia carlinarum* (Eulophidae), *Ormyrus orientalis* (Ormyridae), *Colotrechnus viridis*, *Pteromalus* sp. (Pteromalidae), *Eurytoma acroptilae* (Eurytomidae); *Isocolus tinctorius* (Cynipidae). 2) Pest insects feeding around the flower heads (bolls) and their natural enemies: *Oxycarenus palens*, *Oxycarenus hyalipennis*, *Lygus* spp. (Lygaeidae), unidentified specimens (Dermestidae), Aphids and Thripses. 3) Pests insects feeding on other parts and their natural enemies: *Uroleucon compositae*, *Pleotrichophorus glandolosus*, *Brachycaudus helichrysi* (Aphididae), *Lysiphlebus fabarum* (Braconidae), *Pachyneuron concolor* (Pteromalidae), *Coccinella septempunctata*, *Hippodamia variegata* (Coccinellidae), *Orius* spp. (Anthocoridae); *Chrysoperla carnea* (Chrysopidae); *Neoaliturus fenestratus*, *Euscelis alsius*, *Macrosteles laevis*, *Psammotettix striatus*, *Circulifer haematoceps* (Cicadellidae); *Reptalus bitinctus* (Cixiidae), *Thrips tabaci* (Thripidae); *Aeolothrips collaris* (Aeolothripidae); *Haplothrips* sp. (Phlaeothripidae), *Chromatomyia horticola* (Agromyzidae), *Agrotis* sp., *Helicoverpa peltigera* (Noctuidae). The results indicate that various insect pests and their natural enemies are active in the safflower fields, and that their identification is very important for various control methods.

Key words: Pest, fauna, safflower, integrated pest management.

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is one of the world's oldest crops (Vargas et al., 2008). Evidence of seeds and dyes from *Carthamus* has been found in Egyptian tombs, along with pictographic representations (Hallman, 2008). Historically, the crop was grown for the flowers that contained cardimin, an agent that was used to dye cloth. The flowers were also used in food preparation and Chinese herbal medicines. It was not until the 1800s that safflower was grown as an oil crop (Sabzalian et al., 2008). It has traditionally been grown in small plots for personal use and remains a minor crop in the world market. Currently, it is grown in more than 60 countries, with area of growth totaling 691,436 ha worldwide (FAO, 2008) with greatest production in India, Mexico and the USA. India is the largest producer of safflower seed in the world with most of the oil used for the domestic food market. It is still grown in China for herbal medicines derived from the floral tissue (Vaishampayan and Kapoor, 1970). In North America, safflower is grown in the USA, Canada, and Mexico for both oil and bird seed. It is an

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annual plant from the family of Compositae or Asteraceae and the genus *Carthamus*. Safflower is available in 25 important species, and the *C. tinctorius* is the only agricultural crop in the world. The safflower is an annual plant with bulky branches and thorny leaves. Its height ranges from 30 to 150 cm. Its seeds contain between 30 to 45% oil (Naseri, 1991). The safflower meal is used to feed the cattle and poultry (Khajepour, 1991).

According to statistics, the area under the cultivation of the safflower is about 1000 ha^2 in Iran with an average annual production of 700 tons (Froozan, 1999). This size of cultivation has been promoted due to the policies set by the Iranian Ministry of Agriculture. Hence, the Province of Kohgiloyeh and Boyerahmad increased the cultivation area from 20 ha^2 in the farming year of 1998 to 100 ha^2 in the farming year of 2002 (Personal interview with the Provincial Head of the Jihad Organization). The increase in the cultivation area prepares the ground for the activities of the pests and, hence, the damage to the plants. Therefore, the study of fauna of the pest of the safflower and the natural enemies is an effective step in the optimal management of the produce and an integrated management of the pests of this crop. Within the country, there is a scarcity of information on the safflower pests. In Iran there are only three described insect pests of safflower, namely (the lygaeidae of the safflower seeds or *Oxycarenus pal*ens H. Sch. and lygaeidae of the cotton seeds or *Oxycarenus hyalipennis* Costa) and one species of fruit fly (the safflower capsule fly or *Acanhiophilus helianthi* Rossi) (Behdad, 1989; Modaresaval, 1994). All over the world, there are only 22 species of safflower pests which are related to the order of Diptera and Coleoptera insects. In the Middle East, 15 species of safflower pests have been reported out of which 11 species are Coleoptera and four species are Diptera (Campobasso et al., 1999).

In the description of the safflower, there is a mention made of 15 species and 5 genera of insects and one species of mite as the pests of the safflower (Anon, 1987). The findings by the Indian researchers show that two species of Tephritidae flies are the main pests of the safflower, and that the population of the aphids increased in a week in a cloudy condition (Bhadauria et al., 1999). In Tooskani region, two agents, namely rust of the safflower and the safflower capsule fly, were of the destructive agents to the safflower (Sakra, 1999). In Egypt, the safflower capsule fly is one of the most important pests of the safflower, which is attacked by three species of parasitoid wasps from the families of Eulophidae, (*Pronatalia* sp.) Torymidae, (*Antistrophophlex conthurnatus*) and Pteromalidae (*Pteromalus* sp.) (Hegazi and Moursi, 1983). According to Giray (1979), the safflower capsule fly can also attack the *Xanthium spihosum*, which is medicinally significant. In an investigation to the safflower pest in Iraq, the following were discovered about the safflower: 23 species of insects including 11 species of beetles, 6 species of bug, 2 species of diptera, 2 species of thrips, one species of butterfly and one species of termite (Selim, 1977).

In the study on the species from the genus *Chaetorellia*, (Dip.: Tephritidae) the species *Chaetorellia. carthami*, Stackelberg was reported as the safflower pest common to such countries as Iraq, Isreal, and Kirkizistan (Gharali and Jozian, 2001). The weed of the wild safflower (*Crataegus oxycanthus*) is an annual weed called Carithamus (Shimi and Termeh, 1994). This weed is also known as the yellow thorn. The wild safflower has long been naturally growing in different regions, and due to its morphological and biological features, there has been fauna rich in insects in the past years. This weed is a self-growing plant in the wild (as it is in the regions of Basht, Dehdasht, Dill and Yasooj), and it also grows in different safflower fields of the province. Since this plant can be an ecological source for the dissemination of the pests or the factor contributing to their population rise and given the vast areas under the cultivation of the safflowers, it is essential to study the insects living in them. It has been reported that based on the wild species of the safflower, known as *Citrullus lantatus*, 11 species of insects from different orders have been identified, some of which are in common with the farming safflower (White and Marquardt, 1989). The studies carried out on the weed *Centurea* in Turkey showed that two species of the fruit flies and one species of snout beetle from the family of Curculionidae have a key role in its biological control (Kedici et al., 1994).

According to the reports by Manojlavie (1991), four species of fruit flies are active in the weed Centurea. In Romania, it became known that 5 species of insects from the orders of Diptera and Coleoptera feed on the stem, seeds and flowers of this weed (Perju and Moldovan, 1991). The studies conducted on the fruit flies which control the weeds from the family of Cichoriaceae show that the flies *A. helianthi* and *Urophora quadrifasciata* have limited hosting domain. This is probably due to the sibling hosting species (White et al., 1990). Among the flies which have the highest control over the production of the seeds of the Sonchus weed, the following can be named: 5 species of the fruit flies, minosis flies, and the carabidae beetle from the genus *Harpalus* which reduces 30 to 50% of the amount of the seeds (Shurvenko, 1983).

MATERIALS AND METHODS

Safflower is cultivated in Kohgiloyeh and Boyerahmad in both spring and summer. Statistics were consulted to identify the main regions of cultivation in this province. Sampling was conducted during the growing season. To investigate the distribution of the pests, they were divided into three groups and the sampling was carried out as follows:

The pests that feed on the inside of the flower head: After the formation of the flower head, the intended fields were visited and 10 samples, each of which had 30 flower heads, were randomly

collected. In the laboratory, the samples were inspected under the microscope and the percentage of their contamination was determined. About 100 flower heads were randomly picked and were placed in the lab growth dish. The insects were collected and their frequency per one hundred flower heads was determined. In this study, the existing parasitoids were also identified.

The pests that feed on the outside of the flower heads: After the formation of the flower head, the intended fields were visited and about 100 flower heads were randomly picked. The insects on them were collected by means of shaking, using an aspirator and so on. Next, the density of each species was separately recorded.

The pests that feed on the other parts of the plant: For sampling, when the insects were not as active as the aphids, and fed on certain areas, three plants were randomly selected and the number of the infested stems was counted. In each plant, two infested stems which were as long as 10 cm were chosen and the insects living on them were counted. In the case of the insects which were active, three plants were randomly chosen and the insects living on them were collected and counted. Meanwhile, on each farm five nets were installed along the sides of the farms. The captured insects were separated in the laboratory and their density determined. For the control of the wild safflowers, in addition to the visits to the farms, the insects on the bushes of this plant inside and on the margins of the farms were collected in different ways such as hitting or using aspirators. The infested flower heads which had larvae were transferred to the laboratory and placed in the growth dishes. The sampling was conducted in some regions of the province where there were plains with wild safflowers (as in the regions of Basht, Dill, Dehdasht and Yasooj). The collected samples of the insects with the valid keys of identification were sent to the specialists for the determination or confirmation of their scientific names.

RESULTS AND DISCUSSION

In the laboratory, the collected insects were separated and identified based on the reliable sources and by consulting experts. The insects which have been phenologically collected and identified so far are as thus described.

The pests that feed on the inside of the flower heads

They include such species as *A. helianthi*, *C. carthami* and *Trellia luteola* (Table 1). The species *A. helianthi* has long been known as the safflower capsule fly in different areas in the province where safflower were raised. It has been considered as the main pest of the safflower (Behdad, 1989). This fly is 4 to 5 mm long and its general color is grey-greenish. It has sporadic dark colors at the top of the wings, which is more outstanding in the males. The females have outstanding ovipositors. In the infested flower heads, there are at least 7 and at most 25 pupas. However, on average in the majority of the flower heads there are 3 to 8 pupas. It has been estimated that there are about 16.5% flies in an infested flower head. In the city of Basht, this figure amounted to 32.5% in the areas of Dehdasht (Kohgiloyeh) and Dill. The sampling carried out in the field of spring time cultivation showed that the density and the severity of the damage by the safflower capsule flies at the late cultivation (late March and April) was higher than those in the early cultivation (late February). From the flower heads containing the safflower capsule flies, some samples of parasitoid wasps were collected and sent to an institute for identification. Lotfalizadeh labeled these samples as: *Antistrophoplex conthurnatus* Masi (Torymidae), *Bracon hebetor* Say (Braconidae), *Pachyneuron concolor* (Forster) (Pteromalidae).

It should be noted that in most sources the last species has been named hyperparasitoid. All the three species of fruit flies were reported in the province for the first time. In Iran, *C. carthami* species was first reported in 2001 in Ilam Province (Gharali and Jozian, 2001). This species is generally yellow. It has four outstanding brown stripes on its wings. A limited number of this species were collected from the growth dishes containing the infested flower heads gathered from the regions of Gachsaran and Basht.

The pests that feed on the outside of the flower head

The collected insects include lygaeidae bugs, aphids, thrips, and dermestidae beetles (Table 2). Basically, these insects feed on the aerial organs, such as flower head, but some others like lygaeidae specifically damage the surface of the flower head. There are two species of lygaeidae from the genus *Oxycarenus* namely, *O. palens* and *O. hyalipennis* (Behdad, 1998). These two species are distinguished by their body color, the length of their proboscis, and the thorny legs. The damage that these insect bring about is in the way they feed on the flower head, which causes the latex to leave the flower head, the internal seeds turn dark and get spoiled and the infested flower heads lean sideway. The density of these species in different regions and in different periods of cultivation was different. It seems that the density of the lygaeidae is higher in the summer cultivation than that in spring, and the density is higher in the early periods of spring cultivation than in late periods.

In the spring cultivation, there were, on average, 20 to 25 lygaeidae from both species in 100 nets, while in the summer cultivation there were, on average, 30 to 35 lygaeidae from both species in 100 nets. The percentage of contamination of the flower heads was different and on average amounted to 40%. It is necessary to mention that the damage of the large Lygacidae like *Lygus* spp. was similar to the Lygacidae and caused the flower head to lean sideway. Moreover, the damage of the thrips on the surface of the flower head was in the form of latex exiting. Given the presence of these insects on the safflower farms, it seems that these insects must be studied more carefully in terms of the separation of the damage signs.

The Dermestid beetles are seen when the flower heads become ripe and dried on the farms. They are probably

Table 1. Pest insects feeding inside the flower heads of safflower.

Number	Scientific name	Common name	Family	Order
1	*Acanthiophilus helianthi*	Safflower fly	Tephritidae	Diptera
2	*Chaetorellia carthami*	Fruit fly	Tephritidae	Diptera
3	*Trellia luteola*	Fruit fly	Tephritidae	Diptera
4	*Larinus flavescens*	-	Curculionidae	Coleoptera
5	*Larinus liliputanus*	-	Curculionidae	Coleoptera
6	*Helicoverpa peltigera*	-	Noctuidae	Lepidoptera

Fruit flies (Dip.: Tephritidae)

Table 2. Pest insects feeding outside the flower heads of safflower.

Number	Scientific name	Common name	Family	Order
1	*Oxycarenus palens*	-	Lygaeidae	Hemiptera
2	*Oxycarenus hyalipennis*	-	Lygaeidae	Hemiptera
3	*Lygus* sp	-	Lygaeidae	Hemiptera
4	Unidentified specimen	-	Dermestidae	Coleoptera
5	Unidentified specimen	- Aphids	Aphididae	Homoptera
6	Unidentified specimen	Thripses	Thripidae	Thysanoptera

Hem. : Lygaeidae.

Table 3. Pest insects feeding on the parts of safflower.

Number	Scientific name	Common name	Family	Order
1	*Uroleucon compositae*	-	Aphididae	Homoptera
2	*Pleotrichophorus glandolosus*	-	Aphididae	Homoptera
3	*Brachycaudus helichrysi*	-	Aphididae	Homoptera
4	*Neoaliturus fenestratus,*	-	Cicadellidae	Homoptera
5	*Euscelis alsius*	-	Cicadellidae	Homoptera
6	*Macrosteles laevis*	-	Cicadellidae	Homoptera
7	*Psammotettix striatus*	-	Cicadellidae	Homoptera
8	*Circulifer haematoceps*	-	Cicadellidae	Homoptera
9	*Thrips tabaci*	-	Thripidae	Thysanoptera
10	*Aeolothrips collaris*	-	Aeolothripidae	Thysanoptera
11	*Haplothrips sp*	-	Phlaeothripidae	Thysanoptera
12	*Helicoverpa peltigera*	-	Noctuidae	Lepidoptera

from the genus *Athagenus* and apparently feed on the dried flower heads. It is necessary to mention that at the time when the flower heads get dried, the thrips start acting on the flower heads.

The pests that feed on the other organs of the plant

No damage or activity by the insect was seen on the roots of the safflowers. However, there was some insect activity on the aerial organs of the bushes (Table 3). This can be generally classified into two groups:

A) *Sucking insects*

This group includes two species of aphids, several species of leaf hoppers and one species of thrips. The final definite identification of the species is in progress. At present, the damage of the aphids is of higher economic importance as their density and severity of the damage in some regions like Gachsaran are so high that the farmers have to use pesticide against them:

The aphids (Hom.: Aphididae): There are two aphids on the safflowers: 'blood' or maroon aphids and the green

aphids. Generally, the population of the blood aphids is bigger than that of the green aphids, which are mainly seen just as some tiny spots in the fields. These aphids damage the bushes in the process of growth. The severe contamination of the bushes by the blood aphids is seen in the first stages of the growth of the bushes in some regions such as Basht. In this case, the bushes undergo dwarfing and lateness in growth. The density of the blood aphids in the region of Gachsaran was on average 220 to 280 aphids on the final 10 cm part of the branches. This number was, on average, 83 in other regions. Many natural enemies were collected in the fields. The hunting insects collected included ladybugs (*Coccinella septempunctata* and *Hippodamia variegata*), bugs Anthocoridae (*Orius* spp.) and green lecewings (Chrysoperlla*carnea*) and the (unknown) bugs (Miridae). Some species of parasitoid wasps from the mummified aphids were collected and sent to an institute for identification.

Leaf hopper (Hom.: Cicadellidae): The leaf hoppers collected included two species of green and black whose scientific names have not been established yet. The damage that these leaf hoppers inflicted was minor and was seen as chlorotic spots on the leaves. On average, 4 or 7 green and black leaf hoppers were caught in 12 nets.

Thrips (Thys.: Thripidae): A species of black thrips with an average density of 7 in 100 nets has been collected. In addition to the aforementioned insects, some sample psyllids have also been gathered.

B) *The insects that feed on the leaves and stem*

These insects include one species of Minosis, *Noctuidae* spp, and *Helicoverpa armigera* Hb.:

Minosis fly (Dip.: Agromyzidae): The damage that this pest inflicts is in the form of spiral canals on the surface of the leaf. The damage is seen on the initial leaves of the bushes at the beginning of the growing season in the spring time cultivation. At present, this pest is seen in some regions such as Gachsaran. It also emerges like spots in some adjacent bushes. The larvae of anthocoridae usually move to the back level of the leaf to transform into pupas. This transformation occurs in a thin cocoon.

***Noctuidae* spp or (Lep.: Noctuiidae):** In some fields, the larvae of *Agrotis* sp. are seen. At present, this pest mostly inflicts damage to the regions of Basht and Dill. In some cases, it causes a reduction to the cultivation area.

The insects on the wild safflowers: On the safflower farms of the province, there are different weeds which include yellow thorn or Carihamus (*C. oxycanthus*), *Centuraibrica*, and *Salsola* spp. Among these weeds, Carithamus or wild safflowers are most serious, because, in addition to the safflower farms, they grow in some areas of the province as a wild plant. They can be seen on the sides of the farms or in the vast plains (such as in the regions of Basht, Dill and Dehdasht). Different insects gather on the wild safflower. Most of these insects are the same insects as those collected on the safflower farms. The insects collected on the wild safflowers are the following 3 species of the fruit flies: 1) *C. carthami*, 2) *A. helianthi* and 3) *T. luteolla*. These species were identified by Bernard Mertz. In *T. luteolla*, the wings are simple, and on the chest, there is a sign resembling a harp. The latter can be seen in the regions of Basht and Dehdasht.

Two species of Col.: Curculionidae, namely *Litoria falvescens* and *Larinus liliputanus*, were collected in such regions as Basht, Dill and Dehdasht. The larvae of Helicoverpa, aphids, leaf hoppers and thrips were the insects that were collected on the wild safflowers in different regions. Meanwhile some mummified aphids were collected in the region of Dehdasht and were placed in the growth dishes to raise parasitoids. An increase in the cultivation area in the province and the presence of plains with the self-growing yellow thorns in most regions of the province which are the ecological sources of pests can bring about an increase in the population of pests and hence the extent of the damage. Therefore, it is necessary to regularly keep track of the population of insects, such as the fruit flies on the wild safflowers and on the safflower farms because the formation of biotypes and their settlement on the farming safflowers are alarming.

It should be reminded that the precise and definite identification of the insects on the farming safflowers and the wild safflowers are particularly important and, in fact, should be considered as the first step in executing the integrated management of the safflower pests. Considering the policy for an increase in the cultivation area of safflowers, it is necessary to identify the fauna of the insects of this plant so that suitable methods for the control of the pests can be achieved and appropriate measures for the integrated management can be taken. Accordingly, the collection and identification of some of these species were conducted; however, this technique still needs further development.

Conclusion

Safflower is a highly valued oilseed, extensively cultivated in warm temperate and cool subtropical regions. Due to its specific floristic and faunistic status, safflower has provided particular microclimate, which is the breeding ground for insects and arthropods. Successful and integrated pest management (IPM) in oilseed farms will depend on multidisciplinary approaches and identification of fauna insects and arthropods. The

results suggest that the precise and definite identification of the insects on the farming safflowers and the wild safflowers are particularly important and, in fact, it is the first step in executing the integrated management of the safflower pests.

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