Biodiversity of insects associated with safflower (*Carthamus tinctorius*) crop in Gachsaran, Iran

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Abstract

The present research conducted to see the biodiversity of insects in warm and cool areas from March to April in 2009 at the Gachsaran Agricultural Research Station. A total number of 4261 specimens, which were identified into 31 families and 92 species. Out of total 31 families collected, 10 families were pests, 2 families belongs to predators and beneficial insects and 7 families belongs to parasitoids and beneficial insects and finally, 12 families of insects are saprophage and polyphagous. There was no significant difference (P>0.05) in the number of insects collected between months. The mean number of insects collected in the month of March, April and May was 34.7, 30.7 and 36.2 respectively. The Basht area is most susceptible host for insects (37.9), while the Gachsaran and Lishter areas is less susceptible (33.5) and (28.4) so both sites not differ significantly in the population of insects. The family Coccinellidae had more population in the Gachsaran-safflower zone (98.3) than the Basht-safflower zone (54.6) and it was significantly similar to the family cicadellidae. Similarly, different families like Aphididae (98.0), Cicadellidae (74), Thripidae (50.0), Curculionidae (26.6), Noctuidae (25.0) and Torymidae (27.3) had higher population in the Gachsaran-safflower zone than in the Basht-safflower area with means of 92.3, 63.0, 42.6, 21.0, 21.6 and 19.3 respectively. Also the families like Nymphalide, Pieridae, Lygaeidae, Papilionidae, Miridae, Pentatomidae, Reduviidae, Geometridae, Gryllotalpidae, Mantidae, Acrididae, Saturnidae and Anthocoridae had mean population of 12.6, 7.4, 12.0, 4.1, 4.4, 8.6, 1.9, 0.5, 7.5, 2.4, 11.3, 3.3 and 8.9.

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Introduction

Insects are the most diverse group of organisms on the planet with over one million described species until now (Borror *et al*., 1989). However, these numbers represent less than the actual species richness of insects (Gullan & Cranston, 2005). Species richness provides an extremely useful measurement of diversity where a complete catalogue of species in the community is obtained (Ahmed *et al*., 2004). Biodiversity is not only an issue of curiosity, but stands firm on the political agenda as a resource for humanity (Heywood, 1996). One of the key features of this agricultural intensification is the crop specialization in the production process, resulting in reduction in the number of crop species, often leading to monoculture. Monoculture rendering the system unstable, gives way to pest attack on crop that may lead to total collapse of the crop. Stability refers to constancy of system in which pest populations are kept at the level below those causing economic crop loss (Way & Heong, 1994). Swift and Ingram (1996) and some others are of the view that the low planned diversity of crop systems is critical not only in terms of production but also it is an important determinant of the total biodiversity. It influences the compositions and abundance of the associated biota such as those of the pest complex and the soil insects and microorganisms, which in turn affect plant and soil processes. Insects have great potential for understanding ecosystem as measures of ecosystem health, but the incompleteness of knowledge and the limitation of resources increase the difficulty of work on insect biodiversity (Spellerberg & Fedor, 2003). In Iran there are only three-reported insect's pests of safflower, namely *Oxycarenus pallens* H. Sch. and *Oxycarenus hyalipennis* Costa (Hemiptera: Lygaeidae), and *Acanthiophilus helianthi* Rossi (Diptera: Tephritidae) (Behdad, 1989; Modaressaval, 1994).

In the Asia about 24 insect species associated with safflower comprising of Coleoptera (14 spp.), Diptera (4 spp.), Homoptera (1 spp.), Hemiptera (2 spp.), Lepidoptera (2 spp.) and one species of Thysanoptera (Campobasso *et al*., 1999). In Iraq, 23 species of safflower pests have been reported including 11 coleopteran species, 6 hemipteran species, 2 dipteran species, 2 thysanopteran species, 1 lepidopteran species, and 1 isopteran species (Selim, 1978).

In India, there are 15 species and 5 genera of insects and one species of mite recorded as the pests of the safflower (Anon, 1987). 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 & Moursi, 1983). According to Giray (1979), the safflower capsule fly can also attack the *Xanthium spihosum*, which is medicinally significant. In the study on the species from the genus *Chaetorellia* (Dip.: Tephritidae) the species *Ch. carthami*, Stackelberg was reported as the safflower pest common to such countries as Iraq, Israel, and Kirgizstan (Gharali & Joozian, 2001).

In India, Safflower has been reported to be attacked by 36 species of pests (Bharaj *et al.,* 2003). Out of these the safflower aphid, *Uroleucon compositae* (Theobald), capsule borer, *Helicoverpa armigera* (Hubner) and leaf eating caterpillar, *Perigea capensis* (Walker) are considered to be major pests of the crop in northern parts of Karnataka (Bharaj *et al*., 2003). The Safflower aphid alone is one of the most destructive pests reported to cause 35 to 72 per cent loss in yield during heavy infestation period (Ishaq *et al.,* 2004). Survey results indicated that in general the intensity of *H. armigera* was more wherever safflower was sown as sole crop and intercropped with Bengal gram (Nasreen *et al*., 2004).

As previously no work has been done on the insect fauna of safflower and biodiversity of insects associated with safflower crop in Kohgiluyeh va Boyerahmad province, south west of Iran. Therefore, the present research studies were focused to collect, identify and compare the insect's fauna of safflower and the natural enemies of safflower capsule fly in Gachsaran, Kohgiluyeh va Boyerahmad province.

Materials and methods

Sample collection for insect fauna of safflower

Based on different cropping patterns and agro climatic conditions, safflower cultivation in Kohgiluyeh va Boyerahmad province (Figure 1) is classified into three major zones. The samplings were specifically conducted at Gachsaran Agriculture Research Station, Basht and Lishter. These represented Gachsaran-safflower zone, Basht-safflower zone and Lishter-safflower zone, respectively (Figure 1). The three localities were at least 15-20 km apart from each other.

The size of each site was 2000 square meters (one hundred square meters long and twenty square meters width). Sampling was conducted once a week from early March to end May 2008. Three methods of insect sampling were employed namely sweep netting, yellow sticky traps (especially for flying insects) and pit fall traps.

A total of 10 sweeps per site was done. A sweep is made by swinging the net through the crop canopy so the top of the net was at crop height. At the end of last sweep immediately swing the net quickly back and forth through the air well above the canopy to force the insects to the bottom of the net. Samples were then transferred to a universal bottle and brought back to the laboratory for further identification and the number of trapped insects was recorded.

A total of ten yellow sticky traps were set up per sites. Yellow sticky traps were composed of polyethylene plates with dimensions 20×20 cm. The traps were set up 1.5 m from ground level; oriented to the south-west and separated from each other by 200 m. Traps were checked once a week during all the trial. Insects trapped in each trap were counted and removed after each sampling. Yellow sticky traps in each study had been fully cleaned and if necessary re-glued.

Ten pitfall traps per site were set up. Pitfall traps were placed in the middle and sides of the study site. Pitfall traps were dustbin of 8-inch diametre and 12 inch height, buried in the soil. Each trap was laid in such a way that the tip of the traps leveled to the surface of the ground. Ten percent formaline solutions were used in these pitfall traps and the number of trapped insects was recorded.

Data analysis

The comparison of insect fauna within months and sites were analyzed subjected to one-way analysis of variance (ANOVA). The means obtained were compared by Duncan's multiple range test at 5% level of probability.

Results and discussion

Insect fauna of safflower

A total of 4261 specimens of various insects were collected from three sites. The collected specimens comprised of 31 families and 92 species of insects (Table 1). Out of total 31 families collected, 10 families were pests, 2 families belongs to predators and beneficial insects and 7 families belongs to parasitoids and beneficial insects and finally, 12 families of insects are saprophage and polyphagous. There was no significant difference (P>0.05) in the number of insects collected between months. The mean number of insects collected in the month of March, April and May was 34.7, 30.7 and 36.2 respectively (Figure 2). The Basht area is most susceptible host for insects (37.9), while the Gachsaran and Lishter areas are less susceptible (33.5) and (28.4) so both sites not differ significantly in the population of insects (Figure 3).

The family Coccinellidae had more population in the Gachsaran-safflower zone (98.3) than the Basht-safflower zone (54.6) and it was significantly similar to the family cicadellidae. Similarly, different families like Aphididae (98.0), Cicadellidae (74), Thripidae (50.0), Curculionidae

Figure 1. The geographical position of Kohgiluyeh va Boyerahmad province on map of Iran.

Table 1. Overall populations of insect species associated with safflower in Gachsaran, Basht and Lishter areas.

S. No.	Order: Family	Gachsaran Total	Basht Total	Lishter Total
1	Coleoptera: Bruchidae			
	a. *Spermophagus sericeus*	5	17	0
2	Coleoptera: Coccinelidae			
	a. *Adalia bipunctata*	4	10	0
	b. *Adalia decimpunctata*	0	7	2
	c. *Coccinella septempunctata*	8	16	0
	d. *Coccinella undecimpunctata*	19	57	15
	e. *Exochomus nigromaculatus*	0	14	23
	f. *Hippodamia convergens*	9	15	20
	g. *Hippodamia tredecimpunctata*	50	70	27
	h. *Hippodamia variegata*	16	34	26
	i. *Oenopia conglobata*	44	42	0
	j. *Psyllobora vigintiduopunctata*	11	18	17
	k. *Scymnus syriacus*	3	12	10
3	Coleoptera: Curculionidae			
	a. *Apion aestivum*	10	18	26
	b. *Larinus flavescens*	24	45	21
	c. *Larinus liliputanus*	0	0	10
	d. *Sitona humeralis*	18	12	7
	e. *Sitona puncticollis*	11	5	0
4	Coleoptera: Dermestidae			
	a. *Anthrenus* sp.	0	12	13
	b. *Anthrenus verbasci*	5	7	20
	c. *Anthrenusvorax*	11	11	0
	d. *Athagenus* sp.	9	16	21
5	Dermaptera: Forficulidae			
	a. *Forficula auricularia*	16	24	20
6	Diptera: Tephritidae			
	a. *Acanthiophilus helianthi*	18	5	15
	b. *Chaetrollia carthami*	30	10	10
	c. *Terellia luteolla*	31	25	34
7	Hemiptera: Anthocoridae			
	a. *Anthocoris nemoralis*	14	23	0
	b. *Anthocoris nemorum*	0	9	0
	c. *Orius* sp.	9	13	13
8	Hemiptera: Aphididae			
	a. *Aphis gossypi*	53	41	40
	b. *Aphis nerii*	53	40	55
	c. *Brachycaudus helichrysi*	50	65	30
	d. *Eucarazzia elegans*	21	20	0
	e. *Hyadaphis sphondyti*	55	63	50
	f. *Pleotrichophorus grandolosus*	45	40	45
	g. *Uroleucon compositae*	0	25	0
9	Hemiptera: Callaphididae			
	a. *Ephedraphis ephedrae*	25	15	10
10	Hemiptera: Cicadellidae			
	a. *Austroagalia sinuata*	40	30	42
	b. *Circulifer haematoceps*	30	16	0
	c. *Empoasca* sp.	17	28	17
	d. *Euscelis alsius*	0	0	40
	e. *Macrosteles laevis*	36	42	0
	f. *Neoaliturus fenestratus*	37	63	42
	g. *Psammotettix striatus*	29	43	20
11	Hemiptera: Diaspididae			
	a. *Parlatoria ephedrae*	0	15	0
12	Hemiptera: Lygaeidae			
	a. *Lygus* sp.	14	20	20
	b. *Oxycarenus hyalipennis*	10	7	10
	c. *Oxycarenu palens*	12	12	3
13	Hemiptera: Miridae			
	a. *Myrmecoris gracilis*	14	0	3
	b. *Myrmecoris* sp.	4	10	9
14	Hemiptera: Pentatomidae			
	a. *Andralus* sp.	0	7	0
15	Hemiptera: Reduviidae			
	a. *Reduvius personatus*	8	3	2
	b. *Reduvius* sp.	0	3	2
16	Hymenoptera: Braconidae			
	a. *Bracon hebetor*	6	5	5
	b. *Bracon luteator*	3	2	5
17	Hymenoptera: Cynipidae			
	a. *Isocolus tinctorius*	4	7	8
18	Hymenoptera: Eulophidae			
	a. *Pronotalia carlinarum*	6	5	5
	b. *Pronotalia* sp.	5	8	5
19	Hymenoptera: Eurytomodae			
	a. *Eurytoma acroptilae*	6	7	6
20	Hymenoptera: Pteromalidae			
	a. *Coletrechnus* sp.	6	3	3
	b. *Coletrechnus viridis*	5	7	7
	c. *Pachyneuron concolor*	11	7	12
	d. *Pteromalus* sp.	5	5	7
21	Hymenoptera: Torymidae			
	a. *Antistrophoplex conthurnatus*	68	42	63
	b. *Microdontomenus annulatus*	14	16	19
22	Lepidoptera: Geometridae			
	a. *Acontia groelis*	0	5	0
23	Lepidoptera: Noctuidae			
	a. *Agrothis ipsilon*	5	7	1
	b. *Agrothis segetum*	0	7	0
	c. *Caradrina exigua*	15	19	14
	d. *Eublemma parva*	10	7	8
	e. *Helicoverpa armigera*	6	3	2
	f. *Helicoverpa peltigera*	8	9	13
	g. *Helicoverpa* sp.	2	1	0
	h. *Plusia gamma*	17	3	4
	i. *Spodoptera litura*	12	9	8
24	Lepidoptera: Nymphalidae			
	a. *Argyreus hyperbius*	6	7	5
	b. *Junonia hierta*	0	6	9
	c. *Nymphalis xanthomolus*	13	4	1
	d. *Sphingonotus* sp.	7	11	14
	e. *Vanessa indica*	13	6	12
25	Lepidoptera: Papilionidae			
	a. *Papilio demoleus*	7	3	5
	b. *Papilio polyctor*	8	6	8
26	Lepidoptera: Pieridae			
	a. *Pieris brassicae*	15	5	10
	b. *Pieris rapae*	19	13	5
27	Lepidoptera: Saturnidae			
	a. *Attacus atlas*	0	11	9
28	Orthoptera: Acrididae			
	a. *Acrotylus* sp.	11	12	0
	b. *Aiolopus* sp.	9	4	7
	c. *Heteracris* sp.	10	14	11
	d. *Sphingonotus* sp.	16	0	8
29	Orthoptera: Gryllotalpidae			
	a. *Gryllotalpa gryllotalpa*	20	19	29
30	Orthoptera: Mantidae			
	a. *Mantis religiosa*	4	9	9
31	Thysanoptera: Thripidae			
	a. *Haplothrips* sp.	75	60	47
	b. *Thrips tabaci*	53	90	40
	Number of insects	1428	1619	1214

(26.6), Noctuidae (25.0) and Torymidae (27.3) had higher population in the Gachsaran-safflower zone than in the Basht-safflower area with means of 92.3, 63.0, 42.6, 21.0, 21.6 and 19.3 respectively. Also the families like Nymphalide, Pieridae, Lygaeidae, Papilionidae, Miridae, Pentatomidae, Reduviidae, Geometridae, Gryllotalpidae, Mantidae, Acrididae, Saturnidae and Anthocoridae had mean population of 12.6, 7.4, 12.0, 4.1, 4.4, 8.6, 1.9, 0.5, 7.5, 2.4, 11.3, 3.3 and 8.9.

It is thus clear that all of these families had more population in the Gachsaran-safflower area and significantly differed from the Basht-safflower area. The minimum mean value of 0.5 specimens was given by the family Geometridae, which was statistically similar to most other families.

Since the identification of insect pests is one of the most efficient methods for pest management, an attempt was made to investigate insect fauna in the Iranian province of Kohgiluyeh va Boyerahmad. The results showed that safflower flies including: *Acanthiophilus helianthi*, *Chaetorellia carthami* and *Terellia luteola*, that larvae of which attack the flower heads and seeds are most important safflower pest in Iran. The insects occurring on flower heads of safflower were determined during this study. Also, *Oxycarenus palens*, *Oxycarenus hyalipennis*, *Lygus* sp. aphids and thripses were found on flower heads of safflower (Table 2).

The results indicate that various insect pests are active in the safflower fields, so due to the specific floristic and faunistic status, safflower has provided particular microclimate, which is the breeding ground for insects and arthropods. Successful and integrated pest management in oilseed farms will depend on multidisciplinary approaches and identification of insect fauna 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. The results showed that from total of 4261 specimens of various insects were collected from safflower farms during 2008, comprised 19 families including chewing pest, sucking pests and plant feeders. Also, families such as, Pentatomidae, Miridae, Anthocoridae, Acrididae and Lygaeidae is saprophagous insects and active in safflower farms. Finally, 7 families comprised benefit insects (Natural enemies) including, predators and parasitoids.

The above results suggest that three the Gachsaran, Basht and Lishter areas acted as alternate hosts for different insects. The most serious insect pests of the major crops in experiments were present in the Gachsaran area, but they also used the Basht area as an alternate habitat.

Table 2. Comparison of means for families.

Family	Gachsaran	Basht	Lishter	Means
Aphididae	98.0	92.3	73.3	87.6[a]
Coccinellidae	98.3	54.6	46.6	66.5[b]
Cicadellidae	74.0	63.0	53.6	63.5[b]
Thripidae	50.0	42.6	29.0	40.5[c]
Torymidae	27.3	19.3	27.3	24.6[d]
Curculionidae	26.6	21.0	21.3	22.9[d]
Noctuidae	25.0	21.6	16.6	21.1[d]
Tephritidae	13.3	26.3	19.6	19.7[de]
Dermestidae	15.3	8.3	18.0	13.8[e]
Nymphalidae	11.3	13.0	13.6	12.6[e]
Lygaeidae	13.0	12.0	11.0	12.0[e]
Acrididae	10.0	15.3	8.6	11.3[e]
Anthocoridae	15.0	7.6	4.3	8.9[e]
Pentatomidae	7.3	9.0	9.6	8.6[e]
Pteromalidae	7.3	9.0	9.6	8.6[e]
Gryllotalpidae	6.3	6.6	9.6	7.5[f]
Pieridae	6.0	11.3	5.0	7.4[f]
Forficulidae	8.0	5.3	6.6	6.6[g]
Callaphididae	5.0	8.3	3.3	5.5[fg]
Miridae	3.3	6.0	4.0	4.4[fg]
Papilionidae	3.0	5.0	4.3	4.1[fg]
Eulophidae	4.3	3.6	3.3	3.7[gh]
Saturnidae	3.6	0.0	3.0	3.3[gh]
Braconidae	2.3	3.0	3.3	2.8[h]
Bruchidae	5.6	1.6	0.0	2.4[h]
Mantidae	3.0	1.3	3.0	2.4[h]
Eurytomidae	0.0	3.6	3.0	3.3
Cynipidae	2.3	1.3	2.6	2.1[h]
Reduviidae	2.0	3.6	1.3	1.9[h]
Diaspididae	5.0	0.0	0.0	1.6[h]
Geometridae	1.6	0.0	0.0	0.5[i]

[a-i] Dissimilar letters in each column with using Duncan's test at level of 5% together have significant differences.

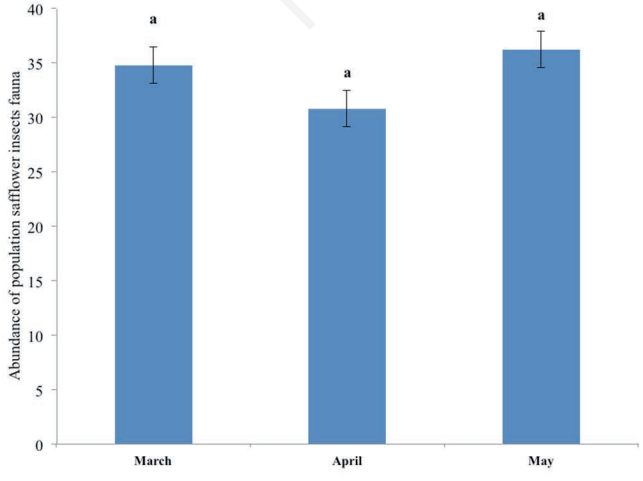

Figure 2. Comparison of means for months.

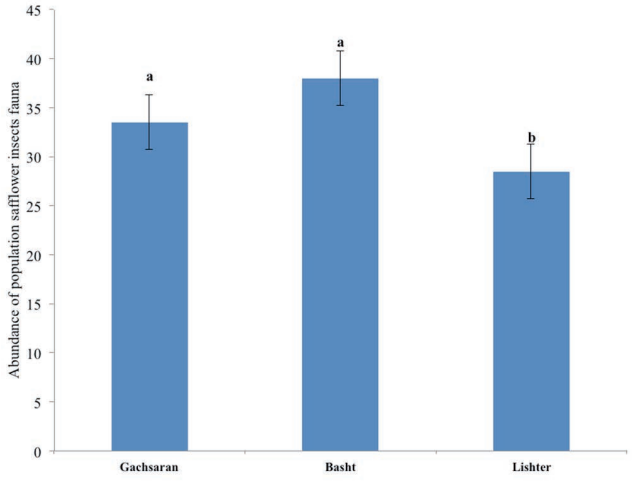

Figure 3. Comparison of means for localities.

The maximum mean value of 87.6 specimens was obtained for the family Aphididae, which had significant difference with other families. The minimum mean value of 0.5 was achieved in the family Geometridae and it was statiscally similar to most of other families.

The above results cannot be compared with those of Ashri (1971), Hegazi and Moursi (1983), Talpur *et al.* (1995) and Campobasso *et al.* (1999), who collected and identified many different families and species without mentioning the number of species and families and their population in different localities. These results are not in conformity.

Conclusions

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.

Safflower is a highly valued oilseed, extensively cultivated in warm temperate and cool subtropical regions. Due to its specific floristic and faunistic status, the safflower has provided particular microclimate, which is the breeding ground for insects and arthropods. Successful and integrated pest management 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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