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Short Research Article

Impact of Habitat on Insect Pollinator Diversity on Coriander (*Coriandrum sativum* L.) Bloom

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Abstract

The study was conducted at Pandah farm and Khaltoo farm of seed technology and production centre, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan Himachal Pradesh, India during 2012−2013 to find out the impact of habitat on insect pollinator diversity on coriander (*Coriandrum sativum* L.) bloom. The survey was conducted at two different habitats, in habitat 1, field was surrounded by cultivable crops while, in habitat 2, field was surrounded by natural vegetation. Insect pollinators were identified and the Shannon–Weiner diversity index was used to measure their diversity. The diversity of insects by different sampling methods (fluorescent pan traps, scan sampling and sweep net capture) showed that more insects were observed in coriander field surrounded by natural vegetation (habitat 2) as compared to field surrounded by cultivable crop (habitat 1). Thirty nine insects belonging to 31 genera under 18 families and 8 orders were observed in the experimental habitats surrounding coriander crop. Pollinator diversity indices compared for different sampling methods in both the habitats showed different trends. The pollinator diversity indices and eveness amongst the various groups was higher in habitat 1. Richness (H max) was same in both the habitats in all sampling methods indicating that the insect visitors groups were homogenous in the two habitats for individual sampling method. Different Shannon Weiner pollinator diversity indices for different sampling methods indicated that for sampling pollinator diversity all the methods have to be collectively employed as no single method is fully reliable.

1. Introduction

Habitat alteration is the primary cause for decline of crop pollinating insects and an agriculture crisis in crops which are pollinator-dependent (Carvalheiro et al., 2010). A decline in pollinator population abundance and diversity has been registered worldwide. Anthropogenic alterations in climates and habitats have resulted in reductions in the biodiversity of many pollinator families (Biesmeijer et al., 2006). Human impact has modified the original landscape through degradation, destruction and fragmentation of natural habitats and also through the establishment of new anthropogenic habitats and alterations in pollinator communities which have been closely linked to changes in land-use practices (Kremen et al., 2007). Destruction and fragmentation of natural or semi-natural habitats and land use intensification in agricultural landscapes are the two major threats for pollinator diversity which have significant effects on pollinator communities and crop pollination services (Tscharntke et al., 2005). A rapidly increasing human population will reduce the amount of natural habitats through an increasing demand for food-producing areas, urbanization and other land-use practices putting pressure on the ecosystem service delivered by wild pollinators (Kjhol et al., 2011). Crop pollination services are being hampered by a decline in the number and diversity of pollinator populations (Partap, 2010). Pollinators rely on semi-natural habitat for a diversity of food sources and breeding sites (Winfree et al., 2009). Land-use change and agricultural intensification has reduced the amount of such semi-natural habitat and simplified landscape structure (Robinson and Sutherland, 2002), and is one of many factors (Vanbergen, 2013) linked to historic and continuing losses of wild pollinator biodiversity (Burkle et al., 2013). Forest fragmentation can lead to declines in flower visitation by native pollinator species (Schuepp et al., 2014). Extensive habitat loss and fragmentation can isolate populations and reduce their persistence by erecting barriers to gene flow, reducing gene diversity and leading to low effective population sizes (Darvill et al., 2006). Nesting habit is a strong predictor of bee species sensitivity to the loss

of semi-natural habitats because of the concomitant loss of particular nesting resources (e.g. stems of perennial grasses, herbs and shrubs or dead wood cavities) (Williams et al., 2010).

In the present investigation coriander crop was selected for studying the impact of habitat on insect pollinators diversity of the two different habitats. Coriander is an herbaceous annual plant belonging to family umbelliferae and it is cultivated as a summer or winter annual crop depending upon the climatic conditions (Tiwari and Agarwal, 2004). Coriander is also used as a strip crop to attract pollinators in order to facilitate pollination of major crops. This strip crop planting is important in determining the occurrence and abundance of pollinators in a locality (Pywell et al., 2005).

2. Materials and Methods

Studies were conducted during 2012−2013 at Pandah farm and Khaltoo farm of seed technology and production centre, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan Himachal Pradesh. Two different habitats were selected/ differentiated on the basis of different parameters like aspects, elevation, latitude, longitude, distance from forest and water source. Habitat 1 (Pandah farm) was at south west aspect, 30.51° N latitude, 77.09° E longitude and 1183 m amsl while Habitat 2 (Khaltoo farm) was at south aspect 30.51° N latitude, 77.11° E longitude and 987 m amsl. Distance from forest area and water source for habitat 1 was 300, 38 m. However, for habitat 2 it was 150, 170 m. Vegetation was assessed by taking visual observations during March within 200 m radius of the selected experimental coriander field. The information on different trees, shrubs, climbers and field crops was recorded separately. Distance from water body, main road and from forest area was measured with the help of metric tape. On the basis of this we find that in habitat 1, field was surrounded by cultivable crop while in habitat 2, field was surrounded by natural vegetation.

Diversity of insect visitors on coriander was recorded in the two different selected habitats by fluorescent pan traps, scan sampling and sweep net captures methods. Twenty four bowls, eight of each colour were used. Traps were placed prior to 0900 h in the morning and removed after 1500 h. Observations were recorded at onset of bloom, full bloom and end of bloom during three sunny days.

For scan sampling number of insect visitors was recorded on 100 umbels in each of the 4 plots located in the experimental site on three sunny days. The sampling was done by walking slowly along a set path in between rows. The insect visitors were counted by looking at individual umbel one by one in sequences. For sweep net captures, the net sweeps were taken by transect walks between the ground flora. Five insect collection net sweeps were taken at all the random five spots equally distributed in the crop area. Observations were recorded during three different day hours (1000, 1200 and 1500 h) at onset of bloom, full bloom and end of bloom for both the sampling methods.

The Insect visitors collected by different sampling methods were divided into seven groups (Hive bees: *Apis cerana, A. mellifera*, *Episyrphus balteatus*, other syrphids: *Sphaerophoria indiana, Scaeva pyrastri*, *Metasyrphus corollae, Eupeodes frequens*. *Metasyrphus confrater, Ischiodon scutellaris, Melanostoma univittatum, Eristalis* sp. *Betasyrphus serarius,* wild bees: *Halictus* sp., *Lasioglossum* sp.*, Sphecodes* sp., *Megachile* sp., *Ceratina sexmaculatus*, other dipterans: *Musca* sp., *Bactrocera* sp., *Chrysomya megacephala*, lepidopterans: *Helicoverpa armigera, Colias* sp., *Pieris brassicae* and other insect visitors: *Nezara viridula, Bagrada* sp., *Hippodamia* sp., *Coccinella septempunctata, Tribolium castaneum, Macromia magnifica, Schistocerca americana, Thrips* sp.). *E. balteatus,* an individual species was kept as separate group amongst various syrphids, because of its dominance.

The data collected on insect pollinators diversity by different methods were pooled and analyzed statistically to calculate the pollinator diversity indices, species richness and evenness in both areas separately.

The Shannon diversity index was calculated (Shannon, 1948) using the following formula:

A) Diversity index (H)=-Σ (pi ln (pi)), where,

pi =proportion of i^{th} species

ln=natural logarithm

B) Richness (H max)=log of total number of groups/species

C) Eveness (J)=H/H max

D) Dominance (D)=1-J

The diversity indices calculated for both the habitats were compared by t-test (Hutcheson, 1970) as given below:

$T_{cal}=(H_1-H_2)/(\text{Variance } H_1+\text{Variance } H_2)^{1/2}$

(Where H_1 is the diversity index of habitat 1 (Pandah farm) and H_2 represented the diversity index of habitat 2 (Khaltoo farm).

Variance of habitat:

$(\text{Variance H})=([\Sigma(pi)(lnpi)^2-\Sigma((pi)(lnpi))^2]/N)-((S-1)/(2N^2))$

(Where N is total number of insect visitors and S is number of groups/individuals sp.) T_{cal} was compared with T_{tab} value at 5 per cent level of significance and specified degrees of freedom and the degrees of freedom is calculated as under:

$df=(\text{Variance } H_1+\text{Variance } H_2)^2/([\text{Variance } H_1)^2/N_1]+[(\text{Variance } H_2)^2/N_2]$

3. Results and Discussion

3.1. Florescent pan trap method

The pollinator diversity index computed for florescent pan

trapped insects in both the habitats was different (Table 1). The pollinator diversity index was significantly higher in habitat 2 (1.41) in comparison to habitat 1 (1.21). Total numbers of 1730 insect visitors were trapped in both the habitats. Out of these, 795 insects were trapped in habitat 1 and 935 in habitat 2. Thirty eight per cent of the total groups were dominant in habitat 1. These included *E. balteatus,* other syrphids and other dipterans. However in habitat 2 only 28% of insect visitors (*E. balteatus* and other syrphids) were dominant amongst the trapped insects. H max value for both the habitats is same which indicated that the species richness of pollinators was same in both the habitats. J value or eveness within seven groups of insect visitors was more in habitat 2(0.72) as compared to habitat 1(0.62) indicating that the pollinators were more evenly distributed in habitat 2 than in habitat 1.

3.2. Scan sampling method

The pollinator diversity indices for both the habitats were similar computed for the number of insects counted on coriander bloom by scan sampling method. Under scan sampling method total 4296 and 6875 number of insects was counted in habitat 1 and habitat 2, respectively. About Seventy per cent of the total groups (*E. balteatus*, other syrphids, other insect visitors, other dipterans and lepidopterans) were dominant in both the habitats. H max value showed (Table 1) that species richness was same in both the habitats. Eveness in both the habitats was also same indicating closeness among the relative abundance of insect groups.

3.3. Sweep net method

The pollinator diversity index for sweep net method in both the habitats was different. The pollinator diversity index was significantly higher in habitat 1(1.02) in comparison to habitat 2(0.88) (Table 1). Species richness was same in both the habitats. J value showed that the eveness with five groups of insect visitors was more in habitat 1(0.63). The percentage of dominant species was more in habitat 2(45%) than habitat 1(37%).

Total no of 14006 insect visitors were collected/counted in both the habitats. Out of these, 5585 insects were collected/counted in habitat 1 and 8421 in habitat 2. The pollinator diversity index was higher in habitat 1(0.87) comparison to habitat 2(0.85). H max value (Table 1) showed that distribution of insect visitors were same in both the habitat. Fifty five per cent of the total groups were dominant in habitat 1. However in habitat 2 fifty six per cent of insect visitors were dominant.

Pollinator diversity indices compared for different sampling methods in both the habitats showed different trends. Pollinator diversity indices for florescent pan traps in both habitats were different. J value or evenness within the seven groups of insect visitors being more in habitat 2(0.72) as compared to habitat 1(0.62). The pollinator diversity indices compared for scan sampling revealed that the pollinator diversity indices did not vary among the two habitats. The eveness among the insect visitors groups was also almost same in both the habitats. The present finding further revealed that pollinator diversity indices for sweep net capture method vary among two habitats. The pollinator diversity indices and eveness amongst the various groups was higher in habitat 1. The data on richness (H max) was same in both the habitats in all sampling methods indicating that the insect visitors groups were homogenous in the two habitats for individual sampling method. The pollinator diversity indices are in a given range of 0 to 4.6 (Mudri-Stojnic et al., 2012). Different ranges of Shannon Weiner diversity index have also been calculated by various workers. For example, Shannon Weiner diversity index ranged from 2.262 to 2.945 for hymenopterans pollinators of Himalayan foot hills (Hussain et al., 2012), and from 1.478 to 2.653 for hymenoptera and diptera in semi-natural habitats (Mudri-Stojnic et al., 2012). Our results are in line with the Gray's (1989) hypothesis who postulated that in habitats affected by increased disturbance, diversity should decrease; opportunist species should gain dominance and mean size of the dominant species decrease. The Shannon Index of Diversity is considered to be the most complete measure of diversity because it takes into account both the number of species and the abundance of each species (Usha and John, 2015).

Different Shannon Weiner diversity index for different

Table 1: Shannon-Weiner pollinator diversity index computed for different sampling method

Biodiversity components	Pan traps		Scan sampling		Sweep net		Overall diversity index	
	Habitat1	Habitat 2	Habitat 1	Habitat 2	Habitat 1	Habitat 2	Habitat 1	Habitat 2
Diversity (H)*	1.21	1.41	0.59	0.61	1.02	0.88	0.87	0.85
Max. diversity (H max)	1.95	1.95	1.95	1.95	1.61	1.61	1.95	1.95
Eveness (j)	0.62	0.72	0.3	0.31	0.63	0.55	0.45	0.44
Dominance (D)	0.38	0.28	0.7	0.69	0.37	0.45	0.55	0.56

T_{cal}: 5.26 *Significant at (p=0.05); T_{cal}: 1.00 *Non significant; T_{cal}: 2.82 *Significant at (p= 0.05); T_{cal}: 2.15 *Significant at (p=0.05)

sampling methods indicated that for sampling pollinator diversity all the methods have to be collectively employed as no single method is fully reliable. Pan traps have several known biases in catching less number of bumble bees and honey bees (Tolar et al., 2005). On the other hand pan traps are beneficial for catching small bee species that are often missed during transect walks, low in cost, reliable and simple to use. These can be used to attract pollinators in the absence of bloom and have no collector bias, hence to characterize local bee fauna, there is need to supplement pan trapping protocols with the other sampling method.

An assessment of the complicated structure of interactions on a plant-pollinator level is essential, especially in terms of reported pollinator declines affected by anthropogenic influences, and some studies have reported that variation in the density and diversity of plant communities surrounding an investigated area could affect both species variability and the composition of pollinators of particular plant species in a given area (Bosch et al., 2009).

3. Conclusion

The observations on diversity of insects by different sampling methods (fluorescent pan traps, scan sampling and sweep net) showed that more insects were observed in coriander field surrounded by natural vegetation (habitat 2) as compared to field surrounded by cultivable crop (habitat 1). Pollinator diversity indices compared for different sampling methods in both the habitats showed different trends. Different Shannon Weiner diversity index for different sampling methods indicated that for sampling pollinator diversity all the methods have to be collectively employed as no single method is fully reliable.

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