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POLLINATION STUDIES ON KIWI CROP (*ACTINIDIA DELICIOSA* CHEV.) IN HIMACHAL PRADESH, INDIA

Minakshi Sharma, V.K. Mattu and M.L. Thakur*
Sociobiology and Behavioral Ecology Research Laboratory
Deptt. of Biosciences, Himachal Pradesh University, Shimla-171 005 (HP), India
*Present address: Himachal Pradesh State Biodiversity Board, Department of Environment, Science and Technology, Shimla-2

ABSTRACT
A total of 280 cob broilers were fed from day 1-21 on diets based on corn-soybean meal. At the age of 22-56 days the diets Pollination studies have been conducted on kiwi (*Actinidia deliciosa* Chev.) crop in orchard located at Phagli in Shimla hills of Himachal Pradesh. Kiwi flowers were visited by 15 insect species belonging to 4 orders and 6 families. Of these, 4 belonged to Hymenoptera, 6 to Diptera, 2 to Lepidoptera and 3 to Coleoptera. Relative abundance data on kiwi bloom showed that rock bee *Apis dorsata* was the most dominant insect pollinator on both staminate (25.50%) and pistilate (32.60%) flowers of kiwi. Besides this, other effective hymenopteran pollinators were: *Apis mellifera* (13.40%, 14.10%) and *Apis cerana* (9.01%, 6.64%) on staminate and pistilate flowers respectively. Kiwi flowers were also visited by various dipterans, *Syrphus* sp. (21.06%, 19.09%) being the most dominant visitor on male and female flowers.

KEY WORDS: Insect Visitors, Kiwi Crop, Himachal Pradesh

INTRODUCTION

Pollination is the transfer of pollen grains from male to the female part of the flower with the help of abiotic and biotic pollen dispersal agents. Wind, water and gravity are the important abiotic agents, whereas, insects, birds, bats and small mammals are the primary biotic agents (Free, 1993). Various insect groups which are of prime significance in pollination of agricultural and horticultural crops are Hymenoptera, Diptera, Lepidoptera, Coleoptera and Thysanoptera (Michener, 1974). Of these, hymenopterans are the most important insect pollinators because of their high energy requirements and tendency for collecting provision for their brood in the form of pollen and nectar. Honeybees, bumble bees and solitary bees are some of the most important pollinators belonging to order Hymenoptera (Kozin, 1972; McGregor, 1976). Among Hymenopterans, honeybees are considered as the most efficient pollinators of cultivated crops because of their floral fidelity, potential for long working hours, presence of pollen baskets, maintainability of high population, micromanipulation of flowers and adaptability to different climatic conditions (Verma, 1990). Further, honeybees can be domesticated, marked and transported from place to place (Ribbands, 1953; Crane, 1990). Besides honeybees, in recent years much attention is also being given to commercial exploitation of other hymenopterans and dipterans like bumble bees, solitary bees, wasps, *drone fly*, *muscids*, *syrphids* etc. as important pollinators in developed countries (Gupta and Gupta, 1997). At present Himachal Pradesh is one of the major temperate fruit growing states of the country. Every year, more and more land is coming under fruit cultivation; therefore, some management problems inevitably have arisen. Important temperate fruits grown here are apple, almond, cherry, peach, pear, plum and apricot. Most of these fruit blossoms are either self-incompatible, partially self-compatible or self-compatible in nature and need services of different insects (Kozin, 1972; Free, 1993). A major problem is related to crop pollination because of self-incompatible nature of most of temperate fruit crops. This has become more relevant currently because the population of pollinators is also decreasing at an alarming rate due to increased use of toxic pesticides. Therefore, a large horticultural undertaking as at present in Himachal Pradesh will not be able to flourish in the long run without the use of honeybees and other pollinators for efficient and sufficient pollination of temperate and tropical fruit crops (Mattu, 1992). Many investigators have studied the pollination ecology of horticultural crops in relation to *A. mellifera* L. in Europe and America (Kozin, 1972; McGregor, 1976; Szabo, 1980; Anderson and Buys, 1990; Goodman and Fisher, 1991; Gary, 1992, Free, 1993). But a little is known about the role of Indian hive bee, *Apis cerana* F in pollinating various horticultural especially temperate fruit crops (Mattu and Verma, 1985; Mattu et al., 1994; Verma, 1990; Verma and Dulta, 1986; Verma and Partap, 1993). Therefore, need to conduct studies on pollination ecology of kiwi crop in relation to the role of insects especially honeybees in the Himachal Pradesh was urgently felt.

METHODOLOGY

Pollination studies have been conducted on kiwi (*Actinidia deliciosa* Chev.) crop in orchard located at Phagli (latitude $31^0 9'$ N, longitude $77^0 5'$ E and altitude 1924 m) in Shimla hills of Himachal Pradesh, during the months of April and May of the years 2002 and 2003, when these orchards were in full bloom. Kiwi orchard had more than 60 to 70 trees belonging to

Hayward, Allison, Abbott and Monty varieties.Studies on diversity, distribution and relative abundance of various insect visitors to kiwi flowers have been made by selecting trees at random, almost in the middle of the orchard, on the basis of their size, age, flowering state and number of branches. The experimental branches selected had nearly same size with respect to their spread, phase of flowering and height above the ground. The observations were started 2 to 3 days after the flowering commenced and continued under good climatic conditions till petal fall. Relative abundance, of different insect visitors was determined in terms of their visits per 500 flowers/10 minutes (Verma and Chauhan, 1985). The observations were recorded from 0800 to 1700 hours of a day and average counts at these hours gave abundance of an insect pollinator for that particular day. All insect visitors on kiwi flowers were collected, killed and identified. Identification of different insect specimens was done with the help of standard keys.

RESULTS & DISCUSSION

Kiwi flowers were visited by 15 insect species belonging to 4 orders and 6 families. Of these, 4 belonged to Hymenoptera, 6 to Diptera, 2 to Lepidoptera and 3 to Coleoptera (Table 1). These results corroborate the earlier findings of Macfarlane (1995) who also observed comparative abundance of hymenopteran pollinators including honey bees on kiwi fruit in New Zealand. Earlier, Corbett et al. (1988), and Ferquson and Pusch (1991) also reported bumblebees as effective pollinators of kiwi crop. Recently, Gupta et al. (2000) recorded six types of insect pollinators including honeybees on this crop in Solan hills of Himachal Pradesh. Sharma (2000) recorded 28 species of insect pollinators on balsam crop in Shimla hills, of which 11 species belonged to Hymoneptera, 10 to Diptera, 5 to Lepidoptera and 2 to Coleoptera. Recently, Singh (2003) observed 44 and 46 species of insect pollinators on citrus and litchi crops in Shimla hills.

TABLE 1: Insect species visiting kiwi flowers with their taxonomic status

Order Hymenoptera	Order Diptera	Order Lepidoptera	Order Coleoptera
Family Apidae	Family Syrphidae	Family Pieridae	Family Coccinellidae
1. *Apis cerana* F.	5. Eristalis cerealis	11. *Pieris canidia*	13. *Coccinella* sp.
2. *Apis mellifera* L.	6. *Syrphus* sp.	12. *Pieris* sp.	14. *Coccinella septumpunctata*
3. *Apis dorsata* F.	7. *Episyrphus* sp.		Family- Chrysomelidae
4. *Bombus tunicatus*	8. *Metasyrphus* sp.		15. *Altica* sp.
	9. *Macrosyrphus* sp.		
	Family- Cordiluridae		
	10. *Musca* sp.		

TABLE 2: Relative abundance of different insect pollinators visiting kiwi flowers (staminate tree) in Shimla hills

Family	Genus/ Species	Mean ± S.E.	Percent Population	Family No.	Family %age	Order No.	Order %age
Hymenoptera							
Apidae	*Apis dorsata* F.	4.13±0.15*	25.50	7.99	49.33	7.99	49.33
	Apis mellifera L.	2.17±0.14	13.40				
	Apis cerana F.	1.46±0.14	9.01				
	Bombus sp.	0.23±0.21	1.42				
Diptera							
Syrphidae	*Eristalis* sp.	1.98±0.14	12.2	6.23	38.43	7.39	45.59
	Syrphus sp.	3.41±0.05	21.06				
	Metasyrphus sp.	0.3±0.9	1.85				
	Macrosyrphus sp.	0.26±0.11	1.60				
	Episyrphus sp.	0.28±0.22	1.72				
Cordiluridae	*Musca* sp.	1.16±0.16	7.16	1.16	7.16		
Lepidoptera							
Pieridae	*Pieris canidia*	0.05±0.04	0.30	0.05	0.30	0.60	0.30
Coleoptera							
Chrysomellidae	*Altica* sp.	0.76±0.18	4.69	0.76	4.69	0.76	4.69

* Each value is an overall average for an insect species.
S.E. Standard error about the mean

Moreover, *A. dorsata* (4.13±15, 25.50%) was the most frequent visitor to kiwi bloom on staminate tree followed by *A. mellifera* (2.17±0.14, 13.40%) and *Apis cerana* (1.46±14, 9.01%). Among dipterans, most abundant pollinators were *Syrphus* sp. (3.41±0.05, 21.06%) followed by *Eristatis tenax* (1.98±14, 12.2%), *Musca domestica* (1.16±0.16, 7.16%), *Metasyrphus* sp. (0.3±0.9, 1.83%), *Macrosyrphus* sp. (0.26±0.11, 1.60%) and *Episyrphus* sp. (0.28±0.22, 0.72%). This fruit crop was also visited by a lepidopteran i.e. *Pieris* sp. (0.5±0.04, 0.30%) and a coleopteran viz., *Altica* sp. (0.76±0.18, 4.69%) (Table 2; Fig. 1).

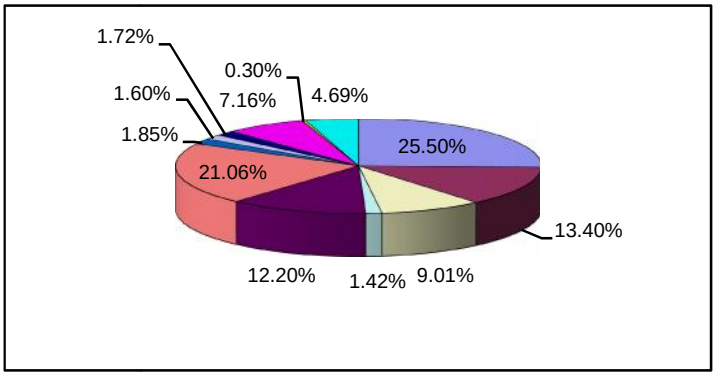

FIGURE 1: Relative abundance of different insect pollinators visiting kiwi flowers (staminate) in Shimla hills

Pistillate tree of kiwi was visited by important hymenopterans like, *Apis dorsata* (8.60±7.2, 32.6%), *Apis mellifera* (3.72±0.12, 14.1%), *Apis cerana* (1.75±0.07, 6.69%) and *Bombus tunicatus* (0.12±0.09, 0.45%). Among dipterans, most abundant insect pollinators were: *Syrphus* sp. (4.50±0.14, 19.09%) followed by *Eristalis* sp. (2.92±0.16, 11.09%), *Musca* sp. (0.80±0.08, 3.03%), *Metasyrphus* sp. (1.67±0.64, 6.34%), *Macrosyrphus* sp. (0.85±0.03, 3.20%) and *Episyrphus* sp. (0.33±0.10, 1.25%). Among coleopterans, *Coccinella* sp. (0.12±0.01, 4.5%) and *Altica* sp. (0.35±0.01, 1.32%) were the only insect visitors, whereas, *Pieris* sp. (0.18±0.02, 0.68%) and *Pieris canidia* (0.42±0.08, 1.59%) were the only lepidopteran insects visiting this fruit crop (Table 3; Fig. 2).

TABLE 3: Relative abundance of different insect pollinators visiting kiwi flowers (pistillate tree) in Shimla hills

Family	Genus/ Species	Mean ± S.E.	Percent Population	Family No.	Family %age	Order No.	Order %age
Hymenoptera							
Apidae	*Apis dorsata* F.	8.60±7.20*	32.60	14.19	53.79	14.19	53.29
	Apis mellifera L.	3.72±0.12	14.10				
	Apis cerana F.	1.75±0.07	6.64				
	Bombus sp.	0.12±0.09	0.45				
Diptera							
Syrphidae	*Eristalis* sp.	2.92±0.16	11.09	10.27	38.97	11.07	42
	Syrphus sp.	4.50±0.14	19.09				
	Metasyrphus sp.	1.67±0.64	6.34				
	Macrosyrphus sp.	0.85±0.03	3.20				
	Episyrphus sp.	0.33±0.10	1.25				
Cordiluridae	*Musca* sp.	0.80±0.08	3.03	0.80	3.03		
Lepidoptera							
Pieridae	*Pieris canidia*	0.42±0.08	1.59	0.60	2.27	0.60	2.27
	Pieris sp.	0.18±0.02	0.68				
Coleoptera							
Coccinellidae	*Coccinella* sp.	0.12±0.01	0.45	0.12	0.45	0.47	1.78
Chrysomellidae	*Altica* sp.	0.35±0.1	1.33	0.35	1.33		

* Each value is an overall average for an insect species.
SE Standard error about the mean

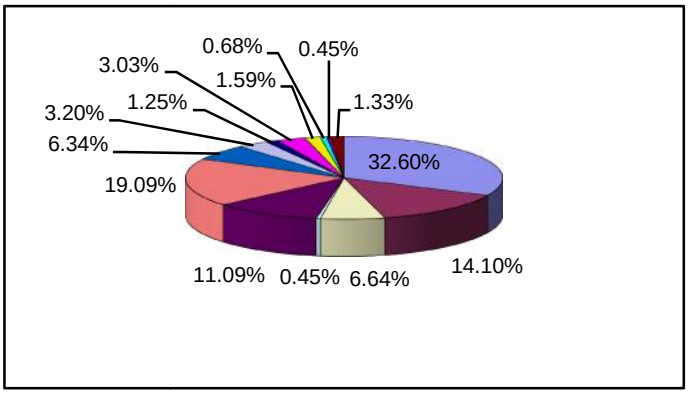

FIGURE 2: Relative abundance of different insect pollinators visiting kiwi flowers (pistillate) in Shimla hills

Relative abundance data on kiwi bloom showed that rock bee *Apis dorsata* was the most dominant insect pollinator on both staminate (25.50%) and pistilate (32.60%) flowers of kiwi. Besides this, other effective hymenopteran pollinators were: *Apis mellifera* (13.40%, 14.10%) and *Apis cerana* (9.01%, 6.64%) on staminate and pistilate flowers respectively (Tables 2, 3; Fig. 1, 2). These results are in accordance with the recent observations of Gupta et al. (2000) who also found *Apis dorsata* (40.5%) as the predominant visitor to this crop, whereas, *A. mellifera* and *Apis cerana* constituted only 7.87% and 4.42% respectively. However, Barbattini et al. (1994) reported *Apis mellifera* as the most important pollinator of kiwi crop. Ferguson and Pusch (1991) reported effective role of bumble bees in kiwi flower pollination. Besides, kiwi flowers were also visited by various dipterans, *Syrphus* sp. (21.06%, 19.09%) being the most dominant visitor on male and female flowers. Gupta et al. (2000) also found *Episyrphus* sp. (27.07%) as effective dipteran pollinator of this crop in Solan hills of Himachal Pradesh.

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