

Insect pollination and relative value of honey bee pollination in strawberry, *Fragaria ananassa* Duch

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ABSTRACT

Five cultivars of strawberry were evaluated for variation in attracting insect pollinators to the bloom and consequent increase the yield and quality of fruits. The results obtained during 2003 revealed that none of the honey bee species was found on the bloom and syrphid flies were the most frequent visitors of the crop (48% of total insect visitors) under open pollinated conditions. However during 2004 in the same area Italian honey bee, *Apis mellifera* L. constituted for 43 per cent of the visitors on the bloom followed by syrphids (39%). The pollinators did not show preference to any particular cultivar of strawberry. The average weight of the fruit in five test cultivars varied from 6.64 to 9.48 g during 2003 and 13.7 to 14.4 g during 2004. Significant variations were observed in fruit size (length, breadth), weight and yield in all the cultivars under bee pollination and the open pollinated crops. The fruit yield increased in bee pollinated crop over open pollinated ones by 9.85 to 33.32 per cent during 2003 and by 26.5 to 45.8 per cent during 2004.

Keywords: Insect pollinators; strawberry cultivars; pollinators

INTRODUCTION

Strawberry (*Fragaria ananassa* Duch) (Family: Rosaceae) is one of the most important soft fruits throughout the world. It is a small creeping plant and is perennial in nature. The flower has 50 to 500 stigmas and pollination of all ovules is needed for maximum fruit size and perfect shape. Most of the commercial strawberry cultivars are self fertile but insect pollinators and wind assist in pollination (Jaycox 1979). Insect

pollinators carry pollen between flowers and also help the pollination process by shaking or moving the flowers. Antonelli et al (1988) reported that in Benton and Shuksan varieties of strawberry plants denied insect pollination produced significantly fewer and poor quality berries. Moore (1969) reported that in some varieties of strawberry both yield and quality parameters were improved after proper pollination while in others either of these parameters was improved. Kumar et al

(1997) reviewed the information on insect pollination of strawberry and highlighted the advantages of insect pollination in strawberry varieties grown in India. The present study was carried out to evaluate the natural pollinator fauna associated with strawberry cultivation in Himachal Pradesh and the effect of assured pollination using honey bees under caged conditions on fruit yield and quality.

MATERIAL and METHODS

The study was conducted at the Regional Horticultural Research Station at Bajaura in Kullu valley of Himachal Pradesh. Five leading cultivars of strawberry grown in the region namely Dana, Etna, Belrubi, Chandler and Fern were raised in the experimental block of the research station. A colony of *Apis mellifera* was transferred to a spot near the plot marked for open pollination and observations were recorded on the pollinator activity on the open pollinated plants (all species of insect pollinators having free access to the bloom). In another plot plants of all the test cultivars were caged and a colony of *A. mellifera* (4-frame strength) was placed inside the cage just before initiation of flowering.

The activity of insect visitors was recorded consecutively on three sunny days for 5 min at 1000, 1200 and 1500 h on one m² planted area (covering about 8 plants) and the insect visitors were grouped

as honey bees, syrphids, lepidopterans and other visitors. Ripened berries from open and bee pollinated plants were picked up on alternate days and changes in quality of berries due to honey bee pollination were assessed by recording the length and breadth of fruits, average weight and yield/plant. The data were analyzed statistically using randomized block design.

RESULTS and DISCUSSION

The data regarding activity of insect visitors on the bloom of different cultivars of strawberry revealed that during 2003 under open pollinated conditions honey bees were not found visiting the bloom (Fig 1, Table 1) although an apiary was present within 100 m radius of the experimental area and also a colony of *A. mellifera* was kept for pollination near the experimental plot and syrphid flies (Diptera: Syrphidae) were the predominant pollinators (48% of the insect visitors). However in the same area during 2004 *A. mellifera* constituted 43 per cent of insect visitors on the strawberry bloom (Fig 2, Table 2) followed by syrphids (39%). None of the pollinator species showed preference to any particular cultivar of strawberry.

During 2003 the average weight of berry in different cultivars varied from 6.64 to 9.49 g while during 2004 it varied from 13.7 to 14.4g (Table 3, 4) revealing thereby that bloom visited by *A. mellifera* resulted

Insect and honey bee pollination

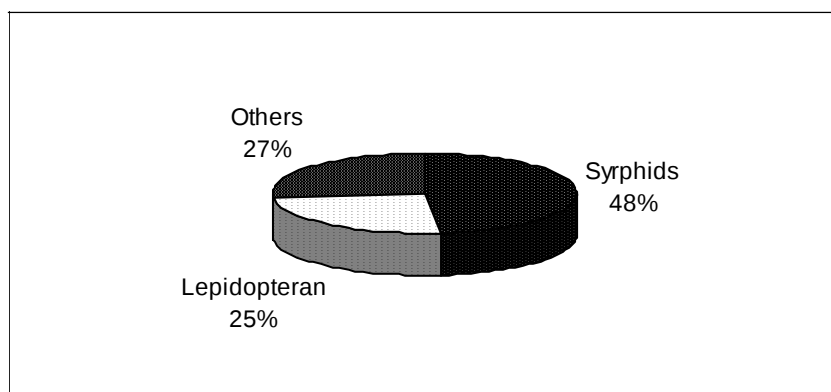


Fig 1. Proportion of insect visitors on strawberry during 2003

Table 1. Insect Activity (5 min/m²) on different cultivars of strawberry during 2003

Cultivar	Activity (number/5 min/m ²) of insect visitors									Mean
	Syrphids			Lepidopterans			Others			
	1000 h	1200 h	1500 h	1000 h	1200 h	1500 h	1000 h	1200 h	1500 h	
Chandler	5.33	2.33	3.33	1.66	1.66	1.66	1.33	2.00	1.66	1.99
Dana	2.33	2.66	1.00	1.33	1.33	1.00	1.33	1.33	1.00	1.77
Etna	3.33	4.33	1.66	1.33	1.66	1.00	1.33	1.33	1.33	2.44
Belrubi	2.33	3.00	2.33	1.00	1.66	2.00	1.33	2.00	1.33	2.22
Fern	3.00	1.66	2.00	1.00	1.33	1.33	1.66	2.33	1.33	1.77
Mean	2.80			1.53			1.80			

CD_{0.05}: Cultivars= NS, Insects = 0.53, Timings= NS, Timing x Insects= 0.52

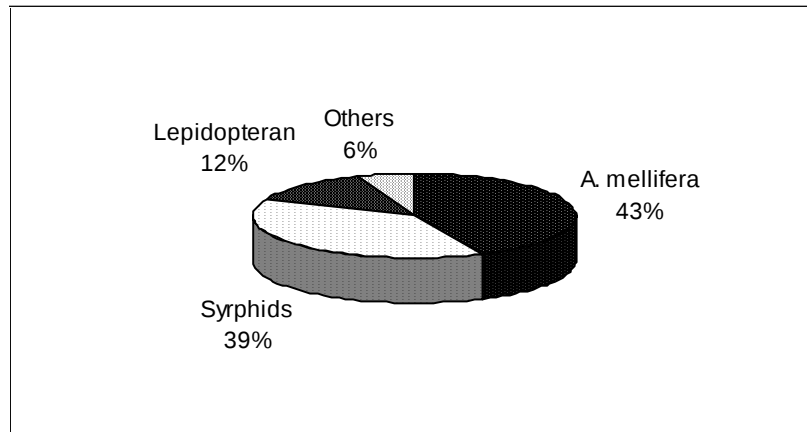


Fig 2. Proportion of insect visitors on strawberry during 2004

in heavier berries as compared to those not visited by honey bees. Since multiple visits were required for perfect fruit set in strawberry bee pollination in caged plots revealed significant increase in weight and fruit yield/plant in both the years (Table 3, 4). Among the test cultivars significant variations were observed in fruit length, breadth, weight and yield/plant between open pollination and bee pollinated crop except in Belrubi in terms of fruit length during 2003.

The honey bee activity on test cultivars at different day hours under caged conditions (Table 5) revealed that *A. mellifera* did not show preference to any cultivar in both the years but in general the activity was low (0.86 to 1.40 bees/5min/m²) during 2003 than during 2004 (2.13 to 4.80 bees/5min/m²). Increase in the average

weight of fruits from bee pollinated crop (caged with honey bees) over open pollination (Table 3, 4) ranged from 26.79 per cent in Belrubi to 73.34 per cent in Etna during 2003 as compared to 28.9 per cent in Dana to 43.5 per cent in Chandler during 2004 all being significant at 5 per cent level of significance. However no specific trend was evident with regard to increase in fruit weight during both the years. The highest increase (73.34%) was in Etna during 2003 and in Chandler (43.5%) during 2004. However increase in fruit weight under caged conditions was generally more during 2003 than during 2004 which could be related to poor insect activity during 2003 and consequently low fruit set.

Although strawberry flowers produce both nectar and pollen yet the flowers are not known to be highly

Table 2. Insect activity (5 min/m²) on different cultivars of strawberry during 2004

Cultivar	Activity (Number/5 min/m ²) of insect visitors												Mean			
	<i>A mellifera</i>				Syrphids				Lepidopterans					Others		
	1000 h	1200 h	1500 h		1000 h	1200 h	1500 h		1000 h	1200 h	1500 h			1000 h	1200 h	1500 h
Chandler	0.33	1.00	2.00		0.00	1.33	2.00		0.00	0.33	0.33		0.00	0.00	0.00	0.61
Dana	1.00	1.00	2.00		0.66	1.66	2.33		0.33	0.33	0.66		1.00	0.00	0.00	0.91
Etna	1.33	1.00	2.33		1.00	1.33	1.66		0.66	0.33	0.33		1.00	0.00	0.00	0.91
Belrubi	1.33	2.66	2.33		0.00	2.66	2.00		0.00	0.00	0.33		0.00	1.00	0.00	1.02
Fern	0.00	1.33	2.33		0.00	1.00	2.00		0.00	0.33	0.33		0.00	0.00	0.00	0.61
Mean	1.46				1.30				0.29				0.20			

CD_{0.05}: Cultivars= NS, Insects= 0.30, Timings= 0.19, Timing x Insects= NS

Table 3. Increase in quality parameters in bee pollinated over open pollinated strawberry crop during 2003

Cultivar	Fruit length (cm)			Fruit breadth (cm)			Fruit weight (g)			Yield/ plant (g)		
	Open	Caged	Increase (%)	Open	Caged	Increase (%)	Open	Caged	Increase (%)	Open	Caged	Increase (%)
Chandler	2.76	3.23	17.03	2.14	2.40	12.15	6.73	9.21	36.85	209	253	21.05
Dana	2.96	3.32	12.16	1.96	2.80	42.85	7.12	11.43	60.53	199	239	20.10
Etna	2.74	4.48	63.21	2.24	2.73	21.87	6.64	11.54	73.34	191	219	14.66
Belrubi	4.29	4.31	0.005	2.40	2.72	13.33	9.49	12.02	26.65	179	239	33.52
Fern	3.94	4.29	8.88	2.43	2.61	7.40	8.78	11.14	26.88	200	219	9.50
CD _{0.05}	0.06			0.13			0.12			5.66		

Table 4. Increase in quality parameters in bee pollinated over open pollinated strawberry crop during 2004

Cultivar	Fruit length (cm)			Fruit breadth (cm)			Fruit weight (g)			Yield/ plant (g)		
	Open	Caged	Increase (%)	Open	Caged	Increase (%)	Open	Caged	Increase (%)	Open	Caged	Increase (%)
Chandler	3.87	4.13	6.70	3.05	3.82	25.24	13.80	19.80	43.48	195	270	38.46
Dana	3.26	3.85	18.10	3.24	3.67	13.27	14.20	18.30	28.87	237	345	45.56
Etna	3.11	3.54	13.80	3.14	3.82	21.65	14.40	19.10	32.60	262	331	26.33
Belrubi	3.83	4.57	19.32	3.11	3.71	19.29	13.70	19.10	39.41	213	291	36.62
Fern	3.27	3.92	19.88	3.08	3.24	5.20	13.90	18.70	34.53	183	240	31.15
CD _{0.05}	0.06			0.09			0.23			32.15		

attractive to bees and even different cultivars are visited by bees to varying degrees (Skrebtsova 1957). However the pollinator activity data did not indicate preference of pollinator species to any of the five cultivars included in the study either under open pollination or under caged conditions. Earlier studies have shown that although insect pollinators may not help in more fruit set yet fruit size and yield may increase under adequate insect pollination (McGregor 1976). Similar results were evident during 2003 when only syrphid activity was recorded on the flowers of all the cultivars. Contrary to this during 2004 when *A. mellifera* was found visiting the bloom under open pollination conditions the fruit size increased significantly in all the cultivars. Although syrphid flies are known

to help in pollination yet their role seems unreliable due to variations in their population over time and space and as consumers of pollen grains they may reduce pollination by competing with more efficient pollinators (Nye and Anderson 1974, Antonelli et al 1988). Use of honey bees under such conditions (by caging) proved effective in increasing the production of quality fruits. During 2003 the increase in weight of berries ranged from 26.79 to 73.34 per cent in different cultivars while during 2004 the increase was 28.90 to 43.5 per cent with good bee activity. These results suggest that in small area under strawberry cultivation the crop should be caged with honey bee colonies for assured fruit quality and increased yield. Earlier workers have suggested use of 5 to 10

Table 5. Insect activity (5 min/m²) of *Apis mellifera* on different cultivars of strawberry under caged condition during 2003 and 2004

Cultivar	Activity (Number/5 min/m ²) during (mean)							
	2003				2004			
	10.00 h	12.00 h	15.00 h	Mean	10.00 h	12.00 h	15.00 h	Mean
Chandler	1.00	1.66	1.33	1.33	1.66	5.33	3.33	3.44
Dana	1.00	1.66	1.33	1.33	2.33	4.66	3.00	3.33
Etna	1.00	1.33	0.33	0.88	2.66	4.66	2.66	3.33
Belrubí	1.66	1.00	0.33	1.00	2.33	5.00	3.00	3.44
Fern	1.00	1.33	1.00	1.11	1.66	4.33	3.00	3.00
Mean	1.13	1.40	0.86		2.13	4.80	3.00	
CD _{0.05}	Cultivars= NS, Timings= 0.38, Interaction= 0.85				Cultivars= NS, Timings= 0.19, Interaction= 0.52			

colonies in the area (Skrebstova 1958. However it would be an uneconomical venture compared to caging the crop with a honey bee colony. Pratap (2000) used *Acerana* F colony under caged conditions for pollination of strawberry and reported an increase of 21.4 and 20.3 per cent in fruit set and fruit weight respectively over the open pollinated crop. Other workers have also reported that honey bee pollination increased the fruit yield by 18-100 per cent depending upon the cultivar (Free 1968, Nye and Anderson 1974, Antonelli et al 1988, Svensson 1991). The fruit yield in the present study increased by 9.85 to 33.32 per cent during 2003 and from 26.5 to 45.8 per cent during 2004 over open pollinated crop.

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Received: 20.01.14

Accepted: 14.04.14