

Impact of Number of Bee Visits on Cauliflower Pollination

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Insect pollinators, particularly honeybees, are known to increase yield in *Brassica* crops that are more or less self-incompatible. Sakharov (1958) reported that the weight of 1000 cabbage seeds produced in the absence of bee visits was only 1.1 g, with a few visits 2.2 g, and with ample visits 3.6 g. The present studies were, therefore, undertaken to quantify the increase in yield with increases in the number of bee visits in order to ascertain how many bee visits are needed for maximum yields (Landridge and Goodman, 1982). In Himachal Pradesh, both *Apis cerana* and *A. mellifera* are domesticated. Hence a comparison was also made on the effect of number of visits of each bee species on siliqua set and number of seeds per siliqua of cauliflower.

Material and Methods

These studies were carried out at Bairty, Solan (1150 m) in the vegetable-seed multiplication farm of the Department of Agriculture, Himachal Pradesh. Seedling of cauliflower var. Pusa and var. Snowball-1 were transplanted to 3.6 m x 3 m plots with spacing of 60 cm x 60 cm. These plots were given the usual agronomical practices.

To assess the influence of visits of *A. cerana* and *A. mellifera* on seed yield, two plants in each of 10 selected plots of equal vigour and growth

under each treatment were used. On each plant, 20–25 buds (ready to open) were marked at the base of the flower filament and caged. Each morning, opened flowers from these marked buds were marked and tagged for the number of bee visits (1, 3, 5, 7 and 9). Observations were continued until 1, 3, 5, 7 and 9 visits of each bee species to tagged flowers were obtained. No other pollinator was allowed to visit marked flowers. After bee visits, marked flowers were individually bagged in perforated butter paper envelopes (6 cm x 4.5 cm). Replicates consisted of 15–20 flowers/plant for each number of visits for each bee species. The experiment was repeated for three continuous days. Butter paper bags were removed after six days anthesis. Percentage siliqua set and number of seeds per siliqua were recorded after one month. Observations were recorded on crop sprayed with insecticides (either endosulfan 0.05% or oxydemeton methyl 0.025%) during pre-bloom stage and on unsprayed crop.

Results and Discussion

Effect of bee visits on siliqua set are presented in Table 1.

The number of the visits irrespective of bee species per flower significantly affected siliqua

Table 1. Effect of number of bee visits on the siliqua set in cauliflower

Insecticides	Number of bee visits									
	1		3		5		7		9	
	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>
Endosulfan (0.05%)	36.11 (36.75)*	33.33 (35.11)	50.00 (43.00)	47.22 (45.36)	63.88 (53.29)	55.55 (48.23)	58.33 (50.02)	58.33 (51.65)	61.11 (51.65)	66.67 (54.89)
Oxydemeton-methyl (0.025 %)	32.12 (34.36)	30.55 (33.33)	44.44 (41.77)	41.67 (40.13)	52.77 (46.64)	50.00 (45.05)	63.88 (53.25)	66.67 (55.33)	66.67 (54.89)	61.11 (51.65)
Control	47.22 (43.36)	33.33 (35.11)	58.33 (50.02)	47.22 (43.40)	66.67 (55.41)	61.11 (51.65)	63.88 (53.25)	63.88 (53.82)	61.11 (51.46)	55.55 (48.23)
Mean	38.48 (38.16)	32.40 (34.52)	50.92 (45.59)	45.37 (42.30)	61.11 (51.78)	55.55 (48.31)	62.03 (52.17)	62.03 (52.39)	62.96 (52.57)	61.11 (51.59)
Mean visit (irrespective of bee species)	35.44 (36.46)		48.15 (43.95)		58.33 (50.05)		62.03 (52.28)		62.04 (52.13)	

CD(0.05) * Figures in parentheses are angular transformed values
 Visits = 4.47 + *A. mellifera*
 Interaction (bee x visits) = NS ++ *A. cerana*
 Interaction (bee x visits x insecticides) = NS

Table 2. Effect of number of bee visits on seeds per siliqua in cauliflower

Insecticides	Number of bee visits									
	1		3		5		7		9	
	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>	<i>A. mell</i>	<i>A. cer</i>
Endosulfan (0.05%)	6.15	4.31	9.06	7.71	11.27	9.97	12.71	13.06	11.72	13.05
Oxydemeton-methyl (0.025%)	4.17	3.31	7.88	5.81	11.02	9.75	12.62	11.94	12.56	12.72
Control	3.80	4.50	6.64	6.42	13.65	10.03	13.03	13.58	12.76	13.02
Mean	4.70	4.04	7.86	6.65	11.90	9.92	12.79	12.86	12.35	12.93

Mean (irrespective of bee species) 4.37 7.25 10.95 12.82 12.64

CD(0.05) Visits = 0.72 + *A. mellifera*
 Interaction (bee x visits) = 1.02 ++ *A. cerana*
 Interaction (bee x visits x insecticides) = NS

set in cauliflower (Table 1). One bee visit resulted in only 35.44% siliqua set and increased significantly to 48.15% with three visits and 58.33% with five visits. However, with further increase in visits there was no significant increase in corresponding siliqua set. It ranged from 58.33% to 62.04% with 5-9 visits per flower. Dhaliwal (1980) also reported that there was substantial increase in per centage siliqua set

with up to six visits by *A. cerana*. Siliqua set in the present study was not influenced by whether flowers were visited by *A. cerana* or *A. mellifera*. Application of insecticides did not affect siliqua set significantly in comparison to control.

Results on the effect of number of bee visits on seeds per siliqua are presents in Table 2.

The numbers of seeds per siliqua irrespective of bee species was maximum in flowers having

seven (12.82 seeds) and nine (12.64 seeds) bee visits. Siliqua formed from flowers having one, three and five bee visits averaged 4.37, 7.25 and 10.95 seeds per siliqua respectively (Table 2).

Interestingly, the number of visits of a particular bee species, influenced the number of seeds per siliqua. Flowers having three visits from *A. mellifera* resulted in siliqua having 7.86 seeds in comparison to only 6.65 seeds for three visits from *A. cerana*. Similarly five visits from *A. mellifera* produced 11.9 seeds per siliqua and from *A. cerana* 9.92 seeds per siliqua. However, with seven and more visits per flower, there were no significant variation in the number of seeds per siliqua whether the flower were visited by *A. mellifera* or *A. cerana*. There were no significant difference in the number of seeds per siliqua in the insecticide sprayed and the control crop.

The results suggested that there was no apparent effect on percentage siliqua set in cauliflower whether flowers were visited by *A. mellifera* or *A. cerana*. However, the number of bee visits significantly increased siliqua set up to five visits per flower. Furthermore, although maximum set may be obtained with five bee visits, seven visits per flower are needed for maximum filling of siliqua. In relation to bee species, at least five visits of *A. mellifera* resulted in maximum number of seeds, whereas seven visits of *A. cerana* were needed. This may be because the comparatively bigger size of *A.*

mellifera results in more loose pollen grains being available for pollination. Although Free (1970) considered relative efficiencies of pollinators on the basis of abundance, foraging rate and foraging methods, other factors such as body size, loose pollen on body and number of visits required for maximum pollination are equally important to determine the efficiency of pollination (Adlerz, 1966; Badar and Anderson, 1962; Drake, 1948; McGregor *et al.*, 1965).

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