Chapter 51

Diversity, Visitation Frequency, Foraging Behaviour and Pollinating Efficiency of Insect Pollinators Visiting Turnip Blossoms

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Turnip (*Brassica rapa*) is a self-incompatible crop and needs pollen vectors for cross-pollination of its flowers (Free, 1993; Sihag, 1985). Several species of pollinators visit its flowers (Sihag, 1986). However, all are not equally important. Some make a better contribution to pollination because of their more suitable attributes. These include abundance, foraging behaviour, number of loose pollen grains carried on the body, foraging rate and activity duration. An index value derived from these attributes was used to compare the efficiency of the pollinators of pigeon pea (*Cajanus cajan*) (Sihag and Rathi, 1994). This paper uses the same approach to study the pollinators of turnip.

Materials and Methods

These investigations were conducted in 1995 at the Vegetable Research Farm and Zoology Department of CCS Haryana Agricultural University, Hisar, India. Among visitors to turnip blossoms, pollinators and non-pollinators were characterised on the basis of their foraging mode (Sihag, 1988). Visitors were collected with a sweep net and identified. Abundance of visitors was recorded in five randomly selected 1 m × 1 m plots of the crop for 5 min at 2-h intervals from morning until evening on the observation day. These observations were repeated at weekly intervals during the entire blooming period of the crop. Foraging rates in terms of number of flowers visited per minute were calculated for 10 insects. Mean foraging activity duration was determined using the following formula.

$$T = \sum_{i=1}^{x} \frac{ni \times ti}{N}$$

where, T = mean activity duration of the pollinator (in hours)
n_i = total number of insects of a species active at i^{th} hour of the day
t_i = total foraging activity duration of the visitors of a species active at i^{th} hour of the day
N = total number of visitors of a species through the course of the day

Number of loose pollen grains adhered to the body of the pollinator was counted with a haemocytometer as suggested by Kumar *et al.*

(1985). To determine the pollinating efficiency of pollinators, performance scores were derived by using the following formula suggested by Sihag and Rathi (1994).

$$P_{sij} = \frac{N_{ij}}{N_j} \times S$$

where, $i = 1$ to x and $j = 1$ to r, both taking positive, whole number and finite values

P_{sij} = performance scores of ith species for j^{th} attribute

N_{ij} = importance value of ith species for j^{th} attribute

N_j = total importance value of all the species for j^{th} attribute

S = total number of species

The values of performance scores for different attributes of a species were multiplied to obtain its pollination index. Then pollinators were ranked for their pollinating efficiency.

Results and Discussion

Blossoms of turnip were visited by 14 insect pollinators (Table 1). *Apis mellifera* was the most abundant. Foragers of *A. mellifera* visited the greatest number of flowers per minute.

Average foraging rate of *A. mellifera* was also greatest, followed by *A. dorsata, A. florea, Halictus* sp. and the flies. *Apis mellifera* remained active for a longer duration than other pollinators. Bee species also carried a greater number of loose pollen grains on their bodies than dipterans. On the basis of maximum abundance, highest foraging rate, longer mean activity duration, greater number of loose pollen grains carried on its body and maximum pollination index, *A. mellifera* was ranked as the best pollinator of turnip (Table 2). *Apis dorsata* and *A. florea* followed *A. mellifera*. The role of dipterans as pollinators was less than hymenopterans.

Among pollinators of turnip, the major proportion consisted of hymenopterans; dipterans and others followed. *Apis mellifera* was the most abundant and had the highest foraging rate. This was perhaps because of the compatibility of its tongue length with the depth of the corolla of the turnip flower. Inouye (1980) and Free (1993) reported the role of tongue length of the visiting species in deciding its suitability to a host plant. Mean activity duration of *A. mellifera* was greatest because more bees were active throughout the day. Bees carried a larger number of loose pollen grains because they have more branched hairs on their body than other pollinators, and *A. mellifera* had the highest pollinating efficiency.

Since there are only 24 ovules in the ovary of turnip flower and each bee transfers more pollen grains than this in a single visit, all bee species are capable of enhancing full seed set in a single visit. On the basis of a single visit, pollinators of this crop cannot be ranked. For determining the pollinating efficiency of visitors to turnip blossoms, therefore, observation of their behavioural attributes is important. Pollination index values show the relative contribution of each species towards pollination of turnip. As used earlier by Sihag and Rathi (1994), the present method of ranking, therefore, seems to be logical.

Table1. Insects visiting the flowers of *Brassica rapa* at Hisar

Insect visitor	Order	Family
Apis dorsata	Hymenoptera	Apidae
Apis florea	Hymenoptera	Apidae
Apis mellifera	Hymenoptera	Apidae
Halictus sp.	Hymenoptera	Halictidae
Chrysomya bezzaina (villeneuve)	Diptera	Calliphoridae
Gasterophilus sp.	Diptera	Gasterophilidae
Sarcophaga sp.	Diptera	Sarcophagidae
Eristalis sp.	Diptera	Syrphidae
Coccinella septumpunctata	Coleoptera	Coccinellidae
Danis chrysippus	Lepidoptera	Danaidae
Potanthus rectifasciata	Lepidoptera	Hesperiidae
Chaetoprocta odata	Lepidoptera	Lycaenidae
Eurema hecaba	Lepidoptera	Pieridae
Pieris brassicae	Lepidoptera	Pieridae

Table 2. Pollinating efficiency ranking of turnip pollinators on the basis of different pollinating attributes (all mean values)

Insect pollinators	Abundance (No./m²)	Foraging rate (No./min.)	Mean activity duration(h)	No. of loose pollen grains	Pollinating index	Pollinating efficiency ranking
Apis florea	1.86	6.42	2.15	6506.40	1.325	3
	(0.909)	(1.041)	(1.015)	(1.380)		
Apis mellifera	8.89	11.31	2.61	8793.25	18.315	1
	(4.344)	(1.834)	(1.232)	(1.866)		
Apis dorsata	3.24	9.91	2.47	9720.40	6.116	2
	(1.583)	(1.607)	(1.166)	(2.062)		
Halictus sp.	0.62	5.40	2.11	5622.35	0.315	4
	(0.303)	(0.876)	(0.996)	(1.193)		
Chrysomya bezzaina	0.29	3.32	1.77	1534.25	0.021	8
	(0.142)	(0.538)	(0.835)	(0.325)		
Gasterophilus sp.	0.40	4.04	1.84	1798.50	0.042	7
	(0.195)	(0.655)	(0.868)	(0.382)		
Sarcophaga sp.	0.46	4.17	1.99	1836.10	0.056	6
	(0.225)	(0.676)	(0.939)	(0.390)		
Eristalis sp.	0.61	4.76	2.01	1890.95	0.087	5
	(0.298)	(0.772)	(0.949)	(0.401)		
Others	0.80	-	-	-	-	-

Notes: Figures in parenthesis are performance scores; – observations not recorded.
CD ($p \leq 0.05$): abundance = 1.155; foraging rate = 1.001; loose pollen grains = 760.250.

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