Chapter 50

Role of *Apis cerana himalaya* Pollination on Yield and Quality of Rape Seed and Sunflower Crops

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A separate race of Asian hive bee, *Apis cerana himalaya,* exists in the northeast Himalayan region (Singh and Verma, 1992; Singh *et al.*, 1990). Although this native bee has been successfully managed for the production of honey and beeswax, its effectiveness as a pollinator of entomophilous crops is not understood and often underestimated. Therefore this study details investigations into the role of this bee on seed production of commonly grown oilseed crops (rape seed, *Brassica campestris,* and sunflower, *Helianthus annuus*).

Materials and Methods

Field experiments were conducted for two consecutive years during winter 1992 and 1993 on rape seed var. M-27 and sunflower var. Morden at the Oilseed Research Farm of the College of Agriculture, Central Agricultural University, Imphal, India (24° 49′ N and 93° 8′ E).

Three treatments replicated four times were imposed on each crop as follows: control (plants in a cage with no insect pollinators); open pollination (no cage with plants accessible to

Utilisation of honeybees in sunflower hybrid-seed production

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Studies on the foraging behaviour of honeybees on female and maintainer lines of sunflower, *Helianthus annuus,* and their utilisation in the production of hybrid seeds revealed their potential. All 5 species of honeybees foraged on the crop throughout the day. Filled-seed weight, seed number and oil content were considerably increased in plots pollinated by honeybees. Seed weight was greatest (25.42 g/head) in honeybee-pollinated plots followed by hand-and-bee-pollinated (24.73 g/head), other pollinators (13.59 g/head) and exclusively hand-pollinated (12.98 g/head) plots in the female parent. Filled grain (92.95%) and oil content (53.10%) were also greatest in bee-pollinated plots. In the maintainer line, seed weight was greatest (14.49 g/head) in plots pollinated by bees and other pollinators followed by exclusively hand-pollinated (12.66 g/head), and without hand or bee pollination (9.75 g/head). Number of seeds was (407.95) in plots pollinated by bees and other insects followed by exclusively hand-pollinated (395.31), and without hand or bees pollination (238.70).

naturally occurring insect pollinators); and, bee pollination (*A. c. himalaya* in a cage with plants). For the control and bee-pollinated plots, mosquito nets of 24 mesh were erected on the standing crop just before the initiation of flowering. In the bee-pollination treatment, all four plots were covered with one pollination cage (24 m × 5 m × 3 m) and a medium-sized colony of *A. c. himalaya* (with seven frames covered with bees and free of any sign of disease) was placed when about 10% of the crop was in bloom. The bees were kept inside the pollination cage until the end of flowering. For control plots, individual cages (6 m × 5 m × 3 m) were erected on each plot so that no insect pollinators could enter the cage and pollinate the flowers.

After the rape seed crop was mature, 10 plants were collected randomly from each replication of control, open-pollinated and bee-pollinated treatments. Effects on the quantity and quality of seed production as a result of bee pollination were assessed in terms of per centage siliqua set, siliqua length, number of seeds per siliqua, weight of 1000 seeds, seed yield, per centage seed germination and oil content.

Similarly, 10 sunflower heads were collected randomly from each replication of the three treatments. Per centage seed set, weight of 1000 seeds, number of seeds per gram, seed yield, per centage seed germination and oil content were determined.

Data were analysed statistically using analysis of variance.

Results

The effects of bee pollination on the quantity and quality of rape seed production are summarised in Table 1.

Siliqua setting in plots caged with bees (BP) exhibited an increase of 239.77 % over plots pollinated without insects (PWI) and 2.65% over open pollinated (OP) plots. BP increased the siliqua length by 14.72% compared to PWI and 8.65 % compared to OP. BP also significantly increased the number of seeds per siliqua and seed weight by 50.55% and 17.41 % over PWI, and by 17.85 % and 2.16 % over OP. The increase in seed yield in the BP treatment was 586.22 % over PWI and 8.73 % over OP treatments. The quality of seeds assessed in terms of per centage seed germination and oil content was found to be highest in BP treatment. The germination of seeds from BP plants was 50.90 % greater than from PWI and 2.5 % greater than from OP plants. Moreover, seeds from BP plants showed 21.3 %

Table 1. Quantitative and qualitative effects of *Apis cerana himalaya* pollination on rape seed

Yield parameters	Control (PWI)	Open-pollinated (OP)	Bee-Pollinated (BP)	CD at 5%	% increase over PWI	% increase Over OP
Siliqua set (%)	20.67	68.42	70.23		239.77	2.65
	(26.39)	(56.01)	(57.34)	(5.00)		
Siliqua length	3.94	4.16	4.52		14.72	8.65
(cm)	(2.11)	(2.12)	(2.24)	(0.07)		
No. of seeds	9.12	11.65	13.73		50.55	17.85
per siliqua	(3.14)	(3.52)	(3.80)	(0.24)		
Wt. of 1000	2.01	2.31	2.36		17.41	2.16
seeds (gm)	(1.66)	(1-75)	(1-76)	NS		
Seed yield (q/ha)	1.96	12.37	13.45	2.90	586.22	8.73
Seed	55.00	81.00	83.00		50.90	2.50
Germination(%)	(47.93)	(65.98)	(66.02)	(5.21)		
Oil content (%)	33.25	38.75	40.33		21.30	4.10
	(35.18)	(38.48)	(39.41)	(0.81)		

Figures in parentheses are transformed values.

Table 2. Quantitative and qualitative effects of *Apis cerana himalaya* pollination on sunflower

Yield parameters	Control (PWI)	Open-pollinated (OP)	Bee-Pollinated (BP)	CD at 5%	% increase over PWI	% increase Over OP
Seed set (%)	2.93	60.50	71.58		2343.00	18.31
	(9.84)	(51.13)	(57.81)	(2.20)		
Wt. of 1000 seeds (gm)	50.32	64.29	54.88	3.26	9.06	17.15
No. of seeds per gm	20.87	16.58	17.04	2.77		
	(4.63)	(4.13)	(4.19)	(0.37)		
Seed yield (q/ha)	2.06	16.60	18.55	1.47	800.49	11.75
Seed germination (%)	69.88	86.50	91.13		30.41	5.35
	(56.78)	(68.80)	(74.55)	(11.94)		
Oil content (%)	35.96	46.79	43.70		21.52	7.07
	(36.85)	(43.16)	(41.38)	(1.32)		

Figures in parentheses are transformed values.

higher oil content than PWI plants and and 4.1 % than OP plants.

The effects of bee pollination on the quantity and quality of sunflower seed production are summarised in Table 2.

The crop pollinated by bees (BP) enhanced seed set 2343 % compared to pollination without insects (PWI) and 18.31 % compared to open pollination (OP). However, OP increased seed weight by 27.76% compared to PWI and 17.15 % compared to BP plants. The maximum number of filled seeds per gram was obtained in PWI plants with 25.87 % increase over OP plants and 22.48 % over BP plants. The increase in seed yield in BP treatment was 800.49 % greater than PWI and 11.75 % than OP. The germination of seeds from BP plants was 30.41 % higher than seeds from PWI and 5.35 % higher than OP plants. However, the maximum oil content was obtained in seeds from OP plants with 30.12 % increase over PWI and 7.07 % over BP plants.

Discussion

Bee pollination increased siliqua set, siliqua length, number of seeds per siliqua, seed weight, seed yield, germination rate and oil content of seeds in comparison with open-pollinated rape seed plants. Increase in siliqua set and seed set as a result of bee pollination could be owing to both greater numbers of pollinators in the plots caged with bees, and to a superior pollinating efficiency of honeybees. Natural insect pollinators, on the other hand, owing to their lower numbers and lower pollinating efficiency pollinated fewer flowers. Similar studies (Bisht *et al.*, 1980; Langridge and Goodman, 1975; Radchenko, 1964; Sihag, 1986) have shown that cross-pollination by honeybees increased the per centage of siliqua setting in rape seed. Svendsen (1990) reported that rape seed flowers after bee pollination had longer siliqua length and many seeds, which agrees with the present observations.

The longer siliqua with higher seed content in bee-pollination plots may be owing to better and timely pollination, and fertilisation of more ovules per ovary. Increase in seed weight as a result of bee pollination could be owing to the better pollination efficiency of honeybees that might help in the production of auxin, a growth hormone, resulting in better size of seed. Panda *et al.* (1989) also observed a similar trend in rape seed: 1000 seed weight was highest in the plants enclosed with bees. The yield difference between bee-pollination and control treatments indicates the extent of self-sterility and self-incompatibility of the rape seed variety and the relative increase in crop yield due to bee pollination. Moreover, yield differences between bee-pollination and

open-pollination treatments indicated a lack of natural insect pollinators needed for maximum pollination at the experimental site, and suggested that the provision of bees would increase potential yield. Rahman (1945) also reported that by placing two colonies of *A. cerana* per acre of toria crop, seed yield was increased by 10–25 %.

The quality of seeds can be assessed by their oil content and germination efficiency. Honeybee pollination increased oil content and seed germination over open pollination. It may be because in bee pollination, flowers are pollinated in the phase of fully functional generative organs producing better quality seeds. Similarly, Radchenko (1964) and Panda *et al.* (1989) found a higher per centage of oil content and an increase in seed germination after bee pollination.

Bee pollination increased seed set, seed yield and germination rate of seeds compared with open-pollinated sunflower plants. This could be owing to both greater numbers of pollinators in the plots with caged bees and to a superior pollinating efficiency of honeybees. Negligible seed set due to self-pollination in bagged sunflower plants indicated that the crop is self-incompatible and requires cross-pollination by insect pollinators. Stamm and Schuster (1989) also reported that the per centage seed set of sunflower was 70–80% in plants caged with bees and 30–40% in the plants caged without insects. Increase in seed yield of sunflower after bee pollination has been reported frequently (Goyal and Atwal, 1973; Krause, 1983; Mahmood and Furgula, 1983; Panda *et al* ., 1993).

El-Suhhar and Ewies (1977) reported that seeds obtained from the bee-pollinated sunflower plants gave higher germination rates. This confirms with the present findings. However, oil content was maximum in seeds obtained from open-pollinated plants.

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