

## Effect of Pollination Strategies on Fruit Set of Apple in Himachal Pradesh

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Most apple cultivars grown on a commercial scale in Himachal Pradesh are self-unfruitful. They require a compatible cultivar for cross-pollination to set a good crop. Red Delicious, Royal Delicious and its bud sports are commercial cultivars, and Golden Delicious and Red Gold are pollinising cultivars generally used in Himachal Pradesh. Orchardists rely on honeybees for effective pollination.

The indigenous Asian hive bee, *Apis cerana*, is available in the vicinity of apple orchards but its population has been drastically reduced since the outbreak of Thai Sac Brood Virus Disease in 1984. In order to supplement the bee population at flowering, the European hive bee, *Apis mellifera*, has been tried (Verma, 1992; Kakar, 1993). Pollinator management in apple orchards in the Himalayas may differ on different aspects (north, south, east, west). Also the placement of bee colonies at top, middle and bottom of slopes may affect fruit set and yield. The proximity of bees to the polliniser and competing crops are other important considerations. Therefore, investigations were undertaken to study the effect of various pollination strategies on fruit set of apple.

### Materials and Methods

Studies on pollinator management were conducted in the University apple orchards located at 2282 m during 1994-95. Apple trees were selected randomly and data on bee visits and fruit set were recorded for different distances from hives on northwest, northeast and southwest aspects; for colonies placed at the top, middle and bottom of a slope; for different distances from the polliniser; and, for different distances from other competing crops such as mustard, radish and clover.

Colonies of *A. cerana* (6-7 frames) and *A. mellifera* (8-9 frames) were introduced into the orchard at 5-10% flowering. Data on bee visits were recorded by counting number of bees visiting marked blooms (10 or 100 flowers) during a 10-min period. Data on fruit set was recorded by tagging pre-counted flowers (buds) and later counting number of fruits set.

### Results and Discussion

#### Effect of aspect

Data on bee visits and fruit set on three aspects are presented in Table 1.

Table 1. Performance of honeybees on different aspects in apple orchards

Aspect	Bee species	No. of bees/100 flowers at different distances from hive						Fruit set (%) at different distances from hive					
		6.5 m	13.0 m	19.5 m	26.0 m	32.5 m	39.0 m	6.5 m	13.0 m	19.5 m	26.0 m	32.5 m	39.0 m
Northwest	<i>Apis cerana</i>	4.5	8.0	14.0	18.0	20.0	11.0	9.0	11.5	13.5	15.0	14.5	14.0
	<i>Apis mellifera</i>	6.0	7.5	10.0	12.0	14.0	15.0	8.0	9.5	12.0	12.5	11.0	10.5
Northeast	<i>Apis cerana</i>	11.0	14.0	15.0	20.0	15.0	16.0	6.0	10.5	13.0	14.0	14.5	13.5
	<i>Apis mellifera</i>	7.5	9.0	11.0	12.5	15.0	13.0	7.5	9.0	11.5	11.0	10.0	9.5
Southwest	<i>Apis cerana</i>	5.0	6.0	6.5	8.0	7.5	6.0	2.0	2.5	3.5	4.0	3.5	2.5
	<i>Apis mellifera</i>	4.5	4.0	4.5	5.0	6.0	5.5	1.5	2.0	2.5	3.0	2.0	2.0

There was gradual increase (6 to 15 bees/100 flowers) in visits to blooms by *A. mellifera* on northwest aspects from trees located near (6.5 m) the hive to those further away (39 m). Whereas *A. cerana* only increased its visits up to 32.5 m (4.5 to 20 bees/100 flower) then dropped to 11 bees/100 flowers for 39.0 m. This second trend in bee activity was similar for both species on northeast and southeast aspects. Maximum *A. cerana* and *A. mellifera* foraging occurred on trees located on sunny aspects and minimum for those on shady aspects. Highest fruit set (12–15%) was recorded for trees on northwest and northeast aspects; 2–4% fruit set was recorded on southwest aspects. These results indicate that more bees visit blooms on sunny aspects than shady ones.

#### Effect of location of bee colonies

Data on location of bee colony are presented in Table 2.

Results show that when colonies were maintained in the middle of the orchard a maximum number of bees visited blooms: 3–4 bees/10 flowers for *A. cerana* and 2–4 bees/10 flowers for *A. mellifera*. The number of bees foraging on trees located at the top and bottom of the slope were lower: 2.5–3.0 for *A. cerana* and 2.0 for *A. mellifera* at the top, and 1.0–1.5 for *A. cerana* and 2.0–2.5 for *A. mellifera* at the bottom. The greater number of bees pollinating flowers in the middle of the orchard may be owing to ease of access.

As a result of higher numbers of bees visiting blooms in the middle, there was greater fruit set:

Table 2. Effect of placement of honeybee colonies on bee visits and fruit set of apple

Bee species	Location of colony	No. of bees/10 flowers at a distance of		Fruit set (%) at a distance of	
		6.5 m	13 m	6.5 m	13 m
<i>Apis cerana</i>	Top level	2.5	3.0	3.5	4.0
	Middle level	3.0	4.0	10.0	15.0
	Bottom level	1.5	1.0	2.5	3.0
<i>Apis mellifera</i>	Top level	2.0	2.0	3.0	4.5
	Middle level	2.0	4.0	8.5	10.0
	Bottom level	2.0	2.5	4.0	5.0

10–15% for *A. cerana* and 8.5–10% for *A. mellifera*. Lowest fruit set—2.5–3.0% for *A. cerana* and 4.0–5.0% for *A. mellifera*—was recorded on trees at the bottom of the orchard. Moderate fruit set—3.5–4.0% for *A. cerana* and 3.0–4.5% for *A. mellifera*—was recorded on trees at the top.

#### Effect of distance from polliniser

Data on the effect of distance from pollinising cultivars is given in Table 3.

Maximum fruit set (6.08%) was recorded when pollinisers were located at the shortest distance (6.5 m). There was gradual reduction in fruit set from 5.60% to 4.44% as the distance from the polliniser increased (13 to 32.5 m). Therefore, for a higher fruit set the commercial cultivar and the polliniser should be located near to each other. Planting pollinisers at 15% (third tree in every third row) is advised because every tree is adjacent to a polliniser (Mayer *et al.*, 1985).

**Table 3.** Effect of distance from polliniser on fruit set

Polliniser	Fruit set (%) recorded at different cultivar distances from pollinisers				
	6.5 m	13.0 m	19.5 m	26.0 m	32.5 m
Granny Smith	6.0	5.50	4.75	4.25	4.00
Red Gold	5.71	6.60	6.00	5.25	5.00
Tydeman Early	7.50	5.00	4.50	4.20	4.00
Worcester					
Golden Delicious	5.70	5.86	5.25	5.00	5.00
Lord Lambourne	5.50	5.00	4.50	4.50	4.20
Average	6.08	5.60	5.00	4.64	4.44

### Effect of competing crops on fruit set of apple

The flowering period of apple (April) coincides with flowering of other crops such as mustard, radish and clover. Bee colonies introduced into apple orchards for pollination at initiation of flowering are reported to shift to these competing crops. In order to ascertain the shift in bee population, an apple orchard with no competing crops and an apple orchard with competing crops were selected. Data are presented in Table 4.

Results show that normal non-bee activity was recorded in apple orchards but there was sizable reduction in both *A. mellifera* (20%) and *A. cerana*

**Table 4.** Visiting of honeybees in apple orchard with and without competing crops

Description of orchard	Per cent reduction in bee population in comparison to control		
	<i>Apis mellifera</i>	<i>Apis cerana</i>	Other insects
Apple orchard with competing crops*	20.0	15.0	No effect
Apple orchard without competing crops (control)	Normal	Normal	No effect

\* Competing crops were mustard, radish and clover

(15%) populations. The reduction may be owing to greater attraction to competing crops.

### References

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