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Effect of supplementary feeding on *Apis cerana* F. colony development at Katrain in Kullu valley of Himachal Pradesh

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Abstract
This experiment was conducted to work out the optimum schedule for supplementary feedings. The experiment was conducted at Katrain, District Kullu situated at an altitude of 1473 m amsl. No systematic studies have been undertaken in Himachal Pradesh on these aspects, hence, the same was conducted with the objective to find the optimum schedule for supplementary feedings. The study revealed that there is no need of giving traditionally practiced supplementary feedings as in the form of pollen and sugar during the prolonged wet months of July to August in Katrain area as sufficient bee flora is available to the colonies during this period in this region. It may thus be possible to start economical bee keeping with *Apis cerana* on small scale at farmers'/ orchardists 'level.

Keywords: Supplementary feeding, pollen and sugar, low temperatures, insufficient bee flora, reduced bee activities

1. Introduction
Apis cerana is a part of the natural heritage of mountain communities. It is an excellent pollinator of mountain crops and helps in the maintenance of biodiversity. Indigenous methods of keeping bee colonies in log and wall hives are still common in Himachal Pradesh. In this Himalayan region bee colonies require special care particularly in the winter and monsoon seasons. In these seasons, bee activities are reduced to a minimum due to the low outside environmental temperatures particularly during January and February, and the prolonged wet conditions during July-August. Consequently there are problems of inadequate food reserves, queenlessness, reduced fecundity and diseases. As a result of this *Apis cerana* colonies often abscond or desert the hives (Verma, 1990) [1]. Provision of adequate food stores in terms of honey and pollen during the monsoon and winter seasons is therefore essential. Woyke (1976) [2] and Raj and Basavanna (1983) [3] found that supplementary pollen feeding also reduced absconding in *A. cerana*.

This experiment was conducted to work out optimum schedule for supplementary feedings in Kullu valley of Himachal Pradesh. It may thus be possible to start economical bee keeping with *Apis cerana* on small scale at farmers'/ orchardists'level who cannot afford commercial beekeeping with *Apis mellifera* by adopting migration during winter months. This will definitely boost even horticulture production in the state. No systematic studies have been undertaken in Himachal Pradesh on these aspects, hence, the proposed experiment was conducted with the objective to find optimum schedule for supplementary feedings.

Various substances and formulae, for pollen substitutes (Bhupen, 1943) [4] and pollen supplements have been tried as feeds for *A. cerana*. Beekeepers in hills of Uttar Pradesh use wheat pancakes and jaggery. Similarly substitutes like pea flour, gram flour, soybean flour and skimmed milk powder have been used for feeding *A. cerana*. Except the last two, others were not useful as pollen substitutes. Sharma (1951) [5] reported that buckwheat flour prepared in the form of half-cooked sweetened pancake was the best among the cereals tried on *A. cerana* in Himachal Pradesh for bee colonies. Shah and Shah (1979) [6] found that soft patties made out of one part of sun-dried pollen mixed with half its weight of sugar, three parts of expeller processed soybean flour and two parts of 2:1, sugar-water syrup was readily accepted by *A. cerana* bees in Srinagar (J& K). Brood rearing started early in these colonies and pollen income and honey production in spring flow was 1.5 times higher than in colonies without supplement feeding.

2. Material and methods

The experiment was conducted at the apiary of Regional Horticultural Research Sub-Station of Dr. Y.S. Parmar University of Horticulture and Forestry, Katrain (Distt. Kullu) situated at 32.1ºN and 77.2ºE longitude with altitude of 1473 m amsl during 2010-11 under DST funded project. The methodology is as follows.

Four groups, each having 3 *Apis cerana* colonies were selected from the available stock. These groups of colonies were given four types of feedings

i) Sugar feeding (SF)

Two kilograms of sugar (50% sugar syrup) was fed to the colonies in four installments at 4-day interval during July.

ii) Pollen feeding (PF)

Pollen was fed in the form of patties prepared by kneading stored pollen in sugar syrup. Each colony was fed with 350 g of patty wrapped in butter paper with perforations. The pollen was collected from multiple plant sources.

iii) Sugar and pollen feedings (SPF)

Both sugar and pollen feedings as described under (i) and (ii) were given to these colonies.

iv) Control (no feeding)

Nothing was fed to these colonies.

Initial performance of the colonies was recorded on the second week of July month before giving various types of feedings. After the start of the experiment the performance of the colonies was recorded for two brood cycles i.e. first and last week of August month which was later compared. All the colonies were replaced with the new queens in the previous swarming season i.e. during the months of March and April, The data were statistically analyzed as per RBD using log transformations (Gomez and Gomez, 1984) [7]. The other statistical tests viz., t- tests, standard errors, coefficient of variation and correlation were also worked out.

To estimate the number of bees per frame, photographs of the combs covered with bees from three different colonies were taken. The numbers of bees on one side of the frame were counted from the photographs. This number of bees was multiplied by a factor of 2 for getting total number of bees on both sides of the frame. Average counts of three frames gave the number of bees per frame. Population of a colony was expressed in terms of number of bees (calculated by multiplying the average number of bees on a frame with the number of frames covered by bees).

3. Results

Effects of supplementary feedings on the colonies of *A. cerana* for two brood cycles are presented in tables 1 to 4

3.1 Effect of supplementary feedings on bee population in the colony

The data recorded on different types of supplementary feedings given to the colonies and presented in table 1 revealed that, irrespective of different dates of observations, the average colony population was 12970 bees in colonies fed with sugar and pollen (SPF). The population in colonies fed with sugar (SF), pollen (PF) and control averaged 11570, 9096 and 12570 bees per colony, respectively. Irrespective of type of feeding, the bee population was statistically similar during the two brood cycles, varying between 11130 to 11880 bees/colony. The colonies given SPF had more bee population on all the dates of observations and minimum in colonies given PF. In the control colonies the bee population was almost equivalent to that found in SPF treatment by second brood cycle.

The low bee population in pollen fed colonies could be attributed to the fact that these colonies were having minimum brood rearing activity as compared to the colonies subjected to other treatments (SF, SPF and control colonies).

Table 1: Effect of supplementary feedings on the bee population in *A. cerana* colonies at Katrain (District Kullu)

Treatment	Colony Population (no. of bees)			
	II Week of July	First Brood Cycle	Second Brood Cycle	Mean
Sugar feeding (SF)	11370 (4.38)	11970 (4.07)	11370 (4.05)	11570 (4.17)
Pollen feeding (PF)	9469 (3.95)	9208 (3.95)	8609 (3.92)	9096 (3.94)
Sugar and pollen feeding (SPF)	11370 (4.06)	13770 (4.14)	13770 (4.14)	12970 (4.11)
Control (C)	11970 (4.07)	12570 (4.10)	13170 (4.12)	12570 (4.10)
Mean	11130 (4.11)	11880 (4.06)	11730 (4.06)	

Effects	$CD_{0.05}$
Supplementary feeding	0.18
Dates	NS
Supplementary feeding x dates	0.31

Figures in parentheses indicate log transformed values

3.2 Effect of supplementary feedings on brood rearing

Data on effect of supplementary feedings on brood rearing (Table 2) revealed that irrespective of dates of observations, SPF colonies had maximum brood area of 1635 cm^2 followed by 1431 cm^2 in control (difference was non significant). However, brood rearing was significantly less in SF (981.9 cm^2) and PF (923.6 cm^2) treatments. The average brood area, irrespective of types of feeding was 1208 cm^2 on 19th of July month and 1052 cm^2 on 8th of August. The brood increased significantly to 1468 cm^2 by 28th August. Colonies given SPF treatment had more brood during both the brood cycles as compared to other feedings and the control.

Table 2: Effect of supplementary feedings on the brood area in *A. cerana* colonies at Katrain (District Kullu)

Treatment	Brood area (cm^2 / colony)			
	19th July	First Brood Cycle	Second Brood Cycle	Mean
Sugar feeding (SF)	1062.0	583.3	1300.0	981.9
Pollen feeding (PF)	1021.0	891.7	858.3	923.6
Sugar and pollen feeding (SPF)	1146.0	1665.0	2094.0	1635.0
Control (C)	1604.0	1069.0	1621.0	1431.0
Mean	1208.0	1052.0	1468.0	

Effects	$CD_{0.05}$
Supplementary feeding	413.90
Dates	358.48
Supplementary feeding x dates	716.90

3.3 Effect of supplementary feedings on honey stores

The results revealed that irrespective of the dates of observation, the colonies given different types of supplementary feedings were statistically at par with each other with respect to honey stores (Table 3). Even on different dates of observations, irrespective of types of feeding, the amount of honey stored in colonies did not differ.

Table 3: Effect of supplementary feedings on honey stores in *A. cerana* colonies at Katrain (District Kullu)

Treatment	Honey stores (g /colony)			
	19th July	First Brood Cycle	Second Brood Cycle	Mean
Sugar feeding (SF)	750.0	1467.0	1342.0	1186.0
Pollen feeding (PF)	1417.0	1200.0	669.3	1095.0
Sugar and pollen feeding (SPF)	1183.0	2283.0	1771.0	1746.0
Control (C)	1800.0	1533.0	925.7	1420.0
Mean	1287.0	1621.0	1177.0	

Effects	$CD_{0.05}$
Supplementary feeding	NS
Dates	NS
Supplementary feeding x dates	NS

3.4 Effect of supplementary feedings on pollen store

Irrespective of dates of observations, the amount of pollen collected by colonies fed on SPF was 298.3 cm^2 (Table 4) which was statistically identical with control and SF. However, significantly lesser (59.48 cm^2) pollen stores were found in colonies fed on PF. The pollen stores, irrespective of types of feeding, were significantly less on 19th July (7.57 cm^2), which increased significantly to 322.9 cm^2 on 8th August and no significant increase was further observed by 28th August when colonies had on an average 248.4 cm^2 of pollen area.

Table 4: Effect of supplementary feedings on the pollen stores in *A. cerana* colonies at Katrain (District Kullu)

Treatment	Pollen Stores (cm^2 / colony)			
	19th July	First Brood Cycle	Second Brood Cycle	Mean
Sugar feeding (SF)	2.70	268.70	325.00	198.80
Pollen feeding (PF)	9.70	112.50	56.25	59.48
Sugar and pollen feeding (SPF)	1.11	489.60	404.20	298.30
Control (C)	16.77	420.80	208.30	215.30
Mean	7.57	322.90	248.40	

Effects $CD_{0.05}$	
Supplementary feeding	98.70
Dates	85.46
Supplementary feeding x dates	170.92

4. Conclusion

In Katrain area of Kullu valley, there is second honey flow during autumn period. Colony strength is needed to avail this particular honey flow for which supplementary feeding is traditionally practiced. Three different types of supplementary feedings traditionally used aimed at strengthening colonies were therefore tried in present studies i.e. sugar feeding, pollen feeding, sugar and pollen feeding and compared with the control (no feeding). It was observed that the average bee population, brood area and food stores in *A.cerana* were more when fed with both sugar and pollen as compared to the other feeding treatments. But when the performance of sugar and pollen feeding colonies was compared with the control, there were no significant differences between these two groups. These results thus point out that there is no need of giving additional supplementary feedings traditionally given in the form of pollen and sugar during the prolonged wet months of July and August in Katrain area as sufficient bee flora in nature is available to the colonies during this period in this region.

5. References

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