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Effect of supplementation of Ascorbic acid on the comb building behaviour of worker bees (*Apis cerana)* during colony division

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Abstract

Honey bees are social insects which lead a fascinating colonial life. *Apis cerana* is an important bee in apiculture. They play an important role in maintaining food security and biodiversity through their pollination services. There is a steady decline in the population of *Apis cerana* due to many reasons. Climate change, use of pesticides, deforestation, pathogenic infections are the major threats for bee population. Their colony consists of a queen, thousands of workers and a few male drones. Worker honey bees, the slave females in the bee colony are always engaged in comb building, hive cleaning, pollen collection, nectar collection, honey making, nursing queen bee and larvae. In the present study we have studied the effect of supplementation of Ascorbic acid on the comb building behavior of *Apis cerana* during colony division. Honey bee colonies were constructed in suitable places and standard procedures were maintained for all colonies. Bee colony with full strength of adult bees was divided in to two colonies, one having Queen and one without queen. Queen right colonies after colony division were selected for further studies. Control colonies were provided with sugar syrup and experimental colonies were supplemented with Ascorbic acid sugar syrup. We observed that in the experimental colonies comb building was increased when compared to that of control group when supplemented with ascorbic acid. This behavior of worker bees can be utilized for increasing the brood area after colony division for the overall growth of the colony.

Keywords: Apiculture, comb building behaviuor, ascorbic acid, *Apis cerana.*

Introduction

Honey combs are mass of wax cells built by worker honey bees to care their larvae and to store honey and pollen. The wax is produced by eight wax-producing glands in the abdominal segments of worker bees. The wax is released from the abdomen as wax scales, which are used for comb construction. Honey comb in the lower chamber forms the brood which contains egg, larvae, pupae. Queen, the only reproductive female in the colony lays egg in each cell. Fertile queen lays thousands of eggs per day. Egg hatches to larvae, which is fed by the worker bees. Larva then enters in to pupal stage and then come out of the cell as adult. The brood is cared and monitored by nursing worker bees. Honey comb in the upper chamber of bee box forms the super, in which workers will store honey. Comb building is an important job of worker bees because they need comb to maintain their colony.

Honey bees require proteins, carbohydrates, lipids, vitamins and water. Bees collect nectar as their carbohydrate source and pollen as their protein source from flowers.During rainy season, beekeepers supplement sugar syrup for the bee colonies to compensate the inadequate supply of nectar from flowers. There is a need for supplemental food as the modern land use practices reduce dependable nectar and pollen supply [1].

Materials and methods

Apiary construction and management

Artificial bee hives were constructed in suitable places.Standard procedures were

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adopted for all colonies, which is periodically checked to exclude the presence of honey bee diseases. Study was conducted during the period of colony division, from October to December.

Colony selection

Bee colony with full strength of adult bees was selected for the study. Before selecting bee colonies, we have ensured the presence of sufficient number of adult workers, sealed worker cells, adult drones, sealed drone cells and eggs in the comb cells.

Colony division

Selected colonies were subjected to division. All colonies have six frames of comb in their brood chamber. During division of the selected colonies, queen bee along with three frames of comb is placed in another bee box. Now one colony is a queen right colony and one colony is a queen less colony. Then both the colonies are provided with three free frames. Queen right colonies after division are placed in a different location. Control and experimental queen right colonies were set in the same location. Control and experimental queen less colonies were set in another location.

Feeding

Control colonies are fed with 50% sugar syrup and experimental colonies are provided with 0.2% ascorbic acid supplemented sugar syrup. The sugar syrup was provided *ad libitum* to all the colonies every alternate day.

Results

We observed a busy schedule for workers for the construction of new comb in the free frames in all the colonies. We had observed that in the experimental group, workers were very active in building new comb as compared to that of control group. Table 1 shows the comb building behavior shown by different groups during feeding period. Experimental groups started comb building in the first week after division. But control groups started only in the second week. Experimental groups completed comb building in all the three frames by the fourth week. Control groups took five weeks to complete all the three frames. Table 2 shows the total brood area of control and experimental groups during the test period. Total comb area is found to be highest in the test colonies which are supplemented with Vitamin C(Figure 1). The total comb area of Queen Right test colonies is significantly high when compared to that of all other groups. Figure 2 shows the extra combs constructed by the worker bees in the Queen Right colony when supplemented with Vitamin C. These extra combs are found to be attached to the top of the bee box.

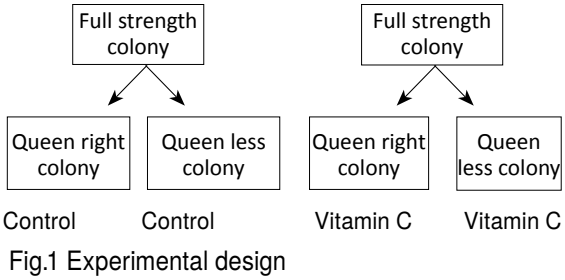

Fig.1 Experimental design

Fig. 2. Additional comb constructed by worker bees in Queen Right colony supplemented with Vitamin C

Discussion

In the present study we have studied the effect of supplementation of Ascorbic acid on the comb building behavior of *Apis cerana* during colony division. Table 1 shows the behavior of worker bees in control and experimental groups during the feeding period. During the first week after division we observed that in control groups, worker bees are focused on building platform in the first frame. But in experimental colonies, worker bees already constructed platform and started to extend new comb. In the Queen less colonies workers constructed queen cells to raise a new queen. Table 1

Table 1. Comb building behavior of control group and experimental group during feeding period

	Control (Queen right)	Control (Queen less)	Test colony (Queen right)	Test colony (Queen less)
Week 1	Started comb building in frame 1	Started comb building in frame1. Three queen cells present.	Started comb building in frame 1	Started comb building in frame 1. Presence of more than three queen cells.
Week 2	Building comb in frame 1	Building comb in frame 1.presence of new queen.	Completed comb building in frame 1.started comb building in frame 2	Building comb in frame 1 and started comb building in frame 2. Presence of new queen.
Week 3	Completed frame 1 and Started comb building in frame 2.	Completed frame 1 and started in frame 2.	Completed comb building in frame 2 and started comb building in frame 3.	Completed frame 1 and frame 2 .started comb building in frame 3.
Week 4	Completed frame 2 and Started comb building in frame 3.	Completed frame 2 and started frame 3.	Started building combs towards the top of the box.	Completed frame 3.
Week 5	Completed comb building in frame 3.	Completed frame 3.	Attached extra combs to the top of the bee box.	

Table 2. The total brood area of control and experimental groups during test period.

	Control (Queen right)	Control (Queen less)	Test colony (Queen right)	Test colony (Queen less)
Week 1	Frame 1-0 Frame 2-0 Frame 3- 0	Frame 1-0 Frame 2-0 Frame 3-0	Frame 1- 20cm^2 Frame 2- 0 Frame 3- 0	Frame 1- 12cm^2 Frame 2- Frame 3-
Week 2	Frame 1- 40cm^2 Frame 2-0 Frame 3-0	Frame 1- 24cm^2 Frame 2-0 Frame 3-0	Frame 1- 91cm^2 Frame 2- 60cm^2 Frame 3- 0	Frame 1- 40cm^2 Frame 2- 12cm^2 Frame 3- 0
Week 3	Frame 1- 187cm^2 Frame 2- 21cm^2 Frame 3-0	Frame 1- 150cm^2 Frame 2- 32cm^2 Frame 3-0	Frame 1-150cm^2 Frame 2- 126cm^2 Frame 3- 105cm^2	Frame 1- 132cm^2 Frame 2- 130cm^2 Frame 3- 36cm^2
Week 4	Frame 1- 187cm^2 Frame 2- 160cm^2 Frame 3- 44cm2	Frame 1- 192cm^2 Frame 2- 165cm^2 Frame 3- 18cm^2	Frame 1- 204cm^2 Frame 2- 176cm^2 Frame 3- 150cm^2	Frame 1- 165cm^2 Frame 2- 160cm^2 Frame 3- 140cm^2
Week 5	Frame 1- 187cm^2 Frame 2- 176cm^2 Frame 3- 180cm^2	Frame 1- 192cm^2 Frame 2- 187cm^2 Frame 3- 160cm^2	Frame 1- 204cm^2 Frame 2- 192cm^2 Frame 3- 150cm^2	Frame 1- 180cm^2 Frame 2- 187cm^2 Frame 3- 176cm^2

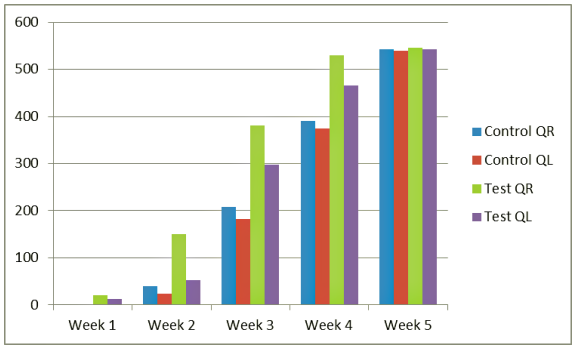

fig. 3. The total brood area of control and experimental groups during test period.

shows that when Queen less colonies are provided with Vitamin C, they contructed more number of queen cells when compared to that of control Queen less colonies.

Table 2 shows the total brood area of control and test groups during the feeding period. Significant increase in the total brood area was observed in test groups by week 4, which was supplemented with Ascorbic acid. Ahmadi Andi *et al*[2] studied the influence of vitamin C in sugar syrup on brood area, colony population, body weight, and protein in bees. They fed the control group with sugar syrup while experimental groups with different concentrations of soluble Vitamin C. They found that the highest average brood area was in the experimental group provided with 2000 mg/L Vitamin C. Herbert J [3] studied the effect of dietary vitamin C on brood rearing of honey bees using both free-flying and confined colonies. In this study they reported that colonies showed significantly more broodwhenthe diet was supplemented with 2000 mg/L ascorbic acid. Marek Farjan*et al*[4] reported the diet supplementation with vitamin C positively influenced some of the physiological and biochemical indicators in emerging worker bees. These results suggest that vitamin C can be recommended as a natural, safe, and relatively cheap diet supplement, elevating resistance to stress factors of wintering bees and spring generation of worker bees.

Conclusion

The present study indicates that supplementation of Vitamin C to the colonies after colony division shows a significant increase in the total brood area when compared to that of control colonies which are provided with sugar syrup.Total brood area increase in the bee colonies can be considered as an indicator of colony growth. So the supplementation of Ascorbic acid containing sugar syrup can be used to enhance the colony growth after colony division.

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