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EFFECT OF SUPPLEMENTAL FEEDING AT DIFFERENT PERIODS ON ACTIVITY AND BUILD UP OF HONEY BEE COLONIES

Mohamed A. Abdalla[a], Mohammed M. Khodairy[b] and Adham M. Moustafa[a]

[a]Plant Protection Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt.

[b]Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut 71526, Egypt.

Abstract: The study was carried out in apiary at Sohag region during the period from December, 2006 to March, 2007. The influence of supplemental feeding at different periods on activity and build up of honey bee colonies was studied. The feeding periods under experiment were 13-week, 11-week, 9-week, 7-week, 5-week and 3-week. The total consumption of supplemental feeding was recorded for all feeding periods. The greatest rate of consumed food was recorded at 13-week feeding period. Positive correlations were found between supplemental feeding and both of bee population size and brood-rearing activity. Bee colonies fed supplemental feeding at different periods produced significantly more bees and bee brood than unfed control colonies. The maximum average of both of bee population size (7047.3 bee/colony) and brood area (229.5 inch^2/colony) was resulted by bee colony fed for 13-week period. The 13-week feeding period resulted 68.4% increment in bee population size and 121.1% increment in brood area. It can be recommended the beekeepers in Sohag region usage of supplemental feeding during the period of 13-week, for achieving the maximum development of honey bee colonies. This supplemental feeding benefit to increase the food storage of bee colonies, which important to build up colony populations for pollination and honey production, artificial swarm and queen rearing.

Key words: Honey bee, bee population, bee brood, supplemental feeding, feeding period.

Introduction

The basic food for honey bee is represented by honey as energetic source and pollen that rich in protein, vitamins, enzymes, mineral, lipids, etc. Which is necessary for the growth, development and activity of honey bees. Shortage of pollen results in decreasing of brood rearing, developmental abnormalities, decreased length of workers life and poor honey production (Kleinschmidt and Kondos, 1978, Winston *et al.*, 1983). Since pollen is often not present in adequate quantities in the field and it is a limiting factor in colony development. So the

beekeepers are concerned with providing an effective pollen supplements or substitutes,when natural pollen supplies are in sufficient to promote colony development and health. Pollen supplements contain honey bee-collected pollen (5-10%) mixed with other protein sources such as yeast, soybean flour and/or other materials. Pollen substitutes repl-ace pollen totally with nutritionally adequate materials (Herbet, 1992). In Egypt, several beekeepers use to feed their bee colonies on sugar syrup during late autumn and early spring to accelerate brood rearing. This feed stimulates the oviposition (Doull, 1973) but it has usually a limited effect due to lack of pollen. The probability of proteinious feeding during autumn is essential to increase the ability of brood rearing and to prepare the bees for over wintering (Omar, 1989). Moreover, obtaining high population of bees in the spring is of a particular interest to beekeepers.

The useful pollen substitute should stimulate colony growth and support aspects of worker quality, such as high brood survival and long adult life (Winston *et al.*, 1983). Meanwhile, the pollen substitute should be acceptable and has the necessary stimulation for bees to consume their food (Doull, 1973). Haydak (1970) recommend ded beekeepers to feed their bee colonies with sugar syrup and pollen supplements or substitutes to maintain the brood rearing activity at times and in areas where the bees natural food sources are inadequate.

The aim of the present investigation was conducted to evaluate the effect of supplemental feeding at different periods on colony status; brood rearing activity and bee population. In addition to know the ideal period of pollen supplemental feeding for bee colonies build up.

Materials and Methods

The experiments were carried out in apiary at Sohag governorate, during the period from the first of December, 2006 to the end of March, 2007.

Experimental honey bee colonies:

Twenty-eight honey bee colonies of the first hybrid of carniolan honey bee, *Apis mellifera* L., nearly in equal strength, contained stored pollen and honey, and headed with sister queens were initiated. The colonies were randomly divided into seven groups (four colonies for each) dependent on feeding period as follows:

- group I, feeding period was 13 weeks, from December 15th to March 21st.
- group II, feeding period was 11 weeks, from December 30th to March 21st.
- group III, feeding period was 9 weeks, from January 15th to March 21st.

- group IV, feeding period was 7 weeks, from January 30th to March 21st.
- group V, feeding period was 5 weeks, from February 15th to March 21st.
- group VI, feeding period was 3 weeks, from March 1st to March 21st.
- group VII, control, the colonies were not fed with supplemental feeding, nor receiving natural free feeding.

Diet preparing and administration:

The diet in the present study used according to Mostafa (2000). It contains of 5 parts of powdered sugar, 3 parts defatted soybean meal, 1 brewer's dried yeast, 0.5 skimmed milk powder and 0.5 date palm pollen. The diet was offered in cake form at the rate of 150 gm per colony.

It was offered and renewed continuously to each colony at different feeding periods, starting on December 15th and ending on March 21st. The cakes were placed over the brood nest in perforated polyethylene bags to reduce the water evaporation.

Measurements of honey bee activities:

-Bee population size: the numbers of adult honey bees were determined every 12 days by a visual method of comparison with standard photographs of known numbers of honey bees on combs (Jeffree, 1951). Inspections were conducted as far as possible, when few bees were flaying.

- **Sealed brood and stored pollen**: in all colonies, the total areas of worker sealed brood and stored pollen were measured. A graduated frame divided into square inches as used after the bees had been shaken from the combs (Jeffree, 1958). This procedure was carried out at 12-day intervals throughout the different feeding periods of the experiment.

The increment of bee population size, sealed brood and stored pollen, which due to supplemental feeding was calculated from the following equations:

$$\text{-Increase in bee population (BP)} = \frac{\text{BP of treatment - BP of control}}{\text{BP of control}} \times 100$$

$$\text{-Increase in sealed brood (SB)} = \frac{\text{SB of treatment - SB of control}}{\text{SB of control}} \times 100$$

$$\text{-Increase in stored pollen (SP)} = \frac{\text{SP of treatment - SP of control}}{\text{SP of control}} \times 100$$

Determination of food consumption:

Throughout the investigation, the food consumption was recorded by calculating the difference in the weight of diet before and after feeding (gm/colony).This procedure was made several times at different periods of supplemental feeding.

Statistical analysis:

The statistical analysis was conducted using the SAS general

linear models procedure and F-test. Differences among means were determined by Duncan's multiple range test. Simple correlations for the relation between studied factors was calculated (SAS Institute, 1990).

Results and Discussions

Consumption of supplemental feeding

The results in Fig. 1 show the average of total consumption of supplemental feeding at different periods. The total consumption of supplemental feeding was 727.8, 471.3, 468.0, 451.3, 319.5 and 263.8 grams/ colony for 13-week, 11-week, 9-week, 7-week, 5-week and 3-week feeding periods, respectively.

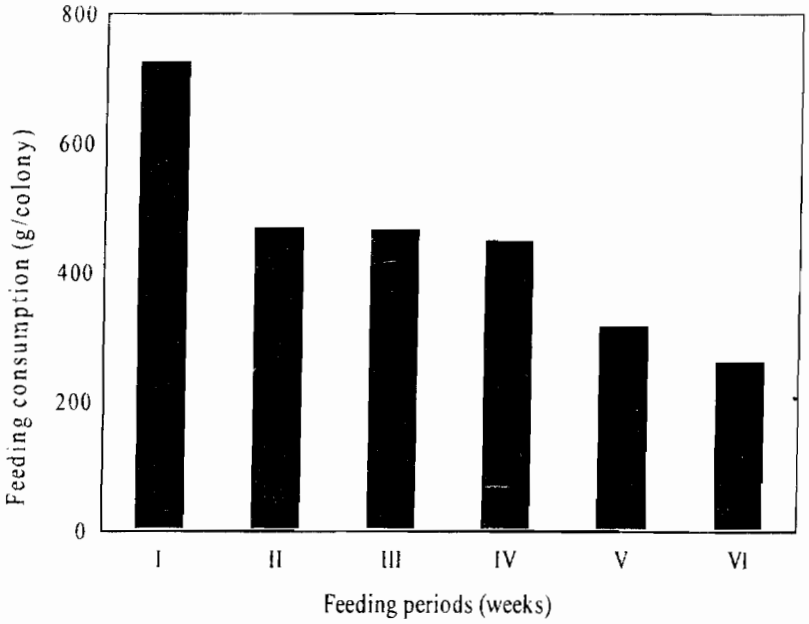

Fig. 1. Average of supplemental feeding consumption at different periods by honey bee colonies.

I. 13-week feeding period; II. 11-week feeding period; III. 9-week feeding period: IV. 7-week feeding period; V. 5-week feeding period: VI. 3-week feeding period

Feeding period and bee population:

The results in Fig. 2 show fluctuation in adult bee population from 15th December till 21st March. The fluctuation pattern showed that bee populations started to decline in January and reached their minimum in February. Beginning in March, the bee populations rose again and reached the maximum in 21st March. A positive high correlation was found between supplemental feeding and bee population sizes (r= 0.770).

The present results indicated that the supplemental feeding at different periods affected the bee population. In general, honey bee colonies fed with supplemental feeding at different periods produced significantly more bees than unfed control colonies. No significant difference was observed among 11-week, 9-week, 7-week, 5-week and 3-week feeding periods (Table 1).

The maximum average number of bees resulted on 21st March for all feeding periods. The feeding period of 13-week gave the highest average of bee population (7047.3 bee/colony), whereas the lowest average was recorded by 3-week feeding period (4753.5 bee/colony). The 13-week period resulted 68.4% increment in bee population, whereas the increment percentages were nearly similar for 11-week, 9-week, 7-week and 5-week feeding periods. The 3-week period gave the lowest increment (13.6%) (Table 1).

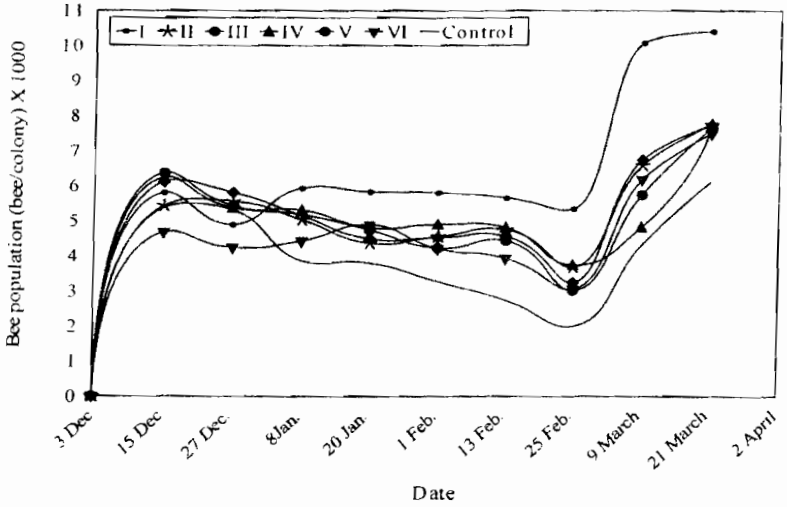

Fig.2. Effect of supplemental feeding at diffrent periods on honey bee population

I, 13-week feeding period; II, 11-week feeding period; III, 9-week feeding period; IV, 7-week feeding period; V, 5-week feeding period; VI, 3-week feeding period, control (natural nutrition).

Table(1): Effect of supplemental feeding at different periods on honey bee activity.

Feeding periods (weeks)	Honey bee activity					
	Bee population (bee/colony)		Brood area (inch²/colony)		Stored pollen (inch²/colony)	
	Mean ± SD	Increment (%)	Mean ± SD	Increment (%)	Mean ± SD	Increment (%)
I 13-week	7047.3$^{(A)}$ ±452.2	68.4	229.5^{A} ±20.1	121.1	44.3^{b} ±11.5	64.1
II 11-week	5305.3$^{(B)}$ ±400.2	26.7	170.0^{B} ±21.9	63.8	39.8^{bc} ±9.3	47.4
III 9-week	5381.8$^{(B)}$ ±607.0	28.6	177.8^{B} ±19.2	71.3	35.5^{c} ±6.3	31.5
IV 7-week	5304.0$^{(B)}$ ±1012.4	26.7	168.0^{B} ±31.3	61.9	41.0^{bc} ±21.2	51.9
V 5-week	5369.0$^{(B)}$ ±973.2	28.3	157.3^{B} ±26.6	51.5	52.8^{a} ±11.1	95.6
VI 3-week	4753.5$^{(C)}$ ±480.2	13.6	164.3^{B} ±18.9	58.3	44.5^{b} ±16.5	64.8
Control (natural nutrition)	4186.0$^{(D)}$ ±359.7	-	103.8^{C} ±7.4	-	27.0^{d} ±4.8	-

Feeding periods and brood-rearing activity:

The fluctuation pattern of worker brood showed that the brood level was low in December started to increase slightly in February and reached their maximum level in 21st March (Fig.3). A positive high correlation was found between supplemental feeding and bee brood area (r= 0.631). Also, a positive high correlation was found between bee population size and bee brood area (r= 0.783).

Honey bee colonies fed supplemental feeding at different periods raised significantly more bee brood than those unfed control colonies. While, no significant differences were found in brood production among the colonies fed for periods of 11-week, 9-week, 7-week, 5-week and 3-week.

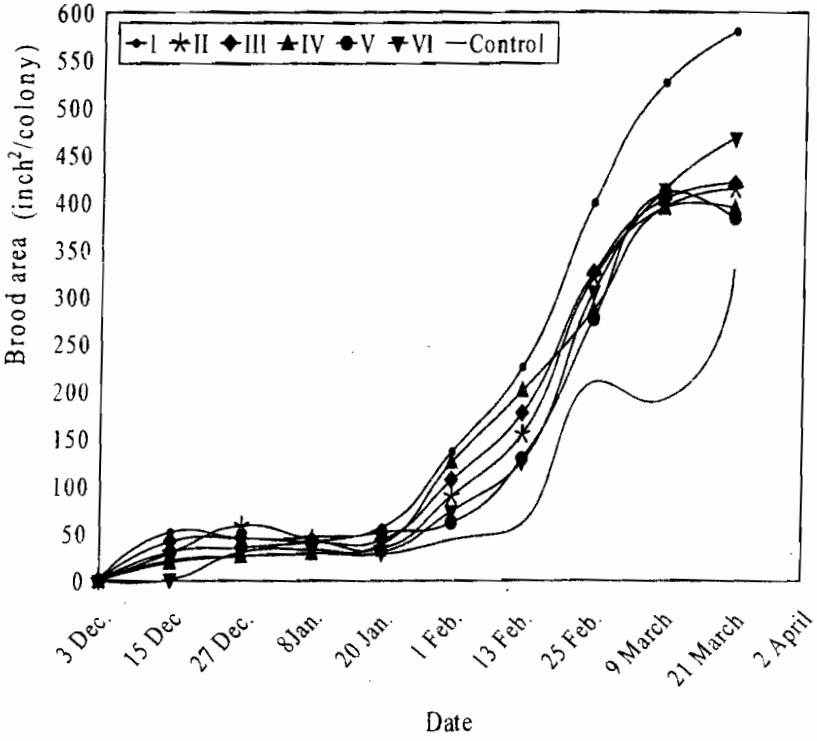

Fig.3. Effect of supplemental feeding at diffrent periods on honey bee brood activity.

I. 13-week feeding period; II. 11-week feeding period; III. 9-week feeding period; IV. 7-week feeding period; V. 5-week feeding period; VI. 3-week feeding period, control (natural nutrition).

The maximal average area of bee brood (229.5 inch^2/colony) was resulted by bee colonies fed for 13-week period. Whereas colonies fed for 5-week or 3-week gave the minimal average of brood area (157.3, 164.3 inch^2). The 13-week feeding period induced 121.1% increment in bee brood area compared to unfed control colonies. The other feeding periods induced 17.3-51.5% brood increment(Table 1).

Feeding periods and stored pollen: The present results indicated that the supplemental feeding at different periods affected the stored pollen process (Fig. 4). There were significant different-ces in the average of the stored pollen between control and all fed colonies, and also, among fed colonies at different periods. The highest rate of stored pollen was observed on 9th March for all treatments and control colonies (Table 1).

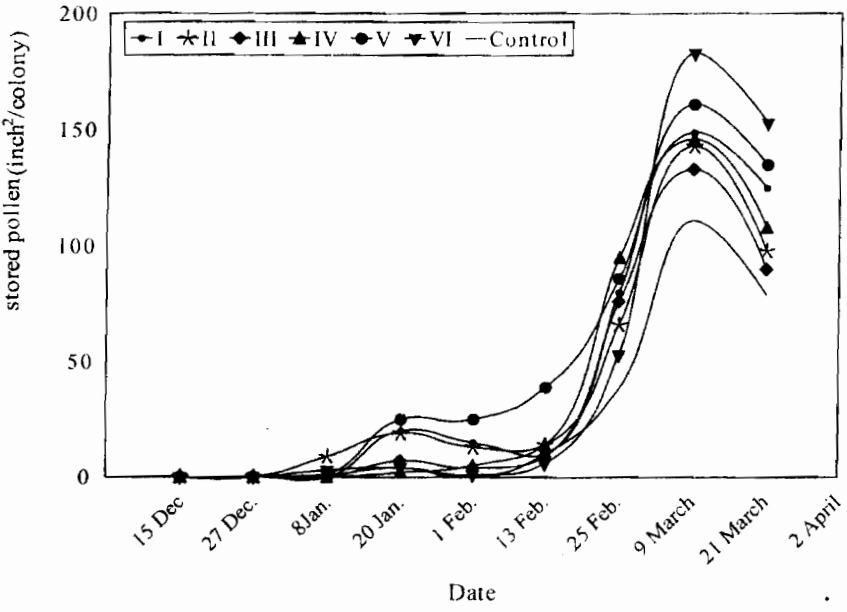

Fig.4. Effect of supplemental feeding at diffrent periods on the honey bee storing pollen.

I, 13-week feeding period; II, 11-week feeding period; III, 9-week feeding period; IV, 7-week feeding period; V, 5-week feeding period; VI, 3-week feeding period, control (natural nutrition).

No clear correlation was found between supplemental feeding and stored pollen (r= 0.010), whereas weak correlations were found between stored pollen and both of bee population (r= 0.131) and brood area (r= 0.220).

Colony growth can be limited by either a lack of pollen or by the available pollen not containing the necessary nutrients. Thus, it is advantageous under some circumstances to feed pollen supplements (additional pollen) or substitutes (Doull, 1980). Since pollen may

not be present in adequate quantities in the field, beekeepers frequently supplement fresh pollen supplies by feeding bees with pollen substitutes or supplements to promote colony growth and health. This feeding is particularly useful to stimulate brood rearing for exploitation of spring honey flows and for spring pollination, and is also important for queen rearing and package bee production (Winston *et al.*, 1983).

The present results indicated that the honey bee colonies fed with supplemental feeding at different periods in winter produced significantly more bees and brood than unfed control colonies. These results are confirmed by Free and Racey (1968), they found the size of colony in spring depends directly on the number of bees in late autumn. The present results showed a positive high correlation between supplemental feeding, and both of bee population size and bee brood activity. These results agree with those of Akyol *et al.* (2006), they found that the bee population and brood area sizes were positively affected by additive feeding before wintering.

The present data resulted a positive correlation between bee population size and bee brood activity. This means that brood was increased by increasing bee population during the natural growth period of bee colony. These results are confirmed by Nelson and Jay (1972) and Harbo (1986), they found that larger populations of workers produced more brood than smaller populations. Simulative feeding of bees is considered important factor in preparing colonies for better spring development and early flows (Skubida *et al.*, 2008). In the present work, the 13-week feeding period gave the highest average of both of bee population size and bee brood areas. It also resulted the highest percentage of increment in both of bee population (68.4%) and bee brood area (121.1%). This means that the time and longitude of supplemental feeding periods are very important and must choose in carefully. Several investigators have studied the influence of early and late spring supplemental feeding on colonies build up. In early feeding, the bee population size increased significantly more than late time (Herbert, 1992). The present results are confirmed by Szymas and Przybyl (1996) they found that the increase of the brood area in bee colonies that were supplemented with that substitute was by 90% higher than that in the non supplemented colonies. Also, these results agree with those of Peng and Marston (1984) and Mostafa (2000), they found that the colonies fed protein supplement produced significantly more bees than non supplemented control colonies.

Populations in March and April months reflected the advantage of fall and winter feeding. The

colonies that were supplemented with pollen or pollen substitute started rearing brood earlier than the non supplemented colonies (Mattila and Otis, 2006). Bee population and brood depends on the protein of bee colony. Supplemental feeding affected the development of hypopharyngeal glands and fat body (Szymas and Przyloyl, 1996). When brood rearing is decreased or stopped in fall and winter the emerging workers tank up on pollen, and since they have no or less brood to feed, they store all that good food in their bodies. Thus preparing themselves, for a long life through the winter, the stored fat bodies is indicator to colony health, successful wintering, spring build up and honey production (Sommerville, 2005 and Mussen, 2007). Bees not only store pollen and honey in the combs, but also store feed reserves in their bodies, mainly in vitellogenin compound. It classed as a glycolipoprotein, meaning that is has properties of sugar (glyco, 2%), fat (lipo, 7%) and protein (91%) (Wheeler and Kawooya, 2005). Vitellogenin is used by bees as an egg yolk protein precursor, as a food storage reservoir in their bodies, to synthesize royal jelly and more important in honey bee physiology and behaviour (Nelson *et al.*, 2007). It is also used as a fountain of youth to prolong queen and forager life spans as well as functioning as a hormone that affects future foraging behavior (Amdam *et al.*, 2003). This would ensure that vitellogenin-rich bees stayed in the nest as useful nurses of the brood and other bees, whereas vitellogenin-exhausted bees became foragers (Anon, 2007). Furthermore, Amdam (2004) showed that vitellogenin scavenged free radicals from bee systems, thereby allowing queens and winter bees to live longer, by suppressing oxidative stress damage (Seehus, 2006).

In Sohag region, the population and brood of honey bee colonies decline during the period of October-March. This may be due to mainly the deficiency in pollen sources and other factors. The present study is recommended the beekeepers usage of supplemental feeding during this period of pollen dearth. For achieving maximum of colonies development, it is necessary to provide additional protein and carbohydrate to supplement stores within the hive and available food outside. The best results in the present study was achieved when the colonies were fed for 13-week feeding period. This supplemental feeding benefit to increase the food storage of bee colonies, then pump the bees full of vitellogenin and other storage proteins. These are important to build up colony populations for pollination and honey production, artificial swarm and queen rearing.

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تأثير التغذية الصناعية لفترات مختلفة على نشاط وبناء طوائف نحل العسل

محمد على عبد الله * ، محمد محمد خضيرى** ، أدهم مصطفى مصطفى**

*معهد بحوث وقاية النبات – مركز البحوث الزراعية – الدقى – الجيزة

**قسم وقاية النبات – كلية الزراعة – جامعة أسيوط – أسيوط 71526 – مصر

أجريت هذه الدراسة فى منحل بمنطقة سوهاج خلال الفترة ما بين ديسمبر 2006 ومارس 2007م . بغرض دراسة تأثير التغذية الصناعية لفترات مختلفة على نشاط وبناء طوائف نحل العسل. وفترات التغذية تحت التجربة هى : 13 أسبوع ، 11 أسبوع ، 9 أسابيع ، 7 أسابيع ، 5 أسابيع ، 3 أسابيع . وسجلت التغذية لمدة 13 أسبوع أعلى معدل إستهلاك . أوضحت النتائج وجود إرتباط معنوى موجب ما بين التغذية الصناعية وكل من تعداد النحل ونشاط تربية الحضنة . كما أوضحت النتائج أن طوائف النحل التى تم تغذيتها صناعيا أعطت إنتاج أعلى بصورة معنوية لكل من تعداد النحل ومساحة الحضنة بالمقارنة بطوائف الكنترول . وسجل أعلى متوسط لكل من تعداد النحل (7047.3 نحلة / طائفة) ومساحة الحضنة (229.5 بوصة مربعة / طائفة) للطوائف التى تم تغذيتها لمدة 13 أسبوع. والتغذية فى هذه الفترة أعطت 68.4% زيادة فى تعداد النحل و 121.1% زيادة فى مساحة الحضنة المنتجة. هذه الدراسة توصى النحالين فى هذه المنطقة باستخدام التغذية الصناعية فى الفترة المذكورة والتى تقل فيها مصادر حبوب اللقاح ولمدة كافية لا تقل عن 13 أسبوع وذلك لكى نحصل على أعلى مستوى من النشاط لطوائف النحل . والتغذية الصناعية هذه مفيدة فى زيادة الغذاء المخزون للطوائف والذى يكون هام فى زيادة تعداد نحل الطوائف اللازم لتلقيح النباتات وإنتاج عسل النحل وأيضا لإنتاج طرود النحل وتربية الملكات .