

**INFLUENCE OF DIFFERENT NUMBERS OF SYRIAN HONEYBEE NUCLEI
(*Apis mellifera syriaca* L.) ON THE PRODUCTION OF FABA BEAN (*Vicia faba* L.)
IN PLASTIC HOUSES**

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ABSTRACT

This experiment was carried out at the Faculty of Agriculture, Research Station at Mut'ah University / Al-Karak during 2003/2004 growing season, to study the efficiency of different numbers of honeybee nuclei on pollination and yield of faba bean (*Vicia fabae* L.) under uncontrolled plastic house conditions. Honeybees showed no differences on their behavior of visiting flowers at a temperature range between 19.8°C-31.3°C during day time and the experiment period. The plastic house sections which contained 3 honeybee nuclei produced significantly higher yield of faba bean than one honeybee nucleus section and the control, respectively. Demarcated 15 faba bean plants labeled inflorescences; flower pod set percentage were 52 %, 33 %, and 15 % for the three bee nuclei, one nucleus and the control, respectively. The pods quality pollinated by honeybees were superior, early harvested and were with more seeds and exhibited better appearance. Individual pods randomly collected from the 15 demarcated faba bean plants in 2nd, 4th and 6th row beds in the plastic house weigh during first harvest time were 14.14 , 11.22 and 7.65g and 13.47 , 9.42 and 8.04 g during the second harvest time, for the three nuclei, one nucleus and the control, respectively. Moreover, pod number showed also significant differences. For all plants in both harvest times the total pod number was 5516, 2898 and 882. The highest in 3 nuclei section and the lowest in the control treatment section, faba bean were harvested twice in 6 and 21, April 2004. In conclusion, treatment of faba bean plants with three nuclei increase pod weight, seed number per pod, pod length and middle seed weight in each pod.

Key words: *Apis mellifera* L. , *faba bean*, *honeybee*, *pollination*.

1. INTRODUCTION

Increasing world population, increased food demand which leads to develop and improve more agricultural crops and find out alternative techniques to cover food shortages (FAO, 1994). Protected cultures mainly plastic houses, were introduced to produce vegetables in different seasons and along the year. In open fields, the natural pollination agents, like insects and wind, are available, but in plastic houses, pollination agents are limited or not available due to complete isolation by covering with plastic sheets and net meshes. Inadequate pollination is still a major constraint to the potential yields of faba bean (*Vicia faba* L.) and fruit quality (Meeuse, 1961). The winter legume faba bean is considered one of the world important annual crops for humans food and livestock feed. Farmers are interested in faba bean due to its high protein content, and ability to conserve soil

nitrogen and its use in crop rotation (Somerville, 2002). Jordanian farmers started to plant faba bean under plastic house conditions during cold winter against frost and to gain high prices. Adequate pollination of faba bean guarantees better fruit quality and higher yields (Musallam *et al.*, 2004). The contribution of honeybees in its pollination is essential because of its attractive white flowers (Frisch, 1950). Honeybees visit flowers to collect pollen and nectar for their food requirements. Pollen is the only natural source of protein and nectar is the natural source for carbohydrate. In addition, the bees body plumose hair coverage, meta-legs pollen basket, and perennial colony life, encourage this study to be carried out (Ribbands,1955). Also flowers constant foraging bees behavior and colonies manipulation (Stanley and Linskens, 1974) are the most factors encouraging this experiment to apply pollinator agent local honeybees Syrian

race (*Apis mellifera syriaca* L.) as a pollinator for faba bean under plastic house conditions.

The objectives of the present study were:-

- 1- To avoid simultaneous flowering of other crops that are more attractive to honeybees in open fields.
- 2- To profit from bees and faba bean growth during cold weather inside plastic houses as a suitable condition against frost time in Jordan.
- 3- To increase faba bean production by comparing different bee nuclei techniques and to profit from honeybees.

2. MATERIALS AND METHODS

2.1. Plant material

This trial was carried out in 2003/2004 growing season in uncontrolled plastic house at the Agriculture College Research Station at Mu'tah University. The temperatures inside and outside plastic house were daily recorded. The selected plastic house dimensions were 40 m length, 8 m width and 3 m height. The area of the plastic house was divided into three sections; the area of each section; was 106 m². Each section was divided to seven longitudinal beds (13.30 m length and 0.50 m width) for faba bean plantation. The distance between the beds was 0.55 m. Faba bean seeds were sown at 5-8 cm depth in mid November, 2003 with 30 faba bean seeds in each bed and 0.45 m distance between seeds (with a grand total 210 plants for each section). The plastic house was drip irrigated with about 0.27 m³ / m² of water. The mineral nutrient solution containing all the essential elements was provided. For periodic observations, fifteen plants demarcated with iron pole in the 2nd, 4th and 6th bed rows (5 plants for each) equidistantly and with three replications. On each plant one inflorescence was labeled to observe flowering, pod set time, number of pods, pod weight, seed number and pod middle seed average weight. Data were analyzed by using MSTAT program and mean separation was done by Duncan multiple range test (DMRT) (Steel and Torrie, 1980).

2.1.1. Faba bean flower type

The faba bean plant grows more than 1 m in height towards the end of the growing season, flowering extends for 5-6 weeks. Winter legume crop faba bean is a self-pollination crop with significant levels of cross-pollination that varies greatly between cultivars (Suso *et al.*,1996), therefore requiring insect pollinators to maximize seed set (Grant, 1951), which is a typical flower of leguminosae having a standard petal; two wing petals and two keel petals, all of which are

partially joined at their bases to form a corolla tube; the keel petals enclose the staminal column of 10 stamens and a single style (Rowland.,1958). Faba bean flowers are open in early morning and mid afternoon and close again at dusk. Nectar is secreted at the base of the corolla tube; bed plants will not set seed unless visited by insects to increase faba bean yield especially honeybees (Williams *et al.*, 1993).

2.1.2. Honeybees management

Faba bean provides very little nectar to the honeybees; it is desirable because it increases; its demand for gathering more pollen which gives greater chance of achieving maximum pollination and pollen collection to provide breeding opportunities for the colony. The bees which need a source of energy were fed weekly with about 350 ml of syrup based on dissolving 1 kg of granulated cane sugar in a liter of water. In addition, honey combs were introduced before placing hives (Cribb *et al.*, 1993). Efforts were made to avoid adding excess syrup to the colonies because of the risk of fermentation in the warm and humid environment of the plastic house sections. The value of the honeybees as a pollinator is far greater than its value as a honey producer. For that reason, two methods for pollination were selected. The first plastic house section was provided with 3 honey bee nuclei; the second section was provided with one nucleus, and the third section was left as a control. In most circumstances, a colony contains 3-4 combs of brood, queen and bees (Cooper and Emmett, 1977). Strong and healthy local Syrian honey bees races were used for pollination. Nuclei were managed to ensure that the maximum number of bees have to visit the crop to be pollinated. The nuclei were placed 1 meter above the ground at equidistantly in a place that is opposite to the sun rise to lead early foraging activities and to encourage the honeybees to work over the whole area. The flight holes are open after closing the plastic house sections with a fine mesh to prevent honeybees from going outside the plastic house.

3. RESULTS AND DISCUSSION

At the flowering stage of faba bean, the bee nuclei were introduced in sections nominated for pollination by bees. Honey bees mortality rate was very low. The number of dead bees per nucleus being collected each day was 20 bees, with a total of 3200 bees for each nucleus by the end of the experiment. This might be due to providing sugar syrup and stored honey to prevent starvation, especially before plant blooming stage

(Heinrich, 1979). Average monthly temperature inside and outside plastic house, during the growing season are presented in Table (1), which is the most suitable for bees activities (Somerville, 2002) and plant growth conditions. In mid November sown faba bean, plant height reached about 40-45 cm by the end of February and 135 cm towards late April 2004 (Table 1).

Table (1): Average monthly temperature inside and outside plastic house and plant height during experiment period.

Months	Average monthly temperature(° C) inside and outside plastic house		Average plant height (cm)
	inside	outside	
Start in 13, November, 2003	23.5	19.0	Sown date
December, 2003	29.4	13.7	15
January, 2004	21.5	11.6	30
February, 2004	19.8	12.1	43
March, 2004	27.9	16.9	110
Until 21, April, 2004	31.3	21.5	130

Blooming started in late January and reached the maximum during February and declined during March. There was no significant variation in flower blooming starting date between the three treatments. Also, the number of flowers for the demarcated 15 plants and the number of flowers for the fixed inflorescences were not significantly affected by different pollination treatments when recorded during early March (Table 2).

Table (2): Flower number per plant and per inflorescence of faba bean as influenced by the number of bee nuclei on March, 10, 2004.

Treatment	Flowers/plant	Flowers/inflorescence
Control	57.80 a*	4.000 a
1 bee nuclei	59.87 a	3.733 a
3 bee nuclei	61.80 a	3.933 a

*Values within the same column having same letters are not significantly different at 5% according to DMRT.

Table (3) shows the effects of two pollination treatments on the labeled inflorescence and there pod set percentage for the demarcated faba bean

Table (3): Number of inflorescences and pod set percentage of faba bean as influenced by number of bee nuclei on March, 10, 2004.

Treatment	Number of inflorescences	Pods number and pod set %
Control	3.933 a *	0.9333 c (15%)
1 bee nucleus	3.867 a	2.067 b (33%)
3 bee nuclei	4.267 a	3.267 a (52%)

*Values within the same column having same letters are not significantly different at 5% according to DMRT.

plants compared with the control. The highest pod set was obtained by using 3 bee nuclei (52%) compared with 1 bee nuclei (33 %) and the control (15%). These results are in agreement with (Wafa and Ibrahim, 1960) who found that bee pollination accelerated the rate of set of faba bean pods.

Table (4) shows faba bean yield during both harvest periods. The results indicated high variations in yield weight and pod number according to different treatments.

Table (4): Pods number and weight for faba bean as influenced by number of bee nuclei for the both harvesting time.

Treatment	First faba bean harvest (6-4-2004)		Second faba bean harvest (21-4-2004)	
	Pods number and %	Pods weight (kg) and %	Pods number and %	Pods weight (kg) and %
3 bee nuclei	2142 (% 51)	17.836 (% 51)	3374 (% 66)	22.750 (% 68)
1 bee nucleus	1540 (% 37)	13.090 (% 38)	1358 (% 26)	07.700 (% 23)
Control	0483 (% 12)	03.682 (% 11)	0399 (% 8)	02.800 (% 9)
Twice harvest grand total and %	4165 (% 100)	34.598 (% 100)	5131 (% 100)	33.250 (% 100)

The section treated with three bee nuclei produced the highest faba bean yield and pods number and the lowest yield was produced in the control. Pod weight significantly increased with the application by bee nuclei for both harvesting times. The obtained results showed that the highest average pod weight, pod length and middle seed weight per pod occurred in the section contained three bee nuclei and the lowest in the control section (Table 5). The average seed number per pod was higher in the plots treated with super bee nuclei, but the differences were not significant. Also, pod middle seed weight was significantly higher in the section treated with 3 bee nuclei.

Table (5): Pod weight and length, seed number per pod and pod middle seed weight of faba bean as influenced by number of bee nuclei on early and late April harvesting time.

Treatment	Pod weight (gm)	Seed number /pod	Pod length (cm)	Pod middle seed weight (gm)
First harvest time (April/6/2004)				
Control	7.647 c*	2,000 a	9.667 a	0.9933 b
1 bee nuclei	11.22 b	3,400 a	12.33 a	1.217 b
3 bee nuclei	15.57 a	2,933 a	13.83 a	2.133 b
Second harvest time (April/21/2004)				
Control	8.046 b	2,000 a	10.10 a	1.080 b
1 bee nuclei	9.480 a	2,267 a	10.13 a	0.8267 b
3 bee nuclei	14.33 a	2,200 a	10.23 a	2.843 a

*Values within the same column having same letters are not significantly different at 5% according to DMRT.

Conclusion

Observations during the time of the experiment showed the importance of using honeybees as a pollinator in faba bean. The results indicated that three bee nuclei could be used successfully in plastic house for faba bean pollination. The three bee nuclei treatment gave the highest yield, higher number of seed and pods firmness than the other treatments. Therefore, it is recommended that honeybees be used as a pollinator to increase yield and improve quality of faba bean inside the plastic house.

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تأثير أعداد مختلفة من نويات النحل السوري (*Apis mellifera syriaca L.*) على إنتاج الفول (*Vicia faba L.*) داخل البيوت البلاستيكية

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ملخص

أجريت الدراسة في محطة البحوث الزراعية التابعة لكلية الزراعة بجامعة مؤتة لمعرفة فعالية وتأثير أعداد مختلفة من نويات النحل السوري على إنتاجية الفول تحت ظروف بيت بلاستيكي تم تقسيمه إلى ثلاثة أجزاء تحت الظروف الطبيعية وتم وضع ثلاثة نويات نحل في الجزء الأول ونويه واحده في الجزء الثاني وترك الجزء الثالث كشاهد . لسم يظهر النحل مشكلة في زيارة أزهار الفول خلال فترة التجربة وعلى معدلات درجات الحرارة والتي تراوحت ما بين 19,8 - 31,3 درجة مئوية خلال ساعات النهار والتي كانت سائدة تحت ظروف البيت البلاستيكي.

وقد أظهرت الدراسة زيادة في نسبة عقد الأزهار على النورات الخمسة عشر المحددة على خمسة عشر نباتا حيث كانت بمعدل ٥٢% للجزء الذي يحتوي على ثلاثة نويات و ٣٣% للجزء الذي يحتوي على نوية واحدة و ١٥% للشاهد. كذلك أظهرت الدراسة تفاوتاً في أوزان القرن الواحد والتي تم قطفها عشوائياً من على النباتات الخمسة عشر المحددة في كل جزء خلال فترتي الحصاد والتي تمت بتاريخ ٦ و ٢١/نيسان/٢٠٠٤ حيث كان معدل وزن القرن الواحد ١٤,١٤ ، ١١,٢٢ ، ٧,٦٥ جم لفترة الحصاد الأولى و ١٣,٤٥ ، ٩,٤٢ ، ٨,٠٤ جم لفترة الحصاد الثانية لكل من الجزء الذي يحتوي على ثلاثة نويات ونويه واحده والشاهد على التوالي . وقد كان إجمالي عدد القرون المجموعة خلال فترتي الحصاد ٥٥١٦ ، ٢٨٩٨ و ٨٨٢ للأجزاء الثلاثة، كان أعلاها جزء النويات الثلاثة وأدناها جزء الشاهد وقد كان تأثير التلقيح واضحاً بوجود فروق معنوية على زيادة المحصول من خلال معدلات وزن وعدد القرون المنتجة، عدد بذور القرن الواحد، أطوال القرون ،وزن البذرة الوسطى لكل قرن وجوده المظهر حيث كانت أعلاها في الجزء الذي يحتوي على ثلاثة نويات وأدناها في الشاهد لكلا القطفتين .

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