

## **INFLUENCE OF SOME POLLEN SUBSTITUTES ON BROOD REARING OF HONEY BEE AND WORKERS LONGEVITY**

**EI-Hady, A. M. E.**

**Plant Protection Institute, A.R.C.**

### **ABSTRACT**

The present study was performed in a private apiary at Ayash village, El-Mehalla EL-Kobra, GharbiaGov. during the dearth season from January up-to March, 2011. Three protein diets were used as pollen substitutes for honey bees, *Apis mellifera*, feeding i.e. soybean flour, maize flour and wheat flour (alternative protein diets), Also sucrose solution (sugar syrup;) (2 : 1 w/w) was added. All the cages were fed on the mentioned diets for 12 weeks. Results indicated that, significant differences were found between treatment groups in sealed brood rearing workers produced by colonies during the study period when compared with the control treatment. Colonies feeding on soybean flour showed the increase in the mean of brood rearing by 75.30 inch<sup>2</sup> followed by wheat flour (51.00 inch<sup>2</sup>) then maize flour (35.30 inch<sup>2</sup>) comparing with the control treatment (20.30 inch<sup>2</sup>). Soybean occupied the first rank in the consumption rate (48.46 gm /10 days) followed by 30.00 gm/10 days, in case of maize flour, while was (26.60 gm/10 days) in case of wheat flour. The consumption of sugar syrup increased with soybean diet (711.50 cm<sup>3</sup>) of sealed brood than the others. Also, The newly emergence workers fed on soybean cake showed the longest mean of age at (16 – 18 days) comparing with the other treatments.

### **INTRODUCTION**

Feeding of bees is very important in bee breeding, as it helps much in maintaining strong hives with sufficient brood during the whole season. Honey bee, *Apis mellifera* L., colonies can be stimulated to increase in population, even in the absence of sufficient forage, by providing sugar syrup. However, colony growth and maintenance are limited by the protein available. Protein, normally in the form of pollen, is necessary for the production of bee brood. Honey larvae are especially dependent on protein and brood production is strongly affected by shortage of this nutrient (Brodschneider and Crailsheim, 2010). During the first 3 days after exclusion from the egg, bee larvae consume mostly royal jelly, a protein-rich glandular secretion produced by young worker bees, called nurse bees. Nurse bees must consume pollen to develop their hypopharyngeal glands, which secrete the major components of royal jelly. Four to 6 days old larvae are fed a mixture of pollen and diluted honey (Morse, 1975). An average colony consumes 15-30 kg of pollen per year (Seeley 1985). Adult bees live an average of only 30 days during the active season (De Jong and De Jong 1983), which is all year in tropical climates. Therefore, colonies that have no access to protein during the active season have a reduced capacity to rear replacement bees, quickly decline in population, and may eventually die. The wintering ability, survival rates of adult bees and brood areas were positively affected by feeding and feed additives (Akyel *et al*, 2006). In the colony of honey bee pollen with regurgitated nectar, honey and glandular secretions to produce bee-bread

(Ellisand Hayes,2009). A lack of carbohydrates limits the number of larvae reared in spring (Rortais *et al*,2005).The objective of our study was to assess some diets as pollen substitutes by measuring the worker,s sealing brood rearing activities of honeybees (*Apis mellifera* L) fed such diets and obtained their effective on workers longevity.

## **MATERIALS AND METHODS**

The experiment was performed in a private apiary at El-Mehalla EL-Kobra district from January up-to Mach, 2011. Twelve colonies in the same strength( 5 combs )of *A. mellifera* in the standard Langstroth bee hives, havingmetad queens of the same age were selected. This study was demonstrated by choosing four diets as pollen substitutes which are not expensive and available for everyone. These colonies were divided into four groups( each contains 3 colonies) randomly selected for each diet.

Each group was received different diet as the following , :

Group (1) Soybean cake without fat consists of :

30 gm soybean flour , 20 gm dry yeast powder,  
30 gm casein milk powder, 20 gm sugar powder.

Group (2) Wheat cake consists of :

30 gm Wheat flour , 20 gm dry yeast powder,  
30 gm casein milk powder, 20 gm sugar powder.

Group(3 ) Maize cake consists of :

30 gm maize flour , 20 gm dry yeast powder,  
30 gm casein milk powder, 20 gm sugar powder.

Group (4 ) Control treatment (without pollen substitutes).

All of them were mixed with honey (3 diet::1 honey w \ w). Sugar syrup (2 sugar : 1 water)was placed in glass bottles (750 ml) for each colony. Soybean flour was prepared by mix its ingredients with honey (3:1).according to Rafique and Nasreen,1984).The diets were placed on the top of the frames in the bee hives and replaced every 10 days intervals for determining the consuming rate of diets was conducted and tabulated. Each diet was prepared by mixing with honey before introduced to the colonies. Area of sealed worker brood was measured in square (in.<sup>2</sup>) after every 12 days intervals by means of a wire grid with divisions giving an area /one square inch according to ( Clarx *et al* .,(1971). The worker's sealed brood areas (one square inch of worker brood 25cell) was used as criteria for judging on the development of the colonies and which diet was the best.

### **Determination of worker's Longevity.**

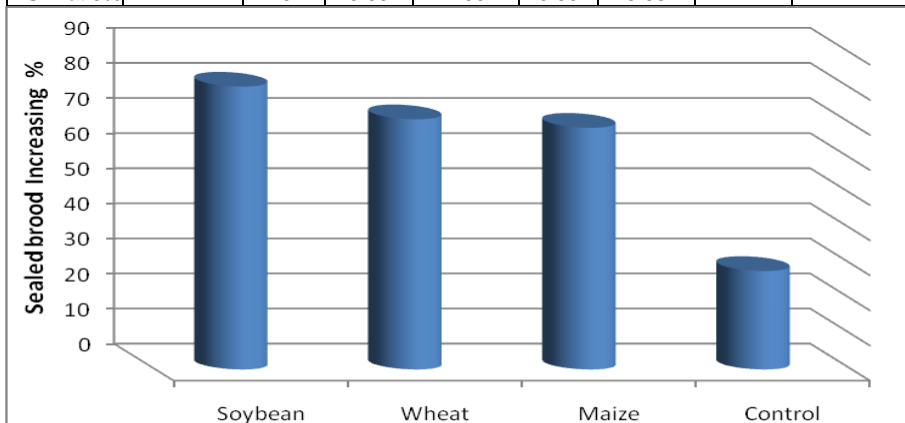
Twelve cages covered with wire net were used as three cages per each treatment. The cage dimensions was 11×15×18 cm. each cage provided with a part of wax comb and about newly 100 emerged workers from experiment groups. All cages were held in the incubator at 32±1°C and 70% RH. Each cage was provided with tested pollen substitutes. . All treatments cages were received sugar syrupand those pollen substitutes were changed every 3 days. Dead workers in each cage were counted and removed every 3 days until all workers were dead Nowar2011.

### RESULTS AND DISCUSSION

Data in Table (1) and graphically illustrated in fig (1) proved that there were significant differences between all treatments. Data also, clearly indicated that the highest mean of worker's sealed area was obtained in the colonies fed with soybean cake 75.30 inch<sup>2</sup> releasing 80.61 % increase followed by wheat cake with brood area 51.00 inch<sup>2</sup>; (71.30 % increase) then maize cake was 35.30 inch<sup>2</sup> (68.88 % increase). While, the lowest mean of worker's sealed brood was observed in the control treatment (only received sugar syrup). Results also appeared that the mean of worker's brood area was increased gradually from the starting time of the experiment till the end. Results also revealed that the mean of worker's brood area was increased gradually from the starting time of the experiment till the end. (Kalevet *al* 2002) found that the colonies given pollen substitutes (500 gm per week) maintained a high level of brood production. Also, Kleinschmidt and Kondos (1976, 1977) reported that when honey bees are provided with insufficient pollen, or pollen with low nutritional value, brood rearing decreases.

**Table (1): Effect of some pollen substitutes on mean worker's sealed brood areas (in.²) from January – March, 2011.**

Pollen substitute	Before treatment	Mean of sealed worker brood areas (in.²) after treatments at						Increasing %
		20/1	1/2	12/2	28/2	10/3	23/3	
soybean	14.60	27.30 <sup>a</sup>	34.30 <sup>a</sup>	41.30 <sup>a</sup>	53.30 <sup>a</sup>	64.00 <sup>a</sup>	75.30 <sup>a</sup>	80.61
Wheat	14.60	16.00 <sup>b</sup>	20.30 <sup>b</sup>	23.30 <sup>b</sup>	30.6 <sup>b</sup>	41.00 <sup>b</sup>	51.00 <sup>b</sup>	71.30
Maize	14.60	11.00 <sup>b</sup>	14.60 <sup>bc</sup>	17.00 <sup>bc</sup>	21.00 <sup>c</sup>	28.00 <sup>c</sup>	35.30 <sup>c</sup>	68.88
Control	14.60	10.00 <sup>b</sup>	10.50 <sup>c</sup>	11.60 <sup>c</sup>	14.00 <sup>d</sup>	16.66 <sup>d</sup>	20.30 <sup>d</sup>	28.07
L.S.D.at 5%		7.04	6.65	7.05	6.86	5.88	12.27	



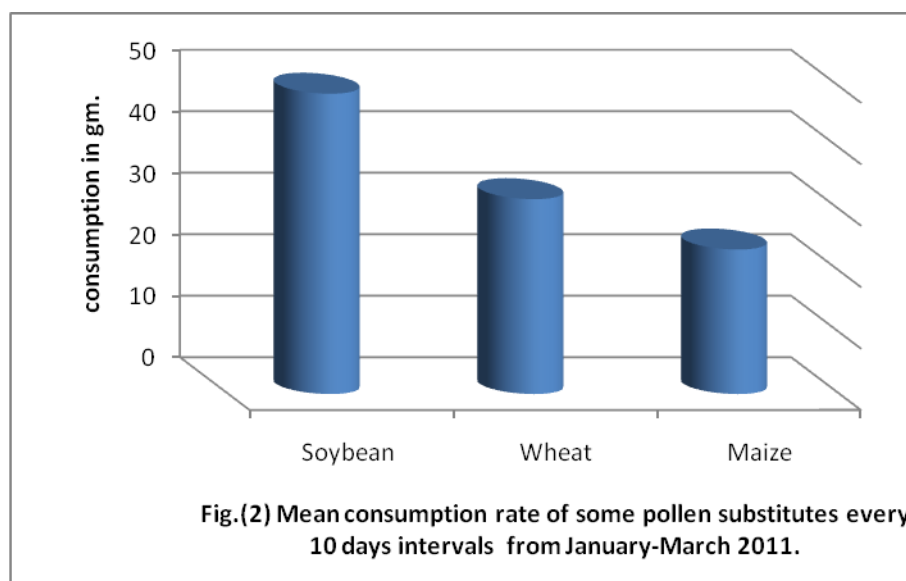
**Fig.(1) Effect of some pollen substitutes on sealed worker brood (inch²) during dearth period from January-March 2011.**

**Consumption of pollen substitutes :-**

Results in Table (2) and graphically illustrated in Fig (2) indicated that the highest mean consumption rate was in colonies fed with soybean cake (48.6 gm / 10 days) followed by colonies received wheat cake (31.70 gm /10 days, while the lowest consumption rate was in colonies fed with maize cake ( 23.51 gm). Also, there were significant differences between all treatments. A good pollen substitute for honey bees should have the same features of good natural 1). bees will readily consume it, 2). it is easily digested by bees, and 3). it has the correct the amino acid balance and enough crude proteins). Pollen provides bees with protein, minerals, lipids, and vitamins (Herbert and Shimanuki, 1978).When honey bees are provided with insufficient pollen, or pollen with low nutritional value, brood rearing decreases and workers live shorter lives (Knox *et al.*, 1971). These effects ultimately affect colony productivity( Keller *et al.*, 2005). Similar trend of results was obtained by Rafique and Nasreen (1984) and Farooqi (1986) who reported that soybean mixed with different substitutes proved good pollen substitutes. Crailsheinet *al.*,( 1992) reported that honey bee consumes an average 3.4 – 4.3 mg pollen per day with a peak at the age of nurses.

**Table (2): Mean consumption rate of some pollen substitutes every 10 days intervals from January – March, 2011.**

Pollen substitute	consumption rate in(gm.) during 10 days						consumption mean
	18/1	30/2	11/2	23/2	7/3	19/3	
soybean	43.30 <sup>a</sup>	45.30 <sup>a</sup>	50.00 <sup>a</sup>	40.00 <sup>a</sup>	46.60 <sup>a</sup>	50.00 <sup>a</sup>	48.86
Wheat	23.00 <sup>b</sup>	36.60 <sup>a</sup>	40.00 <sup>a</sup>	35.00 <sup>ab</sup>	25.60 <sup>b</sup>	30.00 <sup>b</sup>	31.70
Maize	20.30 <sup>b</sup>	21.00 <sup>b</sup>	21.60 <sup>b</sup>	31.60 <sup>b</sup>	20.00 <sup>b</sup>	26.60 <sup>b</sup>	23.51
L.S.D.at 5%	17.71	14.80	16.85	12.64	13.62	13.62	



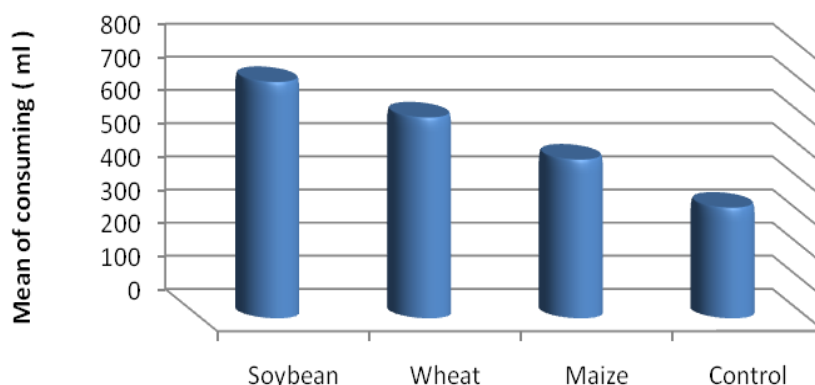
Furthermore, Alqarni (2006) recorded that the highest consumption rate in bees fed on improved traditional substitute followed by mixed date palm with pollen +soybean flour, whereas the lowest consumption was for traditional substitute. Also, Degrandi-Hoffman *et al.* (2008) evaluated three diets, Bee-Pro®, Feed-Bee®, and MegaBee®, in two separate trials. In both trials, Bee-Pro® and MegaBee® patties were consumed at rates similar to pollen cake, but Feed-Bee® was consumed significantly less. Higher food consumption was significantly correlated with increase in brood area and adult population size. According to this study, Mega-Bee appeared to be superior to both Bee-Pro® and Food-Bee® in terms of brood production or adult population.on contrast.

**Sugar syrup consumption rate .**

Results in Table (3) and graphically illustrated in Fig (3) showed that the highest sugar syrup consumption rate was in colonies received soybean cake (711.10 ml/10 days) followed by colonies fed with wheat cake(604.27ml/10 days) then colonies fed with maize cake (477.21 ml/colony), respectively. While, the lowest sugar syrup consumption was in the control colonies which non received pollen substitutes (332.21 ml/10 days).

**Table (3): Mean of consuming rate of sugar syrup with feeding diets of pollen substitutesduring10days intervals from January– March, 2011.**

Treatment	Sugar syrup Consuming rate (ml) at						Mean consuming /10 days	Increase %
	18/1	30/2	11/2	23/2	2/3	19/3		
soybean	633.33	716.66	700.00 <sup>a</sup>	723.33 <sup>a</sup>	733.33 <sup>a</sup>	750.00 <sup>a</sup>	711.10	53.28
Wheat	546.66	656.66	616.66 <sup>a</sup>	640.00 <sup>a</sup>	515.66 <sup>b</sup>	650.00 <sup>a</sup>	604.27	45.02
Maize	480.00	486.66	456. <sup>c</sup>	410.00 <sup>b</sup>	536.66 <sup>b</sup>	493.33 <sup>b</sup>	477.21	30.38
Control	326.66	366.66	333.33 <sup>c</sup>	316.66 <sup>b</sup>	326.66 <sup>c</sup>	323.33 <sup>c</sup>	332.21	
L.S.D.at 5%	25.09	23.91	24.32	33.43	30.69	35.24		



**Fig.(3) Mean of consuming rate of sugar syrup with feeding dietsof pollen substitutes during 10 days from January–...**

Data also obtained showed that there was significant differences between all treatments. Huang (2011) found that colonies with 50000 bees needs 1.1 liter per day of 50 % sugar syrup. The consumption is lower during winter times.

**Workers longevity of honey bee:-**

Data presented in Table (4) and graphically illustrated indicated that the longevity of honey bee workers was observed the higher longest life when they fed on soybean cake followed by bees fed on wheat cake then bees fed on sugar syrup only (control).While the lowest longevity were observed in bees fed on maize cake. These results are in agreement with other investigators,Schmidtet *al* (1995) reported that adult honey bees can survive for a very long time when fed on carbohydrates, but bees allowed to feed on pollen show greater longevity. In addition, Gregory (2006) found that the honeybee longevity varied among bees fed different diets (fresh pollen > Food Bee<sup>®</sup> > Bee Pro<sup>®</sup> > old pollen).

**Table (4) Effect of somepollen substitutes on honey bee workers longevity(age in days).**

No. of initial bees	Feeding treatments							
	Soybean cake		Wheat cake		Maize cake		Control (Sugar syrup)	
Workers age (day)	No. of dead bees	% Mortality	No. of dead bees	% Mortality	No. of dead bees	% Mortality	No. of dead bees	% Mortality
0-3	0	0%	0	0%	6	0.5%	4	4%
4-6	13	13%	17	17%	30	30%	28	28%
7-9	29	29%	39	39%	٦٢	62 %	68	68%
10-12	60	60%	68	68%	٨٤	84 %	100	100%
13-15	86	86%	100	100%	١٠٠	100%	---	---
16-18	100	100%	---	---	---	---	---	---

**REFERENCES**

Akyel, E; H. Yeninar; N. Sahinler and a.Guler (2006) The effect of additive feeding and feed additive before wintering on honey bee colony performances, wintering and survival rates at the East Mediterranean Region. *Pakist. J. boil. Sci.*, 9 (4) ;589 – 592.

Alqarni, A.S. (2006) Influence of some protein diets on the longevity and some physiological conditions of honey bee (*Apismellifera*) workers. *J. Biological Sci.* ,6 (4) :734 – 737.

Brodshneider, R. and K. Crailsheim (2010) Nutrition and health in honey bees. *Apidologie*, 41 (3): 278 – 294.

Clarke, Jr. W.; W.W.S.A.Tikrity;R.C.Hillmanand A.W, Benton (1971).Anew instrument for brood measutment in honey bee colony . *Amer. Bee J.*,111 (1):20-26.

Crailshein, K.; L. H.W. Schneider; N. hrassnigg; G. Buhlmann; V. Brosch; R. gmeinbauer and schoffmann (1992)Pollen consumption and utilization in winter honey bees (*Apismellifera*) canica) ; dependence on individual age and function. *J. Insect Physiol.* 38 ; 409 – 419.

- De-Grandi-Hoffman, G.; G. Wardell; F. Ahumada-Secura; T.E. Rinderer; R. Danka J. and Pettis (2008) Comparisons of pollen substitute diets for honeybees consumption rates by colonies and effects on brood and adult populations. *J. Apicult. Res.*, 47:265-270.
- De Jong, D., and P. H. De Jong. (1983) Longevity of Africanized honey bees (Hymenoptera: Apidae) infested by *Varroajacobsoni*(Parasitiformes, Varroidae). *J. Econ Entomol.* 76: 766-768
- Nowar, E.E., (2011) Feeding technology of colonies and its effect on some worker's glands (*Apis mellifera* L-Apidae-hymenoptera) Ph.D. Thesis, Fac. Of Agric., Moshtohor, Benha Univ., pp. 167.
- Ellis, A.M. and G.W. Hayes (2009) An evaluation of fresh versus fermented diets for honey bees (*Apis mellifera*). *J. of Apic. Res.*, 48 : 215.
- Farooqi, F.A., (1989) Studies on the nutritional effect of different feeds on the development of *Apis mellifera* L. colonies. Univ. of Agri Faisalabad, Pakistan, PP74.
- Gregory, R. (2006) Protein diets and their effects on worker weight, longevity, consumption and hemolymph protein levels of *Apis mellifera*. *American Bee J.*, (Abstract)
- Herbert E. W. Jr., Shimanuki H. (1978) Chemical composition and nutritive value of bee collected and bee-stored pollen. *Apidologie*, 9(1):363-369.
- Huang, Z.Y. (2011) Honey bee nutrition. *American Bee J.*, pp : 1 -9
- Kalev, H A. Dag and S. Shafir (2002). Feeding pollen substitutes to honey bee colonies during pollination of sweet papper in Enclosures. *American Bee J.* , 142 (90; 675 – 679.
- Keller, I.; P. Fluri and A. Imdorf (2005). Pollen nutrition and colony development in honey bees-part II. *Bee world J.*, 33(4):125-128.
- Kleinschmidt, G; and Kondos, N (1976) The influence of crude protein levels in colony production. *The Australasian Beekeeper.* 78 (2) : 36-39.
- Kleinschmidt, G; and Kondos, N (1977 ). The effect of dietary protein on colony performance. *Proceedings of the 26<sup>th</sup> International Apicultural Congress, Adelaide* 357-361.
- Knox, D.A.; H. Shimanuki and E.W. Herbert (1971): Diet and the longevity of adult honey bee (*Apis mellifera*) *Apidologie*, 13 (4):347-352.
- Morse, R. A. 1975. Bees and beekeeping. Cornell University Press, Ithaca, NY.
- Rafique, A and M. Nasreen (1984) *Jadeed Magasbami. P.A.R.C.*, PP:346.
- Rortais, A.; G. Arnld; M.P. Halm and F. Touffet-Briens (2005). Modes of honey bee exposure to systemic insecticides ; Estimated amounts of contaminated pollen and nectar consumed by different categories of bees. *Apidologie*, 36 : 71 – 83.
- Schmidt, L.S.; J.O. Schmidt; H. Rao; W. Wang and L. Xu (1995). Feeding preference of young worker honeybees (Hymenoptera- Apidae) fed rape, sesame and sunflower pollen. *J. Econ. Entomol.*, 88:1591-1595
- Seeley, T. D. 1985. Honey bee ecology. Princeton University Press, Princeton, N J.

**تأثير بعض بدائل حبوب اللقاح على تربية حضنة نحل العسل وعمر الشغالات**  
**عاطف مصطفى السيد الحادى**  
**معهد بحوث وقاية النباتات - مركز البحوث الزراعية**

أجريت هذه الدراسة بمنحل خاص بقرية عياش مركز المحلة الكبرى محافظة الغربية حيث تفتقر هذه الناحية مصادر الرحيق وحبوب اللقاح وذلك خلال الفترة من يناير إلى مارس ٢٠١١ . تم استخدام ثلاثة بدائل لبروتين حبوب اللقاح وهى كيك فول الصويا - كيك دقيق القمح - كيك دقيق الذرة بالإضافة إلى محلول سكري بنسبة ( ٢ سكر : ١ ماء ) . كما تم التغذية على محلول سكري فقط كمعاملة كمنترول.

أظهرت النتائج وجود فروق معنوية بين المعاملات في متوسط زيادة نشاط الحضنة وكذلك بينها وبين معاملة الكمنترول . أدت معاملة التغذية على كيك فول الصويا إلى زيادة متوسط نشاط تربية الحضنة إلى ٧٥,٣٠ بوصة مربعة يليها كيك دقيق القمح ٥١,٠٠ بوصة مربعة ثم كيك دقيق الذرة بمتوسط ٣٥,٣٠ بوصة مربعة مقارنة بمعاملة الكمنترول ٢٠,٣٠ بوصة مربعة . ولقد سجلت معاملة كيك فول الصويا أعلى نسبة استهلاك ٤٨,٦٨ جم ١٠ ١ أيام وكذلك أعلى متوسط استهلاك للمحلول السكري ٧١١,٥٠ سم<sup>٣</sup> ١٠ ١ أيام مقارنة بالمعاملات الأخرى وكذلك معاملة الكمنترول ٣٢٢,٢١ سم<sup>٣</sup> ١٠ ١ أيام . كانت الشغالات الناتجة حديثا في الطوائف المغذاة على كيك فول الصويا أطول عمرا حيث طال عمرها الي ١٦ - ١٨ يوم يليها الطوائف المغذاة على كيك دقيق القمح ١٣ - ١٥ يوم ثم الطوائف المغذاة على كيك دقيق الذرة ١٠ - ١٢ يوم مقارنة بمعاملة الكمنترول ١٠ - ١٢ يوم .

من نتائج هذا البحث يمكن التوصية بتغذية طوائف نحل العسل ببدائل حبوب اللقاح فى فترات الجفاف ( عدم الفيض) وذلك للمحافظة علي حيوية وقوة الطوائف وتنشيطها قبل موسم الفيض.

**قام بتحكيم البحث**

**كلية الزراعة - جامعة المنصورة**  
**كلية الزراعة بمشتهر - جامعة بنها**

**أ.د / حسن محمد فتحى**  
**أ.د / متولى مصطفى خطاب**