

Influence of feeding on the production of honey bee queens during the dearth period under Nasr City conditions – Cairo

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ABSTRACT

Under Nasr City conditions, honey bee colonies exposed to dearth period, which occurs in the summer season. This work was designed to overcome the bad effects of this period by feeding on fresh and stored pollen (for one and two years) to study the effect of pollen on queen rearing of (F₁ hybrid Carniolan and Italian) by measuring the food consumption, success grafting and mean of virgin queen body weight. During the dearth period from 31 Jul. to 15 Aug. 2019, twenty-four honey bee colonies of the same strength (12 Carniolan and 12 Italian) were distributed as follows, three treatments and control (three replicates for each) from every race. Food consumption mean by the two tested honey bee races from fresh pollen, was (143.7g) while it was (121.7 and 113.5g) from the stored pollen for one year and for two years respectively in the same period. The Italian race consumed higher quantity from different diets than the Carniolan race and the nocturnal consumption was more than diurnal one. The successful grafting percentages mean for the two tested races resulted from feeding on fresh pollen, the stored pollen for one-year, stored pollen for two years and control were (66.2, 39.9, 37.9 and 24.3%) respectively. The mean of the Carniolan and Italian newly emerged virgin queen weight resulted from feeding on fresh pollen (0.224g), while those resulted from feeding on stored pollen for one year and two years were (0.217 and 0.202g) respectively. The mean of the Carniolan and Italian newly emerged virgin queen weight of control was (0.185g). The Italian newly emerged virgin queen had a larger weight mean than Carniolan one.

Keywords: Stored pollen, honey bee, queen, fresh, weight, dearth period, food consumption.

INTRODUCTION

Honey bee colonies are highly dependent upon the availability of floral resources from which they get the necessary nutrients to their development and survival. The honey bees, are essential to the functioning of natural and agricultural ecosystem (Adham 2000; Ahmet and Hakan 2013).

Pollen is the sole protein food of honey bee colony harvested by bee foragers in their natural environment. The presence of pollen in the nest is essential for normal colony development and for regular growth and development of the brood. Brood rearing is a major factor in apiary production and affected by colony feeding on nature pollen and nectar, (Roman 2006).

Colony development, reproduction, population size and food reserves are the major criteria to measure the success of honey bee colony surviving in different regions (Paxton and Echagarreta 1997). They are affected by many environmental factors, (Harbo 1986; Chinh *et al.*, 2005). In honey bees, floral nectar containing carbohydrates and stored as honey, is the energetic supply of individuals and pollen provides most of the nutrients required for their physiological development (Alaux *et al.*, 2010).

During the shortage or complete absence of pollen, or in the presence of only poor-quality

pollen, beekeepers often feed colonies of honey bees with either pollen substitute (with no pollen) or supplement (with pollen) diets (Saffari *et al.*, 2006).

The pollen substitute diet and pollen are equality accepted by the bees. The pollen substitute diet is thus, as highly palatable as natural pollen and easily provided as patties to colonies in standard hives (Saffari *et al.*, 2004).

The possibility of improving the efficiency of beekeeping by providing proteinaceous feed lies, in part, in the development of an effective pollen substitute to feed the colonies when pollen is scarce (Zahra and Talal 2008), especially in preparation for early nectar flows (Skubida *et al.*, 2008). Providing proteinaceous feed to stimulate colony strength would then help, in maximizing honey production and crop pollination, to overcome pesticide damage and resistance to parasites and diseases, and for package-bee production flows (Skubida *et al.*, 2008).

The queen rearing is one of the major objectives of apiaries especially for the commercial beekeepers, and it is the main factor to beekeepers there is only one queen in honey bee colony. It is known that economic characteristics of the honey bee colony are dependent mainly on the quality of its queen (Harris 2009).

The queen quality in turn, depends on the genetic, the environmental factors, the breeding

conditions and queen rearing methods (Hoopingranger and Farrar, 1959; Nagi 1984; Zedan 2002; Taha, 2005; John *et al.*, 2011).

The most important factors affecting quality of queen are rearing period and grafting methods. She was recommended to be raised when the weather is warm, drones are plentiful, nectar and pollen are rich in terms of quality and productivity and mating rate are at the optimum levels. (Kaftanoglu and Kumova 1992; Genc 1997).

The aim of this work, study the effect of feeding on fresh pollen, stored pollen for one year and stored pollen for two years on queen rearing during the dearth period, which occurred in the summer months, in which both pollen and nectar are absent, by studying the following parameters: Food consumption, Success percentages of grafting and Mean of virgin queen body weight.

MATERIALS AND METHODS

This study has been carried out at the apiary of plant protection Department, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

This study was carried during the summer season (from 31 Jul. to 15 Aug./2019). Twenty-four honey bee colonies of equal strength (12 Carniolan and 12 Italian), distributed as follows:

Three treatments and control (three replicates for each) from every race.

Procedures

The power of each colony was Seven combs covered with bees (four sealed brood combs plus three honey and pollen combs) + plastic feeder. Breeding frames have three strips arranged in three different locations (upper, middle, lower), each strip carrying 16 plastic cups. The breeding frames is exposed to the breeding colony two hours before the grafting to polishing. Choosing the parent colony of the Carniolan and Italian bee hybrid to lay the eggs between the folded brood frames to force the queen to lay eggs and follow up until the hatching is completed three days later.

The fourth day is the first larval instar (larvae of one day age). The queens of the breeding colony were removed for 48 hours. The grafting began 48 hours after the queens

was removed from the colonies. The effect of feeding on each of fresh pollen, stored pollen for one year and stored pollen for two years on queen rearing during dearth period by measure the following parameters:

Food consumption.

Diurnal and nocturnal food consumptions were calculated for all tested pollen.

successful grafting percentages.

Successful grafting percentages were calculated after 48 hours in three different locations (upper, middle, lower) of grafting.

Mean of virgin queen body weight.

The queen cell was placed under a hemisphere cage after the end of the ninth day of the grafting until the newly emerged virgin queen, and finally it was taken and weighed.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using "COSTAT" computer statistical program. Mean values were compared using Duncan's multiple range test, (Duncan 1955).

RESULTS AND DISCUSSION

Food consumption.

The results in Table (1) Show that the highest consumption mean by the two tested honey bee races recorded from fresh pollen, was (143.7g) with the consumption rate (96.2%) followed by the consumption from the stored pollen for one year (121.7g) with consumption rate (81.2%), the lowest food consumption occurred from stored pollen for two years (113.5g) with consumption rate (75.7%).

The Italian race consumed (65.7g) with consumption rate (43.8%), from different tested pollens, while the Carniolan race consumed (60.6g) with consumption rate (40.4%).

Consumption quantity in the nocturnal period was (84.7g) with consumption rate (56.5%), higher than diurnal one (41.6g) with consumption rate (27.7%). Statistically there was a significant difference between the effect of fresh pollen and each of other treatments. On the other hand, there was a significant difference between control and stored pollen.

Table 1. Mean of food consumption by honey bee from different tested pollen (in g) / colony at Nasr city during summer season the period from 31/7- 15/ 8/2019.

Treatments	Carniolan			Italian			Mean		Mean / Diets
	Diurnal	Nocturnal	Mean	Diurnal	Nocturnal	Mean	Diurnal	Nocturnal	
Diets									
Fresh	43.3	97.1	70.2	45.9	101.1	73.5	44.6b	99.1a	143.7A*
%	28.8	64.7	46.8	30.6	67.4	49.0	29.7	66.5	96.2
Stored 1 year	37.9	77.8	57.8	43.2	84.5	63.8	40.6b	81.2a	121.7B*
%	25.3	51.9	38.6	28.8	56.3	42.6	27.1	54.1	81.2
Stored 2 year	40.3	67.3	53.8	38.9	80.4	59.7	39.6b	73.9a	113.5C*
%	26.9	44.9	35.9	25.9	53.6	39.8	26.4	49.3	75.7
Mean	40.5b	80.7a	60.6B	42.7b	88.7a	65.7A	41.6B	84.7A	126.3
%	27.0	53.8	40.4	28.4	59.1	43.8	27.7	56.5	84.2

Means in the same row or column with the same small or capital letters do not differ significantly according to Duncan's multiple range test at 5% probability.

These results are in harmony with those obtained by several authors Ismail (2001) who found that queen rearing began when the brood nest was congested and nectar and pollen were abundant, the maximum queen cups production recorded in March. Keller *et al.*, (2005), Who recorded that the consumption of high-quality pollen induces the development of the hypopharyngeal glands in young honey bee workers. As protein – rich secretions from these glands are an important component of larval food, a direct relationship between pollen supply and brood rearing can be expected. Consequently, the availability of pollen is likely to be a central parameter influencing the development of honey bee colonies. Hassan (2016) During spring and winter seasons, It was found that feeding honey bee colonies on brewer's yeast – chick pea cake supported by pollen as a protein supplement in addition to sugar syrup (1:1) at 3 days intervals for two months of spring season (25/3 – 29/5/2014) produced more broods with a higher brood rearing rate, stored honey and pollen than the other feeding regimes in the experiment. It was found that commercial cake (1) of pollen substitute or commercial cake (2) of protein substitute caused more broods with a higher brood rearing rate and stored honey and pollen without any significant differences between them. Commercial cake 1 of pollen substitute consists of (sugar + protein + attractive material + vitamins). Commercial cake 2 of protein substitute consists of (sugar + brewer's yeast +

Zea mays flour + citric acid + cinnamon flour + korkom flour + cuspara flour + digestive material + vitamins).

Successful grafting percentages.

The data in Table (2) Showed that the general Success of grafting. mean was recorded in Carniolan (43.7 %) while it was (40.4%) for the Italian race.

Feeding on fresh pollen gave the highest acceptance percentages (66.2%) as mean for the two tested races, while feeding on the stored pollen for one year, stored pollen for two years and control (without feeding) were (39.9, 37.9 and 24.3%) resp. As respect the strip level, the middle level had the highest acceptance percentage mean (49.3%) followed by the lower one (40.1%), the upper level had the lowest percentage mean (37.0%). While a significant difference there was between food consumption means of the two races.

Many authors discuss acceptance percentage. Abd Al Fattah and El-Shemy (1996) found that the plastic queen cups caused significant increase in the acceptance percentage (84.7%) than wax (76%) when they grafted with young larvae and introduced into queen rearing colony. Gençer, *et al.* (2000) Found that supplemental feeding of rearing colonies improves the acceptance rate of grafted larvae ($p < 0.05$). Larval age did not affect the acceptance rate.

Table 2. The effect of different tested pollens on successful grafting percentages mean of grafted queen cups / three colonies in Nasr city during Summer season the period from 31/7- 15/ 8/2019.

Treatments	Carniolan				Italian				Mean / Level			Mean ± SEM Diets
	Upper	Middle	Lower	Mean ±SEM	Upper	Middle	Lower	Mean± SEM	Upper	Middle	Lower	
Fresh	54.2	72.9	66.7	64.5 ± 5.5a	64.6	70.8	68.6	68 ± 1.8a*	59.4	71.6	67.7	66.2 ± 3.6A
Stored 1 year	37.5	50.0	41.7	43.05 ± 3.6b	39.6	41.7	29.2	36.8 ± 3.8b*	38.6	45.6	35.5	39.9 ± 2.9B
Stored 2 year	33.3	52.1	35.4	40.2 ± 5.9b	31.3	45.8	29.2	35.4 ± 5.2b*	32.3	49.0	32.3	37.9 ± 5.5B
Control	18.8	33.3	29.2	27.08 ± 4.3b	16.7	27.1	20.8	21.5 ± 3.02c*	17.8	30.2	25.0	24.3 ± 3.5B
G. Mean	35.9	52.1	43.2	43.7 ± 4.6A	38.1	46.4	37.0	40.4 ± 2.9A	37.0B	49.3A	40.1B	42.1 ± 3.6

Means in the same row or column with the same letters do not differ significantly according to Duncan's multiple range test at 5% probability with significant differences between the effect of the three levels.

El-Waseef (2002) stated that the mean number produced queen cups were higher in spring – 1998 (16.77/col) and winter (5.741/col) than the summer (2.89/col) and autumn (0.20/col) in the indoor colonies in closed area. While, in the second experimental period (1999-2000) the mean number of produced queen cups were higher in winter (3.17/col) and summer (3.48/col) than in spring (3.00/col) and autumn (0.29/col) under the same conditions.

Eissa *et al.* (2012) As respect to the queen cells bar position in dictated the lower position of bars gave the best result of acceptance (90%) followed by middle (76.66%) then upper bar which gave (53.3%) there was no difference of acceptance percent found between grafted lower of larvae aged 1 and 2 days, there was found significant differences of acceptance percent among spring, summer and late summer, whereas. The early summer season was the best period for acceptance of queen cells followed by spring then late summer of period. The tested diets (cakes) did not affect on queen cells, where acceptance percent 41.11-56.60% and 40-98.88% for grafted larvae aged 1 and 2 days, respectively.

Khalil (2019) Showed that, the mean of acceptance numbers of grafted queen cups for the colonies treated with diets (a), consist of (2

parts) Wheat Germ + (1 part) brewer's yeast + (3 parts) Sugar Powder. (b), consist of (1 part) Soybean flour + (1 part) brewer's yeast+ (2 parts) Sugar Powder. (c), consist of (1 part) Dates paste (Agwa) + (1 part) brewer's yeast + (2 parts) Sugar Powder. (d), consist of (6 parts) wheat germ + (2 part) brewer's yeast + (1 part) pollen + (9 parts) Sugar Powder. and Control, in all grafts were 50.17, 40.5, 38.6, 43.83 and 35.5 cup/colony, respectively. Generally, the diet (a) produced the greatest number of accepted queen cups followed by diet (d), then diet (b), then diet (c) While, the control colonies produced the lowest number. Statistical analysis showed that, there were significant differences among diet (a) and all treatments. While, there were no significant differences between diet (b) and diet (c).

Mean of virgin queen body weight.

Data in Table (3) recorded that the highest queen weight as mean for the two races resulted from feeding on fresh pollen was (0.224g) while this queen weight mean resulted from feeding on stored pollen for one year and two years were (0.217 and 0.202g) resp. The mean of the Carniolan and Italian newly emerged virgin queen weight of control (without feeding) was (0.185g). The Italian newly emerged virgin queen had larger general weight mean (0.208g) than

Carniolan one (0.205g). As regard to the level of strip, the middle level gave the largest queen weight mean (0.210g) followed by the upper

one (0.207g) and the smallest one (0.204g), resulted from the lower level.

Table 3. The effect of feeding on tested pollens on the mean of virgin honey bee queen weight (g) in Nasr city during Summer season the period from 31-7 to 15-8 /2019.

Treatments	Carniolan				Italian				Mean / Level			Mean ±SEM/ Diets
	Upper	Middle	Lower	Mean ±SEM	Upper	Middle	Lower	Mean ±SEM	Upper	Middle	Lower	
Diets												
Fresh	0.220	0.226	0.219	0.221± 0.002a	0.224	0.229	0.222	0.225 ± 0.002a	0.222	0.228	0.221	0.224 ± 0.002A
Stored 1 year	0.215	0.218	0.213	0.215± 0.001b	0.219	0.221	0.216	0.218 ± 0.001b	0.217	0.220	0.215	0.217 ± 0.001B
Stored 2 year	0.201	0.203	0.198	0.201± 0.001c	0.203	0.205	0.200	0.202 ± 0.001c	0.202	0.204	0.199	0.202 ± 0.001C
Control	0.186	0.186	0.179	0.184± 0.002d	0.187	0.190	0.183	0.186 ± 0.002d	0.187	0.188	0.181	0.185 ± 0.002D
G. Mean	0.206	0.208	0.202	0.205± 0.008A	0.208	0.211	0.205	0.208 ± 0.008A	0.207 B	0.210 A	0.204 C	0.207 ± 0.008

Means in the same row or column with the same letters do not differ significantly according to Duncan's multiple range test at 5% probability.

The same trend of results obtained by Koç and Karacaoglu (2004) Reared honey bee queens in the Aegean region in turkey from the end of March to Sep., they found the better-quality March until the end of April.

Nowar (2011) Found that the highest weight of virgin queen produced by grafting method occurred when the colonies received pollen substitute number 4 in the two years of study. Results also indicated that there were significant differences between used diets and control (sugar syrup only).

Masry *et al.*, (2015) Found that the (81 queens of each genotype) were weighed at emergence and allocated into three groups as : light (110-130 mg) 45 queens, medium (140-160 mg) 68 queens, heavy (over 160 mg) 130 queens and introduced into mating nuclei.

CONCLUSION

It could be concluded that food consumption ratio, type of honey bee races, stored pollen watch used at pollen supplements and honeybee queen rearing conditions were very important and greatest factors affecting honeybee queen rearing and quality, especially during dearth period.

Newly emerged virgin queen weight is a good indicator of honeybee queen quality which reached to 228 mg. that produced by Italian F₁ hybrid orphan colonies and feeding by fresh pollen, while the highly general mean was (43.7±4.6%) accepted grafted cups for F₁ hybrid Carniolan. We are carrying out further studies to find the effect of these factors on mating success, availability and their offspring's activities of honeybee mated queens.

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تأثير التغذية على تربية وإنتاج الملكات خلال فترة القحط تحت ظروف مدينة نصر- القاهرة

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الملخص العربي

تحت ظروف مدينة نصر يتعرض نحل العسل الى فترة تندر فيها حبوب اللقاح (فترة قحط) خلال اشهر الصيف، لذا تهدف الدراسة الى التغلب على الآثار السلبية لتلك الفترة من خلال تغذية نحل العسل على حبوب اللقاح (الطازجة والمخزنة لمدة عام وعامين) ودراسة تأثيرها على إمكانية تربية وإنتاج الملكات (هجين أول كرنوبولى وإيطالى) من خلال قياس معدل استهلاك الغذاء ونسبة التطعيم الناجح ومتوسط وزن الملكات عند الخروج خلال فترة القحط من 31-7 حتى 2019/8-15م. أربعة وعشرون مستعمرة نحل العسل متساوية القوة (12 كرنوبولى و 12 إيطالى) ، موزعة (ثلاثة معاملات والكنترول (كل معاملة ثلاث مكررات). كان اعلى معدل استهلاك للسلاطين في حبوب اللقاح الطازجة وبلغ متوسط 143.7 جرام بينما كان 121.7 و 113.5 جرام في حبوب اللقاح المخزنة لمدة عام ثم عامين على التوالي في نفس الفترة. وتفوقت السلالة الإيطالى على الكرنوبولى في متوسط كمية الاستهلاك وكان اعلى معدل استهلاك في السلاطين في الفترة المسائية عنها في الصباحية. كما أظهرت النتائج ان اعلى نسبة التطعيم الناجح للملكات كانت في السلالة الكرنوبولى عن الايطالى حيث اعطت التغذية على حبوب اللقاح الطازجة الأعلى يليها المخزنة لمدة عام ثم عامين ثم المقارنة حيث بلغت 66.2 و 39.9 و 37.9 و 24.3% على التوالي. كما أظهرت النتائج ان اعلى متوسط لوزن الملكات عند الخروج كان في التغذية على حبوب اللقاح الطازجة وبلغ 0.224 جرام ، بينما كان 0.217 و 0.202 و 0.185 جرام في حبوب اللقاح المخزنة لمدة عام ثم عامين ثم المقارنة على الترتيب. كما تفوقت السلالة الايطالى على الكرنوبولى في متوسط وزن الملكات عند الخروج وبلغت 0.208 و 0.205 جرام على التوالي.

الكلمات المفتاحية: حبوب اللقاح المخزنة، مستعمرة نحل العسل، الملكة، طازج، وزن، فترة الندرة، استهلاك الغذاء.