

Journal of Plant Protection and Pathology

Journal homepage: www.jppp.mans.edu.eg
Available online at: www.jppp.journals.ekb.eg

Sustainable Beekeeping in North Sinai Region By Monitoring The Biological Activity and Productivity of Honeybee Colonies in Bir El-Abd and Sheikh Zowied Zones Comparing with El-Arish Province

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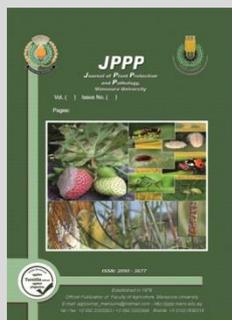
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ABSTRACT

The suitability of the three major provinces, (Bir El-Abd, El-Arish and Sheikh Zoweid) of north Sinai governorate for establishing and propagating of honeybee colonies was evaluated for two successive years, (2019& 2020). Colonies established in regions of Sheikh Zoweid and Bir El-Abd attained significant progression in all biological and productive evaluated activities than those presented at El-Arish. The rates or percentages of increase in the mean values of two combined years of different activities were 65.3 % & 48.7 % in worker brood production; 183.1 % & 136.8 % in drone brood production; 28.5 times & 8.3 times in queen cells construction; 54 % & 25.4 % in the number of adult worker population; 2.3 times & 1.2 times in the quantity of stored pollen and 4.5times & 4.3 times in honey production for colonies located at Shiekh Zoweid and Bir El-Abd, than El-Arish, respectively. Therefore, El- Shiekh Zoweid and Bir El-Abd to be considered more pronounce in the qualitative and quantitative of honeybee colonies than El-Arish province and could be included in the sustainable beekeeping programs in Egypt.

Keywords: Shiekh Zoweid, Bir El-Abd, El-Arish, queen cells; storing pollen; honey production.



INTRODUCTION

Colonies of honeybees, *Apis mellifera* L., are characterizing by the potential to survive in various environmental regions worldwide, (Seeley, 1985 and Moritz & Southwick, 1992). They react to the different environmental conditions in a similar manner wherever they occur. Although, the reproductive development of honeybees and storing food, (nectar and pollen) are heritable and responded to selection (Rinderer 1986 and Ruttner, 1988), they are the major criteria to measure the success of honey bee colony in surviving among different regions (Paxton and Echagarreta, 1997).

Regarding to various regions of the four directions in the Egyptian country, it could be notice that many researchers investigated the honeybee activities at Delta in Northern regions of Egypt such as Khattab, (1976), El-Dakhkhni, (1980), Taha, (2005), Abd Al-Hady, (2007), Abd Al-Fattah et. al.,(2010), Hamada, (2011) and Serag El-Dein, (2021). While Rizk & Atallah, (1979), Abd Al-Fattah, (1983), Hassan, (2016), Abou Yahia, (2016&2020) and others covered the middle regions of the country. In the southern regions, the studies were applied by several investigators such as Hussein, (1981, 1983 & 1985), Abdel-Rahman, (1998 & 2004), Ahmed, (2011), Hassan et. al., (2015) and Mahbob, (2015). For the Western regions, many subjects of honeybees were took inconsideration by Ghoniemy, (1984), Mabrouk, (1999), Abdel Aziem, (2007), El-Feel, (2008), Nasr Allah,(2009) , Elsayh, (2012), and others . Concerning the Eastern regions of Egypt, especially Sinai which located at the northeastern region of Egypt , nearly all studies were concentrated and occurred in El-Arish province,(El-

Basiony,2002a,b&c; Abd Al-Fattah,et.al.,2003a&b;Zaref, 2008, and Mahfouz, 2002 , 2016 a& b). But till now, there is not available data about the suitability of the other provinces for reproduction of honeybee colonies and increasing their productivity.

Therefore, the aim of this work is to monitor the biological activities and productivity of honeybee colonies in the provinces of Bir El-Abd and Sheikh Zoweid comparing with El-Arish province.

MATERIALS AND METHODS

Preparing the experimental colonies

Fifteen honeybee colonies of about equal strength headed by six months open mated F1 hybrid Carniolan queens were ,each, contained three sealed and unsealed brood combs and two store combs,(honey and pollen), and all the five combs covered with workers. These new colonies were randomly divided into three equal groups, (each of 5 colonies) and distributed in three provinces of North Sinai governorate. These provinces were Bir El-Abd, EL Arish, and Sheikh Zoweid. Bir El-Abd locates at about 80 Kilometers Western El-Arish, while Sheikh Zoweid locates at about 20 Kilometers Eastern El-Arish.

The bees in these investigated colonies were allowed to free flight for collecting available nectar and pollen from cultivated crops as well as natural plants existed in these locations. The biological measurements of these colonies were followed at 21 day intervals throughout the period from January,5 to December, 29 of year 2019.

The biological parameters of study

To evaluate the effect of different environmental conditions in the three locations on the biological

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DOI: 10.21608/jppp.2021.205742

characteristics of honeybee colonies, the measurements of the following activities were taken in consideration:-

1. Rearing activity of workers and drones brood.
2. Storing activity of pollen.
3. Colonies activity in constructing of queen cells.
4. The activity of colonies in gathering and producing honey.

The areas of worker and drone brood and stored pollen were measured using a Langstroth frame divided into square inches. The numbers of built queen cells in each colony were counted at 7 day intervals and then pooled at 21 day intervals. Amounts of harvested honey from each group of colonies (in each province), were determined by the difference between the weight of honey combs before and after extraction.

Statistical analysis

Data were analyzed by split plot in randomized complete block design using MSTAT program, version,2,0,0,1 and the means were compared by Duncan Multiple Range test at 5% probability,(Sendecor, and Cochran, 1980) .

RESULTES AND DISCUSSION

1. Worker brood rearing

Data in Table (1) showed that the provinces of

Sheikh Zoweid and Bir El-Abd, were significantly increased than EL-Arish in the reared areas of worker brood. The highest mean areas of worker brood was recorded in Sheikh Zoweid,(468.8 in²/ colony) followed by Bir El-Abd, (421.8 in²/ colony), while the lowest amount was recorded in EL-Arish, (283.7 in²/ colony).So, the regions of Sheikh Zoweid and Bir El-Abd enhanced the production of worker brood by 65.3 % and 48.7 % increase than EL-Arish, respectively.

Activity of colonies in worker brood rearing had a major peak during spring season in all provinces with a mean value of 568.6 in²/ colony which represented 36.4 % of the total year brood. However, Sheikh Zowied, (643.0 in²/ colony) and Bir El-Abd, (648.7 in²/ colony) were significantly increased than EL-Arish,(414.1 in²/ colony) in this activity. Summer season came next,(464.1 in²/ colony represented 29.6 % of the total produced brood areas), with no significant difference with spring. During summer season, the amounts of reared brood at Sheikh Zoweid, were significantly increased than those reared at EL-Arish, while colonies presented in Bir El-Abd province produced an intermediate amounts of worker brood areas. The same trend was noticed between the three provinces during autumn and winter seasons as shown in Table (1).

Table 1. Mean areas (in²) of worker brood reared at 21-day intervals within colonies established in three different provinces of North Sinai Governorate.

Season	Month	Bir El-Abd		EL-Arish		Sheikh Zowied		Mean/month	± SD	%
		Mean	± SD	Mean	± SD	Mean	± SD			
spring	Mar.	596.7	91.7	428.8	186.8	595.0	15.2	540.2	96.5	11.1
	Apr.	660.7	113.6	470.4	99.3	613.0	65.3	581.4	99.0	12.0
	May	688.7	56.0	577.7	130.1	721.2	212.2	662.5	75.3	13.7
Mean		648.7 A a	99.7	414.1 B a	138.2	643.0 A a	69.4	568.6 A**	133.9	36.4
Summer	Jun.	379.4	66.0	461.8	124.7	656.0	53.8	499.0	142.0	10.3
	Jul.	569.9	129.9	347.5	128.7	512.9	86.4	476.7	115.5	9.8
	Aug.	469.3	145.3	299.2	98.1	523.8	105.5	430.8	117.2	8.9
Mean		472.9 B c	17.9	355.2 B bc	112.9	564.2 A a	78.8	464.1A**	104.8	29.6
Autumn	Sep.	376.4	144.7	240.4	78.8	398.6	64.5	338.4	85.7	7.0
	Oct.	271.8	136.7	226.6	79.1	351.0	58.5	283.1	63.0	5.8
	Nov.	266.5	112.4	193.3	113.8	273.0	53.7	244.3	44.3	5.0
Mean		304.9 ABcd	119.5	193.8 B cd	89.8	340.8 A b	57.1	279.8 B**	76.7	17.9
Winter	Dec.	155.5	66.4	138.7	47.2	221.6	28.5	171.9	43.8	3.5
	Jan.	226.5	159.0	141.7	78.6	259.7	28.8	209.3	60.9	4.3
	Feb.	400.4	112.7	340.0	268.9	499.7	61.5	413.3	80.7	8.5
Mean		260.8 B d	101.3	171.9 C d	129.4	327.0 A b	39.0	253.3 B**	77.8	16.2
Mean / province		421.8 A*	25.7	283.7 B*	106.8	468.8 A*	47.1	391.4	96.2	100.0

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It obvious from results in Table (1) that the activity curve of worker brood rearing started in gradual decline during autumn for all provinces to register a mean brood area of 279.8 in²/ colony (represent 17.9 % of the total produced brood areas).

It continued in declining through winter season to record the least brood quantity,(253.3 in²/ colony which represented 16.2 % of the total produced brood areas) in the three regions. The worker brood production during the latest two seasons was significantly less than those reared during spring and summer seasons.

On the other hand, there are some variable fluctuations in the curve of monthly brood rearing between the three studied regions, in spite of the highest brood production was occurred during May, representing 13.7% of the total reared brood. They, also, agreed in December

as the lowest month in brood production, (3.5%).However, there was second small peak during July, (569.9 in²/ colony) in rearing worker brood, only, at Bir El-Abd province. It was noticed, also, that colonies of honeybees actively started in brood rearing during January, (4.5%) and continued in progress afterward in all regions of study.

It could be concluded from these results that due to the three studied provinces to be considered as coastal regions of north Sinai they are influencing with the climate of Mediterranean Sea. Under this climate, the flowers of major plants are issuing during the periods of late winter, spring and summer seasons. Honeybee colonies, in this warm environment, are more active and speedily build up to reach their highest peak of worker brood production during spring or early summer seasons. This conclusion coincided with Mahfouz, (2016) who surveyed 123 plants

of 49 botanical families included fruits, vegetables, ornamental and medicinal plants and wild weeds as pollen sources for honeybees in various locations of El-Arish region. He, also, found that 78%, 48%, 45% and 25% of those plants bloomed during spring, summer, winter and autumn seasons, respectively. In this respect, El- Basiony, (2002a) found that the highest peak in worker brood rearing occurred during April at El-Arish province. Also, it was found that the almond, peaches, citrus, apple and cantaloupe plants cultivated at Sheikh Zoweid and Bir El-Abd in large areas bigger than those found in El-Arish region (El- Basiony, 2002b). Similar results were reported by many investigators under the similar prevailing conditions. Shawer *et al.* (2003) reported that the large amount of worker brood of Carniolan colonies was reared through spring followed by summer then winter while the least amounts were reared in autumn season. Abd Al-Hady (2007) recorded in Damietta governorate that the highest rate of worker brood rearing within F1 carniolan colonies was during spring, (37.28%), followed by summer, (25.92%), winter, (21.24%) and autumn, (15.56%), seasons. Also, Serag El-Dein, Amany, (2021) noticed in Kafr El-Sheikh region that the highest average of sealed worker brood area reared in honeybee colonies was found during May and July, while the lowest area was found during November.

2. Drone brood rearing

Data presented in Table (2) cleared that, the activity of honey bee in drone brood rearing at Bir El-Abd, El-Arish and Sheikh Zoweid throughout the months and different season of year 2019. It indicated that, colonies located in Sheikh Zoweid reared the highest mean amount of drone brood, (38.5 in²/ colony), followed by those located at Bir El-Abd, (32.2 in²/ colony) with no significant difference between them. Drone brood production at El-Arish,(13.6 in²/ colony), recorded the least significant area between the three provinces. Therefore, colonies of Sheikh Zoweid and Bir El-Abd enabled to increase their productivity of drone brood by 183.1 % and 136.8 % than those of El-Arish region.

Colonies established in the three regions reared the highest mean amount of drone brood during spring season. No significant difference in these drone brood areas was found between Sheikh Zoweid, (91.9 in²/ colony) and Bir El-Abd, (97.7 in²/ colony), but they significantly increase than those produced in El-Arish, (27.9 in²/ colony) province during spring . In general, the mean areas of reared drone brood during spring season, (72.5 in²/ colony) was significantly higher than those recorded during the rest of year seasons where it represented 64.5% of the yearly total drone brood as appeared in Table (2). Drone brood rearing in colonies at the three regions was retarded to the lowest values, with no significant difference between them, during autumn season with a general mean value of 3.1 in²/ colony represented 2.7% of the yearly total drone brood. There were a sharp decrease in the reared drone brood of Bir El-Abd colonies, (6.7 in²/ colony), which was significantly low than those produced at El-Arish, (16.9 in²/ colony) and Sheikh Zoweid, (17.2 in²/ colony). The general mean value of drone brood produced during summer season was 13.6 in²/ colony represented 12.1% of the yearly total drone brood as appeared in Table (2).

During winter season, honeybee colonies established in Sheikh Zoweid were more pronouncing in rearing drone brood,(42.2 in²/ colony) than colonies in Bir El-Abd, (19.1 in²/ colony) and El-Arish,(8.6 in²/ colony). So, winter season followed spring in the general mean value,(23.3 in²/ colony) of reared drone brood which represented 20.7% of the yearly total drone brood as appeared in Table (2).

It is, also, noticed from data in Table (2) that, in all provinces, colonies started slowly in rearing drone brood through January and progress in their production until reach its climax during March at Sheikh Zoweid and El-Arish and during April at Bir El-Abd. Drone brood rearing was nearly stopped during November at Sheikh Zoweid and El-Arish, while it stopped during October and November at Bir El-Abd. Therefore, the two provinces could be successfully used for rearing mass production and mating pure honeybee queens.

Table 2. Mean areas (in²) of drone brood reared at 21-day intervals within colonies established in three different provinces of North Sinai Governorate.

Season	Month	Bir El-Abd		EL-Arish		Sheikh Zowied		Mean/month	± SD	%
		Mean	± SD	Mean	± SD	Mean	± SD			
spring	Mar.	96.8	11.2	41.7	40.4	125.0	26.5	87.8	42.4	26.0
	Apr.	108.3	22.5	35.0	41.6	115.8	17.6	86.4	44.6	25.6
	May	88.0	46.9	7.0	2.6	35.0	21.8	43.3	41.1	12.8
Mean		97.7 A a	21.7	27.9 B a	28.0	91.9Aa	19.0	72.5 A**	38.7	64.5
Summer	Jun.	0.0	0.0	1.0	1.0	25.8	11.3	8.9	14.6	2.7
	Jul.	16.7	15.8	7.2	8.6	15.7	9.0	13.2	5.2	3.9
	Aug.	3.4	2.8	42.3	43.8	10.0	5.0	18.6	20.8	5.5
Mean		6.7 B c	6.1	16.9 A ab	16.9	17.2 A bc	8.4	13.6BC**	6.0	12.1
Autumn	Sep.	16.2	9.3	2.8	1.2	5.2	2.3	8.1	7.1	2.4
	Oct.	0.0	0.0	0.7	0.6	2.3	0.6	1.0	1.2	0.3
	Nov.	0.0	0.0	0.3	0.6	0.0	0.0	0.1	0.2	0.0
Mean		5.4 A c	3.1	1.3 Ac	0.4	2.5 A c	0.9	3.1 C**	2.1	2.7
Winter	Dec.	5.7	9.8	14.3	16.0	2.3	0.6	7.4	6.2	2.2
	Jan.	1.6	2.8	6.0	5.3	40.0	21.7	15.9	21.0	4.7
	Feb.	50.0	13.7	5.3	2.5	84.2	19.1	46.5	39.5	13.8
Mean		19.1 B b	4.7	8.6 B bc	7.0	42.2 A b	10.1	23.3B**	17.2	20.7
Mean / province		32.2 A*	6.7	13.6 B*	8.8	38.5 A*	4.5	28.1	12.9	100

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The obtained results coincided with the other findings, under the same or similar weather conditions, of many investigators. Shower *et al.* (2003) revealed that, the largest amount of drone's brood reared throughout the blooming seasons of citrus, clover and cotton when colonies moved to area rich with food sources. The largest amount of drones brood rearing was found in late March to mid-April (citrus season), followed by May (clover season) then July and August (cotton season). Serag El-Dein (2004) indicated that under the environmental conditions of Biala, Kafr El-Sheikh region, the highest average of sealed drone brood area was found during May, while the lowest area was found during November in 2002 and 2003 seasons. Taha (2005) in the same region, noted that the largest amount of drone brood, for Carniolan race colonies, rearing (6.72 & 7.22 in²/12days/col.) was occurred at late March till mid-April (citrus season) and during May 6.23 & 7.41 (in²/12days/col.) in the two studied years. But in Motobes region, the largest total drone sealed brood area/col. (64.25 & 64.38 in². /12days / col.) was recorded during faba bean blooming period.

Abd Al-Hady (2007) at Damietta, reported that the highest rate of drone brood rearing, for, was during spring season followed by winter, summer and autumn recording 56.63%, 34.05 %, 7.91% and 1.41%, respectively.

Shaheen, (2012) followed the activity of honey bee in drone brood rearing under north Sinai conditions. Who revealed that the major peak of this activity was recorded

during spring season in El- Arish (3.3inch² / colony). In addition and the lowest mean was in autumn season (0.1inch²/ colony).

Serag El-Dein, Amany, (2021) noticed in Kafr El-Sheikh region that the activity of colonies in rearing drone brood is nearly ceased during November and began slowly during December where it reached high levels throughout February,(132 ± 12.8 in²/ colony & 142± 8.2 in²/ colony) and March,(101± 7.2 in²/ colony & 108 ± 4.4 in²/ colony) during two successive years of study. She, also, stated that spring is the fruitful season for rearing drone brood by about 52.9% & 50 % then winter season by 27 % & 30.1% for the two studied years, respectively.

3- Queen cells construction

The activity of colonies in constructing queen cells at the three provinces appeared the same trend of drone brood rearing as shown in Table(3).

It indicated that, colonies located in Sheikh Zoweid built the highest mean number of queen cells, (11.8 queen cells/colony) than those located at Bir El-Abd, (3.7 queen cells/colony) and El-Arish,(0.4 queen cells/colony) with significant differences between the three provinces. Therefore, colonies located in Sheikh Zoweid region could increase about twice,(2.2 times) in queen production than those of Bir El-Abd, but by 28.5 times than colonies of El-Arish. On the other side, colonies of Bir El-Abd attained progression estimated by 8.3 times more than El-Arish.

Table 3. Mean number of reared queen cells at 21-day intervals within colonies established in three different of North Sinai governorate provinces

Season	Month	Bir El-Abd		EL-Arish		Sheikh Zowieid		Mean/ month	± SD	%
		Mean	± SD	Mean	± SD	Mean	± SD			
spring	Mar.	15.7	2.1	0.7	0.6	88.7	35.4	35.0	47.1	55.3
	Apr.	8.0	3.0	1.3	0.6	16.8	2.9	8.7	7.8	13.8
	May	6.0	3.0	2.3	1.5	3.4	1.4	3.9	1.9	6.2
Mean		9.9 B a	2.0	1.4 C a	0.8	36.3 A a	13.3	15.9 A**	18.2	75.2
Summer	Jun.	1.0	1.0	0	0	0.0	0.0	0.3	0.6	0.5
	Jul.	0.7	0.6	0.0	0.0	0.0	0.0	0.2	0.4	0.4
	Aug.	0.3	0.6	0.0	0.0	0.0	0.0	0.1	0.2	0.2
Mean		0.7 A c	0.6	0.0 A a	0.0	0.0 A c	0.0	0.2 C**	0.4	1.1
Autumn	Sep.	0.7	1.2	0.0	0.0	0.0	0.0	0.2	0.4	0.4
	Oct.	0.3	0.6	0.0	0.0	0.0	0.0	0.1	0.2	0.2
	Nov.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean		0.3 A c	0.6	0.0 A a	0.0	0.0 A c	0.0	0.1 C**	0.2	0.5
Winter	Dec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Jan.	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
	Feb.	11.7	5.9	0.3	0.6	32.1	14.4	14.7	16.1	23.2
Mean		3.9 B b	2.0	0.1 C a	0.2	10.7 A b	4.8	4.9 B**	5.4	23.2
Mean / province		3.7	1.2	0.4 C*	0.3	11.8 A*	4.5	5.3	5.8	100.0

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The major peak of the constructed queen cells was during spring season in colonies of Sheikh Zoweid, (36.3 queen cells/colony), Bir El-Abd,(9.9 queen cells/colony) and El-Arish,(1.4 queen cells/colony) with significant differences between them. The general mean number of built queen cells during spring season was 15.9 queen cells /colony represented 75.2 % of the yearly total queen cells. A few numbers of queen cells were only observed within colonies of Bir El-Abd during summer and autumn seasons. The mean number of constructed queen cells

during winter season, (4.9 queen cells /colony) represented 23.2 % of the yearly total queen cells.

It is, also, noticed that colonies strongly started in queen cells construction during February, (23.2 %) and reach its peak during March at Sheikh Zoweid and Bir El-Abd from one side and during May at El-Arish from the another one,(Table 3). Queen cells were completely disappeared from colonies located at Sheikh Zoweid and El-Arish during the period from June until January and from November to January at Bir El-Abd, (Table 3).

Similar data were recorded by Abd Al-Hady, (2007) at Damietta and Hamada,(2011), in El-Manzala region where no queen cells constructed in colonies from September- October till the end of December-January, then the colonies strongly started in building queen cells during February and still in their progression until reached its peak at May. Shaheen, (2012) in north Sinai region, stated that the numbers of queen cells were strongly noticed during April (2.0 cells/col.) in El-Arish. He indicated that, the major peak of this activity was occurred during spring season, after that no queen cells were found from July to February.

4 - Worker population

Results in Table (4) represented the worker population as number of combs covered with bees within colonies located at the tested provinces. Colonies of Sheikh Zoweid contained the highest population with 9.8 combs / colony, followed by those of Bir El-Abd, (7.9 combs /

colony) then EL-Arish,(6.3 combs / colony) with significant differences between them. Therefore, colonies of Sheikh Zoweid and Bir El-Abd contained population of adult workers higher than those of EL-Arish by 54 % and 25.4 %, respectively. On the other hand, colonies in each region contained the highest number of worker population during summer season registered 12.8 combs / colony ,9.4 combs / colony and 7.6 combs / colony for Sheikh Zoweid, Bir El-Abd and EL-Arish, respectively. The worker population in colonies of Sheikh Zoweid was significantly increased during autumn,(10.8 combs / colony) than during spring,(9.2 combs / colony). But colonies of Bir El-Abd and EL-Arish contained high worker population during spring,(8.7 combs / colony & 6,7 combs / colony) than during autumn,(7.9 combs / colony &6.3 combs / colony) , respectively. Winter season represented the least population of workers at all studied regions as shown in Table (4).

Table 4. Mean number of combs covered with bees at 21-day intervals within colonies established in three different provinces of North Sinai Governorate.

Season	Month	Bir El-Abd		EL-Arish		Sheikh Zowieid		Mean/month	± SD	%
		Mean	± SD	Mean	± SD	Mean	± SD			
spring	Mar.	7.7	0.3	6.0	0.4	7.7	0.3	7.1	1.0	7.4
	Apr.	8.7	0.6	6.7	0.6	9.0	0.0	8.1	1.3	8.5
	May	9.8	0.3	7.3	0.8	10.8	0.3	9.3	1.8	9.8
Mean		8.7 A b	0.2	6.7 B b	0.5	9.2 A c	0.2	8.2 B**	1.3	25.6
Summer	Jun.	8.7	0.5	7.5	0.5	12.3	0.6	9.8	2.5	10.2
	Jul.	8.5	0.5	7.8	0.8	13.0	0.4	9.8	2.8	10.2
	Aug.	8.3	0.3	7.7	0.6	13.0	0.0	10.0	2.9	10.4
Mean		9.4 B a	0.3	7.6 C a	0.6	12.8 A a	0.2	10.0 A**	2.6	31.2
Autumn	Sep.	8.2	0.3	7.7	0.4	12.6	0.1	9.7	2.7	10.1
	Oct.	6.7	0	6.2	0.3	10.8	0.3	8.3	2.6	8.7
	Nov.	5.2	0.5	5.1	0.4	8.9	0.1	7.0	2.2	7.3
Mean		7.9 B c	0.2	6.3 C b	0.3	10.8 A b	0.2	8.3 B**	2.3	26.1
Winter	Dec.	4.3	0.5	4.0	0.0	7.3	0.6	5.6	1.8	5.9
	Jan.	5.3	0.6	5.2	0.3	5.0	0.0	5.2	0.2	5.4
	Feb.	6	0.5	5.1	0.1	6.4	0.1	5.8	0.7	6.1
Mean		5.6 Bd	0.3	4.8 C c	0.1	6.3 A d	0.2	5.6 C**	0.8	17.2
Mean / province		7.9 B*	0.1	6.3 C*	0.4	9.8 A*	0.1	8.0	1.7	100.0

Similar capital letters in the same row do not significantly differ according to Duncan's Multiple Range test at 5% probability

Similar capital letters with one aster do not significantly differ according to Duncan's Multiple Range test at 5% probability

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Similar capital letters with two asters do not significantly differ according to Duncan's Multiple Range test at 5% probability

The obtained findings are in agreement with those found under the same circumstances by several researchers. El-Basiony, (2002a) at El Arish, determined the density of adult bees on the base of the number of combs that covered from both sides with adult workers and found that the general mean number was 5.94 ± 1.73 all over the year. The highest number of covered combs (7.6 combs/colony) was recorded during March and the lowest (6.2 combs /colony) was obtained during May. Abd Al-Hady (2007) reported that the rates of worker population during spring, summer, autumn and winter seasons were 37.64, 22.85, 16.69% and 22.82%, respectively. Hamada, (2011) revealed that the Carniolan honeybee colonies under the environmental conditions of Manzala region which characterized as an isolated area, Dakahlia Governorate had the highest mean numbers of combs covered with workers in spring season, (7.0 combs / colony with a range from 5.55-8.18 combs/colony). Summer season came next with a value of 6.18 combs /colony and a range of 5.55-6.68 /colony. On the other hand, winter

season indicated mean value of 4.48 /colony, with range of 3.77 to 5.36 / colony, whereas autumn season had the lowest mean value of 3.85 / colony with a range of 3.64 to 4.18/colony. Shaheen, (2012) recorded the highest worker population within carniolan colonies at El Arish during summer season by a mean value of 7.3 combs / colony of two studied years.

5 - Storing Pollen

Data arranged in Table (5) revealed that, the mean areas of stored pollen within colonies established at the three evaluated provinces during months and seasons of year 2019. Colonies of Sheikh Zoweid attained the highest rate of storing pollen, (206.5 in²/ colony), while those at EL-Arish,(89.4 in²/ colony) recorded the lowest significant ones. Colonies at Bir El-Abd stored intermediate pollen areas,(104.3 in²/ colony) between them. So, Sheikh Zoweid and Bir El-Abd regions could offer various sources of flowering plants enabled colonies to store quantities of pollen higher than colonies of EL-Arish by 2.31 times and 1.2 times, respectively.

Table 5. Mean amounts of stored pollen areas (in²) at 21-day intervals from colonies established in three different provinces of North Sinai Governorate

Season	Month	Bir El-Abd		EL-Arish		Sheikh Zowieid		Mean/month	± SD	%
		Mean	± SD	Mean	± SD	Mean	± SD			
spring	Mar.	88.7	19.1	68.3	32.1	161.7	37.9	106.2	49.1	6.6
	Apr.	106.0	40.7	134.2	50.3	266.7	80.8	168.9	85.8	10.6
	May	177.3	33.1	198.3	56.2	361.7	108.9	245.8	100.9	15.4
Mean		124.0Ba	6.5	133.6 B a	46.0	263.3 A a	102.6	173.7 A**	77.8	32.5
Summer	Jun.	117.7	109.3	130.3	20.7	372.5	187.3	206.8	143.6	12.9
	Jul.	145.7	36.7	130.0	45.8	313.3	179.5	196.3	101.6	12.3
	Aug.	332.7	19.7	115.0	36.1	263.3	156.7	237.0	111.2	14.8
Mean		98.7Ba	40.1	125.1 Bab	33.3	316.4 A a	173.5	213.4 A**	96.5	40.0
Autumn	Sep.	38.8	3.1	92.8	30.1	216.7	133.8	116.1	91.2	7.3
	Oct.	52.4	21.8	66.7	23.6	130.0	62.6	83.0	41.3	5.2
	Nov.	46.0	12.5	51.7	10.1	87.5	23.8	61.7	22.5	3.9
Mean		45.70 B b	6.9	70.4 B bc	19.5	144.7 A b	72.2	86.9 B**	51.5	16.3
Winter	Dec.	38.8	23.2	33.3	10.4	55.0	15.0	42.4	11.3	2.6
	Jan.	46.0	20.4	20.0	7.5	85.8	55.3	50.6	33.2	3.2
	Feb.	61.5	20.5	32.5	19.8	163.3	113.1	85.8	68.7	5.4
Mean		48.80 B b	12.9	28.6 B c	7.5	101.4 A b	60.1	59.6 B**	37.6	11.2
Mean / province		104.3B*	12.9	89.4 B*	10.6	206.5 A*	99.6	133.4	63.7	100.0

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Generally, colonies stored the highest areas of pollen during summer (213.4 in²/ colony which represented 40 % of total stored pollen) followed by spring (173.7 in²/ colony which represented 32.5 % of total stored pollen) with insignificant difference between them. The areas of stored pollen during autumn (86.9 in²/ colony, equal 16.3%) and winter (59.6 in²/ colony, equal 11.2%) were significantly less than those stored during summer and spring seasons.

However, the maximum peak of stored pollen relatively varied between the three regions as shown in Table (5). It was during June at Sheikh Zoweid, (372.5 in²/ colony), at August at Bir El-Abd, (332.7 in²/ colony) and during May at EL-Arish, (198.3 in²/ colony). On the other hand, least amounts of stored pollen were investigated during December for colonies at all tested regions.

In this respect, El-Basiony, (2002a&b) and Mahfouz, (2016) surveyed the sources of nectar and / or pollen at El-Arish and mentioned that more than 70% of them are blooming during spring season. So, this confirmed the present results for the highest area of stored pollen in colonies located at El-Arish province. Shaheen, (2012) found that colonies located at El-Arish stored the highest pollen area during spring in the first year of study and during summer in the second ones. He attributed this pattern in stored pollen to the change in the cultivated areas of various crops and late in opening flowers due unsuitable climatic factors that varied from period to period and from year to another. Under similar conditions at Damietta governorate Abd Al-Hady (2007) found that the highest amount of stored pollen was during summer season which significantly proceeded any other season representing 44.39% of the yearly stored pollen. Spring season came in the second category with 25.30%. The amount of stored pollen during autumn and winter seasons represented 17.48% & 12.83%, respectively. Serag El-Dein, Amany, (2021) noticed in Kafr El-Sheikh region that the highest peak of stored pollen in colonies provided with different treatments of sugar feeding was recorded during spring, while the minimum areas were during autumn season.

6 - Honey production

Data in Table (6) appeared that the three regions differed significantly from each other. The highest mean amounts of net gained honey were from colonies established in Bir El-Abd, (40.0 & 45.8 kg./colony) and Sheikh Zoweid, (43.3 & 47.5 kg./colony) with no significant difference between them during the two years, respectively. The lowest yield of honey was recorded in EL-Arish, (10.6 & 9.7 kg./colony) during the two years, respectively.

Results in Table (6) revealed, also, that honey could be gain four times throughout the year from colonies of Sheikh Zoweid and Bir El-Abd. The first extraction occurred during April, the second during May- June, the third during July- August and the fourth during September - October. The mean yearly total honey yields for the two previous regions were 45.4 kg. / colony and 42.9 kg. / colony, respectively. However, at El-Arish, only two weak honey gains were recorded, (the first during May-June and the second during July- August) and attained 10.1 kg. / colony as a mean yearly total honey yield.

Therefore, colonies at Sheikh Zoweid and Bir El-Abd superior those at El-Arish by about 4.5 and 4.3 times in honey production, respectively.

The present results of colonies at El-Arish are coincided with those found by El-Basiony, (2002a) at the same province where the highest numbers of honey combs per colony, (3.8 combs) registered during June while the lowest ones, (2.6 combs) was during May. Also, Shaheen, (2012) at the same region gained two extractions of honey, (the 1st. during May and the 2nd. during August) with a yearly total mean of 6.6 kg. / colony.

It could be concluded that Bir El-Abd and Sheikh Zoweid are food sources-rich areas enable honeybee colonies to collect high amounts of pollen and nectar which enhancing the rearing activity, caring and producing great amounts of worker brood. Consequently, the colony worker population, foraging force, worker life span and the net income of honey per bee will significantly increase, (Woyke, 1984; Harbo, 1986; Szabo and Lefkovetch, 1989; Gene and Aksoy, 1993; Abd Al- Fattah, *et. al.*, 2010; Taha

and Al-Kahtani, 2013 and Abd Al- Fattah, *et. al.*, 2021). So, colonies located at the two mentioned provinces had potential to gather great quantities of nectar and produce surplus amounts of honey than El-Arish region.

Therefore, it could be concluded that Bir El-Abd and Shiekh Zoweid provinces are more suitable for establishing and spreading honeybee colonies through sustainable beekeeping programs in the new reclaimed lands. This may be due to the large cultivated areas of different nectar and /or plant sources in Sheikh Zoweid (

especially citrus about 1500 fedden and sage 35 feddan), and Bir El-Abd (citrus about 1000 fedden and sage 30 fedden) than EL- Arish.

Concerning the mentioned results, it could, also, concluded that Bir El-Abd and Shiekh Zoweid were more suitable for rearing and propagating honeybee colonies than EL- Arish. In addition, the two regions could be used in rearing and mating pure honeybee queens as new isolated areas located far away from other regions within the Egyptian country.

Table 6. Total and Mean amounts of honey yield harvested from honeybee colonies located at three different provinces under the environmental conditions of North Sinai during two successive years, (2019 and 2020)

Harvesting period	Bir El-Abd		EL-Arish		Sheikh Zowieid		Date	
	Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD
Year (2019)								
Apr.	14.9	3.9	0.0	0.0	14.2	3.5	9.7	7.7
May/Jun.	10.4	3.4	6.3	3.0	7.3	1.3	8.0	3.0
Jul./Aug.	10.8	3.4	4.3	2.5	11.2	0.6	8.8	4.0
Sep./Oct.	8.8	3.5	0.0	0.0	10.6	3.8	6.5	5.6
Total/Province	44.8	14.1	10.6	5.6	43.4	8.8	32.9	18.9
Mean/Province	11.2	3.5	2.7	1.4	10.8	2.2	8.2	4.7
Year (2020)								
Apr.	15.8	3.1	0.0	0.0	14.3	2.9	10.0	7.8
May/Jun.	8.3	1.9	4.0	1.5	11.8	4.3	8.1	4.2
Jul./Aug.	13.2	2.1	5.6	0.6	13.1	4.4	10.6	4.5
Sep./Oct.	8.4	1.8	0.0	0.0	8.2	3.0	5.6	4.5
Total/Province	45.8	8.8	9.7	2.1	47.5	14.5	34.3	20.4
Mean/Province	11.4	2.2	2.4	0.5	11.9	3.6	8.6	5.1

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تربية النحل المستدامة في منطقة شمال سيناء من خلال رصد الأنشطة البيولوجية والإنتاجية لطوائف نحل العسل في منطقتي بئر العبد والشيخ زويد مقارنة بالعريش حاتم محمد محفوظ

قسم الإنتاج النباتي، كلية العلوم الزراعية البيئية، جامعة العريش، 45511، مصر

تم تقييم مدى ملاءمة المراكز الثلاث الكبرى (بئر العبد والعريش والشيخ زويد) بمحافظة شمال سيناء لأنشطة وتكاثر طوائف نحل العسل لمدة عامين متتاليين (2019 و 2020). حققت الطوائف في منطقتي الشيخ زويد وبئر العبد تقدماً ملحوظاً في جميع الأنشطة البيولوجية والإنتاجية المقيمة مقارنة بتلك التي تم تقييمها في العريش. كانت المعدلات أو النسب المنوية للزيادة في القيم المتوسطة لعامين مجتمعين للأنشطة المختلفة 65.3% و 48.7% في إنتاج حضنة الشغالات. 183.1% و 136.8% في إنتاج حضنة الذكور؛ و 28.5 و 8.3 مرة في بناء الكؤوس الملكية؛ 54% و 25.4% من عدد الشغالات البالغة؛ 2.3 مرة و 1.2 مرة في كمية حبوب اللقاح المخزنة و 4.5 مرات و 4.3 مرة في إنتاج العسل للطوائف الموجودة في الشيخ زويد وبئر العبد مقارنة بالعريش على التوالي. لذلك، تفوق مركزي الشيخ زويد وبئر العبد في الأنشطة البيولوجية والإنتاجية في طوائف نحل العسل مقارنة بمركز العريش ويمكن تضمينهما في برامج تربية النحل المستدامة في مصر.