

ORIGINAL ARTICLES

Wintering of Honeybee Colonies (*Apis mellifera* L.) by Using a New Technique During Winter Season in Sohag Region, Egypt.

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ABSTRACT

This work was conducted in Plant Protection Dept., Faculty of Agriculture, Sohag University during 2008/2009 and 2009/2010. This study aimed to increase the activities of honey bee colonies in winter season, to maintain the strength of colonies and production of packages to take greater than normal in the early spring and increase the density of bees to production citrus honey early during spring and Queen rearing during the recession season, depend on the design of the new device, using with Electric-powered containing structured organizer to adjust the temperature inside the bee hive. Through this study, I could record the temperature of the bee hive in the free part of the combs and bees in the winter season, recorded the lowest temperature of the outer edge of cluster was reached to 20.9 and 21°C in Jan. during two season, respectively. The percentage of honey area when using, UN wintering (UNW), Normal wintering (NW) and Heat Device (HD) groups were 9.20%, 18.31% and 72.48% during first season, while in the second season were 3.77%, 10.70%, and 84.27%, respectively. Percentage of pollen area when using (UNW), (NW), and (HD) were 12.50%, 28.39% and 59.27% during first season, respectively, while in the second season were 11.08%, 25.34% and 63.57% respectively. The percentage of sealed brood area were 11.66%, 33.39% and 54.93%, respectively, while in the second season were 11%, 21.06%, and 67.93% and bee population were 27.34%, 36.07% and 36.57% in the first season, while in the second season were 17.84%, 29.57% and 52.57%, respectively. Bee population were 27.34%, 36.07% and 36.57%, when using UNW, NW and HD during first season, respectively, while in the second season were 17.84 %, 29.57% and 52.57%, respectively. When using heating device appeared significant increase in honey area, pollen area, sealed brood and bee population.

Key words: wintering of honey bee colonies, heat device, electric-powered, new technique

Introduction

In many countries of the world, there have been many attempts to reduce the loss of honey bee colonies in winter, by improving the conditions of temperature inside the bee colonies, such as: Büdel, 1968, Owens, 1971, Villumstad, 1974, Detroy *et al.*, 1982, Anderson, *et al.*, 1983, Furgala, and McCutcheon, 1992, Abrol, 2001, Wineman *et al.*, 2003, Cetin, 2004, Dodologlu, *et al.*, 2004 and Erdogan, *et al.*, 2009. It attempts to isolate the impact of cells on the temperature inside the colony, and reduce consumption of honey within the colonies due to the low temperature inside the hive from about 21 to 25%, Detroy *et al.*, 1982, to up to 43% (Himmer, 1926). Some researchers have made a proposal heating bee colonies using solar energy: Morse (1999), recommended keeping bee colonies in the Northern U.S. during the winter in dark-painted hives and exposed to full sunlight, but provided no experimental data to indicate any beneficial effect of such a treatment indeed, one of the most debated and controversial topics of beekeeping in recent times has been that of the choice of the most desirable methods for wintering of bees in cold climates (Detroy *et al.*, 1982). A major part of world honey and queen production is located in the subtropical zone (latitudes 23.5-34). It represents nearly a quarter of the earth's land surface where plants grow (Southern United States, Northern Mexico, Southern Australia, Northern Argentina and South Africa). In subtropical climates the day length changes less than in temperate zones and winters are milder. Hence, workers are foraging and queens are laying eggs almost year-round. In these regions, nectariferous plants supply nectar and pollen throughout the year and support a major part of the world honey and honey bee queen industry (Crane, 1990).

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The weather is very cold at night and hot during the day in Sohag region. The importance of the beekeeping in Egypt is particular, through bee products multiple, and increasing yield many crops that need bees in the completion of pollination, and also contributes directly to solve the problem of unemployment in many young graduates of both sexes working in beekeeping or work in the marketing of bee products. In the past twenty years, notes the existence of a significant decline in this sector, it became clear through the feasibility study on the feasibility of this projects. And direct contact, with many of the beekeepers and visit many of the apiaries in the region to identify the most important problems facing beekeepers. It became clear that there are problems all contribute to a nested directly or indirectly in the degradation of the apiaries and decrease in the productivity of the colonies. Of the most important of these factors, especially at the end of the summer and early autumn, after harvest dates are hives a fierce attack from the oriental hornet and exposed his bee colonies from diseases that were not typical of beekeepers, which led to the colonies is not good health and loss occurs for many of the colonies can not be out of winter. Cold night followed by diurnal heat, which prevents the bees outside the hives for search of food, leading to the weakness of the colonies. Besides the cost price of sugar, which is used to feed bees, some beekeepers provide to the hive about 18 kg sugar per year, which raises the cost of operating the one hand and on the other hand increases the prices of products. However, there is no data on the effect of increasing temperature inside bee hives during the winter and its correlation with honey production, loss of many bee colonies and the remaining colonies. Affected by low temperature in winter, particularly the temperature of night, specifically in the desert areas during the winter temperatures drop significantly by night, and therefore can not be spend the winter successfully. It is known that the temperature of the colony of bees inside the cluster of between 32: 34 ° C, due to the weakness of colonies of bees in the winter, leaving a large part of the hive without bee combs covered with bees from both sides. At the low temperatures at night in winter, observed worker bees out of their hives late near the end of the first third of the day when the brightness of the sun and the warmth of the day. From here originated the idea of measuring the temperature in the hive of bees part that is free of the hive and outer edge of the cluster in the winter night and day to find out their impact on the activities of the colony, during the study and after knowing the hive temperature outer edge of the cluster and their impact on the activities of honeybee colonies.

From objectives of this study are to design a special device used in wintering of honey bee colonies and effects on: hive temperature, sealed brood, stored food and colony population inside the hives.

Materials and methods

The investigated carried out in experimental apiary Faculty of Agriculture, Sohag University during two successive seasons 2008 / 2009 & 2009/2010.

This paper was divided into three axes:

I. Device design of power heating technique for bee colonies:

Description of device: Fig.(1) a central unit working through an orderly purpose of controlling the temperature of the hive in the empty part to adjust the temperature of the hive up to 35 ° C, and electricity passed through the electric wire 2 ml., with working to link the central unit with sub-units. Design of the device in order to stop automatically by regular manner, when the temperature are high or low then the degree for the device before the driver of the main unit in device and three sub-units, sub-units stop when it stops the main unit. Activities were compared for the colonies when using of a device , in the case leaving the colonies without any wintering and using normal wintering which applied by beekeepers in the region. When the location of apiaries are far from the source of electricity should be collected the colonies at the end of active season and transfer to a place near the source of electricity. Record the activities of the experimental colonies which the device installed in it and compared to colonies that do not any method or ant technique of wintering and the colonies which have been applied normal wintering using by beekeepers in the search region.

ii. The Temperature Recording in Outer Edge of Cluster Inside Bee Hives During Winter:

A total of nine colonies of honey bees (hybrid carniolan) were selected and used in the present study, these colonies were equal in the strength, food stocks, queen's age (about 8 months old) and each colony contains 6 combs covered with bees, the colonies divided into three groups as follows: (NW) Normal wintering group, (HD) Head device group and (UNW) Un wintering control group. and each group consisted three colonies.

After selected the colonies, the temperature were measured of the hives when using normal wintering (NW) in the free part of the bees located in the edge of the combs covered with bees, using Thermo-hydrometer (model: 303 C clock indoor/outdoor), the temperature was measured during the diurnal, and calculated the averages of three readings, the first, mid and the end of the day. This work was conducted onset of winter, every 12 days.

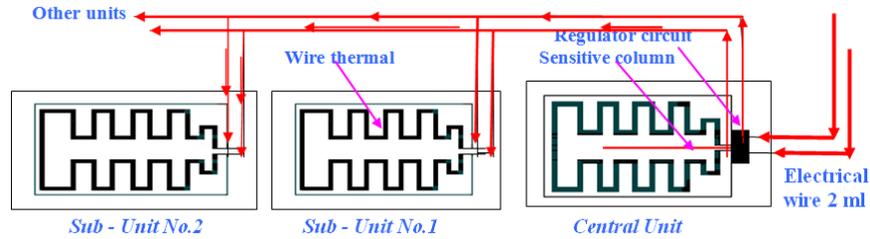


Fig. 1: Heat Device (HD).

Values of percentage were calculated as follows:-

$$\text{Values of percentage} = \frac{\text{Resulted from treatment}}{\Sigma (\text{UNW} + \text{NW} + \text{HD})} \times 100$$

UNW= UN wintering NW= Normal wintering HD = Heat device

III. Activities of Honeybee Colonies: Food Stores (Honey, Pollen), Brood Rearing and Bee Population:

1. Areas of stored food: - surplus sealed honey, and stored pollen or bee bread, in sq. inch., was measured, for experimental colonies, using a standard frame divided into square inches, during winter 2008/2009 and 2009/2010 seasons in Sohag region. Average area of food stores/ colony was estimated and monthly activity of storing food was calculated.
2. Brood rearing activity: - they were measured every 12 days, and conducted monthly average. The areas of sealed workers cells (in sq. inch.) in each of the inspected colonies, were measured by using standard frame divided into square inches (Fresnaye and Lensky, 1961). This procedure was carried out through winter 2008/2009 and 2009/2010 seasons.
3. Bee population: - number of combs covered with bees from both sides were counted, during 2008/2009 and 2009/2010 seasons in all colonies under investigation in Sohag region. Bees or adult population was estimated in the rate of 2000 adult bees which can cover a comb from both sides (Hauser and Lensky, 1994).

This work was conducted onset of winter season. At the same time, some activities were log by honey bees colonies such as activities, food stocks (Honey - pollen), the area of sealed brood per square inch and the population of bees, every 12 days throughout the winter season.

IV. Data analysis:

After measuring the activity of colonies were calculated the correlation factor (r), as the relationship between the temperature of the outer edge of cluster (in the part that is free of bees) and activities of honey bee colonies have been recorded, and interaction.

Statistical analysis between the three treatments UN wintering hives, Normal wintering hives and Heat device with hive activity under studying was valued by least significance difference (LSD) when significant differences between treatments.

Results and discussion

Effect of the Degree of Temperature in Outer Edge of Cluster During Winter Season on Activities of Honey Bee Colony Through Normal Wintering:

The presented data in Table (1) shows the degree of temperature of the outer edge of the cluster inside the hive during the day through the winter season every twelve days and some activities of honey bee colony,

stored food (Honey area - Pollen area), sealed brood area and bee population. When used natural wintering by beekeepers in the region (raise the combs in excess of the need for the colony, with a piece of sackcloth over the combs). This cover keeps water resulting from the evaporation process of the hive, causing the water problems, such as lowering the temperature of the colony, the colony also get fungal diseases, have an impact on the activities of the colony and thus a great destruction in the colonies within the apiary, as well as the colonies graduated from winter in case of severe weakness. It appears clear from the results obtained by a decrease of apparent in temperature at the outer edge of the cluster. Have an impact on the activities of the colony and thus a great destruction in the colonies within the apiary, as well as the colonies graduated from winter in case of severe weakness. Temperature ranged from 20 to 27 °C in the first season while in the second season was 21 to 29 °C. Also from the obtained results, the data clear that the temperature at the outer edge of the cluster less than the temperature of cluster by the range of 5 to 12 degrees and 3 to 11 degrees during the first and second season respectively (Tables1,2). The lowest temperature was recorded inside the hive in the edge of the clusters in the wintering day; the lower degree of temperature was recorded in January month. Which leads to consumption of stored honey, as well as less brood area and less bee population during the first season (Table1), and the data in table 2 in the second season confirms the same results. The data in the same table indicated that the temperature of the outer edge of cluster had an impact clear on the activity of the colony. In general, I can say that in the winter season during the wintering and storage combs, this process leads to empty part of the combs and bees in the outer edge of the cluster, the temperature of the part that is free of bees close to the temperature outside the hive.

Table 1: Average temp. °C through the diurnal in outer edge of cluster during winter season and some activities of honey bee colonies in Sohag region during the first season (2008/ 2009).

Date	Temp. in outer edge of cluster	Honey area	Pollen area	Sealed brood	Bee population
1/12/2008	27.6	33.6	55	140	12970
12	25.9	21	35.3	90	10540.6
24	26	18	30	70.6	9200
Total	--	72.6	120.3	250.6	31810.6
Mean	--	24.2	40.1	183.5	9603.5
5/1/2009	22.3	16.3	20	99	6725
17	20.9	16	21.6	100.3	7000
29	23	19	22	98	6420.6
Total	--	51.3	63.6	297.3	20145.6
Mean	--	17.1	21.2	99.1	6715.2
10/2/2009	25	23	13	116	7840.3
22	24.3	22	17.3	100.3	7125.6
Total	--	45	30.3	216.3	14965.9
Mean	--	22.5	15.15	108.15	7482.95
6/3/2009	26.6	23.6	70	277	7740
18	27	26.3	72	283.3	7940.3
30	27.3	27.3	98.6	286	8740
Total	--	77.2	240.6	846.3	24420.3
Mean	--	25.7	80.2	282.1	8140.1

Table 2: Average temp. °C through the diurnal in outer edge of cluster during winter season and some activities of honey bee colonies in Sohag region during the second season (2009/2010).

Date	Temp. in outer edge of cluster	Honey area	Pollen area	Sealed brood	Bee population
1/12/2009	29	74.3	63	139.6	12150
12	26.3	43	20	123	8000
24	25.3	40.6	10.3	90.6	7500
Total	--	157.9	93.3	353.2	27650
Mean	--	52.6	31.1	117.7	9216.6
5/1/2010	21	22	22	32.3	7420
17	23.6	26	32	30	7000
29	24.3	26	24.6	22.6	7800
Total	--	74	78.6	84.9	22220
Mean	--	24.6	26.2	28.3	7406.6
10/2/2010	23.3	22.6	25	120	8015
22	22.6	16.6	13.3	119.2	7810
Total	--	39.2	38.3	239.2	15825
Mean	--	19.6	19.15	119.6	7912.5
5/3/2010	26	28.3	33	258	8000
17	28	60	56	300	11000
29	29	68	64	324	11000
Total	--	156.3	153	882	30000
Mean	--	74.3	63	139.6	12150

Using Heat Device Technique in the Honey Bee Colony:

No risk of the wintered colonies when uses of this device. Where the hate device is turned in times of low air temperature, in the night, from 8 pm to 6 am in the next day, and a stop during the afternoon when the temperature is higher. The designer was economic in the consumption of electricity, because operating the temperature at which the device is set was not high (35 degrees). The periods of the device operate works has been recorded, and estimated at ten hours a day, the work of the device during that period was hour and one-third only and the difference in the period operate of the device, it is separates. Period of operating of the device in one hour was only 8 minutes. The actual periods to operate of the device in the day were 80 minutes. Is not specified, during this research did not specify the device from electricity consumption in real, but the wire thermal power user 2-volt only.

Table 3: The correlation (r) between hive temperature in outer edge of the cluster and honey area, pollen area, sealed brood area and bee population inside bee colony and interaction through winter months during two seasons 2008/2009 and 2009/2010 in Sohag region

Variable	Honey area	Pollen area	Sealed brood	Bee population
Temp.	0.925**	0.788**	0.722*	0.839**
Honey area	---	0.707**	0.588	0.889**
Pollen area	---	---	0.771**	0.439
Sealed brood	---	---	---	0.187

3. The Relationship Between the Temperature (°C) in Ouster's Edge of Cluster and Activities of Honey Bee Colonies:

Data in Table 3 show the relationship between temperature in outer edge of the cluster and some activities of honey bee colony (honey area, pollen area, sealed brood and bee population) during two seasons. Through this relationship found that a significant correlation between high temperature and food stocks of honey, also found a correlation between temperature in outer edge of the cluster and each of the area of pollen stored, sealed brood area, and the bee population within the colony, the correlation factor was 0.925**, 0.788**, 0.722* and 0.839** between temperature in outer edges of the cluster and honey area, pollen area, sealed brood and bee population inside the bee hive during winter through the two experimental seasons, respectively.

From the above results, I can conclude that, the temperature in winter season was very necessary of the bee cluster inside the bee colony because, the workers of the honey bee should be foraging in order to spend the winter period. The temperature in outer edge of the clusters have a direct factor on activities of the colony in the winter season, Impact could be first on the food stocks of honey and pollen, also stock food affect the activity in the colony brood rearing, brood rearing in turn affect the number of individuals of the honey bee colony.

On the other side of the study was possible to determine the relationship between the honey area and pollen area as a food stores within the bee colony, as well as illustrated in Table (3), where they found that the value of the correlation between the stored honey area within the colony and each of the area of pollen, area of sealed brood and bee population within the colony was $r = 0.707^{**}$, 0.588 and 0.889** respectively, from same table the data also cleared that, the correlation between pollen areas and each of sealed brood and bee population within the bee colony were $r = 0.771^{**}$ and 0.439 respectively, and same correlation between sealed brood and bee population was $r = 0.187$. From these results, it showed that there was a correlation ranged between significant and highly significant between the degree of temperature at the outer edge of the cluster and the activities of honey bee colonies under study. The study also showed that there was a highly correlation between honey area and pollen area, as well as, a honey area and bee population, found correlation and high significant between pollen and sealed brood areas and only significant with pollen area and bee population, during winter through two seasons.

4. Effectiveness Heat Device on Activities of Honey Bee Colony:

The presented data in Table 4 and Figs. 2, 3, 4 and 5 showed that, there were clear differences in the area of food stocks of honey and pollen in the honey bee colony in three successive months (January, February and March) were 18.31, 72.48 and 9.20 % during first season when using normal wintering, heat device and control treatment, respectively, while for the second season were 10.70, 84.27 and 3.77 %, respectively. However, when I use of modern technology (heat device), the differences in the percentage between them and the other treatments (control treatment and normal wintering) in honey area, were 54.17 %, 73.57 %, pollen area were 40.96% and 38.23%, sealed brood area were 21.54 % and 46.87% and bee population has were 0.50 % and 23% during two seasons respectively. The results during the second season confirmed that results in the first

season. Through the results show that there was no significant difference in all of the area of honey and pollen stored inside the hive during the December month in the two years of the study, These results were very logical as it is during December, This is due to more of the factors, first factor because the food stocks of honey and pollen is already inside the hives from autumn season, and the second factor that was the air temperature in the beginning of autumn, Therefore, the results were not significant during December month in the first year of study and the results in the second year was this confirm. While the activity of honey bee colony in rearing sealed workers brood (in sq inch /colony), the colonies which used the industrial heating using a new technique of wintering gave the largest area in the rearing brood area, and the differences were significant in all winter months except December month, the differences were not significant when using the normal wintering which used by beekeepers and heating using a new hot, and the reason is due to the bees in the normal wintering making a high effort to generate and keeping it from the loss, and bee population in Sohag region during the normal wintering , using heat device (artificial heating) and un wintering hive (Control) during two seasons 2008/2009 & 2009/2010.

Table 4: Food stores (honey and pollen areas), sealed brood area (in sq inch /colony) and bee population in Sohag region during the normal wintering, heat device (industrial heating) and un wintering hives during two seasons (2008/2009 & 2009/2010).

Activity	Treatment	Dec.				Jan.			
		2008	%	2009	%	2009	%	2010	%
Honey area	UNW	20.00	28.98	30.30	20.25	4.00	4.62	0.00	0.00
	NW	24.20	34.78	52.60	35.16	17.10	19.76	24.60	26.97
	HD	25.00	36.23	66.70	44.58	65.40	75.60	66.60	73.02
	L.S.D	NS	--	NS	--	14.97	--	20.63	--
Pollen area	UNW	34.00	27.61	11.00	13.31	7.00	9.51	8.00	7.23
	NW	40.10	32.57	31.10	37.65	21.20	28.83	26.2	24.06
	HD	49.00	39.80	49.50	59.92	45.33	61.64	76.00	68.70
	L.S.D	NS	--	NS	--	19.38	--	12.62	--
Sealed brood area	UNW	172.00	31.49	116.00	31.12	14.00	4.87	9.70	4.25
	NW	183.50	33.59	117.70	31.58	99.10	34.50	28.3	12.41
	HD	190.66	34.90	139.00	37.29	174.10	60.61	191.00	83.77
	L.S.D	NS	--	75.25	--	68.99	--	51.83	--
Bee population	UNW	9107.00	31.66	7861.60	26.72	5256.90	25.34	4660.00	19.18
	NW	9603.50	33.38	9216.60	31.33	6715.20	32.37	7406.60	30.48
	HD	10053.6	34.95	12338.6	41.94	8770.20	42.28	12226.6	50.32
	L.S.D	NS	--	2357.87	--	1965.78	--	1990.98	--

Feb.		Mar.		%	
2009	%	2010	%	2009	%
9.00	7.29	10.00	7.25	12.00	5.72
22.50	18.23	19.60	12.03	25.70	12.25
91.90	74.47	108.33	78.53	172.00	82.02
42.93	--	29.57	--	35.95	--
6.00	6.48	12.00	10.76	22.00	8.34
15.15	16.38	19.15	17.17	80.20	30.43
71.33	77.13	80.33	72.05	161.33	61.21
24.85	--	16.86	--	50.65	--
6.00	1.59	12.00	2.34	43.00	5.34
108.15	28.68	119.60	23.36	282.10	35.06
263.00	69.76	380.33	74.29	479.00	59.54
130.85	--	85.41	--	79.67	--
4925.00	17.88	4615.00	15.22	4930.00	16.88
7482.95	27.17	7912.50	26.09	8140.10	27.88
15126.3	54.93	17790.0	58.67	16120.00	55.22
2131.80	--	2695.56	--	2343.33	--

UNW = UN Wintering NW = Normal Wintering. HD = Heat Device. % = Result from any treatment / \sum (UNW + NW + HD) \times 100 LSD = Least significant difference with .05% NS = no significant.

Studies have showed that the temperature inside un isolated wooden bee hives differs little from ambient temperature (Owens, 1971), Heinrich (1993) reported that there some temperature effects on honeybees and the bees activity to control temperature in bee hive. The brood area growth activity was higher when using heat device than those of other groups. This result is similar to the results obtained by Gene *et al.*, (1999). The results of average brood area activities in current study are higher than the results reported by numerous researchers (Guler and Kaftanoglu, (1999), Karacaoglu *et al.*, (2003). The highest pollen area was found when using heat device. However , this finding are higher than he results obtained by Dodologlu and Gene (2002) The result of bee population when using heat device was found higher than previous carried out by different researchers (Guler, 2000; Dodologlu *et al.*, 2004).

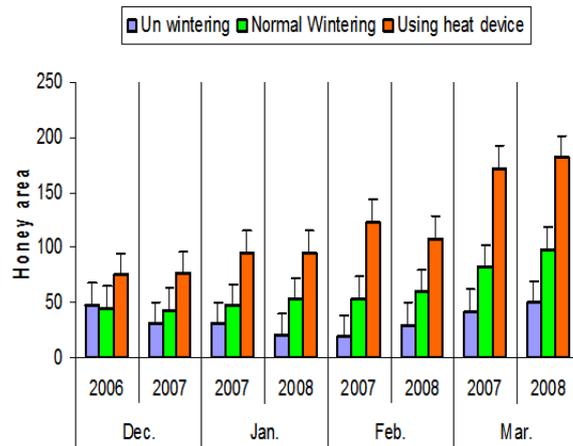


Fig.2: Effect of wintering type on honey area

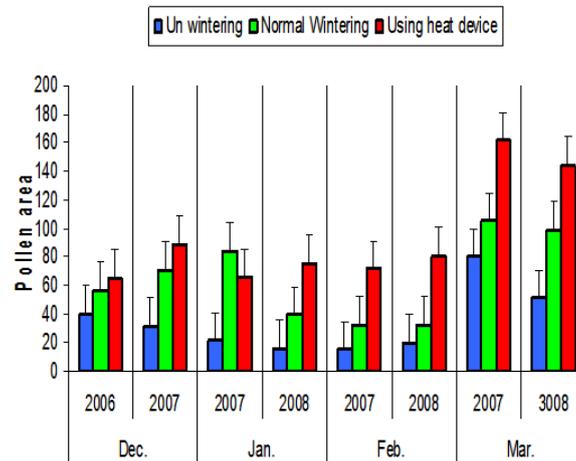


Fig. 3: Effect of wintering type on pollen area

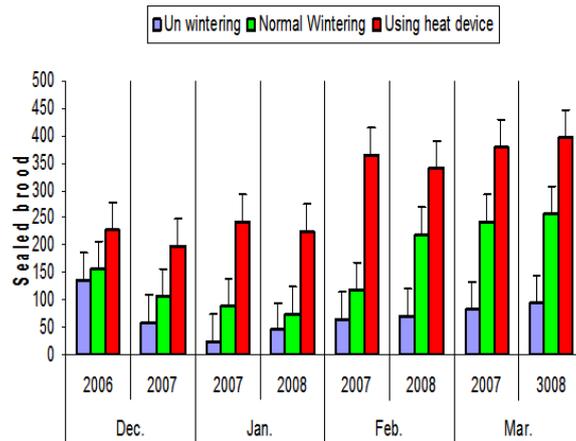


Fig. 4: Effect of wintering type on sealed brood

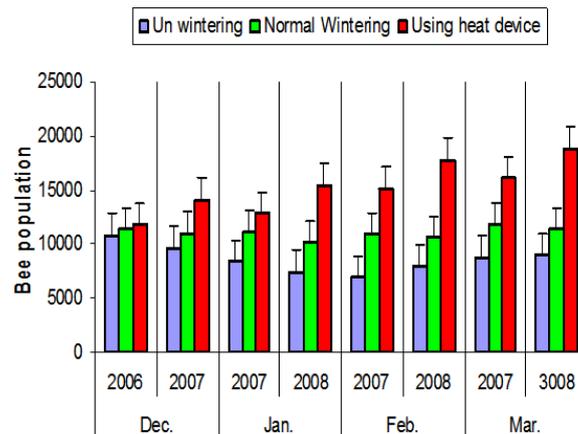


Fig. 5: Effect of wintering type on bee population

Recommendation:

The present study may send a clear message saying that a good knowledge about wintering of honey bee colonies by using a new technique (heat device) during winter season, is the ideal manner for the scientific and practitioners to dealing with the honeybee colonies, existed in areas which their low temperatures during winter to get a lot of benefits for these colonies and everyone who deals with it. Taking into consideration the fluctuations that have occurred in recent years in the temperature of the high and low, and the bees from being exposed to diseases, can not be ignored this danger, and therefore has no place here for apiaries random, but must follow the modern techniques in the various processes, Including the wintering.

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