EVALUATION OF THE RELATIVE EFFICACY OF DIFFERENT ACARICIDES AGAINST *VARROA DESTRUCTOR* ON *APIS MELLIFERA CARNICA*

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ABSTRACT

The effectiveness of five acaricides; Apistan, Bayvarol, Apivar, Perizine and Bee Strips against *Varroa Destructor* was evaluated during three successive seasons (October – December, 2003 , 2004 and 2005). During 1st season, Apistan, Bayvarol (2-Strips), Bayvarol (4-Strips) and Apivar were compared where the Bayvarol (4-Strips) showed the maximum efficacy level (96%), followed by Apivar (95%) and 2 Strips of Bayvarol (89%), while Apistan remained at minimum level (85%). During 2nd season, Apistan, 4 strips of Bayvarol, Apivar and Perizin were evaluated. Apivar presented the maximum efficacy (95%), followed by Perzine (94%), whereas the Apistan and Bayvarol (4-strips) showed 80%. During the 3rd season, Apistan, Bayvarol (4-strips), Apivar and Bee Strips were compared where the Bee strips presented the highest efficacy (95%), followed by Apivar (92%) and 4 strips of Bayvarol (70%), whereas the efficacy level of Apistan further reduced to 60%. The results revealed a decline in the efficacy of Apistan and Bayvarol, which was attributed to the development of resistance in *Varroa Destructor* against fluvalinate and flumethrin, while the Apivar was proved still most effective acaricide. The Perizine and Bee strips were also proved very effective for *Varroa* control.

KEY WORDS: *Varroa Destructor, Varroa jacobsoni,* Apistan, Bayvarol, Apivar, Perizine , Bee Strips, acaricides, *Apis mellifera carnica*, chemical control.

INTRODUCTION

The ectoparasitic mite, *Varroa Destructor* is considered the most serious global threat to beekeeping industry (**DeJong *et al.*** 1990 and **Matheson,** 1995). In Saudi Arabia, *Varroa* mite was traced in most of the beekeeping parts in 1989 and was proved as a major devastating pest of honeybee (**Al Ghamdi**, 1991). Beside the other deleterious effects on the host, the mite increased the incidence of honeybee diseases because it also acts as vector of some honeybee pathogens (**Ball**, 1994) and eventually the unmanaged mites invaded colonies usually parish within four years after infestation (**Ritter**, 1981).

The chemical control of *Varroa Destructor* is being practiced worldwide. In Saudi Arabia, the only registered product is Apistan but the beekeepers use a variety of acaricide such as Flumethrin, Apivar and Perizine etc.

Beside great acaricides effectiveness, their indiscriminate use together with inadequate application produced a reduction in effectiveness, especially concerning mite produced resistance (**Milani,** 1995). Subsequently, higher concentration of acaricide are used in an effort to combat resistance, which results in increased residues and a greater likelihood of harming the bees themselves (**Slabezki *et al.***, 1991 and **Lodesani *et al.***, 1995).

Efficacy of Apistan is generally high (**Milani and Barbattini**, 1989; **De Ruijter and Eijnde**, 1990 and **Hillesheim *et al.,*** 1996). However, recently mites have developed resistance to Apistan in some countries such as Italy (**Lodesani *et al.***, 1995) and USA (**Sanford,** 1998). Flumethrin; the active ingredient of Bayvarol, specific for *Varroa* control is under registration process in Saudi Arabia and has good efficacy against *Varroa* mites (**Ferrer- Dufol *et al.***, 1995).

Apivar strips measuring 20 x 4x 0.2cm containing 5g of Amitraz, is a new product under registration process in Saudi Arabia and is commonly practiced in France. **Richer *et al.*** (1999)

performed three multicentre clinical studies during spring and winter in France to evaluate the therapeutic properties of Apivar in the treatment of varroasis. The percentage efficacy of the treatment showed a curative action of at least 99% for Apivar in all studies.

The aim of the present study is to evaluate the relative efficacy of different acaricide administered in controlling the *Varroa* mite in Saudi Arabia.

MATERIAL AND METHODS

The experiment was designed to carry out in three consecutive years (2003, 2004 and 2005) with 25 -*Apis mellifera carnica* colonies for each year under Saudi Arabia (Riyadh) conditions. The treatments were applied during the period from Uctober to December, after the honey flow when honeybees were active and sealed brood was present.

First Season (2003):

The hives were arranged at random into five groups (A, B, C, D and E). Each colony of group 'A' received two Apistan (Sandoz) strips which are consisted of polyvinyl chloride strip (PVC) impregnated with fluvalinate. One strip (250 x 30 x 1 mm) contains 10% fluvalinate. Each colony in the designated group was treated with two strips in the brood nest hung between frame 3 and 4, and between frame 7 and 8. Apistan strips were kept in the hives for 60-days. Colonies of group 'B' received 4 strips of Bayvarol, each containing 3.6 mg of flumethrin. The treatment duration as recommended on the label should be at least four but not more than eight weeks. So it was used for 45-days. Colonies of group 'C' received 2 strips of Bayvarol. Colonies of group 'D' each received two strips of Apivar measuring 20 x 4x 0.2 cm, containing 5g of Amitraz, produced by Laboratories Apivar. The treatment duration was 6 weeks as recommended in the label. Colonies of group 'E' were left as control without any acaricide treatment.

Second Season (2004):

Each colony of group 'A' received two Apistan (Sandoz) strips. Colonies of group 'B' received 4 strips of Bayvarol. Colonies of group 'C' received Perizin (1 ml solution contains 32mg O, O-diethyl-O"-(3-chloro-4-methy-7-cumarimyl) thiophosphate). Perizin was applied after preparing a ready to use emulsion, 50ml to each colony. Colonies of group 'D' each received two strips of Apivar. The doses and durations for colonies of groups A,B and D remained the same as in 1st season. Colonies of group 'E' were kept as control and received no acaricide treatment.

Third Season (2005):

Each colony of group 'A' received two Apistan (Sandoz) strips. Colonies of group 'B' received 4 strips of Bayvarol. Colonies of group 'C' received 2-Bee Strips (O,O-Diethyl O-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl) phosphorothioate (coumaphos).. Bee Strips are 8-3/8″ x 1″ white plastic strips containing 10% coumaphos designed to release sufficient active ingredient for up to 45 days for *Varroa* control. Colonies of group 'D' each received two strips of Apivar. The doses and durations for colonies of groups A, B and D remained the same as in 1st and 2nd seasons. Colonies of group 'E' were kept as control and received no acaricide treatment. To avoid possible contamination in all experimental seasons, the treated colonies were kept at a different place to the control ones.

Mites were collected using sticky-board collection devices (**Calderone and Spivak** 1995), each made from a piece of synthetic paper that covered the bottom board of a hive. The paper was coated with a transparent adhesive material (Sticky-Stuff; Oslen) and attached to a narrow wooden frame. The open side of the wooden frame was covered with hardwire (0.3175-mm mesh) that allowed mites to fall through, but that protected bees from the sticky surface and prevented them from removing the mites. One sticky-board collection device was present in each colony at all times during the experiment. The fallen mites were collected after treatment on different dates and to assess the number of remaining mites, all the colonies were post-treated with Perizin or Apivar in case of Perizine treatment. The effectiveness of each acaricide was evaluated as follows:

$$\text{Efficacy} = \frac{\text{Total No. of mites fallen after acaricidal treatment}}{\text{No. of mites after treatment + remaining mites.}} \times 100$$

RESULTS AND DISCUSSION

The data recorded during the 1st season, 2003 for the estimation of relative efficacy of each acaricide Apistan, Bayvarol 2-strips, Bayvarol 4-strips and Apivar against *Varroa* mites are presented in Table 1 and Fig. 1. The results revealed that the maximum efficacy was achieved with 4 strips of Bayvarol 96%, followed by Apivar (95%) and 2strips of Bayvarol (89%), while the minimum efficacy was presented by Apistan (85%). In control the recorded natural mortality was 25%.

A detailed probe of the one way analysis of the variance of acaricides effectiveness data (Table 1) revealed a significant difference between the control and other acaricides treatments. The comparison of the treatment means indicated that maximum efficacy (96%) was witnessed in T4 (4 Strips of Bayvarol), which remained statistically at par with the results of treatment T3 (Apivar) (95%).The treatment T2 (2 Strips of Bayvarol) 89%, efficacy showed a significant difference between control and the treatment T3 and T4 but remained statistically similar to T1 (85%).

During 2nd season, 2004 Apistan, Bayvarol, Apivar and Perizin acaricides were applied to estimate their relative efficacy against *Varroa* mites presented in the Table 1 and Fig. 2. The data clearly show that the maximum efficacy (95%) was recorded in Apivar treatment, followed by Perizin (94%), Bayvarol (80%) and Apistan (80%). In control the natural mortality was 18%.

A scan of the one way analysis of the variance of acaricides effectiveness data (Table 1) revealed a significant difference between the control and other acaricides treatments. The comparison of treatment means indicated that maximum efficacy (95%) was recorded in T2 (Apivar) which remained statistically at par with the results of treatment T3 (94%) (Perizin). The treatment T4 (Bayvarol) 80% efficacy showed a significant difference between control and the treatment T2 and T3 but remained statistically similar to T1 (80%).

The data presented in Table 1 and Fig. 3 recorded during 3rd season, 2005 to evaluate the relative efficacy of the Apistan, Bayvarol, Apivar and Bee strip against *Varroa* mites indicated that maximum efficacy (95%) was achieved with Bee strip, followed by Apivar (92%), Bayvarol (70%) and Apistan (60%), while in control group the natural mortality was 11%.

A perusal of the one way analysis of the variance of acaricides effectiveness data (Table 1) revealed a significant difference among all the acaricides treatments and control. The comparison of the treatment means indicated that maximum efficacy (95%) was recorded in T2 (Bee Strips) which remained statistically at par with the results of T4 (Apivar). Likewise T3 (Bayvarol) (70%), T1 (Apistan) (60%) and control (11%) were found significantly different from each other.

The data recorded for Apistan during the three seasons were 85, 80 and 60%, respectively, which is an indication of decline in its effectiveness. The results revealed the efficacy of Bayvarol as 95% with 4 strips and 87% with 2 strips in 1st season, while 80 and 70% with 4 strips during the 2nd and 3rd seasons, respectively, which also predicted the decline in its effectiveness. Apivar remained very effective throughout the experiment and presented high efficacy level; 95, 95 and 92% during the three successive seasons, respectively. Perizine, which was tested against *Varroa* mites showed high effectiveness (94%) and Bee strips also presented high efficacy level (95%). The natural mortality in control colonies was remained significantly lower than the treated colonies, being 25, 18 and 11% in the three seasons, respectively as shown in Fig. 4.

The data for the average mite downfall on sticky board after different acaricides treatments were recorded and correlated with average daily temperature for the same period. The results of the correlation between temperature and acaricides performance showed no considerable relationship where the maximum correlation coefficient was recorded ($r = 0.51$) in Apivar followed by Apistan ($r = -0.338$), 2 strips of Bayvarol ($r = 0.311$), 4 strips of Bayvarol ($r = -0.114$) and in control where no acaricide was used. The correlation between temperature and natural mite mortality was ($r = 0.143$) at the temperatures ranged between 25.3-30.7°C. The average mites downfall on sticky board for the year 2003 was presented in the Fig. 5.

The results of the temperature and acaricides performance correlation revealed a strong negative correlation where the maximum correlation coefficient was (r = - 0.803) in Perizin and Apivar followed by Apistan (r = - 0.54), Bayvarol (r = 0.234) and in control (r = 0.41) at the temperatures ranged between 25.3 - 30.7°C. The average mites downfall on sticky board for the year 2004 was presented in the Fig. 6.

The results of the data recorded during 2005 showed no strong correlation between temperature and acaricides performance where the maximum correlation coefficient (r = 0.48) was recorded for 4 Strips of Bayvarol, followed by Apivar (r =0.439), Bee strips (r =0.277), Apistan (r=0.101) and in control (r = 0.242) at the temperatures ranged between 32.9 - 36.9°C. The average mites downfall on sticky board for 2005 was presented in the Fig. 7.

After receiving several complaints from the beekeepers, about the effectiveness of the Apista (Fluvalinate) which was the main and only officially registered acaricide against *Varroa Destructor* i the Kingdom, this experiment was planed to evaluate the relative efficacy of different acaricides use against *Varroa Destructor*. The experiment was carried out in three seasons where the Apista presented 85%, 80% and 60% efficacy respectively. This decline in the effectiveness was attributed t the development of resistance in *Varroa* mites against fluvalinate after a consecutive use of th acaricide for several years. The development of resistance in *Varroa* mites against fluvalinate was als reported from rest of the world. **Loglio and Plebani** (1992) indicated for the first time an importa decrease in the fluvalinate efficiency in Italian apiaries. **Baxter *et al*.** (1998) reported *Varro* resistance against Apistan in commercially managed bee colonies from the USA. **Milani** (199 reported that indiscriminate use together with inadequate application have produced a reduction i effectiveness, especially concerning mite produced resistance to the main components fluvalinat flumethrin and acrinatrine. Therefore, the results of the present study are in agreement with oth authors, who reported development of resistance in *Varroa* mites to fluvalinate. Whereas, the mite mortality in colonies received Apistan was higher than control in all seasons, being 25, 18 and 11 respectively.

The results of the data recorded for the estimation of relative efficacy of Bayvar (flumethrin) during the three seasons showed efficacy 87%with 2 strips, 96% with 4 strips during 1 season while 80 and 70% during 2nd and 3rd seasons, respectively. The results also predicte development of resistance in mites to flumethrin, which was in agreement with **Milani** (1995). Lo effectiveness of Bayvarol showed by the present experiment agreed with the results obtained b **Milani and Barbattin** (1989) who obtained effectiveness ranged between 84% and 100%. Th resistance to Bayvarol could be attributed to cross resistance since Apistan and Bayvarol bo belonging to pyrethroid group.

The acaricide Apivar presented the highest relative efficacy in all experimental seasons amon other acaricides (95%, 95% and 92%, respectively), which indicated that the acaricide was highl effective against *Varroa* mite. These findings are in agreement with **Richez *et al.*** (1999) who found curative action of at least 99% for Apivar in all studies. In the present experiment, Perizin was teste during 2nd season showed 94% efficacy and Bee strip was applied during 3rd season which presente 95% efficacy level, which indicated Perizin, and Bee strip could be used for effective control o *Varroa* mites in the Kingdom. The results obtained with Bee strip was close to those given by **Sanfor** (1998) who indicated Bee strips 97-99% effective against *Varroa*. The findings with Perizine wer also very close to **Ritter** (1988) who obtained 95.7% effectiveness against *Varroa*.

Mite mortality in colonies received Apistan, Bayvarol, Apivar and Perizine was significantly higher than control in all experimental seasons, i.e. 25, 18 and 11% respectively. But the results presented no significant difference within each treatment.

The data Regarding the relative efficacy of different acaricides during 1st season presented that 4 strips of Bayvarol showed highest efficacy (96%), followed by Apivar (95%), 2 strips of Bayvarol (89%) and Apistan (85%), respectively, while the mortality in control was 25%. During 2 nd season, Apivar gave the highest effectiveness (95), followed by Perizine (94%), Bayvarol (80%) and Apistan (80%), respectively, while the mortality in control was 18%. In 3rd season, the data presented the highest efficacy percentage in Bee strips (95%), followed by Apivar (92%), Bayvarol (70%) and Apistan (60%), while the mortality in control was minimum as 11%.

The results of the correlation between temperature and acaricides effectiveness revealed that a negative correlation existed below 30°C but above this degree no significant relationship was recorded.

REFERENCES:

Al Ghamdi, A. (1997) The interaction of *Apis mellifera* and *Varroa jacobsoni* population dynamics in Michigan: simulation modeling and field biology. **Ph.D. Thesis. Dept. of Entomol., Michigan State Univ., USA**.

Ball, B.V. (1994) Host parasite–pathogen interaction. In **Matheson, A** (ed) New prospective on Varroa. **IBRA; Cardiff, UK; pp 5-11.**

Baxter, J., F. Eischen, J. Pettis, W. T. Wilson and H. Shimanuki (1998) Detection of fluvalinate-resistant varroa mites in U. S. honey bees. **Am. Bee J. 138: 291.**

Calderone, N.W. and M. Spivak (1995) Plant extracts for control of the parasitic mite *Varroa jacobsoni* (Acari:Varroidae) in colonies of the western honeybee (Hymenoptera:Apidae). **J. Econ. Entomol. 88 (5), 1211-1215**.

De Ruijter, A. and Van Den Eijnde, J. (1990) Field experiment to determine the efficacy of Apistan on varroa mites in bee colonies and effect on spring development of treated colonies. **Vet. Med. Rev. 2:158-163.**

DeJong, D. (1990) Mites: Varroa and other parasites of brood, pp. 200-218. In **R. A. Morse and R. Nowogrod** [eds.], Honeybee pests, predators, and diseases, **2nd ed. Cornell University press, Ithaca, NY.**

Ferrer-Dufol, M., Moreno- Manera, C., Martinez-Vinuales, A., Sanchez-Acedo, C. and Gracia-Salinas, M. (1995) Field trials of treatments against *Varroa jacobsoni* using fluvalinate and flumethrin strips in honey bee colonies containing sealed brood. **J. Apic.Res.34 (3), 147-152.**

Hillesheim, E., Ritter, W. and Bassand, D. (1996) First data on resistance mechanisms of *Varroa jacobsoni* against tau-fluvalinate. **Exp. Appl. Acarol.20: 283-296.**

Lodesani, M., Colombo, M. and Spreafico, M. (1995) Ineffectiveness of Apistan registered treatment against the mite *Varroa jacobsoni* in several districts of Lombardy (Italy). **Apidol. 26(1), 67-72.**

Loglio, G. and Plebani, G. (1992) Valutazione dell'efficacia dell'Apistan. **Apicultura Moderna 83: 95-98**.

Matheson, A. (1995) World bee health update. **Bee World 76(1), 31-39**

Milani, N. (1995) The resistance of *Varroa jacobsoni* to pyrethroids: a laboratory assay**. Apidologie 26: 415-429**.

Milani, N. and Barbattini, R. (1989) Treatment of varroatosis with Bayvarol strips (Flumethrin) in northern Italy. **Apicoltura 5:173-192.**

Richer, P., Le Conte, Y., Collin, B. and Salvy, M. (1999) The therapeutic efficacy of a new formulation Apivar for the treatment of varroasis in honeybees. **34th Congress Apimondia' 99 Vancouver, Canada pp. 261.**

Ritter, W. (1981) Varroa diseases of honeybee *Apis mellifera*. **Bee World 62:141-153.**

Sanford, M. (1998) Varroa Certification Changed in Florida. **Apicultural information 16 (2). University of Florida, Department of Entomology and Nematology.**

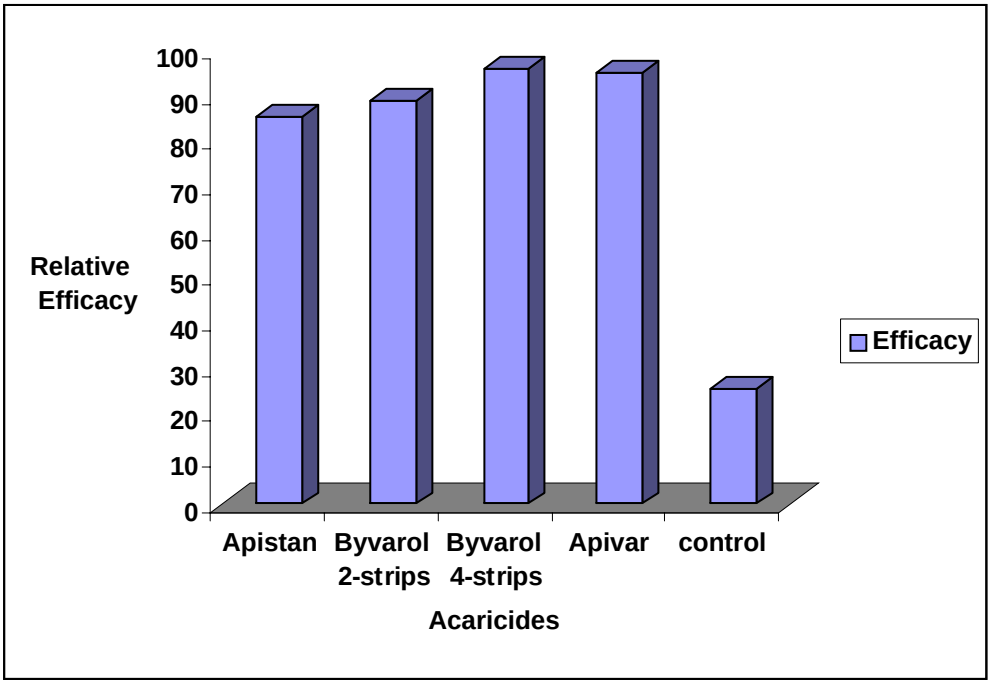
Slabezki, Y., H. Gal & Y. Lensky (1991) The effect of fluvalinate application in bee colonies on population levels of *Varroa jacobsoni* and honey bces (*Apis mellifera L.*) and on residues in honey and wax**. Bee Sci. 1 (4), 189-195.**

Table (1): Efficacy (%) of tested acaricides against *Varroa Destructor* during threesuccessive seasons under Saudi Arabian environmental conditions.

Treatments	Seasons		
	2003	2004	2005
Apistan	85.20 c	79.82 ed	6032 d

Bayvarol (2-Strips)	88.60 cd	--	--
Bayvarol (4-Strips)	95.90 a	80.34 c	70.22 c
Apivar	9500 ab	94.64 a	92.30 ab
Perizine	--	93.86 ab	--
Bee Strips	--	--	95.06 a
Control (Untreated check)	25.19 e	17.72 e	10.80 e
F. Values	197.54**	396.43**	1209.17**
L.S.D. at 0.05	6.25	4.72	2.88

** , Significant at 1%



Figure(1): Relative efficacy of different acaricides against *Varroa destructor* recorded during 1st season, 2003.

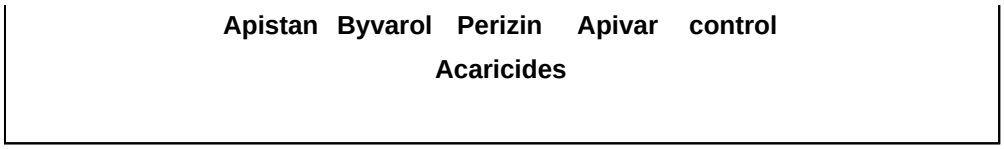


Figure 2 Relative efficacy of different acaricides recorded against *Varroa destructor* during 2nd season, 2004.

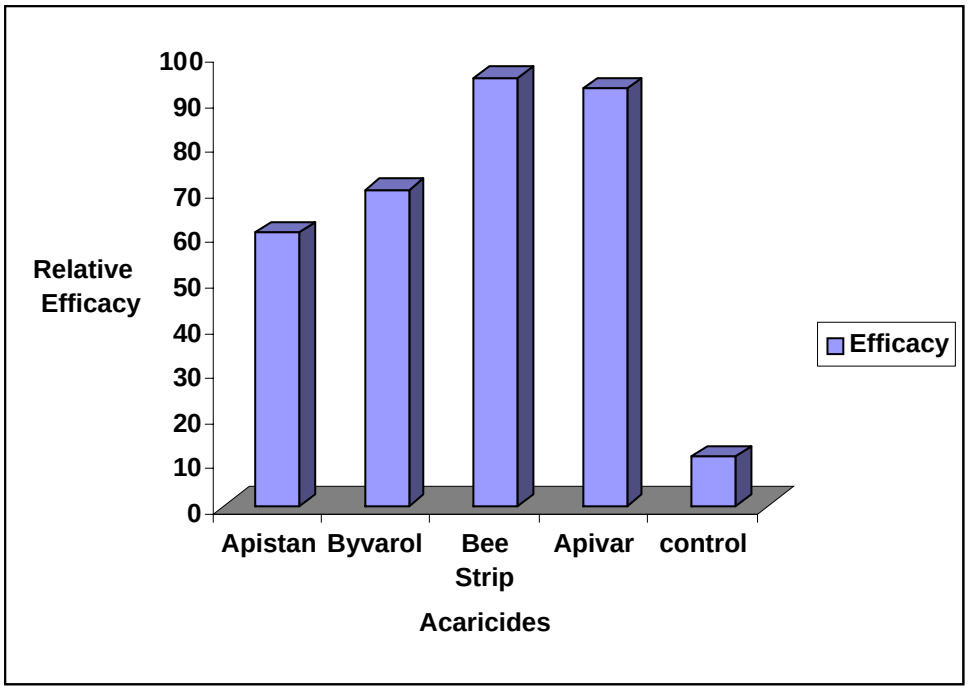


Figure 3. Relative efficacy of different acaricides recorded against *Varroa destructor* during 3rd season, 2005.

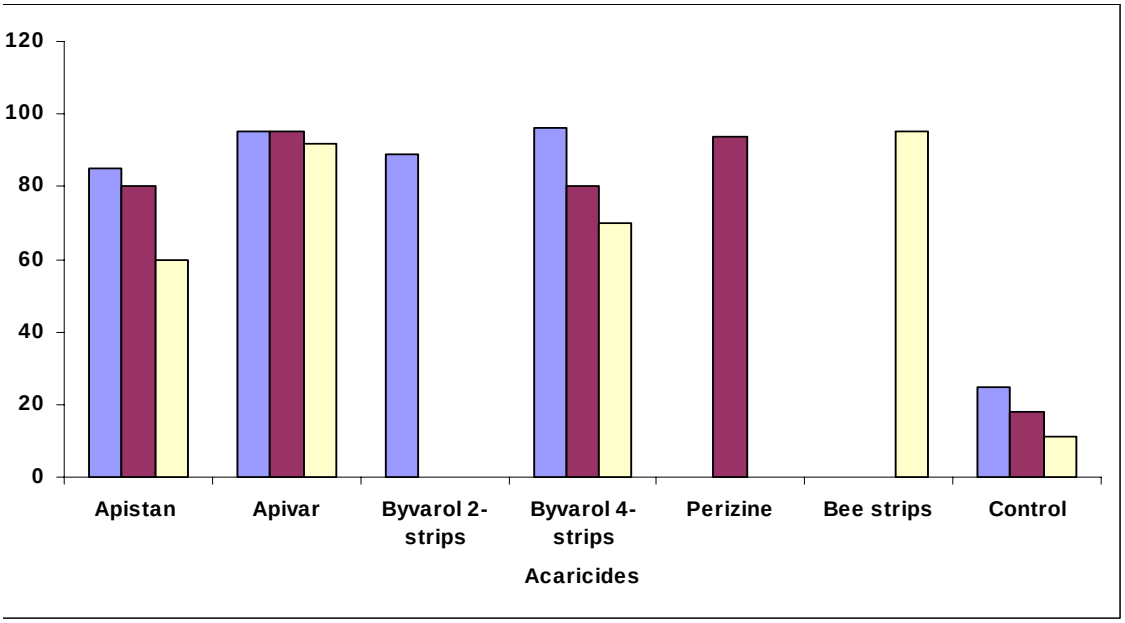


Figure 4. Relative efficacy of the different acaricides recorded during three seasons (2003, 2004,

٢٠٠٥) and the natural mortality in the control group.

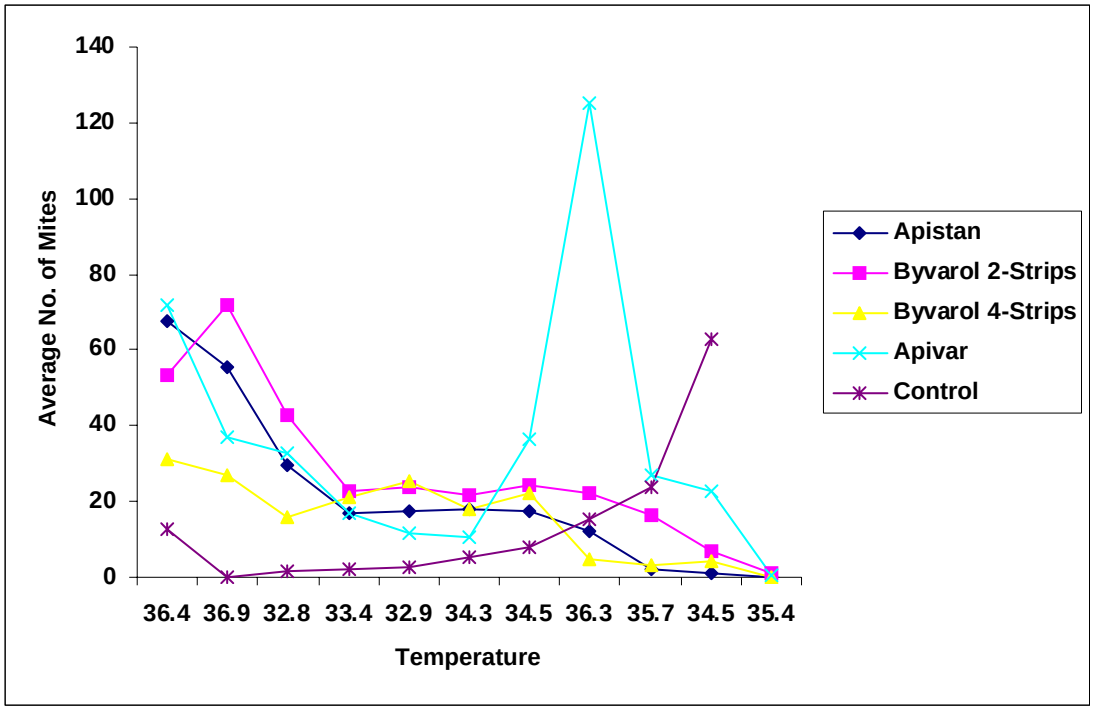
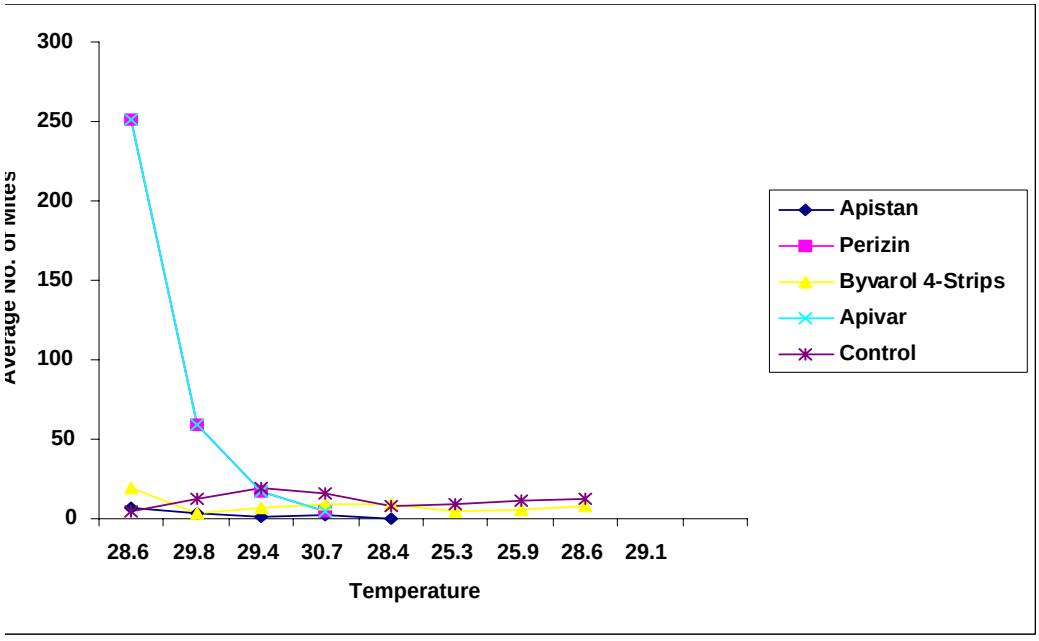


Figure 5. Average mites downfall on sticky board after different acaricides treatments at average daily temperature(°C) collected on the day of each sticky board replacement during 1st season 2003.

Figure 6. Average mites downfall on sticky board after different acaricides treatments at average daily temperature(°C) collected on the day of each sticky board replacement during 2nd season 2004.



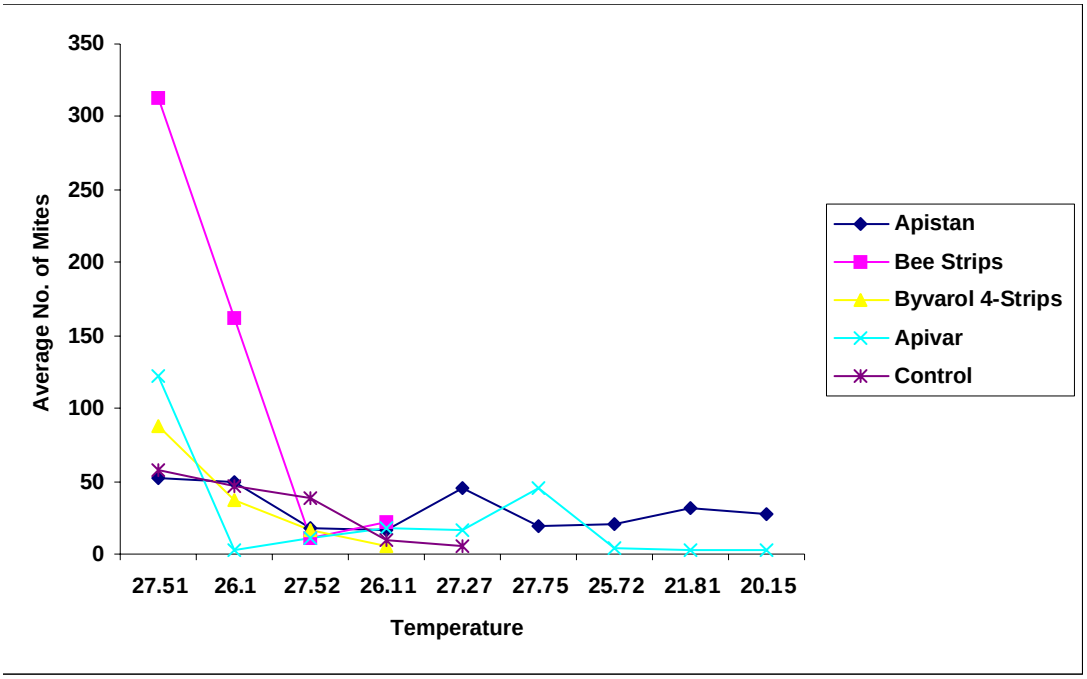


Figure 7. Average mites downfall on sticky board after different acaricides treatments at average daily temperature (°C) collected on the day of each sticky board replacement during 3rd season 2005 .