

تقييم كفاءة بعض المبيدات الأكاروسية الكيميائية ضد حلم الفاروا *Varroa jacobsoni* على نحل العسل الكارينيولي *Apis mellifera carnica* في المملكة العربية السعودية.

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الخلاصة

تم تقييم كفاءة خمسة من مبيدات الأكاروس وهي الإيبستان و البايفرول والأيفار والبيريزين وشرائط باير ضد حلم الفاروا على في ثلاثة مواسم خلال الفترة من أكتوبر-ديسمبر. في الموسم الأول (أكتوبر - ديسمبر ١٩٩٩م) تم مقارنة الإيبستان ، والبايفرول (٢ شريط) والبايفرول (٤ شرائط) والأيفار وأظهرت النتائج أن كفاءة البايفرول (٤ شرائط) كانت بنسبة ٩٦% تلاها الأيفار ٩٥% و البايفرول (٢ شريط) ٨٩% بينما الإيبستان أعطى اقل نسبة ٨٥%. في الموسم الثاني (أكتوبر - ديسمبر ٢٠٠٠م) استخدم الإيبستان ، والبايفرول (٤ شرائط) ، والأيفار والبيريزين وكانت نسبة الأيفار عالية ٩٥% تلاها البيريزين ٩٤% بينما الإيبستان والبايفارول (٤ شرائط) أعطت ٨٠%. في الموسم الثالث (أكتوبر - ديسمبر ٢٠٠١م) تم مقارنة الإيبستان ، والبايفرول (٤ شرائط) ، والأيفار وشرائط باير وأظهرت النتائج أن شرائط باير أعطت أعلى كفاءة ٩٥% تلاها الأيفار ٩٢% وأخيراً البايفرول (٤ شرائط) بنسبة ٧٠%. أوضحت نتائج هذه الدراسة انخفاض كفاءة المبيدان الأيبستان والبايفرول من موسم إلى آخر وذلك يُعزى إلى أن الحلم *Varroa jacobsoni* قد اصبح مقاوم لهذين المبيدين ذات الأصل النباتي نتيجة للاستخدام الطويل والغير صحيح أحيانا لمبيد الأيبستان.



EVALUATION OF THE RELATIVE EFFICACY OF DIFFERENT ACARICIDES AGAINST *VARROA JACOBSONI* IN *APIS MELLIFERA CARNICA*.

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ABSTRACT:

The effectiveness of 5-acaricides, Apistan, Bayvarol, Apivar, Perizine and Bee Strips against *Varroa jacobsoni* was evaluated during 3-seasons. During 1st season (Oct.-Dec., 1999) 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 Bayvarol (2-Strips) 89% while Apistan remained at minimum level 85%. During 2nd season (Oct. - Dec., 2000) Apistan, Bayvarol (4-strips), Apivar and Perizin evaluated as Apivar presented the maximum efficacy 95% followed by Perzine 94% where as the Apistan and Bayvarol (4-strips) showed 80%. During the 3rd season (Oct. - Dec., 2001) Apistan, Bayvarol (4-strips), Apivar and Bee Strips were compared where the Bee strips presented the highest efficacy 95% followed by Apivar 92% and Bayvarol (4-strips) 70% where as 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 jacobsoni* 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.

INTRODUCTION:

The ectoparasitic mite *Varroa jacobsoni* 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 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 jacobsoni* 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 has developed resistance to Apistan in some countries such as Italy (Lodesani *et al.*, 1995) and USA (Sanford, 1998). Flumethrin an active ingredient of the 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. Richez *et al.* (1999) performed three multicentre clinical studies during spring and winter in France to evaluate the therapeutic properties of Apivar (5g amitraz) 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 present study was carried out to evaluate the relative efficacy of different acaricide administered in controlling the Varroa mite in Saudi Arabia.

MATERIALS AND METHODS:

The experiment was designed to carryout in three consecutive years (1999, 2000 and 2001) with 25 *-Apis mellifera carnica* colonies for each year under Saudi Arabia (Riyadh) conditions. The treatments were applied after the honey flow when honeybees were active and sealed brood was present.

FIRST SEASON (1999):

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 consist of polyvinyl chloride strip (PVC) impregnated with fluvalinate. One strip (250 x 30 x 1mm) 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 and received no acaricide treatment. To avoid possible contamination, the treated colonies were kept at a different place to the control ones.

SECOND SEASON (2000):

Each colony of group- 'A' received two Apistan (Sandoz) strips. The dose and duration remained the same as in 1st season.

Colonies of group 'B' received 4-strips of Bayvarol. The dose and duration remained the same as in 1st season.

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 dose and duration remained the same as in 1st season.

Colonies of group 'E' were treated as control and receive no acaricide treatment. To avoid possible contamination, the treated colonies were kept at a different place to the control ones.

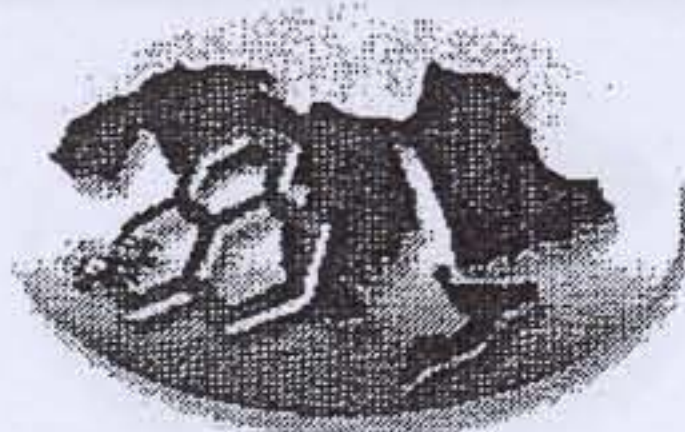
THIRD SEASON (2001):

Each colony of group- 'A' received two Apistan (Sandoz) strips. The dose and duration remained the same as in 1st and 2nd seasons.

Colonies of group 'B' received 4-strips of Byvaro. The dose and duration remained the same as in 1st and 2nd seasons.

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 dose and duration remained the same as in 1st and 2nd seasons.



Colonies of group 'E' were treated as control and receive no acaricide treatment. To avoid possible contamination, 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 hardware (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:

$\text{Efficacy} = \frac{\text{Total no of mites fallen after acaricide treatment}}{\text{no. of mites after treatment} + \text{remaining mites}} * 100.$

RESULTS:

The results of the data recorded during the 1st session, 1999 for the estimation of relative efficacy of each acaricide Apistan, Bayvarol 2-strips, Bayvarol 4-strips and Apivar against Varroa mites were presented in Tab. 4 and Fig. 1. The result revealed that the maximum efficacy was achieved with Bayvarol 4-strips 96% followed by Apivar 95% and Bayvarol 2-strip 89% while the minimum efficacy was presented by Apistan 85% respectively. In control the natural mortality was recorded 25%.



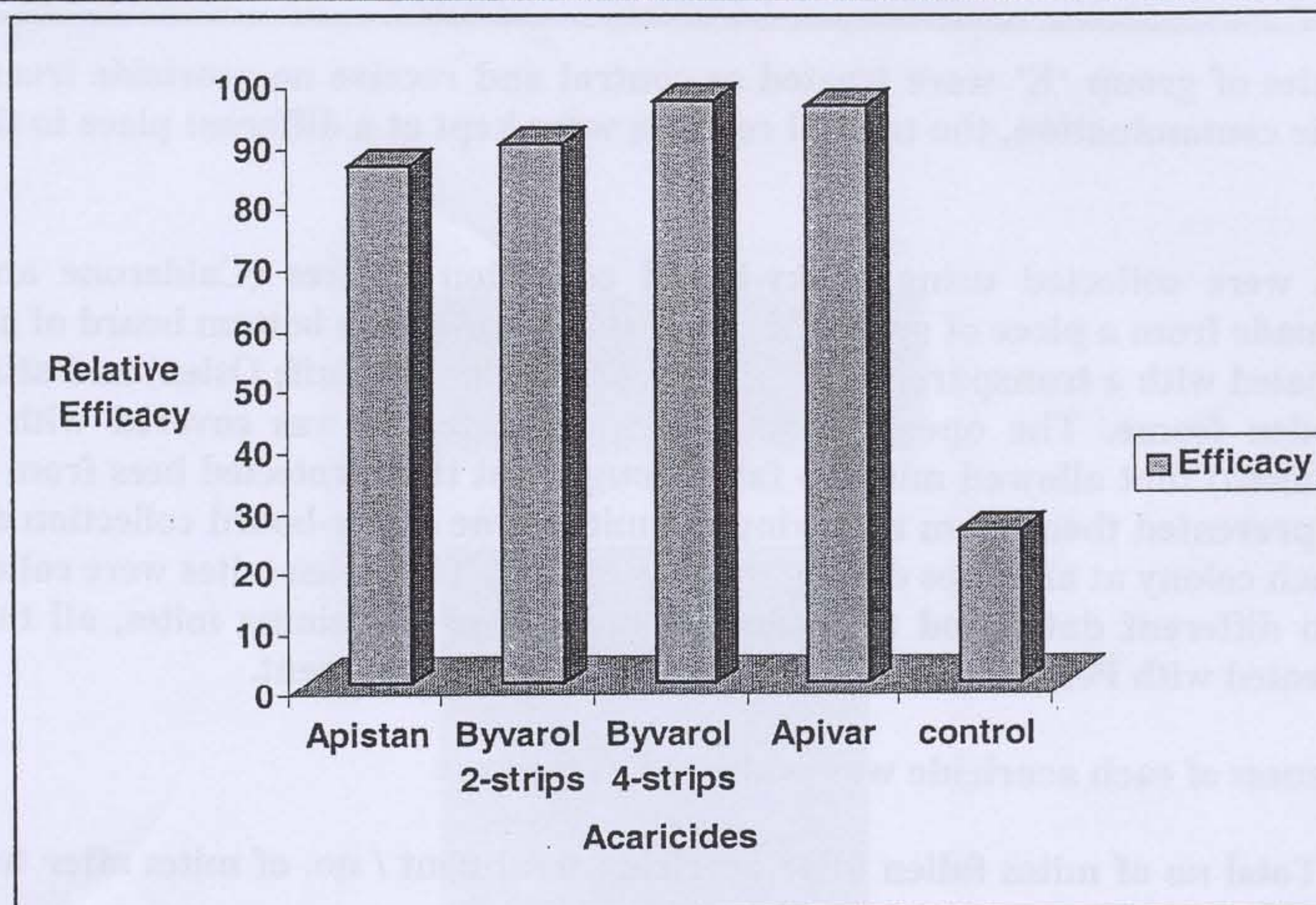


Figure 1 Relative efficacy of different acaricides against *Varroa jacobsoni* recorded during 1st session, 1999.

A detailed probe of the one way analysis of the variance of acaricides effectiveness data (Tab. 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 (Bayvarol 4-Strips) which remained statistically at par with the results of treatment T3 95% (Apivar). The treatment T2 (Bayvarol 2-Strips) 89% efficacy showed a significant difference between control and the treatment T3 and T4 but remained statistically similar to T1 85%.

Table 1. Results of the Analysis of Variance corresponding to the treatment efficacy against *Varroa jacobsoni* in *Apis mellifera carnica* carried out during 1999.

Source	DF	SS	MS	F**	P
Treatment	4	17810.4	4452.6	197.54	0.000
Error	20	450.8	22.5		
Total	24	18261.2			

At $\alpha = 0.05$

Treatments	Means
Apistan T1	= 85.20 c
Bayvarol (2-S) T2	= 88.60 cd
Bayvarol (4-S) T3	= 95.90 a



Apivar T4 = 95.00 ab
 Control T5 = 25.19 e
 LSD = 6.25

During 2nd session, 2000 Apistan, Bayvarol, Apivar and Perizin acaricides were applied to estimate their relative efficacy against *Varroa* mites presented in the Tab. 4 and Fig. 3. The data indicated that the maximum efficacy 95% was recorded in Apivar treatment followed by Perizin 94%, Bayvarol 80% and Apistan 80% respectively. In control the natural mortality was recorded 18%.

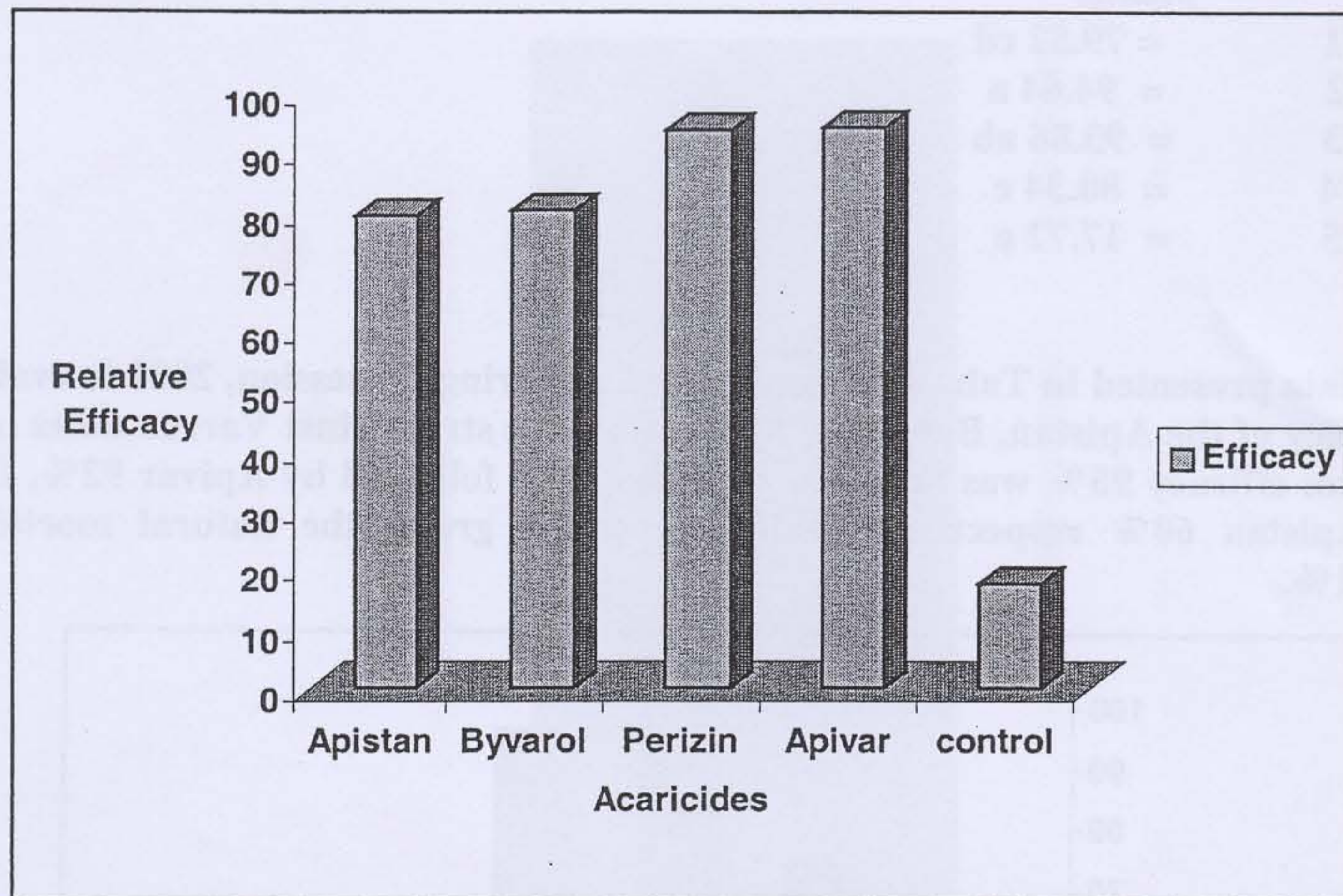


Figure 2 Relative efficacy of different acaricides recorded against *Varroa jacobsoni* during 2nd session, 2000.

A scan of the one way analysis of the variance of acaricides effectiveness data (Tab. 2) 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%.



Table 2. Results of the Analysis of Variance corresponding to the treatment efficacy against *Varroa jacobsoni* in *Apis mellifera carnica* carried out during 2000.

Source	DF	SS	MS	F**	P
Treatment	4	20277.3	5069.3	396.43	0.000
Error	20	255.8	12.8		
Total	24	20533.1			

At $\alpha = 0.05$

Treatments	Means
Apistan T1	= 79.52 cd
Apivar T2	= 94.64 a
Perizin T3	= 93.86 ab
Bayvarol T4	= 80.34 c
Control T5	= 17.72 e

LSD= 4.72

The data presented in Tab. 4 & Fig. 5 recorded during 3rd session, 2001 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% respectively while in control group the natural mortality was calculated 11%.

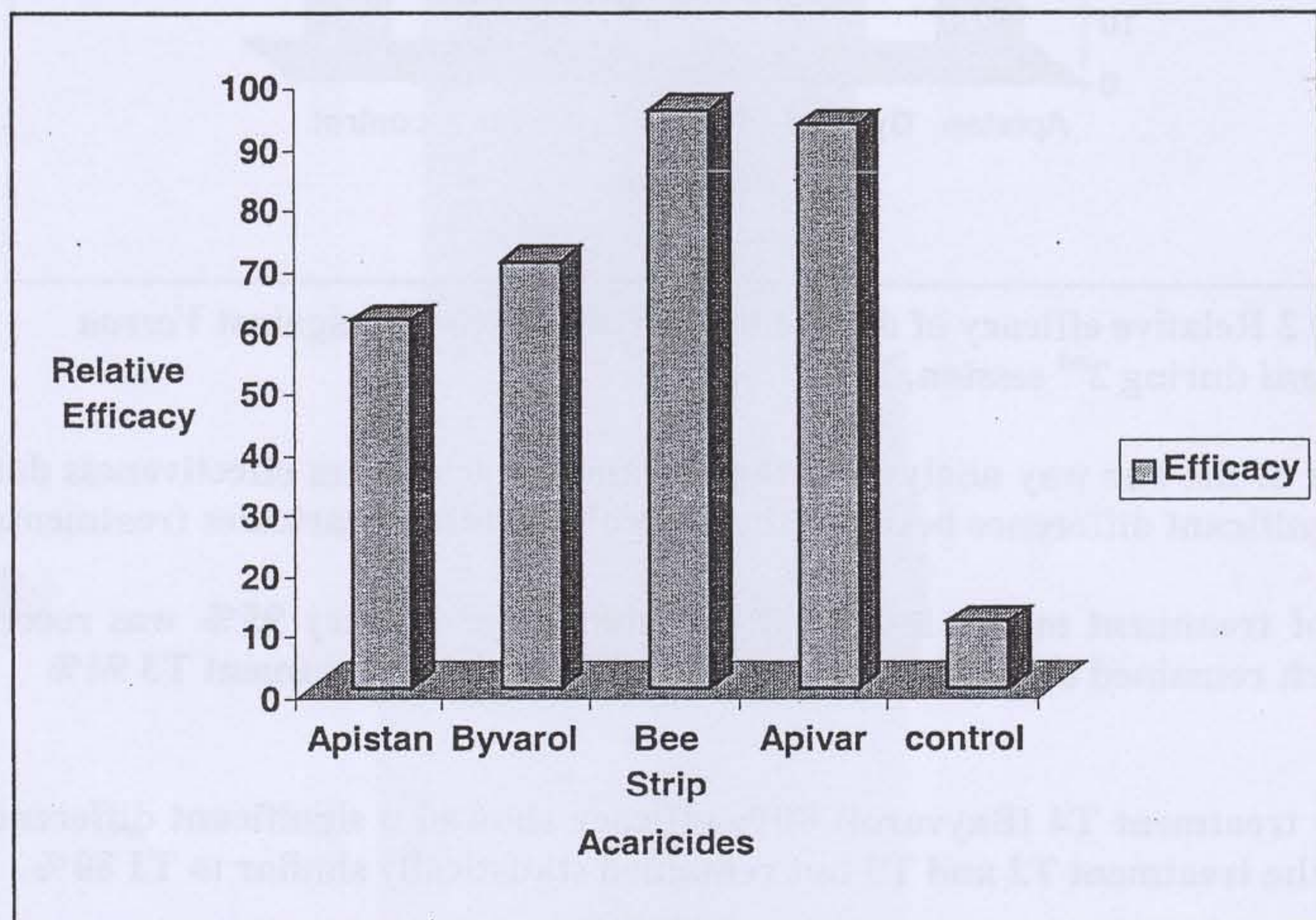


Figure 3. Relative efficacy of different acaricides recorded against *Varroa jacobsoni* during 3rd session, 2001.



A perusal of the one way analysis of the variance of acaricides effectiveness data (Tab. 3) 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.

Table 3. Results of the Analysis of Variance corresponding to the treatment efficacy against *Varroa jacobsoni* in *Apis mellifera carnica* carried out during 2001.

Source	DF	SS	MS	F**	P
Treatment	4	23164.73	5791.18	1209.17	0.000
Error	20	95.79	4.79		
Total	24	23260.52			

At $\alpha = 0.05$

Treatments	Means
Apistan T1	= 60.32 d
Bee Strip T2	= 95.06 a
Bayvarol T3	= 70.22 c
Apivar T4	= 92.30 ab
Control T5	= 10.80 e
LSD	= 2.88

Table 4. Efficacy of different acaricides against *Varroa jacobsoni* during 3-seasons.

Treatments	Efficacy %		
	1 st Season 1999	2 nd Season 2000	3 rd Season 2001
Apistan	85	80	60
Bayvarol (2-Strips)	89	--	--
Bayvarol (4-Strips)	96	80	70
Apivar	95	95	92
Perizin	--	94	--
Bee Strips	--	--	95
Control	25	18	11

The data recorded for Apistan during the three sessions was 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 session while 80 and 70% with 4-strips during the 2nd and 3rd season 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% respectively, during the three sessions. 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 25, 18 and 11% in three sessions respectively as shown in the Fig. 4.

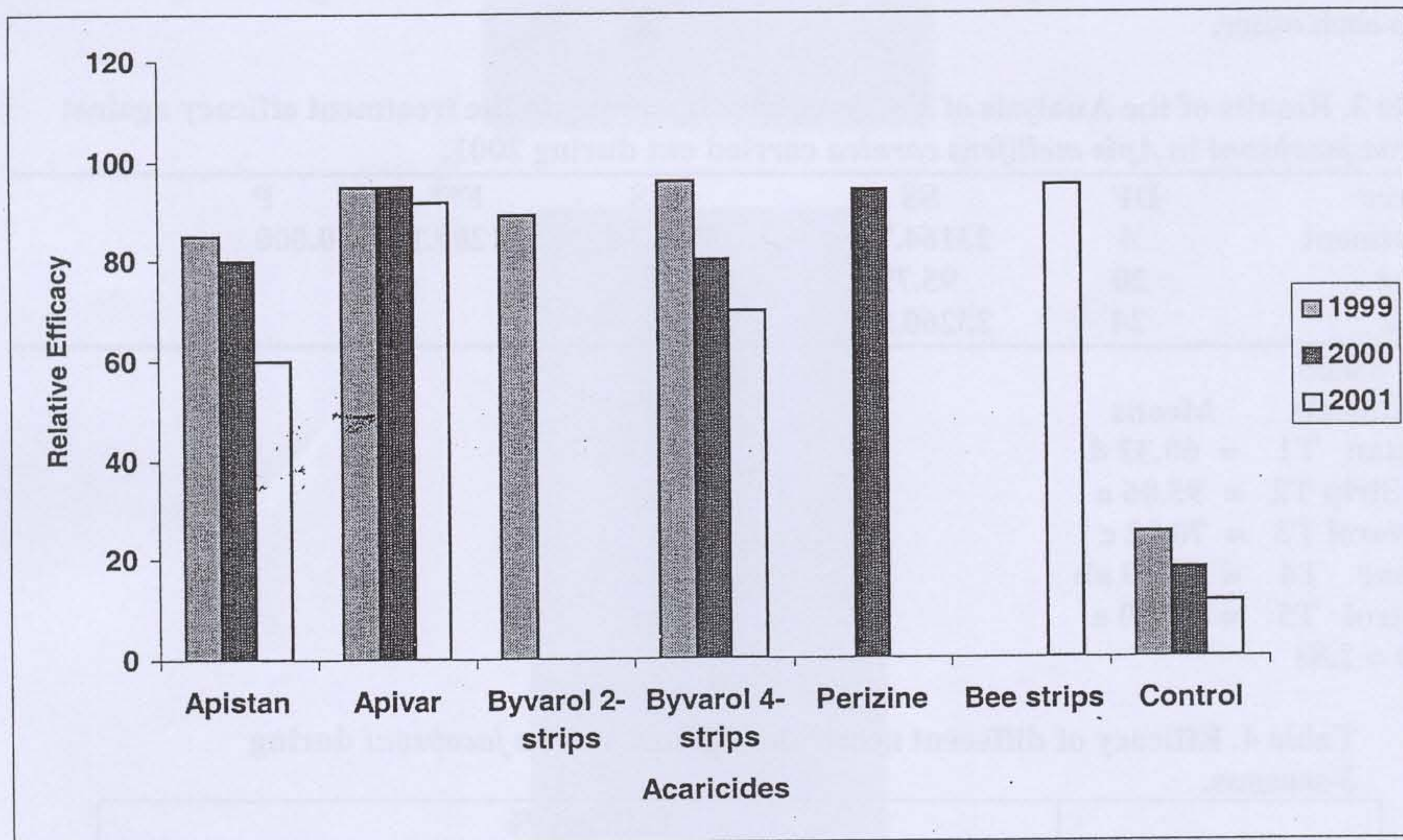


Figure 4. Relative efficacy of the different acaricides recorded during three sessions and the natural mortality in the control group.

The data for the average mite downfall on sticky board after different acaricides treatments was 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 ($r = -0.338$), Bayvarol 2-strips ($r = 0.311$), Bayvarol 4-strips ($r = -0.114$) and in control where no acaricide was used the correlation between temperature and natural mite mortality was recorded ($r = 0.143$) at the temperatures ranged between 25.3-30.7°C. The average mites downfall on sticky board for the year 1999 was presented in the Fig. 5.



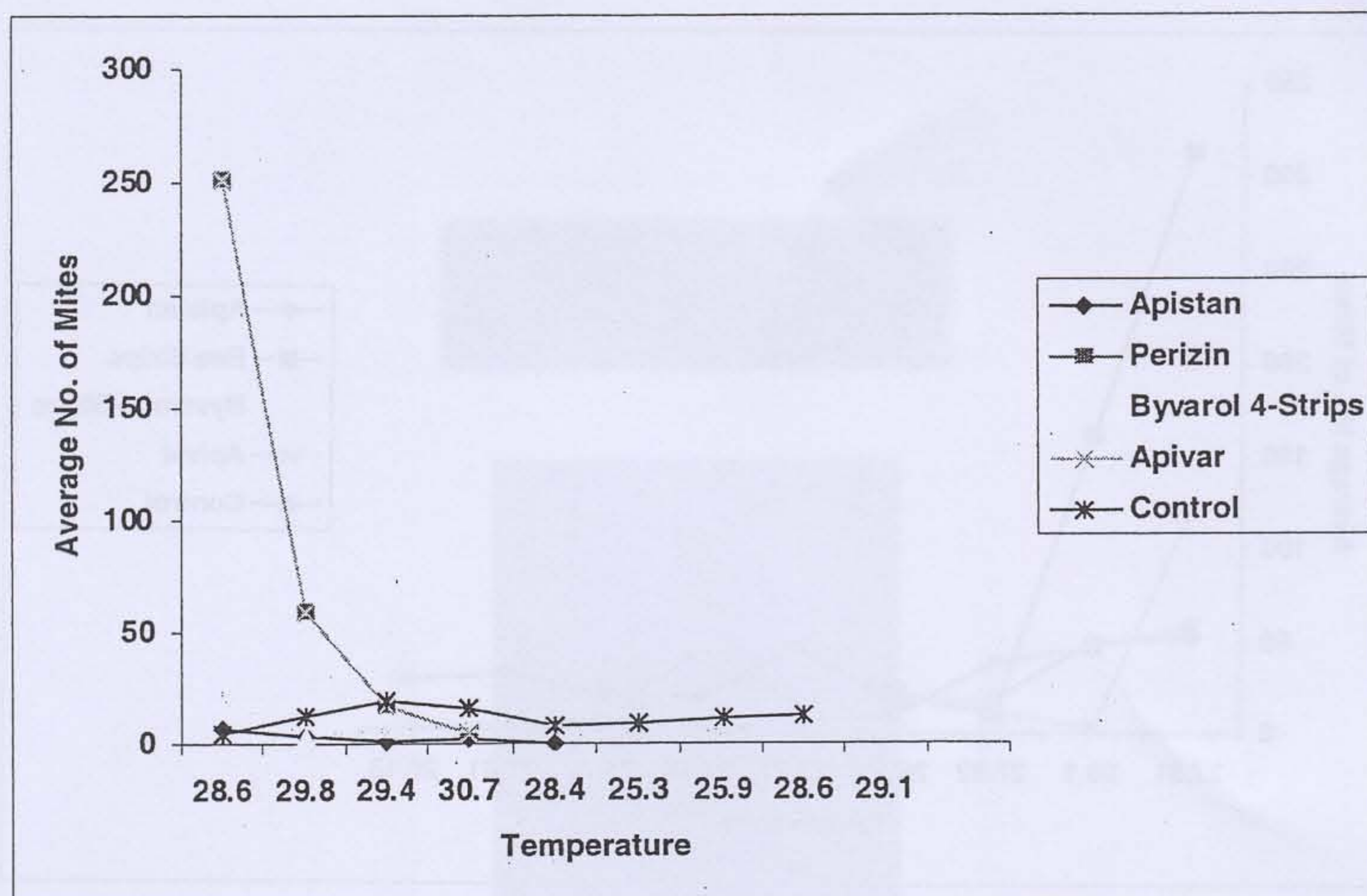


Figure 5. Average mites downfall on sticky board after different acaricides treatments at average daily temperature(°C) collected on the day of each sticky board replacement during 1st season 1999.

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 1st season 2000.

The results of the temperature and acaricides performance correlation revealed a strong negative correlation where the maximum correlation coefficient was recorded ($r = -0.803$) 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 2000 was presented in the Fig. 6.

The results of the data recorded during 2001 showed no strong correlation between temperature and acaricides performance where the maximum correlation coefficient ($r = 0.48$) was recorded for Bayvarol 4-Strips followed by Apivar ($r = 0.439$), Bee strips ($r = 0.277$), Apistan ($r = 0.101$) and in control where no acaricide was used the correlation between natural mite mortality was recorded $r = 0.242$ at the temperatures ranged between 32.9-36.9°C. The average mites downfall on sticky board for 2001 was presented in the Fig. 7.



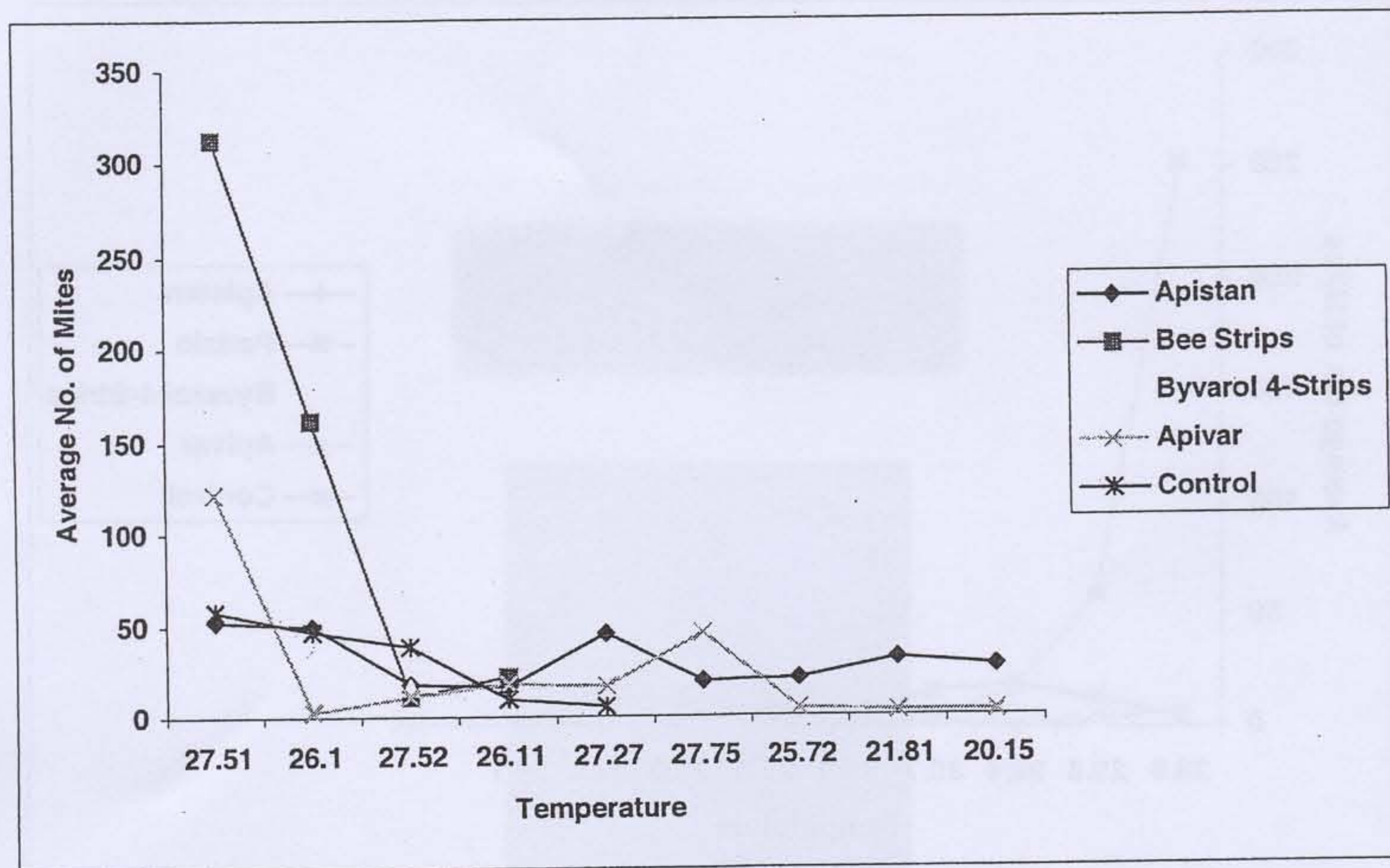


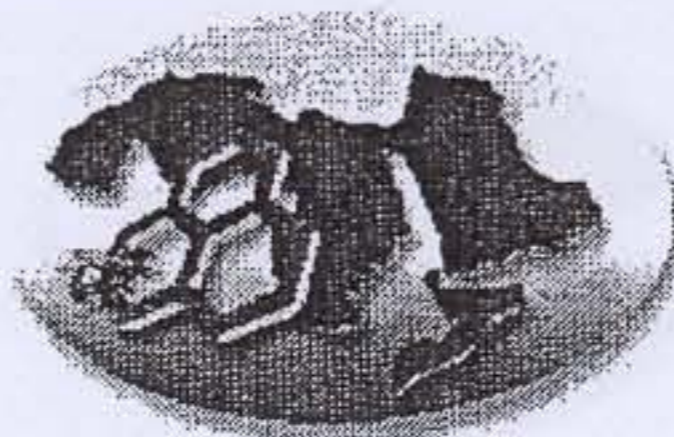
Figure 7. Average mites downfall on sticky board after different acaricides treatments at average daily temperature ($^{\circ}\text{C}$) collected on the day of each sticky board replacement during 1st season 2001.

DISCUSSION:

After receiving several complaints from the beekeepers, about the effectiveness of the Apistan (Fluvalinate) which was the main and only officially registered acaricide against *Varroa jacobsoni* in the Kingdom, this experiment was planned to evaluate the relative efficacy

of different acaricides used against *Varroa jacobsoni*. The experiment was carried out in three sessions where the Apistan presented 85%, 80% and 60% efficacy respectively. This decline in the effectiveness was attributed to the development of resistance in *Varroa* mites against fluvalinate after a consecutive use of the acaricide for several years. The development of resistance in *Varroa* mites against fluvalinate was also reported from rest of the world. Loglio

and Plebani (1992) indicated for the first time an important decrease in the fluvalinate efficiency in Italian apiaries. Baxter *et al.* (1998) reported *Varroa* resistance against Apistan in commercially managed bee colonies from the USA. Milani (1995) reported that indiscriminate use together with inadequate application have produced a reduction in effectiveness, especially concerning mite produced resistance to the main components fluvalinate, flumethrin and acrinatrine. Therefore, the results of the present study were in



agreement with other researchers who reported development of resistance in Varroa mites to flumethrin. Whereas, the mites mortality in colonies received Apistan was higher than control in all sessions 25, 18 and 11% respectively.

The results of the data recorded for the estimation of relative efficacy of Bayvarol (flumethrin) during three sessions showed efficacy 87% with 2-strips, 96% with 4-strips during 1st session while 80 and 70% during 2nd and 3rd season respectively. The results also predicted development of resistance in mites to flumethrin, which was in agreement with

Milani (1995). Low effectiveness of Bayvarol showed by the present experiment agreed with the results obtained by Milani and Barbattin (1989) who obtained effectiveness ranged between 84% and 100%. The resistance to Bayvarol could be attributed to cross resistance since Apistan and Bayvarol both belonging to pyrethroid group.

The acaricide Apivar presented the highest relative efficacy in all the sessions among other acaricides 95%, 95% and 92% which indicated that the acaricide was highly effective against Varroa mite. These findings are in agreement with Richez *et al.* (1999) who found a curative action of at least 99% for Apivar in all studies. In the experiment Perizin was tested during 2nd session showed 94% efficacy and Bee strip was applied during 3rd sessions which presented 95% efficacy level, which indicated Perizin, and Bee strip could be used for effective control of Varroa mites. The results obtained with Bee strip was close to Sanford (1998) who indicated Bee strips 97-99% effective against Varroa. The findings with Perizine were also very close to Ritter (1988) who obtained 95.7% effectiveness and Marchetti and Agaro (1986) reported 92-100% effectiveness against Varroa.

Mite mortality in colonies received Apistan, Bayvarol, Apivar and Perizine was significantly higher than control in all sessions 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 session presented that Bayvarol 4-stripe showed highest efficacy 96% followed by Apivar 95%, Bayvarol 2-strips 89% and Apistan 85% respectively, while the mortality in control was recorded 25%. During 2nd session 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 session the data presented the highest efficacy percentage in Bee strips 95%

followed by Apivar 92%, Bayvarol 70% and Apistan 60% respectively, while the mortality in control was recorded minimum 11%.

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



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