4- RESULTS AND DISCUSSION

4.1. Biological, Histological, and Chemical studies:

4.1.1. Biological studies:

Results concerning with the influence of different hosts and two degrees of temperatures on the different developmental stages of spider mite *T. urticae*, which was reared on six *Phaseolus* genotypes: Henderson (***P. lunatus***), King of the garden (***P. lunatus***), Tepary 16 (***P. acutifolius***), Tepary 13 (***P. acutifolius***), Bronco (***P. vulgaris***) and Giza 3 (***P. vulgaris***) under two different temperatures distinctly, 28°C and 25°C and 60±5% RH. are presented in **Tables (1, 2, 3 & 4).**

During the present biological study of the red spider mite *T. urticae*, it was observed that this mite passed through two nymphal stages in addition to the larvae, before reaching the adult stage. Generally, males tended to emerge earlier than females. In addition, it was found that the host genotype, directly affected motion, colour and size of the two spotted spider mite *T. urticae,* whereas mite individuals reared on the Henderson and King of The Garden cultivars, and Tepary 16 line, were more active and acquire green yellowish colour, while those were reared on other cultivars, (Tepary 13, Bronco, and Giza 3), were less active and had absolutely green colour. In addition, old females, which were reared on the previously mentioned cultivars or line, appeared to be globose in shape and sluggish in motion.

A- Incubation Period:

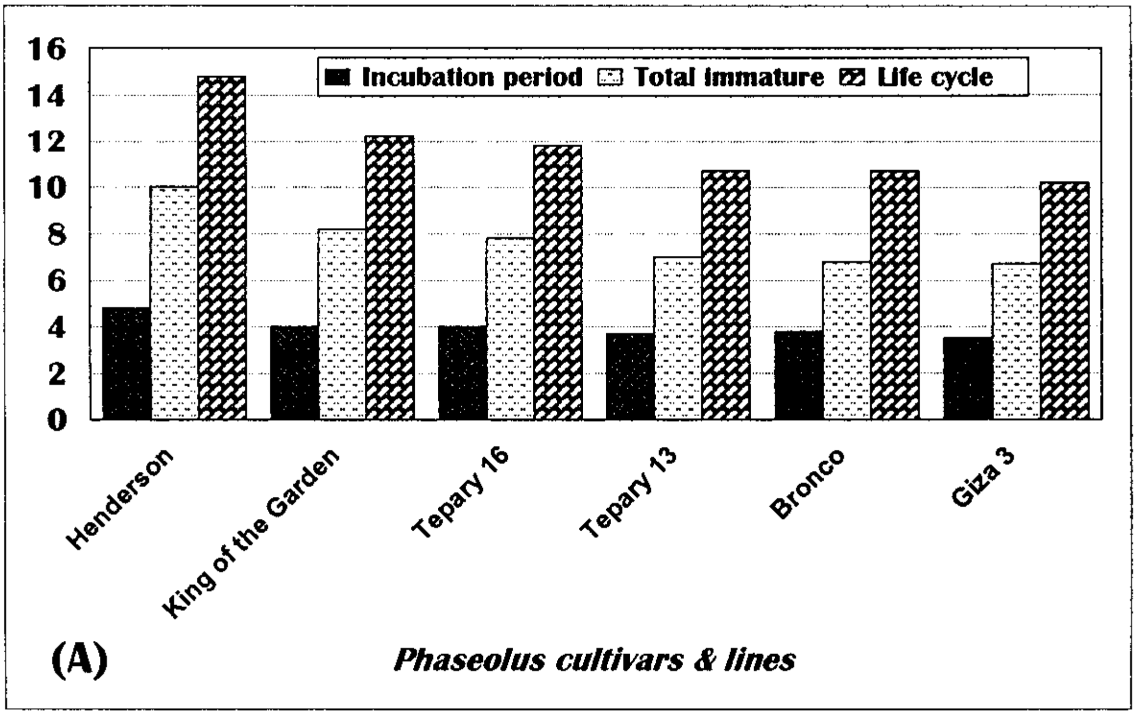
The required period for incubation of *T. utricae* eggs varied according to the variability in both hosts and/or temperatures. It ranged from 3.3 to 4.0 days when eggs were maintained under temperature degree of 28±2°C **(Table 1)**, while it varied from 3.5 to 4.8 days under temperature degree of 25±2°C **(Table 1 & 2 and Fig. 1A, 1B)**. The rate of embryonic development averaged 4.0 days when mites were fed on leaves of Henderson, King of the Garden and, Tepary 16. While the period needed for incubation was 3.8 days, when mites were reared on leaves of Tepary 13 and Bronco and 3.3 days when mites were fed on Giza 3 **(Table 1)**. On the other hand, when the above mentioned *Phaseolus* genotypes were used as food sources under temperature of 25±2°C, the incubation periods were 4.8, 4.0, 4.0, 3.7, 3.8 and 3.5 days for Henderson, King of The Garden, Tepary 16, Tepary 13, Bronco and Giza 3, respectively **(Table 2)**. The prolonged an incubation period reflects, to some extent incompatible interaction between the host genotype and the two-spotted spider mite, in contrast with the short incubation period, which reflects a positive compatible interaction between both the mite and the host plant. Based on these results, Henderson cultivar, King Of The Garden cultivars and Tepary 16 line had, relatively longer incubation periods **(Tables 1& 2, Fig., 1A, B)** comparing to other cultivars. The long incubation period can be considered as one of the resistance components against the two-spotted spider mite. Differences among *Phaseolus* genotypes concerning resistance to mites have been reported **(Farrag *et al.*,**

Table (1): Durations of developmental stages of *T. urticae* female fed on different *Phaseolus* cultivars and lines at 28±2°C and RH 60±5%

Varieties	Incubation period	Larva	Protonymph	Deutonymph	Total immature stages	Life cycle
Henderson (*P. lunatus*)	4.0 ± 0.00	3.3 ± 0.17	3.2 ± 0.17	2.7 ± 0.17	9.2 ± 0.17	13.2 ± 0.17
King of the Garden (*P. lunatus*)	4.0 ± 0.00	2.8 ± 0.17	2.5 ± 90.0	2.2 ± 0.17	7.5 ± 0.00	11.5 ± 0.00
Tepary 16 (*P. acutifolius*)	4.0 ± 0.00	3.0 ± 0.00	2.3 ± 0.00	2.0 ± 0.00	7.3 ± .017	11.3 ± 0.17
Tepary 13 (*P. acutifolius*)	3.8 ± 0.17	2.7 ± 0.17	2.4 ± 0.16	2.0 ± 0.00	7.0 ± 0.00	10.8 ± 0.16
Bronco (*P vulgaris*)	3.8 ± 0.17	2.5 ± 0.00	2.3 ± 0.17	2.0 ± 0.00	6.8 ± 0.17	10.7 ± 0.17
Giza 3 (*P. vulgaris*)	3.3 ± 0.16	2.2 ± 0.17	1.8 ± 0.17	1.8 ± 0.29	5.8 ± 0.17	9.2 ± 0.17
L.S.D 0.05	0.37	0.44	0.41	0.52	0.32	0.93

Table (2): Durations of developmental stages of *T. urticae* female fed on different *Phaseolus*, cultivars and lines at 25±2°C and RH 60±5%.

Varieties	Incubation period	Larva stage	Protonymph	Deutonymph	Total immature	Life cycle
Henderson (*P. lunatus*)	4.8 ± 0.17	3.7 ± 0.33	3.3 ± 0.17	3.0 ± 0.00	10.0 ± 0.29	14.8 ± 0.44
King of the Garden (*P. lunatus*)	4.0 ± 0.00	3.0 ± 0.00	2.8 ± 0.17	2.3 ± 0.17	8.2 ± 0.17	12.2 ± 0.17
Tepary 16 (*P. acutifolius*)	4.0 ± 0.00	3.0 ± 0.00	2.5 ± 0.00	2.3 ± 0.17	7.8 ± 0.17	11.8 ± 0.17
Tepary 13 (*P. acutifolius*)	3.7 ± 0.17	2.7 ± 0.17	2.3 ± 0.17	2.0 ± 0.00	7.0 ± 0.00	10.7 ± 0.18
Bronco (*P vulgaris*)	3.8 ± 0.17	2.5 ± 0.00	2.3 ± 0.17	2.0 ± 0.00	6.8 ± 0.17	10.7 ± 0.17
Giza 3 (*P. vulgaris*)	3.5 ± 0.00	2.5 ± 0.00	2.3 ± 0.17	1.8 ± 0.17	6.7 ± 0.16	10.2 ± 0.17
L.S.D 0.05	0.39	0.46	0.58	0.37	0.55	0.72



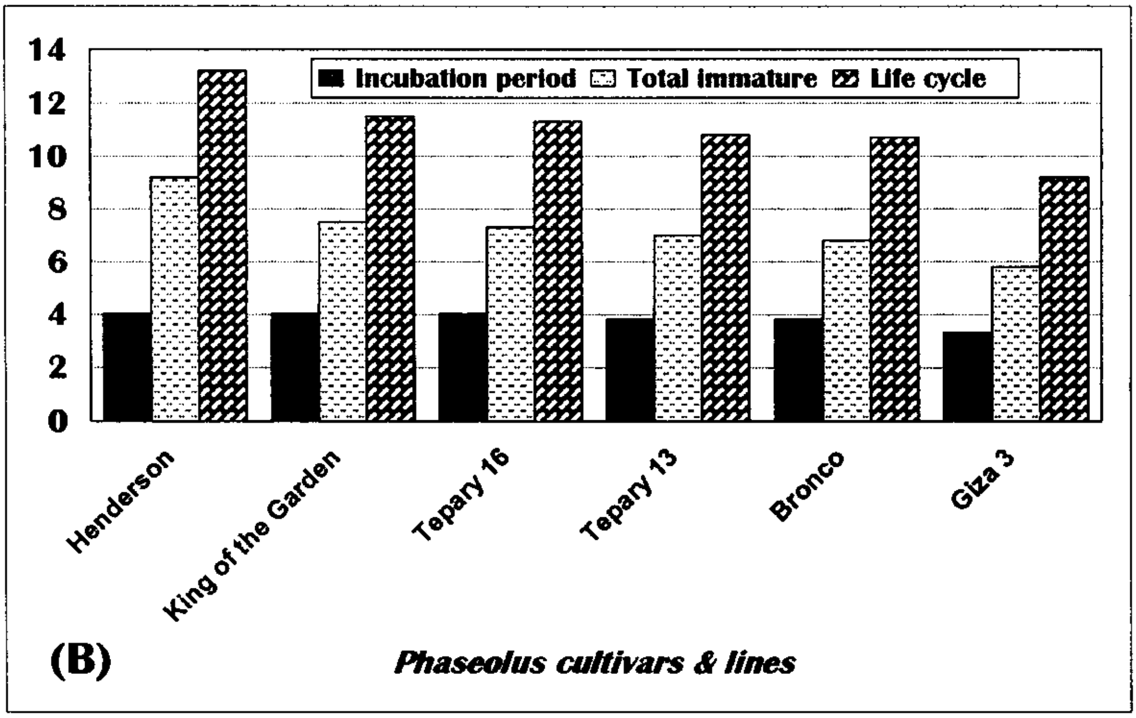


Fig. (1): Durations of developemntal stages of *T. utricae* females fed on different *Phaseolus* cultivars & lines.
(A) at 25±2 C **(B)** at 28±2 C RH = 60±5%

1980; Wahba *et al,* **1986; Faris** *et al,* **1991; Aydemir & Toros, 1992; Megali, 1997; Megali & Faris, 1997**). The periods of incubation, associated with different temperatures, were close to each other, (**Tables 1 & 2**).

B- Immature stages:-

The effects of different *Phaseolus* genotype and temperatures on the periods of different immature stages are presented in **Tables (1 & 2)**. The following are the postembryonic stages:

1. Larval stage :-

Duration of larval stage was found to be affected by both *Phaseolus* genotype and temperature degrees, under which mites developed. This duration ranged from 2.2 to 3.3 days at 28±2 °C, while at 25±2°C the larval stage required, from 2.5 to 3.7 days when the red spider mite was fed on different *Phaseolus* varieties (**Tables 1 & 2**). The longest period of larval stage was associated with Henderson cultivar, which were 3.3 or 3.7 days at temperatures of 28°C and 25°C, respectively, (**Tables 1 & 2**). It is worth mentioning that the elongation of the larval stage duration period reflects some kind of incompatible interaction between genotype of the host and the mite. Based this fact Henderson cultivar is considered more resistant to *T. utricae* comparing to the other tested *Phaseolus* genotypes, using larval stage duration period as acriterion.

2. Protonymphal stage:

Data presented in (**Tables 1& 2**), indicate that the average duration of the protonymphal stage ranged from 1.8 to 3.2 days and from 2.3 to 3.3 days when the red spider mite *T. urticae* was reared on different *Phaseolus* genotypes at 28°C and 25°C **(Tables 1 & 2)**, respectively. The longest duration period of protonymph was associated with Henderson (*P. lunatus*) cultivar since the duration period was either (28°C) 3.2 days or (25°C) 3.3 days. It is obvious that the incubation temperatures used in the present study had similar effect on the period needed for protonymphal stage. However, the *Phaseolus* genotype host had the major effect in such respect. These results disagreed with those of **Hassan & Zaher (1956), El-Atrouzy (1968), Osman (1974), Duzgunes & Cobanoglu (1983), Liu (1991), Morros & Aponte (1994) and Rao *et al.* (1996)**, who found significant effect of temperature on the duration of different developmental stages of spider mite. However, such differences could be due to using different *Phaseolus* genotypes and/ or different degrees of temperature.

3- Deutonymphal stage:

Data included in **(Tables, 1 & 2)** also show that the genotype of *Phaseolus* host had no effect on the development of the deutonymphal stage, where similar trend of the previously mentioned results, appeared to predominate. The deutonymphal duration period, lasted 2.7, 2.2, 2.0, 2.0, 2.0, and 1.8 days at temperature of 28°C, while the analogous periods lasted about 3.0, 2.3, 2.3, 2.0, 2.0 and 1.8 days at temperature of 25°C when the two spotted spider mite was fed on Henderson (*P. lunatus*), King of The Garden (*P. lunatus*), Tepary 16 (*P. acutifolius*), Tepary 13 (*P. acutifolius*), Bronco (*P. vulgaris*) and Giza 3 (*P. vulgaris*), respectively (**Tables 1 & 2**). Feeding on Giza 3 cultivar mite exhibited the shortest period of the deutonymph, which reflects considerable compatible interaction between the genotype of such host and the two spotted spider mite (*T. urticae*). These results agreed with those of **Sawires (1978), Farrag *et al.* (1980), Wahba *et al.*, (1986), Sawires *et al.* (1990), Faris *et al.* (1991), Aydemir & Toros (1992), Taha *et al.*, (1993) Chahine *et al.* (1994), Darwish *et al.* (1996), Yasin (1997), Khafagi *et al.* (1997), Megali (1997), Megali & Faris (1997), and Waheeb (1998),** who found significant effect of the genotype host on the duration period of the different developmental stages of mites, including deutonymph.

4- Total immature stages:

The average period from egg hatching till the adult emergence is known as the total immature stages. Concerning that of *T. urticae* it ranged from 5.8 to 9.2 days at 28°C, while at 25°C, this period varied from 6.7 days to 10.0 days when red spider mite (*T. urticae*) individuals were reared on the different *Phaseolus* cultivars or lines. In this respect, the tested hosts could be arranged in a descending order of preference for such development as follows Giza 3 (*P. vulgaris*) 5.8 and 6.7 days, Bronco (*P. vulgaris*) 6.8 and 6.8 days, Tepary 13 (*P. acutifolius*) 7.0 and 7.0 days, Tepary 16 (*P.

acutifolius) 7.3 and 7.8 days, King of the garden (*P. lunatus*) 7.5 and 8.2 days and Henderson (*P. lunatus*) 9.2 and 10.0 days at temperatures of 28°C and 25°C, respectively **(Tables 1 & 2) and Fig. (1 A, B).**

Based on these results, it can be mentioned that Giza 3 cultivar was highly preferred by the two-spotted spider mite, while Henderson cultivar had the lowest preference. The variations observed between the different hosts are of great value for those who are interested in designing breeding programs for beans, resistance to the spider mite *T. urticae.* Differences among *Phaseolus* genotypes concerning resistance to spider mites have been also reported by many researchers workers (**Farrag, *et al.*, 1980, Wahba, 1986, Faris *et al.*, 1991, Aydemir & Toros, 1992, Megali, 1997, Megali & Faris, 1997**).

C- Life cycle:

The period required for the life cycle of *T. urticae* was found to be affected by the different genotypes of the host plants. It is obvious from **Tables (1 & 2)** that, life cycle lasted 13.2 & 14. 8 days, 11.5 & 11.8 days, 10.8 & 10.7 days, 10.7 & 10.7 days, and 4.2 & 10.2 days, when the red spider mite *T. urticae* was fed on *Phaseolus* genotypes; Henderson, King of The Garden, Tepary 16, Tepary 13, and Bronco at temperatures of 28°C and 25°C, respectively, (**Tables 1 & 2**) and **Fig. (1A, B)**. Based on such results, the longest period of life cycle, whether measured at temperature 28°C or 25°C was associated with Henderson cultivar, which indicated that this cultivar possess certain level of resistance component(s) against *T. urticae.* On the other hand, the shorter periods of life cycle were associated with the other genotypes indicating considerable preference of *T. urticae* to such genotypes. In this respect, Giza 3 cultivar was highly-preferred by *T. urticae* **(Table 1 & 2)**.

D- Pre oviposition period:

The results presented in **Tables (3 & 4)**, show that the pre-oviposition period averaged 1.5 and 2.5 days at 28 & 25°C, respectively. In general, the longer period of pre-oviposition reflects less preference by *T. urticae* to certain genotype. Considering this fact and based on these results, it can be mentioned that the two spotted spider mite exhibits more preference to Giza 3 cultivar (1.5 days) comparing to other cultivars/lines, in descending order by, Bronco (1.7 days) cultivar Tepary 13 (2 days), Tepary 16 (2.5 days), King of the Garden (2.3 days) and Henderson (2.5 days) cultivars.

E- Oviposition period:

The obtained result presented in **Tables (3 & 4)** show that there was a strong relationship between the genotype of the host plants and the oviposition periods, which was recorded when the red spider mite *T. urticae* was reared on the different *Phaseolus* cultivars and lines. When *T. utricae* was allowed to feed on Henderson cultivar at 28°C, the oviposition period averaged 3.5 days and at 25°C, this period was 3.0 days, on the other hand, the

Table (3): Effect of *Phaseolus*, cultivars and lines on female longevity and fecundity of *T. urticae* at 28±2°C and 60±5% RH.

Varieties	Pre-oviposition period	Oviposition period	Post-oviposition period	Longevity	Life span	Fecundity
Henderson (*P. lunatus*)	2.5 ± 0.00	3.5 ± 0.00	0.5 ± 0.00	6.5 ± 0.00	19.7 ± 0.17	15.3 ± 1.45
King of the Garden (*P. lunatus*)	2.3 ± 0.17	7.0 ± 0.29	1.2 ± 0.17	10.5 ± 0.29	22.0 ± 0.29	40.0 ± 1.16
Tepary 16 (*P. acutifolius*)	2.5 ± 0.00	7.2 ± 0.17	1.5 ± 0.00	11.2 ± 0.17	22.5 ± 0.29	44.3 ± 2.60
Tepary 13 (*P. acutifolius*)	2.0 ± 0.00	8.8 ± 0.17	1.7 ± 0.17	12.5 ± 0.29	23.3 ± 0.44	70.0 ± 4.37
Bronco (*P vulgaris*)	1.7 ± 0.17	9.7 ± 0.17	2.0 ± 0.00	13.3 ± .0.17	24.0 ± 0.29	69.3 ± 5.81
Giza 3 (*P. vulgaris*)	1.5 ± 0.00	12.5 ± 0.29	2.0 ± 0.00	16.0 ± 0.28	25.2 ± 0.22	106.3 ± 6.69
L.S.D 0.05	0.33	0.66	0.32	0.76	0.99	14.1

Table (4): Effect of *Phaseolus*, cultivars and lines on female longevity and fecundity of *T. urticae* at 25±2°C and 60±5% RH.

Varieties	Pre-oviposition period	Oviposition period	Post-oviposition period	Longevity	Life span	Fecundity
Henderson (*P. lunatus*)	2.5 ± 0.00	3.0 ± 0.29	0.5 ± 0.00	6.0 ± 0.29	20.8 ± 0.17	10.3 ± 0.088
King of the Garden (*P. lunatus*)	2.5 ± 0.00	6.7 ± 0.17	1.7 ± 0.17	10.8 ± 0.17	23.0 ± 0.00	34.0 ± 2.008
Tepary 16 (*P. acutifolius*)	2.3 ± 0.17	7.3 ± 0.17	1.8 ± 0.17	11.5 ± 0.00	23.0 ± 0.00	34.0 ± 2.008
Tepary 13 (*P. acutifolius*)	2.2 ± 0.18	8.5 ± 0.29	2.0 ± 0.00	12.7 ± 0.33	23.3 ± 0.17	65.0 ± 3.005
Bronco (*P vulgaris*)	2.0 ± 0.00	10.2 ± 0.17	2.0 ± 0.00	14.2 ± 0.17	24.8 ± 0.16	70.0 ± 5.29
Giza 3 (*P. vulgaris*)	1.5 ± 0.00	12.3 ± 1.32	2.3 ± 0.00	16.1 ± 1.45	26.3 ± 1.042	91.3 ± 7.42
L.S.D 0.05	0.35	1.81	0.39	2.0	2.0	12.2

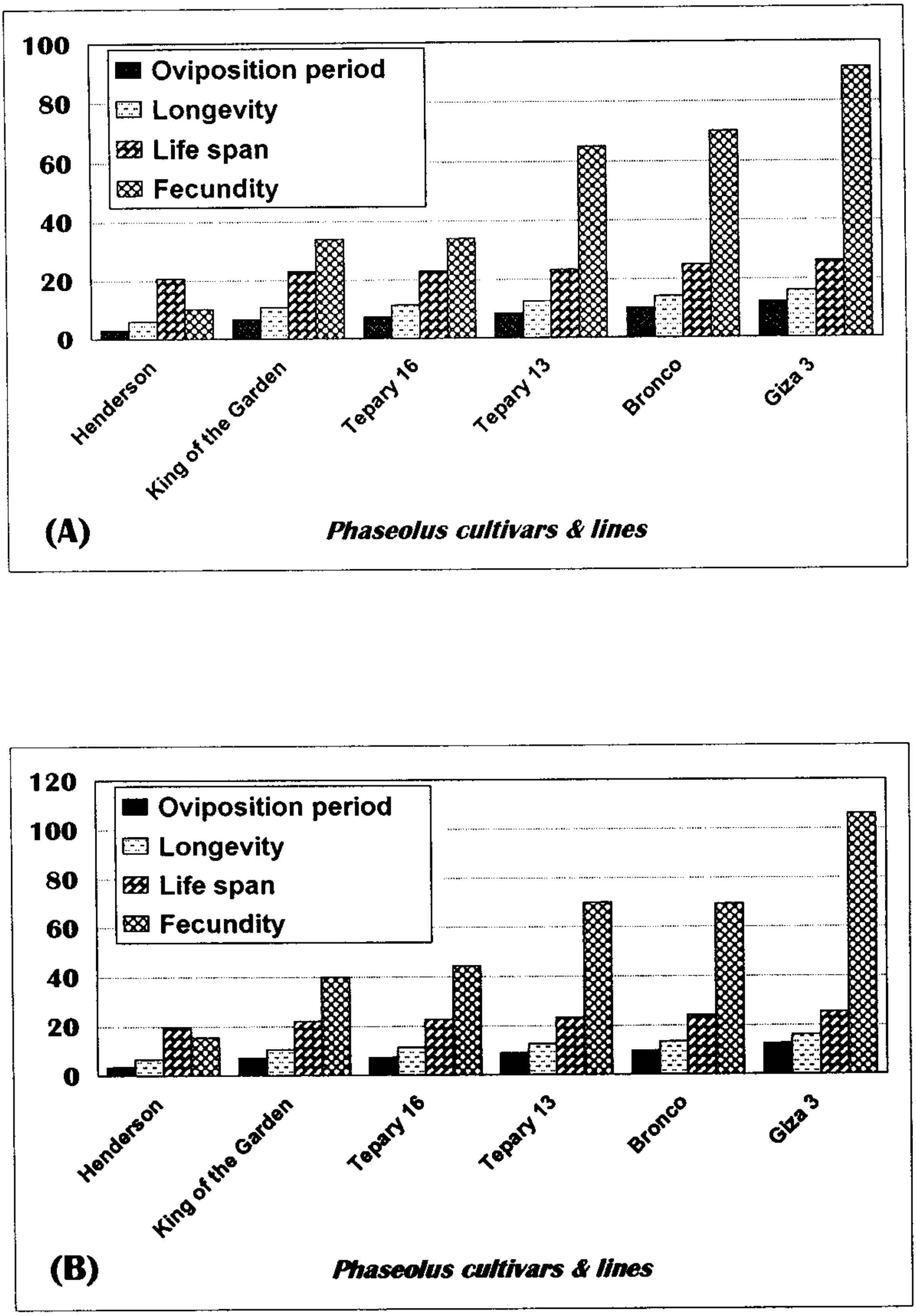


Fig. (2): Effect of *Phaseolus* cultivars & lines on female preoviposition period, longevity and fecundity of *T. utricae*.
(A) at 25±2 C (B) at 28±2 C RH = 60±5%

longest oviposition periods, (12.5 & 12.3 days, at temperatures of 28°C and 25°C, respectively), were recorded when *T. urticae* was reared on plants of Giza 3 cultivar. Variations in the oviposition period among *P. lunatus* cultivars (Henderson & King of the Garden) and among *P. acutifolius* lines (Tepary 13 & Tepary 16), were detected. The oviposition periods 3.5 and 3.0 days at temperature of 28°C and 25°C, respectively were associated with the mites reared on cultivar Henderson (*P. lunatus*) comparing to those reared on King of the Garden 7.0 and 6.7 at 28°C, respectively were shorter than those on line Tepary 13 (*P. acutifolius*) **(Tables 3 & 4) and Fig. (2 A, B)**. Furthermore, the adult females reared on the cultivars of species *P. vulgaris* showed differences in this respect, whereas the adult females reared on Bronco cultivar had shorter oviposition period than those reared on Giza 3 **(Tables 3 & 4) and Fig. (2 A, B)**. Such information are considered of great value in breeding programs for resistance to *T. urticae in* beans, especially when evaluating different parental genotypes for their resistance to this mite species. Based on those findings, it is recommended for the research workers, who will be in need to make mass production of such mite species for the purpose of biological studies, to use plants of the most preferable cultivar (*i.e.* Giza 3) in rearing *T. urticae* in the laboratory.

F- Post-oviposition period:

The post-oviposition periods ranged from 0.5 to 2.0 days, when adult females were reared on the different *Phaseolus* genotypes at 28°C, (**Table, 3**), while at 25°C the post-oviposition periods ranged from 0.5 to 2.3 days. The adult females reared on Henderson cultivar lasted alive for a very short time after laying the last egg (0.5 days at both temperatures of 28°C & 25°C), while those were reared on the other cultivars or lines had, relatively, longer post-oviposition periods (**Tables 3 & 4**). The long post-oviposition period on a certain genotype, could be an indication for some kind of preference showed by the adult females to such genotype.

G- Longevity:

The maximum period for longevity of the adult females was observed when *T. urticae* was reared on Giza 3 cultivar either at 28°C (16 days) or at 25°C (16.1 days) , while the minimum longevity period, was recorded when mite was fed on Henderson cultivar at temperatures of 28°C (6.5 days) and 25°C (6.0 days) **(Tables 3 & 4) and Fig. (2A, B)**. Additionally, duration of longevity, recorded for females of *T. urticae,* reared on King of the Garden cultivar was 10.5 days at temperature of 28°C and 10.8 days at 25°C, which indicated clear variability among different cultivars within *P. lunatus* species.

H- Fecundity:

Data, presented in **(Tables 2 & 4)** concerning fecundity reveal, affirmative relationship between fecundity (number of eggs/ female) and the genotype of the *Phaseolus* host plants. The number of eggs which was deposited by the adult female when it was fed on leaves of Giza 3 cultivar was about 7-times greater than that which was deposited on leaves of Henderson one at 28°C, while at 25°C **(Tables 3 & 4) and Fig. (2A, B)**. The number of deposited eggs by the mite adult female on leaves of Giza 3 cultivar, was 106.3 & 91.3 eggs at 28°C & 25°C, respectively, while on Henderson the mean total number of eggs deposited by the adult female was 15.3 & 10.3 eggs at temperature of 28°C & 25°C, respectively. It is worth mentioning that the lower number of eggs laid on leaves will give less number of mite individuals, which in consequence will result in less plant damage. Furthermore, it can be concluded that the less the individuals of *T. urticae,* the more, the efficiency of the control methods against the mite. Putting these facts in consideration, it can be mentioned that Henderson cultivar (*P. lunatus*) possess certain component(s) of resistance to *T. urticae*, expressed by in such low number of eggs / female (Fecundity) counted on the leaves of this cultivar. Such components could have negative effect on the fertility of the adult females of *T. urticae*.

4.1.2. Histological Studies

4.1.2.1 Thickness of leaf epidermis:

Results presented in **Table (5)** and **Fig. (3)** show that Henderson and King of the garden cultivars (*P. lunatus*) had higher thickness of upper leaf surface epidermis than that of the other cultivars or lines. In addition Henderson (*P. lunatus*) cultivar had the highest thickness of epidermis at the lower leaf surface, which was 23.6 μ, followed by Tepary 16 line (18.6 μ) King of the Garden

Table (5): Thickness of both upper and lower leaf epidermis and number, and length of hairs on lower leaf surface of six *Phaseolus*, cultivars and lines.

Varieties	Epidermis thickness (μ) (upper leaf surface)	Epidermis thickness (μ) (lower leaf surface)	Number of leaf hairs / mm^2	Length of leaf hairs (μ)
Henderson (***P. lunatus***)	30.9	23.6	22.5	121.6
King of the Garden (***P. lunatus***)	32.0	16.5	23.0	241.6
Tepary 16 (***P. acutifolius***)	22.7	18.6	17.0	91.2
Tepary 13 (***P. acutifolius***)	21.6	15.5	14.0	119.2
Bronco (***P vulgaris***)	22.6	13.4	14.0	64.5
Giza 3 (***P. vulgaris***)	23.8	13.4	8.0	88.8
L.S.D 0.05	8.14	4.7	8.6	60.5

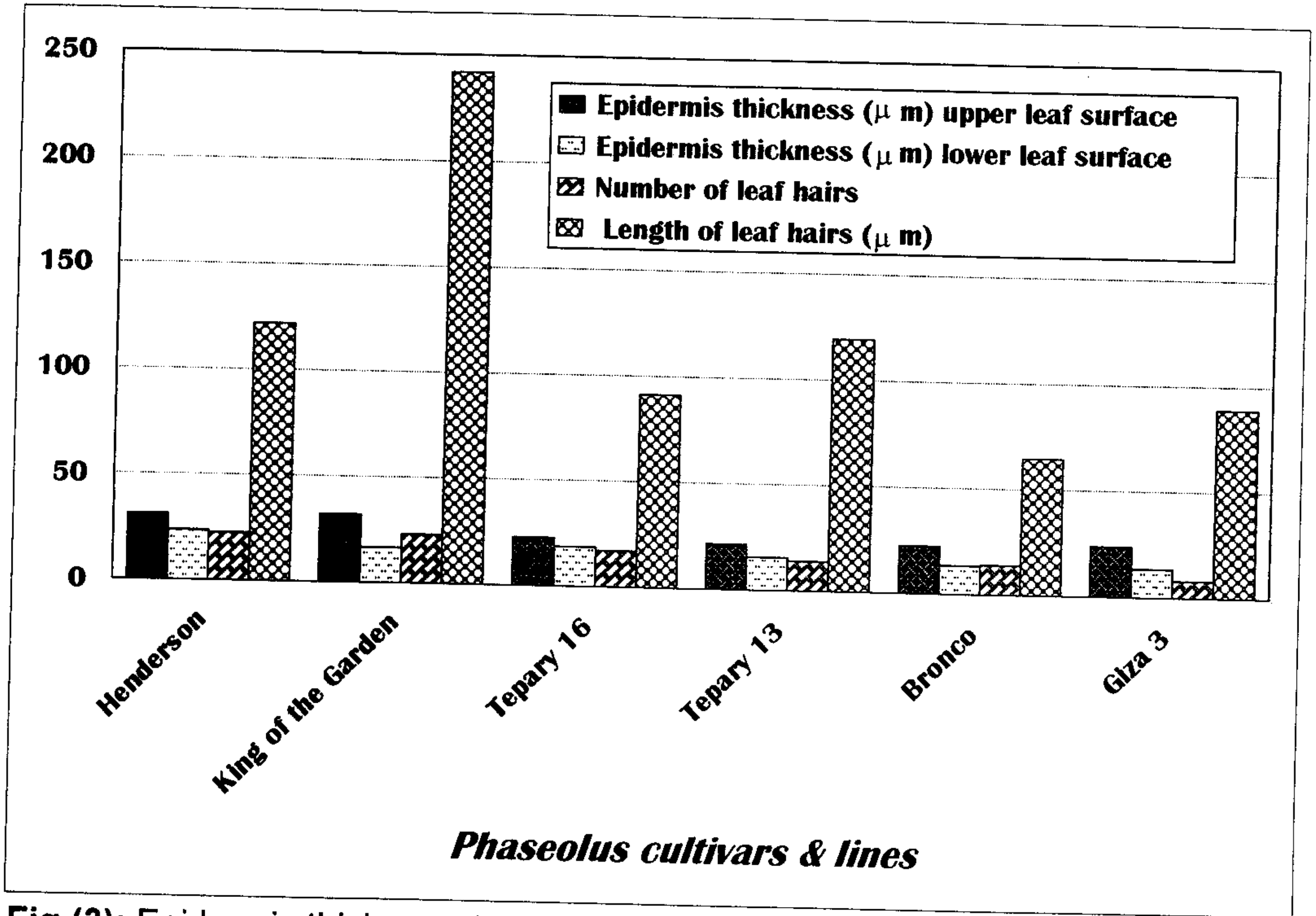


Fig.(3): Epidermis thickness (μm), number and length of leaf hairs on upper and lower surfaces of six *Phaseolus* cultivars and lines cultivars (16.5 μ), Tepary 13 line (15.5μ), Bronco cultivar (13.4 μ), and Giza 3 cultivar (13.4 μ) **(Table 5)**. The high thickness of epidermis especially that of the lower surface can be considered as a physical resistance factor, against feeding mechanism of *T. urticae*. Putting this fact in consideration it can be mentioned that Henderson (*P.lunatus*) cultivar possess such physical resistance factor against *T. urticae* which, negatively interferes with the feeding mechanism of the two spotted spider mite *T. urticae*.

4.1.2.2. Density of the leaf hairs

The highest density of leaf hairs was associated with King of the Garden (*P. lunatus*), cultivar (23.0 mm^2), followed in descending order by Henderson (*P. lunatus*), cultivar (22.5 mm^2), Tepary 16 line (*P. acutifolius*) (17.0 mm^2), Tepary 13 line (*P. acutifolius*) (14.0 mm^2), Bronco (*P. vulgaris*) cultivar (14.0 mm^2), and Giza 3 (*P. vulgaris*) cultivar (8.0 mm^2), **Table (5) & Fig. (3)**. Differences between Henderson and King of the Garden (*P. lunatus*) cultivars, and Tepary 16 (*P. acutifolius)* line concerning hair density, were not significant.

It is a matter of fact that the presence of hairs on plant parts is considered as a physical resistance factor. However, certain aspects concerning hairs, such as density, length, and position on various plant parts together contribute to the efficiency of such physical resistance factor. The relatively high density of hairs associated with Henderson and King of the Garden cultivars could have an adverse effect on the feeding and/or oviposition of *T. urticae*.

4.1.2.3. Length of the leaf hairs:

The length of the leaf hairs associated with King of the Garden (*P. lunatus*) cultivar (241.6µ) was, significantly longer than that associated with the other cultivars or lines, [*i.e.*, Henderson (*P. lunatus*) cultivar (121.6µ), Tepary 16 (*P. acutifolius*) line (91.2µ), Tepary 13 (*P. acutifolius*) line (119.2), Bronco cultivar (*P. vulgaris*) (64.5µ), and Giza 3 cultivar (*P. vulgaris*) (88.8 µ) **(Table 5)& Fig. (3)**.

Based on the results obtained in the present study, it can be mentioned that King of the Garden cultivar (*P. lunatus*) posses genes for high number and length of leaf hairs, which are considered as important aspects of physical resistance factors against *T. urticae*. **Fig. (4a & 5a)** show the relatively high thickness of the epidermis of both the upper and lower leaf surfaces of Henderson and King of the Garden (*P. lunatus*) cultivars comparing to those of the other *Phaseolus* genotypes **(Figs. 6a, 7a, 8a, and 9a).** Furthermore, **(Fig. 5b)** show that length of the leaf hairs of King of the Garden cultivar, was more than that of the other *Phaseolus* cultivars **(Figs 4b, 6b, 7b, 8b & 9b).** Such variation observed among the different *Phaseolus* genotypes should be put in consideration, when the nature of bean resistance to *T. urticae* is needed to be studied, because both hair density and length are considered as resistance factors not only against *T. urticae*, but also against other serious insects and mites.

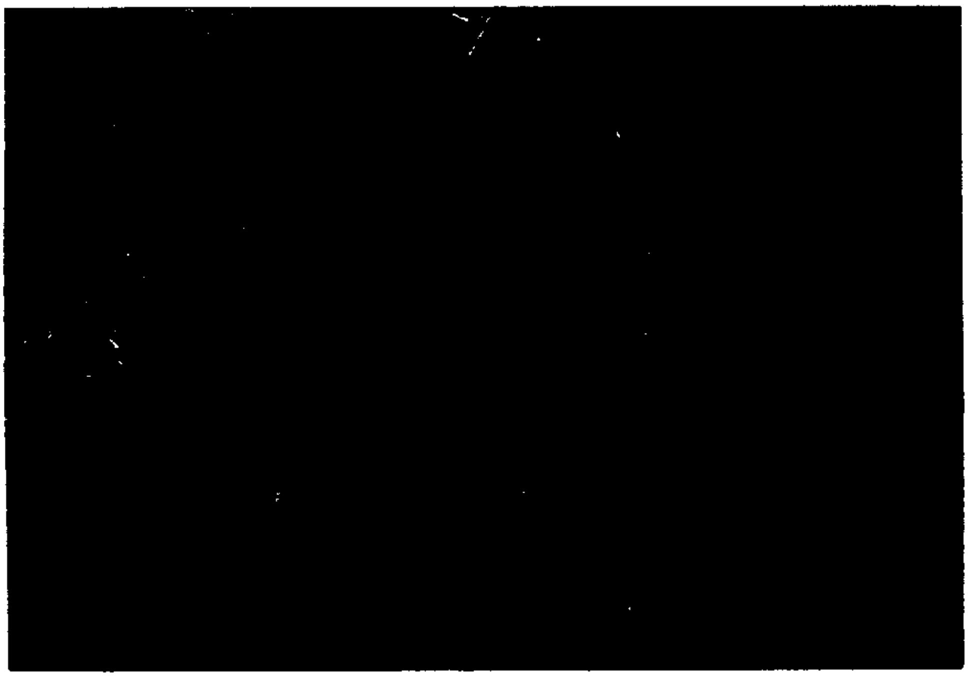


Fig. (6A): Upper and lower leaf epidermis of Tepary 16 line (*P. acutifolius*).

Fig. (6b): Length and density of leaf hairs on the lower surface of Tepary 16 line (*P. acutifolius*).

Fig. (7A): Upper and lower leaf epidermis of Tepary 13 line (*P. acutifolius*).

Fig. (7b): Length and density of leaf hairs on the lower surface of Tepary 13 line (*P. acutifolius*).

Fig. (8A): Upper and lower leaf epidermis of Bronco cultivar (*P. vulgaris*).

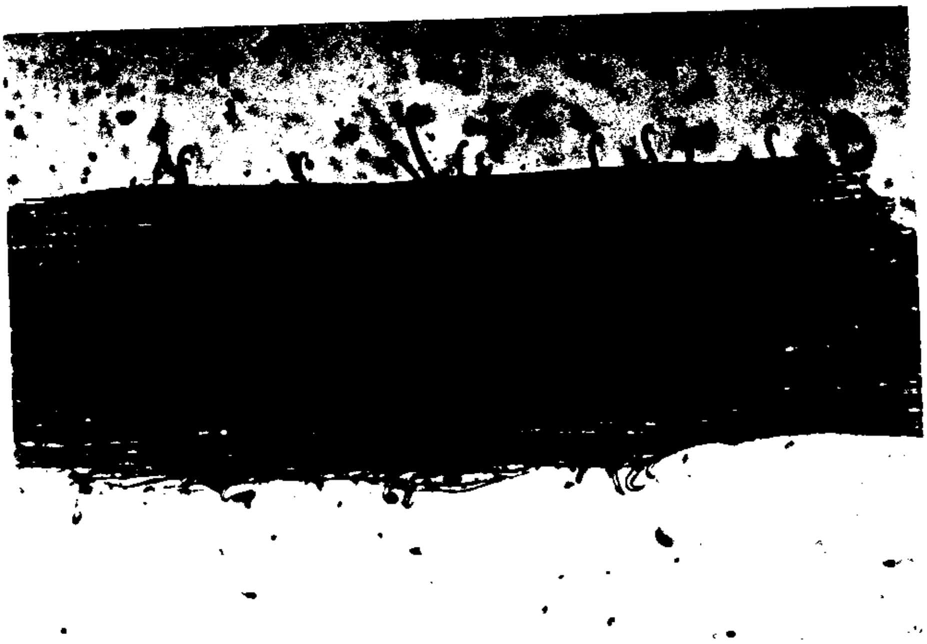


Fig. (8b): Length and density of leaf hairs on the lower surface of Bronco cultivar (*P. vulgaris*).

Fig. (9A): Upper and lower leaf epidermis of Giza 3 cultivar (*P. vulgaris*).

Fig. (9b): Length and density of leaf hairs on the lower surface of Giza 3 cultivar (*P. vulgaris*).

4.1.2.4. Relationship between biological and histological aspects of leaves:

Positive correlations were observed between thickness of epidermis in the upper as well as in the lower surfaces and each of incubation period duration of each of the larval protonymphal and deutonymphal stages, life cycle and pre-oviposition period **(Table, 6).** In contrast, negative correlations were observed between thickness of the epidermis in both upper and lower leaf surfaces and each of oviposition and, post-oviposition periods, female longevity, life span, and number of eggs per female (fecundity) **(Table 6).**

It is worth mentaining here that thickness of the epidermis is considered as an important component of resistance against *T. urticae* because the high thickness of leaf epidermis, especially that of the upper surface, will negatively affect the feeding process of such mite. Results obtained here support this fact. For example, the decreasing observed in oviposition period and female fecundity due to the increase in the thickness of the upper leaf epidermis (r = –0.51 & – 0.55, respectively) or the lower one (r = –0.79 & –0.72, respectively). These results indicate that such character can be considered as a resistance factor against the two-spotted spider mite (*T. urticae*). The importance of leaf epidermis as a resistance factor against several mite and insect species has been reported by some researchers **(McGregor & McDonough, 1917; Kuehen, 1951, Baker & Connell, 1963, Mohamed, 1964, Kou-Koung *et al.*, 1972).**

Table (6): Correlation coefficient between biological aspects of the red spider mite *T. urticae* and histological measurements of leaves of *Phaseolus* sp.

Anatomical measurements of leaves	Incubation period	Duration of larval stage	Duration protonymphal stage	Duration of Deuto. Stage	Deuration of immature stages	Life cycle	Pre oviposition period	Oviposition period	Post oviposition	Female longevity	Life span	No. of eggs (fecundity)
Thickness of upper leaf surface epidermis	0.306	0.498	0.328	0.604**	0.520*	0.511*	0.453	-0.514*	-0.567**	-0.528*	-0.514*	-0.545
Thickness of lower leaf surface epidermis	0.409	0.695**	0.748**	0.561**	0.825**	0.792	0.632**	-0.790**	-0.790**	-0.793**	-0.728**	-0.717**
No. of hairs / mm2	0.742**	0.657**	0.695**	0.518**	0.783**	0.836	0.766**	-0.782**	-0.782**	-0.849**	-0.848**	-0.862**
Length of leaf hairs	0.413	0.205	0.309	0.079	0.262	0.319	0.346	-0.400	-0.400	-0.358	-0.308	-0.343

Results presented in **(Table 6)** show, highly significant positive correlations between density of leaf hairs and each of the incubation period, of each of larvae, prtonymphal, and deutonymphal stages, life cycle, and pre-oviposition period. On the other hand, highly negative correlations were observed between density of leaf hairs and each of oviposition and post-oviposition periods; female longevity life span and female fecundity **(Table 6)**. Based on the calculated correlation coefficients, the decrease in the period of oviposition, female longevity, and fecundity is the result of the increase in leaf hairs density (r= –0.78, –0.85 & –0.86, respectively). These results indicate that leaf hairs density can be considered as a factor of resistance against *T. urticae*.

This could be due to the interference of high density of leaf hairs with feeding and laying eggs of the two spotted spider mite females. The results presented in **Table (6)** show that the observed correlations between length of leaf hairs and different biological aspects, had about similar trend to what was observed in the correlation between leaf hair density and different biological aspects. However, correlation coefficients appeared insignificant.

These results indicate that, density of leaf hairs is considered, was more effective defense mechanism against mites, than length of leaf hairs. Density and length of leaf hairs as resistance factors against mites in different plant species have been reported by some researchers **(Abu El-Nasr, 1960; Butler *et al.*, 1986; Heyer *et al*, 1986 & Megali, 1997).**

4.1.3. Chemical composition of leaves:

During both seasons of 1997 and 1998, leaves of Henderson had the lowest nitrogen content, while those of Giza 3 cultivar had the highest one **(Tables 7 & 8); Figs. (10 A, 11A).** Concerning leaf phosphorus content, the lowest percentages (0.21%&0.27%) were associated with Henderson cultivar, while the higher percentages were observed in Tepary 13 line (0.40% & 0.35%), Bronco cultivar (0.31% & 0.33%) and Giza 3 cultivar (0.35% & 0.38%), during seasons of 1997 and 1998, respectively.

Respecting leaf potassium content, the lowest percentages were associated with Giza 3 (*P. vulgaris*) cultivar (1.30% & 1.40%), while the highest ones were associated with Henderson cultivar (2.51% & 2.64%), during the seasons of 1997 and 1998, respectively **(Tables 7 & 8).**

The lowest leaf sodium content in 1997 season, was associated with Giza 3 cultivar (0.37%), while in 1998, the lowest percentages were associated with Tepary 16 line (0.38%) and Giza 3 cultivar (0.45%). On the other hand, the highest percentages of leaf sodium content were associated with King of the Garden cultiver (0.64% & 0.66%), followed by Henderson (0.58% & 0.59%), in 1997 and 1998 seasons, respectively.

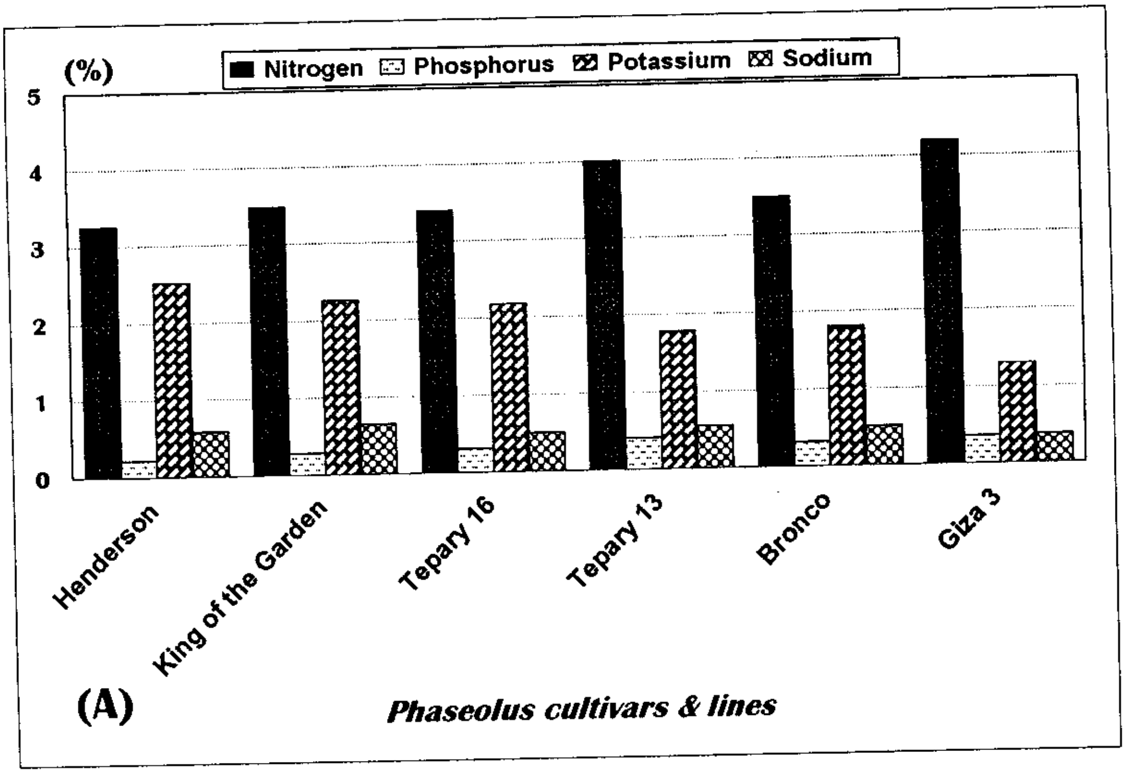
Respecting reducing, non- reducing and total sugars contents of leaves, the highest percentages were associated with Giza 3 cultivar, during both of 1997 and 1998 seasons **(Tables 7 & 8); Figs. (10B & 11B).** On the other hand, the lowest percentages of

Table (7): Chemical composition of dry leaves for six *Phaseolus*, cultivars and lines during season of 1997.

Varieties	Nitrogen %	Phosphorus %	Potassium %	Sodium %	Reducing sugars %	Non-Reducing sugars%	Total sugars %	Protein %
Henderson **(*P. lunatus*)**	3.25	0.21	2.51	0.58	4.60	5.73	10.37	20.31
King of the Garden **(*P. lunatus*)**	3.48	0.28	2.26	0.64	4.33	5.83	10.17	21.79
Tepary 16 **(*P. acutifolius*)**	3.40	0.30	2.17	0.49	5.17	6.37	11.53	21.25
Tepary 13 **(*P. acutifolius*)**	4.00	0.40	1.79	0.54	5.33	6.10	11.43	25.59
Bronco **(*P vulgaris*)**	3.50	0.31	1.80	0.50	5.97	6.47	12.43	21.87
Giza 3 **(*P. vulgaris*)**	4.19	0.35	1.30	0.37	6.60	7.87	14.47	26.21
L.S.D 0.05	0.47	0.13	0.55	0.24	3.46	1.5	2.38	2.95

Table (8): Chemical composition of dry leaves for six *Phaseolus*, cultivars and lines during season 1998.

Varieties	Nitrogen %	Phosphorus %	Potassium %	Sodium %	Reducing %	Non-Reducing %	Total sugars %	Protein %
Henderson (*P. lunatus*)	3.20	0.27	2.64	0.59	6.13	5.80	11.93	19.97
King of the Garden (*P. lunatus*)	3.78	0.28	2.26	0.66	5.60	5.47	11.07	23.60
Tepary 16 (*P. acutifolius*)	3.66	0.28	1.85	0.38	6.23	5.97	12.20	22.85
Tepary 13 (*P. acutifolius*)	4.05	0.35	1.77	0.49	6.27	6.40	12.67	25.33
Bronco (*P vulgaris*)	3.70	0.33	1.74	0.53	6.30	7.33	13.63	23.10
Giza 3 (*P. vulgaris*)	4.15	0.38	1.40	0.45	8.86	8.87	17.73	25.93
L.S.D 0.05	0.48	0.12	0.43	0.16	4.5	2.09	2.88	3.06



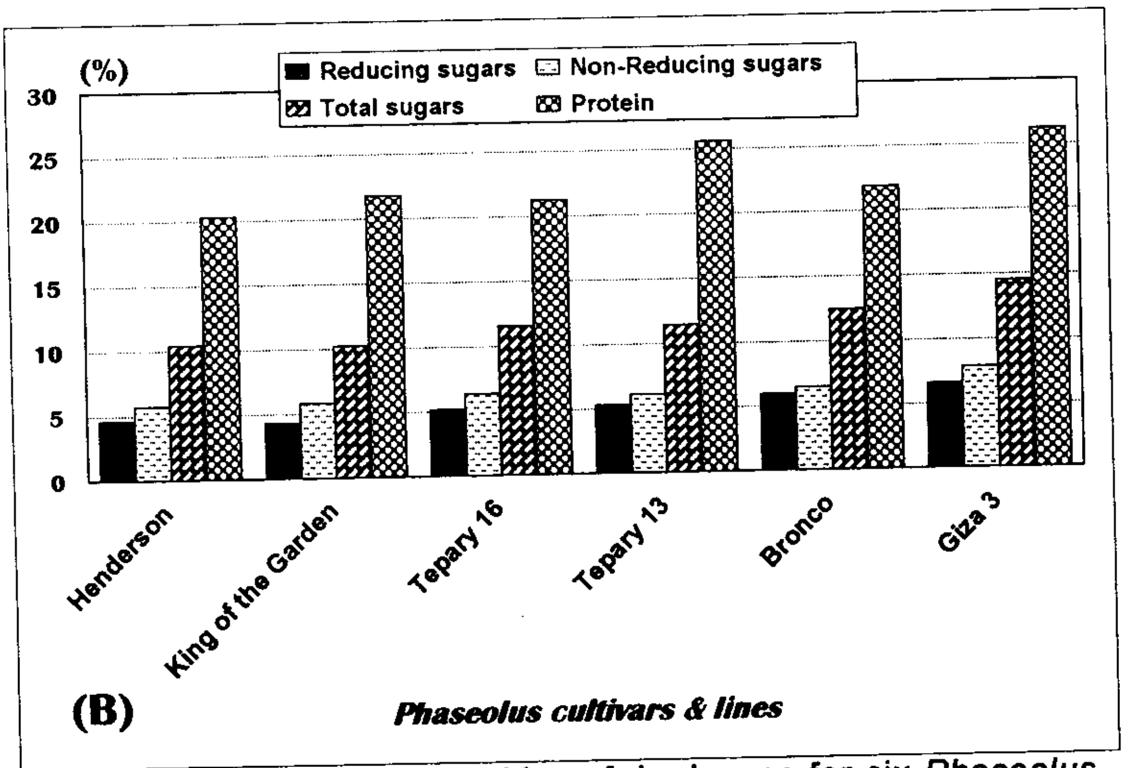
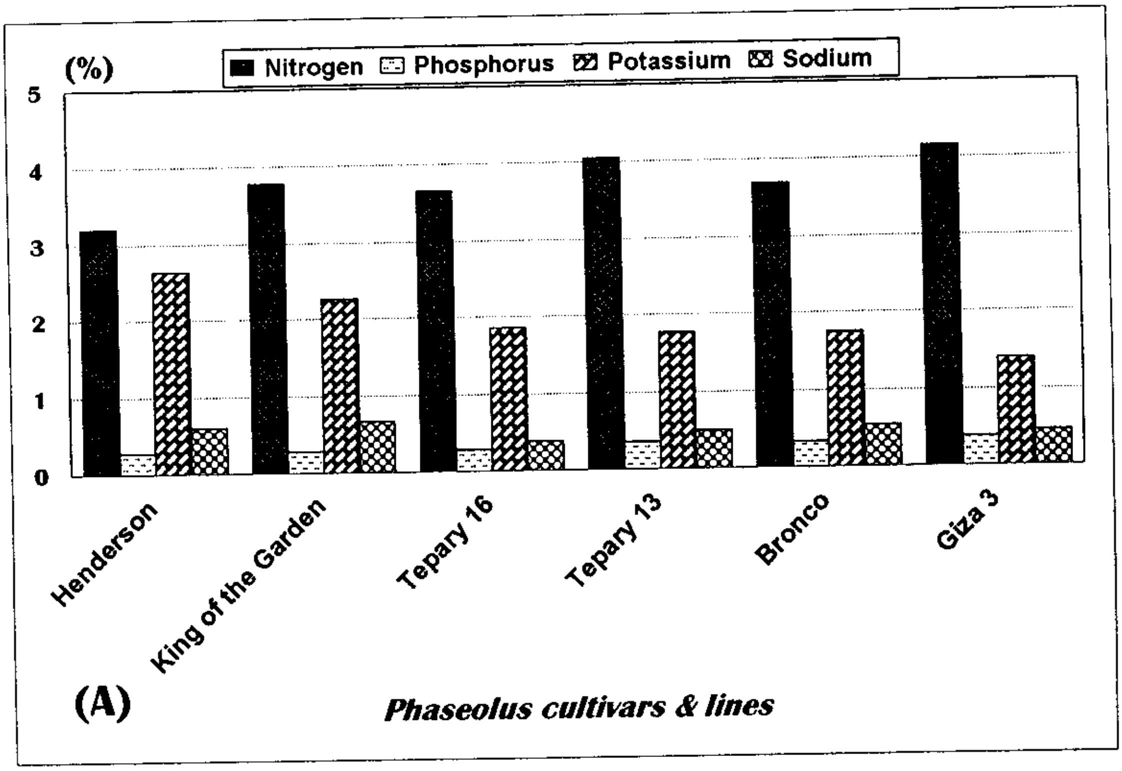


Fig. (10): Chemical composition of dry leaves for six *Phaseolus* cultivars during season of 1997.



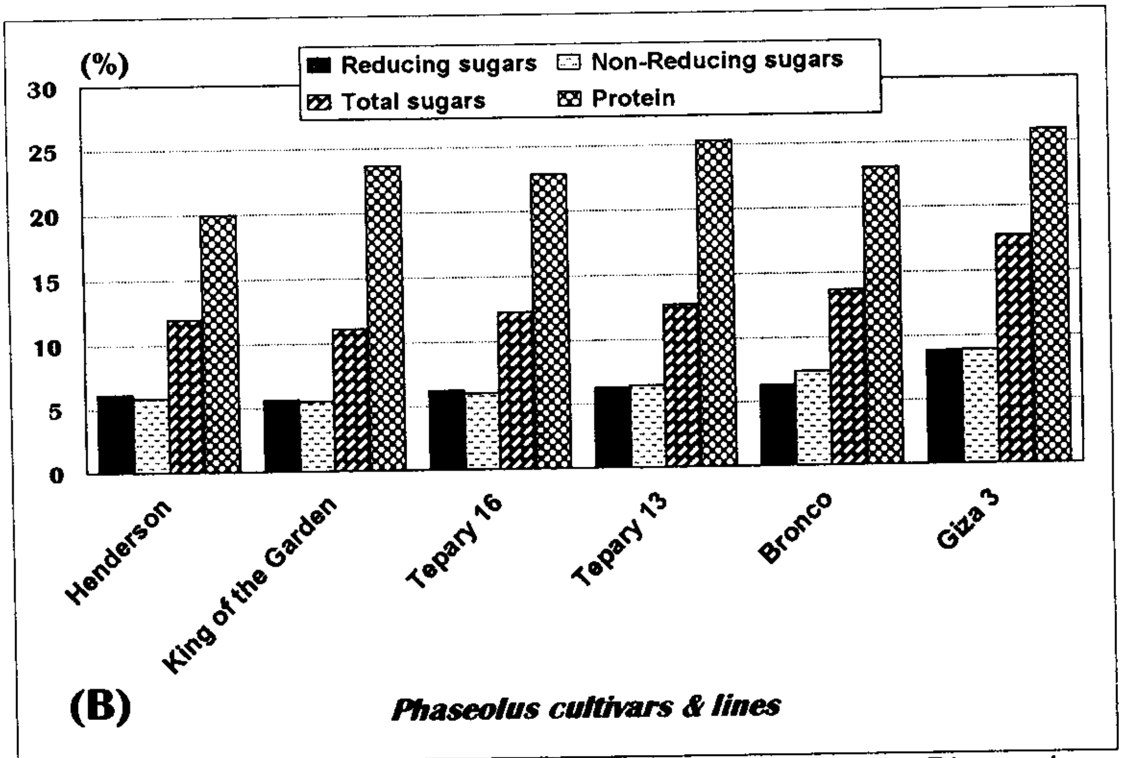


Fig. (11): Chemical composition of dry leaves for six *Phaseolus* cultivars during season of 1998.

reducing, non-reducing, and total-sugars of leaf content were associated with Henderson and King of the Garden cultivars in the seasons of 1997 and 1998 **(Tables 7 & 8); Figs. (10B & 11B)**. In both 1997 and 1998 seasons, Giza 3 (*P. vulgaris*) cultivar had the highest leaf protein contents, while Henderson (*P. lunatus*) cultivar had the lowest leaf protein contents **(Tables 7 & 8).**

Results presented in **Table (9)** show, significant negative correlations between incubation period and each of leaf nitrogen, phosphorus, reducing-, non-reducing-, and total-sugars, and protein contents and incubation period. In addition, significant negative correlations between leaf nitrogen, phosphorus, reducing-, non-reducing-, and total-sugars, and protein contents and duration of each of the various immature stages the larval, protonymphal and deutonymphal stages durations. It is worth mentioning here, that the reduction of the incubation period and immature stage duration will result in shorter life cycle of *T. urticae* which means more damage to plants of *Phaseolus* species in shorter time. Such conclusion was, partially supported by the significant negative correlations, which were found in both seasons of 1997 and 1998 between leaf nitrogen, phosphorus, reducing-, non-reducing- and total-sugars, and protein contents, and life cycle **(Table 9)**.

In addition, significant negative correlations were observed between leaf nitrogen, phosphorus, reducing-, non-reducing- and total-sugars, and protein contents and pre-oviposition period. Furthermore, significant positive correlations between leaf nitrogen, phosphorus, reducing-, non-reducing, and total-sugars and protein contents, and

Table (9): Correlation coefficient (r) between chemical composition of leaves and biological aspects of the two-spotted spider mite (*T. urticae*) reared on different genotypes of *Phaseolus* species.

Leaf chemical composition	Season	Incubation period	Duration of larvae stage	Duration protonymph stage	Duration of deutonymph stage	Duration of immature stages	Life cycle	Pre-oviposition period	Oviposition period	Post-oviposition	Female longevity	Life span	No. of eggs (fecundity)
Nitrogen	1997	-0.68**	- 0.51 *	-0.62**	-0.53*	-0.61**	-0.64**	-0.59**	0.66**	0.60**	0.60**	0.65**	0.70**
	1998	- 0.38	-0.81**	- 0.53*	- 0.52*	-0.75 **	-0.72**	-0.53*	0.74**	0.63**	0.74**	0.74**	0.75**
Phosphorus	1997	-0.43	-0.48*	-0.61**	-0.50*	-0.59**	-0.56*	-0.50*	0.40	0.67**	0.43	0.23	0.50*
	1998	-0.63**	-0.43*	-0.40	-0.34	-0.48	-0.55*	0.57**	0.59**	0.46	0.56**	0.59**	0.59**
Potassium	1997	0.74	0.56	0.66**	0.78**	0.74**	0.75**	0.63**	-0.76**	-0.69**	0.75**	-0.68**	-0.80**
	1998	0.51	0.82**	0.86**	0.49	0.92**	0.90**	0.64**	-0.88**	-0.93**	-0.92**	-0.88**	-0.85**
Sodium	1997	0.32	0.25	0.27	0.46*	0.36	0.35	0.43	-0.51*	-0.25	-0.46*	-0.52*	-0.50*
	1998	0.09	0.26	0.36	0.12	0.34	0.31	0.15	-0.30	-0.41	-0.34	-0.33	-0.31
Total sugars	1997	-0.68**	-0.51*	-0.62**	-0.53*	-0.61**	-0.64*-*	-0.59**	0.66**	0.60**	0.65**	0.56**	0.70**
	1998	-0.38	-0.81**	-0.53	-0.52*	-0.75**	0.72**	-0.53*	0.74**	0.63**	0.74**	0.73**	0.75**
Reducing sugars	1997	-0.43	-0.54*	-0.33	-0.37	-0.46*	-0.46*	-0.66**	0.53*	0.44	0.50*	0.42	0.61**
	1998	-0.65**	-0.26	-0.48*	-0.02	-0.39	-0.59**	-0.50*	0.60**	0.50*	0.57**	0.60**	0.57**
Non-Reducing sugars	1997	-0.52*	-0.54*	-0.39	-0.50*	-0.36	-0.54*	0.65**	0.62**	0.49*	0.59**	0.53*	0.71**
	1998	-0.65**	-0.26	-0.48*	-0.02	-0.39	-0.48*	-0.39	0.48*	0.37	0.47*	0.50*	0.47*
Protein	1997	-0.31	-0.49*	-0.24	-0.22	-0.64**	-0.35	-0.59**	0.40	0.35	0.36	0.28	0.45
	1998	-0.97**	-0.49*	-0.47*	-0.03	-0.45*	-0.57**	-0.50*	0.54	0.51*	0.54*	0.56	0.53

each of the oviposition, life span, and female's fecundity **(Table 9).** These results indicate that the increase in leaf contents of nitrogen, phosphorus, sugars, and/or proteins will have a positive effect on female longevity, life span, female fecundity, which in consequence, will result in more damage to plants, which have high leaf contents of the previously mentioned chemical compounds.

The presence of such chemical compounds at certain levels in leaf tissues could affect both cell size, structure of leaf tissues, as well as nutritional value and taste of plant cell sap which in consequence, might have direct or indirect effects on the feeding and fertility of *T. urticae*. More research works are still needed in this respect. However, the effect of nitrogen on the duration of different developmental stages was early reported by **Hamstead & Gould (1957), Henneberry & Schriver (1964), Van Devrie & Boersma (1970), Farrag *et al.* (1980), Lewis (1994) and Taha & El-Raies (1996)**. In addition, similar results were observed by **Mohamed (1982)** who found positive correlation between leaf phosphorus content and the level of damage caused by phytophagous mites.

Positive correlations between leaf contents of potassium and sodium and each of, incubation period, duration of the different immature stages, life cycle, and pre-oviposition period, were observed in both seasons of 1997 and 1998 **(Table 9).** However, the correlation coefficients in case of leaf sodium content did not reach the level of significance. It is worth mentioning here, that prolonging each of incubation periods and durations of different immature stages will prolong life cycle and pre-oviposition period.

In case of the presence of potassium or sodium, at relatively high levels in leaf tissues of bean plants *(Phaseolus sp)*, reflects an adverse effect for these elements on the previously mentioned biological aspects of *T. urticae*. On the other hand, negative correlations were observed between both leaf potassium and sodium contents and each of oviposition period, post-oviposition period, female longevity, life span, and fecundity **(Table 9)**. It should be noted that reducing of oviposition period, and female fecundity, as a result of the presence of potassium and sodium in the leaf tissues at, relatively high levels will cause less damage to bean plants because the next generation of *T. urticae* will have low population comparing to the damage, which may occur in case of prolonging the oviposition period and/or increasing number of eggs/female. Such negative effects of the relatively high levels of potassium and sodium in bean leaf tissues, observed in the present study could be due to the effect of these elements on cell size, leaf tissue structure, and/or chemical compositions of cell sap, which may, consequently create the unsuitable taste or nutritional value for feeding and oviposition of *T. urticae*. However, more research works are needed to explore the obscure points in this respect.

These results agreed with that of **Emedn (1966), Mohamed (1982) and Ibrahim (1987)** who found that increasing of potassium level resulted in decreasing the damage caused by mites. In addition, results found in the present study, agreed with that of **Taha & El-Raies (1996),** who observed considerable decrease in damage caused by mites due to the increase in leaf sodium content.

4.2. Plant resistance of *Phaseolus* genotypes to the red-spider mite (*T. urticae*) infestation:

4.2.1. Density of mite eggs/inch^2 of plant leaf area:

Results presented in **Tables (10 & 11); Fig. (12A,B)** show that the lowest numbers of eggs counted on leaves inch^2 under natural and artificial infestation with *T. urticae* during both seasons of 1997 and 1998, were associated with Henderson cultivar (*P. lunatus*) while the highest numbers of eggs were associated with Giza 3 cultivar (*P. vulgaris*). These results indicated that Giza 3 cultivar was more preferred by *T. urticae*, comparing to other cultivars or lines. In addition, the plants sap sucked up by *T. urticae* from leaf cells of Henderson cultivar could have certain substances which might have negative effect on fertility of adult female of *T. urticae* resulting in low number of laid eggs per inch^2 of examined leaves, even in the advanced weeks of counting (**Table 10 & 11).**

In general, the number of laid eggs, counted on leaves per inch^2 of the different cultivars under natural and artificial infestation conditions increased in the advanced weeks of counting, during both seasons of 1997 and 1998 **(Tables 10 & 11).** The number of laid eggs reached the maximum in the 6th or 7th week of counting and then, it was, clearly observable that in the 8th week of counting in cases of Tepary 16 and Tepary 13 lines (*P. acutifolius*) and Bronco and Giza 3 cultivar (*P. vulgaris*) (during both seasons of 1997 and 1998) *T. urticae* laid by females eggs started to decrease **(Tables 10 & 11),** which could be attributed to the dryness of the foliage of the previously mentioned susceptible cultivars and lines.

Table (10): Numbers of counted eggs of *Tetranychus urticae* Koch. on leaves ($inch^2$) of different *Phaseolus* cultivars or lines under artificial and natural infestation conditions in the field, during season of 1997.

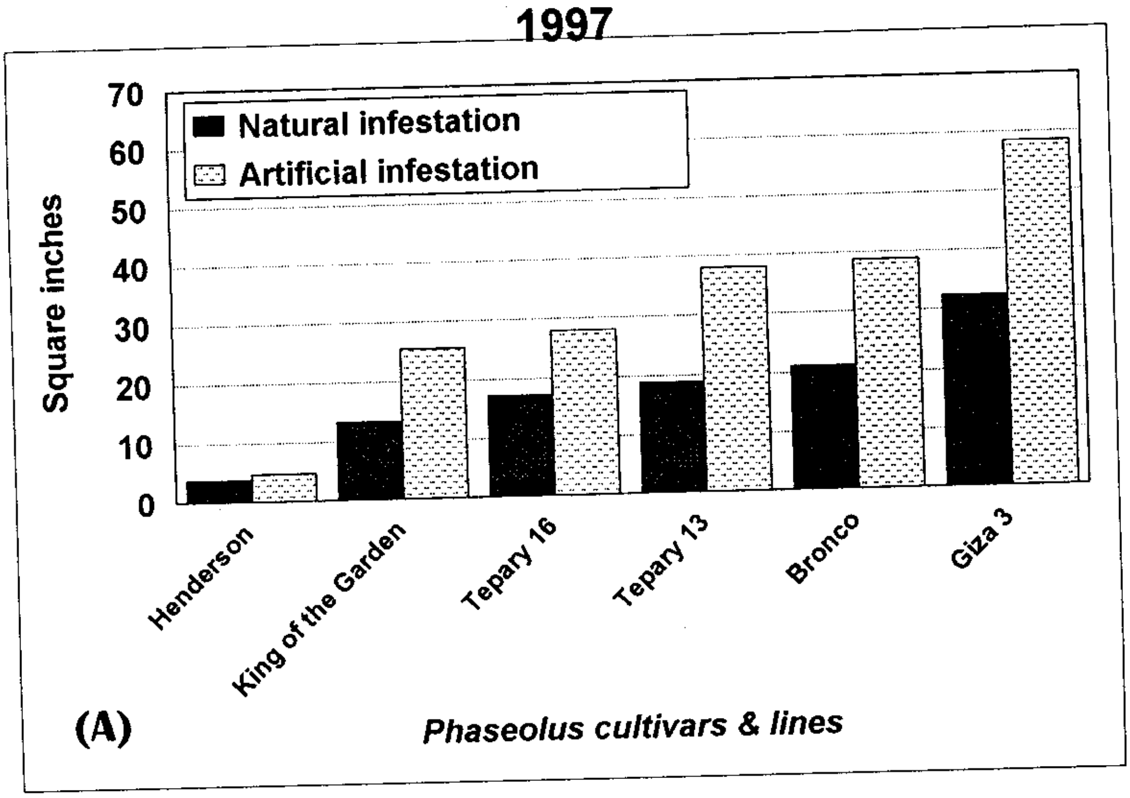
Week of counting	**Henderson** *P. lunatus*		**King of the Garden** *P. lunatus*		**Tepary 16** *P. acutifolius*		**Tepary 13** *P. acutifolius*		**Bronco** *P. vulgaris*		**Giza 3** *P. vulgaris*	
	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.
1st week	0.7	0.9	1.7	1.8	1.7	2.9	2.5	3.2	2.1	3.5	3.7	6.9
2nd week	1.5	1.3	3.1	5.5	3.2	6.8	4.1	8.4	3.8	10.0	9.2	14.6
3rd week	2.1	2.1	5.6	11.1	9.4	14.0	10.6	17.6	11.8	20.5	18.3	38.5
4th week	2.9	3.7	8.6	19.8	1.4	19.8	13.1	32.0	15.7	34.5	25.7	63.8
5th week	3.6	4.9	12.6	30.8	19.4	38.6	22.0	50.1	24.6	52.1	39.4	85.1
6th week	4.5	5.8	16.9	36.8	33.5	44.1	30.8	67.8	37.2	65.3	67.7	123.7
7th week	6.1	8.5	23.6	44.3	35.1	52.1	41.1	74.4	42.8	70.8	58.7	93.1
8th week	8.2	10.5	34.3	54.7	24.6	45.7	62.5	49.6	30.8	53.1	35.2	41.7
Mean	3.7	4.7	13.3	25.6	17.2	27.9	18.8	37.9	21.1	38.7	32.2	58.4

1- $L.S.D_{0.05}$ to compare between means of two cultivars or Lines (averaged overall counting weeks) under the same or different infestation conditions = 1.8
2- $L S D_{0.05}$ to compare between means of two counting means at the same combination of infestation condition and cultivars or lines = 6.2
3- $L S D_{0.05}$ to compare between means of two cultivars or lines at the same combination of infestation condition and cultivar or line = 7.0
4- $L S D_{0.05}$ to compare between means of two infestation conditions at the same combination of cultivar or line and the week of counting = 15.3.

Table (11): Numbers of eggs of *Tetranychus urticae* Koch., counted on leaves ($inch^2$) of the different *Phaseolus* cultivars or lines under the artificial and natural conditions in the field, during season of 1998.

Week of counting	Henderson *P. lunatus*		King of the Garden *P. lunatus*		Tepary 16 *P. acutifolius*		Tepary 13 *P. acutifolius*		Bronco *P. vulgaris*		Giza 3 *P. vulgaris*	
	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.
1st week	0.8	1.1	2.0	2.7	1.9	2.2	3.3	3.9	1.9	3.1	4.1	9.3
2nd week	1.4	1.8	3.6	4.9	3.8	4.8	4.3	5.3	4.4	5.3	8.9	16.8
3rd week	2.6	2.4	5.3	7.1	6.1	9.2	6.4	10.4	7.1	11.2	11.3	26.7
4th week	3.7	4.2	7.6	11.9	6.6	11.9	9.5	15.6	12.9	18.6	19.3	45.1
5th week	4.6	5.5	18.9	26.2	16.8	23.8	24.2	35.5	25.2	31.9	42.9	77.8
6th week	5.6	6.8	18.7	30.0	28.3	39.4	42.2	60.3	36.0	61.3	53.7	120.8
7th week	6.5	8.2	23.4	37.3	29.5	39.1	47.1	65.8	36.2	64.7	64.4	83.1
8th week	8.4	9.5	30.0	45.6	24.4	30.4	28.2	30.0	25.4	30.0	25.2	27.8
Mean	4.2	4.9	13.7	20.7	14.7	20.1	20.7	28.9	18.6	28.3	28.7	50.9

5- $L.S.D_{0.05}$ to compare between means of two cultivars (averaged overall counting weeks) under the same or different infestation conditions = 2.4
6- $L S D_{0.05}$ to compare between means of two counting weeks at the same combination of infestation condition and cultivars or lines = 4.6
7- $L S D_{0.05}$ to compare between means of two cultivars or lines at the same combination of infestation condition and the week of counting = 5.2
8- $L S D_{0.05}$ to compare between means of two infestation conditions at the same combination of cultivar or line and the week of counting = 10.3



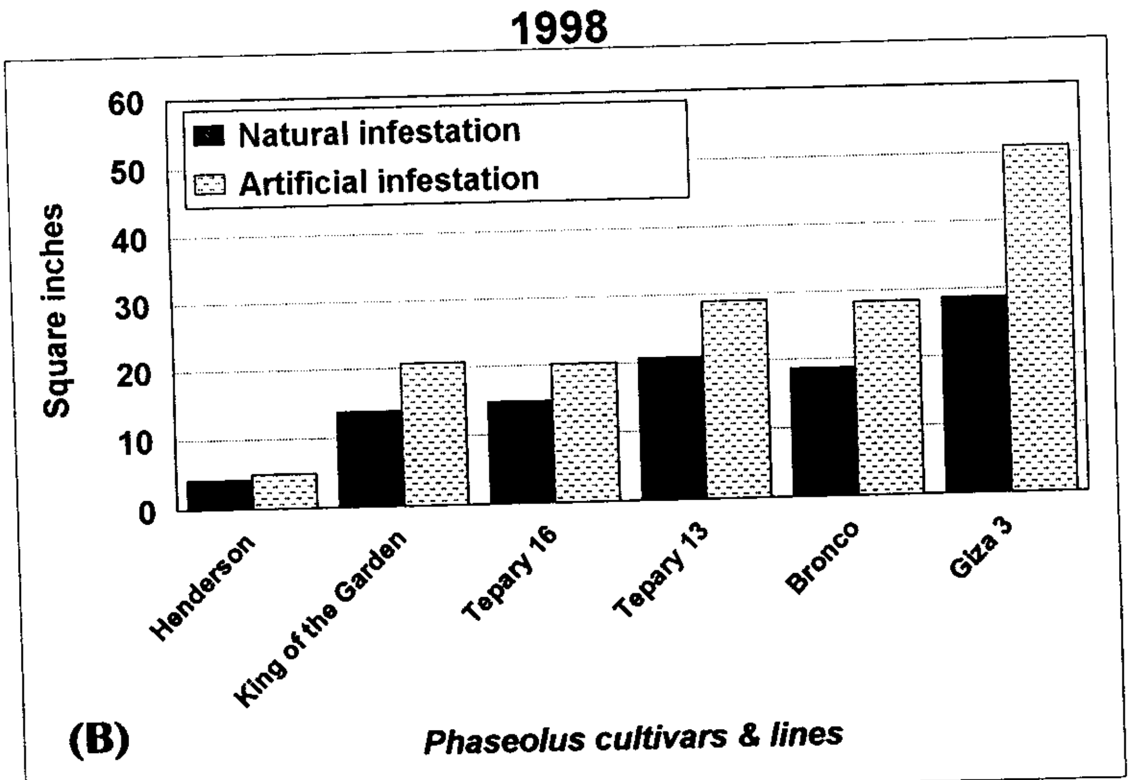


Fig. (12): Mean number of eggs of *T. urticae* counted on leaves (in2) of the different *Phaseolus* cultivars or lines under natural and artificial conditions in the field during 1997 and 1998 seasons.

The dryness or death of the foliage will result in, immigration and/or death of the *T. urticae* individuals, which depend in its feeding on sucking up the plant sap from alive leaf cells, and consequently the decrease in numbers of laid eggs will occur. These results indicate that, the week of counting should be considered when evaluating plants of *Phaseolus* species for resistance to *T. urticae*.

4.2.2. Density of moving individuals/inch^2:

Density of mite individuals is estimated by counting number of individuals existing on one square inch of leaf area under the natural infestation condition, the lowest numbers of moving individuals, (larvae, protonymphs, deutonymphs and adults of both sexes) counted in the first week on leaves were associated with Henderson cultivar (0.6 & 0.7 ind./inch^2), while the highest numbers were those observed on Giza 3 cultivar (6.2 & 3.3 ind./inch^2), during the seasons of 1997 and 1998, respectively **(Tables 12 &13)**.

Furthermore, under the condition of artificial infestation, about similar trend of results were observed, where numbers of moving individuals, were 1.0 and 0.8/ inch^2, in Henderson cultivar while those associated with Giza 3 cultivar were 8.7 & 7.4 ind./inch^2, in the first week of counting during seasons of 1997 and 1998, respectively **(Tables 12 & 13)**. The number of moving individuals counted on leaves (per inch^2) of the different *Phaseolus* cultivars or lines increased by the same trend in the advanced weeks

Table (12): Number of counted moving stage individuals of *Tetranychus urticae* (Koch) on leaves ($inch^2$) of the different *Phaseolus*, cultivars and lines under natural and artificial infestation conditions in the field, during season of 1997.

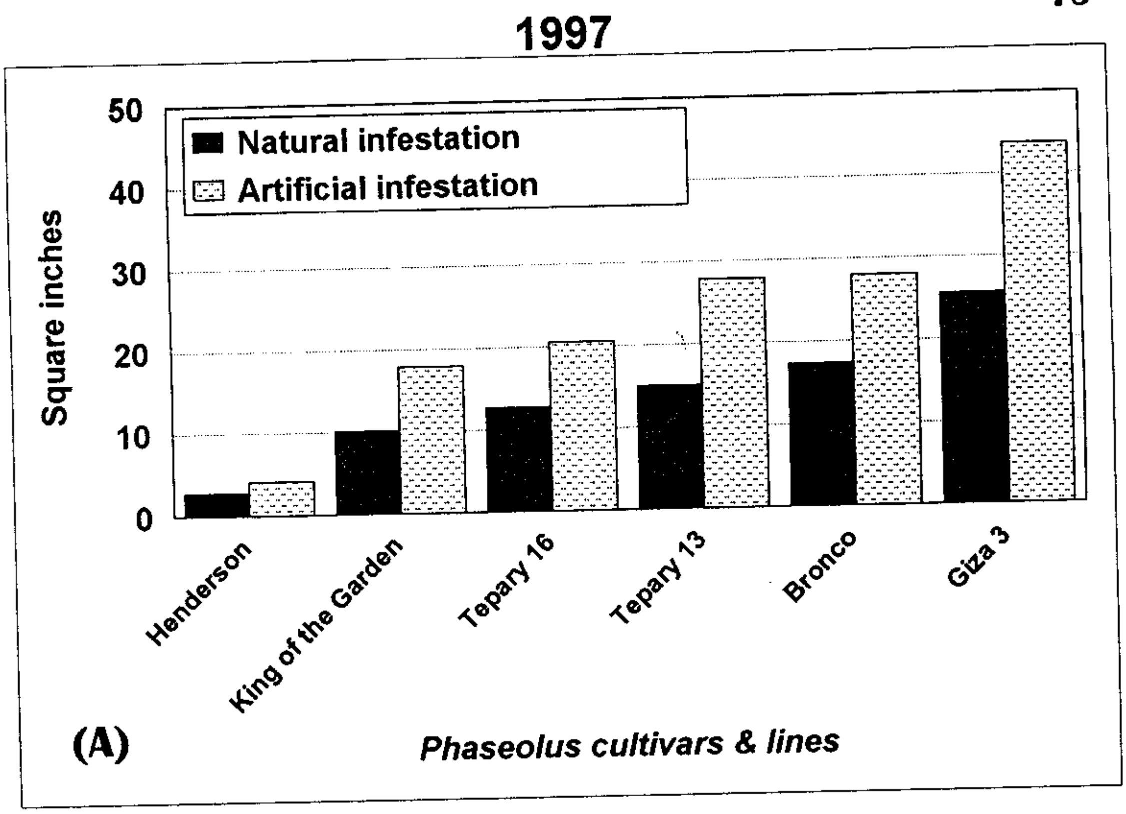
Week of counting	Henderson *P. lunatus*		King of the Garden *P. lunatus*		Tepary 16 *P. acutifolius*		Tepary 13 *P. acutifolius*		Bronco *P. vulgaris*		Giza 3 *P. vulgaris*	
	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.
1st week	0.7	1.0	1.5	2.5	2.2	2.4	2.4	3.3	3.1	3.7	6.2	8.7
2nd week	1.2	1.4	2.7	4.3	4.0	5.4	4.5	6.3	5.5	8.6	9.1	14.7
3rd week	1.7	2.5	4.7	6.3	4.7	8.6	5.7	12.3	7.8	14.9	16.2	26.8
4th week	2.3	3.6	6.4	14.8	9.2	16.4	11.6	24.1	15.0	23.4	27.3	43.6
5th week	2.9	4.2	8.5	19.3	14.8	23.7	16.7	33.1	20.9	35.2	32.2	56.8
6th week	3.5	4.9	12.4	22.8	20.3	33.7	23.8	50.8	28.9	50.9	36.9	87.5
7th week	4.5	6.2	18.3	30.5	26.5	42.2	33.3	60.8	33.1	55.6	45.9	79.6
8th week	5.8	9.2	26.4	42.4	20.3	31.6	21.9	31.1	24.3	30.1	30.3	31.5
Mean	2.8	4.1	10.1	17.9	12.7	20.5	15.0	27.7	17.3	27.9	25.5	43.7

1- $L.S.D_{0.05}$ to compare between means of two cultivars (averaged overall counting weeks) under the same or different of infestation conditions = 1.8
2- $L.S.D_{0.05}$ to compare between means of two counting weeks at the same combination of infestation condition and cultivars or line = 4.6
3- $L.S.D_{0.05}$ to compare between means of two cultivars or lines at the same combination of infestation condition and the week of counting = 4.9
4- $L.S.D_{0.05}$ to compare between means of two infestation conditions at the same combination of cultivar or line and the week of counting = 10.9

Table (13): Numbers of counted moving stage individuals of *Tetranychus urticae* (Koch) on leaves on leaves (inch^2) of the different *Phaseolus* cultivars/ lines under natural and artificial infestation conditions, in the field during season of 1998.

Week of counting	**Henderson** *P. lunatus*		**King of the Garden** *P. lunatus*		**Tepary 16** *P. acutifolius*		**Tepary 13** *P. acutifolius*		**Bronco** *P. vulgaris*		**Giza 3** *P. vulgaris*	
	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.	Nat. Inf.	Art. Inf.
1st week	0.6	0.8	1.1	1.9	0.9	2.0	1.1	2.2	1.0	2.5	3.3	7.4
2nd week	0.8	1.4	1.7	3.0	1.7	2.4	2.7	3.7	2.6	3.7	5.7	11.4
3rd week	1.3	2.1	3.6	5.7	5.4	7.1	5.4	7.5	4.5	7.6	9.2	19.9
4th week	1.7	2.7	6.8	9.4	7.0	10.2	8.8	14.3	8.4	12.9	17.0	32.3
5th week	2.9	4.0	10.9	16.2	12.7	18.3	14.5	27.6	15.8	26.2	25.2	49.6
6th week	4.2	5.7	14.3	22.2	18.3	29.1	25.4	46.3	26.2	53.2	40.2	83.6
7th week	5.4	7.3	20.1	33.6	22.4	38.3	29.2	55.6	30.1	44.6	42.2	69.7
8th week	6.6	8.2	24	38.7	19.1	27.2	21.7	26.9	20.5	25.0	24.9	24.8
Mean	2.9	4.0	10.3	16.4	10.9	16.8	13.6	23.0	13.6	22.0	20.9	37.3

1- L.S.D.05 to compare between means of two cultivars (averaged over all counting) under the same or different infestation conditions = 2.3
2- L S D .05 to compare between means of two counting weeks at the same combination of infestation condition of cultivars or line = 3.7
3- L S D0.05 to compare between means of two cultivars or lines at the same combination of infestation condition and the week of counting = 4.4
4- L S D0.05 to compare between means of two infestation conditions at the same combination of cultivar or line and the week of counting = 8.6



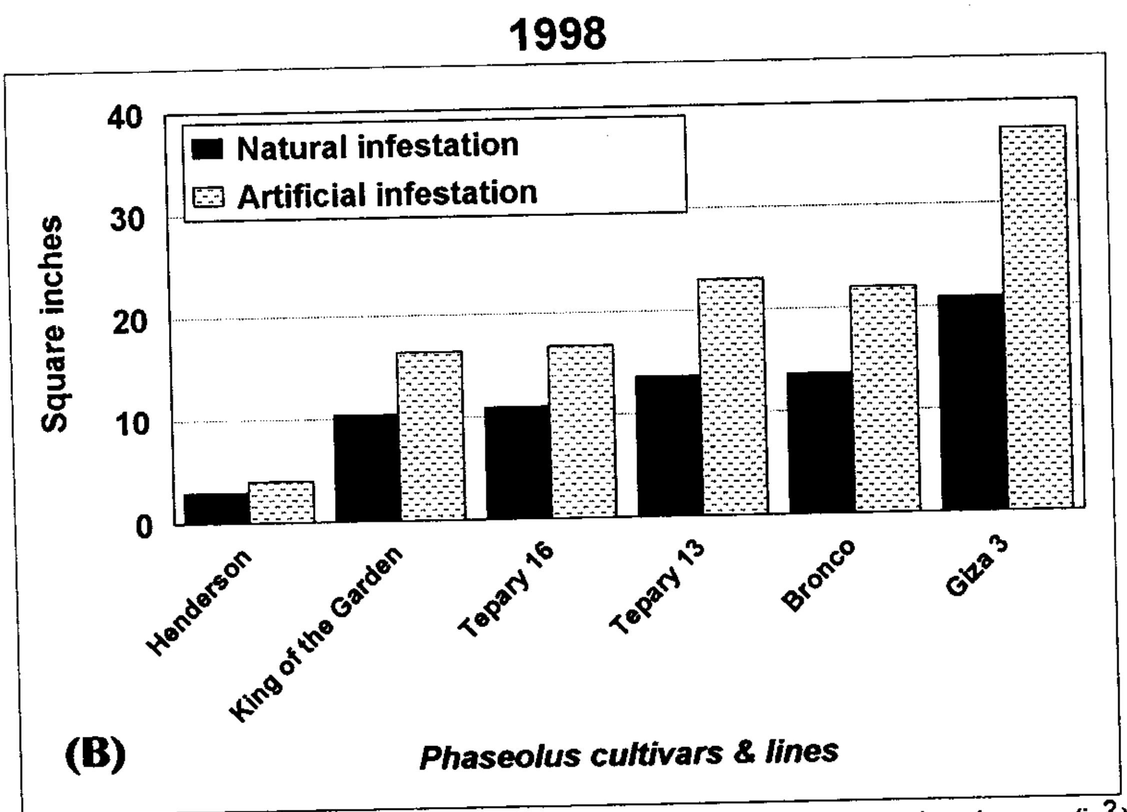


Fig. (13): Mean of moving stages individuals of *T. urticae* counted on leaves (in^2) of the different *Phaseolus* cultivars or lines under natural and artificial conditions in the field during 1997 and 1998 seasons.

of counting, for the evaluated plants under natural or artificial infestation conditions, during both seasons of 1997 and 1998, **(Tables 12 & 13)**. Under artificial infestation condition, the highest numbers of moving individuals were recorded in the sixth week for Giza 3 cultivar (87.5 & 83.6), during seasons of 1997 and 1998, respectively **(Tables 12 & 13)**. The same cultivar had also the highest number of moving individuals, at the seventh week of counting under the condition of natural infestation during seasons of 1997 (45.9 ind./inch^2) and 1998 (42.2 ind./inch^2), **(Tables 12 &13)**.

On the other hand, the maximum numbers of moving individuals counted for Henderson cultivar, under the condition of natural infestation (5.8 & 6.6 ind./inch^2) during the seasons of 1997 and 1998, respectively, were much less than the numbers recorded for the other cultivars or lines, recorded in the eighth week of counting **(Tables 12 & 13).** These results indicated that Henderson cultivar was the most resistant one while Giza 3 cultivar was the most susceptible one. Some criterion was found to be efficient in evaluating bean for mite resistance **(Farrag *et al.*, 1980; Sharaf, 1986)**.

Results presented in **Tables (12 & 13); Fig. (13 A,B)** show that the numbers of moving individuals counted on leaves of Tepary 16 and Tepary 13 lines and Bronco & Giza 3 cultivars in the eighth week of counting were less than the numbers counted in the previous week (*i.e.* the seventh), whether under natural or artificial infestation conditions during the seasons of 1997 and 1998. In contrast, the numbers of moving individuals counted on leaves (inch^2) of Henderson and King of the Garden cultivars, were higher in the eighth week of counting than those recorded in the seventh week, whether under natural or artificial infestation conditions during both seasons of 1997 and 1998 **(Tables 12 & 13).** However, in case of the Henderson cultivar, the difference was not significant. The decrease in numbers of moving stages individuals in the eighth week of counting, comparing with those recorded in the previous week of counting in case of Tepary 16 and Tepary 13 lines (*P. acultifolius*) and Bronco, and Giza 3 cultivars (*P. vulgaris*) could be due to the severe damage, caused to the plants of these genotypes by *T. urticae* which resulted in dryness of the foliage and, as a consequence, individuals of the *T. urticae*, which survive on sucking up the sap from alive plant cells will not find the proper food on such plants, resulting in immigration and/or death of the mite. On the other hand, the increase in numbers of moving individuals in the eighth week of counting comparing to those were recorded in the seventh week of counting on leaves (per inch^2) of Henderson and King of the Garden cultivars could be attributed to the tolerance of plants of these cultivars to *T. urticae*. Such to tolerance kept the plants of these cultivars alive for longer time and consequently, the mite individuals had better chance to reproduce feed on sap of plant leaves. In addition, due to the relatively high resistance of Henderson cultivar, numbers of moving individuals recorded on its leaves in the seventh and eighth week under conditions of natural and artificial infestation were relatively very low, as the difference between the two counting weeks, (7^{th} & 8^{th}), was not significant, during both of 1997 and 1998 seasons **(Tables 12 & 13)**.

These results are of great value for both zoologists and bean breeders to design successful breeding programs for resistance to such serious mite *T. urticae*.

4.2.3. Plant characteristics in relation to its resistance to the red spider mite *T. urticae*:

4.2.3.1. Fresh weight/plant:

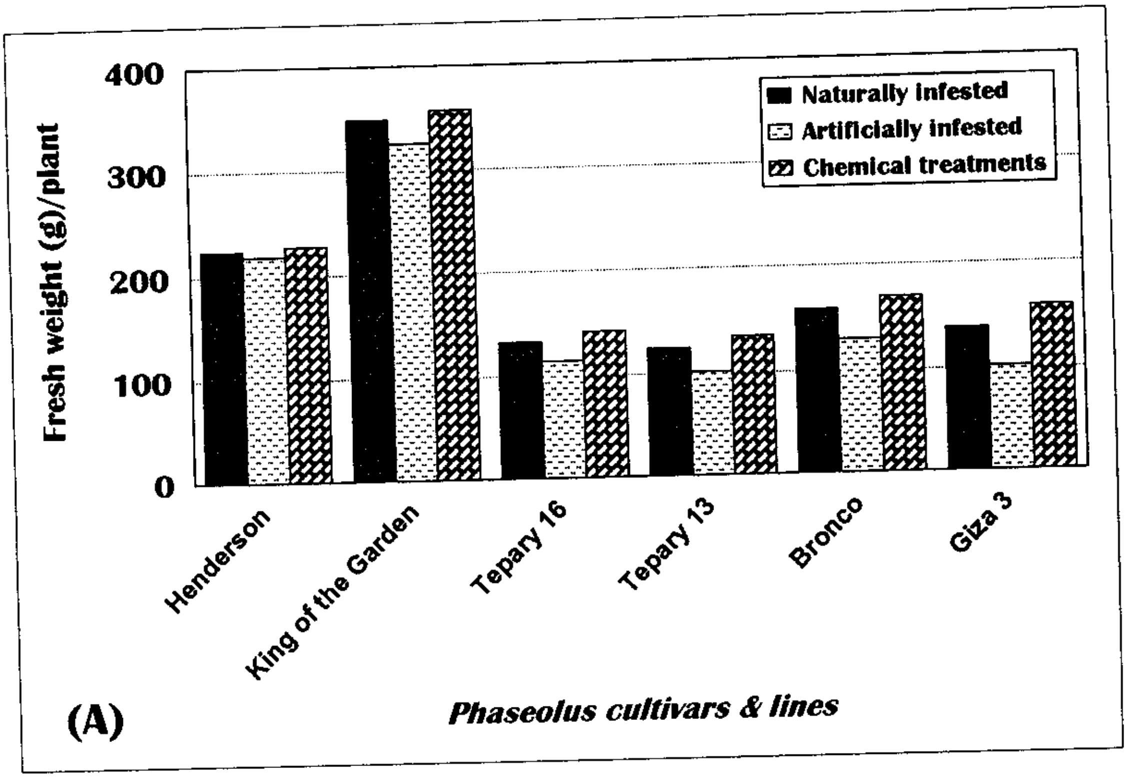
Concerning plant fresh weight, The different *Phaseolus* genotypes showed considerable variability in differences under various infestation conditions, distinctly the natural and artificial conditions in addition to the chemical control treatment during the seasons of 1997 and 1998, **(Tables 14 & 15)**. Simultaneously, the decrease in percentage of plant fresh weight due to both natural and artificial infestations, showed wide variations among the different *Phaseolus* cultivars or lines during the 1997 and 1998 seasons **(Tables 14 & 15) and Figs. (14 & 15)**. The Henderson cultivar (*P. lunatus*), showed the lowest decrease in percentages of fresh weight under the natural (1.74 % & 3.00%) and artificial (4.22% & 7.34 %) infestation conditions during the seasons of 1997 and 1998, receptively, **(Tables 14 & 15) and Figs. (14 & 15)**. Additionally, the decrease percentages of plant fresh weight under the conditions of natural and artificial infestations, associated with King of the Garden cultivar (*P. lunatus*), were slightly higher than that associated with Henderson cultivar (*P. lunatus*), but much less than the decrease in percentages associated

Table (14): Fresh weight/plant (g) of six *Phaseolus* cultivars or lines under both natural and artificial infestation conditions, and chemical control application, during season of 1997.

Cultivars/lines	Treatments			Fresh weight decrease %	
	Naturally infested	Artificially infested	Chemical treatments	Natural infestation	Artificial infestation
Henderson *P. lunatus*	223.5	217.9	227.5	1.74	4.22
King of the Garden *P. lunatus*	348.3	324.9	357.1	2.46	9.00
Tepary 16 *P. acutifolius*	133.2	114.2	142.2	6.17	19.59
Tepary 13 *P. acutifolius*	124.4	100.9	134.8	7.7	25.00
Bronco *P. vulgaris*	158.0	129.7	168.5	6.22	23.00
Giza 3 *P. vulgaris*	139.0	101.6	158.5	12.16	35.62
L.S.D at 0.05		9.1		6.5	7.2

Table (15): Fresh weight/plant (g) of six *Phaseolus* cultivars or lines under both natural and artificial infestation conditions, and chemical control application, during season of 1998.

Cultivars/lines	Treatments			Fresh weight decrease %	
	Naturally infested	Artificially infested	Chemical treatments	Natural infestation	Artificial infestation
Henderson *P. lunatus*	238.1	227.5	245.6	3.00	7.34
King of the Garden *P. lunatus*	368.7	342.3	380.5	3.02	10.02
Tepary 16 *P. acutifolius*	150.4	128.1	161.2	6.67	20.26
Tepary 13 *P. acutifolius*	139.4	114.3	152.6	8.58	24.95
Bronco *P. vulgaris*	166.2	135.5	179.6	6.54	23.85
Giza 3 *P. vulgaris*	153.1	112.5	170.5	10.17	33.90
L.S.D at 0.05	11.3			4.7	9.4



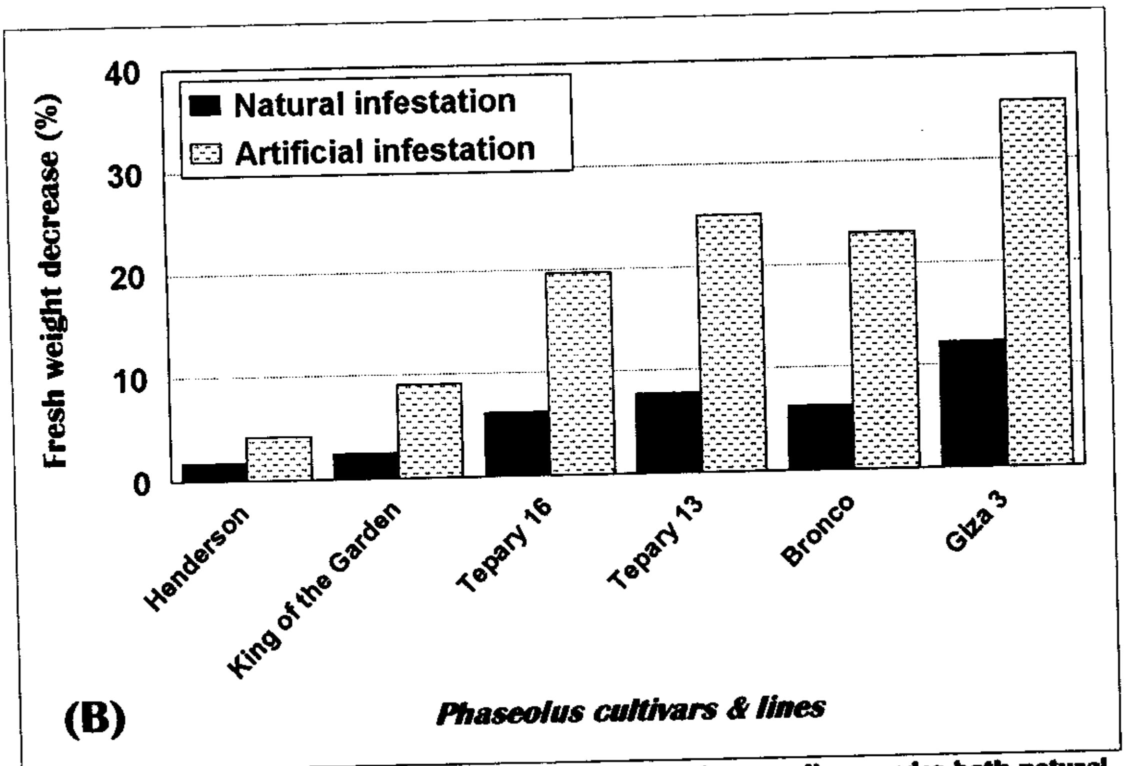
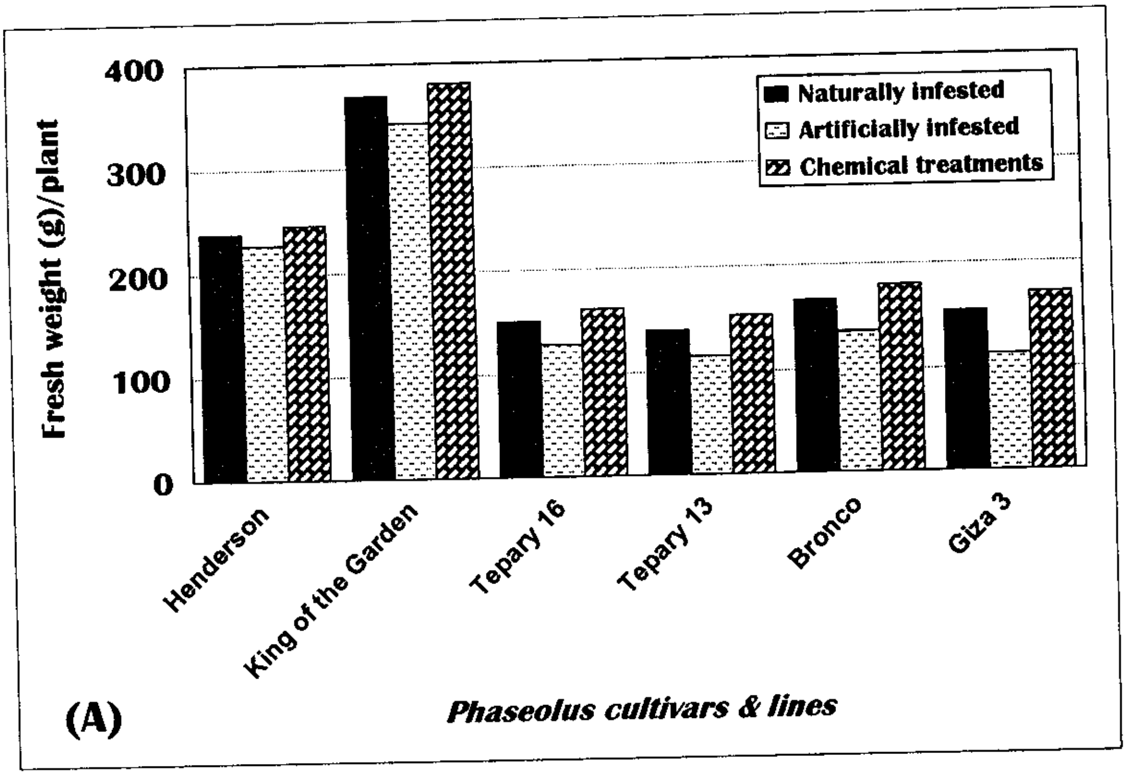


Fig. (14): Fresh weight/plant (g) of six *Phaseolus* cultivars or lines under both natural and artificial infestations, and chemical control conditions (A), and % decrease in weight due to infestation (B)during season of 1997.



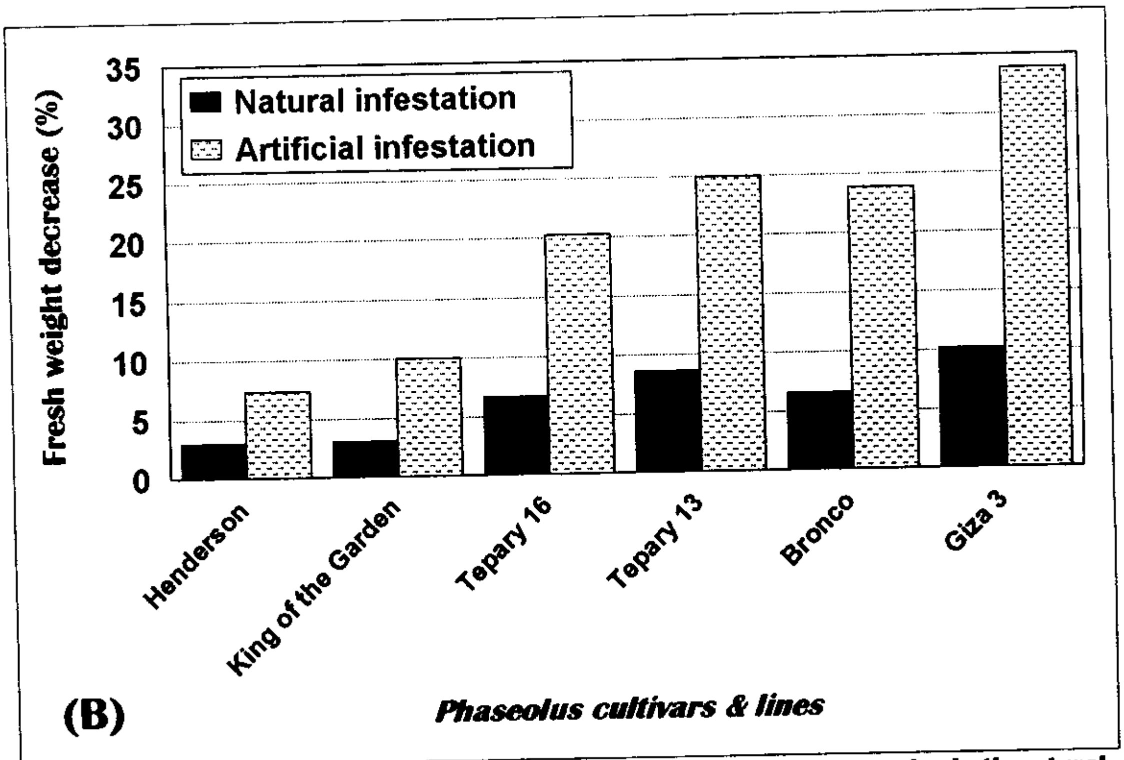


Fig. (15): Fresh weight/plant (g) of six *Phaseolus* cultivars or lines under both natural and artificial infestations, and chemical control conditions (A), and % decrease in weight due to infestation (B)during season of 1998.

with Tepary 16 and Tepary 13 lines (*P. acutifolius*) and Bronco and Giza 3 cultivars (*P. vulgaris*) during the seasons of 1997 and 1998 **(Tables 14 & 15) and Figs. (14 & 15)**. It is worth mentioning here, that the true decrease percentage of plant fresh weight associated with a certain genotype, whether under natural or artificial infestation conditions, indicates high level of preference of the two spotted spider mite to such genotype, because such decrease in plant fresh weight under infestation condition could be caused by the high rate of mite feeding and/or dryness of large numbers of the infested leaves. Using the decrease percentage in plant fresh weight, as a criterion of plant resistance to *T. urticae*, it can be mentioned that Giza 3 cultivar was the most susceptible cultivar, whether under the condition of natural (12.16% & 10.17%) or artificial (35.62%& 33.90%) infestation, while Henderson cultivar was the most resistant one under the natural infestation conditions (1.74% & 3.00%) in both 1997 and 1998 seasons, respectively **(Tables 14 & 15)**. Based on these results, Henderson cultivar (*P. lunatus*) can be considered as a good source for genes controlling this component of resistance, *i.e.* the low decrease in plant fresh weight, which occur after infestation with the two spotted spider mites.

4.2.3.2. Flowering and pod characteristics:

Some flowering and pod characteristics of different *Phaseolus* genotypes were considered here as indicators of plant resistance against *T. urticae*, which are presented as follows:

Table (16): Some flowering and pod characteristics of the different *Phaseolus* genotypes under natural and artificial infestation conditions with *T. urticae* during the season of 1997.

Genotype	Infestation condition	The period to the first flower	Fruit set percentage %	Number of pods/ plant	Number of seeds / pod	Seed weight / pod (g)
Henderson *P. lunatus*	Nat. Inf	45.00	80.00	44.00	2.30	0.825
	Art. Inf.	45.30	78.30	43.00	2.20	0.806
	Mean	45.20	79.20	43.50	2.23	0.816
King of the Garden *P. lunatus*	Nat. Inf	48.60	66.70	26.30	1.30	1.27
	Art. Inf.	50.30	53.30	17.70	1.20	1.19
	Mean	49.50	60.00	22.00	1.30	1.23
Tepary 16 *P. acutifolius*	Nat. Inf	38.30	84.30	106.00	3.50	0.457
	Art. Inf.	39.30	75.80	94.30	3.20	0.398
	Mean	39.00	80.00	100.20	3.30	0.427
Tepary 13 *P. acutifolius*	Nat. Inf	38.30	80.00	85.70	3.00	0.412
	Art. Inf.	40.30	70.80	67.70	2.50	0.364
	Mean	39.30	75.40	76.70	2.70	0.388
Bronco *P. vulgaris*	Nat. Inf	40.00	76.70	39.70	4.70	0.784
	Art. Inf.	42.00	64.20	26.00	4.30	0.677
	Mean	41.20	70.40	32.80	4.50	0.730
Giza 3 *P. vulgaris*	Nat. Inf	42.00	75.80	30.30	4.00	0.932
	Art. Inf.	45.00	57.50	16.30	3.70	0.830
	Mean	43.50	66.70	23.30	3.80	0.881

$L.S.D_{0.05}$ to compare between the two means recorded at the natural and artificial infestation conditions within the same cultivar = 0.94, 2.3, 4.70, 0.19, and 0.149, for the period to the first flower, fruit set percentage, number of pods / plant, number of seeds / pod, and seed weight/pod, respectively.

$L.S.D_{0.05}$ to compare between any two genotypes averaged over the two infestation conditions = 0.54, 2.4, 3.2, 0.16, and 0.066 for the period to the first flower, fruit set percentage, number of pods/ plants, number of seeds / pad and seed weight / pod, respectively.

$L.S.D_{0.05}$ to compare between any two cultivars at the same or different methods of infestation conditions =0.87, 2.9, 4.6, 0.24 and 0.120 for the period to the first flower, fruit set percentage, number of pods/ plant, number seeds / pod and seed weight/pod, respectively.

Table (17): Some flowering and pod characteristics of the different *Phaseolus* genotypes under natural and artificial infestation conditions with *T. urticae* during the season of 1998.

Genotype	Infestation condition	The period to the first flower	Fruit set percentage %	Number of pods/ plant	Number of seeds / pod	Seed weight / pod (g)
Henderson *P. lunatus*	Nat. Inf	45.70	80.80	49.30	2.20	0.868
	Art. Inf.	46.00	77.50	44.30	2.10	0.825
	Mean	45.83	79.18	46.83	2.17	0.846
King of the Garden *P. lunatus*	Nat. Inf	49.30	65.00	21. 30	1.30	1.279
	Art. Inf.	51.00	54.20	14.70	1.20	1.124
	Mean	50.16	59.58	18.00	1.27	1.201
Tepary 16 *P. acutifolius*	Nat. Inf	38.70	84.20	103.30	3.50	0.466
	Art. Inf.	40.00	75.80	92.00	3.20	0.414
	Mean	39.33	80.00	97.67	3.33	0.440
Tepary 13 *P. acutifolius*	Nat. Inf	39.00	80.80	88.70	3.10	0.427
	Art. Inf.	41.00	69.20	68.00	2.90	0.368
	Mean	40.00	75.00	78.33	3.00	0.397
Bronco *P. vulgaris*	Nat. Inf	40.70	75.80	37.00	4.70	0.752
	Art. Inf.	42.70	64.20	25.70	4.30	0.670
	Mean	41.67	70.00	31.50	4.50	0.711
Giza 3 *P. vulgaris*	Nat. Inf	42.30	74.20	28.30	4.10	0.958
	Art. Inf.	45.00	57.50	16.00	3.80	0.866
	Mean	43.67	65.83	23.17	3.93	0.912

$L.S.D_{0.05}$ to compare between the two means recorded at the natural and artificial infestations within the same cultivar =0.59, 2.22, 4.94, 0.17, and 0.056, for the period to the first flower, fruit set percentage, number of pods / plant, number of seeds / pod, and seed weight / pod, respectively.

$L.S.D_{0.05}$ to compare between any two genotypes averaged over the two infestation conditions = 0.61, 2.22, 2.97, 0.12, and 0.090 for the period to the first flower, fruit set percentage, number of pods/ plants, number of seeds / pad and seed weight / pod, respectively.

$L.S.D_{0.05}$ to compare between any two cultivars at the same or different methods of infestation conditions =0.75, 2.74, 4.65, 0.17 and 0.099 for the period to the first flower, fruit set percentage, number of pods/ plant, number of seeds / pod and seed weight / pod, respectively.

A) Period required to start flowering

Results presented in **Tables (16 & 17) and Figs. (16A & 17A)** show that the exact time spent till the emergence of the first flower of Henderson cultivar under natural infestation condition was not significantly different from that recorded for the same cultivar under artificial infestation condition, during both seasons of 1997 and 1998. Such insignificant difference could be an indication for the relative resistance of Henderson to *T. urticae*, since the artificial infestation did not significantly affect the earliness of flowering comparing to the effect of the natural infestation. On the other hand, number of days to the first flower anthesis of the other cultivars or lines, were significantly higher under the artificial conditions than those recorded under the natural ones **(Tables 16 & 17).** The artificial infestation of King of the Garden cultivar, Tepary 16 & Tepary 13, lines and Bronco & Giza 3 cultivars might had been resulted in delaying the flowering stage of these genotypes due to their susceptibility to *T. urticae.*

B) Fruit set percentage:

Results presented in **Tables (16 & 17); Figs. (16B, 17B),** show that fruit set percentages, which were associated with the different genotypes, under the natural infestation condition for some genotypes, indicated that the artificial infestation with *T. urticae* had a negative effect on fruit set percentage. Under artificial infestation condition with *T. urticae*, the highest percentages of fruit set were associated with Henderson cultivar (*P. lunatus*) during

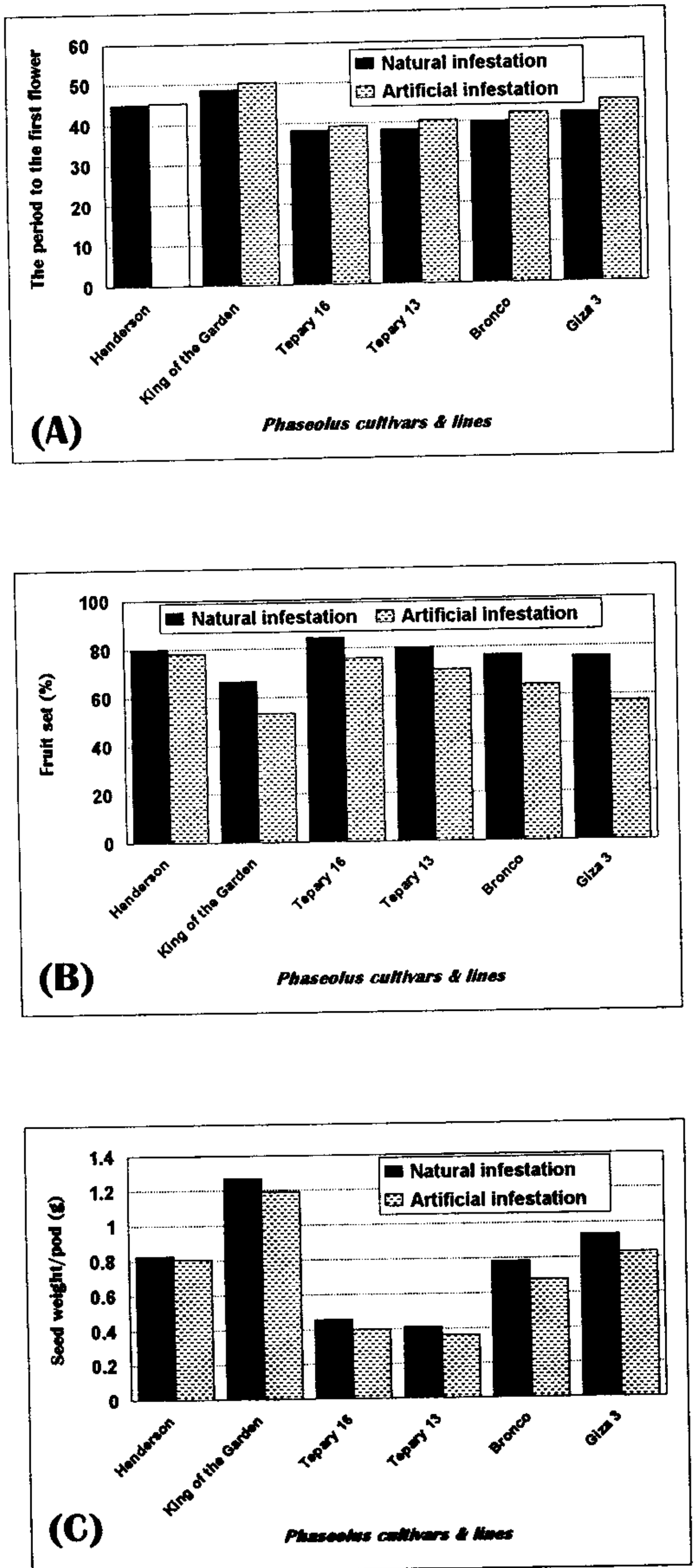
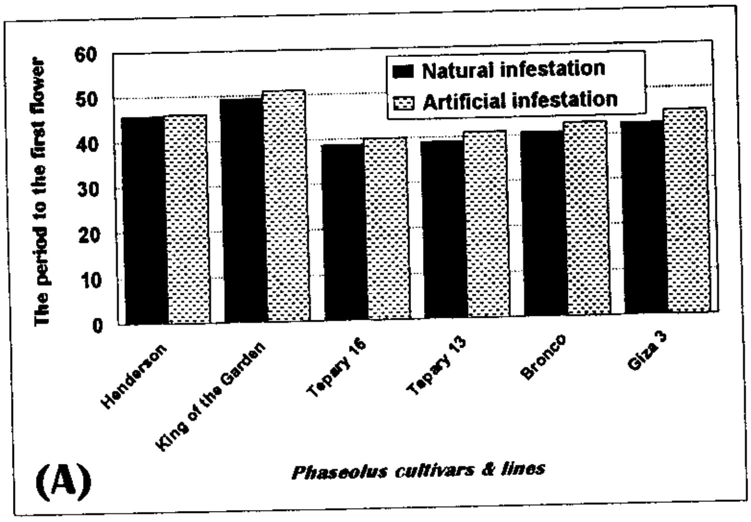
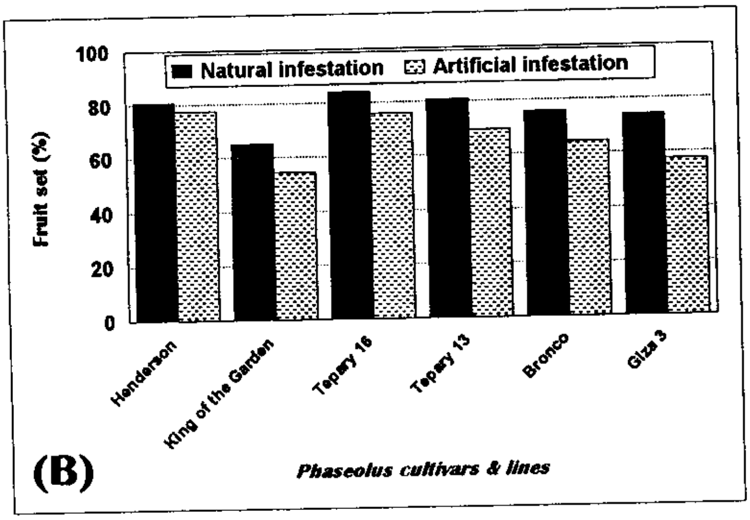


Fig. (16): Some flowering and pod characteristic of the different *Phaseolus* genotypes under natural and artificial infestation with *T. urticae* during the season 1997.





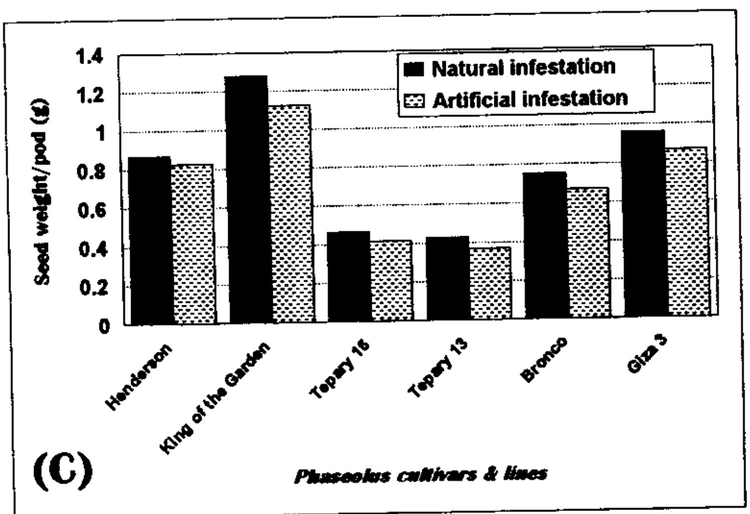


Fig. (17): Some flowering and pod characteristic of the different *Phaseolus* genotypes under natural and artificial infestation with *T. urticae* during the season 1998.

seasons of 1997 (78.3%) and 1998 (77.5%), **(Tables 16 &17)**. On the other hand, the lowest percentages of fruit set under the artificial infestation condition were associated with King of the Garden cultivar (53.3% & 54.2%) and Giza 3, (57.5% & 57.5%), during the seasons of 1997 and 1998, respectively. These results indicated that Henderson cultivar was the most resistant one to *T. urticae*, since fruit set percentage of this cultivar was less affected by the artificial infestation with *T. urticae*.

C) Number of pods / plant:

Results included in **Table (16)**, indicated that number of pods /plant for Henderson cultivar under the natural infestation condition (44.0) was not, significantly different from the number recorded under the artificial infestation condition (43.0) , during season of 1997. In contrast, during the season of 1998, slightly, significant difference between number of pods / plant was recorded under the natural infestation condition (49.3), and that was recorded under the artificial infestation condition (44.3) **(Table 16)**.

On the other hand, wide significant differences between number of pods / plant were recorded under the condition of natural infestation as well as under the artificial infestation condition, for the different *Phaseolus* genotypes during both seasons of 1997 and 1998 **(Table 16 & 17)**. In all cases, number of pods / plant under artificial infestation condition was significantly higher than the recorded number under the natural infestation condition, for the same genotype **(Tables, 16 &17)**. Similar decrease in number of pods/bean plant, due to the infestation with *T. urticae* was observed by **Papaioannous and Souliotis (1979)**.

These results show that number of pods / plant of Henderson cultivar was less affected by the artificial infestation with *T. urticae*, comparing to the other cultivars or lines which showed considerable level of resistance of such cultivar to such tetranychid mite.

D) Number of seeds/pod:

Results comprised in **Tables (16 & 17)** show that the recorded number of seeds/pod under the artificial infestation condition, was less than the recorded one, under the natural infestation condition, for the different genotypes of *Phaseolus* during both seasons of 1997 and 1998. However, the difference between the two recorded numbers was not significant in case of Henderson and King of the Garden cultivar, while in case of Tepary 16 and Tepary 13 lines and Bronco and Giza 3 cultivars, this difference was significant. The insignificant differences between numbers of seeds/pod recorded under both artificial and natural conditions with *T. urticae*, could be due to the resistance of these genotypes to such mite. A decrease in number of seeds/pod was observed also before by **Papaioannous and Souliotis (1979)**.

E) Weight of Seeds/pod:

The recorded weights of seeds/pod for plants of the different genotypes under the artificial infestation condition, was less than that recorded under the natural infestation condition during both seasons of 1997 and 1998 **(Tables 16 & 17); Figs. (16C & 17C)**. However, the recorded difference between weight of seeds under natural and artificial infestation conditions in 1997 season was not significant, for all *Phaseolus* genotypes, while such difference in 1998 season, was significant in all cases, except with Henderson cultivar, in which the recorded difference between weight of seeds/pod under natural and artificial infestations with *T. urticae,* was not significant. These results indicate, that the effect of artificial infestation in reducing weight of seeds/pod was stronger than that of natural infestation.

In addition, the non-significant difference between weight of seeds/pod, which was recorded under natural and artificial infestation conditions for Henderson cultivar in 1998 season (**Table, 17**), could be due to the resistance of this cultivar to the red spider mite *T. urticae.*

F) Dry seed yield:

The estimates of the total dry seed yield for plants of the different cultivars or lines which were evaluated under the condition of applying chemical control program against the tetranychid mite, during seasons of 1997 and 1998, were 0.640 & 0.745; 0.394 & 0.422; 0.884 & 0.868; 0.674 & 0.719; 0.481 & 0.482, and 0.530 & 0.554 Ton/Feddan for Henderson, King of the Garden, Tepary 16, Bronco and Giza 3 respectively **(Tables 18 & 19); Figs (18A & 19A)**. These results indicated that the *Phaseolus* cultivars or lines, used in the present study, differ in their yielding capacities under mite-free condition, where Tepary 16 line, exhibited the highest yielding capacity, while King of the Garden cultivar showed the lowest yielding capacity under such conditions **(Tables 18 & 19); Figs (18A & 19A)**.

Table (18): Dry seeds yield (ton/feddan) and percentages of yield losses of six *Phaseolus* cultivars/ lines cultivated in Beni Suef, under natural and artificial infestation conditions and chemical control application during season of 1997.

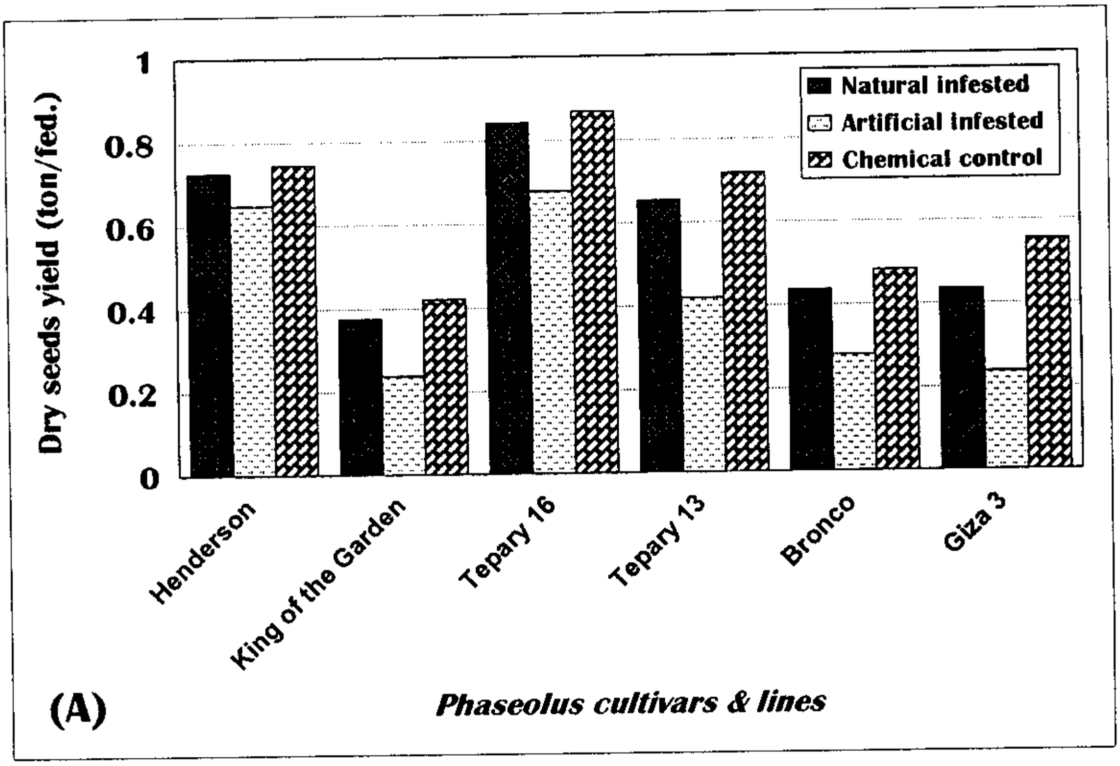
Cultivars/lines	Infestation condition			Yield loss %	
	Natural Inf.	Artificial Inf.	Chemical control	Natural Inf.	Artificial Inf.
Henderson *P. lunatus*	0.624	0.588	0.640	3.42	8.12
King of the Garden *P. lunatus*	0.364	0.249	0.394	7.65	36.80
Tepary 16 *P. acutifolius*	0.855	0.691	0.884	3.40	21.83
Tepary 13 *P. acutifolius*	0.630	0.424	0.674	6.44	36.97
Bronco *P. vulgaris*	0.442	0.297	0.481	8.10	38.29
Giza 3 *P. vulgaris*	0.427	0.258	0.530	19.43	51.32

1. $LSD_{0.05}$ to compare between two different cultivars at the same infestation condition = 0.032
2. $LSD_{0.05}$ to compare between two infestation conditions at the same or different cultivars = 0.042
3. $LSD_{0.05}$ to compare between two different cultivars at the same infestation conditions = 6. 8
4. $LSD_{0.05}$ to compare between two infestation conditions at the same or different cultivars = 7.7

Table (19): Dry seeds yield (ton/feddan) and percentages of yield losses of six *Phaseolus* cultivars/ lines cultivated in Beni Suef, under natural and artificial infestation conditions and chemical control application during season of 1998.

Cultivars/lines	Infestation condition			Yield loss %	
	Natural Inf.	Artificial Inf.	Chemical control	Natural Inf.	Artificial Inf.
Henderson *P. lunatus*	0.727	0.648	0.745	3.26	13.02
King of the Garden *P. lunatus*	0.376	0.236	0.422	10.78	43.94
Tepary 16 *P. acutifolius*	0.842	0.679	0.868	3.00	21.85
Tepary 13 *P. acutifolius*	0.654	0.418	0.719	8.97	41.72
Bronco *P. vulgaris*	0.436	0.279	0.482	9.35	42.02
Giza 3 *P. vulgaris*	0.434	0.236	0.554	21.50	57.31

1- $L.S.D_{0.05}$ to compare between two different cultivars at the same infestation condition = 0.053
2- $L.S.D_{0.05}$ to compare between two infestation conditions at the same or different cultivars = 0.072
3- $L.S.D_{0.05}$ to compare between two different cultivars at the same infestation conditions = 10.4
4- $L.S.D_{0.05}$ to compare between two infestation conditions at the same or different cultivars = 8.4



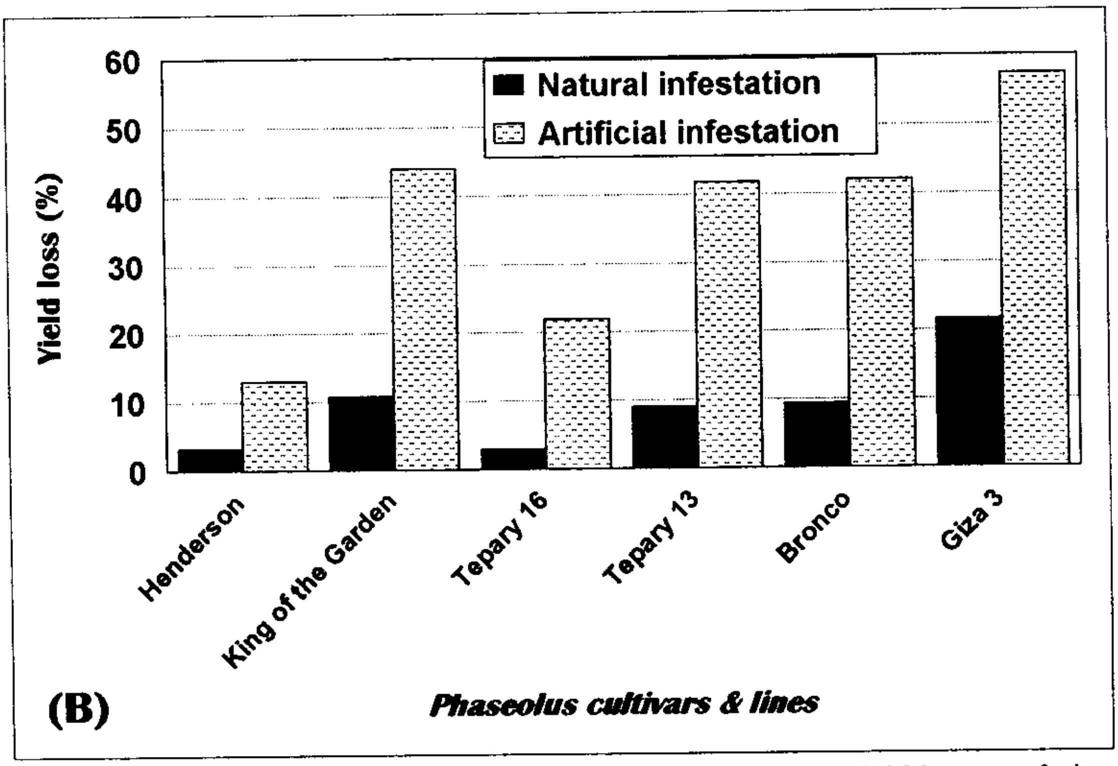
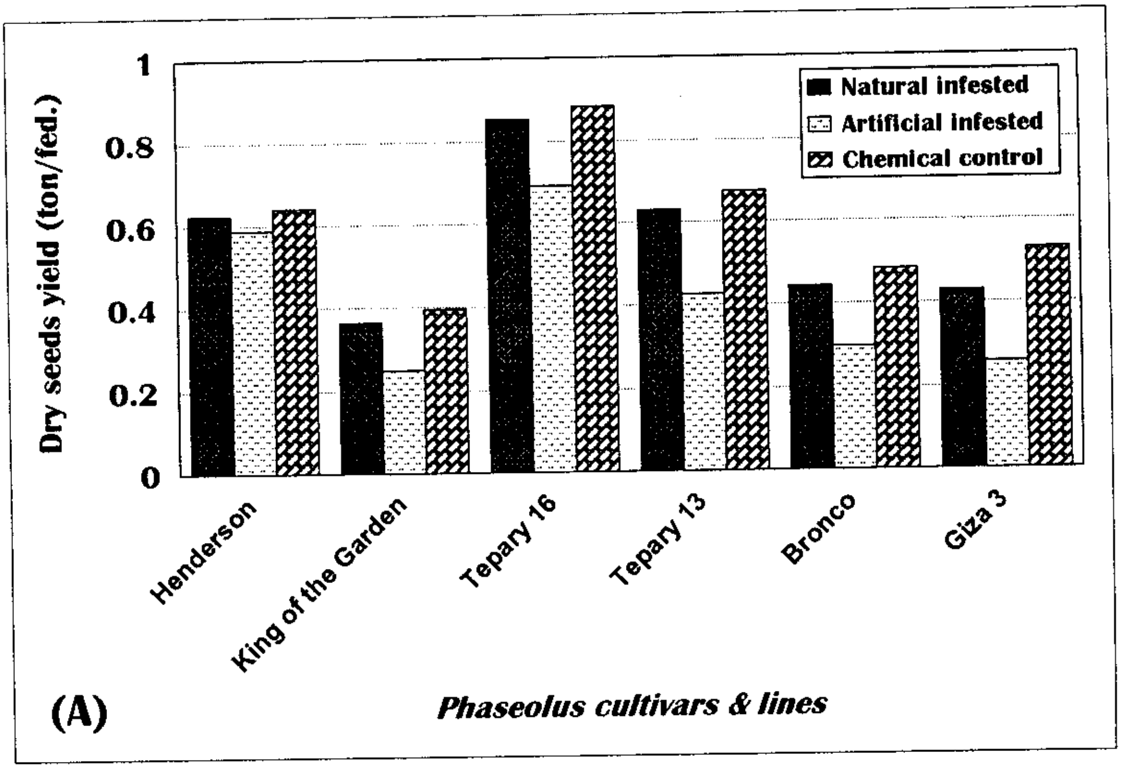


Fig. (18): Dry seeds yield (ton/feddan) and percentages of yield losses of six *Phaseolus* cultivars or lines cultivated in Beni-Suef, under different infestations during season of 1997.



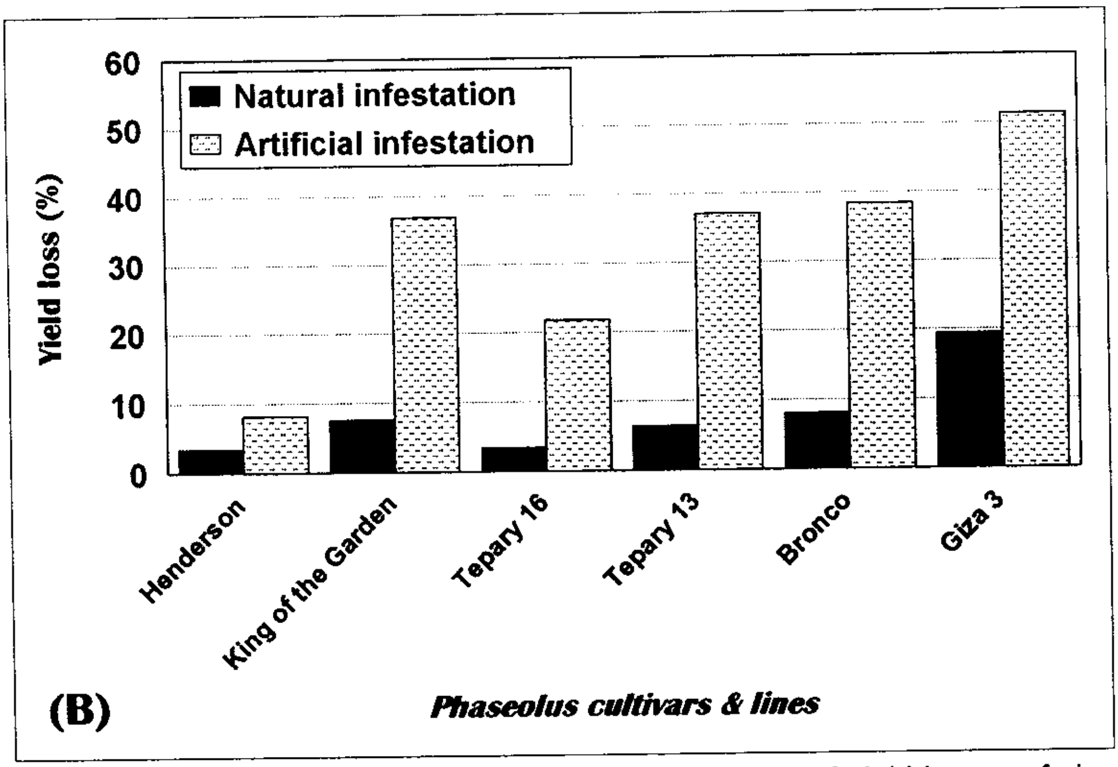


Fig. (19): Dry seeds yield (ton/feddan) and percentages of yield losses of six *Phaseolus* cultivars or lines cultivated in Beni-Suef, under different infestations during season of 1998.

Since the dry seed yielding capacities of the different cultivars or lines were different from each other under mite free conditions, comparing the dry seed yield of the different cultivars or lines under the conditions of natural or artificial infestation with *T. urticae* will to be meaningless and undependable. On the other hand, yield loss percentage will be accurate, and dependable criterion to judge the performance of the different cultivars or lines under the conditions of both natural and artificial infestation with *T. urticae,* because it reflected the effect of infestation with *T. urticae* on the yield of different cultivars or lines. The lowest yield loss percentages due to the natural infestation (3.42% & 3.26%), or due to the artificial infestation (8.12% & 13.02%) were associated with Henderson cultivar during the seasons of 1997 and 1998, respectively **(Tables18 & 19).** On the other hand, the highest yield loss percentages due to the natural infestation (19.43% & 21.50%) or due to the artificial infestation (51.32% & 57.31%), were associated with Giza 3 cultivar (*P. vulgaris*), during the seasons of 1997 and 1998, respectively **(Tables 18 & 19).**

Based on these results it can be mentioned that Henderson cultivar (*P. lunatus*) was the most resistant genotype to *T. urticae* because its yield was less affected by infestation, while Giza 3 cultivar (*P. vulgaris*) was the most susceptible genotype to this dangerous mite, because its yield was severely affected by the infestation. The effect of mite infestation on decreasing yield and quality of beans was recorded by **Faris *et al.* (1997)** Also, yield losses because of the red spider mite infestation was recorded by

Darwish *et al.,* **(1996)** on pea, **Rao** *et al.,* **(1990)** on *Vigna radiata*, **Milliron, (1958), Sawires, (1978 and 1983)** on soybean, and **Hoda, (1974)** on cotton. Additionally, the resistance of lima bean (*P. lunatus*) to the mite infestation, observed in the present study, had also been early reported by **Takabayashi** *et al.*, **(1991) and Dicke & Dijkman (1992).**

4.2.4. Host preference of T. urticae to diffenet *Phaseolus* cultivars and lines as indicators of their relative resistance to the mite pest.

Concerning such research topic, it was clearly observed that the red spider mite, *T. urticae*, exhibited, significantly various levels of host preference, which was reflected in its biological aspects and ecological trends. The incubation period was also rather affected by the varying cultivars and lines of the *Phaseolus* host plant. Additionally, the developmental stage exhibited the longest periods of duration when *T. utricae* were fed on leaves of Henderson cultivar followed by the King of the Garden, then Tepary 16, Tepary 13, Bronco and finally Giza 3, on which the developmental stages and consequently life cycle needed minimum periods. That indicates that the latter cultivar was the most preferable host to *T. urticae*, which efficiently, favoured the mite pest. The fertile mite female required a shorter period to deposit its first egg when it was dependent on Giza 3 cultivar in its feeding, while such period was prolonged when Henderson cultivar was used as food source. In descending order, such parameters was tended towards shortening, after the latter one, with King of the Garden, Tepary 16, Tepary 13, Bronco and ended with the aforementioned Giza 3, respectively.

Reversed trend was observed with both the oviposition and post-oviposition periods, as they were shortest with Henderson cultivar, but reached their maxima with Giza 3, while the others exhibited similar descending order, as shown in the latter phenomenon, respectively. Periods of post-oviposition, longevity and life span showed typically similar trend of the latter observations.

Concerning the mite female fecundity, it was indicated that, it was much more fecund, when Giza 3, was utilized in mite feeding, in contrast with Henderson cultivar, which exhibited the lowest levels of fecundity of the mite female.

Such findings obviously, reflect various levels of resistance among different *Phaseolus* cultivars and lines to *T. urticae*. From the obtained results, it could be observed that different cultivars and lines varied significantly, in their contents of nitrogen; phosphorus; reduced-, non-reduced- and total-sugars; protein, potassium and sodium, which directly affected the variability in the plant response to the red spider mite preferability, as suitable host. Periods of both incubation; larval, protonymphal and deutonymphal stages; and life cycle were negatively correlated with plant leaf contents of nitrogen; phosphorus; reduced-, non-reduced- and total-sugars and protein, while positively affected the periods of oviposition, post-oviposition, longevity. Such findings mean that the higher the aforementioned elements and compounds, the shorter the periods of incubation, developmental stages, and life cycle and the longest the oviposition, the post-oviposition, the longevity, the life span, and also female fecundity, which indicate the more the susceptibility of the host plant, other wise, the greater the preference of such host plant to the red spider mite *T. urticae*. Such contents seemed to represent, relatively the higher percentages in Giza 3, while it was descendingly, lower in Bronco, Tepary 13, Tepary 16, King of the Garden, and the lowest in Henderson cultivar, which appeared to be, adequately resistant to such mite pest. In contrast, the high contents of both potassium and sodium, positively elongated each of incubation period, developmental stages and consequently life cycle and pre-oviposition period, but simultaneously shortened the oviposition and post-oviposition periods, seeming to reduce the nutritional value of some *Phaseolus* cultivars.

From the above mentioned observation, it can be concluded that Giza 3 was the most preferred for feeding by *T. urticae* followed by Tepary 13, Tepary 16, King of the Garden, while the least preferred one was Henderson cultivar. These results indicate that the most susceptible cultivars or lines favoured more of the mite pests, exhibited in shortening each of incubation period, developmental stages, life cycle, and pre-oviposition period, simultaneously elongated oviposition period, longevity and life span and increased female fecundity of the mite pest. It was observed also that the rich cultivars or lines in nitrogen; phosphorus, reduced-, non-reduced- & total-sugars and protein and poor in potassium and sodium favoured more, the red spider mites *T. urticae*, which was reflected in the mentioned biological aspects.

In other words, it can be, also concluded that such tested cultivars and lines have variability relative resistance to such mite pest, seeming to be highest in Henderson cultivar and lowest in Giza 3 one. The other cultivars and lines exhibited also, relative degrees of resistance, tolerancy and susceptibility, in which King of the Garden can be considered as resistant one, Tepary 16 & 13 as tolerant ones, while Bronco can be estimated as susceptible cultivar, other than the highly, susceptible Giza 3.

Such findings could be promoted from the observed mechanical constituents of resistance such as both density and length of leaf hairs, as it was most dense on the upper surface of leaves in both Henderson and King of the Garden cultivars, and also on the lower one of the former. Also, leaf hairs were longer on both surfaces of King of the Garden leaves, but slightly shorter in Henderson cultivars, while it was scarce and very short in the other ones. Concerning thickness of the upper epidermis, it reached its maximum thickness in both Henderson and King of the Garden, in addition to the thicker one of the lower surface also of Henderson cultivar. The other one, however, exhibited thin epidermis on both surfaces, compared with the aforementioned resistant cultivars.