

CONTROL OF APHID-BORNE PEPPER VIRUSES

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Abstract

In field experiments, during two successive fall seasons, the best treatment in reducing aphid population on California Wonder pepper cv. was the use of Actellic followed by Sisi and Shakrona oils. While on Long Red Cayenne the lowest number of aphid was recorded in Sisi oil and Actellic treatments during 1992 and 1993, respectively.

The percentage of virus infection, during 1992, was least in aluminium foil and white plastic mulching (12-14%) as compared to control (65-74%), whereas in 1993, the two tested cvs. showed low virus infection percentage (8-10%) with aluminum foil mulching compared to the untreated control (55-60%).

On excised pepper leaves previously treated with Sisi oil (15 ml/l) the average number of *Myzus persicae* probes/hr was increased by 46.79%. Also, Sisi oil treatment killed 39.9% of the aphid on plants compared to 10% in untreated control after 24 hr from treatment. On the other hands, *M. persicae* failed to transmit PVY in the first 3 days when fed on Sisi oil treatment plants and only on the 4th day that a successful transmission occurred. The Sisi oil treatment decreased number of off-springs of aphid by 22.90% after 24 hours from oil spraying.

INTRODUCTION

Pepper (*Capsicum annum* L.) is an economically important vegetable crop grown in both plastic houses and open fields in Egypt. The presence of virus diseases is considered a limiting factor in the production of pepper in many countries. Many aphid-borne viruses have been reported to infect pepper plants i.e., pepper vein-banding mosaic virus, potato virus A, tobacco etch virus, alfalfa mosaic virus, po-

tato virus and cucumber mosaic virus. The last two viruses are the most common viruses that infect peppers and cause severe damage (Makkouk and Gumpf, 1974; Tobias *et al.*, 1982 and Khalil *et al.*, 1985).

Two aphid species, *Myzus persicae* (Sulzer) and *Aphis gossypii* (Glover) were effective vectors of PVY and CMV in a non-persistent manner (Simons, 1965 and Gowda and Reddy, 1989). Insecticides when used to control aphid vectors were of very little importance, as they did not prevent the non-persistent viruses from being transmitted due to the fact that the vectors were killed after the virus had been transmitted (Broadbent, 1957). There are some non-insecticidal approaches to the control of aphid-borne viruses including reflective mulches (Johnson *et al.*, 1967; Wyman *et al.*, 1979 and Chiang *et al.*, 1983) and oil sprays (Reagan *et al.*, 1979; Basky *et al.*, 1987 and Kiss *et al.*, 1988).

In the present work, the effect of two reflective surfaces (aluminium foil and white plastic), two mineral oils (Sisi and Shakrona), insecticide (Actellic) and mixture of insecticide and oil on aphid infestation and virus infection of pepper plants were studied. The effect of mineral oil on probing, reproduction, mortality of aphids and virus acquisition efficiency was also investigated.

MATERIALS AND METHODS

Viruses extracted from suspected pepper plants were maintained *Nicotiana tabacum* white Burely. Physical and serological studies were conducted to confirm the identity of such viruses (PVY and CMV).

1. Effect of some treatments on aphid population and virus infection:

Two field experiments were carried out in 1992 and 1993 at Kalubia Gov. to study the effect of some methods of controlling aphids. Reflective surface repellents, oils and Actellic (aphidicide) were used against the green peach aphid (*Myzus persicae*, Sulzer) on pepper (*Capsicum annum* L. cv. California Wonder and Long Red Cayenne). The pepper seedlings were produced from true seeds during January-March. Each experiment in this study consisted of seven treatments (aluminium foil, white plastic, Sisi oil, Shakrona oil, Actellic, Mixture of Sisi oil and actellic and control). Each treatment was replicated 3 times in a randomized block design. Each plot comprised three rows (8 m. long and 50 cm width). Distance between plants was 20 cm. Concerning testing the repellency of reflective surface, the aluminium and plas-

tic surfaces were placed on bare soil between the rows, seedlings were transplanted in holes made in the reflective surfaces, Mineral oils were kindly supplied by the Central Agricultural Pesticide Laboratory, Dokki, Giza, Egypt. Oil spraying (15 ml/L) was carried out weekly after transplanting by ordinary knapsack. Acetelic was applied biweekly at 0.2% as soon as first appearance of alate aphid insects. On the other hand, a mixture was made of Acetelic and Sisi oil which was sprayed ten days after the appearance of winged forms. At the same time, three plots were left without any treatment as a control. Plants were checked daily for aphids infestation on the foliage of pepper plants and then aphids were counted repeatedly for 5 times at 7 days intervals each. The number of aphids on 20 proximal leaves was used as sample size in each replicate.

The visual virus symptoms were checked on ten plants in each replicate (3 replicates in each treatment). The percentage of infected plants was calculated at the end of the growing season. Results were analyzed statistically according to Snedecor and Cochran (1969).

II. Effect of Sisi oil on feeding behaviours, mortality, reproduction and virus acquisition of *M.persicae* :

1. The mean number of aphid probes/hr:

To estimate the effect of sisi oil on the mean number of aphid probes/hr, non-viruliferous colonies of the green peach aphids (*Myzus persicae* Sulzer) were reared on cabbage seedling in an insect proof cage. Individual starved apterous insects were placed on excised pepper leaf discs which were previously treated with Sisi oil (15 ml/L). Control leaf discs were treated with distilled water. The aphids were left to feed for one hr. and then removed. The leaf discs were transferred to a petri-dish containing Fuchsin stain (0.20%) for one hr. Then rinsed in tap water and dried (Bowling 1980). The number of stained sheaths were used as an indicator of feeding behaviour. Each treatment was tested using 3 discs (1 aphid/disc) and replicated 3 times.

2. Reproduction of aphids on plants sprayed with oil:

California Wonder pepper seedlings were cultivated in pots in the greenhouse. Ten insects in the apterous stage were placed on a caged single seedling previously sprayed with Sisi oil (15 ml/L). Twenty four hours later, the off-spring individuals were counted. Pepper seedlings used as control were sprayed with water instead of

oil. The experiment was repeated three times.

3. Mortality of aphids on plants sprayed with oil:

Groups of ten aphids were placed on each pepper seedling, which was kept under a cage. Plants were sprayed with the Sisi oil (15ml/L) and kept for 24 hours. Killed aphids were counted and results were analyzed according to Abbott's formula (1925).

$$\frac{X - Y}{X} \times 100$$

X = The percent living in the check (control)

Y = The percent living in the treated plot.

4. Effect of oil on virus acquisition:

Potato virus Y- infected pepper seedlings were oil sprayed (Sisi 1.5%) and left for one hr. Five starved apterous aphids (*M.persicae*, Sulzer) were left to feed for five minutes on infected, sprayed and unsprayed plants (as acquisition period). Viruliferous insects were transferred to healthy pepper plants, and this was repeated on the second, third and fourth day. Virus symptoms were recorded. This experiment was repeated three times (5 aphids in each treatment, each including 5 plants).

RESULTS AND DISCUSSION

I. Effect of some applications on aphid population and virus infection

Mean number of *M.persicae* Sulzer/20 leaves at 5 intervals (one week) were followed in 1992 and 1993 on two pepper cvs untreated or treated with aluminium foil, white plastic, or sprayed with sisi oil, Schkrona oil, oil + Actellic and Actellic. Results are tabulated in Table (1) and illustrated in figs (1 and 2).

During 1992, in California Wonder and Long Cayenne cvs., the lowest mean number of aphid population was recorded in the Actellic (34.33/20 leaves) and Sisi oil (22.2/20 leaves) treatments, respectively. While highest numbers (166.5-120.92/20 leaves) were recorded for aluminium foil treatment in the two tested cvs. Significant differences were found between Sisi oil and Actellic treatments and the control in California Wonder cv., while in Long Red Cayenne, no significant dif-

ferences were found between different treatments and the control with respect to the mean number of aphid population.

Regarding the percentage of virus infection during the fall of 1992, the two tested pepper cvs exhibited the lowest percentage in case of aluminium foil and white plastic mulching (12-14%) followed by oil treatments (23-26%), while it reached (65-74%) in the control treatment (Table 1 and Figs. 1 and 2).

In the season 1993, data in Table (1) show that the Actellic treatment resulted in the lowest number of aphid population (17.3-25.53/20 leaves) in the two tested cvs. compared to control. However, the highest number of aphid was obtained in aluminium foil and white plastic for California Wonder and Long Red Cayenne cvs., respectively. The data also indicated that Shakrona oil and Actellic treatments had significantly decreased the mean number of aphids when compared with control in California Wonder cv. On the other hand, in the two tested cvs., mulching with aluminium foil and white plastic showed low virus infection percentage (8-10%) followed by oil treatments (15-19%) compared to untreated control (55-60%)

Table 1. Percentage of virus infection and mean of number of *M.persicae* Sulzer/20 leaves of California Wonder and Long Red Cayenne pepper cvs. under treatments during fall of 1992 and 1993.

Treatment	1992				1993			
	California Wonder		California Wonder		California Wonder		California Wonder	
	Number % of virus of aphid infection	Number % of virus of aphid infection	Number % of virus of aphid infection	Number % of virus of aphid infection	Number % of virus of aphid infection	Number % of virus of aphid infection	Number % of virus of aphid infection	
Aluminium foil	165.5* A	12**	120.93 A	14	84.40 A	8	34.66 B	10
White plastic	75.33 B	13	96.40 B	13	62.07 B	17	71.46 A	11
Sisi oil	39.53 C	26	22.30 G	23	40.93 C	18	37.03 B	19
Shakrona oil	73.20 B	26	76.53 CD	23	34.63 C	15	48.30 B	17
Sisi oil + Actellic	73.80 B	27	63.00 DE	22	39.30 C	21	40.40 B	20
Actellic	34.33 C	44	42.80 F	43	25.53 C	36	17.30 C	37
Control	163.70 A	74	89.46 BC	65	58.07 B	65	75.36 B	55
L.S.D. at 0.05 level	23.47		17.95		16.29		12.00	

Means with the same letter are not significantly different at 0.05 level.

* Average of 5 intervals, 3 replicates.

** Average of 3 replicates.

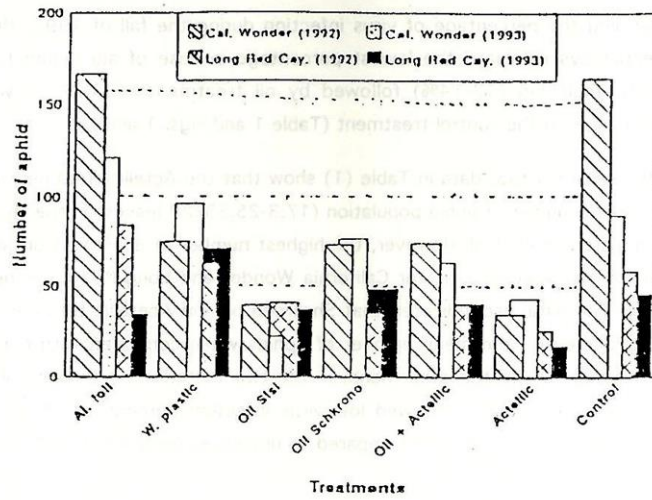


Fig. 1. Aphid population on pepper cv California Wonder and Long Red Cayenne under certain treatments.

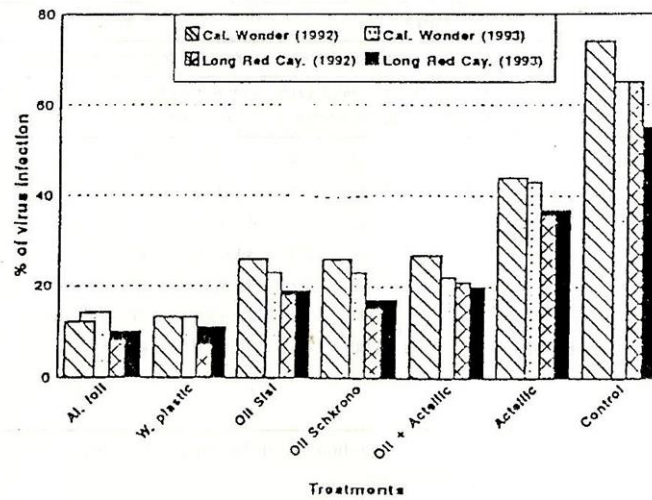


Fig. 2. Percentage of virus infection on pepper cv. California Wonder and Long Red Cayenne under certain treatments.

No effects of reflective surface were obtained on the mean number of *M.persicae*/20 leaves, while the percentage of virus infection was greatly reduced as compared to control. This may be attributed to their effect on the aphid infestation but not on aphid colonization. Therefore, any control programme which includes reflective mulching to repel alate individuals would also require insecticide spraying to reduce the aphids. Bachatly (1992) found that mulched plots had the highest number of caught aphids and white flies on cucurbit plants. She mentioned that this was probably due to the effect of mulching on plants; stimulation of plant growth (sunlight enhancement, soil temperature adjustment, weed control and water conservation (Wyman *et al.*, 1979) resulting in a well developed plant foliage.

However, the repellent effect was evident on young seedling where more mulched surface was exposed. As soon as plants grow, foliage covered mulched surface, obscuring the white colour of polyethylene, repellent effect is diminished or would be probably annihilate (Johnson *et al.*, 1967).

The results revealed that oil treatment reduced the percentage of virus infection and mean number of *M. Persicae* Sulzer/20 leaves of the two tested pepper cvs and Sisi oil was found superior to the other Shakrona oil. Many investigators reported that oil sprays have given promising results in reducing the spread of aphid transmitted stylet-borne viruses including PVY and CMV, in both greenhouse and field experiments (Loebenstein *et al.*, 1964, Reagan *et al.*, 1979 and Basky *et al.*, 1987). Bachatly (1992) suggested that, because virus transmission depends on landing and probing behaviour of alate aphids, the mineral oils effectiveness inhibiting the spread of viral diseases was not due to the controlling of aphid population growth but it prevented the normal transmission of virus.

During two seasons, Actellic, reduced the population of aphids and percentage of virus infection in the two tested pepper cvs as compared to control. Many investigators reported the reduction of viral incidence by insecticides in field (Gibsan *et al.*, 1982 and Bell and Hany, 1986). Actellic controlled the number of aphids but did not prevent spread of virus diseases or delayed symptoms on plants because it did not prevent aphids from probing and feeding before dying (Bachatly, 1992).

II. Effect of Sisi oil on feeding behaviors, mortality, reproduction and virus acquisition by *M.persicae*:

1. The mean number of aphid probes/hr:

Data in Table (2) show that average number of aphid probes/hr was increased by 46.79% when plants were sprayed by Sisi oil. This result is in agreement with Bachatly (1992). Increasing number of probes with higher concentration of oils facilitate greater number of short probes by stylet aphid but probable site of action of oil is on the tip of the labium. The oil has contaminated the tip of the labium and could wipe the virus off stylet during its exit, thus reducing virus transmission on leaves coated with oil (Simons *et al.*, 1977).

2. Reproduction of aphids on plants sprayed with oil:

Data in Table 2 illustrated that Sisi oil treatment decreased the aphid off-spring by 22.90% after 24 hours from oil spraying. Bachatly (1992) reported that number off-spring on both oils Star and Supermisrena treated leaves decreased with the higher concentration of oils.

Table 2. Effect of mineral oil (Sisi) on feeding behaviour, mortality after 24 hours and reproduction of *Myzus persicae* Sulzer.

Characters	Sisi oil treated	Untreated planted	% of decrease or increase
Number of probes/hour	59.6*	40.6	+46.79
Percentage of mortality after 24 hours	39.9%	10.0%	+2.99
Number of offsprings	10.1	13.1	-22.90

* Average of 3 replications

3. Mortality of aphids on plants sprayed with oil:

Application of Sisi (1.5%) caused 39.9% mortality percentage of *M.persicae* compared to 10% in untreated plants (Table 2). Similar result was obtained by Bachatly (1992) who found that oil treatments caused mortality of aphid ranging from 20% to 60% according to concentration and type of oil. Higher concentration of oils provided a good coverage of leaves after evaporation of water and decreased aphid survivals on plants (Walkey and Dance, 1979).

4. The effect of oil on virus acquisition :

Results show that *M.persicae* Sulzer failed to transmit PVY to pepper plants during the first 3 days from oil spray on the source plant and transmitted it on the fourth day. Loebenstein *et al.* (1964) reported that the mineral oils reduced CMV-

transmission and the infectivity of aphids was reduced much, only when they fed on freshly sprayed plant. This may be due to the thinness of the oil film and its denaturation or evaporation, or it may be that when the leaf continues to grow, the film from the low concentration is ruptured, leaving leaf surface exposed. On the other hand, during acquisition, the stylets pass twice through oil (insertion and withdrawal), the chance of oil disrupting the transmission process with this double exposure is higher (Goodman and Nault, 1983).

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مقاومة فيروسات الفلفل المنقولة بالمن باستعمال الطرق الحديثة

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فى تجربة حقلية على مدى موسمين متتاليين وجد أن أحسن المعاملات فى خفض تعداد المن على صنف الفلفل كالفورنيا وندر هى المعاملة بالمبيد الحشرى الأكتليك ويليها الزيوت المعدنية (سى سى وشاكرونا). بينما على الصنف لونج رد كايين كانت أحسن المعاملات هى الزيت سى سى والمبيد أكتليك فى موسمى ٩٢ ، ١٩٩٣ على التوالي.

سجلت معاملة التغطية برقائق الألومنيوم والبلاستيك الأبيض أقل نسبة مئوية فى الإصابة الفيروسية فى كلا الصنفين أثناء موسم ١٩٩٢ . أما فى موسم ١٩٩٣ فكانت التغطية برقائق الألومنيوم أحسن المعاملات (مقارنة بالكنترول).

زاد عدد وخزات المن على أوراق الفلفل السابق معاملةها بزيت سى سى (١٥ مل / لتر) بنسبة ٤٩,٤٩٪ مقارنة بالكنترول وكذلك زادت نسبة الموت لحشرة المن إلى ٣٩,٩٪ بينما كانت ١٠٪ فى الكنترول. فشلت حشرة المن فى نقل فيروس وى البطاطس فى الثلاثة أيام الأولى بعد الرش بالزيت ونجحت فى اليوم الرابع. وكذلك انخفض عدد النسل الناتج على الأوراق المعاملة بنسبة ٢٢,٩٪ بعد ٢٤ ساعة من الرش بالزيت.