Field Tests with Oil Sprays for the Prevention of Aphid-spread Viruses in Peppers

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ABSTRACT

Oil emulsions applied from emergence in the nursery were highly effective against aphid-borne cucumber mosaic virus and potato virus Y on peppers. Air-blast sprayings at concentrations of 1-2% were given in the nursery every 3-7 days, and in the field at weekly intervals with a concentration of 2.5%. In 2 consecutive years, oil sprayings suppressed virus incidence almost completely in autumn nurseries during periods with high aphid populations. In control plots planted from unsprayed nurseries, infection rates reached 50-60% as soon as 9 to 11 weeks after transplanting. Early infection in the nursery caused a complete failure of the crop, whereas protection afforded by oil sprays resulted in normally developed plants with high yields of 5,000-6,000 kg/1,000 m^2. Oil sprays similarly protected the nursery and young transplants of spring-grown peppers, increasing development and yields of the plants. Oil sprays were less effective against late infections of mature plants. Although infection was delayed, the increases in yields were small. For practical purposes, it seems sufficient to protect the nurseries or young transplants during the season of intense virus dissemination, and to discontinue spraying in the field. Phytopathology 60:212-215.

Bell peppers (*Capsicum annuum* L.) are grown in Israel throughout the year, from April until November in the open, and during the winter under plastic covers. They are severely affected by potato virus Y (PVY) and cucumber mosaic virus (CMV), whereas tobacco mosaic virus (TMV) is of secondary importance (10). Rapid field spread occurs mainly in the late autumn and in the spring, when aphid populations, especially of *Myzus persicae* Sulzer, are high (1). The use of cultivars resistant to PVY, such as Yolo Y (4, 8) and PVY-resistant Puerto-Rico Wonder, gave only partial success due to their susceptibility to CMV. Furthermore, these varieties were also susceptible to some strain(s) of PVY prevalent in Israel.

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 (2, 3, 6, 7). It seemed worthwhile, therefore, to evaluate the effectiveness of oil sprays in preventing the spread of these viruses in peppers. In these experiments, oil sprays were begun immediately after emergence of the plants in the nursery. It was expected that protection of nurseries of peppers grown during seasons with high aphid populations would result in significant increases in yield (9), because early infections of young plants affect peppers more severely than late infections.

MATERIALS AND METHODS.—Pepper cv. California Wonder were grown for 9-11 weeks in nurseries, sown in mid-October 1967, mid-March 1968, and 1 October 1968, then transplanted to experimental fields at Bet Dagan. The spring nursery was sown under plastic covers, whereas the autumn nurseries were covered with polyethylene sheets in mid-November, 4-6 weeks after emergence. The nurseries were divided into two blocks, 30-50 m apart, one being sprayed and the other serving as control.

Blancol (Pazchem), a commercial summer oil spray consisting of 80% white medium-light oil and 20% water and emulsifiers, was emulsified at different concentrations in water. The sprays were applied with a Holder motor-driven air-blast knapsack sprayer at a rate of 10-25 liters/1,000 m^2 (low volume), depending on the size of the plants. A nozzle with an orifice of 1.5 mm diam was used.

In the autumn nurseries, the first three sprayings, at a concentration of 1% Blancol, were carried out at 3- or 4-day intervals, starting when about half the plants had emerged. Nine or 10 additional sprayings were applied at weekly intervals, or after a rainfall, until transplantation; the first five at a concentration of 1.5% and the remaining ones at 2%. In the spring nursery, the first six sprays were given at somewhat shorter intervals, as aphid populations are generally higher during March and April (100-250/week), than in the autumn (1). No phytotoxic damage was observed.

Peppers from the 1967 and 1968 autumn nurseries were transplanted in the 1st week of December into 185 or 200m^2 plots, comprising nine or 10 12-m-long plastic covers, respectively. Forty-five peppers were planted in two rows under each cover. Peppers from the spring nursery were planted in the open field, in 250-m^2 blocks, comprising 18 20-m rows, 50 plants/row. All plots were separated by 3-10 m of uncultivated borders.

Irrigation in nurseries and fields was applied by overhead sprinklers at intervals of 5-14 days, and the usual horticultural practices were employed.

Winged aphids were trapped in Moerike pans painted yellow and filled with water plus nicotine sulfate. The trapped aphids were collected at weekly intervals.

The rate of virus incidence was determined by visual symptoms and by calculating the percentage of plants affected. Inoculations from mosaic and symptomless pepper plants to *Chenopodium amaranticolor* Coste & Reyn., *Nicotiana glutinosa* L., *Cucumis sativus* L., and *Physalis floridana* Rydb. were carried out sporadically

to check the reliability of the visual observation and to determine the causal virus. TMV was seldom recovered. Agreement between visual observations and inoculation tests was high (more than 90%), and those symptomless plants from which PVY or CMV was recovered developed symptoms after a certain time.

RESULTS.—*Autumn-spring season, 1967-1968.*—Peppers from the oil-sprayed nursery were transplanted into two plots. One week after transplanting, when the plants were established, one of the plots was sprayed with a 2.5% emulsion of Blancol; the second plot was sprayed with a 5% emulsion; subsequent sprays were applied at weekly intervals. A similar-sized plot was planted with peppers from the unsprayed nursery, and served as an untreated control.

Sprayings were continued throughout the winter, and terminated in mid-June to enable dinocap (Karathane) application against powdery mildews, which should not be used in conjunction with oils. No phytotoxic effects were observed. On the contrary, in March the average height of plants in the sprayed blocks was 50 cm, as compared to 30 cm in the control block. However, on sunny days during the winter, care was taken to leave the plastic covers open for 4-5 hr after a spraying to prevent scorching. All plants were counted for symptom incidence, and the percentage of plants affected is summarized in Fig. 1-A. Although no symptoms were observed in the nursery, virus incidence in the control plot planted from the nonsprayed nursery rose steeply during February. In the sprayed plots, visible infection remained below 10% until the end of April, whereas at that time, infection rates in the control plot were already more than 90%. In April, the plants in the oil-sprayed plots were fully developed and yielding, whereas in the control plot, the plants remained stunted. Infection of the control plants apparently occurred in the nursery, as aphid populations from December to mid-February are low. The number of winged aphids trapped ranged between 0 and 3/week, whereas during October-November generally high numbers, 50-100/week, occur (1). Aphid populations again increase in the spring, ranging between 50 and 100/week during March-May 1968. When juice inoculations were made from mosaic-affected peppers to test plants, PVY was found in 69% and CMV in 39% of the plants, some of them carrying both viruses, with no marked differences between oil-sprayed and control plots.

Although infection rates in the oil-sprayed plots increased from May onward, there was a very significant increase in yield between the oil-sprayed plots and the control. A total of 6,000 and 5,300 kg/1,000 m^2 were harvested in the 2.5- and 5%-sprayed plots, respectively, compared to 2,800 kg/1,000 m^2 in the control. The relative increases between the oil-sprayed plots and control were even more pronounced if grade "A" yields were compared (Fig. 2). Grade "A" yields were 3-3.5 times higher as a result of the oil sprayings.

The higher oil concentration did not seem to be more effective than the lower one. On the contrary, higher infection rates and consequently lower yields were observed in the plot sprayed with the 5% emulsion, as compared to the plot sprayed with 2.5% Blancol. This, however, could have been the result of an interaction with the adjacent control block, whereas the 2.5% plot did not border with the control.

Autumn-spring season, 1968-1969.—At the time of transplanting, 48% of the plants in the unsprayed control nursery already showed symptoms, whereas no symptoms were observed in the oil-sprayed nursery. From the sprayed nursery, three plots were planted. One of the plots was sprayed at weekly intervals until mid-June with 2.5% Blancol; a second was sprayed when the number of winged aphids in the trap was 20 or more; i.e., from March until the end of May; and a third plot was left unsprayed after transplanting. These treatments were adopted because the high infection rate in the control nursery and the results of the previous

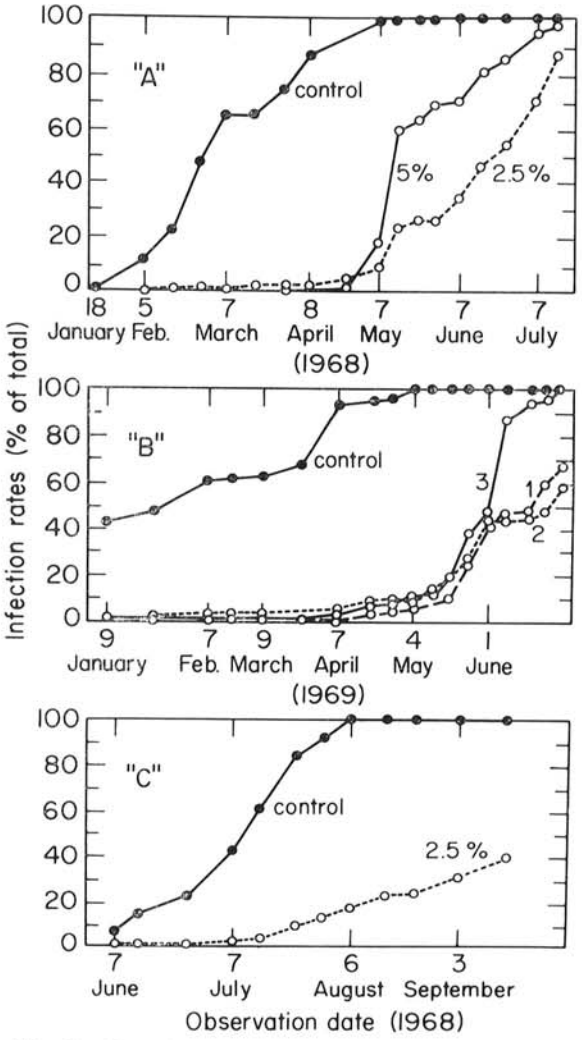

Fig. 1. Spread of virus in oil-sprayed and control plots of peppers. **A)** Autumn-spring season 1967-68. Oil emulsions at 2.5 and 5% were compared to unsprayed control. **B)** Autumn-spring season 1968-69. 1 = Fields sprayed at weekly intervals with a 2.5% oil emulsion; 2 = sprayed when no. of winged aphids trapped 20 or more; 3 = oil sprayings terminated after transplanting. **C)** Spring-summer season 1968. A 2.5% oil emulsion was compared to unsprayed control.

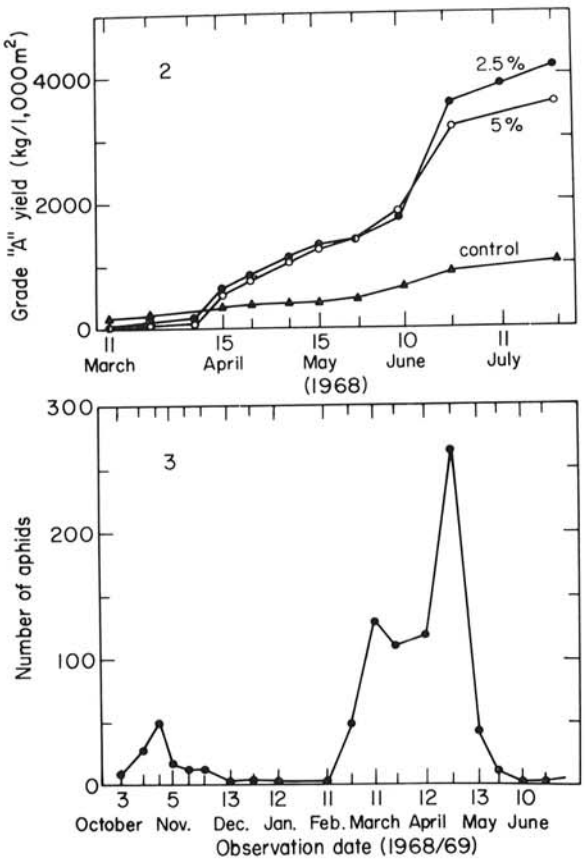

Fig. 2-3. **2)** Grade "A" yields of peppers from oil-sprayed and control plots, autumn-spring 1967-68. **3)** Number of winged aphids trapped in Bet Dagan, Israel. Average from 2 weekly trappings.

year suggested that the most critical period of infection occurs while the plants are in the nursery, and a reduction in the number of sprayings in the field would reduce costs. A fourth plot was planted from the unsprayed nursery and served as an untreated control. However, as symptom incidence was high, only those plants without symptoms were transplanted.

The number of winged aphids trapped is summarized in Fig. 3. The number of *M. persicae* trapped was correlated with the total number of aphids caught, averaging 37% during the autumn and 11% in the spring, whereas no *M. persicae* were trapped in the winter. Infection rates are summarized in Fig. 1-B. Although the unsprayed control plot was planted from plants without symptoms, virus incidence had already reached 60% in February (60 days after planting), causing severe stunting of the plants (Fig. 4-A). Apparently, heavy infection occurred in the nonsprayed nursery immediately after emergence, although the number of winged aphids trapped (50/week at the end of October) was low in comparison to other years. In the treated nursery, oil sprays effectively prevented infection. As a result, visible infection in the three plots planted from the oil-sprayed nursery remained below 10% until the end of April. Plants in April were fully developed (Fig. 4-B), reaching an average height of 60 cm, as compared to 30 cm in the nonsprayed control plot. No difference was observed in the development of the plants among the three plots planted from the oil-sprayed nursery. Infection rates in the nonsprayed plot, planted from the sprayed nursery, rose rapidly after the end of April, whereas in the other two plots the increase was slower. Inoculations made from February to April resulted in 63% PVY and 48% CMV, with some of the plants carrying both viruses; there were no marked differences between oil-sprayed and control plots.

A very marked increase in yields, of more than 5-6 times, was observed in all three plots planted from the sprayed nursery, when compared to the nontreated control plot (Table 1). Increases were even more marked when grade "A" yields were compared. Differences in yield between the three plots were comparatively small. Apparently, the effect on yield is limited if infection occurs late, when the plants are already fully developed.

Spring-summer season.—Two blocks were planted in mid-May 1968 from the oil-sprayed and control nursery, respectively. At the time of transplanting, no virus symptoms were observed. Beginning 10 days after transplanting, when the plants were established, the plot planted from the sprayed nursery was sprayed with 2.5% Blancol at weekly intervals, whereas the other one served as an untreated control. Sprayings were continued until mid-August; no phytotoxic damage was observed, not even when the spraying was carried out on "Hamsin" (easterly desert wind) days, with temperature maxima of 40°C.

A difference in the development of the plants between the two plots was noted. In August, the plants in the sprayed plot reached 61 cm vs. only 45 cm in the control plot. Virus incidence is summarized in Fig. 1-C. A marked delay in symptom appearance was evident. Inoculations to test plants resulted in 75% PVY and 30% CMV. Total and grade "A" yields increased in the sprayed plot to 6,700 and 4,900 kg/1,000 m², respectively, compared to 5,400 and 3,200 kg/1,000 m² in the control plot.

Discussion.—Oil sprayings at short intervals in nurseries of peppers grown when aphid populations were high efficiently suppressed infection by two stylet-borne viruses, PVY and CMV. Applications in the field, although delaying infection, were less effective as compared to treatments in the nursery, as evident from the

Table 1. Yields of green peppers from oil-sprayed plots and control, autumn-spring, 1968-1969

Treatment	Total, kg/1,000 m²	Grade "A" kg/1,000 m²
1. Sprayed at weekly intervals	5,740	3,940
2. Sprayed at weekly intervals when number of aphids trapped was 20 or more	6,300	4,000
3. Spraying terminated after transplanting[a]	6,300	3,660
4. Control[b]	1,060	110

[a] Planted from oil-sprayed nursery.
[b] From unsprayed nursery.

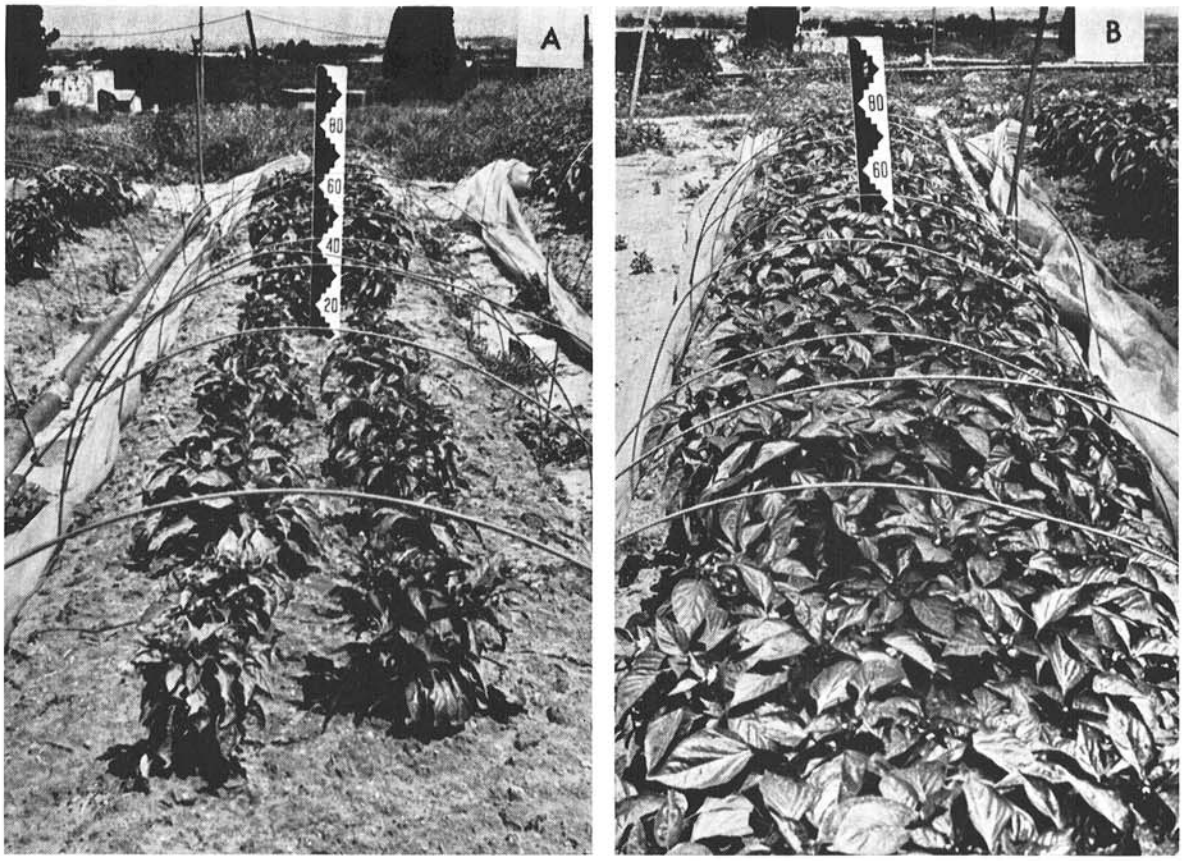

Fig. 4. Development of plants **A)** in control and **B)** oil-sprayed pepper plots at Bet Dagan. Photographed on 20 April 1969. Control of stylet-borne viruses accounts for the difference in growth.

1969 experiment (Fig. 1-B, treatments 1, 2, 3). Apparently, when plants are small, distribution of oil droplets and coverage of the leaves, especially on their lower surfaces, are better than in fully developed plants with a close canopy of leaves. However, the protection of young plants is of major importance, as infection of peppers in the nursery caused a severe stunting of the plants, resulting in a complete failure of the crop. Late infection, when the plants are fully developed, is less critical, as effects on yield are negligible (Table 1, treatment 3). Therefore, for practical purposes it seems sufficient to protect the nursery seedlings, or the young transplants, grown during a season when viruses dissemination is intense but of short duration (autumn nursery), and to discontinue oil spraying in the field. These suggestions have now been adopted by the local advisory agency.

No phytotoxic effects were observed. It should be emphasized, however, that all the nurseries and fields were irrigated by overhead sprinklers, preventing oil accumulation. Care was also taken not to cover the plants with plastic immediately after spraying. Oil sprayings were not tested under dry farming conditions or furrow irrigation. Frequent oil applications under such conditions might damage the plants (5).

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