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EFFECT OF ALUMINIUM STRIPS ON THE SPREAD OF TWO APHID-BORNE CHRYSANTHEMUM VIRUSES[1]

Effect van aluminiumstroken op de verspreiding van twee door bladluizen overgebrachte chrysantevirussen

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A study was made of the effect of reflective aluminium strips placed above a chrysanthemum crop on the spread of tomato aspermy virus (TAV) and chrysanthemum virus B (CVB) in outdoor chrysanthemums. Application of short strips placed across the beds diminished the spread of TAV to about a third but did not appreciably influence the spread of CVB. Aphid numbers caught in yellow water traps were reduced considerably by the treatment. A hypothesis is put forward to explain the difference in the effect of the reflective material on the spread of the two viruses. It is concluded that this method of reducing virus spread is not likely to be of practical value in the culture of elite chrysanthemum plants.

INTRODUCTION

As more virus-tested chrysanthemum plants become available, the need for knowledge of effective means of preventing re-infection becomes more urgent. Especially in outdoor chrysanthemums these means are few. Prevention of the spread of aphid-borne viruses in crops grown outdoors has been attempted in several ways. Control of the vectors by insecticide spraying may be successful with viruses of the circulatory type, but the results with stylet-borne viruses are mostly discouraging, since aphids can acquire and transmit stylet-borne viruses within a few minutes.

A more rewarding approach for preventing the spread of stylet-borne viruses would seem to be to repel the winged aphids from landing on the crop instead of killing them after landing. When ending their distance flight and entering the "attack phase" a reversal in phototactical behaviour occurs in aphids. In the latter phase UV reflection has a repellent action (MOERICKE, 1955). A repellent effect of reflective aluminium on aphids has been reported by KRING (1964). The action of this material on the spread of cucumber mosaic virus has been studied by SMITH *et al.* (1964). They placed reflective aluminium sheets between rows of gladiolus. This reduced the number of aphids trapped in yellow water traps by 96% and the incidence of cucumber mosaic virus infection in the gladiolus was reduced by 67%. The aluminium sheets repelled at least 12 species of aphids.

Protection of cantaloup plants from watermelon mosaic virus by aluminium foil was tried by DICKSON & LAIRD (1966) in California in 1965. They found that the use of aluminium foil did no more than delay infection 5 to 10 days in the range of 2 to 50% infection and concluded that the use of this material under the conditions of their test was not of practical value.

In view of the need for methods of preventing virus spread in outdoor

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chrysanthemums, an experiment was carried out in 1966 to study the effect of aluminium strips on the spread of two aphid-borne viruses, viz. tomato aspermy virus (TAV) and chrysanthemum virus B (CVB).

MATERIALS AND METHODS

Fifteen plots each consisting of four rows of 24 plants (cultivar 'Chatsworth') were grouped in five three-plot beds. Each plot contained 48 healthy and 48 diseased plants which were planted alternately to give maximum infection chance for the healthy plants. The diseased plants were infected with both TAV and CVB. The disease-free plants had been obtained by meristem culture (HAKKAART & QUAK, 1964) and had again been tested before use for the absence of TAV and CVB. Within the beds the plots were separated from each other by groups of 4 × 6 virus-infected plants. The test field was bordered at each side by a three-plot bed of the same composition. In one of these border beds yellow water traps were placed in the crop among the plants to study the effect of the aluminium material on aphid flight. As the plants grew taller, the traps were raised correspondingly. Three treatments were compared in five replications:

1. Four long (6.6 m) strips of foil (10 cm wide, 0.2 mm thick) on each plot. Reflective surface 2.6 m^2 per plot of 6.6 m^2. Direction of the strips from north-west to south-east, the length of the beds.
2. Nineteen short (1 m) strips (same width and thickness) on each plot. Reflective surface 1.9 m^2 per 6.6 m^2. Direction of the strips from north-east to south-west, across the beds.
3. No reflective material on plot of 6.6 m^2.

The strips were fixed on wire netting above the plants. As the plants grew the netting was raised being kept consistently above the plants. For the control plots wire netting without aluminium strips was used and treated in the same way. The young plants were planted on 13 June and the reflective material was fitted on 23 June. The plants were transferred on 3 November to a glasshouse, treated regularly with an insecticide as had been done in the field and were serologically tested for the presence of TAV and CVB after a period of about three months. For CVB the method as described by HAKKAART *et al.* (1962) was used. The presence of TAV was determined by agar double diffusion tests of the sediments obtained by centrifugation of the extracts during 10 minutes at 3000 r.p.m. Every infectable plant was marked. Thus it was known at which locations in the plots infections took place. When analyzing the results of the virus testing the outer rows and the inner rows were treated as separate plots ("half-plots"). The numbers of infected plants were expressed as a percentage of 24 and these percentages were transformed by angular transformation. The transformed numbers were analyzed by analysis of variance with a studentized-range test.

RESULTS

The numbers of infected plants are shown in Table 1. With TAV, the untreated plots had highly significantly ($P < 0.01$) more diseased plants than the plots with short strips; the differences between the untreated plots and those with long strips and between the plots with long and short strips were both nearly significant ($P < 0.10$). There were no appreciable differences between the num-

TABLE 1. Numbers of infected plants in plots treated with aluminium strips.
Aantallen besmette planten in veldjes, die behandeld waren met aluminiumstroken.

Treatment	Total number of infectable plants	Number of plants infected with tomato aspermy virus				Number of plants infected with chrysanthemum virus B			
		Outer rows	Inner rows	Total	%	Outer rows	Inner rows	Total	%
Long strips	240	9	12	21	8.7	28	16	44	18.3
Short strips	240	5	6	11	4.5	27	13	40	16.6
Untreated	240	16	14	30	12.5	27	17	44	18.3
Total	720	30	32	62	8.6	82	46	128	17.7

bers of infections in outer and inner rows; nor was there any interaction, i.e. the effect of the treatments on outer and inner rows was the same. With CVB, on the other hand, there was a highly significant difference ($P < 0.01$) between infection in the outer and inner rows; there were no differences between the treatments and no interactions. The number of infections with CVB was higher than with TAV.

Table 2 shows the effect of the reflective material on aphid numbers caught in yellow traps. The numbers were reduced to roughly a third, which is about the same as the reduction in spread of TAV by the short strips. The names of the species of which at least ten specimens were caught in the untreated plot are given in the table; the numbers of other species are shown collectively under the heading "other aphids". From the figures one gains a strong impression that the repellent action is not species-specific, but a general phenomenon applying to aphids caught in yellow traps. The field vectors of TAV are not known, but as the repellent action is not species-specific, it may be surmised that these vectors also were repelled to at least a third of their numbers.

TABLE 2. Number of winged aphids caught in yellow traps placed in a chrysanthemum crop treated with reflective aluminium.
Aantal gevleugelde bladluizen gevangen in gele vangbakken, geplaatst in een chrysantegewas behandeld met reflecterend aluminium.

Aphid species	Number of aphids		
	Long strips	Short strips	No strips
Aphis fabae Scop. complex	70	81	365
A. gossypii Glov. complex	8	4	20
Capitophorus hippophaes Walk.	15	40	112
C. spp.	5	22	60
Cavariella aegopodii Scop.	1	1	14
Hyalopterus pruni (Geoffr.)	7	6	11
Hyperomyzus spp.	8	9	29
Macrosiphum euphorbiae Thos. complex	12	22	38
Myzus certus Walk.	6	2	16
M. persicae Sulz.	14	15	67
Rhopalosiphum nymphaeae L.	14	16	35
R. padi L.	271	286	685
Sitobion avenae Fabr.	8	7	22
Other aphids	63	93	160
Total	502	604	1634

DISCUSSION

The failure of the reflective material to reduce the spread of CVB cannot be explained by virus spread caused by apterous aphids, since the plants were kept free from colonizing aphids by intensive insecticide spraying. The hypothesis is put forward that a difference in height of flight of the aphid vectors may explain the difference in the effect of the reflective material on virus spread. It is suggested that the vector or vectors of TAV may fly above the crop, thus seeing the reflective material and being repelled to a certain extent. Virus spread would thus be reduced proportionally. The vector or vectors of CVB, on the other hand, may fly low above the ground and not see the reflective material, and this may explain the failure of this material to reduce the spread of this virus. An indication that this may be so is the fact that with TAV there was no difference in infection between the outer and inner rows, whereas with CVB the outer rows contained more infected plants than the inner rows.

Other examples of increased virus infection in edge rows are known. With potatoes NEITZEL & MUELLER (1959) found that infection with potato leafroll virus and virus Y decreased sharply from the edge to the centre of the field: this was ascribed to the low flight of the vectors which tended to stop at the edges of the crop. Is has also been shown that different species of aphids may have different specific heights of flight (SHANDS *et al.*, 1956).

In our case we must assume that each chrysanthemum virus is spread by its own vector(s). The prospects for the use of reflective material in commercial practice, at least as used in our experiment, are not attractive. A reduction in infection with TAV from 12.5% to 4.5% is not considered sufficient to warrant further study, while the results with CVB are completely discouraging.

Other methods are needed to obtain a satisfactory prevention of virus spread.

SAMENVATTING

De invloed van reflecterende aluminiumstroken boven een chrysantegewas op de verspreiding van tomaat-aspermie-virus en chrysant-B-virus werd nagegaan bij chrysanten in de volle grond. Toepassing van korte stroken dwars over de bedden verminderde de verspreiding van het eerstgenoemde virus tot ongeveer één derde, maar had geen duidelijke invloed op de verspreiding van het laatstgenoemde virus. De aantallen bladluizen in gele vangbakken bleken door de behandeling aanzienlijk af te nemen. Er werd een hypothese opgesteld om de verschillen in effect van het reflecterende materiaal op de verspreiding van de twee virussen te verklaren. De conclusie wordt getrokken, dat toepassing van dit materiaal op deze manier niet aantrekkelijk is om virusverspreiding bij de teelt van chrysanten tegen te gaan.

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