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No. 239 JANUARY 1971

CIRCULAR OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN

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Mosaic virus diseases can seriously reduce yield and limit production of summer squash, particularly for the fall harvested crop in Northeastern United States. At this time of the growing season virus infection often seems to burst into a field, spreading rapidly, causing stunted growth, poor fruit set, and sometimes complete crop failure. At present there are no virus resistant varieties of summer squash and insecticides have not provided satisfactory protection. However, reflective surfaces which repel the aphid vectors responsible for transmitting the disease have given significant protection.

Experiments with squash and other crops in Southern Florida (3,6), Beltsville (4), and Long Island (4) have shown that reflective aluminum mulches reduce aphid numbers, delay virus infection, and increase yields. Late season squash has recently been grown commercially in Southern New Jersey (5) by using aluminum foil, although data from replicated experiments have not been reported. In this paper we report results of experiments carried out at Mt. Carmel, Connecticut, to evaluate the effect of various reflective surfaces on virus protection in late season squash.

Two experiments were conducted in the field. The first was a replicated experiment consisting of four treatments; three mulches – black polyethylene plastic (1.5 mil.), paper-backed aluminum foil with a 6" black stripe*, and paper-backed aluminum foil without the stripe* – were compared to a bare soil control. Four replications of the treatments were arranged in a randomized complete block design. Each treatment plot was 36 ft. long and contained 11 plants spaced 3 ft. apart. There was 10 ft. of bare soil between each treatment plot and 15 ft. of bare soil surrounding each complete block.

*We thank Anaconda Aluminum Co., Louisville, Kentucky, for their gift of the aluminum foils used in these experiments.

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The second experiment was a non-replicated demonstration trial consisting of 10 rows, 36 ft. long covered with aluminum foil, and a corresponding adjacent plot of 10 unmulched rows. In both experiments the edges of the mulches were buried in shallow trenches dug between the rows and around the plots. This exposed a strip of mulch about 3 ft. wide in each row. X-shaped cuts were made 3 ft. apart in the mulches to permit planting.

Seeds of "Seneca Prolific," a yellow straight neck hybrid, were sprouted in a seed germinator and planted in 3-inch peat pots in an aphid-free greenhouse on July 17, 1970. The field was irrigated (1.5 inches) on July 29; the mulches were laid and plants set on July 30. A second irrigation was applied on August 19. Fruits were harvested for approximately 3½ weeks commencing on August 27. Incidence of virus infection was recorded at each picking. To prevent mechanical spread of virus, fruits were twisted from the plants and the hands of the picker were washed in detergent when plant contact occurred.

Aluminum foil mulch effectively delayed virus infection (Table 1). No plants showed visible mosaic symptoms 19 days after transplanting, but at the time of initial harvest, 28 days after transplanting, virus infection was prevalent (Fig. 1). The yield of plants mulched with aluminum was more than double that of unmulched plants in both the replicated and demonstration experiments (Table 2). Aluminum foil with black stripe was less effective in delaying virus and total yield was less, though not significantly, than aluminum foil without the stripe.

Aluminum foil mulch tends to cool the soil under it, whereas, foil with black stripe elevates soil temperature, particularly under the stripe (1). These soil temperature differences are important for crops planted early

Fig. 1. Virus-free summer squash plant (right) and virus-infected plant (left). Note stunted growth and lack of fruit set of infected plant. Photograph taken 28 days after transplanting.

Fig. 2. Demonstration trial in foreground, 28 days after transplanting. No mulch (left) compared to aluminum foil mulch (right).

in the spring but are probably not important for crops planted in mid-summer. Therefore, for maximum virus protection for fall-harvested squash aluminum foil without the stripe is suggested.

Plants in both aluminum plots grew faster and set fruit earlier than those in the bare soil and black plastic plots. This is partly indicated in Fig. 2 and by the first harvest yield data (Table 2). The two aluminum treatments could have been harvested 2-3 days earlier than the bare soil plots. The two irrigations would tend to reduce the influence of mulch on

Table 1. The effect of mulches on incidence of mosaic virus infection in late season summer squash

Treatments	*Percentage of mosaic – infected plants*							
	Days from transplanting							
	28	32	36	40	44	48	52	56
	Replicated experiment							
Control (bare soil)	90.3	100.0						
Black plastic	82.4	100.0						
Striped aluminum	61.8	67.6	85.3	97.0	100.0			
Aluminum	33.3	38.9	61.1	83.3	86.1	91.7	94.4	97.2
	Demonstration trial							
Control (bare soil)	96.9	99.0	100.0					
Aluminum	42.8	44.9	74.5	86.7	94.8	96.9	99.0	99.0

growth and yield and place greater emphasis on the effect of virus infection on yield. The dramatic effect of virus infection on yield is shown in Fig. 3. As virus infection increased, resulting in reduced growth and fruit set, yield decreased rapidly.

The effectiveness of the aluminum mulches in repelling aphids was borne out by aphid counts. The numbers of aphids flying at various

Table 2. The effect of mulches on yield in late season summer squash

Treatments	*Marketable fruits per plant*	
	First harvest	Total harvest
	Replicated experiment[x]	
Control (bare soil)	0.6 a	1.7 a
Black plastic	0.7 ab	1.8 ab
Striped Aluminum	1.3 c	2.8 bc
Aluminum	1.0 bc	3.6 c
	Demonstration trial[y]	
Control (bare soil)	0.2	1.3
Aluminum	1.1 °°	3.2 °°

[x] Means followed by the same letter are not significantly different at the 5% level of probability according to Duncan's multiple range test.

[y] For the demonstration trial °° = significantly different from control at 1% level, based on a *t* test.

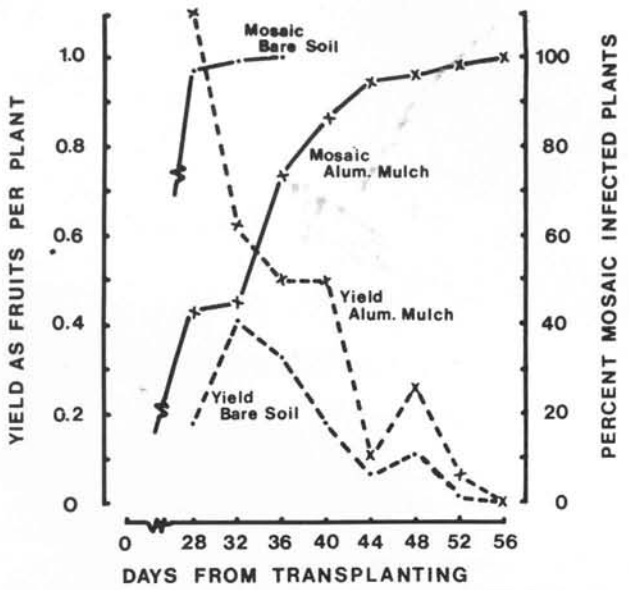

Fig. 3. Relationship between incidence of mosaic virus and yield in unmulched and aluminum mulched late season summer squash. Data from demonstration trial.

heights over the different treatments in both the replicated and demonstration experiments were determined on August 29 and September 23 by trapping for 72 hours on sticky, yellow stakes (Fig. 4) placed in the row (2). More aphids were trapped in the row over bare soil treatment than between the plots (Table 3). This is to be expected since the plants would tend to attract and accumulate aphids. Aluminum foil was the most effective mulch in reducing aphid numbers (Table 3). Similar results were obtained from the demonstration trial and for the collections made on September 23. The foil was as effective in repelling aphids on September 23 as it was on August 29. Most aphids flying over bare soil were trapped below 30 cm., which corresponds to the height occupied by the plants. The reduction of aphids trapped over the various surfaces agrees with the observed delay in virus spread.

Large-scale aphid flights occurred during mid-August and virus introduction and spread probably occurred at this time. In a nearby area on the same farm trapping for 24 hours in mid-August captured 1200 aphids. Aluminum foil does not repel all flying aphids, but reduces the numbers alighting on squash plants by 97 to 98%. This reduction apparently is enough to provide an effective means of delaying virus infection.

The cost of aluminum foil for mulching an acre of squash ranges from $180 to $200. Some of this initial cost, which does not include laying expenses, is recovered by savings from reduced cultivation, spraying, and

Table 3. Numbers of aphids trapped at various distances above bare soil and mulched surfaces. Data from replicated experiment, August 29, 1970. Each column of data is mean of three stakes

Height above surface (cm)	*Numbers of aphids trapped over* Bare soil in row	Bare soil between plots	Black plastic	Striped aluminum	Aluminum
50-60	15	6	5	4	2
40-50	9	7	8	2	0
30-40	19	11	9	1	0
20-30	39	21	7	2	1
10-20	49	27	7	1	0
0-10	31	12	3	1	0
	162	84	39	11	3

irrigation. Machines for laying mulches are available and are well illustrated in the circular by Courter et al. (1).

Higher plant populations than we used in the demonstration trial should give greater yields. In commercial plantings (5), populations of about 7,000 plants per acre have been used – obtained by planting several seeds in a hill, thinning to two plants, and spacing the hills 2½ feet in rows 5½ feet apart.

Seed companies might find aluminum foil mulching useful in insuring good seed quality in seed production areas where aphid-transmitted virus infection in squash and possibly other cucurbits is a problem.

SUMMARY

Aphid-transmitted, mosaic viruses limit production of summer squash planted for fall harvest in the Northeast. Aluminum foil mulch delayed virus infection by repelling aphids and more than doubled yield in comparison to bare soil controls in both replicated and demonstration experiments. Black-striped aluminum foil was less effective in repelling aphids and delaying virus infection than foil without the stripe.

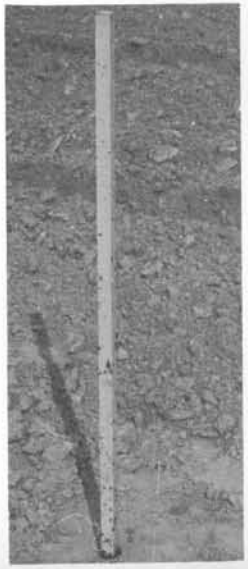

Fig. 4. Sticky, yellow stake used for trapping aphids.

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PUBLICATION

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United States Department of Agriculture

Literature Cited

1. Courter, J. W., H. J. Hopen, and J. S. Vandemark, 1969. Mulching vegetables. Univ. Ill. Ext. Serv. Circ. 1009.

2. Kring, J. B. 1970. Determining the number of aphids over reflective surfaces. J. Econ. Entomol. 63: 1350-1353.

3. Moore, W. D., F. F. Smith, G. V. Johnson, and D. O. Wolfenbarger. 1965. Reduction of aphid populations and delayed incidence of virus infection on yellow straight neck squash by the use of aluminum foil. Proc. Fla. State Hort. Soc. 78: 187-191.

4. Smith, F. F., and R. E. Webb. 1969. Repelling aphids by reflective surfaces, a new approach to the control of insect-transmitted virus, p631-639. In Karl Maramorosch, editor. Viruses, vectors, and vegetables. Interscience Publishers, New York.

5. Smith, N. J. 1970. Aluminum foil foils aphids. Farm J. 94 (11): 28H.

6. Wolfenbarger, D. O., and W. D. Moore 1967. Mulch treatments of squash and tomatoes with respect to virus infections and yields. Proc. Fla. State Hort. Soc. 80: 217-221.