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THE INFLUENCE OF REFLECTIVE MULCHES AND LETTUCE TYPES ON THE INCIDENCE OF ASTER YELLOWS AND ABUNDANCE OF ITS VECTOR, *MACROSTELES FASCIFRONS* (HOMOPTERA: CICADELLIDAE), IN MINNESOTA[1]

Frank G. Zalom[2]

ABSTRACT

Five commercial lettuce cultivars representing different genetic types were grown through aluminum-coated paper, through black polyethylene film, and on bare soil. For each variety, the aluminum mulch reduced the numbers of *Macrosteles fascifrons* (Stål), reduced the incidence of aster yellows, and increased yields when compared to uncovered controls. The head lettuce cultivar 'Minetto' was most susceptible on unmulched plots (74.3%) while the leaf cultivar 'Grand Rapids' was least susceptible (33.8%). The latter also had the greatest infestation of leafhoppers which may indicate either resistance to the aster yellows agent or shorter feeding times by the vector leafhopper. The abundance of aster leafhoppers on the romaine cultivar 'Valmaine', the butter head cultivar 'Buttercrunch', and the bibb cultivar 'Summer Bibb' was much lower than that of the other two and might explain the lower percentage of aster yellows on these types as compared with 'Minetto'.

Aster yellows is one of the most destructive plant diseases of the upper Midwest and the prairie provinces of Canada. It has become the limiting factor in the production of lettuce, carrots, and celery in Minnesota. Lettuce fields have been reported as suffering 100% loss in some years (Schultz 1973).

The principal vector of aster yellows is the aster leafhopper, *Macrosteles fascifrons* (Stål). The vector leafhoppers which migrate from southern breeding areas each spring are the principal source of primary inoculum. The number of migrants and the percentage infected with aster yellows has been used to predict early-season loss potential in Wisconsin, allowing growers to delay initiation of spray programs (Chiykowski and Chapman 1965). Both the vector and the disease have a wide host range. However, lettuce seems to be preferred vegetable host in the midwest (Peterson and Saini 1964, Schultz 1973). No cultivars of commercial lettuce have been developed which are highly resistant to the leafhopper or the disease.

Frequent insecticidal applications are often required for commercial production of lettuce (Richardson and Westdal 1964, Thompson 1967). Though typically effective (Chapman 1973), the failure of insecticides to adequately protect plants from insect transmission has been reported (e.g., Lee and Robinson 1958).

Reflective mulches can decrease the incidence of nonpersistent viruses on lettuce by reducing the number of alate aphids alighting upon plants (e.g., Nawrocka et al. 1975, Toscano et al. 1979). Aluminum foil has been most successfully utilized for this purpose; however, black polyethylene plastic was more effective than yellow or white plastic in field tests (Jones and Chapman 1968). Similarly, reflective mulches may lower the number of aster leafhoppers in lettuce and reduce infection by aster yellows (Chapman 1973).

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This study evaluated the effect of aluminum and black plastic mulches on the abundance of aster leafhoppers, the incidence of aster yellows, and yield for five commercial lettuce types in Minnesota during the 1980 season.

METHODS

Five cultivars of lettuce, representing five distinct genetic types were selected for study: 'Valmaine', a deep green romaine type; 'Buttercrunch', a larger growing butter head type making a dense cluster of leaves; 'Grand Rapids', a heavy leaf type with light green, well frilled leaves; 'Minetto', a small, firm head lettuce with short cores; and 'Summer Bibb', a longer standing bibb type with tight clusters of medium dark green leaves. The plants were seeded in wooden flats in a greenhouse, and transplanted to field plots on the St. Paul campus of the University of Minnesota four weeks after seeding (early June). The bed was disced and leveled prior to planting.

One third of the plots were covered with Reynolds® aluminum-coated construction paper, one third with black polyethylene plastic film, and one third remained uncovered. Each plot measured 5.4 m on a side, with 1 m between plots. There were four replications of each mulch type. The reflective mulches were held in place by 12-gauge galvanized steel wires 100 cm long, bent at the ends to pierce the mulch and continue into the soil. Circular holes, 15 cm diam, were cut out of the mulches through which the lettuce was transplanted. Plants within a row were spaced at 45 cm, with 10 plants in a row. Rows within plots were spaced at 75 cm. Each of the five rows within a plot was planted with a different cultivar selected at random. No insecticides, herbicides, or fertilizers were applied to the plots. Weeds were rogued from the plots when necessary.

One week after transplanting and twice weekly thereafter, the plots were sampled for aster leafhoppers and aster yellows. The relative abundance of aster leafhoppers was estimated by sweeping each lettuce plant in a row four times with a standard 40-cm insect net. Therefore, insect abundance was obtained on both a cultivar and plot basis. The abundance of aster leafhoppers among the five cultivars for each mulch treatment was compared by Friedman's analysis of variance by ranks. The cultivar most heavily infested with the insect on a given sampling date was assigned the rank of 1.

The lettuce was hand harvested by cultivar 5.5 weeks after transplanting (mid-July), weighed individually, and examined for symptoms of aster yellows. After determining the percentage of plants with aster yellows in each cultivar for the reflective mulch treatments and among all replications, the differences between the cultivars and between the reflective mulch treatments were analyzed by Duncan's multiple range test. The mean weight of lettuce from the reflective mulch plots and the uncovered controls was compared by one-way analysis of variance.

RESULTS

Leafhopper abundance. The mean number of aster leafhoppers per 40 sweeps from lettuce grown on bare soil exceeded that from lettuce grown through plastic and aluminum mulch on each sampling date (Fig. 1). Their abundance over plastic was greater than over aluminum mulch. The peak abundance of aster leafhoppers on the lettuce plants occurred in mid-July.

The difference in aster leafhopper abundance between the five lettuce cultivars grown on bare soil and through the plastic mulch was significant ($P < 0.05$). The leaf lettuce (Grand Rapids) and the head lettuce (Minetto) had the greatest infestations (Table 1). No significant difference ($P > 0.05$) was found among cultivars grown through the aluminum mulch.

Aster yellows. At harvest, the percentage of plants with aster yellows in each cultivar for the reflective mulch treatments among all replications was determined. A significant difference ($P < 0.05$, $F = 21.0626$) was found by mulch treatment but no significant difference ($P > 0.05$, $F = 2.2345$) was found by cultivar. Aphid-borne lettuce viruses were not present in the study area.

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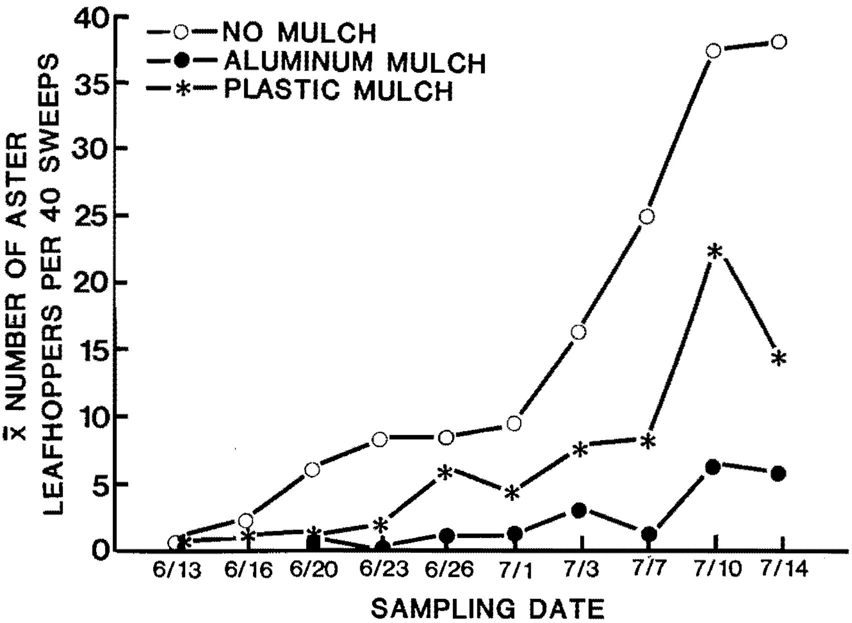

Fig. 1. Mean (n = 4) number of aster leafhoppers per 40 sweeps on lettuce grown through aluminum mulch, plastic mulch, or no mulch.

Table 1. Abundance of aster leafhoppers on five lettuce cultivars grown on bare soil and through revlective mulches.

	Treatment		
Cultivar	Bare soil	Plastic mulch	Aluminum mulch
Buttercrunch	3.40	3.65	3.19
Grand Rapids	1.65	1.05	1.44
Minetto	1.85	2.25	2.69
Summer Bibb	4.20	4.70	3.75
Valmaine	3.90	3.35	3.44
χ^2	22.22[a]	31.20[a]	1.05

[a]$P < 0.05$.

The head lettuce (Minetto) exhibited significantly higher incidence of aster yellows than did the other cultivars when grown on bare soil (Table 2). The leaf lettuce (Grand Rapids) had the lowest incidence. For each cultivar, the percentage of plants with aster yellows was significantly reduced when grown through aluminum mulch instead of bare soil. Aster yellows did not occur on 'Valmaine', 'Buttercrunch', and 'Summer Bibb' when grown through aluminum mulch and was greatly reduced on 'Grand Rapids' and 'Minetto'. The effect of the plastic mulch was variable with respect to cultivar and the other mulch treatments.

Lettuce yields. Lettuce plants of each cultivar were significantly larger ($P < 0.01$) from reflective mulch plots than from uncovered control plots. In every instance, the weight of a plant grown through aluminum mulch was greater than a plant of the same cultivar grown through plastic mulch or on bare soil. When plants infected with aster yellows were eliminated from the calculation of yield per plant, the differences were still significant (Table 3).

Table 2. Mean (± SD; n = 4) percentage of aster yellows infected plants among five lettuce cultivars grown on bare soil and through reflective mulches.

	Treatment		
Cultivar	Bare soil	Plastic mulch	Aluminum mulch
Buttercrunch	41.0 ± 17.2^{a}	30.0 ± 16.9^{a}	0.0 ± 0.0^{b}
Grand Rapids	33.8 ± 11.1^{a}	8.3 ± 9.1^{b}	8.3 ± 9.1^{b}
Minetto	74.3 ± 16.9^{c}	38.5 ± 16.5^{a}	2.8 ± 4.8^{b}
Summer Bibb	42.3 ± 11.0^{a}	5.5 ± 9.5^{b}	0.0 ± 0.0^{b}
Valmaine	41.8 ± 14.2^{a}	19.5 ± 15.7^{d}	0.0 ± 0.0^{b}

[a,b,c,d]No significant difference between values with same superscript. Values with different superscripts significantly different ($P < 0.05$).

Table 3. Mean (± SD, n = 4) weight (g per plant) of (1) all plants and (2) all plants excluding those infected with aster yellows.

	Treatment			
Cultivar	Bare soil	Plastic mulch	Aluminum mulch	F
		(1) ALL PLANTS		
Buttercrunch	249.4± 84.9	458.1± 50.5	733.9±165.2	35.51
Grand Rapids	368.5± 24.2	675.2± 60.1	868.2±165.2	18.14
Minetto	255.2± 68.3	526.1±109.5	775.9±145.4	16.15
Summer Bibb	142.3± 19.4	357.0± 61.0	488.7± 64.7	32.22
Valmaine	440.8± 78.8	849.3±110.5	1258.8±152.5	36.13
	(2) PLANTS NOT INFECTED WITH ASTER YELLOWS			
Buttercrunch	296.0± 95.1	544.0± 46.7	783.0± 72.2	26.41
Grand Rapids	411.7± 32.0	702.9± 41.3	932.6±133.6	29.83
Minetto	381.4± 37.9	654.0± 85.8	806.0±147.1	10.39
Summer Bibb	182.3± 22.6	372.4± 69.2	488.7± 64.7	22.70
Valmaine	569.8±151.4	894.5±116.8	1258.8±152.5	18.23

DISCUSSION

The results indicated that reflective mulches would lower the abundance of aster leafhoppers, lower the incidence of aster yellows, and increase yields with respect to uncovered controls. In most cases, the aluminum-coated construction paper was superior to black plastic.

The greatest abundance of the aster leafhopper in this study occurred in early July. This might have been the result of planting date and hostplant attractiveness. As the plants increased in size more aster leafhoppers would be drawn to them. The numbers would fall as

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the plants reached maturity. No nymphs were found on the lettuce plots until adults were present for 3.5 weeks.

Although both reflective mulch treatments significantly lowered the incidence of aster yellows on the lettuce plantings, no significant difference was found in cultivar susceptibility to the disease. In New York, Linn (1940) determined that romaine and head lettuce were similarly susceptible to aster yellows. The data obtained in Minnesota indicated that the head lettuce cultivar 'Minetto' was more attractive to leafhoppers, which might explain the higher incidence of aster yellows on the cultivar. Interestingly, the leaf lettuce variety 'Grand Rapids' had the greatest infestation of leafhoppers, yet the lowest incidence of aster yellows on the uncovered plots. Perhaps 'Grand Rapids' was resistant to the aster yellows agent, or the leafhoppers had a shorter feeding time, preventing a high level of transmission of the disease agent. The relative abundance of aster leafhoppers on the cultivars 'Valmaine', 'Buttercrunch', and 'Summer Bibb' was much lower than that of 'Minetto' and 'Grand Rapids', and might explain the lower percentage of aster yellows on these cultivars as compared with 'Minetto'.

Yield for each cultivar was greatest on the aluminum mulched plots even when the plants infected with aster yellows were eliminated, indicating additional benefits to the plant from the treatment. In Maine, Hilborn et al. (1957) found that head weight of lettuce grown through black plastic was ca. 33% greater than head weight from nonmulched plots owing to higher soil temperature, weed suppression, moisture conservation, and lack of plant contact with the soil which reduced plant diseases such as bottom rot and bacterial soft rot. Additional advantages to the plant from an aluminum soil covering might include increased light reflection to leaf surfaces, and higher air temperatures immediately over the mulch.

Aluminum mulching is routinely used on a commercial scale for aphid management on tomatoes and peppers in Florida. The benefits derived from the technique including reduced disease incidence, increased yield, and weed suppression lend promise to the technology for production of high value crops and home gardens elsewhere.

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