

FLOATING ROW COVER AND TRANSPARENT MULCH TO REDUCE INSECT POPULATIONS, VIRUS DISEASES AND INCREASE YIELD IN CANTALOUPE

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ABSTRACT

The influence of floating row cover on cantaloupe, alone or combined with transparent polyethylene mulch, was evaluated to determine its effect on population densities of aphids, sweetpotato whitefly, *Bemisia tabaci* (Gennadius), and the vegetable leafminer, *Lyriomyza sativae* Blanchard, as well as virus incidence and yield of cantaloupe, *Cucumis melo* L. Cv. Durango. The study was carried out in a dry tropic region of Colima, Mexico. Aphids, sweetpotato whitefly and vegetable leafminer were completely excluded by floating row cover while the plots were covered. Transparent polyethylene mulch reduced aphids and whitefly populations, but did not affect infestation by *L. sativae*. Floating row cover delayed the appearance of virus-diseased plants for two weeks with respect to control (bare soil). Furthermore, the transparent mulch reduced virus incidence. The yield (weight) and number of cantaloupe melons harvested were nearly four-fold higher in mulch plus row cover plots (when the cover was removed during perfect flowering) compared with the control plots, while the yield with floating row cover alone was tripled. The yield from mulched plants alone and covered plants (the cover removed during vegetative growth) was higher than that from plants grown on bare soil.

Key Words: *Cucumis melo*, aphids, sweetpotato whitefly, vegetable leafminer.

RESUMEN

Se evaluó la influencia de las cubiertas flotantes, solas o combinadas con una cobertura de plástico transparente, sobre la densidad de población de áfidos y de mosca blanca de la batata, *Bemisia tabaci* (Gennadius), y sobre la infestación del minador de la hoja *Lyriomyza sativae* Blanchard, así como sobre la incidencia de virus y la producción de melón "Cantaloupe", *Cucumis melo* L. Cv. Durango. La investigación se realizó en la región tropical seca del estado de Colima, México. Los áfidos, la mosca blanca de la batata y el minador de la hoja fueron completamente excluidos por las cubiertas flotantes, mientras las plantas estuvieron protegidas con la tela de polipropileno. El acolchado con plástico transparente redujo la población de áfidos y mosca blanca, pero no tuvo efectos sobre la infestación por *L. sativae*. La cubierta flotante retrasó durante dos semanas la presencia de plantas afectadas por virus con respecto al testigo (suelo desnudo). El plástico transparente también redujo la incidencia de virus. El número de frutos y el rendimiento del melón en las parcelas con cubierta de plástico + cubierta flotante (la cubierta fue retirada durante la floración perfecta) fue casi cuatro veces más alto en comparación a las parcelas con suelo desnudo, mientras que en aquellas con cubierta flotante sola, el rendimiento se triplicó. La producción de las plantas con cubierta plástica sola o de las plantas con cubierta flotante (retirada durante el crecimiento vegetativo) fue más alta que la de las plantas cultivadas sobre suelo desnudo.

Cantaloupe melon, *Cucumis melo* L., is the major cucurbit crop in the dry tropic areas of Colima State, Mexico, during fall and winter, with more than 1500 ha grown annually. Recently in this area, aphid-borne virus diseases have been a problem for cucurbit crops. In Mexico, a cucumovirus (cucumber mosaic) and potyviruses (watermelon mosaic-2, papaya ringspot-W and zucchini yellow mosaic) are the major virus diseases affecting squash, watermelon, cucumber and cantaloupe (Delgadillo et al. 1989). These viruses are transmitted efficiently by aphids in a nonpersistent manner (Nameth et al. 1986).

The sweetpotato whitefly, *Bemisia tabaci* Gennadius, is an important pest of agricultural and horticultural crops throughout the world, causing damage directly by feeding and indirectly through the excretion of honeydew (Byrne et al. 1990) and the transmission of virus diseases (Cohen 1990). In the past decade, this insect has been reported as a serious pest of various crops in Florida (Schuster & Price 1987), Arizona (Butler 1982) and California (Perring et al. 1991). Recently, it has been found in extremely high populations in the agricultural areas of Arizona, California, Texas and northwestern Mexico (Gill 1992). Also, in the last two years, sweetpotato whitefly has become the most important pest in melon-growing areas of Colima, Mexico (Farias et al. 1994). Other pests affecting melon crops are the vegetable leafminer, *Lyriomyza sativae* Blanchard, and some species of *Diabrotica*.

Most of the management strategies against cucurbit virus diseases have been targeted at the aphid-borne viruses. Several measures are used to influence the behavior of the insect vectors in an attempt to interfere with virus transmission, including the use of transparent polyethylene mulch (Brown et al. 1993, Lecoq & Pitrat 1983, Orozco et al. 1994), oil sprays (Simons & Zitter 1980) and floating row covers (Natwick & Durazo 1985, Natwick & Laemmlen 1993, Orozco et al. 1994, Perring et al. 1989, Webb & Linda 1992). However, in dry tropic conditions, the use of oil sprays can cause phytotoxic symptoms on the foliage and reduce the fruit yield of cantaloupe (Orozco et al. 1994). The use of plastic mulches in agriculture continues to increase in high technology systems for horticultural crop production, and more recently, floating row covers of spunbonded polyester or polyethylene have been introduced to protect cucurbits from insect-vectored viruses and their aphid and whitefly vectors (Natwick & Laemmlen 1993, Perring et al. 1989, Webb & Linda 1992) and from direct damage from pests, such as the vegetable leafminer (Natwick & Laemmlen 1993), melonworm, *Diaphania hyalinata* (L.), pickleworm, *D. nitidalis* (Stoll) (Webb & Linda 1992) and cucumber beetles (Adams et al. 1990). Plastic mulch in combination with floating row covers show promise as a method for excluding insects, reducing virus diseases and increasing yield of cucurbit crops (Orozco et al. 1994, Ramirez & Lopez 1991, Webb & Linda 1992). However, there is little information on the development of the cantaloupe crop grown under floating row cover in a semi-arid tropical region.

This study was carried out to evaluate the effect of transparent polyethylene mulch and floating row covers, with or without transparent mulch, on insect populations, viral diseases and yield of melons grown in the field under semi-arid tropical conditions.

MATERIALS AND METHODS

The field experiment was conducted at the Tecoman Experimental Station in Colima, Mexico during the winter-spring of 1992-1993. On February 19, 1993, melon (*Cucumis melo* L.) Cv. Durango was directly seeded at 23 cm intervals in the center of 1.78 m wide beds, and plots were watered with a drip irrigation system to promote germination. Each bed had an emitter tube with emission spacing of 0.5 m, and flow rate of 2.3 liter per h. Five treatments were evaluated: (1) transparent polyethylene mulch (TPM), (2) floating row cover (FRC, spunbonded polyethylene fiber: AGRIBON-

17, Bonlam S.A. de C.V. San Luis Potosi, Mexico) removed at the vegetative stage (20 March, before staminated flowers appeared in the plants) or (3) the reproductive stage (28 March, when 50% of the plants had their first perfect flower); and (4) TPM + FRC removed at the reproductive stage. Bare soil plots (5) were included as the check (control).

After seeding, FRC was set on the beds with both edges and ends of covers secured with soil. Weeds became a problem under the covers, mainly in the floating row cover with bare soil, and it was necessary to control grass with the herbicide Fluazifop-butil (Fusilade™); broad-leaf weeds were removed manually. In TPM and bare soil plots, eleven insecticide sprays were applied during all the crop cycle, mainly for sweetpotato whitefly control, while in FRC plots, alone or combined with TPM removed at reproductive stage, only five sprays were necessary after the covers were removed. The insecticides used were endosulfan, methamidophos, diazinon, bifenthrin, deltamethrin, cyfluthrin, lambdacyhalothrin, and permethrin. Each treatment consisted of five 6.9 m-long beds replicated four times in a randomized complete block design.

Yellow pan plastic traps for aphids (28 × 22 × 12 cm) containing a mixture of water and detergent were placed in the middle of one row in each plot, and the number of aphids trapped were determined twice weekly to determine the effectiveness of each treatment in delaying aphid infestation. Aphids were stored in 70% alcohol and were identified to species using several aphid taxonomy keys (Basky 1993, Peña 1991, Pike et al. 1990). Counts of sweetpotato whitefly adults were made on 16 plants (two leaves per plant) in early morning (7-8 h A.M.), before flight activity occurred. Leaves were turned over gently and adults visually counted (Butler & Henneberry 1991). On 24 March and 1 April (34 and 41 days after planting, respectively), the numbers of sweetpotato whitefly nymphs on five leaflets from two lower leaves were counted from eight plants with the aid of a 10x dissecting microscope. Also, on 19, 26 March, 2 and 12 April, vegetable leafminer damage was assessed on the main guide shoot on 16 plants per plot. A leaf was considered damaged if more than three miners per leaf were found.

To evaluate virus incidence, all of the plants in each plot showing disease symptoms were counted weekly. At harvest, plant tissue was analyzed by ELISA test (Clark & Adams 1977) to detect infection by cucumber mosaic virus (CMV), watermelon mosaic virus-2 (WMV-2), papaya ringspot virus-W (PRSV-W), zucchini yellow mosaic virus (ZYMV) and squash mosaic virus (SqMV).

Yield was assessed by picking all the fruits in two central beds of each experimental plot and sorting them into marketable and culled categories. The harvest was done every day during two weeks, and marketable fruit (based on export regulations) was sized 9, 12, 15, 18 and 23 fruits per carton.

RESULTS AND DISCUSSION

Fourteen aphid species were caught in yellow water pan traps throughout the experimental period. These species were (% of total): *Aphis spiraeicola* Patch (23%), *Uroleucon ambrosiae* (Thomas) (22%), *Myzus persicae* (Sulzer) (13%), *A. gossypii* (Glover) (12%), *Rhopalosiphum rufiabdominalis* (Sasaki) (11%), *R. maidis* (Fitch) (4%), *A. craccivora* (Koch) (3%), *Schizaphis graminum* (Rondani) (3%), *A. nerii* (Boyer de Fonsc) (2%), *Macrosiphum euphorbiae* (Thomas) (2%), *Lipaphis erysimi* Kalténbach (2%), *R. padi* (L.) (1%), *Toxoptera aurantii* Boyer de Fonsc. (1%) and *A. fabae* Scopoli (1%).

No alate aphids were caught in yellow traps in the plots with FRC until the covers were removed, while on the bare soil plots the highest aphid populations were caught during the first 50 days after sowing (Fig. 1). The use of TPM resulted in fewer aphids

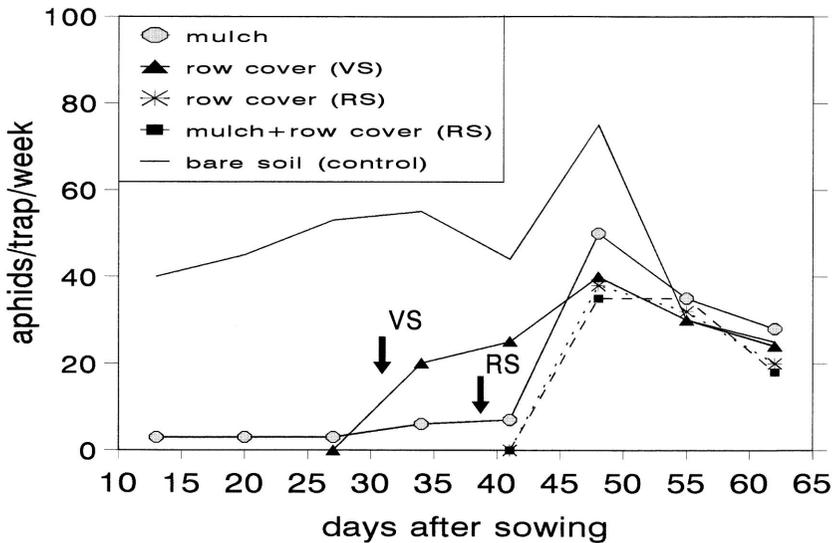


Figure 1. The number of winged aphids collected in yellow water pan traps placed in cantaloupe plots with transparent mulch, floating row cover and bare soil. VS and RS = row cover removed at vegetative and reproductive stage, respectively.

per trap until 41 days after sowing. However, after 50 days, the numbers of trapped aphids were about the same for all the treatments.

Sweetpotato whitefly populations were extremely high, mainly in the bare soil control plots, where 52, 35 and 32 adults per leaf were recorded 25, 32 and 38 days, respectively, after sowing (Fig. 2). Populations of whitefly nymphs and adults were excluded from the melon plants while the polypropylene row cover was on the bed. Transparent polyethylene mulch reduced the number of whitefly adults per leaf with respect to bare soil on some dates during the first 50 days after sowing. In plants with FRC, alone or combined with TPM removed at the reproductive stage, no whitefly nymphs were detected for 35 and 42 days after sowing (Table 1), while leaves from the plants with FRC removed at the vegetative stage had no nymphs at 35 days, and only a few nymphs (4.5 per cm²) at 42 days. The TPM plots significantly reduced the number of nymphs (about one half) compared to the control plots. In contrast, bare soil plots had significantly greater numbers of whitefly nymphs on both dates than the FRC and TPM treatments.

The appearance of virus disease symptoms were delayed one week on plants when FRC was removed at vegetative stage, and symptoms were delayed 2-3 weeks when FRC was removed at reproductive stage (Fig. 3). At harvest (67 days after sowing), the control plots had the highest percentage (24%) of virus-infected plants followed by FRC on bare soil plots (16%). The TPM plots and the TPM + FRC plots showed the lowest (5-12%) number of virus-diseased plants. ELISA tests indicated that PRSV-W was the most prevalent virus in this study, however, ZYMV, CMV, WMV-2 and SqMV were also detected. The PRSV-W, ZYMV, CMV and WMV-2 are transmitted in a non-persistent manner by some aphid species, while SqMV is transmitted by beetles (Nameth et al, 1986).

Leafminer damage was avoided for 35 and 42 days after sowing with FRC removed at the vegetative and reproductive stage, respectively, compared with bare soil (Fig.

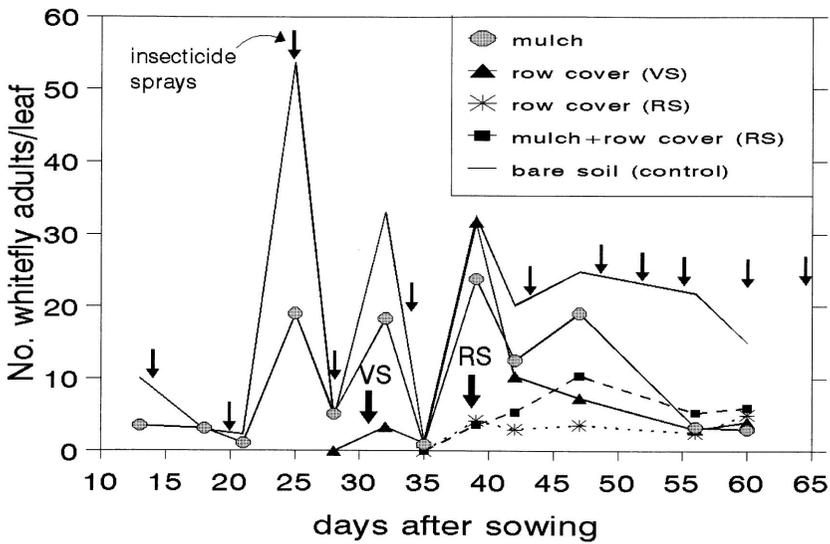


Figure 2. Effect of transparent mulch and floating row cover on whitefly populations in cantaloupe foliage. VS and RS = Row cover removed at vegetative and reproductive stage, respectively.

4). During the first 35 days, control and TPM plots had the highest leafminer damage; however, by 52 days the percentage of damaged leaves was similar in all the treatments.

Yield of cantaloupe melons, expressed as mean number and weight of fruit was significantly higher for TPM + FRC plots than TPM and bare soil with or without FRC (Table 2). The yield of TPM + FRC (removed during reproductive stage) plots was

TABLE 1. EFFECT OF TRANSPARENT MULCH AND FLOATING ROW COVER ON THE NUMBER OF WHITEFLY NYMPHS ON CANTALOUPE LEAVES. TECOMAN VALLEY, COLIMA, MEXICO. 1993.

Treatment	Nymphs/cm ²	
	26 March (35 DAS ¹)	2 April (42 DAS ¹)
Transparent polyethylene mulch (TPM)	2.7 b ⁴	9.1 c ⁴
Floating row cover (VS ²)	0.0 a	4.5 b
Floating row cover (RS ³)	0.0 a	0.0 a
TPM + Floating row cover (RS)	0.0 a	0.0 a
Bare soil (Control)	5.4 c	19.1 d

¹DAS = Days after sowing.

²VS = Removed at vegetative stage.

³RS = Removed at reproductive stage.

⁴ = Mean separation within columns by Duncan's multiple test (P < 0.05).

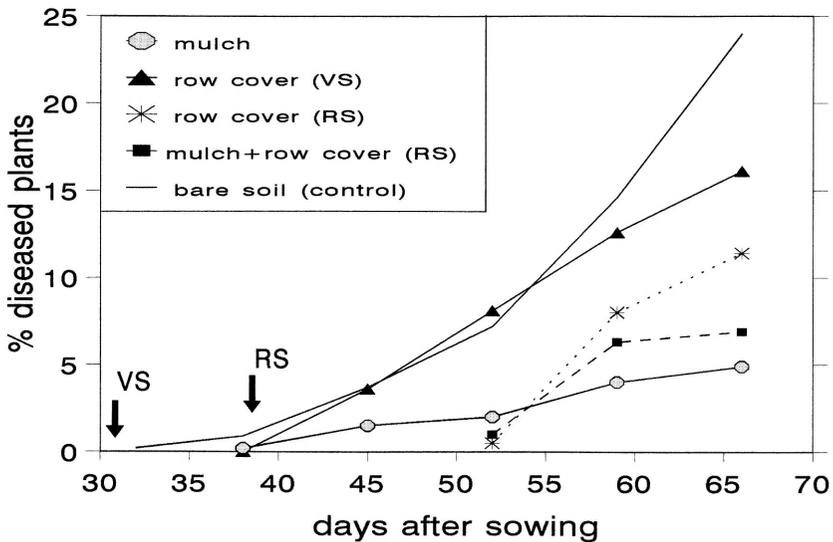


Figure 3. Effect of transparent mulch and floating row cover on incidence of cantaloupe plants with virus symptoms. VS and RS = row cover removed at vegetative and reproductive stage, respectively.

nearly four-fold higher than in control plots, and three-fold higher than with FRC alone. Moreover, the yield obtained in TPM plots and bare soil with FRC (removed during vegetative growth) was higher than that on bare soil plots.

The results of this study demonstrate the beneficial effects of FRC alone or combined with reflective mulch for cantaloupe grown in dry tropical conditions. Floating row covers excluded beetles, leafminers, sweetpotato whitefly, and aphids. The exclusion of insect pests reduced the use of insecticides by 50%. In addition, the foliage of plants was not colonized by whiteflies during the first 42 days with FRC removed at the reproductive stage. Furthermore, TPM resulted in fewer winged aphids caught in yellow traps and fewer whitefly nymphs and adults on foliage with respect to control. These results with FRC are similar to previous research (Natwick & Durazo 1985, Natwick & Laemmlein 1993, Orozco et al. 1994, Perring et al. 1989, Webb & Linda 1992). The repellent effect of the plastic mulch on aphids (Brown et al. 1993, Jones 1991) and whitefly (Kelly et al. 1989) has been attributed to its high reflectance of light (Kring & Schuster 1992).

Virus disease incidence was low in the control plots; this may be related to the low aphid populations caught in yellow traps (maximum 65 aphids per trap per week). In this experiment, the major viruses found were PRSV-W, ZYMV, CMV and WMV-2 which are transmitted by aphids (Nameth et al. 1986). Because of exclusion of aphid vectors in covered plots, and the fewer numbers of aphids alighting on the plants grown in TPM plots, TPM and FRC had a lower virus incidence compared with the control. These data support the observations of Brown et al. 1993, Kring & Schuster 1992, Natwick & Durazo 1985, Orozco et al. 1994, Perring et al. 1989, and Webb & Linda 1992.

The yield in weight of cantaloupe plants grown with TPM + FRC was higher than that of TPM mulch alone and bare soil. This can be attributed to more vigorous growth of plants in TPM plots alone or combined with FRC because of moisture con-

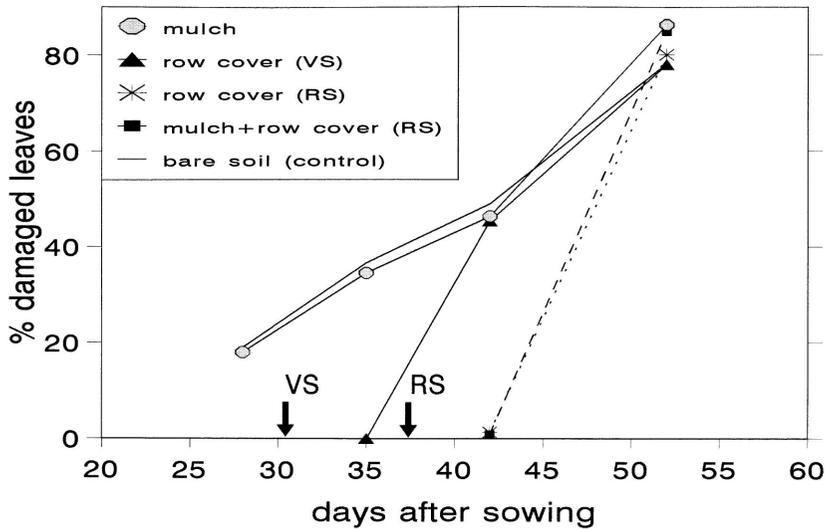


Figure 4. Effect of transparent mulch and floating row cover on the percentage of cantaloupe leaves damaged by the vegetable leafminer. VS and RS = row cover removed at vegetative and reproductive stage, respectively.

servation and higher soil temperature. Preliminary studies have shown a yield increase of cantaloupe with the use of TPM (Orozco et al. 1994) and FRC (Orozco et al. 1994, Perring et al. 1989, Webb & Linda 1992). Also, the effects of transparent mulch on soil temperature (Al-Assir et al. 1992) and moisture conservation (Tindall et al. 1991) have been previously demonstrated.

The beneficial effects of polyethylene transparent mulch and floating row cover might be a practical and economical management tool for producing cantaloupe under the dry tropical conditions of Colima, Mexico. However, additional on-farm trials are

TABLE 2. EFFECT OF TRANSPARENT MULCH AND FLOATING ROW COVER ON THE NUMBER OF FRUIT AND YIELD OF CANTALOUPE. TECOMAN VALLEY, COLIMA, MEXICO. 1993.

	No. of Fruit per 6.9 m of Row ¹	Weight (kg) of Fruit per 6.9 m of Row ¹
Transparent polyethylene mulch (TPM)	33.0 c	28.37 c
Floating row cover (VS ²)	29.5 c	24.69 c
Floating row cover (RS ³)	54.2 b	47.04 b
TPM + Floating row cover (RS)	68.6 a	62.51 a
Bare soil (Control)	19.2 d	16.08 d

¹ = Mean separation within columns by Duncan's multiple range tests (P < 0.05).

²VS = Removed at vegetative stage.

³RS = Removed at reproductive stage.

needed to determine whether or not these methods can be practically integrated into commercial cantaloupe production.

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