DISEASE INCIDENCES AND YIELD IN BELL PEPPER AS AFFECTED BY KAOLIN-BASED PARTICLE FILM ('SURROUND')

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Introduction

Heat stress can produce flower and fruit abortion in peppers, resulting in reduced yields (Deli and Tiessen, 1969; Dorland and Went, 1947). A relatively new technology, developed to control insect damage in fruit trees, incorporates a kaolin-based particle film spray (Unruh et al., 2000; Knight et al., 2001). The particle film also cools the leaves and fruit, protecting the plants from extreme heat and ultraviolet radiation (Glenn et al., 1999). When a kaolin-based particle film was applied to tomato plants, fruit development was delayed and yields were not affected (Makus, 2000). This study, which was part of an interstate project (Russo and Díaz-Pérez, 2005), was undertaken to determine if a commercially available kaolin-based particle film could be employed to affect bell pepper yields. Effects of the kaolin-based particle film on some physiological responses and disease incidences were also determined.

Materials and Methods

The experiment was conducted at the Horticulture Farm, University of Georgia, Coastal Plain Experiment Station, Tifton, Ga. during Spring 2003. The experimental plot consisted of 25-ft long raised beds (8 inch high and 36 inch wide) formed on 6-ft centers oriented north to south. Before laying the mulch with a mulch-laying machine, the soil was fertilized with 70N-30P-58K kg·ha^{-1}, by using 700 lb·acre^{-1} of a 10N-10P-10K fertilizer. At the same time the mulch (white-on-black, Plastitech, St-Remi, Quebec, Canada) was laid, drip irrigation tape (T-Tape; T-Systems Intl., San Diego, Calif.), with 12-inch emitter spacing and a 17 mL·min^{-1} (1.0 gallon/h) emitter flow, was placed 2-inch deep in the center of each bed.

Six-week-old greenhouse-grown bell pepper seedlings of cvs. Camelot (Seminis, Oxnard, Calif.) and Heritage VR (Harris Moran, Modesto, Calif.) were produced by a local grower (Lewis Taylor Farms, Ty Ty, Ga). Transplants were planted on 24 Apr. 2003 using a mechanical transplanter in beds with double rows with a between row separation of 1 ft, and an in-row spacing between plants of 1 ft, which provided a population equivalent of 15,120 plants/acre.

After transplanting, one cup of a soluble starter fertilizer solution was applied directly to the base of each transplant. Three weeks after transplanting, plants were fertilized weekly through the drip system with N and K. The total amount of N and K received by the plants after transplanting was 137 lb/acre. The rate of irrigation water applied was equal to 100% of the evapotranspiration, corrected by crop factor.

Evapotranspiration and temperature data during the course of the experiment were collected from a nearby weather station.

Plants were treated with a kaolin-based particle film (Surround©; Engelhard Corp., McIntyre, Ga.) applied at 56 kg·ha^{-1} (50 lb/acre, using 100 gallons of water per acre). The suspension was applied weekly to plants for the entire season with a back-pack sprayer starting two weeks after transplanting. Controls were plants treated with water only.

Leaf gas exchange measurements (net photosynthesis, stomatal conductance and transpiration) and leaf temperature were determined with a portable photosynthesis system (LI-6400, LI-COR Inc., Lincoln, Neb.). Gas exchange measurements were conducted under ambient temperature [31.0 to 32.5 °C (28 May) and 35-36 °C (31 May)] and air humidity conditions (18 to 26 mmol H_2O·mol^{-1}).

Plants were monitored weekly for symptoms of southern blight (*Sclerotium rolfsii* Sacc.), tomato spotted wilt, Pythium rot (*Pythium* spp.), or Phytophtora blight (*Phytophtora capsici* Leonian). Insecticides were applied as needed, based on scouting (1-2 times a week) of the plants.

Bell pepper fruit were harvested twice on 23 June and 7 July and graded according to the USDA standards (USDA, 1989). Number and yield of marketable and cull fruit were determined. Among cull fruit, numbers of fruit with symptoms of either blossom-end rot or sun-scald were determined. Average fruit weight was derived mathematically from the total weight and the total number of fruit produced in plots. The design was a latin square with four treatments (cvs. Camelot and Heritage VR; and two levels of the kaolin-based particle film, 0 and 56 kg·ha^{-1}), and four replications.

Results and Discussion

Cultivar affected all gas exchange variables except leaf temperature, but those variables were not affected by the kaolin-based particle film (data not shown). 'Heritage VR' had higher values of net photosynthesis, and lower values of stomatal conductance and leaf transpiration compared to 'Camelot'. Although the effect of kaolin-based particle film was not significant, treated plants tended to have increased values of net photosynthesis and stomatal conductance, and decreased values of leaf transpiration.

Only cultivar affected any of the measured yield variables (Table 1). 'Heritage VR' produced higher numbers of marketable and cull fruit, and a higher marketable yield than did 'Camelot'. In both marketable and cull categories, average fruit weights were similar between cultivars. The number of fruit and fruit yields (marketable and cull) were not affected by the kaolin-based particle film applications and there was no Cultivar X Particle film interaction. The number and weight of fruit with symptoms of sun-scald or blossom-end rot were not affected by kaolin-based particle film applications (data not shown).

'Heritage VR' had a lower (0%) incidence of tomato spotted wilt than 'Camelot' (4%), but there were no differences between cultivars in the incidences of the *Phytophtora* spp./*Phythium* spp. complex and southern blight. The incidence of southern blight (*S. rolfsii*) was lower (0.5%, $p<0.05$) in plants treated with the kaolin-based

particle film compared to untreated plants (6%), and incidences of tomato spotted wilt (mean = 2%) and the *Phytophtora* spp./*Phythium* spp. complex (mean = 9%) in kaolin-based particle film treated plants were not different than in untreated plants.

Use of the kaolin-based particle film did not significantly reduce leaf temperature, and this could explain the limited effect of the kaolin-based particle film on physiological responses. Our results contrast with those of Jifon and Syvertsen (2003) who found that application of a particle film decreased leaf temperatures and increased net photosynthetic and stomatal conductance values under heat stress conditions. The lack of effect of the particle film was possibly because of the reduced amount of particle film applied [26 mL/plant of the kaolin aqueous suspension (rate recommended by the manufacturer)] compared to the study of Jifon and Syvertsen (300 mL/plant), even though in the two studies the same concentration of kaolin aqueous suspension was used (60 $g \cdot L^{-1}$). Additionally, plants in our study were treated with particle film less frequently (once a week) than those in the study of Jifon and Syvertsen (twice a week). Yield was not benefited by use of the kaolin-based particle film. The lack of benefit was probably due to plants not being exposed to temperatures high enough to result in stress. It is also possible that application rates of the kaolin-based particle film may have been too low to produce a significant degree of leaf whiteness, and reduce leaf temperature.

Conclusion

Based on the results the kaolin-based particle film is not recommended for use in production of spring-grown bell peppers. However, additional research can be undertaken to determine if variation in rate, or frequency, of application can be used to improve bell pepper yield.

Literature Cited

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Table 1. Effects of cultivar and kaolin-based particle film on bell pepper yields in Georgia.

	Marketable			Cull		
Source	no. of fruit (1000·ha^{-1})	yield (Mg·ha^{-1})	fruit wt. (g/fruit)	no. of fruit (1000·ha^{-1})	yield (Mg·ha^{-1})	fruit wt. (g/fruit)
Cultivar	0.001	0.001	0.061	0.050	0.073	0.058
Particle film	0.542	0.815	0.098	0.789	0.655	0.999
Cultivar						
Camelot	45.7 b [Z]	8.0b	191 a	18.7 b	3.6 a	137 a
Heritage VR	78.8 a	17.9 a	176 a	28.8 a	2.5 a	125 a
Particle film						
Yes	58.9 a	11.3 a	189 a	25.0 a	3.2a	129 a
No	65.6 a	11.6a	177 a	22.5 a	2.9 a	133 a

[NS], *, ** nonsignificant or significant at $P \leq 0.05$, 0.01, respectively, ANOVA.

[Z] values followed by the same letter are not significantly different, Duncan's multiple range test, $P<0.05$.