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Application of Imidacloprid and Cultural Techniques for Management of Whiteflies in Cucurbits

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Living mulch, buckwheat *Fagopyrum esculentum* Moench, and ultraviolet reflective mulch in combination with Imidacloprid (Admire® 2F) significantly reduced *Cucurbit leaf crumple virus*, a whitefly-borne virus and its vector (B biotype of *Bemisia tabaci* Gennadius) in zucchini squash (*Cucurbita pepo* L.). Treatments evaluated included living mulch with and without imidacloprid) and ultraviolet reflective mulch with and without imidacloprid. Living and reflective mulches were compared with standard white mulch (control) in a completely randomized block design in Fall 2006 in Florida. Results indicated that plants growing within the white mulch had the highest number of whitefly immatures compared with all the other treatments. In November, plants were observed to show virus symptoms, which were identified to be caused by *Cucurbit leaf crumple virus* (CuLCrV). Plants growing within white mulch had the highest incidence of CuLCrV while the lowest incidence was observed in mulches with imidacloprid. Imidacloprid significantly reduced the number of whitefly immature populations in the zucchini squash leaves only when used with buckwheat mulch but not with reflective mulch.

The silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring, is a major pest of cucurbits in Florida. They transmit viral diseases to all cucurbit crops and cause silver leaf of squash. In Florida, the use of pesticides has been the primary tactic for managing whiteflies in cucurbits. However, this strategy is not sustainable because of resistance and environmental contaminations. Synthetic ultraviolet reflective mulch has been used successfully to reduce thrips populations and the incidence of viral diseases in pepper production (Reitz et al., 2003). Reflective mulches reduce whitefly populations because they reflect short-wave ultraviolet light, which repels incoming whiteflies, thus preventing them from alighting on plants. Other types of mulches that have been used to reduce insect damage in vegetables include the living mulch, buckwheat (Frank and Liburd 2005), weed fabrics, and hydromulches (Liburd et al. 1998).

Neonicotinoid insecticides, such as imidacloprid and thiamethoxam (Platinum®), which are systemic in plants when applied as soil drenches, can be used to manage whiteflies (Webb et al., 2007). However, systemic insecticides are not sufficient to stop virus transmission when whitefly populations are high.

We investigated the potential of using mulches in combination with a reduced-risk insecticide imidacloprid to manage whitefly populations; consequently, reducing the symptoms associated with whitefly-transmitted viruses in zucchini squash.

Material and Methods

The experiment was conducted at the Plant Science Research and Education Unit in Citra, FL. Five treatments involving a reflective and a living mulch [buckwheat] with and without the use of imidacloprid were compared to the standard, white polyethylene synthetic mulch (1 mm thick). Each plot size measured 10.4 m by 10.4 m with 7.6-m buffer zones. Seed of 'Wild Cat' zucchini (Harris Moran, Modesto, CA) were hand-seeded on Oct. 2006. Standard land preparation procedures and other agronomic practices were carried as recommended in Florida (Olson et al., 2005). Living mulch was planted on the specified plots 2 weeks before planting the squash to allow time for establishment (Nyoike et al., 2008).

Whitefly Immature and Virus Incidence

Nymphal whitefly populations were determined from the nine selected leaves, three from each plant stratum (upper, mid, lower) (Frank and Liburd, 2005). The leaves were excised and placed in a 1-gal self-sealing polyethylene bags and returned to the laboratory. In the laboratory, a 3.14-cm^2 leaf disc was taken from each leaf using a cork borer and examined for whitefly immature stages under a 40X- dissecting microscope (MEIJI EMZ, Meiji Techno Co. Ltd., Tokyo, Japan).

Incidence of viral symptoms were monitored in the field from Oct. to Dec. 2006. Leaf samples showing viral symptoms were collected and tested for insect-transmitted viruses using enzyme-linked immunosorbent assay (ELISA) for eight viruses that can be found in cucurbits in Florida, including the common aphid-transmitted viruses, *Watermelon mosaic virus* (WMV), *Zucchini yellow mosaic virus* (ZYMV), and *Papaya ringspot virus* type *W*(PRSV-W). Symptomatic leaves were also submitted to Plant Pathology Laboratory, University of Florida, Gainesville, for identification of a suspected whitefly-transmitted virus.

Results and Discussion

The number of immature whiteflies varied significantly as a result of treatments. The addition of imidacloprid to buckwheat mulch resulted in a significant reduction in whitefly immatures (Fig. 1). For whitefly immature counts, buckwheat mulch treat-

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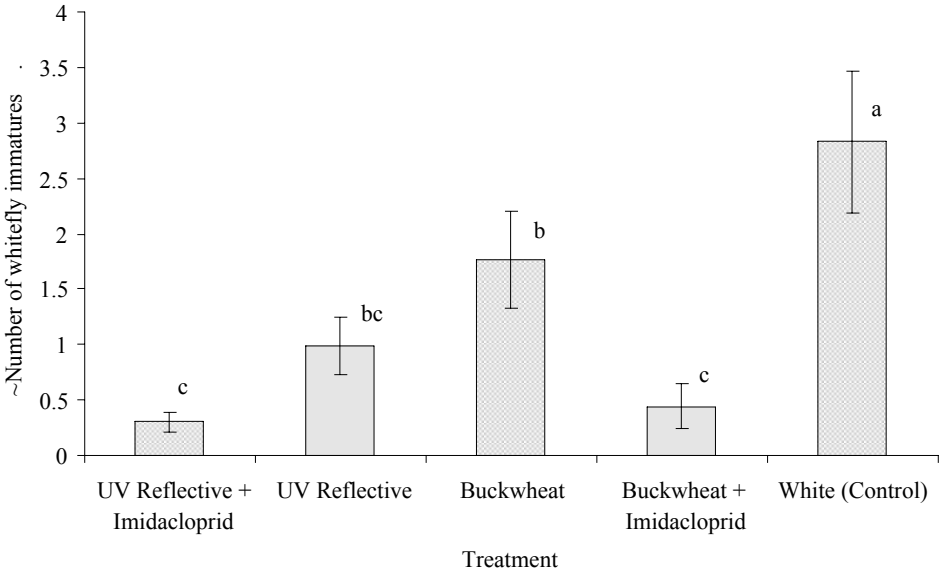

Fig. 1. Effect of mulch treatment combinations on whitefly immatures in zucchini squash in Citra, FL (2006).

Fig. 2. *Cucurbit leaf crumple virus* symptoms recorded in Citra, FL (2006). Photo: Teresia Nyoike.

ment with imidacloprid was not significantly different from reflective mulch treatments (with and without imidacloprid). Plants growing with the white mulch resulted in significantly higher numbers of whitefly immatures per leaf disc compared with all the other treatments.

In November, zucchini leaves were observed showing mottling, curling and crumpling symptoms (Fig. 2). These viral symptoms were more severe on squash growing on white synthetic mulch (control), where they were first observed, than other treatments evaluated (Fig. 3). The samples were negative for all viruses tested with Enzyme linked immunosorbent assays (ELISA). Attempts to mechanically transmit the virus to healthy squash failed but whiteflies were able to transmit a virus from infected field samples to healthy squash in the greenhouse. Polymerase chain reaction (PCR) assays on samples collected from field plants were positive for a whitefly-transmitted virus, and sequence analysis of the PCR product revealed that the virus infecting these plants was *Cucurbit leaf crumple virus* (CuLCrV) (Akad et al., 2008). This was the first time this virus had been detected in Florida.

Cucurbit leaf crumple virus is transmitted by whiteflies in a persistent manner and has a wide host range within the family Cucurbitaceae, infecting most of the domestically grown cucurbits and beans. *Cucurbit leaf crumple virus* cause very noticeable symptoms on the leaves (Fig. 2) and can also affect the fruit of some cucurbits.

The use of mulches, either reflective or living reduced whitefly immature population (Fig. 2). Further reduction of whitefly abundances was achieved with addition of just a single application of imidacloprid. The reflective mulch in combination with imidacloprid resulted in approximately 6-fold reduction in whitefly immatures compared with the standard white plastic mulch treatment. The incidence of *Cucurbit leaf crumple virus*-infected plants was also reduced by the use of reflective and living mulches (Fig. 3). The lowest incidence of virus-infected plants was observed in the treatments that combined reflective or living mulch with imidacloprid.

Our study suggests that the use of reflective mulch alone or in combination with imidacloprid can be used to reduce whitefly populations and reduce the incidence of *Cucurbit leaf crumple virus*-infected squash plants. In addition, since the virus is not transmitted through seeds, these mulches should be used as part of an integrated management program directed towards reducing sources of virus, as well as managing the whitefly vector.

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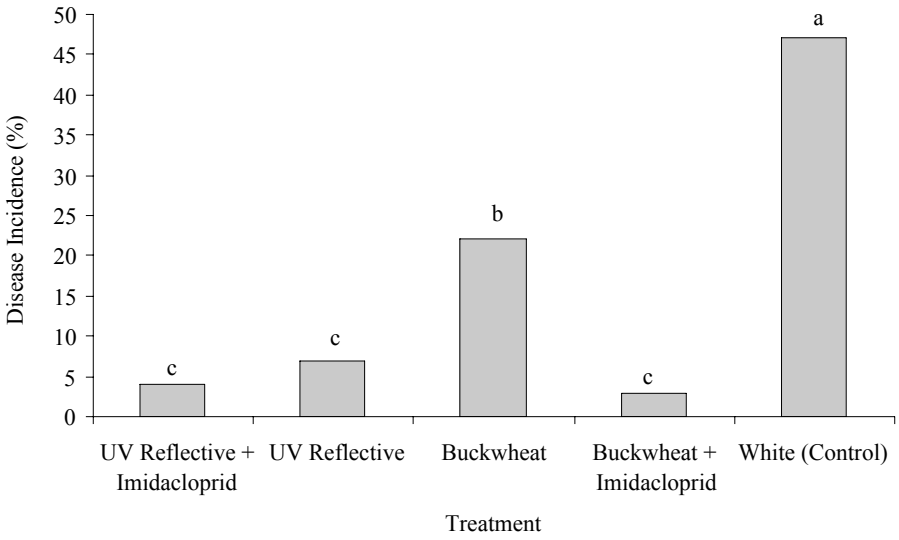

Fig. 3: Effect of mulch treatments with and without imidacloprid on the *Cucurbit leaf crumple virus* in Citra, FL (2006). Bars with the same letter are not significantly different ($P < 0.05$).

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