# Special Research Report #203: Insect Management

## Responses of Whitefly and Poinsettias to Insecticidal Controlled Atmospheres

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## BACKGROUND

Success of insecticidal controlled atmosphere (an $O_2$ level of <2 ppm balance in $N_2$) would provide a non-chemical option for controlling outbreaks of greenhouse and silverleaf whitefly and, thereby, reduce the economic losses resulting from the infestations. This research was conducted to determine if an environmentally safe system could be established for poinsettias.

## MATERIALS AND METHODS

**Effects of reduced oxygen controlled atmospheres on whiteflies.** ADULT WHITEFLIES. Adult greenhouse or silverleaf whiteflies were aspirated into 25 x 150mm tubes, placed in a 20 C controlled environment chamber, and connected to a gas stream that delivered air (control) or a reduced $O_2$ atmospheres. At the end of each treatment time (0, 0.5, 1, or 2 h), tubes were connected immediately to the air stream. At various time intervals after the end of each treatment, live whiteflies were counted. After 24 h, dead insects were removed from the tubes and counted. The remaining live whiteflies were gassed with alcohol vapors and counted to determine the total number of whiteflies in each tube at the start of the experiment. IMMATURE WHITEFLIES. Individual leaves with either the egg, larval, or pupal stage of greenhouse or silverleaf whiteflies were collected from infested poinsettia plants. The particular stage was circled on the leaves. Leaves were then placed in 20 mL vials containing water and treated with a constant flow of air or $N_2$ in the controlled environment chamber described previously. Following the gas treatments, leaves were maintained in a 20 C growth chamber with a 16 h photoperiod. Insects at the designated stages of development within the circled areas were counted weekly. The survival rate at each stage was calculated following the passage of sufficient time for the development of insects into the next stage.

**Effects of elevated $CO_2$ controlled atmospheres on whiteflies.** Greenhouse whiteflies were treated with a constant flow of 25% or 50% $CO_2$ for 0 to 8 h for the adult stage and for 0 to 24 h for eggs and pupae. Percent mortality of adult whiteflies and the survival rate of eggs and pupae were calculated as described previously.

**Tolerance of poinsettias to insecticidal controlled atmospheres.** Rooted stem cuttings of 'Celebrate', 'Annette Hegg Red', 'Freedom Red', 'Lilo Red', 'Pink Peppermint', 'Red Sails', 'Supjibi Red', 'V-14 Glory', and 'V-17 Angelica' were obtained from Paul Ecke Ranch, Encinitas, California.

**Flowering Plants.** To explore the possibility of using controlled atmosphere as a quarantine treatment for saleable plants, rooted stem cuttings of 'CelebrateII', 'Freedom Red', 'V-14 Glory', 'Annette Hegg Red', 'Pink Peppermint', and 'Supjibi' were potted up and grown until anthesis.

## RESULTS

**Effects of reduced oxygen CA on greenhouse whiteflies**

EFFECTS ON ADULTS. Exposure of adult greenhouse whiteflies to an $O_2$ atmosphere of 2 $\mu L \cdot L^{-1}$ for 1 h resulted in

100% mortality within 24 h of treatment.

EFFECTS ON EGGS. An 8 h treatment with $O_2$ at 2 $\mu L \cdot L^{-1}$ significantly reduced eggs from hatching.

EFFECTS ON LARVAE. All larval stages of greenhouse whitefly were highly susceptible to exposure to low $O_2$ (<2 $\mu L \cdot L^{-1}$). Treatment for 4 or 8 h resulted in dehydration and death of larvae within a few days.

EFFECTS ON PUPAE. Exposure of whitefly pupae to $O_2$ at 2 $\mu L \cdot L^{-1}$ for 4 h decreased percent emergence to 40%, 2 weeks after treatment, in comparison to almost 100% emergence for controls.

RESPONSES OF SILVERLEAF WHITEFLY TO REDUCED OXYGEN ATMOSPHERES. In general, responses of silverleaf whitefly to the CA treatment are similar to those of greenhouse whitefly. In both species, the adult stage was most sensitive to the CA treatment with 100% mortality occurring after an exposure time of <2 h at 20 C. In contrast, eggs were most resistant to the treatment.

EFFECTS OF TEMPERATURE ON MORTALITY RATE. Increasing treatment temperature, from 20 to 30 C, significantly decreased the required CA treatment time.

EFFECTS OF ELEVATED $CO_2$ ATMOSPHERE ON WHITEFLIES. An 8 h treatment with 25% or 50% $CO_2$ effectively killed adult greenhouse and silverleaf whiteflies, but was not effective on immature stages.

**Effects of insecticidal controlled atmospheres on poinsettias.** During vegetative growth, no phytotoxicity was observed on any of the nine poinsettia cultivars after exposure of rooted cuttings to $O_2$ at <2 $\mu L \cdot L^{-1}$ for 8 h. Growth was affected only in 'Supjibi Red' and 'V-17 Angelica'. Exposure of flowering poinsettias to reduced – $O_2$ atmosphere for 8h resulted in phytotoxicity symptoms, e.g., discoloration and necrosis, on the bracts of 'Annette Hegg Red' and 'Freedom Red' within 2 days after treatment. Significantly less phytotoxicity occurred on other cultivars

## CONCLUSIONS

Eggs, larvae, pupae, and adult stages of greenhouse whitefly (*Trialeurodes vaporarium* Westwood) and silverleaf whitefly (*Bemisia arrgentifolii* Bellows & Perring) were exposed to insecticidal controlled atmospheres at 20 C or 30 C. Mortality data were calculated for each stage and results demonstrated that reduced $-O_2$ atmospheres (an $O_2$ level of <2 $\mu L \cdot L^{-1}$ balance in $N_2$) resulted in faster and higher mortality than elevated $-CO_2$ atmospheres (25% or 50% $CO_2$). Responses from the least to most tolerant stage was: adult <larvae <eggs + pupae. At 20 C, treatment time required to kill >90% of adults, larvae, and eggs and pupae was 2, 4, and 8 hours, respectively. Increasing the treatment temperature from 20 to 30 C reduced the treatment time to one-half that of 20 C. Treatment time required to achieve complete elimination of the insects also caused phytotoxicity symptoms on poinsettias.

## IMPACT TO THE INDUSTRY

Treatment time required to achieve complete elimination of the insects also caused phytotoxicity symptoms on poinsettias and, certain bedding plants. Thus, its use as the quarantine treatment for whitefly is limited. However, shorter exposure times might be used as part of an IPM program or as a supplemental means to reduce any residual insect population on plant materials prior to shipping.

**For further information:**

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