Greenhouse Screening: Comparison of Materials for Excluding Thrips and Whiteflies

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Although pesticides will remain important tools for pest management in the greenhouse, other suppression methods incorporated into a comprehensive integrated pest management approach must be used to reduce environmental risks and human exposure, slow the buildup of pest resistance and conserve the usefulness of the dwindling supply of registered pesticides. Such methodologies include the use of biological control organisms, insect-resistant plants, proper cultural practices, and physical controls such as insect screening. Of these strategies for control of insect pests and the diseases they may transmit, exclusion should be one of the first considered. Screening for pest exclusion is now more cost effective than in the past (Neal, 1992). Reductions in pest population (Baker & Jones, 1989; Berlinger et al., 1983, 1992, 1991; Robb & Parrella, 1988), incidence of disease (Baker & Jones, 1989, 1990; Berlinger et al., 1983, 1992, 1991), and pesticide applications (Berlinger et al., 1983; Hall, 1992; Robb & Parrella, 1988) have been documented when screening is used.

In selecting the proper screening material, one must first determine the most serious pest(s) of the crop and then choose a screen with the appropriate hole size to exclude that pest (Bethke & Paine, 1991). Though it may seem best to purchase and use screens with the smallest hole size available, there are trade-offs involved. As the screen hole size decreases, effort necessary to move air through the screen increases, and greater screening area is required to maintain adequate air flow. Inadequate air flow may result in high static pressure drop, inadequate air exchange, higher energy consumption by fans, excessive wear and tear on the fans, and high greenhouse temperatures.

With the increased popularity of screening as a control measure, a variety of screening materials are available on the market. The most practical materials for use in greenhouse production are woven polyethylene and polyester fiber screens. Polyester screens (polymeric spun resin fibers) break down more quickly in sunlight, due to effects of ultraviolet light, than do polyethylene screens (thermoplastic resin fibers). Both can be chemically treated to inhibit structural breakdown, but inhibitors benefit polyethylene more than polyester. In addition, the greater strand thickness typically used in the manufacture of polyethylene screens makes them stronger than polyester fabrics. Cost is another consideration when choosing a screen as some materials are less expensive than others.

Styles and types of screening material are constantly changing, and selection of the screen most beneficial to a particular grower requires that he or she be well-informed. Independent laboratory and field studies are needed to characterize a variety of screening products for their effects on airflow restriction and their ability to exclude pest insects. The objective of this study was to determine the relative ability of screens to exclude natural populations of thrips, whiteflies and aphids under conditions closely resembling those present in a greenhouse.

Materials and Methods

Four polyethylene plastic covered, wood framed cages (0.5×0.5×1.0 meter in dimension) were used to study the exclusion efficacy of several screening materials. Each cage was constructed with the front open to allow covering with test materials and was equipped with a 2085 cm^3/min (265 ft^3/min) squirrel cage blower on the other end to pull air through the cage. Using a small wind tunnel, Baker and Shearin (1994) generated resistance curves for each of 21 screening materials by plotting fabric pressure drops against a range of air velocities. Screens were categorized as having low, medium or high resistance. These curves were used to equalize the velocity of air entering the cages through the test material. This was done by measuring the difference in pressure inside an unscreened and screened cage using a Dwyer Mark II, Model 25 manometer (Dwyer Instruments, Inc., Michigan City, Ind.). Using a damper to restrict blower output, the pressure increase was adjusted to equal the pressure drop needed to achieve an approach velocity of 92 m/min (300 ft/min), a value within the recommended range of air flow for production greenhouses.

At each installation of the test materials, one 7.5×13 cm yellow sticky trap was placed in each cage to monitor insect pest levels. A trap placed outside the cages served as an experimental control. The number of trapped thrips, whiteflies and aphids was determined at the family level (we did not attempt to key out each species of each family of insect we counted). Using four cages allowed simultaneous testing of three materials plus the fiberglass window screen as a second control. The eight materials we tested in this study included low, medium and high resistance fabrics of both the woven and polyspun types (Table 1).

Table 1. Characterization of greenhouse screening materials by type and relative air flow resistance, and product source list.

Material	Type	Air flow resistance[z]	Product source
Fiberglass window screen	woven	low	hardware and building supply stores
Reemay™	polyspun	medium	Reemay Inc., 70 Old Hickory Blvd., Old Hickory, TN 37138; (800) 284-2780; fax (615) 847-7068
Pak™ 52 × 52	woven	medium	Pak Unlimited Inc., 3300 Holcomb Bridge Rd., Suite 215, Norcross, GA 30092; (404) 448-1917 and (206) 845-9453
FlyBarr™	polyspun	high	Hydro-Gardens, P.O. Box 9707, Colorado Springs, CO 80932; (800) 634-6362; fax (719) 531-0506
Typar™	polyspun	high	Reemay Inc., 70 Old Hickory Blvd., Old Hickory, TN 37138; (800) 284-2780; fax (615) 847-7068
BugBed™ 123	woven	medium	Green Thumb Group Inc., 3380 Venard Rd., Suite 2, Downer's Grove, IL 60515-1178; (800) 240-3371; fax (708) 964-1963
Econet M™	woven	low-medium	LS Americas, 1813-E Associates Lane, P.O. Box 19548, Charlotte, NC 28219; (704) 357-0457; fax (704) 357-0460
Econet T™	woven	high	LS Americas, 1813-E Associates Lane, P.O. Box 19548, Charlotte, NC 28219; (704) 357-0457; fax (704) 357-0460
No-Thrip™	woven	high	Green-Tek Inc., 407 N. Main St., Edgerton, WI 53534; (608) 884-9454 and (800) 747-6440; fax (608) 884-945

[z]As characterized by Baker and Shearin (1994).

Data were collected from May through August 1994. Natural population fluctuations of thrips resulted in two peak collections, one from mid-May to mid-June (Fig. 1) and another from mid-July through August (Fig. 2). Three consecutive experiments were run during the late spring peak in which a total of six materials were tested; data for this test was pooled over runs. A single, continuous test using three fabrics plus the fiberglass screen control was run during the second thrips peak. During this test, populations of whiteflies rose to numbers sufficient for analysis of treatment effects. More whiteflies were trapped inside the fiberglass screened cage than outside, so results are compared with only the fiberglass screen control (Fig. 2). Aphids were not collected at appreciable levels (data not shown).

Testing of a given material on a given cage constituted one replication. Data were analyzed using analysis of variance (ANOVA). There was no significant cage effect, therefore, replications were pooled over cages for each material. Insect count data were transformed into a percentage of the coinciding control counts. Multiple comparisons were made using the least squares means procedure (SAS Institute, 1988). Exclusion efficacy was computed by subtracting percentages compared with the control from 100%.

Results & Discussion

Of the six materials tested during the first thrips population peak, only the BugBed™123 screen provided greater exclusion than the fiberglass control screen (Fig. 1). Results among the other materials were similar, and these screens provided less exclusion than BugBed™123 (Fig. 1). When exclusion is calculated as a percentage of the fiberglass control, again only BugBed™123 was different from the other materials (Fig. 1).

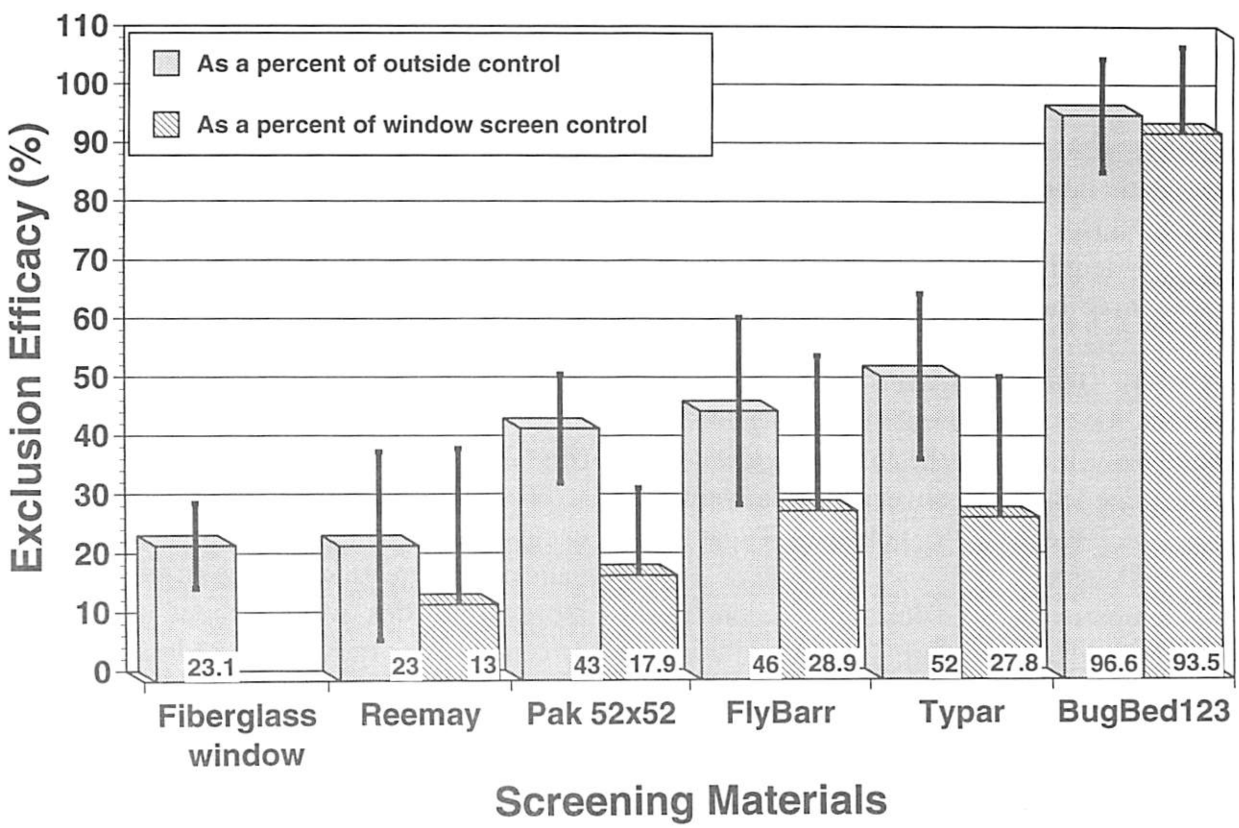

Figure 1. Late spring thrips catches as a percentage of the outside control and the fiberglass window screen control (n = 22, fiberglass; n = 6, Reemay™ and FlyBarr™; n = 16, Pak™ 52 × 52; n = 8, Typar™; n = 14, BugBed™123).

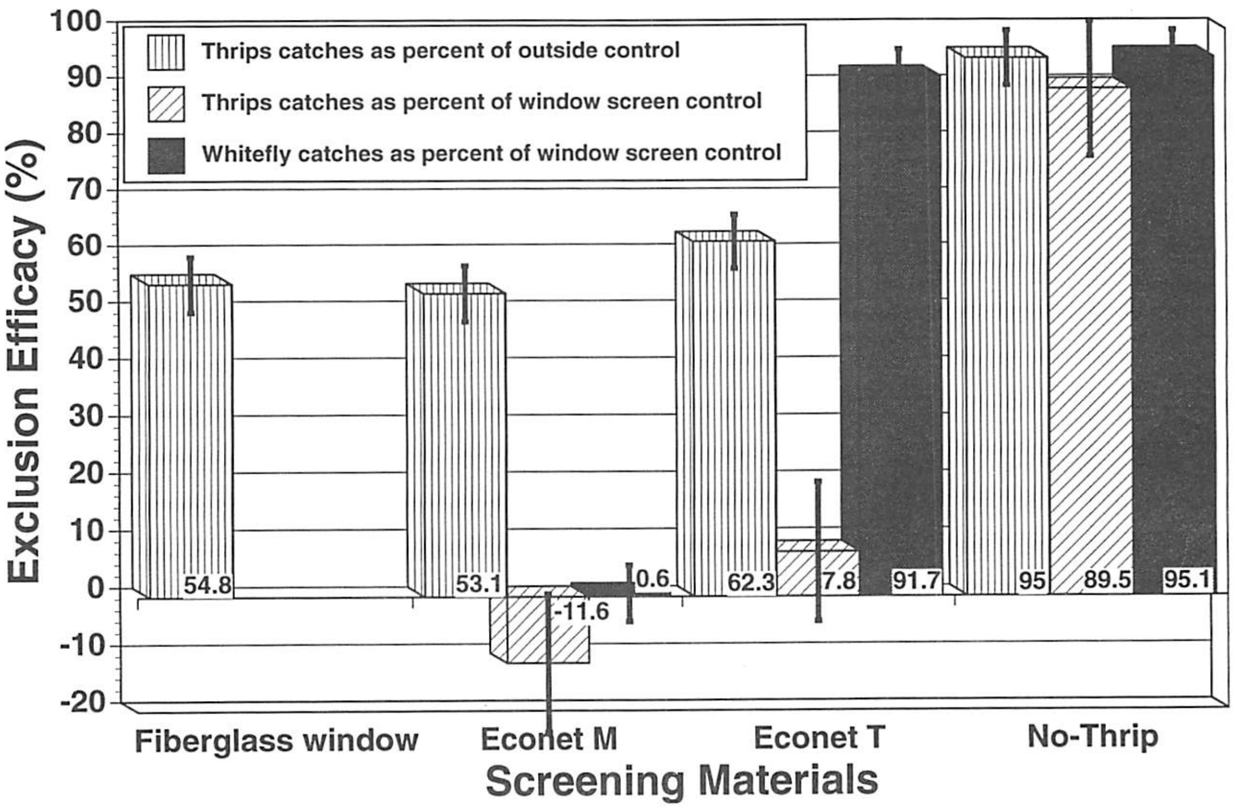

Figure 2. Summer thrips and whitefly catches as a percentage of the outside control and fiberglass window screen controls. (n = 14 for thrips test; n = 10 for whitefly test).

BugBed™123 has been characterized as a medium resistance fabric, yet it proved better able to exclude thrips than Typar™ or FlyBarr™ which are considered highly resistant to air flow. The reason may be that BugBed™123 is a woven fabric whereas Typar™ and FlyBarr™ are polyspun materials. The rigid woven structure may help prevent thrips passage through BugBed™123. Conversely, thrips may be able to wiggle through or are pulled through between the relatively thin, moveable fibers of the polyspun Typar™ and FlyBarr™ screens.

Comparisons made during the second thrips peak showed that No-Thrip™ excluded thrips to a greater degree than the fiberglass control and the two Econet™ products (Fig. 2). As a percentage of the fiberglass control, No-Thrip™ maintained a high level of exclusion against thrips (Fig. 2). Though both No-Thrip™ and Econet T™ have been characterized as high resistance fabrics, No-Thrip™ has smaller holes and can more effectively exclude thrips than Econet T™. Exclusion of thrips by Econet M™ was less than that of the fiberglass control such that when data were transformed to a percentage of that control, the exclusion efficacy of Econet M™ was a negative value (Fig. 2). However, there was no significant difference between Econet M™ and the fiberglass window screen for thrips exclusion (Fig. 2).

For the three screens evaluated for whitefly exclusion, the fiberglass screen serves as the only valid control treatment, since an average of 63% more whiteflies were trapped in fiberglass screened cages than outside (data not shown). Econet M™ was not significantly different from the fiberglass control and thus provided essentially no exclusion when data were transformed as a percentage of the fiberglass control (Fig. 2). No-Thrip™ and Econet T™ very effectively excluded whiteflies (Fig. 2).

Though Econet T™ did not effectively exclude thrips, it was highly effective in excluding whiteflies. According to Bethke & Paine (1991) greenhouse pests are likely to be excluded by screens with hole sizes smaller than the insects' thoracic width. The authors also noted that projecting body parts such as the wings of whiteflies further prohibit their ability to penetrate many screens. In general, the species of thrips attacking greenhouse crops are narrower than species of whitefly pests of these crops. Data presented here suggest that the holes of Econet T™ allow differential passage of the two pests.

The poor performance of Econet M™, a fabric on the low end of the medium resistance group, is somewhat surprising as its air flow resistance curve is well above that of the low resistance fiberglass window screen. Several low resistance fabrics are presently being marketed for use on commercial greenhouses. It is probable that such fabrics would provide pest exclusion similar to or less than that of Econet M™. This situation points to the pressing need for independent evaluation of screens for their pest exclusion properties.

Conclusions

Greenhouses utilized as high value production areas are usually plagued by one or more relatively small insect pests. Sealing those portions of the greenhouse open to the external environment with insect screening will effectively limit the movement of pests into these production areas. Screening for exclusion coupled with the introduction of insect-free plants will markedly reduce the need for pesticide applications. It is now feasible to fit screens on existing greenhouses, and certainly screening will become a major factor in greenhouse design in the future.

This study tested eight screening materials for thrips exclusion and three materials for whitefly exclusion. Although the screens differed in ability to exclude insects, high air flow resistance did not always correspond to greater pest exclusion. The woven materials were generally more effective than polyspun materials for exclusion. BugBed™ and No-Thrip™ excluded 90% of thrips at peak populations. No-Thrip ™ and Econet T™ excluded 90% of whiteflies at peak populations.

We are continuing our efforts to characterize air flow resistance and to compare pest exclusion for all materials available to growers. Thrips and whitefly exclusion tests comparing 29 commercial screens are presently underway. We will report results with these materials in the near future.

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