

Vertical distribution of thrips and whitefly in greenhouses and relative efficiency of commercially available sticky traps for population monitoring

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The vertical distribution of thrips in a *Brighamia* greenhouse culture is described. Also, a comparison is made between several types of commercially available sticky traps for population monitoring of thrips and whitefly. Actual findings are reported in population monitoring of thrips and negative experiences of interchanging sticky trap brands. Thrips vertical distribution followed an exponential pattern that could be described using a linear log/log regression. Among traps tested, a single type of yellow sticky trap was significantly less efficient than other yellow sticky traps for thrips. Also blue was significantly more attractive to thrips than yellow in one of two tests. No significant differences between different yellow traps were detected in attractiveness to whitefly.

Keywords: thrips, whitefly, greenhouse, monitoring, sticky trap, efficiency

It has been known for a long time that insects are differentially attracted to coloured surfaces, particularly yellow is notorious among house painters as a general insect attractant. This feature has been exploited among entomologists for collection of Coleoptera, Cicadellidae, aphids, Hymenoptera and Thysanoptera (Riley & Schuster 1994, Kersting & Baspinar 1995; Masner, pers. comm.).

Also tests on sticky traps on thrips populations revealed differential attraction. However, published results are not consistent. Moffit (1964) in testing between yellow and white traps found significantly more *Frankliniella occidentalis* on white than on yellow traps. Cho *et al.* (1995) compared blue, white and yellow traps, results indicated higher catches for yellow than for other colors. Brødsgaard (1989) compared several hues of blue, yellow and white and found significantly higher catches for two specific hues of blue. The same author also mentioned possibilities of trap materials and reflectance. Results suggest that next to the colour as observed by the human eye, other factors may be important. In the 90's the use of sticky traps for population monitoring in commercial greenhouse cultures was introduced, recommendations were blue for thrips monitoring and yellow for whitefly/ aphid and other insects. In practice, however, most often yellow sticky traps are used whereby the lower efficiency in thrips monitoring is generally not considered affecting control decisions (Loomans *et al.* 1999) also other pests may be monitored simultaneously. Pest control decisions are often based on trap catches. Several different brands are commercially available. In the course of 2004

Table 1. Decrease in thrips counts per project from week before trap change until week after.

Project 1	HorY wk#1	BriY wk#2	BriY wk#3	HorY wk#4
	246	38	28	330
Project 2	HorY wk#1	BriY wk#2		HorY wk#3
	446	26		340

the yellow traps used our company were temporarily unavailable and interchanged by another brand. This led to a sudden unexpected decrease (11%) in thrips numbers counted (Table 1). Returning to the first brand restored numbers. Based on this experience several tests were made for comparison of whitefly and thrips catches between different brands.

Vertical distribution

Suppliers recommend a trap height of 30 cm over the monitored plant canopy. Also Brødsgaard (1989) reports exponentially decreasing *F. occidentalis* numbers with increasing height above plant canopy. However, no actual data is presented. Although flight capacities of thrips are generally poor, many species use their wings to become airborne after which they are transported by wind dispersal. However, Lewis (1973) states that many species should be capable to sustain flight for several hours in still air. Also flight induction is influenced by temperature, daytime and light conditions. Moreover there have been reports that sex differences and physiological conditions of thrips lead to differences in flight characteristics. Where tested, vertical distribution profiles of aerial density approximate to a linear log density/log height relation (Lewis 1973, Brødsgaard 1989).

MATERIAL AND METHODS

Trap comparisons

Four sticky trap types were tested. Traps were of standard size used in population monitoring; 10 × 25 cm. Abbreviations of trap types: BriY (Brinkman® yellow traps, Brinkman, s'-Gravesande), HorY (Horiver® yellow traps), HorB (Horiver® blue traps, both Koppert, Berkel en Rodenrijs), OecY (Oecos, yellow traps, Oecos, Herts UK).

Thrips catches

Two tests were made for thrips attractiveness. Test A compared sides of HorB, HorY, BriY and OecY traps. The test was run as a randomized block design with eight blocks. Trap catches were scored after one week. Results for thrips catches were tested using a Kruskal-Wallis single factor analysis of variance by

ranks (Kruskal & Wallis 1953). A multiple comparison between traps was made using a nonparametric Tukey type test (Nemenyi 1963). Based on the results of test A, test B was also run as a randomized block design comparing HorY, HorB and OecY in eight blocks. Trapping stations for tests A and B were at ca. 170 cm height in a greenhouse compartment with mainly *Ficus benjamina*. Tests were run in October 2004.

Whitefly catches

Test C compared catches of whitefly (*Trialeurodes vaporariorum*) on HorY, OecY and BriY. Counts on each trap face of whitefly were made in a randomized block design with 12 blocks. Significance was tested similarly to tests A and B.

Vertical distribution of thrips and whitefly

Three 3-m long electricity type tubing were hung in a greenhouse by a top hook. Each tube was equipped with 9 wire hooks at 30 cm intervals. On each hook half a HorY trap (10 × 12.5 cm) was attached. Tubes were hung in a greenhouse roof on service railing. The distance of the lowest trap was 60 cm from tablet height (approximately 30 cm from canopy height). Tablet height was 70 cm. Greenhouse planting was *Brighamia insignis*. Each week thrips catches were recorded and traps were renewed. Counts continued for 4 weeks.

Results of the first run were used for fitting a simple linear regression model on transformed data. Residual comparison of square root, reciprocal and log transformations. Based on this a $\log(x+1)/\log(x+1)$ regression of trap catches on height was made for weekly counts. Regression slopes for all four weeks of thrips counts were compared using analysis of covariance (Zar 1984). Whitefly counts were pooled. Also here a regression on log-transformed pooled data was made.

RESULTS

Thrips

Test A showed significant differences between thrips catches ($H=10.940$; $\text{Chi}^2_{0.05,3}=7.815$) The multiple comparison showed significant differences between BriY and all others and between HorB and all others, no significant difference existed between HorY and OecY ($q=2.639$; $q[\text{OecY-HorY}]=2.505$) (Fig. 1).

Test B showed highest catches for HorY, followed by HorB and OecY. However, none of the differences were significant as tested by the Tukey type test ($H=0$).

Test C

Whitefly

Whitefly numbers caught were highest with OecY, followed by HorY and

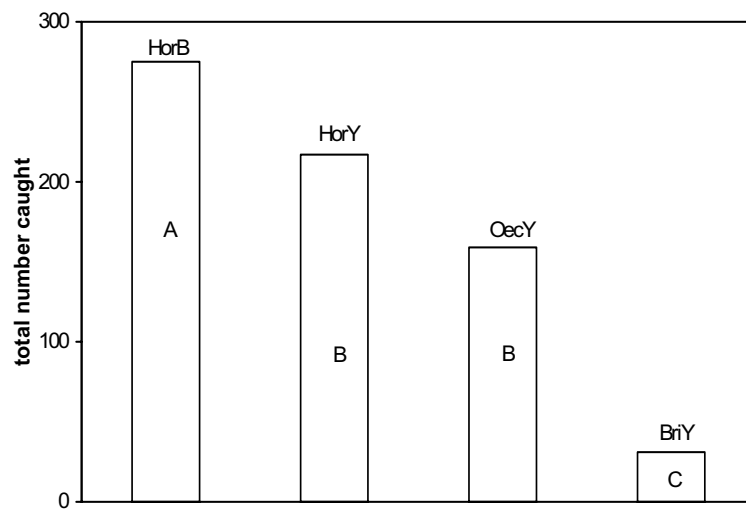


Figure 1. Comparison of thrips catches on different sticky trap brands. Bars with the same letter are not significantly different.

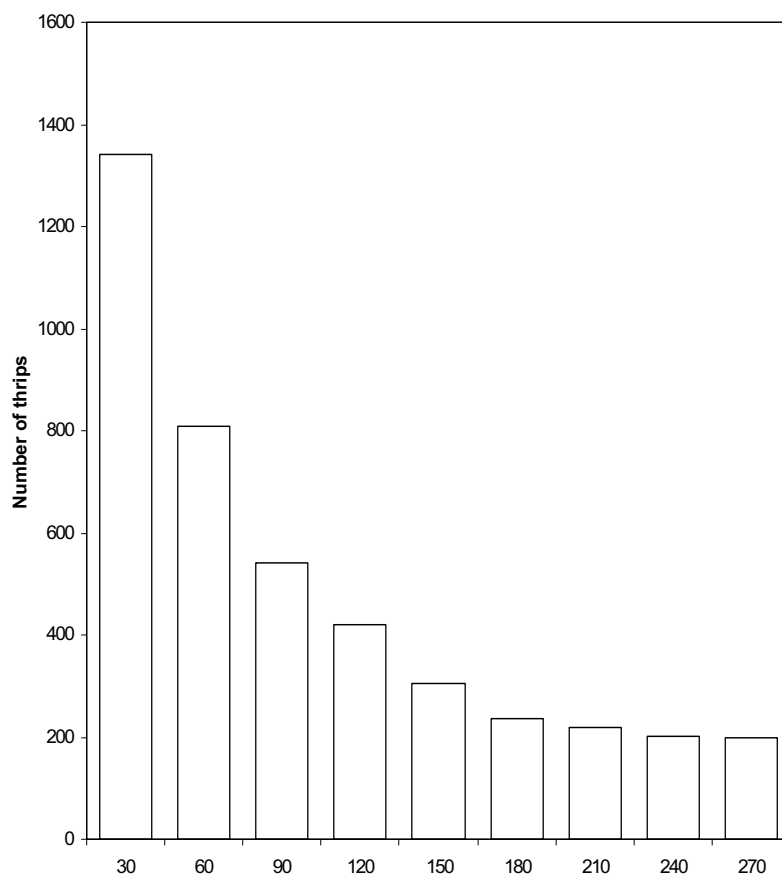


Figure 2. Total number of thrips/height.

Table 2. Slope and R^2 of $\log(\text{height}+1)/\log(\text{number}+1)$ regressed data of thrips catches.

week	trap	slope	R^2
1	1	-1.1842	0.84
	2	-1.0756	0.89
	3	-0.8439	0.93
2	1	-1.1502	0.86
	2	-0.9556	0.83
	3	-0.7837	0.91
3	1	-0.9339	0.86
	2	-1.2075	0.87
	3	-0.8243	0.93
4	1	-0.9603	0.88
	2	-0.7771	0.67
	3	-0.7999	0.92

BriY. Despite the differences in total numbers caught, the Kruskal-Wallis did not reject the H_0 of no significance between traps ($H=4.366$; $\text{Chi}^2_{0.05,2}=5.991$).

Vertical distribution

Totalled trap catches per week suggested nonlinearity (Fig. 2). For all datasets dependent and independent variables were $\log(x+1)$ -regressed. Slopes and R^2 of regressions per week and per trap are shown in Table 2. Slope comparison showed no significant difference between traps or weeks. Regression slope for similarly transformed pooled whitefly catches was -1.5639 , $R^2=0.9547$.

DISCUSSION

Where tested BriY traps were significantly less efficient in thrips catches than other trap types. Significantly larger numbers of thrips were caught on HorB than on all other traps in test A. Also no significant difference was found between HorY and OecY traps in test A or B. For practical scouting purposes this means that BriY traps are less efficient in estimating population changes than any of the other. The use of yellow traps instead of blue traps for estimating thrips population changes may not affect conclusions seriously. In practice result of OecY and HorY do not differ significantly. Results show significant differences in thrips counts per trap in experiment A whereas this could not be replicated in experiment B. Also results of test B do not confirm earlier findings and general thought that blue traps are more attractive than yellow. This may be because of the more robust nonparametric tests used in our comparisons. Other authors may have used parametric equivalents using data transformations. Our data did not warrant the assumption of normality. In practice, scouts choose

traps not only on insect catching efficiency considerations. Factors as time needed for insect counting (grids), ease in handling and renewing and price are important. In large thrips populations attractiveness may lead to 'overloaded' traps, and the need of frequent replacement. In this case yellow may be a better choice. The lower trap catches of BriY may be caused by slight differences in attraction through color or reflectance. Also glue characteristics may differ thereby capturing different proportions of insects attracted.

Thrips vertical distribution has been reported for altitudes up to 2000 and 3000 meter using aircraft. Lower altitudes have been sampled using kites and balloons. Where applicable, the vertical distribution could be fitted to a log density/log height relation. Lewis (1959) reported the distribution of several species of thrips at 5 levels up to 48 feet above ground. He reports a log/log linear relationship of several species and indicated significant difference between species in slope. The vertical distribution of *F. occidentalis* in our observations most resembled the pattern of *Chirothrips manicatus*, an alleged weak flier. In field vertical distributions complicating factors as wind, and other climatic factors as well as thrips physiology may affect flight and dispersal. Brødsgaard (1989) mentions that in *F. occidentalis* the vertical distribution between 0-250 cm above plant canopy follows an exponential decrease in numbers (r reported as -0.9273). For practical purposes a trap location of 30 cm above plant canopy caught 31% of the thrips and 55% of whitefly. The median location for thrips was 60 cm. Effects of placing traps for scouting at different heights may therefore be disproportional. The general advice of placing traps at 30 cm or even lower therefore results in highest trap catches.

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