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Evaluation of Insect Reservoir Type Traps Based On Evaporation Rate

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Reservoir Type Traps

Reservoir type insect traps, such as the McPhail Trap (Figure 1), are designed to hold a volume of liquid bait, typically a mixture of water and yeast. In addition to the liquid contents, a pheromone lure can be added to increase the attractiveness of the trap to the desired insect. The McPhail Traps have a plastic base, which comes in a yellow, green, red, or blue (target insect species find different colors attractive). The upper part of the trap is transparent serving two purposes: trap monitoring (amount of bait remaining in the trap and insects captured) and escape prevention (the typical behavior of many insects is to escape towards the most illuminated area). The trap is typically hung from trees to catch flying insects.

Figure 1: McPhail Trap

ISCA Technologies, Inc. has recently developed an improved version of the McPhail Trap, called the Ball Trap (Figure 2). Similar to the McPhail Trap, it has a brightly colored base and a transparent top, but while the McPhail Trap is more bell-shaped, the Ball Trap is nearly round (much like a ball). In addition, the Ball Trap can hold twice the volume of liquid bait as the McPhail Trap. A larger trap volume reduces the time spent refilling the trap and increases the duration of the trap's effectiveness, resulting in reduced labor costs associated with maintaining the traps. The rounded shape of the Ball Trap was designed to minimize the surface area of water, which decreases the evaporation rate.

Figure 2: Ball Trap

Liquid Bait Evaporation in Reservoir Traps

Temperature, wind, and humidity are the principal factors which affect the evaporation rate of a liquid. High humidity, low wind speeds, and low temperatures will all contribute to a lower rate of evaporation. Conversely, low humidity, high wind speeds, and high ambient temperatures will result in a higher rate of evaporation.

The purpose of the tests reported here was to identify ways in which the trap chosen affects evaporation rate. In tests with an unequal volume of water, the effect of trap capacity would be evident, while in tests with equal volumes of water, the effect of trap shape would be evident.

Evaporation Rate Experiments with Unequal Volumes of Water

Figure 3: Experimental setup of traps used to find evaporation with unequal volumes of water

In order to determine if the design of the Ball Trap affects the evaporation rate of the liquid contents within, several experiments were monitored in Victorville, California for 46 days from August until October 2006. Two sets of traps (a set is one Ball Trap and one McPhail Trap) were placed in direct sunlight and filled to capacity (Figure 3). As the two traps have different capacities for holding water, this resulted in unequal amounts of water. The traps were inspected daily to measure the remaining water, which was determined through weight. HOBO thermocouples were placed inside the trap in two locations (Figure 4): submerged in the water and in the headspace above the water, and another HOBO was placed between all traps to measure ambient temperature.

Figure 4: Placement of thermocouples in trap

When the traps were filled to capacity with unequal volumes of water the Ball Trap maintained its reservoir three times longer than the McPhail Trap (Figure 5). This is expected, as a larger body of water will take longer to evaporate than a small body in the same environment.

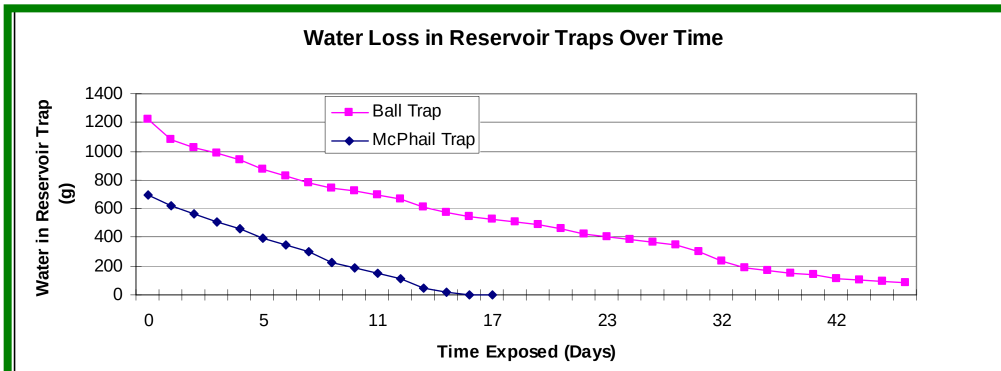

Figure 5: Evaporation of water in traps filled with unequal volumes of water

The temperature of the water and air inside the traps differed from ambient temperatures. Based on an average of daily temperatures, the water in the McPhail Trap was 0.3-1.9 degrees less than ambient, while the water in the Ball Trap ranged from 0.62 centigrade degrees less to 1.82 degrees higher. The cooler temperature of the McPhail Trap water indicates a higher level of evaporative cooling than in the Ball Trap, thereby increasing the rate of evaporation in the McPhail Trap. The air in the headspace of the McPhail Trap was also cooler than ambient, by 0.3-4.0 degrees centigrade, while air in the headspace of the Ball Trap ranged from 0.59 degrees warmer to 1.6 degrees cooler. Headspace temperatures also indicate that more evaporation is taking place in the McPhail Trap than the Ball Trap.

Evaporation Rate Experiments with Equal Volumes of Water

In a separate experiment, evaporation was monitored in Riverside, California for 30 days in July and August 2006 where the average temperature was 98.4 ± 5.6 °F. Two sets of traps were filled with the same volume of water (600 mL) and placed in direct and indirect sunlight. Those traps in direct sunlight were hung from two separate trees and those in indirect sunlight were placed behind a concrete wall among shrubbery. At each observation interval, the volume of liquid remaining in all of the traps was measured. A total of six sets of observations were made within the four-week trial period.

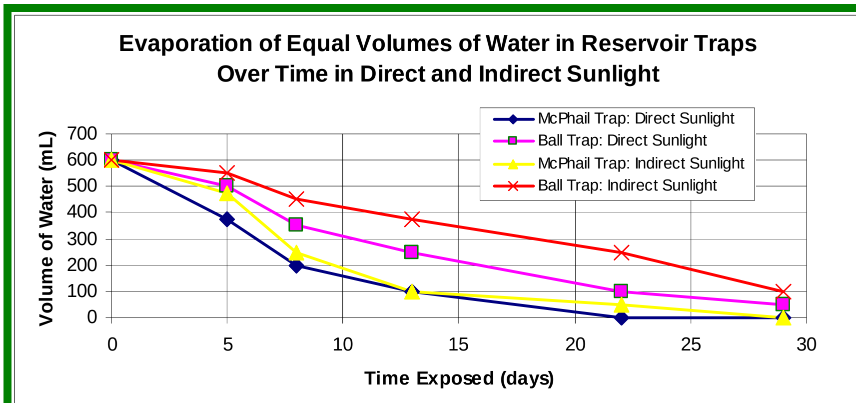

Figure 6: Evaporation of water in traps filled with the same volume of water

After 22 days, the water in the McPhail Trap placed in direct sun had completely evaporated. A week later, the McPhail Trap placed in indirect sun was also dry. At the conclusion of the experiment, the Ball Traps in direct sunlight still had 50 mL water remaining while those in indirect sunlight still had 100 mL water remaining (Figure 6). If the data is extrapolated, the water in a Ball Trap filled at 50% capacity (600 mL) will last approximately 44 days in direct sunlight and 61 days in indirect sunlight.

Conclusion

This study concludes that the use of the Ball Trap increases the length of time between liquid re-fills, even when equal volumes of water are used. The two important factors for the increased length of time are the rounded shape of the Ball Trap which reduces the evaporation rate of its contents and the larger volume of water that the Ball Trap is designed to hold.

Economic Analysis

Based on the results of this study, we attempt to quantify the labor cost savings with the use of the Ball Trap in comparison to the traditional McPhail trap, applying a set of cost assumptions. We concluded that:

> **The use of Ball trap instead of the traditional McPhail trap results in labor cost savings of $13 per trap per season. For an orchard with 100 traps, cost savings total $1,300 per season.**

To view a brochure of the Ball trap: **ISCA Ball Trap (New and Improved McPhail Trap)**

Economic assumptions to quantify the labor cost savings with the use of the Ball Trap in comparison to the traditional McPhail trap

Cost Assumptions:

> Traps are filled to normal capacity with water
> As a result of evaporation, traps are re-filled to normal capacity for the McPhail trap every 2 weeks, and the Ball trap re-filled to normal capacity every 6 weeks.
> Labor cost is $12 per hour
> Time taken to travel to next trap, re-fill and maintain it: 5 minutes
> Orchard has 100 traps
> Season of 9 months, approximately 39 weeks.
> Based on the results from this study, we can conclude that the Ball trap last 3 times longer than the McPhail trap without the need for re-fills

Cost Calculations:

Each McPhail trap is refilled average of 19½ times per season
Each Ball trap is refilled average of 6½ times per season

Each McPhail trap requires 97.5 minutes to maintain per season
Each Ball trap requires 32.5 minutes to maintain per season

Each McPhail trap requires $19.50 in labor cost to maintain per season
Each Ball trap requires $6.50 in labor cost to maintain per season
Cost savings of **$13** per trap per season
For orchard with 100 traps, cost savings of **$1,300** per season

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