SUSPENSION VELOCITY OF THE COLORADO POTATO BEETLE IN FREE FALL

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Abstract

The suspension velocity of the Colorado potato beetle was determined for four stages of its life cycle. Suspension velocities measured using an experimental video technique agreed reasonably well with theoretical values. Suspension velocities for the adults, fourth, third, and second instars were 9.4, 9.5, 7.3, and 5.9 m/sec, respectively.

Recent experimental results suggest that a large percentage of adults and large larvae of the Colorado potato beetle are missed during a single pass of commercial field scale vacuum insect collectors. The relatively low suspension velocity of free falling small larvae explain, at least in part, why only 3% of the small larvae fell to the ground.

Compendio

La velocidad de suspensión del escarabajo de la papa de Colorado fue determinada por cuatro etapas de su ciclo de vida. Las velocidades de suspensión medidas usando una técnica experimental de video correspondieron razonablemente bien con los valores teóricos. Las velocidades de suspensión para los adultos, cuarto, tercero y segundo estadios, fueron 9.4, 9.5, 7.3, y 5.9 m/seg. respectivamente.

Recientes resultados experimentales sugieren que un gran porcentaje de adultos y de larvas grandes del escarabajo de la papa de Colorado, se pierden durante una sola pasada de las aspiradoras colectoras de insectos a escala comercial de campo.

La velocidad de suspensión, en caída libre, relativamente baja de las larvas pequeñas explica, por lo menos en parte, porque sólo un 3% de esas larvas cayeron al suelo.

Introduction

The efficacy of a vacuum insect collector used to control the Colorado potato beetle population was examined by Boiteau et al. (1). In a field study, the researchers found that 13% of the adult beetles avoid capture by the vacuum insect collector by falling to the ground. The results also indicate

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that only 3% of the small beetle larvae fell to the ground and were not collected. In comparison, 23% of the large beetle larvae fell to the ground. The proportion of adults/larvae falling to the ground is only probably in part attributable to the different behavioral traits of each life stage.

Careful examination of the aerodynamic characteristics of the insects needs to be undertaken before the efficacy of the insect collectors can be improved. The results from the work of Boiteau et al. (1) suggest that by improving the suction power of the vacuuming unit, it is reasonable to expect increased catches of adults and large larvae. Insects are carried in an airstream by drag forces generated by air flowing rapidly over the insect surface. The drag forces are related to exponential differences between the air and insect velocities.

Researchers have determined the terminal velocity of small grains (3, 6). They have used this information to develop harvesting systems that separate particles based on the particle terminal velocities (4). Ramachandran (10) has studied the aerodynamic properties of first instar caterpillars (Ectropis excursaria) and determined factors affecting their terminal velocity. DeVries (2) conducted preliminary studies to determine the drag coefficient of adult Colorado potato beetles. It should be noted that suspension velocity and terminal velocity have the same value. Suspension velocity is the term for air flowing at a steady upward velocity with the particle suspended at zero velocity. In both cases, the drag forces balance the weight.

The objective of this study was to determine the suspension velocity of the beetle at different life stages. Factors affecting the magnitude of the suspension velocity were also examined.

Materials and Methods

Experimental Procedure

Several researchers have developed procedures for measuring the terminal velocity of objects. Schmidt and Levin (11) utilized a series of phototubes located along a drop chute to determine the terminal velocity of cherries. Menzies and Bilanski (7) measured the terminal velocity of alfalfa particles in a wind tunnel. A video procedure was developed by Ramachandran (10) to determine the terminal velocity of the first instar caterpillars (Ectropis excursaria).

For our experiment, a video technique was developed to measure the terminal velocities of four life stages of the potato beetle. The standard video picture consists of a series of video frames presented to the viewer at a rate of 30 frames a second. Each frame in turn is composed of two video fields. Field 1 consists of the odd numbered lines of the video picture while field 2 consists of the even numbered lines of the video picture. Two fields are interlaced to form a frame. Thus the field rate is 60 fields per second giving the frame rate of 30 frames per second. The VCR used in this experiment (Panasonic AG-6720) had the capability to let the user observe individual fields. This capability coupled with the camera (Panasonic