AN IMPROVED TRACTOR-MOUNTED PNEUMATIC INSECT COLLECTOR

K. R. Beerwinkle and J. R. Coppedge
USDA-ARS, Southern Crops Research Laboratory
College Station, TX
J. R. Raulston and D. W. Spurgeon
USDA-ARS, Subtropical Agricultural Research Laboratory
Weslaco, TX

Abstract

The design of an improved tractor-mounted pneumatic insect collector for field sampling of cotton insects is described. The experimental machine operates on a combination unidirectional blower and vacuum principle, and it is configured for easy single-person operation. Mechanical specifications for components and air flow characteristics are provided.

Introduction

Farmers, crop consultants, and pest management research scientists must perform in-field sampling to determine the presence of both pest and beneficial insects in order to make informed pest management decisions and/or evaluate the effects of various pest control practices. Such sampling is usually done with manual sweep nets or by visual examination of individual plants which is very tedious and labor intensive. There is a need for mechanical sampling devices to increase the efficiencies of row crop insect sampling procedures.

Several tractor-propelled insect collecting machines for sampling and/or control of various insects on row crops have been described in the literature. Parencia (1968) described two models of tractor-mounted pneumatic "Bug Catcher" machines that were constructed as early as 1944 and commercially sold to farmers throughout the cotton belt as a mechanized means for controlling cotton insect pests. Both of the machines (the Webb Insect Exterminator and the Nesbit Insect Collector) used high-volume blowers to blow air across cotton from one side of a row into a collection scoop on the other side. Insects and plant materials entrained in the air stream were collected in nets positioned in the exhaust air from the collector scoop. No technical specifications regarding characteristic air flow volumes and velocities were given for these machines.

The Webb and Nesbit machines collected many insects, but they did not control the insect pests as completely as the growers expected, and the machines were not nearly as effective as were the inorganic insecticides that came into use at that time. Although tractor-mounted Bug Catchers were not effective as insect control devices in cotton, research interests have continued to further develop and improve the performance of these machines, especially for use to sample insect populations. Kirk and Bottrell (1969) described a pneumatic, tractor-mounted sampler for estimating boll weevil populations. Their machine used the unidirectional blower principle with nozzle dicharge air velocities varible from 91 to 136 mph. They reported weevil collection efficiencies of 63 to 92 % for the machine operating in early-bloom stage cotton with the higher air velocities being the most effective. McCoy and Lloyd (1975) reported results from their evaluations of four different mechanical air flow systems for collecting boll weevils from cotton. They found that a machine (the McCoy Insect Collector) with a dual directional blower (air velocities ≈100 mph) and vacuum system was best. They reported a boll weevil detection efficiency for this machine of 130 % compared to visual detection in maturing cotton that was 45-50 inches tall. However, the literature does not indicate that the McCoy Insect Collector was commercially manufactured or widely used in research.

Ellington et al. (1984a) described a high-clearance, tractor-mounted vacuum insect collector for sampling arthropods in field crops that was reported to have sampling efficiencies superior to those obtained with a sweep net for most species (Ellington et al. 1984b, 1995). Other tractor-propelled vacuum insect collectors have been evaluated for management of lygus bugs (Heteroptera: Miridae) on strawberries (Vincent and Lachance 1993, Pickel et al. 1995) and Colorado potato beetles (Coleoptera: Chrysomelidae) on potatoes (Lacasse et al. 1994).

Our interest in tractor-mounted insect collecting machines was kindled by our need for a fast, efficient cotton-insect sampling capability to support research of boll weevil behavior and the effects of certain early-season boll weevil management practices on beneficial insect population dynamics. In the early stages of our work in 1995, we had access to a one-row insect sampling machine originally constructed in Mississippi (original developer unknown). This machine operated on the unidirectional blower principle with a measured nozzle peak discharge velocity of ≈88 mph. Several modifications were made to the original Mississippi machine to improve its performance. Some field experiments were conducted to evaluate the performance of the modified insect collector during the early part of the 1995 growing season, and it was subsequently used that year in several field research studies in the Lower Rio Grande Valley.

Prior to the 1996 growing season, a new tractor-mounted insect collecting machine (Weslaco machine) was constructed, incorporating the design improvement modifications made earlier on the Mississippi machine. The sampling performance of the Weslaco machine was evaluated in extensive field tests (Raulston et al. 1997), and it was subsequently used in a field research project (Sparks

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1181-1183 (1997)
National Cotton Council, Memphis TN

et al. 1997). The design and mechanical specifications of the experimental Weslaco insect sampler are described here.

Description of Improved Sampler

The major modifications made to the original Mississippi machine and later incorporated in the construction of the Weslaco machine (Fig. 1) were designed to increase the air flow capacity and to convert the operating principle of the machine from that of a unidirectional blower (Fig. 2) to that of a combination unidirectional blower and vacuum (Fig. 3). The modifications included replacing the original power take-off (PTO) driven centrifugal blower (13.5-in. dia. wheel) with a larger unit (15.625-in. dia. wheel, No. 3C106, W. W. Granger, Inc., Lincolnshire, IL) and the addition of air ducts from the sampling air vacuum scoop to the blower inlet with an in-line insect sampling chamber. The larger blower was selected to provide a maximum air delivery velocity of $\approx$130 mph at the vertically-oriented 1.5 X 16-in. rectangular nozzle outlet mounted on the front of the tractor (Fig. 1). The nozzle directed the high velocity air stream across cotton plants in the 11-in. wide sampling throat (Fig. 3) into a vertically-oriented 6 X 18-in. rectangular vacuum scoop inlet. From the vacuum scoop, the air was returned through ducts to the inlet of the blower mounted at the rear of the tractor (Fig. 1). All circular ducts on the machine had nominal inside diameters of 8.0 inches.

Insects and plant debris, entrained in the return air, were removed by an insect collection net (12-in. dia. inlet by 28-in. length, BioQuip # 7212, BioQuip Products, Gardenia, CA) mounted with Velcro® in an air expansion/sampling chamber that was positioned adjacent to the machine operater's seat in the return duct (Fig. 1). The air expansion/sampling chamber had an inside diameter of 14 in. and a length of 30 in. with tapered circular transitions to the 8-in. inside-dia. ducts on both ends. The increased inside-diameter of the chamber relative to that of the ducts caused the air velocity through the net to be about one-third of that in the ducts. The chamber was equipped with windows for veiwing the net inside the enclosure and a hinged side-door for installing and removing the insect net. The location of the sampling chamber adjacent to the operator's seat provided for easy one-person operation of the machine.

On the original Mississippi machine and subsequently on the Weslaco machine, preliminary analyses of the air flow characteristics from the air delivery nozzle into the vacuum scoop inlet with the tractor PTO rotating at 540 rpm and no obstructions in the sampling throat indicated that the peak nozzle oulet velocity was about 130 mph which corresponded to a total system static pressure of about 12 inches of water column as was designed. However, due to the dynamics of the high velocity air stream from the nozzle outlet impacting the slower velocity air stream of the scoop inlet, there was considerable spillage of air at various points around the peripheral edge of the inlet. To remedy this unacceptable condition, it was necessary to reduce the size of the outlet nozzle from 1.5 X 16 in. to 1.5 X 12 in. and add a by-pass valve in the air supply duct (Fig. 3) to vent approximately 40 % of the blower delivered air to the atmosphere and only the remaining 60 % to the outlet nozzle. With the addition of these modifications, the characteristics of the air flow from the nozzle into the vacuum scoop were such that negative pressures were consistently maintained around all of the interior peripheral edges of the inlet.

The added modifications required to eliminate air spillage from the vacuum scoop inlet changed the operating air flow characteristics of the system. On the modified experimental Weslaco machine with PTO rotational speeds of 540, 480, and 420 rpm, the peak measured unobstructed nozzle outlet velocities were 107, 95, and 83 mph, respectively. The effects of these and other variables on the field sampling performance of the Weslaco sampler are reported by Raulston et al. (1997). Although the Weslaco sampler, as it is presently constructed, has proven to be a useful field sampling tool for cotton insects, the machine is still considered to be experimental, and we feel that its performance can be further enhanced with additional design modifications.

Acknowledgments

The authors acknowledge Charlie Jung at College Station and Ralph Morgan at Weslaco for their technical assitance in the fabrication of the experimental tractor-mounted insect collector apparatus.

Disclaimer

Mention of a trade name or a proprietary product is for specific information only and does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply endorsement of the product over other products not mentioned.

References

Ellington, J., K. Kiser, M. Cardenas, J. Duttle, and Y. Lopez. 1984. The Insectavac: a high-clearance high-volume arthropod vacuuming platform for agricultural ecosystems. Environ. Entomol. 13: 259-265.

Ellington, J., K. Kiser, G. Ferguson, and M. Cardenas. 1984. A comparison of sweepnet, absolute, and Insectavac sampling methods in cotton ecosystems. J. Econ. Entomol. 77: 599-605.

Ellington, J., T. Carrillo, K. Schneider, and S. Lombard. 1995. A single row vacuum sampler for cotton. Proc. Beltwide Cotton Prod. Conf., 1057-1059. Memphis, TN: National Cotton Council of America.

Kirk, I. W., and D. G. Bottrell. 1969. A mechanical sampler for estimating boll weevil populations. J. Econ. Entomol. 62: 1250-1251.

Lacasse, B., C. Lague, R. Paul-Martin, and M. Khelifi. 1994. Technical feasability of pneumatic control on Colorado potato beetle. ASAE Paper No. 94-8510. American Society of Agricultural Engineers, St. Joseph, MI. 16 pp.

McCoy, J.R., and E. P. Lloyd. 1975. Evaluation of airflow systems for the collection of boll weevils from cotton. J. Econ. Entomol. 68: 49-52.

Parencia, C. R., Jr. 1968. Control of cotton insects with an insect-collecting machine. J. Econ. Entomol. 61: 274-279.

Pickel, C., F. G. Zalom, D. B. Walsh, and N. C. Welch. 1995. Vacuums provide limited lygus control in strawberries. Calif. Agri. 49: 19-22.

Raulston, J.R., D. W. Spurgeon, K. R. Beerwinkle, and J. Coppedge. 1997. Efficiency of improved tractor mounted sampler for collecting boll weevil. Proc. Beltwide Cotton Prod. Conf. Memphis, TN: National Cotton Council of America.

Sparks, A. N., Jr., D. W. Spurgeon, J. R. Raulston, and I. W. Norman, Jr. 1997. Comparative efficiency of Fipronil and Guthion for boll weevil control. Proc. Beltwide Cotton Prod. Conf. Memphis, TN: National Cotton Council of America.

Vincent, C., and P. Lachance. 1993. Evaluation of a tractor-propelled vacuum device for management of tarnished plant bug (Heteroptera: Miridae) populations on strawberry plantations. Environ. Entomol. 22: 1103-1107.

Fig. 1. Experimental Weslaco tractor-mounted insect collector.

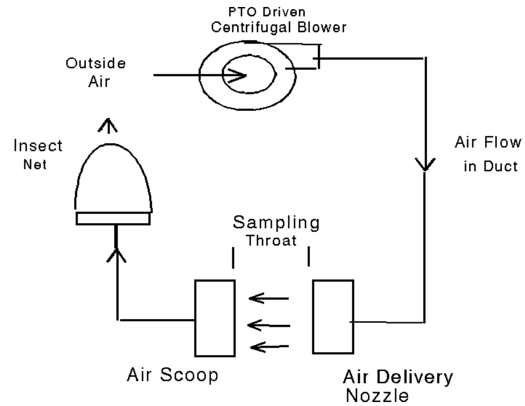

Fig. 2. Major component and air flow schematic of sampler operating on unidirectional blower principle.

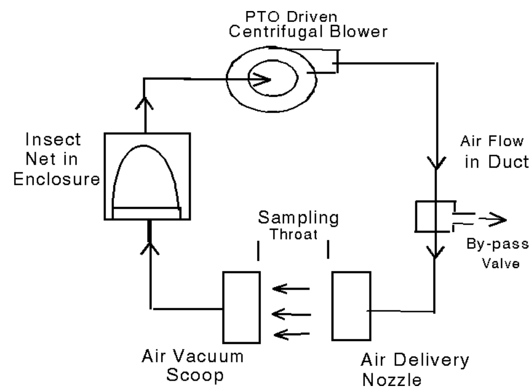

Fig. 3. Schematic of modified sampler operating on unidirectional blower and vacuum principle.