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AERIAL SWATH WIDTHS FOR ULV MALATHION

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Abstract

An aerial spray deposition study with ULV malathion was conducted to determine if spray swath widths specified in boll weevil eradication program contracts are appropriate for achieving uniform spray deposits across treated fields. The results of the study show that swath widths are too wide for uniform spray deposits using the two aircraft included in the study. Reduction of swath widths would improve uniformity of spray deposition, but this study was not designed to determine whether uniform spray deposits would increase boll weevil mortality in fields sprayed under boll weevil eradication program specifications.

Introduction

The National Boll Weevil Eradication Program has been successful in areas that have carried the program to conclusion. The program is based on research conducted by the Agricultural Research Service (ARS) of the U.S. Department of Agriculture (USDA). The Animal and Plant Health Inspection Service (APHIS) of the USDA administered the initial trial and large-scale program. As the program progressed, organizations by states and regions undertook the program. Each entity that undertook the program apparently optimized program guidelines and operational factors based on the best information and technology that was available or that best suited the program area. But questions of effective aerial swath widths, as specified in program guidelines, emerged when the program was initiated in Texas by the Texas Boll Weevil Eradication Foundation, Inc. (TBWEF). There were reports that the fields were being streaked because aircraft swath widths designated by program contracts were too wide. This issue was discussed with research and extension personnel as well as TBWEF program managers. Program managers collected oil-sensitive cards in sprayed fields that indicated coverage was relatively uniform. However, reports of streaked fields continued to persist. Experience with automated aircraft spray swath analysis with water-based spray mixes also suggested that the specified swath widths might be too wide for uniform spray coverage. It was speculated that ULV malathion sprays might generate wider aerial spray swaths than water-based spray mixes. It was further speculated that incidents of streaked fields may have come from in-wind spray applications and that applications in crosswinds may provide relatively uniform spray deposits across the field.

The spray swath recommendations used in eradication program sprays reportedly emanated from APHIS. These swath widths were likely developed, prior to major environmental protection initiatives, when higher boom heights were used to increase swath displacement and effective swath widths. The aerial application protocols used by TBWEF were developed to provide extensive environmental protection measures. Application height, as a measure of spray drift mitigation, was set at five feet above the canopy to minimize off-target spray deposits. It is possible that swath widths were not adjusted for height and were maintained at levels specified by APHIS for less restrictive conditions.

The elusive background of swath width specification for aerial ULV malathion applications and numerous unanswered questions suggested that a swath width study with ULV malathion applied as specified in program contracts would be useful to program participants, educators, and managers. Consequently, a study was conducted to provide information on aerial swath widths for uniform ULV malathion spray deposits across a cotton field.2

Materials and Methods

Two adjacent cotton fields, one with row direction parallel to prevailing winds and one with row direction perpendicular to prevailing winds, were selected for study on the Texas A&M University Farm in Burleson County, Texas. Four treatments, (two aircraft X two wind directions [inwind and crosswind]) were applied three times in the growing season as replicates. Treatment study days were selected 10-15 days apart with prevailing winds approximately down the rows in one field and across the rows in the other field so applications would be inwind in one field and crosswind in the other field. Field layout is shown in Figure 1. The two agricultural aircraft used in the study were a Cessna T188C AgHusky (Cessna Aircraft Company, Wichita, Kansas) and an Air Tractor AT-402B (Air Tractor, Inc., Olney, Texas). The operational setups for the two aircraft, Table 1, were as specified in the TBWEF, 2000 Contract for Aerial Application of Insecticides. Application rate of ULV malathion for these setups was 12 oz/acre.

Each treatment replicate consisted of four passes or swaths applied in the same direction down the cotton rows. Each swath centerline was marked for pilot reference. The inwind and crosswind applications with each aircraft were made in sequence with one aircraft first on one application day and the other aircraft first on the subsequent application day. Samples were collected in every other row across the four swaths for each treatment. Samples included two fully developed leaves at the top of the canopy, a 4"X 4" Mylar card, and a 2"X 3" oil-sensitive card (OSP). The cards were clipped to metal plates and placed on the ground between the rows. Samples were collected immediately after ULV malathion applications. The cotton leaves and Mylar cards were placed in marked plastic bags and the OSP cards were pinned to foam boards. The samples were transferred to the laboratory for analysis. The cotton leaves and Mylar cards were washed in the plastic bags in which they were collected. Ethanol was pipetted into each bag, the bag and contents were agitated by hand, and an aliquot of the rinsate was decanted into sample vials. The sample rinsates were analyzed for malathion by gas chromatography (Hewlett-Packard Company, Wilmington, Delaware) with flame ionization and a J&W DB-1 dimethylpolysiloxane column (30 m X 0.32 mm X 0.25 µm). The chromatograph and auto sampler were operated with Hewlett-Packard's Chemstation software. Surface areas of the cotton leaves in each sample were measured with a LI-COR LI 3100 Area Meter (LI-COR, Lincoln, Nebraska). The treatments were applied in the morning and the OSP cards were analyzed by image analysis in the afternoon of the respective application day. Weather instrumentation and a 21X Micrologger (Campbell Scientific, Inc. Logan, Utah) were used to record air temperature, relative humidity, wind speed, and wind direction while the sprays were being applied.

Results and Discussion

Weather data were typical for the area in mid-summer and relatively uniform during morning spray applications for the three application dates, with average air temperature of 84°F, relative humidity of 75%, and wind speed of 6 mph.

Spray deposition on plant leaves is highly variable because of variable leaf orientation, but deposition on plant surfaces is the criterion of importance for efficacy of most crop protection sprays. Figures 2 and 3 show spray deposits on cotton leaves across the four swaths in a treatment replication for each aircraft, inwind and crosswind. We selected individual treatment replicates for these figures as representative or typical because what is deposited in a series of adjacent passes is what happens in the field rather than an average deposit from several passes. However, the deposit trends across the swath expressed in these figures is also apparent in eleven of the twelve data sets collected in the study. The Mylar and OSP data from these samplers on the ground show the same general trends as observed from the deposits on leaves at the top of the canopy. Deposits on the samplers on the ground tended to decrease as crop canopy closure progressed from the first to the last application.

It is apparent from the deposits across the swaths for both aircraft flying inwind that deposits on the swath edges average about one third of the deposits in the central portion of the swath. If the swath widths were reduced, the overlapping of deposits at the swath edges from adjacent swaths would increase the total deposits at the swath margins. Therefore, it is realistic to conclude from this study that the swath widths specified in the TBWEF program are too wide for uniform ULV malathion deposits across a field.

ULV malathion deposit trends for the crosswind applications show that the deposits are displaced by the wind, but that the crosswind apparently does not fill in the gap or tend to even deposits at swath edges as had been supposed. The same trends for the swath being too wide, as observed from the inwind treatments, are also expressed in the crosswind deposit data. More uniform deposits of ULV malathion across the field could be attained with narrower swaths than specified regardless of whether the flight directions are inwind or crosswind.

Conclusion and Indications for Further Study

Deposits on cotton leaves from aerial applications of 12 oz/acre of ULV malathion could be made more uniform across the swath with narrower swath widths than specified in TBWEF program guidelines. Uniform deposits on cotton leaves at the top of the canopy would average 8-10 $\mu g/cm^2$ based on deposits observed in this study. The malathion AI application rate on a horizontal surface would be 10.2 $\mu g/cm^2$, for the 9.7 lb per gallon formulation used in this study. This study shows that deposits on top canopy leaves with swath widths specified in the program were 2-3 $\mu g/cm^2$ near swath edges and 10-15 $\mu g/cm^2$ near swath centerlines. This study was not designed to determine whether relatively uniform deposits across the field would increase boll weevil mortalities. If increased boll weevil mortalities could be attained with reduced swath widths, then the next question would be whether the increased boll weevil mortalities, along with increased application costs associated with reduced swath widths, would reduce overall program costs.

Acknowledgments

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Table 1. Operational setups for two aircraft to apply ULV malathion.

Aircraft Make	Aircraft Model	Swath Width ft.	Airspeed mph	Nozzles number, size, angle	Pressure psi
Air Tractor	AT-402B	90	140	13, 8002, 90°	41
Cessna	AgHusky	75	130	10, 8002. 90°	42

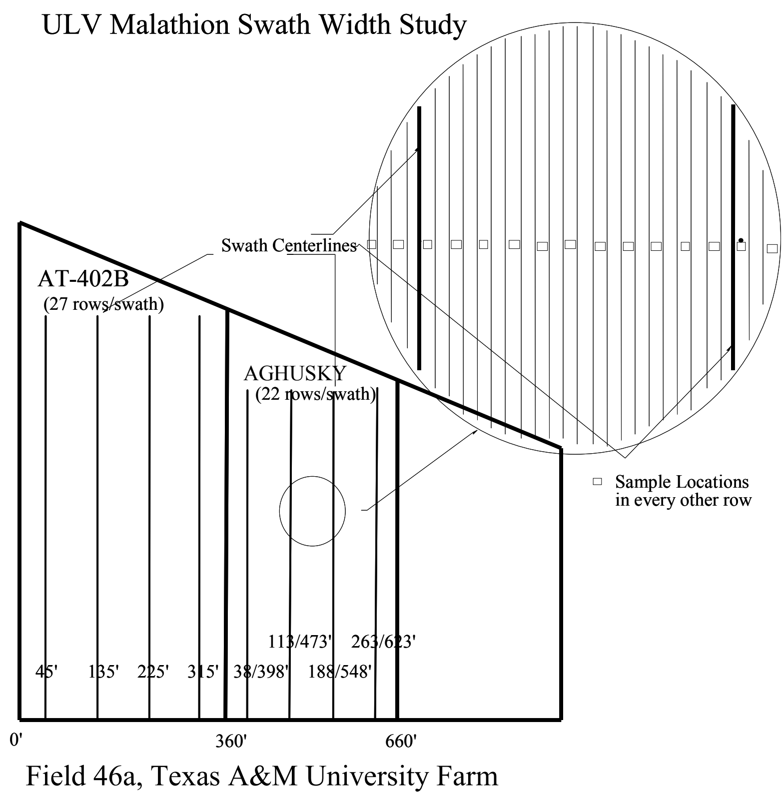
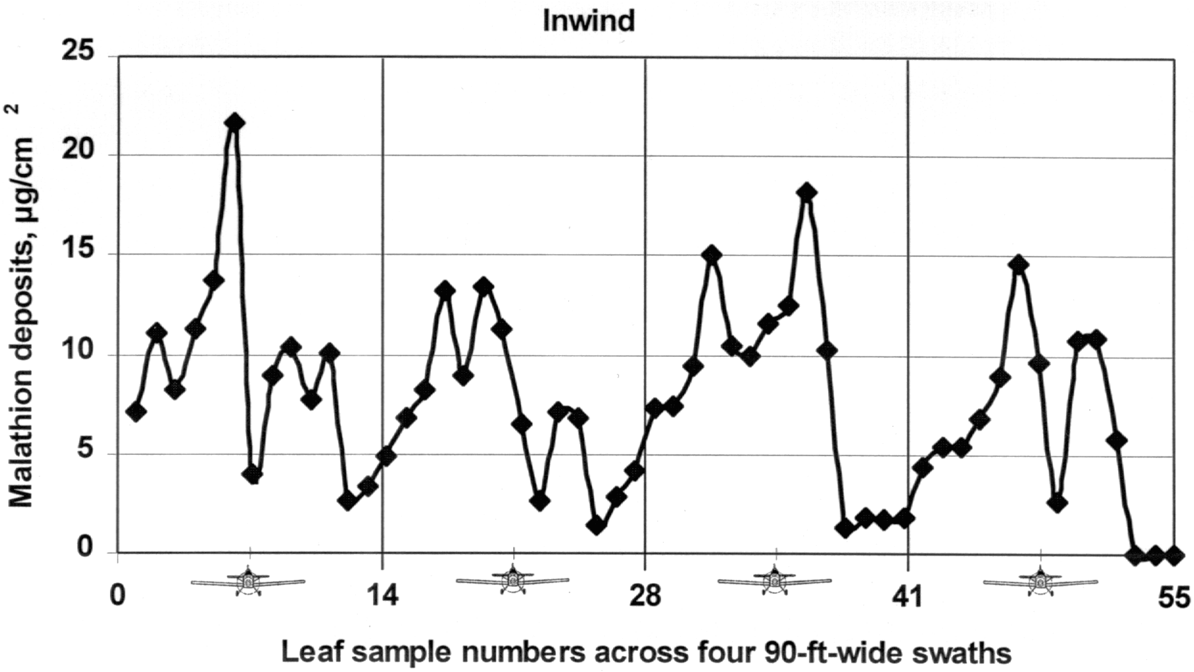


Figure 1. Field layout of Field 46a for ULV malathion swath width study. Field 40, adjacent and to the left of Field 46a had a similar setup, but with rows and swaths perpendicular to those in Field 46a.



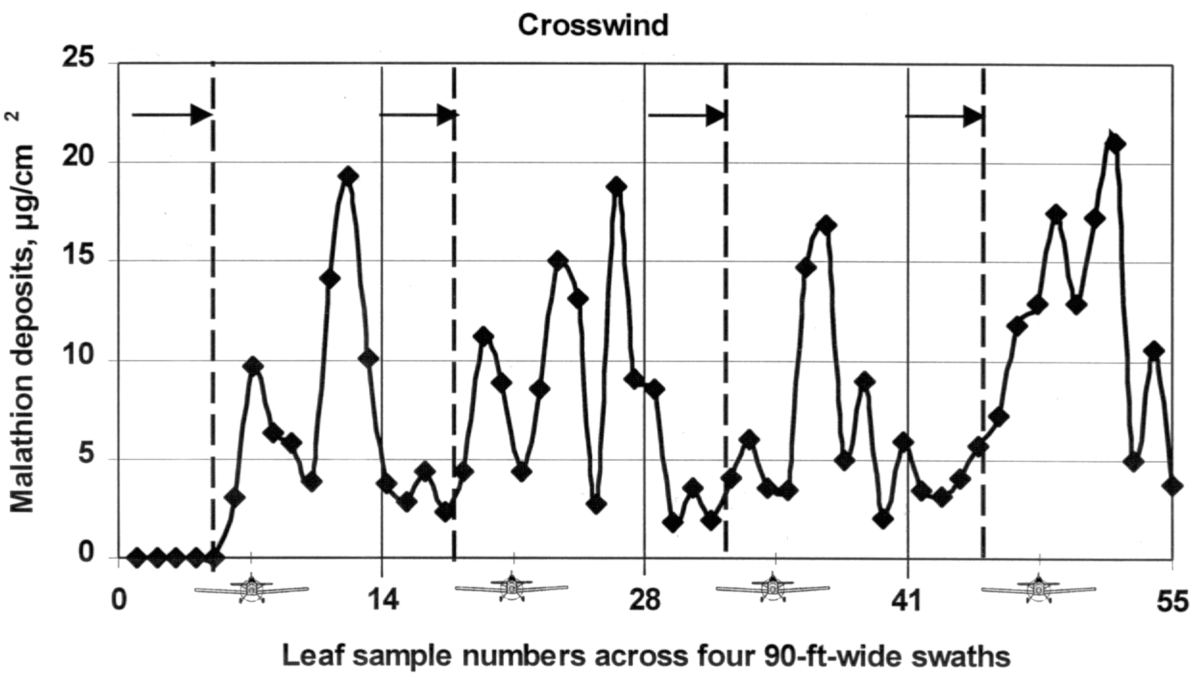


Figure 2. Deposits of ULV malathion on cotton leaves across four swaths both inwind and crosswind with an Air Tractor AT-402B. Aircraft are shown on swath centerline, and swath edges are marked with solid lines. Displaced swath edges on crosswind applications, shown in dashed lines, were estimated based on specified swath widths and measured deposits.

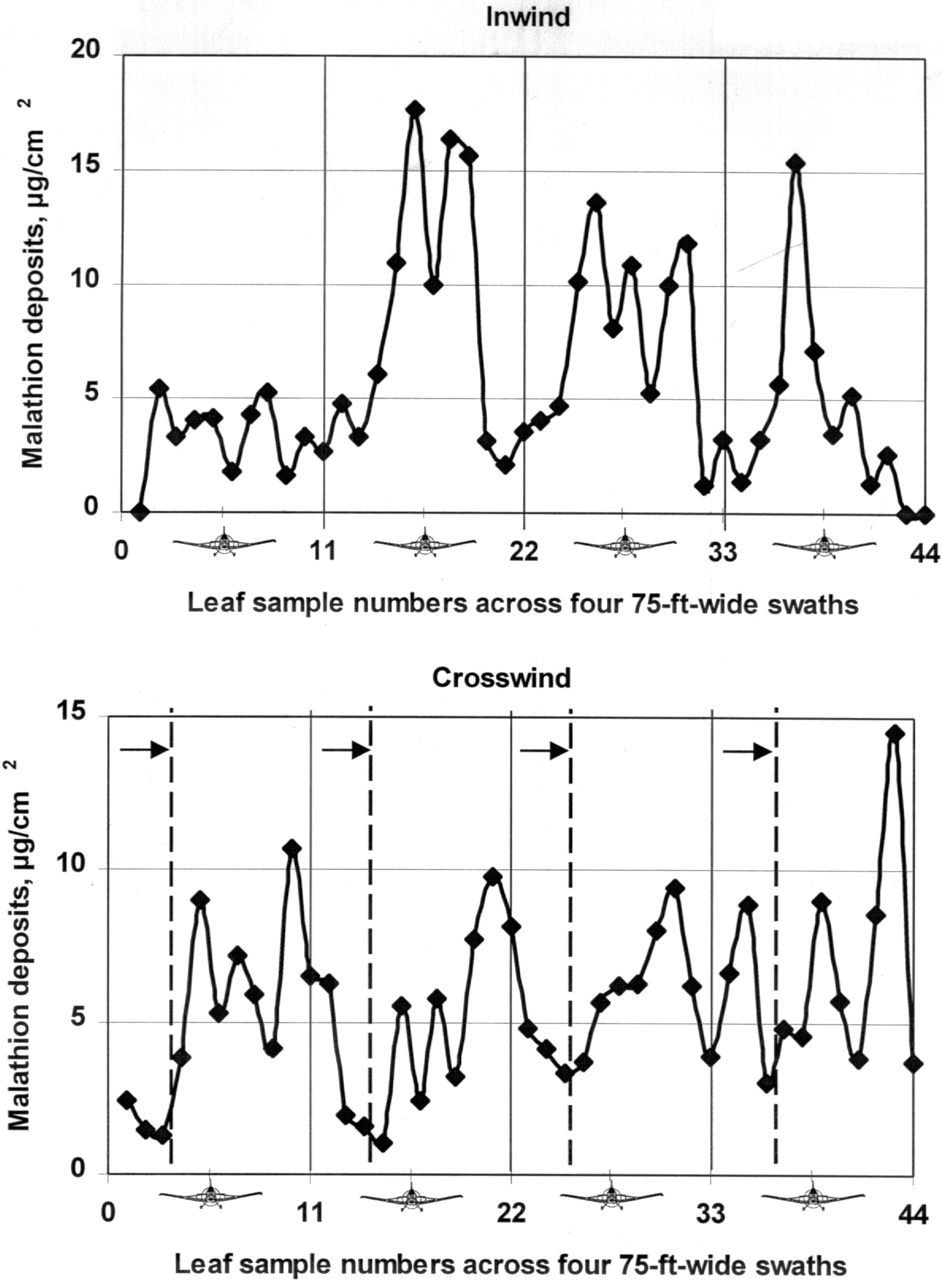


Figure 3. Deposits of ULV malathion on cotton leaves across four swaths both inwind and crosswind with a Cessna AgHusky. Aircraft are shown on swath centerline, and swath edges are marked with solid lines. Displaced swath edges on crosswind applications, shown in dashed lines, were estimated based on specified swath widths and measured deposits.