Air War Against Pests

by H. H. STAGE and FRANK IRONS

THE AIRPLANE holds a bright new hope in the farmers' uphill struggle with insects. Since 1922, when Department engineers and entomologists developed a practical method for dusting cottonfields with calcium arsenate to protect the crop against the boll weevil, commercial airplane dusting has become routine, particularly in cultivated fields that spread over a wide area unbroken by trees or shrubs. Later, and in a more limited manner, the airplane has been used regularly and effectively to control malaria-carrying mosquitoes and pests that destroy shade trees and timber in forests where spraying from the ground is difficult and expensive.

Working with State and commercial aircraft dusting companies and growers and, during the war, with the Army, Navy, and Coast Guard, the Department has found practical ways to spray plants and trees from the air and with the use of DDT to combat adult mosquitoes and other insects. Before these tests had been run no practical means for destroying adult mosquitoes over large areas was known. By using a quart or two of a 5-percent DDT solution per acre we can reduce the adult mosquito population by nearly 100 percent in wooded areas in a few hours.

Equipment for spraying can be installed easily in an airplane or a helicopter. In some designs the forward speed of the plane drives a small propeller attached to a pump, which provides the pressure needed to force the insecticidal solution from its holding tank through a special nozzle, or a series of nozzles, in the form of tiny droplets or a mist.

Several types of distribution apparatus were improved and simplified for military needs during the war. Many of these lend themselves readily to agricultural use. The forerunner of these more recently developed mechanisms for distributing baits and dusts for insect control was de-

scribed by a co-worker, Chester N. Husman, of the Orlando, Fla., laboratory—a hopper having a capacity of 29 cubic feet for installation in a biplane that is powered by a 285-horsepower engine with cruising speed of 90 miles an hour and can carry a pay load of 984 pounds.

In 1945 large aircraft, C–47's and B–25's, were used by the military as a means for dispersing insecticides mainly against mosquitoes and flies. The B–25 equipment consists of spray tanks of about 550 gallons capacity produced by connecting the standard fixed bomb-bay tank with the standard droppable bomb-bay tank. A sump valve connects the tanks with the dispenser and serves to regulate the flow. The end of the straight discharge-pipe dispenser is cut off at a 45° angle with its opening to the rear. The C–47 equipment consists of a standard A–26 droppable bomb-bay fuel tank of 625-gallon capacity. A manually operated control valve connects this tank with the straight discharge-pipe dispenser.

Investigations showed that the best conditions for running spray missions with the B–25 and C–47 equipment were as follows: Altitude of release of spray, 150 feet above ground or treetops; indicated air speed for B–25, 200 miles per hour; for C–47, 170 miles per hour; droplet size, 50 to 150 microns; wind velocity, 3 to 10 miles per hour; line of flight, crosswind or within 22.5° thereof; and a distance between lines of flight about 300 feet. In using the lighter types of aircraft, the pilot found it necessary to fly within a few feet of the crop being treated.

Early in 1943 tests were made in cooperation with the Tennessee Valley Authority. The first tests, in which a 20-percent DDT dust was used against disease-bearing mosquitoes, proved unsatisfactory because the hopper failed to feed the dust into the venturi and because there was an insufficient breaking-up of the dust particles by the air currents in the venturi. During September of that year in the vicinity of Stuttgart and Walnut Ridge, Ark., the entomologists used a 5-percent DDT dust successfully against *Anopheles quadrimaculatus* Say larvae in rice fields. Both Waco and Huff Deland planes were used. Somewhat later tests were made on military reservations near Orlando, Fla., with Cub and Stearman trainer planes equipped with a special portable hopper designed by Husman. In open areas a 90- to 100-percent control of *Anopheles* mosquito larvae was obtained. In tree-covered areas, however, the Cub plane was not powerful enough to create sufficient downdraft to force the dust to the water that contained the larvae.

A semiportable hopper for the J3–65 Piper Cub was designed for mounting in the rear-seat compartment without interfering with the pilot or controls. The hopper, venturi tube, and power unit are mounted by clamping metal clamps to fuselage members and wing struts. There are no structural changes or alterations in any part of the aircraft nor are there holes bored in any of the structural members. The hopper has a dust-sealed cover, and the cabin is provided with adjustable ventilators

to protect the pilot from dust while in flight. The hopper is so installed that as the weight of its contents changes, the center of gravity is still within the approved range. The venturi is held in place by bolting brackets which are mounted on the sides of the venturi to the brackets which are clamped to the lower longerons. The venturi is constructed of 24-gage galvanized iron or 0.065 aluminum.

Spraying Concentrated DDT From an Airplane

The use of concentrated DDT sprays dispersed from an airplane has proved very satisfactory when used over marshes for controlling mosquitoes, and over heavily forested areas for controlling tree-defoliating insects. One such spray is a simple one made by dissolving 5 pounds of technical DDT in 100 pounds of kerosene. This formula, used at the rate of 1 to 2 quarts an acre, has kept adult mosquitoes under control.

A portable spray unit for use on the L–4 (Army Cub), J3–65, and NE–1 Navy Cub planes was developed by Husman and O. M. Longcoy in October 1943. Since that time it has been used in many parts of the world as an effective and satisfactory device for dispersing DDT sprays. The unit, with a capacity of 25 gallons, was simple in design, with a venturi beneath the fuselage of the airplane. A half-inch gear pump, powered by a two-bladed, wind-driven propeller, forced the spray material through the nozzles. Six splatter-plate nozzles were attached to the spray boom near the outer and lower edge of the venturi. Each nozzle was provided with a No. 60 wire gage opening.

The gear pump operated at a pressure of about 50 pounds at an air speed of 70 miles per hour; delivery rate was about 2¾ gallons a minute.

A spray unit for the PT–17 Stearman airplane was a modification of the one designed for the L–4 series plane. The tank, however, had a capacity of 60 gallons and the venturi was considerably larger, also. A 4-bladed, 18-inch, wind-driven wooden propeller was mounted on the pump shaft to build up pressure in the lines. The spray boom, situated near the lower trailing edge of the venturi, consisted of 12 nozzles provided with No. 60 wire gage orifices with an operating pressure of 120 pounds; the delivery rate of the spray solution was 7¼ gallons per minute. The effective swath width was about 80 feet. The droplet size of the spray ranged from 3 microns to more than 200 microns.

Although the original portable spray units produced satisfactory results, there were a number of objections to them. It was desirable to decrease the weight and air resistance and to provide for more uniform distribution of the spray.

The first unit, constructed by Husman while on duty in the Pacific with the Navy, uses the same tank, pump, and wind-driven propeller. The venturi, however, is replaced by two breaker-bar spray booms, one

mounted under each of the wing struts. The booms are clamped to the wing struts just outside the slip stream. Each boom is 4 feet long and has 24 orifices the size of No. 71 wire. The space between the booms is 8 feet, 6 inches on an L–4 airplane. The spray booms are constructed of ⅜-inch (i. d.) aircraft tubing, the 24 orifices being drilled horizontally along the tube. A duralumin spray-breaker bar, ⅝ by ¼ inch, with a 5° convex face, is mounted on the tubing with a space of ½ inch between the tubing and the bar. Since the spray is forced out over a total length of 8 feet, it becomes dispersed through air turbulence caused by the plane. When 5⅗ gallons of solution are applied per minute, the dosage per acre is 2.32 quarts when the plane is flown at 60 miles per hour. At 70 miles per hour the dosage is 1.99 quarts an acre.

The breaker-bar sprayer has several advantages over the original spray unit and is the type now recommended. It is lighter than the original sprayer, and the absence of the venturi reduces air resistance. A wider swath, smaller droplets, and a more uniform distribution of the spray within the swath is also obtained. The droplet size ranges from 10 to 460 microns. Another advantage of this equipment is that the delivery rate and size of the droplets can be readily changed by having available several sets of tubing with different sizes and numbers of orifices.

To treat agricultural crops, uniform swath coverage and close control of dosage are prime essentials to insure effective and economical control. Also, the dosage must remain within limits of the plant tolerance to the spray. In 1945 a J3–65 Piper Cub was fitted with a spray unit at Toledo, Ohio, for insecticide applications for corn borer control. The unit was made portable so it could be easily installed or removed. This unit consisted of a liquid tank, ¾-inch gear pump with wind-driven propeller, pressure regulating relief valve, and nozzle booms. The booms, one on each side, were 11 feet long. They were supported by brackets from the wing struts which held them parallel to a line from the bottom of the fuselage and the wing tips. Each boom carried 11 conventional hollow-cone spray nozzles. The delivery rate was approximately 2 gallons per acre. A uniform swath 40 to 50 feet wide was obtained.

Spraying insecticides from aircraft is not the complete answer to the control of insects. In many instances ground methods of control remain more feasible. The field of application is broadening, however; today the airplane is regularly used to dust and spray forest and shade trees, fresh- and salt-water swamps, orchards, and many other crops.

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