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TESTS OF A LIGHT-WEIGHT *Mist Blower*

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COVER PICTURE

Treating six 30-inch rows of nursery stock with mist blower mounted 4 feet above the ground on a small tractor.

Tests of a Light-Weight Mist Blower for Row Crops, Small Trees, and General Uses

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Introduction

The idea of applying highly concentrated sprays in finely atomized form was tried by Potts in 1928, using an orchard duster to apply concentrated spray and oil-coated dust atomized into the air stream of a 4-inch diameter discharge pipe. This work was preliminary in nature. Inadequate air volume and velocity restricted the projection of either spray or dust to a height of 35 to 40 feet.

The writers' investigations of the fundamentals of concentrated spray application have resulted in the development and modification of a number of machines of various types and sizes (7). These include hand atomizers (2, 4), nozzles for knapsack sprayers (5), a knapsack mist blower, a small 1 to 2 h.p. wheelbarrow and skid model mist blower (8) and various sizes of medium to large shade tree and orchard mist concentrate machines (1, 7). Also included are contributions to the development of so-called low gallonage non-blower type equipment (6) using nozzles with small orifices, spaced on booms or row cultivators, for applying herbicides and insecticides to fields of small grain, pastures, and row crops. A machine of this type was developed and tested by Potts in 1940 (2) on pastures and row crops to control white fringed beetles and truck crop insects. During the past 5 years over 70 million acres have been treated with low gallonage rigs and at least 300,000 machines of various types have been built.

The popularity of these non-blower concentrate rigs has been due to their low cost, light weight, and simplicity. However, they have the following limitations: (a) they cannot treat trees and are restricted to low growing vegetation; (b) the finest spray has droplets averaging 75 microns or greater in diameter compared to the optimum drop diameter of 40 to 50 microns (3); and (c) they cannot apply wettable powder suspensions through small orifice nozzles without too much clogging. When the size of the nozzle orifices are increased to 1/16 to 1/8 inch in diameter to apply suspensions, the spray is too coarse (200 to 400 microns drop diameter) and the gallonage delivered per acre is too great for maximum economy. According to Wilson (9), information so far obtained does not justify the use of concentrates greater than 5x concentration (30 gallons per acre) when applying the coarse spray with non-blower equipment for vegetable disease control.

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The available shade tree and orchard type mist blowers are not well adapted for treating row crops, in addition to being too large and expensive. However, the air blast or mist blower type of machine does offer certain distinct advantages over the above low pressure type of equipment by being capable of (a) applying suspensions, (b) producing finer atomization, and (c) utilizing an air blast to carry and spread the spray stream and to agitate and penetrate the foliage. These features make possible a deposit of more insecticide on the undersides of the leaves, better coverage, and the use of fewer gallons of mixture per acre.

Moreover, there has been a need for a light, multi-purpose mist blower in the 5 to 8 h.p. class which would apply concentrated spray materials efficiently and which could be readily mounted on farm tractors, small trailers, and pick-up trucks. Such a machine, weighing about 200 pounds empty, has now been developed. Its capacity of about 1,500 cubic feet of air per minute at 150 miles per hour velocity, is not enough to spray properly shade trees taller than 40 feet, or orchards of large area. However, the construction and design should adapt it for many uses, including the spraying of row crops, nurseries, low shade and ornamental trees, shrubs ,small orchards, grapevines and blueberries and also for broadcast spraying and mosquito control.

The specifications and needs for making this machine were made known to commercial companies. This resulted in 1949-50 in the construction of a machine according to our specifications by the Homelite Corporation. This paper discusses tests made of the operating efficiency of this mist blower using its various attachments, together with some results obtained against certain pests.

Figure 1. Mist blower mounted on a small tractor with the outlet five feet above the ground for treating row crops. From this position the fish-tail outlet can be used as well as the triple round outlets shown in the figure.

Spray Delivery, Deposit and Drop Size Tests

To determine the machine's spray delivery rate and to test it for efficiency of operation, a number of mixtures were applied at different pressures through various types of nozzles and nozzle orifice sizes at rates ranging from 2.5 to 40 gallons per acre (Table 1). The data in this table are for a triple round outlet (Figure 1) with one nozzle in each of the three outlets. Two cone-type oil burner nozzles with different orifice sizes and the No. 1 Whirljet nozzle have been used at different times for solutions and emulsions. The oil burner nozzles are pointed in the direction of the air blast or at an angle to it, but never directly against the air blast.

TABLE 1. THE VOLUME OF SPRAY MIXTURE DELIVERED PER ACRE USING THE TRIPLE OUTLET AT A SWATH OF 15 FEET AND 2.25 M.P.H. TRAVEL.

Nozzle	Pressure (p.s.i.)	Gallons per acre	Kind of mixture
Monarch oil burner nozzle F80 No. 6.00	50	2.5	25% kerosene emulsion
"	36	1.5	"
"	22	1.0	"
Monarch oil burner nozzle F80 No. 12.00	50	5	"
"	36	3	"
"	22	2	"
No. 1 Whirljet	35	12	"
"	15	8	"
"	12	6	"
No. 2 Whirljet	40	28	Suspension of 1 pound of talc per gallon of water.
"	35	24	
"	12	16	
"	10	12	"
No. 3 Whirljet	40	40	"
"	35	35	"
"	12	18	"

Table 2 gives the drop diameters obtained when an oil of 45 seconds Saybolt viscosity is applied with various nozzles at 30 pounds pressure. Table 3 gives a comparison of swath width, number of droplets deposited per square millimeter, and the drop diameter for the triple round outlet as compared to the fish-tail outlet.

TABLE 2. NUMERICAL DROP DIAMETER OBTAINED AT 30 P.S.I. WITH DIFFERENT TYPES OF OUTLETS AND NOZZLES WITH ENGINE GOING AT FULL SPEED. (DROPS CAUGHT ON MICROSCOPE SLIDES)

Type of outlet	Nozzle	Drop diameter (microns)
Single 5″ dia. outlet	No. 1 Whirljet (cone type)	38
"	No. 2 "	44
"	No. 3 "	50
"	No. 5 "	55
Triple round outlet	No. 1 "	45
"	No. 2 "	52
"	No. 3 "	60
Large fish-tail outlet, 3 nozzles	8001 Teejet (flat type)	70
"	8002 " "	82
"	8003 " "	88
"	8004 " "	96

TABLE 3. Comparison of Swath Width and Number of Droplets Per Square Millimeter for the Triple Round Outlet Versus the Fish-tail Outlet With 20 P.S.I. at 3 M.P.H. Travel, When Applying a 25 Per Cent Oil Emulsion, Slides One Foot Apart.

Outlet type and nozzle	Average drop diameter microns	No. droplets per sq. m.m.																								
		Slide no.																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Triple, round, with No. 2 Whirljet nozzles	53[1]	*Effective swath, about 15 feet*																								
		0	0.3	2.3	6	7	13	22	26	15	17	24	17	27	23	16	26	22	14	21	15	5	7	3	1	0
Fish-tail with No. 8002 Teejet nozzles	82[2]	*Effective swath, about 10 feet*																								
						0	1.2	3	8	10	13	9	14	10	13	9	10	8	7	4	2	0				

[1]Range, 8 to 165 microns.

[2]Range, 25 to 245 microns.

Application of Insecticides to Row Crops

For treating tomatoes and beans the machine was mounted on a Farmall cub tractor (Figure 1) with its base 3 feet above the ground. This places the mouth of the outlets about 5 feet above the ground. The triple outlet was used with one No. 2 Whirljet nozzle in each outlet. It was pointed towards the ground at an angle of 15 degrees from the horizontal so that the air blast reached the ground at a distance of 10 to 12 feet from the sprayer. Twelve pounds pressure was required to deliver 6 gallons of mixture per acre at 2 1/4 miles per hour travel. This covered the area at 4.2 acres per hour with a swath sufficient to cover three 5-foot rows or five 3-foot rows. Visual observations indicated good coverage of sprayed vines as well as of glass slides that were placed on the ground and suspended among the plants. For best coverage of taller plants it was found advisable to raise the machine on the carriage vehicle because the mouth of the outlet should be at least 2 1/2 feet above the tops of the plants.

Towards the end of the season the rank growth of tomato vines completely covered the area between the rows. Therefore, since no vine lifters were available, a very late treatment could not be made without appreciable plant damage. A partial solution of this problem seemed to be the treatment of 30- to 35-foot strips (swaths) from two opposite sides, using the single, round outlet (Figure 2), with the machine traveling 1.5 m.p.h. In this procedure the outlet discharges at right angles (perpendicular) to the line of travel of the mist blower. This reduces vine damage by about half. A better remedy, when using the single outlet in the above manner, would be to leave unplanted one tomato row in every six or seven to serve as a roadway for the machine.

Figure 2. Treating nurseries with the machine mounted in a half-ton truck, using a single, round outlet.

Table 4 shows the degree of effectiveness of certain mixtures applied to control the potato aphid (*Macrosiphum solanifolii*) on tomatoes. Table 5 indicates the degree of Mexican bean beetle (*Epilachna varivestis*) control, on four 1/4-acre plots of beans. In addition, a 1/4-acre bean field infested with adults and larvae was treated with proprietary emulsion[1] at the rate of 8 ounces in 6 gallons of water per acre. This application gave approximately 95 per cent control and was more effective than the methoxychlor treatment. A sample consisted of four properly distributed replicates. Each replicate represented 20 linear feet of row.

TABLE 4. REDUCTION OF APHIDS (*Macrosiphum solanifolii*) ON TOMATOES BY THE APPLICATION OF CONCENTRATED SPRAYS, USING THE TRIPLE ROUND OUTLET AND A TRACTOR SPEED OF 2.25 M.P.H.

Field No.	Material applied in 6 gallons of water per acre	Number of aphids per sample of leaves before treatment	Per cent reduction in number of aphids in treated as compared to check, 3 days after treatment
1	1 pint of 40% nicotine sulfate 6 lbs. of copper oxychloride	2250	75
2	2 pints of 40% nicotine sulfate 6 lbs. of copper oxychloride	2700	86
3	1 pint of 40% hexaethyltetraphosphate 6 lbs. of copper oxychloride	3250	99
4	1 pint of 20% lindane emulsion 6 lbs. of copper oxychloride	2650	97
5	1 pint of 20% lindane emulsion 6 lbs. of copper oxychloride	1850	95
Check	No treatment	2850	0 (3000 aphids per sample)

TABLE 5. MEXICAN BEAN BEETLE (*Epilachna varivestis*) POPULATION BEFORE AND AFTER TREATMENT IN 4 PLOTS TREATED AT THE RATE OF 4 POUNDS OF 50 PER CENT METHOXYCHLOR WETTABLE POWDER IN 6 GALLONS OF WATER PER ACRE AND A TRACTOR SPEED OF 2.25 M.P.H.

Plot No.	Total number of bean beetles in four 20-foot linear samples						Per cent increase in defoliation 10 days after treatment
	At time of treatment			10 days after treatment			
	Adults[1]	Egg masses	Larvae	Adults[1]	Egg masses	Larvae	
1	13	4	76	1	0	2	0
2	3	12	104	0	1	3	0
3	24	7	189	4	1	7	0
4	15	9	217	2	0	10	0
Check	10	6	122	12	23	380	20

[1]Includes pupae.

[1]Dilan—a mixture of 1 part of 2-nitro-1, 1-bis (*p*-chlorophenyl)-propane with 2 parts of 2-nitro-1, 1-bis (*p*-chlorophenyl)-butane.

Treatment for Nursery Pests

For treating row plantings of nursery stock 3 feet or less in height, the blower was mounted on a small tractor about 4 feet above the ground, with the triple outlet pointed towards the ground at an angle of about 15 degrees (see cover picture). This angle may be slightly increased or decreased with increase or decrease in the height of the machine above the plants.

Five 36-inch rows or six 30-inch rows have been covered with the machine traveling 2 to 2 1/2 miles per hour. Coverage has been good at this tractor speed with winds up to 12 miles per hour. When the wind dropped to less than 10 miles per hour, five 30-inch rows (or four 36-inch rows) could be covered at 4 miles per hour travel.

Where the plants were more than 3 feet tall, it was necessary to use the round outlet and treat strips of rows from two opposite sides. Strips up to 30 feet in width can be treated with this machine (Figure 2).

Red Mite Tests in Nurseries

During 1950 and 1951, 16 plots comprising about 12 acres of nursery stock of arborvitae, hemlock, spruce and yew were treated with the miticide mixtures listed in Table 6 for control of the spruce mite (*Paratetranychus ununguis* Jacobi) and the two-spotted mite (*Tetranychus bimaculatus* Harvey).

Aramite, *Ovotran* and *Dimite* gave about the same results at the dosages listed in Table 6. A combination of *Ovotran* with *DMC* was superior to either compound applied alone, and was effective for an entire season with one application. The emulsifiable concentrates of *Aramite* and *Ovotran* were less apt to clog fine nozzles and were compatible with a greater variety of insecticides than the powdered forms.

TABLE 6. MITE CONTROL ON NURSERY STOCK.

	Per acre quantities		Per cent reduction in mites over check after 5 days
I	*Aramite*[1] (50% emulsifiable concentrate)	2 pints	95
	Kerosene	2 quarts	
	Water to make 6 gallons		
II	*DMC*[2] (25% emulsifiable concentrate)	2 quarts	93
	Water to make 6 to 8 gallons		
III	*Ovotran*[3] (20% emulsifiable concentrate)	5 pints	92
	Water to make 6 to 8 gallons		
IV	*DMC*[2] (25% emulsifiable concentrate)	3 pints	98
	Ovotran[3] (20% emulsifiable concentrate)	3 pints	
	Water to make 6 to 8 gallons		
V	*Aramite*[1] wettable powder containing 15% *Aramite*	7 pounds	86
	Water to make 6 to 8 gallons		

[1]Butylphenoxyisopropyl chloroethyl sulfite.
[2]Di (*p*-chlorophenyl) ethanol.
[3]*p*-Chlorophenyl *p*-chlorobenzenesulfonate.

Emulsifiable DDT was used for control of scale insects (*Lecanium fletcheri* and *Pulvinaria floccifera*), strawberry root weevil, black vine weevil,

the gypsy moth and Japanese beetles in combination with the above miticide mixtures in quantities up to 2 pounds of actual DDT per acre without causing an appreciable build-up of mite population.

The most practical volume of mixture for applying a given quantity of insecticide per acre of nursery stock varies more with the size, activity, and habits of the pest to be controlled than with any other factor. For average conditions, estimates of the number of gallons of mixture per acre suggested for the following pests are as follows: gypsy moth, 2; Japanese beetle, and gross feeders, 3; red mites, 6 to 8; and scale insects, mealy bugs and small inactive forms that live at the lower part of the tree on or near its trunk, 10 to 15.

Figure 3. Treating peach trees with the machine mounted 2 feet above the ground so that the fish-tail outlet can deliver spray from a low position.

Summary

Tests were made of a light weight, 6 h.p. mist blower designed for use on row crops, small trees, and for general applications that do not require a more powerful machine.

The spray delivery rate and drop size produced was determined for several different pressures, outlets, and nozzle types and sizes. At the same spray delivery rate, a triple round outlet equipped with cone type nozzles gave an effective swath of 15 feet for row crops compared to 10 feet for a fish-tail outlet equipped with fan type nozzles. For the triple round outlet combination there was an average deposit of 19 droplets per square millimeter, averaging 53 microns in diameter. For the fish-tail outlet the deposit averaged ten 82-micron-diameter droplets per square millimeter.

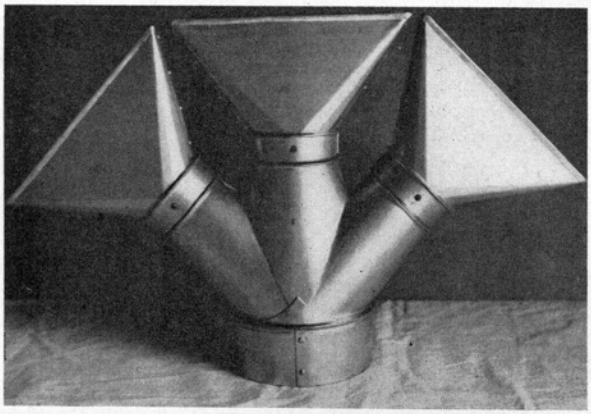

Figure 4. A triple fish-tail outlet giving a 180 degree included angle of spread. The three fish-tail outlets are attached to the three round outlets shown in Figure 1 for treating close plantings of low trees.

The machine was usually mounted on a small tractor when treating rows of vegetables and nursery stock 3 feet or less in height. Its base was 3 to 3 1/2 feet above the ground and its outlet 5 to 5 1/2 feet from the ground (or 2 1/2 to 3 feet from the top of the plants) and pointing towards the plants at an angle of 15 degrees from the horizontal. When using the triple round outlet or the fish-tail outlet, the speed of travel was usually 2 to 3 m.p.h. giving a coverage rate of about 2.8 acres per hour for the fish-tail outlet and 4.2 acres per hour for the triple round outlet. The optimum travel rate for operating with a single 5-inch diameter outlet was approximately 1.5 m.p.h.

Good control was obtained of the potato aphid on tomatoes, the Mexican bean beetle on beans, and mites on evergreens.

For most row crops 5 to 10 gallons of mixture per acre were required. The number of gallons per acre suggested for the following pests are: gypsy moths, 2; Japanese beetle, 3; red mites, 6 to 8; scale insects, mealy bugs and small inactive forms, 10 to 15 gallons.

The results of these tests indicate that, in addition to row crops and nursery stock, the machine may be adapted for treating pests of small orchards,

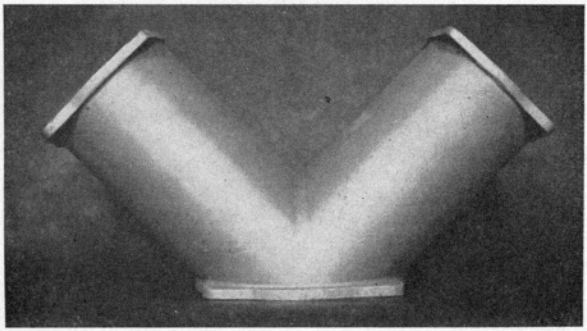

Figure 5. A double round outlet for treating one side of each of two rows of grapes with the machine traveling between the two rows. Two fish-tail outlets can be attached to the two round outlets to increase spread of spray stream close to the outlet.

small fruits, and grapevines when using special types of outlets (Figures 3, 4 and 5) that have been developed for such application. Visual spray coverage trials indicate that the single 5-inch diameter outlet is best for trees more than 12 feet in height. The fish-tail outlet (Figure 3) may be used for lower trees. For treating grapevines (Figure 5) a Y-shaped, double round outlet with 70 degree included angle of spread should provide better coverage than fish-tail types.

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