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MISTBLOWING AND MISTBLOWERS

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The cultivation of a healthy crop has always been the intention of the grower and only when compelled by necessity does he apply chemicals and other means to control pests and diseases of plants.

Therefore it is evident that he will try to control or better to prevent the pests and diseases with the least poisonous means in the smallest quantity at the lowest cost.

Dr Fraser has already given us an excellent survey of the mechanics of producing sprays, while Dr E. Holmes at the first International Plant Protection Conference at Fernhurst put forward the development of the mistblower (air-blast low-volume sprayer) for field crops and drew our attention to the much cheaper hydraulic low-volume sprayers with their more limited purpose.

I should like now to draw your attention to the possibilities of the *mistblower* for orchards, especially on small enterprises, as they are the most numerous in the world.

Other speakers have already dealt with the more usual means of spraying, so it is not necessary for me to enter into that subject again, nor into the value and the quality of spreaders and stickers. The *speedsprayer* came into use in the USA as early as 1937. This gave already an important labour-saving. Because the good is the enemy of the better, as has often been proved, the mistblower did not come so quickly into further application in the USA in spite of the research of Potts, Spencer and others. In the Netherlands, where the *speedsprayer* was almost unknown, the *mistblower* has been tried for the first time after the war in 1948. After adapting the working method with a tenfold concentration the employment of the hand-operated mistblower, and in the last few years also that of the automatic mistblower, increased quickly in the Netherlands. Now the mistblower is to be considered as the greatest improvement in the technique of pest and disease control of the last decades.

Returning to the fundamental side of plant protection, we can state that the poisonous materials have to be brought to the plant or into the soil in such a manner that at all places where the parasites may attack the plant, a just sufficient quantity of poison, necessary for the control, is applied.

It follows that in general one has to try to distribute the poison as equally as possible and preferably in the smallest particles.

Supposing that by mistblowing the diameter of droplets is in average $\frac{1}{2}$ of those when working with the sprayer, this means that with the same volume of liquid the number of particles has become $(2.5)^3$ times as large. The surface, which *one droplet* covers, decreases to $(2.5)^2$. The surface, which will be covered by all droplets when mistblowing increases $(2.5)^3 \times (\frac{1}{2})^2 = 2.5$ times in comparison with the surface covered by the larger droplets when spraying.

Then we may accept that the chance of contact has increased about 15 times.

In spraying full-grown orchards one uses 200-400 gal./acre, in mistblowing only 10-20 gal./acre. The reason for this great difference is partly that by

using the tenfold higher concentration the chance of run-off is much smaller than in spraying and the particles remain as separate droplets on the plants. By the avoidance of run-off and the better sticking of small droplets, the quantity of poison on the plant will be about the same in both methods.

The resulting protection is in both cases nearly identical. In mistblowing the tenfold higher concentration and the lower quantity of liquid ($\frac{1}{15}$ to $\frac{1}{20}$) give a saving of 30-50 per cent of the quantity of poison and 90-95 per cent of the quantity of water. Moreover one saves labour and transport costs of materials.

The *spraying method* differs considerably when working with sprayguns or with hand-operated mistblowers. In using the hand-operated mistblower in orchards, as was worked out in the Netherlands by Bezemer, Houter, and Wegenaar, the tree is taken as the unit. It is this difference, besides the exact time of mistblowing and the composition of the chemicals, which has proved in our country the success of the mistblower. Although some suggested that the good results of the hand-operated mistblower were a result of the moving outlet, in our orchards it was proved that with a stationary outlet an even better penetration was reached. In automatic mistblowing one takes the row as the unit.

The most important point, when applying pesticides to crops, is that the drops reach the leaves and branches and stick there. Whether they get there depends mainly on the energy with which they are projected against the leaves in spraying and on the air-speed and the size of droplets in mistblowing. With increasing droplet size, greater air-speed and less obstruction, the chance that the drops will settle down is also greater, as follows from the research of Brooks. Thus he finds for droplets of 40μ on cylinders $\frac{1}{2}$ inch in



diameter with an air speed of 2½ m.p.h. a catch of 30 per cent and at 72 m.p.h. nearly 90 per cent. With droplets of 100μ the catch at 2½ m.p.h. was already more than 70 per cent and at 18 m.p.h. nearly 90 per cent. If the cylinder has a diameter of ½ inch the catch of droplets of 40μ at 2½ m.p.h. was 66 per cent.

In general the efficiency of the control depends on the thoroughness of coverage of the plants by the chemicals. The degree of coverage depends again on number and diameter of the drops. With a certain quantity of liquid to be sprayed, a dispersion into smaller drops will give a better coverage than dispersion into large drops.

To classify a mist, it is necessary to specify the diameter of the droplets.

The diameter is found from the ratio: $\frac{\sum nd^3}{\sum nd^2}$ in which n is the number of droplets in a certain diameter-series and d is the average diameter of this series. The sizes are determined experimentally.

The uniformity of the spray-nozzle is determined by the ratio

$$\frac{\sum nd^3 : \sum nd^2}{\sum nd}$$

In experiments for the OEEC with knapsack sprayers with mist nozzles our testing department found a ratio of about 3. In Holland a spray nozzle is accepted when this ratio does not exceed 4. Little drops follow the air-stream more easily and give less deviation of their course, so they reach the leaves with more rapidity than larger drops (Brooks). It is known that on branches and needles of firs and the like, one can work with a smaller droplet-size than on a leafy tree. With no wind and in woods, moreover, a smaller size of droplets may suffice. In the Netherlands, which has a very windy climate especially along the sea-coast, this is not possible. This can also be concluded from the research of Brooks. He states that by the blowing away of drops horizontally at a falling height of 10 ft. with a wind-speed of 3 m.p.h., the drift amounts to 4 ft. for drops of 2 mm. (excessive rain); 5 ft. for drops of 1 mm. (moderate rain); 7 ft. for drops of 500μ (light rain); 19 ft. for droplets of 200μ (drizzle); 48 ft. for droplets of 100μ (mist); 409 ft. for droplets of 33μ (cloud); 3-4 miles for droplets of 5μ (sea-fog). From this it follows that fogging is often inefficient, because the minute droplets drift away on air-currents without being deposited.

From these facts, and those concerning the air speed necessary for the sticking of droplets on leaves, it follows that even with a breeze, the wind speed at the place of settling has to be about 11 m.p.h. and near the outlet considerably higher, unless the trees are very small or the outlet very large.

The thoroughness of coverage in mistblowing is illustrated by the following example.

Using 20 gal./acre at average drop-diameter of 80μ (i.e. 3,900 drops from 1 mm.³) and spraying a plant surface five times the ground surface, about 10,000 drops may be deposited on a sq. inch. Even if the average deposit is only ½ of this, this means about 500 drops on a cm.² leaf surface. So the average drop-distance (unprotected space) is about 380μ. Assuming ¾ of the quantity is deposited on the plant then the average distance between the drops will be about 250μ and the coverage about 5 per cent. In practice this seems to be sufficient, because we got in our apple orchards a very

good control by using 20 gal./acre both with insecticides and with fungicides.

Concerning the types of mistblower, in principle those will be the best which give the largest quantity of air with sufficient speed (pressure) with the least energy. Because the diameter of the air stream also plays a part, there will be a compromise between the diameter of the air stream and the air speed in getting a certain penetration. The latter is dependent on the speed of working (moving of the mistblower) and on the temperature conditions.

On the one hand the air stream of the mistblower serves as a transport medium for the drops; on the other hand it serves as a means of producing drops. The production of drops is obtained in several ways, as Mr Fraser has already stated. From Mr Feis' studies in our Institute it is to be expected that the best results can be obtained in expelling a liquid film by an air stream.

It has been proved that the counting of droplets should not be done in a simple way such as counting the drops on glass plates under the microscope. As with other methods the main objection is that besides the catching surface evaporation also plays a part. Moreover it takes a lot of time. Therefore at the Institute of Horticultural Engineering an electronic counting apparatus was developed by Burgstein, Feis and Businger. Herewith it is possible, as by the earlier-developed instrument of Courshee at the NIAE, to measure the chords of droplets automatically and to count the drops in classes.

We now come to the *economic comparison* of the most important spraying methods. For this purpose one can best use a full-grown apple orchard of nearly 80 trees/acre.

1. With an *ordinary sprayer* one sprays an average of $\frac{1}{3}$ acre per man-hour. The capacity of the pump is 15 h.p., three men are spraying.
2. With a tractor with a *hand-operated mistblower* (one man at the tractor, one spraying), 1 acre per man-hour is done.*The capacity of the sprayer amounts to 5-12 h.p., that of the tractor to 10 h.p.
3. With a *speedsprayer with air-propeller* one sprays $2\frac{1}{2}$ acres per man-hour (tractor-driver has to ride and fill). The capacity of the pump is 15 h.p., that of the tractor 24 h.p.; driving of the air-propeller demands 20 h.p.
4. With the *automatic mistblower* this is 5 acres per man-hour. Capacity of the pump is 2 h.p., of the ventilator 10 h.p. and that of the tractor 18 h.p.

In mistblowing a banana plantation for the control of the Sigatoga disease, with the KWL (Kiekens-Whirlwind-London) mistblower giraffe, drawn by a crawler, a capacity 10-25 acres a man-hour was reached.

Table 1 overleaf gives a comparison of the different types of blowers and sprayers for an orchard of 25 acres with 12 spray applications a year.

If one assumes a production of 16,000 pounds of apples per acre at a price of 4d. a lb. for the first grade; 2d. a lb. for the second grade, then 10 per cent less control on 25 acres means a loss of $1,600 \times 2d. \times 25 = \text{£}333 \text{ 6s. 8d.}$ as well as a bad name for the grower.

In summarizing I may repeat that we assumed as our purpose to carry out the controlling of pests and diseases with as little energy and pesticides as possible. In order to get this result we tried to increase the concentration and to reduce the droplet-size.

APPLYING CROP-PROTECTION CHEMICALS

TABLE I

Type of sprayer and price	High pressure sprayer fl. 4500	Speedsprayer with airpropeller fl. 7900	Hand-operated mistblower fl. 4800	Automatic mistblower fl. 5400
Depreciation 10 per cent	fl. 450	fl. 790	fl. 480	fl. 540
Interest $3\frac{1}{2}$ per cent of	95	165	100	115
Maintenance/repairs	100	sprayer fl. 100 set fl. 200	100	60
		300		
Fixed cost of the sprayer	645	1255	680	715
Fixed cost of the tractor	360 h. @ fl. 2,50 900	180 h. @ fl. 2,50 450	170 h. @ fl. 2,50 425	120 h. @ fl. 2,50 300
Fuel for the tractor	360 h. @ fl. 0,70 250	180 h. @ fl. 0,70 125	170 h. @ fl. 0,60 100	120 h. @ fl. 0,60 75
Fuel for the set		$180 \times 2\frac{1}{2} \times$ fl. 0,22 100		
Spraying-liquid	120×3500 \times fl. 0,01 4200	120×2500 \times fl. 0,01 3000	120×200 \times fl. 0,10 2400	120×200 \times fl. 0,10 2400
Labour at fl. 1,50 an hr.	$3 \times 360 \times$ fl. 1,50 1620	$180 \times$ fl. 1,50 270	$2 \times 170 \times$ fl. 1,50 510	$120 \times$ fl. 1,50 180
Total costs	fl. 7615	fl. 5200	fl. 4115	fl. 3670
Cost half-year	fl. 762	fl. 520	fl. 412	fl. 367

fl=Dutch Florin=1.88 shillings

In mistblowing half the amount of poisonous materials is used, due to the absence of run-off and the better deposition of the drops. Moreover labour is also much reduced, on account of the transport of less liquid.

In automatic mistblowing labour is again halved.

We may expect that mistblowing will be applied more generally in the near future, in spite of the fact that working with smaller drops has the disadvantage that the chance of deposition gets relatively smaller.

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