REPORT ON A WORKING-PARTY ON MIST-BLOWERS, 14th APRIL 1961.

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The use of motorized knapsack mist-blowers for spraying tea is becoming increasingly popular and it was felt that a meeting between planters using the machines, the firms selling them, and T.R.I. scientists, would be opportune. The object of the meeting was *not* to inform planters in general about this development, but to provide a forum for discussion and to clarify the issues; hence the number invited to attend was limited. The meeting, convened by Messrs A. L. Elias and J. E. Cranham, was held at Radella Club on April 14th, 1961, from 9.00 a.m. to 12.30 p.m. under the chairmanship of Dr D. L. Gunn, C.B.E., Director, T.R.I. and included members of the Experimental & Estate Committee of the T.R.I. and office-bearers of Radella Club. About 50 people attended. A demonstration of mist-blowing was arranged by the T.R.I. on Radella Estate and the various machines displayed by firms were examined and discussed.

We report herewith the information and views put before the meeting by Dr D. Mulder, Mr A. L. Elias and Mr J. E. Cranham; information on the machines kindly supplied by the manufacturers; the discussion; and the conclusions reached.

Machines

The commercial firms represented at the meeting, the machines displayed, and the manufacturers, are given below.

1. Messrs Shaw, Wallace & Hedges Ltd., P.O. Box 137, Colombo.—the 'Hurricane' and 'Hurricane Minor' (Cooper, Pegler & Co., Ltd.)

2. Messrs A. Baur & Co., Ltd., P.O. Box 11, Colombo.—the 'Micronizer 26' (Birchmeier et Cie, Switzerland).

3. Messrs United Tractor and Equipment Ltd., P.O. Box 343, Colombo.—the 'Motoblo 60' (Kent Engineering & Foundry Ltd., U.K.).

4. Messrs Mackwoods Ltd., P.O. Box 91, Colombo.—the 'Kinkelder' (Machinefabriek de Kinkelder, Holland).

5. Messrs Chatham House Ltd., P.O. Box 743, Colombo.—the 'Boss' and the 'Gnome' (Carl Platz G.M.B.H., W. Germany).

6. Messrs Raja & Peries Ltd., P.O. Box 856, Colombo.—the 'Unus' type F.R. 5 (Chiron Plant Protection Equipments, W. Germany).

7. Messrs Pest Controllers, York Building, York Street, Colombo 1.—the 'K.W.H.' type 25 (Technical Lloyd Ltd., Holland).

Information on these machines was given to the meeting. Some of the salient features are listed in Table 1 (p. 209). The costs of these machines varied from Rs 735/- to Rs 950/-, excluding discounts. All machines can be converted for dusting. Evidence on the life of machines was slender; the life of one make of machine was estimated at 3,000 working hours and another at "five years if well maintained".

Mist-blowing for blister-blight control—D. Mulder

Mist-blowing as it is carried out in other countries has achieved two things: first, a 90% saving on the volume of water used; and second, a 30–50% saving on the quantity of fungicide.

In blister-blight control, the volume has been brought down by 80%, by mist-blowing 2 gallons instead of spraying 10 gallons per acre. The quantity of fungicide used has so far stayed the same. What are the essential characteristics of mist-blowing that have enabled us to achieve such savings? They are basically that, firstly, the fungicide is carried by the air stream over a much larger area; and secondly, the droplet-size is further reduced.

These two facts lead to a much more uniform spread of the fungicide than can ever be achieved by pressurised knapsack sprayers. Uniform spread is really the critical point in our present way of spraying and this was elucidated by small-scale blister-blight trials in 1960, which showed that, on plots of 200 bushes, spraying at the rate of 2 oz per acre was almost as good as spraying at the rate of 6 oz per acre (Fig. 1, p. 210).

The range of size of spray droplets produced by a machine is important. The useful droplet-size range is chiefly 50–100 microns in diameter (a micron is 1/1000th of a millimetre). Droplets larger than this give insufficient distribution and coverage and droplets smaller than 30–40 microns tend not to impact on leaf surfaces at all but to drift away. Therefore the design of the nozzle in relation to the air output and speed is all-important. Clearly, the nozzles on these machines vary somewhat in form and in the droplet pattern they produce. We do not have facilities at the T.R.I. to study the agricultural engineering aspect of this and therefore we rely on the manufacturer to give us a reasonably correct droplet pattern. We can assess the practical result in spray distribution and in blister-blight control.

So much for what the machine should give us. Now let us see what happens when we use a machine in the field and in what way we can contribute towards the efficient use of it. Here we have to distinguish between control of insects and blister-blight control.

Blister-blight control is a peculiar job because we never aim at anything near eradication but we merely try to reduce the infection to about half or one-third of what it would be without control. So we are not doing a "thorough job" but just what is necessary to avoid too big a loss of crop. Depending on the carefulness and the training of the labourer, superintendents achieve this aim by using amounts of fungicides varying between 4 and 8 ounces per acre.

What will now be the new technique of controlling Blister Blight with a mist-blower? Has the labourer to behave in the same way in the field or is the technique of blowing a fungicide over the crop fundamentally different from the spraying technique?

According to experience with mist-blowers in other countries the fact that the fungicide is blown over a considerable distance changes the whole situation. To the movement of the labourer is now added the drift of the fungicide. With knapsack sprayers the fungicide is deposited in a rather small semicircle in front and to the sides of the sprayer. With mist-blowers, we can only make full use of the air current and obtain an even spread of the fungicide by clearly distinguishing between the two movements—the movement of the man and the movement of the air current. This can be achieved by assigning a separate task to each of them. The two movements should take care of the two dimensions of the rectangular area of several rows that we want to cover with fungicide. The forward movement of the man covers the length of the area and the movement of the fungicide covers the width of the rectangle. Therefore the blowing has to be done sideways and on one side only, depending on the direction of the wind. In this way we obtain the most uniform cover possible.

Blowing has to be done with the wind and not against it as far as that is possible in the field, in order to get the full benefit of the air current. Blowing against the wind produces too heavy a deposit on the nearest two or three rows and nothing on those further away. When the wind is strong, the fungicide drifts too far, on a single spray run, and gives too small a deposit over too many rows; but this is counterbalanced in a series of spray runs by the overlapping effect of the strong wind along the next set of rows.

With low-power mist-blowers, about six rows can normally be covered; with high-power blowers, 8–10 rows can be reached.

We have tried to illustrate the effect of sideways blowing and the result of swinging the nozzle in an arc by measuring the deposit on glass slides colorimetrically for both methods (Figures 2 and 3, pp. 211, 212).

It is only natural that the furthest rows should get less fungicide deposit than those nearby. It is our job to reduce this difference as far as possible; in other words the curve should be as flat as possible. If the curve has the form of Adam's Peak (Fig. 3), the method of spraying or the apparatus used is wrong. The best we can do is a kind of Pidurutalagala model as shown in Fig. 2.

The difference between the two methods can be judged from the difference in minimum spray deposit (+20 and +10 micrograms.)

For the moment it looks as if high-power mist-blowers are to be preferred because of the smaller droplet size they produce. It is possible that the droplet size of lower-power models can be improved by better design of the nozzle. There is however also a lower limit to useful droplet size because if the droplets are too small, they lose all their water by evaporation in the air before they settle and the resulting particles of fungicide either go up in the air like dust or fail to impact on a leaf but simply flow round it with the air.

Practical considerations—A. L. Elias

My earliest reaction to mist-blowers was prejudiced. It was said that the machines were excessively heavy and excessively noisy; that there was the risk of labourers falling over and getting burnt. I must say that, after a full season's spraying, I do not find any reason to believe in these ideas. From the purely practical view, the use of mist-blowers gave adequate protection against Blister Blight during periods of extremely adverse weather.

In order to achieve the maximum benefit from these machines, it was found that the following conditions applied:

(*a*) the use of a sunshine recorder, so as to spray only after an average of less than 4 hours sunshine for four consecutive days;

(*b*) a team of two machines and three labourers (able to complete 40 acres per day);

(*c*) the use of copper at a concentration of 4 oz per 2 gallons of water per acre sprayed in 12 to 15 minutes.

The output of liquid from each machine should be checked with a stop-watch and recorded. Output can be fixed at that desired by the use of restrictor jets fitted in the liquid feed pipe.

The organization of water-points in the field is important. It has been found that, with the use of plastic bottles (capacity one gallon), the third labourer can keep a constant supply of liquid by moving with the two spraying labourers.

When spraying, the machine should be used at full throttle with maximum engine revolutions to ensure maximum carry. The spray lance should be moved slowly across an arc from side to side and good use made of prevailing winds. The number of rows of tea sprayed at any one time will depend largely on wind velocity.

An important aspect is regular maintenance. Machines should be cleaned thoroughly after each day's spraying has been completed. The air filter should be removed and flushed out in a petrol-oil mixture. All plastic tubing should be checked periodically for cracks and the sparking plug cleaned occasionally. The tank should be flushed out with water daily.

Since decarbonization will probably be necessary at least annually, agencies selling these machines have been asked to provide this service. It is important that a full complement of spares should be carried by these firms. Certain essential spare parts, however, should be carried on estates.

A list displaying spare parts and the cost of individual items should be readily available to users of these machines. Some consideraton should be given to training operators in Colombo at the firm's cost.

Mist-blowing insecticides and dosage control—J. E. Cranham

The use of insecticides on tea is very much less than the use of copper fungicides, and we hope it will remain so. Nevertheless, for this smaller and restricted use, mist-blowers are likely to have more advantages over conventional knapsack sprayers, and to result in greater savings per acre, than they do with blister-blight spraying.

Our present recommendations for spraying insecticides against the various pests of tea with ordinary knapsack sprayers involve volumes of 50–100 gallons of water per acre. The usual principle with mist-blowing is that we employ the same dose of insecticide per acre at say 10 times the concentration in a tenth of the volume of water, *i.e.* 5–10 gall. per acre. Equally good if not better coverage of the crop is obtained because of the much larger number of smaller droplets, whose distribution is assisted by the air-flow.

I would straight away like to make very clear that mist-blowing insecticides is as different from mist-blowing copper fungicides as the two are different with conventional knapsacks. We are aiming at a high degree of control of most pests, say 95% or more; blister-blight spraying is in a sense palliative and aims at keeping infection below 35%. Also, we spray only one or two rounds of insecticide, not every plucking round as with fungicides. Consequently, spray coverage must be a great deal better, we must not miss a single bush; this means we take fewer rows at a time and we spray from both sides of the bush.

Now, I hold no brief for lashing insecticides about freely on tea. We have a most valuable inheritance of natural control of tea pests which is worth millions of rupees to the industry. This is another subject, and all I would say here is that there is about as much sense in *not* using pesticides on fields that are suffering severely from attack by pests, as there is in a man suffering from pneumonia refusing to use antibiotics. This leads me to the point: I feel certain that one reason why fields are often left to suffer is not the want of a known and tried cure, but the tediousness of the present spraying methods. In this, mist-blowers have the advantages of more rapid spraying and much smaller volumes of water required; because of the more rapid coverage, we have more choice as regards suitable dry days for spraying.

It is my view, therefore, that mist-blowing constitutes a considerable advance in rendering insecticide spraying on tea much easier.

Now, how far have we at the T.R.I. got with insecticidal mist-blowing? So far, we have in trial work on a field scale obtained highly satisfactory control of Nettle Grubs and of Tortrix with DDT, and of Yellow Mite with sulphur. Conclusions on other pests have not yet been reached, but I think it is very likely that the technique is suitable for the control of all pests of the flush and the upper maintenance foliage, including Lygus bug, *Helopeltis*, Red Spider Mite, and a number of caterpillar pests of tea and shade trees. It remains to be seen whether we can control a pest such as Scarlet Mite which is on the undersides of mature leaves. With regard to the use of dieldrin against Shot-hole Borer, our first trials have not yet yielded their full results, though initial results are promising.

We are not yet able to make any firm recommendations, though the information we have on this subject will be gladly given to planters, and we shall co-operate with those who want to use mist-blowers, as much as we can.

An important point, which does not seem to have received due attention, is the matter of dosage control. How are we to put the right dose on a given area? It is obvious that the spray output of the machine must be constant and the labourer must walk at a constant speed if the spray is to be evenly distributed. We have also found that the variable-dosage taps on many machines often in fact give a variable ouput at a single setting, and that the best system of fixing the output of the machine is to fit 'reducing jets' in the liquid-feed pipe, or to use interchangeable nozzles giving different outputs. The method of reducing jets is simpler. There should then be only a simple on-and-off tap on the lance and in this way the labourer is not able to alter the output whilst spraying.

First we decide on a spraying method and the number of rows of tea to be sprayed in one path with good coverage. Secondly we determine a reasonable working speed for the labourer which is usually between 15 and 45 yards per minute (say ½ to 1½ m.p.h.). We can then work out as a guide the theoretical time to spray an acre from the formulae:

(i) Rate of coverage (sq. yd per min) = speed of walking (yd per min) x no. of rows at a time x row spacing in feet ÷ 3.

(ii) Time for spraying one acre (min) = 4,840 sq. yd ÷ rate of coverage (sq. yd per min).

(iii) Output rate of sprayer in gal per min = area dosage required in gal per acre ÷ time for spraying one acre (min per acre).

The actual time for spraying an acre usually turns out to be 15–20% higher than the theoretical time.

The commonest spacing between rows is four feet and some theoretical times for spraying an acre at this spacing are given in Table 2.

TABLE 2.—*Theoretical times for spraying an acre (minutes)*

These are given for a 4-foot row spacing—to calculate for any other row spacing, multiply by $\frac{4}{\text{row spacing (feet)}}$

Number of rows between paths of sprayer	Speed of walking (yards per minute)			
	15	22½	30	45
2	121	81	61	41
3	81	54	40	27
4	61	40	30	20
6	40	27	20	14
8	30	20	15	10
10	24	16	12	8

We can now correlate machine output and the speed of walking. For example if we want to spray 6 pints of DDT emulsion in 6 gallons of water/acre, and the machine is set to spray 2 gallons in 10 minutes, it will take 30 min to spray the 6 gallons; taking 8 rows at a time at 4 ft spacing, we see that to take 30 min over the job, the labourer must walk at 15 yd per min. With 4 rows at a time, he would have to walk at 30 yd/min. These are only examples and the method can be adapted to suit convenience (*see also the article in this issue on control of Shot-hole Borer—Cranham*, 1961).

We want good machines with *all* the parts well designed and strongly built. These are good machines basically, and yet on most, if not all, one comes across minor points which are not well thought out or finished. These are usually little things and seem to me a case of 'spoiling the ship for a ha'p'orth of tar'.

To the planters, I would like to say that this subject seems to provoke the most dogmatic statements. A good instance is the statement that mist-blowers are fine so long as you have a flat estate. Yet we now have machines weighing less, fully loaded, than an ordinary knapsack sprayer and the labourer can move more slowly than he has to in normal blister-blight spraying. He can literally go anywhere that he can reach with a knapsack sprayer and in fact he has to do fewer climbs on steep ground to achieve good cover. Again, it is said that they are too likely to give mechanical breakdowns and that the labourers are not up to using them. Yet they are less complex than a motor cycle. You cannot expect, however, to neglect the very simple maintenance work and not have trouble.

Mr Elias, for example, has shown that the labourers—selected men—are certainly up to it, and will in fact take a pride in the machine and what it can do. This is something of a challenge; the advantages are there if we take a little trouble.

The final decision rests with you. We may show that technically a certain method is more efficient but it still may not be generally workable or acceptable. All sorts of factors enter into it, which we shall no doubt hear about this morning. But please don't be dogmatic about it, or imagine that a generally valid conclusion can be reached by a quick practical test in the field. For our part, there is a good deal of experimental work that needs doing, and provided there is interest from you, then as far as possible we will do it. The thing at stake is your profit. We want to help reduce your C.O.P.

Discussion

Various points raised during the discussion are noted below.

1. Methods of spraying

There was discussion as to relative merits of blister-blight misting being done (*a*) with the wind, in one direction only, or (*b*) by moving the lance slowly from side to side. The meeting, including the T.R.I. staff, was divided on this issue; there has not been enough work critically comparing blister-blight control obtained by the two methods; but both give satisfactory control.

Some planters, when spraying on steep ground, had followed the practice of using the bunds of drains for paths and misting down the slope of tea. In tea in the 3rd and 4th years from pruning, the possibility of cutting back side-branches to give very narrow paths for the sprayer was also mentioned.

2. Design of machines

The designs of the machines were criticized by some planters, but it was more generally agreed that, although not specifically designed for tea, they were the only practicable development by which spraying of Ceylon tea could be mechanized and that only minor modifications were needed to adapt them for tea. Several planters referred to the need for a safety bar or frame behind the machine so that if the labourer accidentally fell, damage to the machine would be minimized; exhaust silencers should also have a guard to prevent burns. It was agreed that further silencing was desirable if it could be done without excessive loss of power, but this was doubtful.

The best combination of engine power and air output for machines for spraying tea was not known. There had been a move towards much lighter machines but were we sacrificing air-output too much?

3. Servicing

The need for good servicing facilities and supply of spare parts by the agents was strongly stressed. Three firms had arrangements for mobile workshop vans visiting estates and also Colombo workshops; others had Colombo workshops only. Breakdowns and minor faults would prejudice the adoption of these machines by estates. The necessity for the small amount of daily maintenance, which had to be done on the estate, was also pointed out.

4. PETROL-OIL MIXTURE

A few planters asked whether the oil companies could be persuaded to supply a ready-mixed petrol-oil for use in these engines, which would ensure that the correct mixture of 1: 25 oil/petrol was in fact used. In any event, agents agreed that small measures, giving the correct amount of oil for a tankful of petrol, could be supplied.

(One petroleum company has been approached by Messrs Shaw, Wallace & Hedges, Ltd. and regrets that it cannot undertake to supply petrol-oil ready mixed.—Ed.)

5. The possible CONFUSION on some machines BETWEEN THE OPENINGS for the petrol-oil tank and the spray-liquid tank (where both are welded together in moulded plastic or metal) was mentioned. It was agreed these should be very different in shape and painted different colours.

6. The DANGERS OF SPRAY DRIFT were discussed. There was no danger with copper fungicides which were used everywhere, but there was a danger of putting insecticides where they were not wanted, and this must be guarded against. The greatest danger was with weed-killers and these machines were not considered suitable for spraying weed-killers.

Planters questioned whether the droplet pattern could not be altered to minimize drift. If the air flow is cut down, bigger droplets are obtained, with a more restricted distribution—this, however, destroys the whole point of the machine and it is better then to use knapsack sprayers.

7. The need for PROPER SUPERVISION and training of labourers was stressed, and the possibility of staff being trained in the maintenance of machines by Colombo firms was mentioned. Because of the noise of the engine, there was a need for a simple sign language by the supervisor in controlling the spraying labourer.

Conclusions

The Chairman, in summing up, recorded that there was evidently a great deal of interest in this development for spraying tea, and there was general agreement by the meeting that there was a future for mist-blowers in the industry. Further work was needed on some aspects and would be taken up by the T.R.I. as far as possible. He thanked all the members for attending.

Acknowledgments

We are grateful to Dimbula A.C.C. for permission to use Radella Club for this meeting and to the Superintendent of Radella Estate for facilities for carrying out a demonstration of mist-blowing there.

TABLE 1.—*Some details of available machines*

Machine	Engine h.p.	Max. air output cu. ft/min	Weight empty lb.	Spray Tank capacity gal.	Horizontal reach of spray beam, still air	Dosage control device	Time to spray 2 gal (range in min).
'Micronizer 26'	J.L.O. 26 cc. 0.85 h.p.	180	32	2.2	20–25 ft	Variable dosage tap	6–18 min.
'Kinkelder'	J.L.O. 0.85 h.p.	154	22	2.2	Not given	Variable dosage tap or reducing jets	4½–16 min.
'Unus', Type FR5	J.L.O. 26 cc. 0.9 h.p.	212	26½	2.2	20–26 ft	Variable dosage tap	Not given
'K.W.H.' Type 25	J.L.O. 26 cc. 0.8 h.p.	140	27	1.66	20–25 ft	None, but reducing jets can be fitted	4–16 min.
'Gnome'	J.L.O. 0.85 h.p.	Not given	25	2.2	25–32 ft	Variable dosage tap	9–27 min.
'Hurricane Minor'	J.L.O. 26 cc. 0.85 h.p.	125	23½	2.2	20–25 ft	Variable dosage tap	4–16 min.
'Hurricane'	Sachs 'Stamo' 50 1.8 h.p.	185	38½	2.2	25–30 ft	or reducing jets can be fitted	3.5–16 min.
'Boss'	J.L.O., L. 60 1.8 h.p.	Not given	33	2.2	26–33 ft	—do—	4–25 min.
'Motoblo 60'	Solo Klein 3.0 h.p.	Not given	27½	2.2	Not given	—do—	2–32 min.

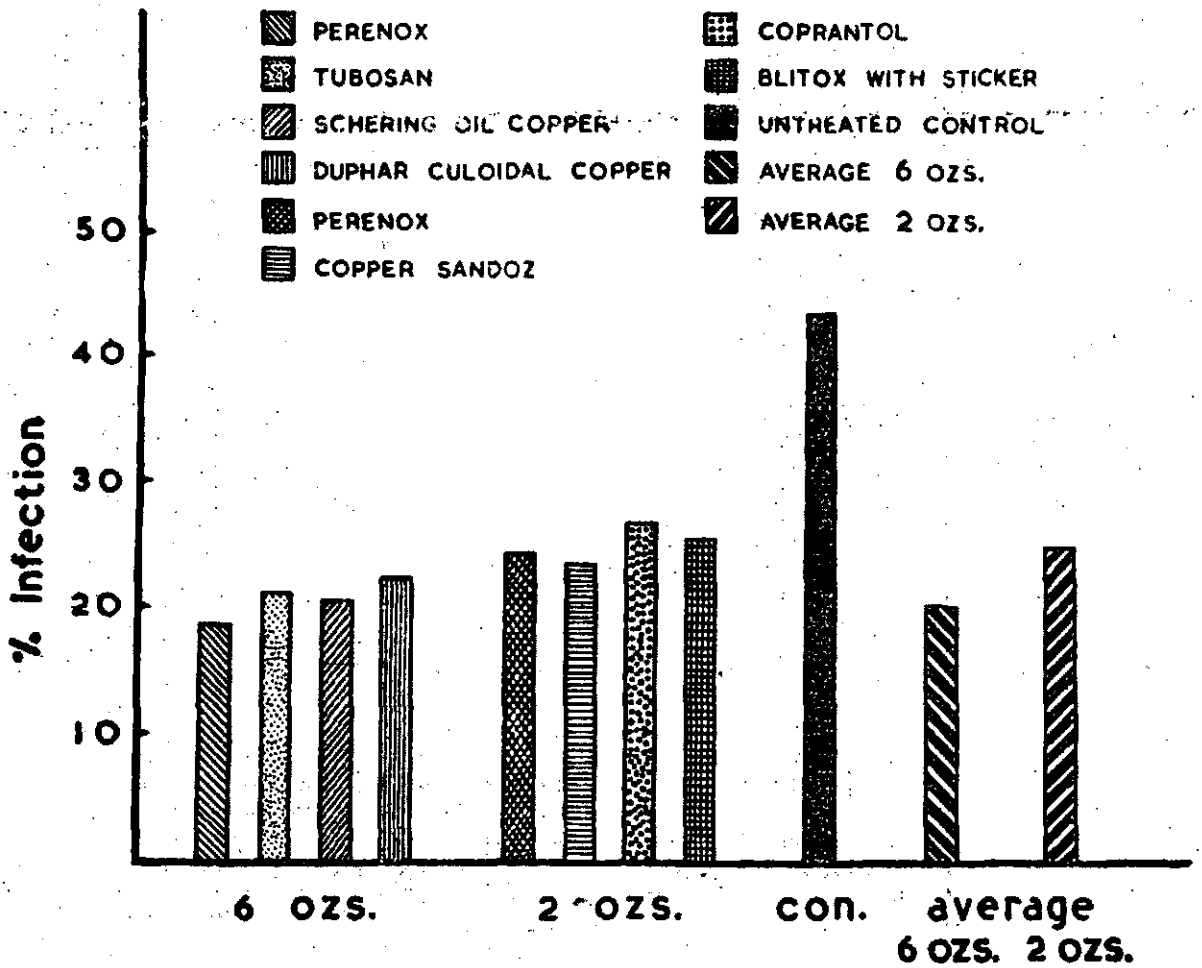

Figure 1. Comparison of blister-blight infection rates after spraying with various copper fungicides at two area-dosages, in ounces per acre. There is not much difference between the results for the two dosages when sprayed experimentally, and both are much better than not spraying.

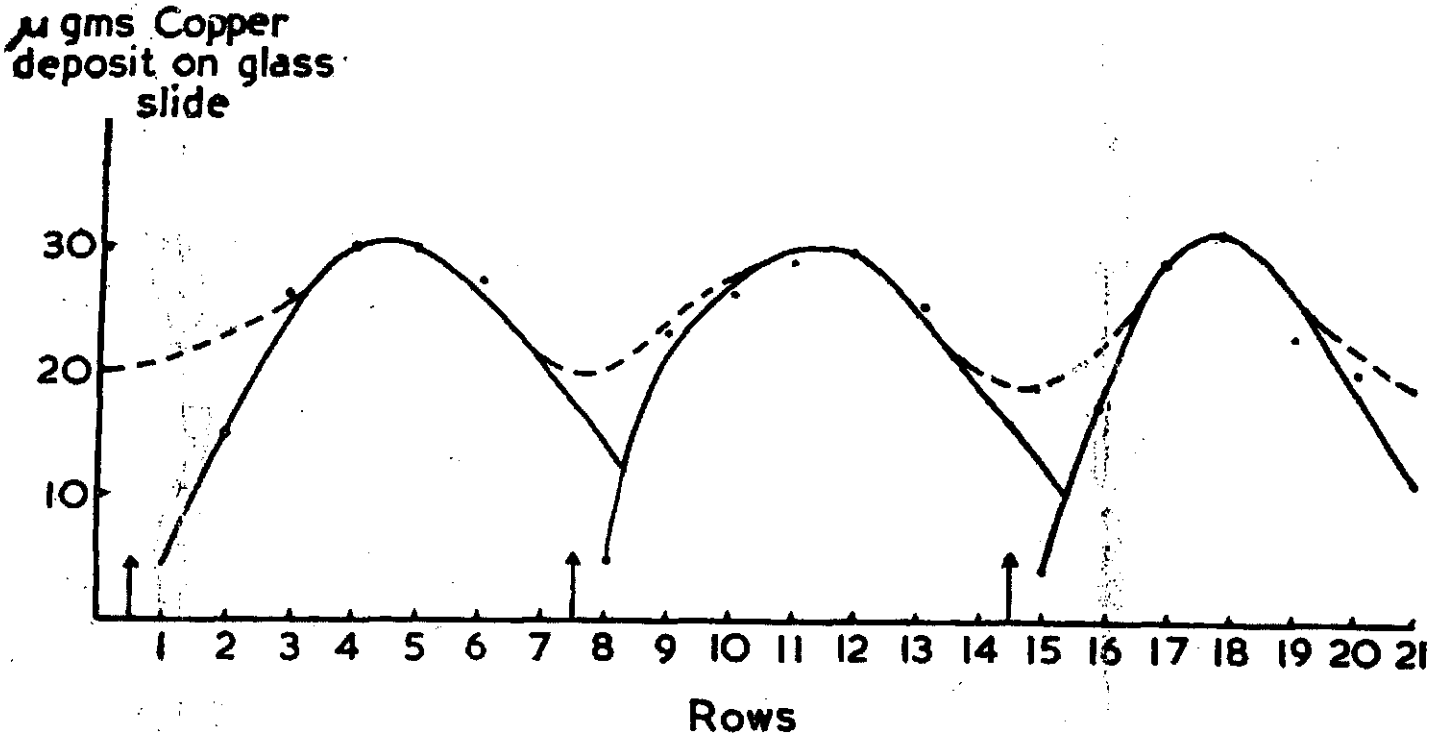

Figure 2. Deposits of copper (indicated by dots) found on glass slides at various distances from the mist-blower line, the nozzle being pointed steadily in one direction (down wind). The three sets of assessments have been combined, to show (dotted line) how the doses build up. Mist applied at intervals of seven rows. The lowest combined deposit was about 20 micrograms.

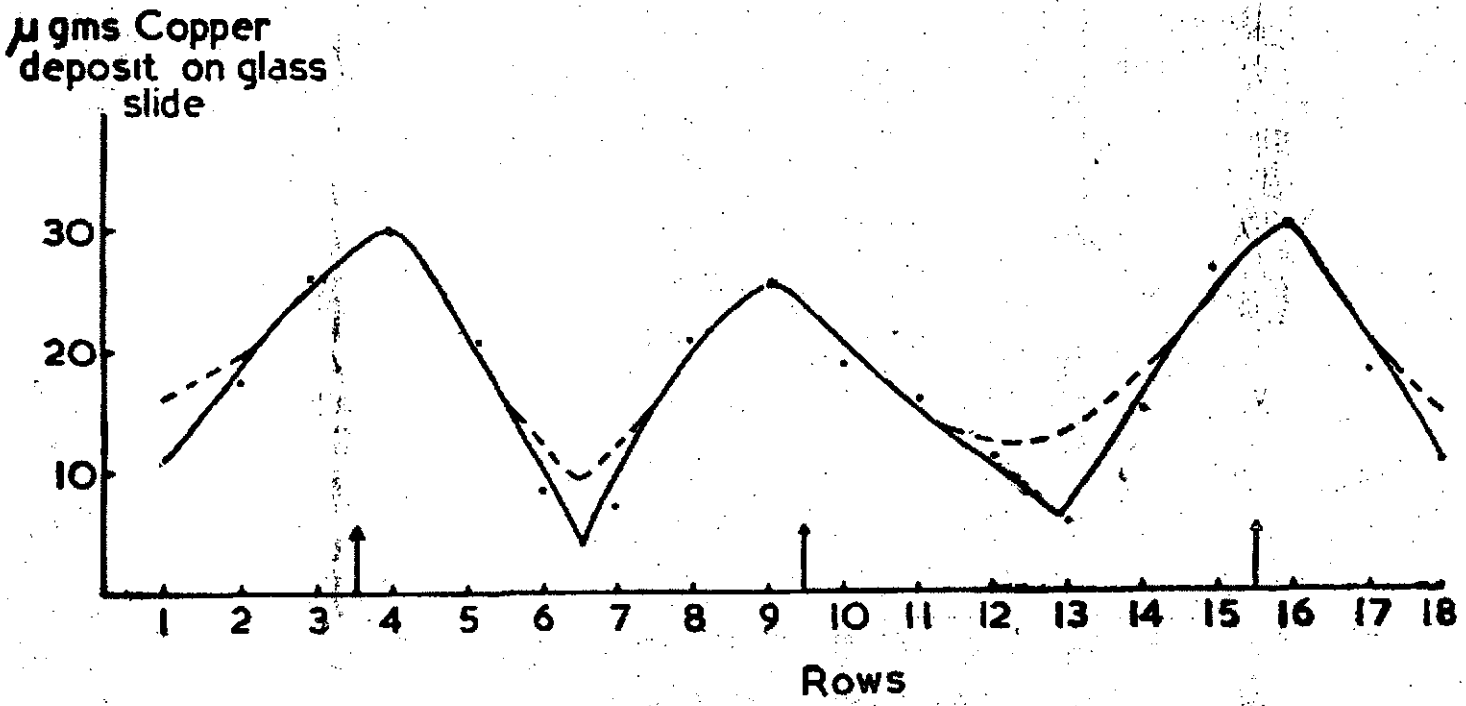

Figure 3. Deposits of copper found, as in Figure 2, except that the mist nozzle was swung from side to side and that application was made at intervals of six rows. The lowest deposit was about 10 micrograms from a slightly higher area-dosage.