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THE EFFECT OF DIFFERENT QUALITIES OF DDT WATER-DISPERSIBLE POWDERS ON NOZZLE EROSION AND FACTORS RESPONSIBLE FOR THIS EFFECT

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INTRODUCTION

It has been agreed by pesticide chemists that the suspensibility test is the most reliable criterion for evaluation of the quality of a water-dispersible insecticide powder designed to be used in hand spraying equipment. Although the erosion of nozzle orifices by suspensions of water-dispersible insecticide powders can result in a considerable economic loss to vector control programmes owing to over-application of insecticides, no test for the erosion of nozzles has been incorporated in the specifications drawn up by USAID or by the World Health Organization for such formulation.

The WHO Expert Committee on Insecticides (Fourth Report) recommended that diluents used in formulating water-dispersible powders should not be abrasive to an excessive degree, but the effects of chemical and physical properties of pesticide water-dispersible powders on nozzle erosion have not, to our knowledge, received detailed study. The hardness of many materials was tested in water suspension by Wilson (1943), who measured the relative abrasion of spray nozzles.

The present study was initiated when a remarkable increase was observed in the discharge rate of stainless steel 8002 nozzles when spraying a five per cent. DDT suspension prepared from locally produced 50 per cent. water-dispersible powder.

Since little or no direct experimental observation data are available for evaluating the effect of different types of DDT water-dispersible powders on the abrasion of spray nozzles, studies were undertaken on some of the factors thought to be responsible for the increased discharge rate.

Field studies were started first to evaluate the effect of local DDT water-dispersible powders on the abrasion of stainless steel and hardened stainless steel 8002 nozzles, and comparison was made under similar field conditions, with imported 75 per cent. DDT water-dispersible powder.

Laboratory work was also started with the few tests described below, and this will be continued in the near future with regard to the effects of the chemical and physical properties of the water-dispersible powders on nozzle erosion. Special attention will be paid to the effect of particle size and shape, and the hardness of the diluent.

FIELD TESTS

Twelve Hudson 710 S/WHO/02 compression sprayers (4 US gal.) were equipped with stainless steel 8002 nozzles, and another twelve with hardened stainless steel 8002 nozzles. The sprayers were used by six squads, each of four spraymen, and all engaged in DDT house-spraying operations in the Field Training Area of the Malaria Eradication Training Centre in June 1963. During the test period only the locally produced DDT 50 per cent. water-dispersible powder was used and the suspension concentration was five per cent. The sprayer tanks were filled each time with 10 litres of spray liquid and this amount was then discharged in such a way that the pressure was maintained between 55 and 25 p.s.i. The tank was pumped-up twice during this operation.

All discharge rates were measured for one minute with clear water in a 1000-ml glass graduate, and at the average working pressure of 40 p.s.i. This was done by means of a device similar to that described by Lonergan & Hall in 1958, but without the solenoid valve attachment.

LABORATORY TESTS

Comparison tests were carried out using small samples of local and imported water-dispersible DDT powders. The suspension prepared from each material was not sprayed to waste, but circulated 20 times from the sprayer under exactly the same conditions as in field spraying and the nozzles were tested for discharge at 40 p.s.i. by the method described above. The same suspension was recirculated another 20 times and again tested for discharge. This procedure is an alternative to the erosion test using the nozzle erosion apparatus described by Hall in 1955, which was not available. Nine stainless steel 8002 nozzles with approximately the same discharge rate were selected for the test.

RESULTS AND DISCUSSION

The discharge rate of the 12 new stainless steel nozzles which were field tested was 725 ± 32 ml/minute, and that of the 12 new hardened stainless steel nozzles was 714 ± 31 ml/minute. The average values of the increase in discharge rate after use are given in Table 1 for the first group of nozzles, and in Table 2 for the second group. In Fig. 1 the increase in discharge rate for the two groups of nozzles are plotted logarithmically against the quantity of material sprayed. The relationship between the plotted points is linear and of approximately the same slope as that determined by Lonergan & Hall (1958). The stainless steel nozzles had a greater increase in discharge than the hardened stainless steel nozzles, but both groups were eroded at an extremely high rate. It was observed from previous spraying operations in the area, under the same field conditions and using a five per cent. DDT suspension prepared from 75 per cent. water-dispersible powder supplied by WHO, that a 20 per cent. increase over initial discharge from stainless steel 8002 nozzles occurred after about 1200 litres. A sprayman would normally use this amount in two weeks operation, after which the nozzle would have to be discarded. The same percentage increase in discharge rate corresponds to 145 ml/minute for the first group of nozzles tested, and 143 ml/minute for the second group. If this increase were applied in Fig. 1, it would occur after spraying 165 and 330 litres respectively, i.e. after one-and-a-half and three days operation only.

The DDT water-dispersible powders available for the laboratory comparison test were: a 50 per cent. DDT Pakistani product, a 50 per cent. DDT Polish product and United States of America DDT 75 per cent. water-dispersible powder. Samples from each product were chemically tested and all were found to comply with the WHO 1961 specifications.

The discharge rate of nine stainless steel nozzles used in the test was 707 ± 7 ml/min. The aim of the laboratory tests was to investigate the effects of the following factors on nozzle abrasion:

1. The amount of diluent in one charge of water-dispersible powder obtained by solvent extraction.

2. Particle size; the original product was passed through a 300 mesh sieve.

3. Amount of water-dispersible powder mixed in one liquid charge.

The increase in discharge rate over the initial discharge, due to erosion of nozzles by the different materials tested, is shown in Table 3. The local 50 per cent. water-dispersible powder showed the highest discharge increase among all the other products, while the 75 per cent. gave the lowest effect. The natural diluent of the local 50 per cent. showed remarkable abrasive effect over that of the synthetic diluent of the 75 per cent. Although both the Pakistani and Polish products contained natural diluents, their abrasive effect on nozzle tips was much less than that of the local 50 per cent. The high abrasive effect of diluent alone can be observed when the discharge increase for nozzles No. 3 and No. 8 is compared.

Although sieving of the local product decreased its abrasive effect, it was still higher than that of the Polish and Pakistani products without sieving.

The abrasive effect when passing two equal quantities of the same material in different concentrations (20 circulations of 5 per cent. suspension and 40 circulation of 2.5 per cent.) was not the same; the higher concentration gave nearly twice as high an abrasive effect, probably due to the amount of solid particles per unit volume passing through the nozzle.

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TABLE 1. FIELD DATA SHOWING THE EFFECT OF EROSION ON THE INCREASE IN DISCHARGE RATE OF 12 STAINLESS STEEL NOZZLES (TYPE 8002) WHEN SPRAYING A 5% DDT SUSPENSION PREPARED FROM LOCAL 50% WATER-DISPERSIBLE POWDER AT 40 PSI AVERAGE DISCHARGE PRESSURE

Average discharge rate at 40 p.s.i. (ml/min.)	Quantity of material passing through nozzle (litres)	Amount of increase over initial discharge rate (ml/min.)	Time between suspension changes
725	0	0	0
214.5	100	114.5	0
363.5	200	163.5	0
502	300	202	0
622	400	222	0
833	550	283	0
1064	750	314	0
1265	900	365	0
1587	1190	397	0
2037	1590	447	0
2597	2070	527	0
2980	2420	560	0

TABLE 2. FIELD DATA SHOWING THE EFFECT OF EROSION ON THE INCREASE IN DISCHARGE RATE OF 12 HARDENED STAINLESS STEEL NOZZLES (TYPE 8002) WHEN SPRAYING 5% DDT SUSPENSION PREPARED FROM LOCAL 50% WATER-DISPERSIBLE POWDER AT 40 PSI AVERAGE DISCHARGE PRESSURE

Average discharge rate at 40 p.s.i. (ml/min.)	Quantity of material passing through nozzle (litres)	Amount of increase over initial discharge rate (ml/min.)	Time between suspension changes
714	0	0	0
170	100	70	0
209	200	109	0
439	300	139	0
567.5	400	167.5	0
852	650	202	0
1027	800	227	0
1242	980	262	0
1538	1240	298	0
1923	1580	343	0
2463	2080	383	0
2733	2300	433	0

TABLE 3. COMPARISON OF EROSION EFFECT ON SS 8002 NOZZLE TIPS FROM DIFFERENT QUALITIES OF DDT WATER-DISPERSIBLE POWDERS

Nozzle No.	Material	Product	Amount of material mixed in 10 litres charge (kgs)	First 20 circulations of 10 litres charge		Second 20 circulations of 10 litres charge	
				Amount of material passed through nozzle (kgs)	Increase over initial discharge %	Amount of material passed through nozzle (kgs)	Increase over initial discharge %
1	DDT 50% w.d.p.	Local	1.000 (5% DDT)	20.000	16.48	40.000	25
2	DDT 50% w.d.p.	Local	0.998* (5% DDT)	19.960	10.17	39.920	13.42
3	Diluent of 1 kg. DDT 50% w.d.p.	Local	0.500	10.000	8.03	20.000	14.08
4	DDT 50% w.d.p.	Pakistan	1.000 (5% DDT)	20.000	7.66	40.000	10.69
5	DDT 50% w.d.p.	Poland	0.985* (5% DDT)	19.700	2.8	39.400	6.04
6	DDT 50% w.d.p.	Poland	1.000 (5% DDT)	20.000	5.71	-x	-x
7	DDT 75% w.d.p.	USA	0.667 (5% DDT)	13.340	2.27	26.680	4.96
8	DDT 50% w.d.p.	Local	0.500 (2.5% DDT)	10.000	2.84	20.000	9.93
9	Diluent of 0.667 kg DDT 75% w.d.p.	USA	0.167	3.340	1.68	6.680	2.66

* Amount of material passed from 300 mesh sieve out of 1 kg. charge. x Prepared suspension was unintentially spoiled.

FIG. 1

EFFECT OF EROSION ON STAINLESS STEEL AND HARDENED STAINLESS STEEL NOZZLES (TYPE 8002) WHEN SPRAYING 5% DDT SUSPENSION PREPARED FROM LOCAL 50% WATER DISPERSIBLE POWDER IN THE FIELD AT 40 PSI AVERAGE DISCHARGE PRESSURE