WEAR OF HOLLOW CONE NOZZLES BY SUSPENSIONS OF WETTABLE POWDERS

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The effect of spraying wettable powder suspensions under field conditions on the physical condition and flow rates of several combinations of hydraulic nozzle components was tested. Brass swirl plates eroded too quickly and were unsatisfactory; case-hardened discs showed a substantial change in flow rate after a through-put of 7,500 liters; totally enclosed tungsten carbide discs and swirls after 2 yr of field use showed no change in output. The use of hardened stainless swirl plates with the proper tungsten discs is recommended.

INTRODUCTION

Agricultural pesticides must be used judiciously and both the efficiency of application and the efficacy of the deposit maximized (Bals 1971; Hurtig 1972). Wettable powder formulations of pesticides are highly abrasive when atomized at high pressure (Marshall 1951; Potts 1958) and the uniformity of a spray pattern is adversely affected by nozzle wear (Cook 1970; Fisher and Hikichi 1971). This paper relates the extent of nozzle wear, under vineyard conditions, to the composition of the component parts.

METHODS

In 1970, a two-row, hooded-boom hydraulic sprayer (Figure 1) was used to apply three water-based wettable powder suspensions to 85 ha of grapes to evaluate wear of new nozzle components when atomizing abrasive suspensions. The test conditions are summarized in Table I (Bals 1971; Cook 1970; Fisher and Hikichi 1971) and the composition of nozzle components in Table II. Following each application, the components were examined and replaced with new disc and swirl plate combinations. In 1971, four applications were made with one set of nozzles. In 1972, two sprayers each applied five sprays as outlined in Table 1.

In 1971 and 1972, the nozzles in positions 1, 3 and 5 (Figure 1) applied the first spray of 28,639 liters, those in positions 1, 2, 3 and 5 applied the second spray of 38,136 liters and the nozzles in all five positions the last two sprays of 47,732 liters each and in 1972 a fifth clean-up spray of 47,732 liters. The Spraying Systems 131 DDTC-TC components used in 1971 were used again in 1972.

A test bench was assembled with a pressure-regulated water supply. At the end of each season the nozzle components were removed from the sprayer and flow rates were measured at a test pressure of 276 kPa. For each nozzle, flow rate was measured three times and averaged. A datum flow rate was established for each disc-swirl combination by using new nozzle components. The percentage increase in flow rate, above the respective datum, was calculated and used as an indicator of nozzle wear.

TABLE I. SUMMARY OF FIELD TEST VARIABLES FOR 1970, 1971 AND 1972

Year	Nozzle pressure kPa	Pesticide† suspension sprayed	Volume sprayed (liters)	Nozzle selection code‡
1970 (1)	2,068	A	22,730	a
1970 (2)	2,068	A	18,185	b
1970 (3)	2,068	A	95,464	c
1971	1,034	B	162,435	d
1972 (1)	1,034	B	162,435	e
		C	47,775	e
1972 (2)	1,034	B	162,435	f
		C	47,775	f

† A, 4.54 kg Microniasul, 4.54 kg Sevin 50% WP, 114 cc Superspread/454.6 liters suspension.
B, as A plus 4.54 kg Phaltan 50% WP/454.6 liters suspension.
C, 11.2 kg Microniasul, 5.6 kg Phaltan 50% WP/561 liters suspension.

‡ a, DTC 6 discs and #23 brass swirls.
b, DTC 3 discs and #25 HSS swirls plus D3 discs and #25 brass swirls.
c, 1 boom 131 DDTC 4 discs and #24 TC swirls.
3 booms D 3 discs and #25 HSS swirls.
d, 2 booms D 4 discs and #25 HSS swirls.
1 boom D4 discs and #25 brass swirls.
1 boom 131 DDTC 4 discs and #25 TC swirls.
e, 1 boom D4 discs and #25 HSS swirls.
2 booms 131 DDTC 4 discs and #25 TC swirls.
1 boom 131 DDTC 4 discs and #25 TC swirls (from 1971).
f, 4 booms D 4 discs and #25 HSS swirls.

All nozzle components Spraying Systems Co. See footnote Table II for composition of components.

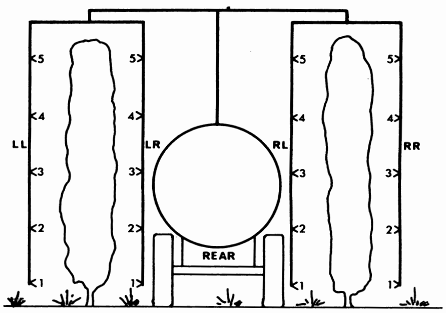

Figure 1. Schematic diagram of two-row hooded-boom sprayer showing nozzle positions.

RESULTS

Brass swirl plates eroded rapidly and in many cases were worn through from the swirl chamber side. Hardened stainless steel swirl plates were slightly worn when used at 2,068 kPa, though not enough to affect their performance. Tungsten carbide swirl plates did not wear but were very brittle and special care was needed during nozzle assembly to prevent cracking.

Case-hardened stainless discs eroded on the upstream shoulder of the orifice initially, and then on the outside shoulder. Significant changes in output occurred as the orifice changed from sharp-edged to rounded. If spraying was continued, the case-hardened surface in the orifice eroded through and undercutting of the softer core occurred. The shape of the orifice then rapidly became irregular as the brittle overhang collapsed, and the size of the orifice increased accordingly. The DTC tungsten carbide disc did not wear at the orifice. However, the nylon retaining gasket was eroded away, exposing the brass casing to the pesticide suspension, with subsequent rapid abrasion and casing failure. The DDTC totally enclosed type of tungsten carbide disc was durable and showed no signs of wear.

From Table II it is obvious that brass swirl plates are unacceptable. There is as much as 191.8% increase in output after one season's use.

Hardened stainless steel discs and swirl plates showed improved wearability. Because there was considerable variability in flow rates, a random selection of new hardened stainless discs were tested for surface hardness at three locations on the upstream face. The 15 N Brale Test at 15.0 kg was used because higher loads would fracture the brittle surface layer. The results for six discs, converted to the Rockwell C scale, averaged 59, 40, 50, 52, 63, and 60. Several new nozzles, selected at random, were cut in half using a diamond saw, were etched in concentrated hydrochloric acid, and observed microscopically. A Vickers split-image eyepiece was used to measure the thickness of the case-hardening of six discs. The thickness varied from 90 to 218 μm on the inside surface and from 129 to 257 μm on the outside face. In one instance, the case-hardening failed to enclose the orifice and left the soft core exposed to the pesticide. Pitted orifices and minute surface cracks were also observed. The range of durability observed in the wear tests is attributed to these variations in disc quality.

There was no difference between flow rates of 131 DDTC-TC nozzles after use in 1971 and 1972 and new nozzles ($P > 0.05$). It is concluded that tungsten carbide nozzles can be used for at least 2 yr and probably longer under these test conditions, with no significant change in output.

The case-hardened stainless discs and hardened stainless swirls, under the same conditions, showed 58.6 ± 9.2% increase in output after one season of use. The change in output of hardened discs increases rapidly when the case hardening begins to erode (Figure 2). It appears, therefore, that these nozzles should be replaced after an output of about 7,500 liters of wettable powder suspensions such as those listed for 1972 (Table I) when sprayed at 1,034 kPa. In any case, hardened stainless discs should be checked regularly because deterioration is rapid once the orifice begins to wear.

Hardened stainless swirls appear to be durable and could be used with the proper tungsten carbide disc to eliminate the problem of brittle fracture that can occur with tungsten carbide swirls, and to reduce the initial cost. Periodic checks of the swirl plates should be made to guard against a change in nozzle output.

TABLE II. SUMMARY OF NOZZLE WEAR DATA FOLLOWING FIELD USE

Nozzle type†		Field nozzle pressure	Pesticide sprayed	% flow rate change from new ± SE of mean
Disc	Swirl	(kPa)	(liters/nozzle)	
DTC	HSS	2,068	1,136	1.7 ± 1.8 (n = 8)
D	BR	2,068	1,136	80.5 ± 25.6 (n = 4)
D	HSS	2,068	4,768	31.1 ± 3.0 (n = 15)
131 DDTC	TC	2,068	4,768	2.0 ± 3.3 (n = 4)
D	HSS	1,034	9,556	16.0 ± 1.3 (n = 6)
D	BR	1,034	9,556	191.8 ± 22.2 (n = 3)
131 DDTC	TC	1,034	9,556	1.9 ± 0.9 (n = 3)
131 DDTC	TC	1,034	21,501	−0.9 ± 1.0 (n = 3)
131 DDTC	TC	1,034	11,945	2.3 ± 2.2 (n = 3)
D	HSS	1,034	11,945	58.6 ± 9.2 (n = 10)
D	HSS	1,034	9,556	42.0 ± 8.2 (n = 4)
D	HSS	1,034	7,167	6.4 ± 2.0 (n = 3)

† DTC, Tungsten carbide disc with nylon gasket, HSS, hardened stainless swirl.
D, case-hardened stainless disc; BR, brass swirl plate.
D, case-hardened stainless disc; HSS, hardened stainless swirl plate.
131 DDTC, totally enclosed tungsten carbide disc; TC, tungsten carbide swirl.
All nozzle components Spraying Systems Co.

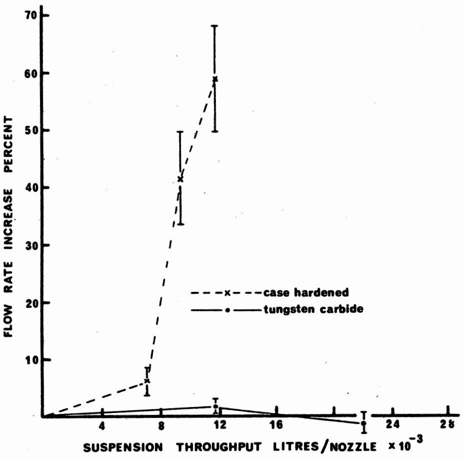

Figure 2. Relationship between percent increase in flow rate ± SE versus amount sprayed for case-hardened stainless discs and hardened stainless swirl plates when spraying wettable powder at 1,034 kPa.

BALS, E.J. 1971. Some thoughts on ULD (ultra low dosage). OEPP/EPPO Bull. No. 2 pp. 27-35.

COOK, P.D. 1970. Survey of the wear of sprayer nozzle tips in the prairies. Tech. Rep.

May and Baker (Can.) Ltd., 200 Bellarmin St., Montreal, Que.

FISHER, R.W. and A. HIKICHI. 1971. Orchard sprayers. Ont. Min. Agric. and Food. Publ. 373, p. 4.

HURTIG, H. 1972. Long distance transport of pesticides. OEPP/EPPO Bull. No. 4, pp. 5-25.

MARSHALL, J. 1951. Nozzle abrasion in orchard spray applications. Sci. Agric. 31: 470-474.

POTTS, S.F. 1958. Concentrated spray equipment, mixtures and application methods. Dorland Books, Caldwell, N.J.