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Differences Among Butyl, Ethyl, and Isopropyl Ester Formulations of 2,4–D, 2,4,5–T, and MCPA in the Control of Big Sagebrush[1]

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It has been difficult to accept as conclusive the indications that butyl ester forms of 2,4–D are more effective in the control of big sagebrush *(Artemisia tridentata)* than are isopropyl ester forms (2, 3, 5). Such indications may have been due to the manner of formulating the materials, and to the additives contained, rather than to differences between the esters. Additional information is necessary to prevent bias in the choice among ester forms.

Previous work has shown that the difference between 2,4–D (2,4–dichlorophenoxyacetic acid) and 2,4,5–T (2,4,5–trichlorophenoxyacetic acid) increased in favor of 2,4,5–T as acid rate decreased (6). This indicates the possibility that sufficient control can be obtained with 2,4,5–T at rates below 1 lb/A, and thus justify its choice over 2,4–D when cost considerations are involved.

MCPA has shown promising effectiveness on big sagebrush, and deserved further consideration.

This paper presents data from an experiment designed to obtain information helpful in the choice among ester forms, herbicides, and acid equivalent rates.

Procedure

Butyl, isopropyl, and ethyl ester forms of 2,4–D, 2,4,5–T and MCPA (2–methyl–4–chlorophenoxyacetic acid) were formulated for this experiment in a standardized manner at an acid concentration of 4 lb/gal.[3] They were emulsifiable in water, but contained no wetting additives. The materials were prepared for spraying at acid equivalent rates of 0.5, 1.0, and 1.5 lb/A by emulsifying in water at 6 gal/A with a wetting agent[4] at 0.5 percent by volume.

The treatment selections for the experiment consisted of a 3 x 3 x 3 complete factorial of 3 ester forms, 3 herbicides, and 3 acid rates. A partially confounded incomplete block design was used in which a component of the second order interaction for 2 degrees of freedom was confounded in each replication. The block size was thus 9 plots, and the experiment was replicated 3 times.

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[3]Experimental compounds used in this study were prepared by the American Chemical Paint Company, Ambler, Pa.

[4]The wetting agent was "Santomerse", Monsanto Chemical Co.

Individual plots were $^1/_{50}$ acre measuring 88 feet long and 9.9 feet wide. All live sagebrush, on an area 80 feet long and 8 feet wide centered within each plot, were counted prior to spraying and again one year after spraying. Percentage-kill data were subjected to analysis of variance.

Spraying was accomplished with a compressed-air sprayer at 35 psi employing a single 8001 nozzle which was moved to obtain a uniform broadcast of solution. Replication I was sprayed on May 1, 1956, replication II was sprayed on May 9, 1956, and replication III was sprayed on May 14, 1956. This timing was in the period of vegetative development when sagebrush susceptibility to the herbicides began in previous years (4, 5, 6). On May 1 sandberg bluegrass *(Poa secunda)* was in the boot stage of development, on May 9 was heading, and on May 14 was fully headed. Such timing gave some opportunity to consider differences in effectiveness between 2,4–D and 2,4,5–T in the period when 2,4,5–T has shown its greatest advantage (6).

The data were analyzed by standard analysis of variance techniques, and treatment means were adjusted for block effects as described by Cochran and Cox (1).

RESULTS AND DISCUSSION

Differences were found among the main effects for ester form, herbicide, and acid rate as evident by the corresponding significant mean squares; however, all interaction mean squares were nonsignificant and small. In previous experiments the primary sources of significant interactions were those involving dates of spraying (4, 6). Since replications in the present experiment involved date differences, an interaction component resulting from the interaction of dates by treatments is likely present in experimental error. Thus, tests of significance for main effects and interactions are perhaps conservative.

Mean kills by ester forms were 46, 53, and 53 percent respectively for isopropyl, butyl, and ethyl esters (Table 1). Butyl and ethyl esters were equally effective, but the isopropyl esters gave kills which were significantly less at a probability level of 1 percent. In the absence of herbicide by ester interaction it is logically assumed that the ester differences were quite uniform with all 3 herbicides; however, it may be observed from the data that the differences among esters were greatest with 2,4–D and least with MCPA. The difference due to ester forms appeared to increase with each successive date of application (Table 2). These data lead one to suspect that the ester differences did not involve MCPA in this experiment, but were concentrated with 2,4–D and 2,4,5–T. On May 14 (a satisfactory timing in practical applications) the isopropyl esters of 2,4–D and 2,4,5–T averaged 11 percent less effective than the mean of the butyl and ethyl esters of these herbicides. However, the deficiency of the isopropyl esters was less apparent at the higher acid rates, which must be used to obtain satisfactory sagebrush control. The practical importance of the difference among ester forms is thus minor, and

Table 1. Big sagebrush mortality following applications of 3 herbicides in 3 ester forms at 3 acid equivalent rates.

Herbicide	Acid rate lb/A	Mortality percentages using various ester forms			
		Butyl	Isopropyl	Ethyl	Average
2,4-D	0.5	37[a]	11	42	30[a]
2,4-D	1.0	46	53	49	49
2,4-D	1.5	72	59	60	64
2,4,5-T	0.5	61	51	53	55
2,4,5-T	1.0	79	66	75	73
2,4,5-T	1.5	86	84	87	86
MCPA	0.5	17	21	26	21
MCPA	1.0	42	33	37	37
MCPA	1.5	33	39	49	40
2,4-D	Average	52[a]	41	50	48[b]
2,4,5-T	Average	75	67	72	71
MCPA	Average	31	31	37	33
Average	0.5	38[a]	28	40	35[b]
Average	1.0	56	50	54	53
Average	1.5	64	60	65	63
Average	Average	53[b]	46	53	51

[a]Interactions were not significant.
[b]LSD at 1 pct. level is 7 percent.

mixtures of the various ester forms as prepared by some chemical companies presumably would have essentially the same effectiveness as straight butyl or ethyl forms.

Replications, which involved a weekly time interval in spraying, were found to be different. Mean kills were 41, 49, and 63 percent respectively on May 1, May 9, and May 14 (Table 2). These data support a previous conclusion that the onset of susceptibility in big sagebrush coincides with the observation of heading on sandberg

Table 2. Big sagebrush mortality following applications of 3 herbicides in 3 ester forms on 3 dates.

Herbicide	Ester form	Mortality percentages on three dates of spraying in 1956			
		May 1	May 9	May 14	Average
2,4-D	Butyl	32	53	70	52
2,4-D	Isopropyl	30	43	50	41
2,4-D	Ethyl	42	48	61	50
2,4,5-T	Butyl	60	75	91	75
2,4,5-T	Isopropyl	59	63	79	67
2,4,5-T	Ethyl	63	73	80	72
MCPA	Butyl	23	24	45	31
MCPA	Isopropyl	28	23	42	31
MCPA	Ethyl	28	38	46	37
2,4-D	Average	35	48	60	48[a]
2,4,5-T	Average	61	70	83	71
MCPA	Average	26	28	44	33
Average	Butyl	38	51	69	53[a]
Average	Isopropyl	39	43	57	46
Average	Ethyl	45	53	62	53
Average	Average	41[a]	49	63	51

[a]LSD at the 5 pct. level is 5 percent.

bluegrass (6). Nearly full susceptibiilty had apparently developed by May 14 when 2,4–D at 1.5 lb/A and 2,4,5–T at 1.0 lb/A killed 78 and 87 percent of the sagebrush respectively (Table 3).

Mean kills by herbicides were 33, 48, and 71 percent respectively for MCPA, 2,4–D, and 2,4,5–T. The superiority of 2,4,5–T was evident throughout the data, and one may note that 0.5 lb/A of 2,4,5–T was more effective than 1.0 lb/A of 2,4–D under the conditions of this experiment.

Table 3. Big sagebrush mortality following applications of 2,4-D and 2,4,5-T at 3 acid equivalent rates on 3 dates.

Herbicide	Acid rate lb/A	Mortality percentages on three dates of spraying in 1956			
		May 1	May 9	May 14	Average
2,4-D	0.5	13	34	43	30
2,4-D	1.0	37	51	59	49
2,4-D	1.5	54	59	78	64
2,4,5-T	0.5	43	52	70	55
2,4,5-T	1.0	63	70	87	73
2,4,5-T	1.5	76	89	93	86
2,4-D	Average	35	48	60	48[a]
2,4,5-T	Average	61	70	83	71
Average	Average	48[a]	59	72	60

[a]LSD at the 5 pct. level is 5 percent.

CONCLUSIONS

Isopropyl ester forms of 2,4–D and 2,4,5–T were less effective on big sagebrush than were butyl or ethyl ester forms. However, the deficiency of the isopropyl esters was less apparent at acid rates high enough to obtain satisfactory sagebrush control. Butyl and ethyl forms might be used with slightly greater confidence, but were not clearly superior to isopropyl forms at practical rates of acid.

The indications are that esters of 2,4,5–T at 1.0 lb/A, or of 2,4–D at 1.5 lb/A, will give kills in excess of 75 percent if applied after sandberg bluegrass is fully headed.

MCPA is not sufficiently effective to compete with the other two herbicides.

LITERATURE CITED

1. COCHRAN, WILLIAM G., and COX, GERTRUDE M. Experimental Designs. John Wiley & Sons, Inc. p. 173. 1950.
2. COLORADO A. & M. COLLEGE. Sagebrush range improvement by eradication, reseeding, management. (Mimeo.) 1950.
3. CORNELIUS, DONALD R., and GRAHAM, CHARLES A. Selective herbicides for improving California forest ranges. Jour. Range Management 4:95–100. 1951.
4. HYDER, D. N. Controlling big sagebrush with growth regulators. Jour. Range Management 6:109–116. 1953.
5. ———. Spray to control big sagebrush. Oregon Agri. Exp. Sta. Bul. 538. 1954.
6. ——— and SNEVA, F. A. Effect of form and rate of active ingredient, spraying season, solution volume, and type of solvent on mortality of big sagebrush, *(Artemisia tridentata)*. Oregon Agri. Exp. Sta. Tech. Bul. 35. 1955.