COMPARISON OF SOIL STERILANTS

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Summary

The disadvantages of soil sterilants for control of weeds in drains is discussed, although the use of isocil is promising for certain hard-to-kill grasses. Sterilants failed where water was present, and short-term specifics were preferred. In waste areas, soil type and fertility influenced results more than rainfall. Diuron and simazine were similar, and monuron was only good where fertility was low and the soil of a sandy nature. Although of high solubility, isocil was a promising material, but tended to have a lower residual life than simazine or diuron. Resistant weed species are mentioned.

INTRODUCTION

IN THIS PAPER no attempt will be made to give the final answer to any preference of chemicals, as results of applications are always subject to variables such as plant vegetation present, rainfall, soil type and seed populations in the soil. The last paper giving details of this type of work was by Devereaux in 1956. Since then the chlorates and borates have largely been replaced by the urea, triazine, and uracil group of chemicals. These organic chemicals are now preferred as less bulk material per acre is required, they are cheaper, and more specific in long-term vegetation control. The discussion on sterilants is divided into the categories of drains and waste areas.

EXPERIMENTAL

All rates quoted refer to the lb active ingredient applied per acre. Most of the drain trials were replicated and randomized and the results are expressed in a general discussion. In the section on waste areas, the results are from trials of three replications in which each treatment is randomized (Trial 4 is of 2 replications).

DRAINS

Although a large number of trials have been conducted during the last seven years using a number of sterilants in drains, in a few cases only was there any advantage gained over short-term materials. The addition of specifics such as amitrole to monuron, diuron, and simazine very greatly enhanced the control of vegetation, particularly on the sides of drains. However, with the exception of a few areas, the usual dichloropropionic acid-amitrole mixture was just as good and much cheaper. The different basic soils such as the stony, silt, clay, and peaty loams did not materially affect results. However, the duration of bareground achieved with any sterilant was generally about half that usually obtained in waste areas. The following were the main disadvantages in the use of sterilants for weed control in drains.

- (1) Poor control obtained when there was much water in the bottom of the drains at the time of application.
- (2) Even if dry, when the drains became flooded within about one week, poor results generally followed.
- (3) If the action of the sterilants was of a long period, and all vegetation removed, "fretting" of the drain sides occurred so that a manual or mechanical cleaning out of the drains was necessary. This was more particularly observed on the less

compact soil structures such as those of the peats and to some extent the silts.

- (4) Any resistant species present soon took the place of those controlled, and a further spraying with another material was necessary.

The resistant species for the following chemicals, included the following:

monuron and diuron — mercer grass (*Paspalum distichum*), paspalum (*P. dilatatum*), reed sweet grass (*Glyceria maxima*), kikuyu (*Pennisetum clandestinum*), plantains (*Plantago* spp.) and watercress (*Nasturtium officinale*).

simazine — buttercups (*Ranunculus* spp.), the paspalums and reed sweet grass.

isocil — paspalum and reed sweet grass.

In one particular trial, a chlorate/monuron/2,4-D proprietary mixture at 450 lb of the actual mixture gave very good control for one year and was equal to monuron at 65 lb. Diuron usually gave about 12 months' further control than monuron when used at equal rates of 16 to 48 lb. The 48 lb rate of diuron gave 80% bareground in a clay drain for three years with re-infestation quickly taking place. There was no evidence that increased control was obtained when a wetting agent was added to diuron and isocil.

Although limited in drain use, simazine was better than the quicker acting monuron, but equal to diuron. Although it does not give a very long-term vegetation control, isocil appears to have a place where mercer grass is a problem.

WASTE AREAS

In this section, of the eight trials described, Trials 3 to 8 are being conducted by the writer. Except where otherwise noted, all figures in the tables are percentage (%) bareground.

TRIAL 1

This trial was laid down on a silt loam soil in August, 1958, to control sweet briar (*Rosa rubiginosa*). Table 1 records the results.

TABLE 1: CONTROL OF SWEET BRIAR

Treatment (lb)	Percentage Bareground		Cover of Sweet briar (%)
	2 years	3 years	
fenuron 4	10	5	30
fenuron 8	20	15	25
fenuron 16	30	10	25
fenuron 32	40	40	10
monuron 4	40	0	80
monuron 8	50	10	70
monuron 16	60	25	45
monuron 32	90	90	5

After treatment the remaining vegetation consisted mainly of grasses and sheep's sorrel (*Rumex acetosella*). Both woolly mullein (*Verbascum thapsus*), which appeared in six months, and storksbill (*Erodium cicutarium*) in nine months, were more prominent on the plots treated with fenuron. Although monuron gave inferior control of sweet briar at equal rates to fenuron, it was much superior on the remaining vegetation, particularly the broadleaved weeds.

TRIAL 2

Laid down on a clay loam soil in November 1958, this trial was to control all vegetation under fencelines. There was no bareground at the end of three years. The main species regenerating

on the monuron plots were bracken fern (*Pteridium esculentum*) and seedling manuka (*Leptospermum scoparium*). Other species included ragwort (*Senecio jacobaea*), seedling gorse (*Ulex europaeus*) and woolly mullein at the lower rates. High rates controlled regrowth gorse. Simazine did not control the seedling or regrowth gorse, bracken fern, cleavers (*Galium aparine*), paspalum and other grasses. A 600 lb rate of borax did not give more than three months' control.

TABLE 2: CONTROL OF GROWTH ALONG FENCE LINES

Treatment (lb)						Percentage bareground	
						1 year	2 years
monuron	32	.....	.....	.....	.....	50	20
monuron	48	.....	.....	.....	.....	80	40
monuron	64	.....	.....	.....	.....	90	60
monuron	80	.....	.....	.....	.....	95	85
simazine	40	.....	.....	.....	.....	80	70

TRIAL 3

Although the area where this trial is situated is regarded as a silt loam, it is primarily of a clay nature, because of excavations about eight years ago. Thus the weed seed population would be relatively less, fertility lower, and any regeneration slow in establishing. These factors may have biased the results. An area was sprayed in October, 1961, on a run out pasture with 8, 16 and 32 lb of isocil with and without paraquat 2 lb. Flatweeds began to appear after 6 months on the 8 lb plots only. After 12 months (total rainfall 52.7 in.), both the 8 and 16 lb rates had given 40% bareground, and 32 lb about 55%. There was no difference with the addition of paraquat. Tauhinu-korokio (*Cassinia leptophylla*) was beginning to show on all plots. After 18 months the 8, 16 and 32 lb rates were giving 35, 55 and 85% bareground respectively. The resistant weeds were dominantly tauhinu-korokio and pearlwort (*Sagina procumbens*), with some white clover (*Trifolium repens*), fleabane (*Erigeron* spp.), mouse-eared chickweed (*Cerastium glomeratum*) and scotch thistles (*Cirsium lanceolatum*) at the lower rates.

TRIAL 4

Sprayed in May, 1962, in the same area as Trial 3. The treatments included 2½, 5, 10, and 20 lb of isocil with and without 10 lb of diuron. Both simazine and diuron were each sprayed alone at 10 lb, and in combination with both isocil 10 lb and paraquat 2 lb separately. After 9 months all treatments were giving 98 to 100% vegetation control, but 2½ lb isocil was only 50%. At the end of one year (49.9 in. of rain) all treatments were giving 97 to 100% bareground, except that the 2½ and 5 lb rates of isocil were 20 and 85% respectively.

Thus after one year, 2½ lb of isocil has almost disappeared, and 5 lb is marginal for acceptable control. It is too early to determine the long-term effect of the higher rates of the three different materials, but some differences are apparent. At equal rates isocil is equal to or slightly better than simazine, but diuron is superior to either. The addition of diuron to isocil is only of advantage for the control of any resistant weeds of the latter chemical. Paraquat does not appear to be of value here. The main resistant weeds at the 10 lb rates are as follows:

isocil — pearlwort, mouse-eared chickweed, groundsel (*Senecio vulgaris*), *Poa annua*, and Chewings fescue (*Festuca rubra* var. *fallax*).

simazine — sorrel, *Poa annua*, Chewings fescue, chickweed, and white clover.

diuron — plantains, groundsel and ragwort.

At the lower rates of isocil there were in addition, hawkesbeard (*Crepis capillaris*), catsear (*Hypochaeris radicata*), sorrel, white clover and grasses. Part of the trial was on a slight slope, and considerable lateral movement was seen.

TRIAL 5

This trial was laid down in September, 1962, on a high fertility cocksfoot-browntop pasture on a loam soil of high base exchange capacity. Paraquat at 1 lb was added to simazine, diuron and monuron. Table 3 shows the average percentage bareground after eight months with a total rainfall of 27 in. during the period.

TABLE 3: EFFECTIVENESS OF SOIL STERILANTS UNDER HIGH FERTILITY

Treatment	Percentage Bareground	
	10 lb	20 lb
simazine	50	100
diuron	50	95
atrazine	20	95
isocil	70	70
monuron	2	10
ureabor (400 lb)	0	0

The more soluble chemicals are quickly losing their residual toxicity in this particular trial site, because of the active growth of the regenerating resistant species present. In eight months the bareground given by the 10 lb rates is only about half that given at six months. The main resistant species present are:

simazine — grasses, docks (*Rumex* spp.), buttercups, and vetches (*Vicia* spp.).

atrazine — docks, grasses, buttercups.

diuron — grasses, docks, plantains and groundsel.

monuron — docks, fennel (*Foeniculum vulgare*), plantains, groundsel and grasses.

isocil — buttercups, and grasses.

ureabor — buttercups, docks, grasses, and flatweeds.

TRIAL 6

Trial 6 was laid down at the same area and time as Trial 5, and was designed to compare the effect of additives paraquat 1 lb and a mixture of dichloropropionic acid 7.4 lb plus amitrole 1 lb to diuron and simazine each at 10 lb. After eight months the following average % bareground was obtained:—

Chemical	No additive	+ Paraquat	Dichloropropionic acid + Amitrole
diuron	35	60	90
simazine	15	10	40

The paraquat failed to control browntop, the dominant grass present, and so the normal mixture for prior "knockdown" was superior. Diuron gave much better control of the buttercups which are beginning (May, 1963) to grow vigorously. It is surprising that the difference between the two chemicals diuron and simazine is so great in view of the results obtained in Trial 5 where similar weed species were present.

TRIAL 7

Laid down in October, 1962, on a sand soil, all treatments in this trial were applied at 20 lb and included paraquat 1 lb. After eight months (23 in. of rain) the results were: simazine and diuron — 99% bareground; monuron — 98%; atrazine — 94%; and isocil — 88%. Resistant species on all plots included lupins (*Lupinus arboreus*). Subterranean clover (*Trifolium subterraneum*) appeared on

atrazine and isocil treated areas, and cress (*Coronopus didymus*) on isocil only.

TRIAL 8

This trial was sprayed in October, 1962, on a sandy loam soil. All sprayed treatments were at 20 lb and included paraquat 1 lb. After six months (19.4 in. rain) the results were: isocil — 100% bareground; simazine — 92%; atrazine — 90%; monuron — 88%; diuron — 85%; fenuron — 22% and ureabor 400 lb — 45%. The resistant species for all treatments included paspalum and Californian thistles (*Cirsium arvense*). Browntop (*Agrostis tenuis*) was present on atrazine and all urea treatments and plantains were present on the urea treatments. Fenuron plots were yarrow (*Achillea millefolium*) dominant.

DISCUSSION

Although largely interim, the results suggest that rainfall is of less importance than soil type and fertility, as the yearly rainfall is about 40 to 50 in. Of the ureas, the most soluble one used, fenuron (3,850 ppm), did not give acceptable control for more than six months, but is of use for certain scrub infestations. Under average rainfall, monuron (230 ppm) is about equal to diuron (42 ppm), but only on the more sandy soils, as loam soils of higher fertility quickly "inactivate" it. This is in agreement with the detailed work of F. A. H. Meeklah (pers. comm.) who has shown that under low rainfall (30 in.) on sandy soils, monuron persisted up to one-and-a-half years, and was equal to simazine. However, under silt loam conditions, he showed that simazine, although possibly inferior to diuron, was much better than monuron. There is little or no difference between simazine and diuron except where buttercups are a problem. Simazine fails to control a number of grasses and also most members of the Papilionaceae family, but is still slightly superior to atrazine except for some specific grass species. Isocil is promising as a sterilant, but it appears that it has less residual life than diuron or simazine, and some members of the Compositae family are resistant. Ureabor at 400 lb gave good control for only three or four months, which is in contrast to the twelve months obtained by F. A. H. Meeklah (pers. comm.) on a silt loam soil.

For satisfactory results, the choice of a sterilant is limited to diuron, simazine, or a uracil (probably bromacil). The vegetation present, the need for added specifics considered, and cost, would determine the decisive choice.

ACKNOWLEDGEMENTS

Most of the drain trials were conducted by Advisory Officers of the Farm Advisory Division. The author is grateful for the helpful comments from F. A. H. Meeklah on his work at the Taieri Agriculture Centre, Mosgiel.

REFERENCE

Devereaux, D. D., 1956: *Proc. 9th N.Z. Weed Control Conf.*, pp. 62-65.