CROPPING WITHOUT CULTIVATION AT MARTON

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Summary

Swedes, turnips and choumoellier were established following pasture destruction with paraquat di-(methyl sulphate) and 2,2-DPA/amitrole and the results were compared with cultivation as a means of seedbed preparation. In addition, the effect of the time of application of the chemicals and the time of sowing after spraying was also determined. 2,2-DPA/amitrole gave results which compared favourably with cultivation, but paraquat allowed regrowth, particularly white clover, and was not satisfactory for chemical ploughing under the medium to high fertility conditions which exist at Marton. Time of application was shown to have a highly significant effect on the numbers of plants which established, but there was no correlation between numbers of plants and the final yield obtained. There were no consistent differences in yield or plant numbers as a result of sowing seed two and four weeks after spraying.

INTRODUCTION

FOR SEVERAL YEARS now it has been demonstrated that crops can be established and grown by chemical methods equally as well as by conventional means, provided that the correct chemicals and techniques are used and that weather conditions following sowing are favourable. This technique of chemical ploughing is universally recognized as being of great potential since it will allow the introduction of pastures and crops in situations where cultivation is difficult or impossible because of rough topography, high rainfall, erosion problems, stony soil or low-lying waterlogged conditions. Until very recently the only grass-killing chemical available for this work was 2,2-DPA which is not altogether ideal. Its two principal disadvantages are a residual toxicity life in the soil and the fact that, when used at economic rates, grasses show marked differences in susceptibility, no one time of application giving optimum control of all species. In 1960, paraquat di-(methyl sulphate) was released for experimental purposes and early work indicated that not only did it have no residual life in the soil but its grass-killing potential was equal to or greater than that of 2,2-DPA (Bramley, 1961). Thus, paraquat appeared to be very suitable for chemical ploughing work and trials were initiated in which its performance was compared with 2,2-DPA. This paper deals with a series of three trials at Marton Experimental Area in which crops were established following treatment with 2,2-DPA and with paraquat, the two chemical methods being compared with cultivation.

EXPERIMENTAL

The trials were situated adjacent to one another on a uniform site at Marton Experimental Area. The soil type is Marton loam, a soil of medium to high natural fertility and the sward prior to treatment was a run-out pasture containing perennial ryegrass

(*Lolium perenne*), cocksfoot (*Dactylis glomerata*), goosegrass (*Bromus mollis*), browntop (*Agrostis tenuis*), sweet vernal (*Anthoxanthum odoratum*) and white clover (*Trifolium repens*). In each trial, a single crop (swedes, turnips, or choumoellier) was sown and the effect of different methods of seedbed preparation, time of application of weedkillers, and time of sowing after spraying on the establishment and production of the crop was determined.

DESIGN

All trials had treatments identical in form — i.e., a $3 \times 2 \times 2$ factorial plus two additional cultivation treatments arranged in three randomized blocks of 14 plots each.

SEEDBED PREPARATION

Chemicals

2,2-DPA/amtrole 7.4 + 1 lb a.i. per acre.

paraquat 2 lb a.i. per acre.

Chemicals were applied in 50 gal. water per acre with a tractor-mounted boom; the height of the sward at spraying was 2 to 5 in. There were three different times of spraying; dates are given in Table 2.

Cultivation

Cultivation was by rotary-hoeing to a depth of 4 to 5 in. but the tilth at sowing was not particularly satisfactory because dry weather had slowed decomposition of the turf.

METHOD AND TIMES OF SOWING

Seed was drilled into the cultivated ground and chemically treated sward at 7 in. spacings. Serpentine-superphosphate 310 lb per acre was applied mixed with the seed, and after drilling the plots were chain harrowed to ensure that the seed was well covered. Varieties, sowing rates and depth of seeding are given in Table 1.

TABLE 1: CROPS SOWN

Crop	Variety	Rate of Sowing (lb. per ac.)	Depth of Sowing (in.)
Turnips	Green Globe	1¼	½ to 1½
Choumoellier	Medium Stem	4	½ to 1½
Swedes	Superlative	1½	½ to 1

Seed was sown two and four weeks after spraying as shown in Table 2.

TABLE 2: TIMES OF SPRAYING, SOWING AND HARVESTING

		Turnips and Choumoelliers	Swedes
Sprayed	.....	Sept. 6, 1961	
Sown	.....	Sept. 29, 1961	
		Oct. 4, 1961	
Sprayed	.....	Sept. 28, 1961	Sept. 28, 1961
Sown	.....	Oct. 12, 1961	Oct. 12, 1961
		Oct. 25, 1961	Oct. 25, 1961
Sprayed	.....	Oct. 17, 1961	Oct. 17, 1961
Sown	.....	Nov. 1, 1961	Nov. 1, 1961
		Nov. 15, 1961	Nov. 15, 1961
Sprayed	.....		Nov. 10, 1961
Sown	.....		Nov. 27, 1961
			Dec. 12, 1961
Cultivated	.....		
Sown	.....	Nov. 1, 1961	Nov. 27, 1961
		Nov. 15, 1961	Dec. 7, 1961

Harvested turnips: Mar. 8, 1962

Harvested swedes: May 1, 1962

Harvested choumoellier: Apr. 12, 13, 1962

METHOD OF ASSESSMENT

All treatments of each trial were sampled for yield and plant numbers at the same time so that a comparison of dates of application could be made. However, to ensure that results of times of application were not anomalous due to differences in maturity, samples of turnips were taken for each time of spraying as the crop became mature. There was no reduction in yield from the first to the final sampling.

RESULTS

COMPARISON OF METHODS OF SEEDBED PREPARATION

Tables 3 and 4 compare the effects of the different methods of seedbed preparation on crop yield and plant numbers.

TABLE 3: EFFECT OF METHODS OF SEEDBED PREPARATION ON PLANT NUMBERS
(Plants per 36 sq. ft)

Method	Turnips	Choumoellier	Swedes
Paraquat	80 cC	116 a	40 b A
2,2-DPA/amitrole	104 bB	131 a	47 a A
Cultivation*	140 aA	120 a	44 ab A
CV	22.9%	17.5%	21.0%

* Not strictly comparable because of the different times of sowing and spraying.

TABLE 4: EFFECT OF METHODS OF SEEDBED PREPARATION ON YIELDS
(lb dry matter per acre)

Method	Turnips	Choumoellier	Swedes
Paraquat	2860 bB	3300 cC	3450 bB
2,2-DPA/amitrole	6820 aA	6940 bB	6220 aA
Cultivation*	7710 aA	8870 aA	5700 aA
CV	18.0%	20.2%	17.3%

* Not strictly comparable because of the different times of sowing and spraying.

The best chemical treatment — *i.e.*, 2,2-DPA/amitrole — did not give a significantly greater number of plants or superior yield over cultivation, but overall results were satisfactory.

Paraquat gave yields which were markedly inferior compared with the other two methods of seedbed preparation and plant numbers were reduced.

EFFECT OF TIME OF APPLICATION

The effect of time of application on plant numbers was consistent for all three crops, the establishment being significantly better on plots sprayed before October 17. However, the effect on yield was not dependent upon plant numbers. For example, for turnips and choumoellier, yields for the late application with only approximately half the number of plants of the early application were similar to (turnips) or significantly better than (choumoellier) those of the early application.

TABLE 5: EFFECT OF TIME OF APPLICATION ON
PLANT NUMBERS
(Plants per 36 sq. ft)

<i>Time of Application</i>	<i>Turnips</i>	<i>Choumoellier</i>	<i>Swedes</i>
Sept. 6, 1961	105 aA	141 aA	
Sept. 28, 1961	103 aA	153 aA	49 aA
Oct. 17, 1961	68 bB	76 bB	40 bA
Nov. 10, 1961			41 bA
CV	22.9%	17.5%	21.0%

TABLE 6: EFFECT OF TIME OF APPLICATION ON YIELD
(lb dry matter per acre)

<i>Time of Application</i>	<i>Turnips</i>	<i>Choumoellier</i>	<i>Swedes</i>
Sept. 6, 1961	4,380 bB	4,260 bA	
Sept. 28, 1961	5,910 aA	5,600 aA	4,720 a
Oct. 17, 1961	4,230 bB	5,490 aA	4,580 a
Nov. 10, 1961			5,210 a
CV	18.0%	20.2%	17.3%

For swedes, the "Chemical $\times$ time of application" yield interaction was significant as shown in Table 7.

TABLE 7: "CHEMICAL $\times$ TIME OF APPLICATION"
INTERACTION — SWEDES
(lb dry matter per acre)

<i>Time of Application</i>	<i>Paraquat</i>	<i>2,2-DPA/amitrole</i>
Sept. 28, 1961	2,920 cC	6,510 a A
Oct. 17, 1961	2,820 cC	6,330 a A
Nov. 10, 1961	4,600 bB	5,560 ab AB

The above interaction shows that there were no differences among the 2,2-DPA/amitrole treatments applied at different times. The latest paraquat treatment, however, gave an increased yield which, although significantly greater than the two earlier paraquat treatments, was still apparently, but not significantly, lower than the 2,2-DPA/amitrole treatment of the same date.

EFFECT OF TIME OF SOWING

The effect of time of sowing after spraying on plant numbers and yield differed for each crop as shown in Tables 8 and 9.

TABLE 8: EFFECT OF TIME OF SOWING AFTER SPRAYING
ON PLANT NUMBERS
(Plants per 36 sq. ft)

<i>Time of Sowing after Spraying</i>	<i>Turnips</i>	<i>Choumoellier</i>	<i>Swedes</i>
2 weeks	82 bB	145 aA	44 a
4 weeks	102 aA	103 bB	43 a
CV	22.9%	17.5%	21.0%

TABLE 9: EFFECT OF TIME OF SOWING AFTER SPRAYING
ON YIELD
(lb dry matter per acre)

<i>Time of Sowing after Spraying</i>	<i>Turnips</i>	<i>Choumoellier</i>	<i>Swedes</i>
2 weeks	4,600 a	5,360 a	5,130 aA
4 weeks	5,080 a	4,880 a	4,540 bA
CV	18.0%	20.2%	17.3%

Sowing four weeks after spraying gave a higher number of turnip and a lower number of choumoellier plants than sowing two weeks after spraying, but yields were not significantly different. Conversely, for swedes, there was no significant difference in plant numbers between the times of sowing, but yields were significantly better if the crop was sown two weeks after spraying.

The "time of sowing $\times$ chemicals" interaction for turnips was significant for number of plants as shown in Table 10.

TABLE 10: "CHEMICAL $\times$ TIME OF APPLICATION"
INTERACTION — TURNIPS
(Plants per 36 sq. ft)

<i>Time of Sowing after Spraying</i>	<i>Paraquat</i>	<i>2,2-DPA/amitrole</i>
2 weeks	80 bB	84 bB
4 weeks	80 bB	125 aA

The interaction shows that the later time of sowing for 2,2-DPA/amitrole produced a higher number of plants than the other three treatments which did not differ significantly among themselves.

The effect of time of sowing cultivated plots on plant numbers and yield is shown in Tables 11 and 12.

TABLE 11: EFFECT OF TIME OF SOWING CULTIVATED
GROUND ON PLANT NUMBERS
(Plants per 36 sq. ft)

<i>Date Sown</i>	<i>Turnips</i>	<i>Choumoellier</i>	<i>Swedes</i>
Nov. 1, 1961	113 bB	133 a	
Nov. 15, 1961	167 aA	107 a	
Nov. 27, 1961			44 a
Dec. 7, 1961			44 a
CV	22.9%	17.5%	21.0%

TABLE 12: EFFECT OF TIME OF SOWING CULTIVATED
GROUND ON YIELD

<i>Date Sown</i>	<i>Turnips</i>	<i>Choumoellier</i>	<i>Swedes</i>
Nov. 1, 1961	8,190 a	7,430 bB	
Nov. 15, 1961	7,240 a	10,300 aA	
Nov. 27, 1961			6,190 a
Dec. 7, 1961			5,210 a
CV	18.0%	20.2%	17.3%

For turnips and choumoellier, the two times of sowing did not give the same relative results either for plant numbers or yield. There were no significant differences between the times of sowing swedes.

DISCUSSION

Although both chemical treatments gave satisfactory seedbed preparation, 2,2-DPA/amitrole gave much better permanent control of the pasture species and with this treatment the crops were never seriously affected by competition from regrowth. In contrast, paraquat gave very good initial control of vegetation but recovery growth began to show approximately six weeks after spraying and,

as the volunteer species developed, they obviously provided real competition to the crops, both for moisture and nutrients. White clover, which is resistant to paraquat, was the most severe competitor to the crops, but cocksfoot and perennial ryegrass were also troublesome. In the absence of interplant competition white clover spread rapidly and surviving plants of cocksfoot and perennial ryegrass developed into large clumps. This severe competition effect in the paraquat treatments apparently caused some reduction in plant numbers and severely reduced the yields compared with the 2,2-DPA/amitrole treatments. Only at the latest time of application for swedes was the total yield after paraquat pre-treatment not significantly less than that given by 2,2-DPA/amitrole (see Table 7). At that time of spraying, conditions were extremely dry and in the month following spraying, rainfall was only 0.79 in. The combination of dry weather plus paraquat resulted in a much better kill of the original sward than previously on the paraquat treated plots, with the result that regrowth was much less and yields were higher.

The trials have shown quite clearly that the chemicals used for crop establishment must give sufficiently lasting control of the pasture species to ensure that recovery growth does not compete with the crop. Therefore, under the medium to high fertility conditions such as exist at Marton, paraquat alone is not a satisfactory chemical to use for crop establishment. If a non-residual clover killer can be combined with paraquat for use in situations where clover is a problem, there is no reason to suppose that results will not be at least equal to those of the 2,2-DPA/amitrole mixture.

Yields of crops established with the 2,2-DPA/amitrole mixture compared well with those of the cultivation treatments. However, for choumoellier established by chemical means, it was observed that the stems tended to be thin, wiry and "hard", whereas those established by cultivation were much more succulent.

Time of application (*i.e.*, seedbed preparation) markedly affected the number of plants which established (see Table 5) but over all times there was no relationship between the numbers of plants and total yield (compare Tables 5 and 6). It seems clear that, within limits, growing conditions after establishment are much more significant than numbers of plants. Seedbed preparation at the end of September gave the best overall result for the three crops.

There were no consistent differences due to sowing seed two and four weeks after spraying. Blackmore (1961a,b) has shown that a period of chemical fallow gives increased yield in low fertility areas, but under the medium to high fertility Marton conditions this effect could not be demonstrated in a dry season.

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