CROP PRODUCTION IN CHEMICALLY KILLED TURF

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SUMMARY

The Department of Agriculture has now conducted a considerable number of trials on the growing of crops in chemically killed turf. Most of this work has been with brassicas and in several replicated trials yields have been obtained statistically equal to those given by conventional cultivation. While it is too early to evaluate the method fully, a thorough investigation of its possibilities is warranted.

INTRODUCTION

I think it is time we took a close look at conventional cultivation practices and endeavoured to discover just what cultivation does and what is necessary or beneficial. Some work of this nature is being undertaken in the United States of America and there "minimum tillage" (1) is already being practised in certain crops. This came about initially because of the problem of compaction under a system of intensive cropping, but because of the good results obtained has become an established practice. In New Zealand the land generally is in crops for only a short period and then back under pasture and loss of soil structure is less of a problem. Nevertheless we are a long way from knowing why we cultivate as we do.

The use of chemicals to destroy existing vegetation and the subsequent establishment of crops without cultivation is carrying this to the extreme. Admittedly we still do not know where this method will prove useful, but we have already obtained some very interesting results in comparison with conventional cultivation. If it did no more than make us look critically at established cultivation practices, the work would be well worth while.

The Department of Agriculture has now conducted 43 field trials on the growing of crops in chemically killed turf. Some similar work has also been carried out in the United States of America (2), though little has been published. The great majority of the New Zealand work has been with brassicas and it is the results achieved with these crops which I will discuss.

TECHNIQUE

(a) *Chemicals Used for Pasture Destruction*

The first essential is a good kill of pasture, enabling the crop to establish ahead of any recovering pasture plants or flatweeds, etc., which may come in. The best mixture used in pasture destruction to date is dalapon at 10 lb per acre plus amitrol at 2 lb per acre. This mixture has given good results under a fairly wide range of conditions. All the common pasture grasses with the exception of *paspalum dilatatum* are controlled with this mixture. White clover (*Trifolium repens*) is severely checked and most weed species are controlled. A few broad-leaved weeds such as buttercup (*Ranunculus* spp.) are resistant and, if present, a little 2,4-D may need to be added to the mixture. The pasture should be sprayed when short and as even as possible; preferably short regrowth after hard grazing. The chemicals are best applied in the minimum amount of water required to give good foliage cover, and preferably 24 hours of fine weather should follow spraying.

Recent work with erbon, dalapon/2,4,5-TP mixtures, and fenac alone and in combination with amitrol have not proved superior to the dalapon/amitrol mixture.

(b) *Method of Sowing*

Brassicas being small seeded have been successfully sown broadcast and drilled. In both cases the seed has usually been sown mixed with the fertiliser (reverted or serpentine superphosphate).

Drilling in the chemically killed turf has mainly been carried out with a grain drill, using hardened "Grassland" tips on the coulters. While this method is reasonably satisfactory, there is need for more work on specially designed drills. The "Grassland" tips tear and consequently leave a rather open drill. A cutting action should be more satisfactory. Further trials with disc drills are necessary.

In the main, sowings about a fortnight after spraying have proved most successful. This is essentially a compromise, allowing the crop to establish ahead of any recovering pasture components and yet avoiding as much as possible any initial nitrogen deficiency during the breakdown of organic matter.

RESULTS OF TRIALS

Many early trials were failures or gave poor results because some experience with the method is necessary before its possibilities can be checked in a particular area. Also many early trials failed because of the use of the wrong chemicals or insufficient quantities to give a good kill of pasture. The results obtained in more recent trials, therefore, are given.

Five trials conducted under moderate to high fertility conditions will be discussed. Two of these trials were conducted at Rukuhia Soil Research Station in the 1958-59 season, the soil type being Horotiu sandy loam.

Both trials had four main treatments:

A. Cultivated (rotary hoed).

B. Cultivated plus 15 lb of sodium monochloroacetate (MCA) post-emergence.

C. Sprayed with dalapon at 10 lb plus amitrol at 2 lb (two weeks before sowing).

D. Sprayed with dalapon at 5 lb plus amitrol at 1 lb (two weeks before sowing).

Each was split into four sub-plots: Broadcast, low seeding rate; broadcast, high seeding rate; drilled, low seeding rate; drilled, high seeding rate. Each sub-plot was split into halves, one of which received nitrogen (2 cwt of "Nitrolime"). There were two replications.

1. Chou Moellier Trial (Medium Stem)

The seed was sown on 23/10/58 at 7 lb and 3½ lb in 14 in. rows and the crop harvested in June-July 1959. The following is the statistical analysis of yields obtained in dry matter lb/acre:

A. Cultivation: No weed control	1,200	b	A	5,040	b	B	6,240	b	B	550	a	A
B. Cultivation + MCA	1,460	a	A	8,580	a	A	10,040	a	A	570	a	A
C. Dalapon 5 lb + Amitrol 1 lb	1,410	ab	A	3,760	c	B	5,170	b	B	450	a	A
D. Dalapon 10 lb + Amitrol 2 lb	1,190	b	A	5,350	b	B	6,541	b	B	490	a	A
Low seeding rate	1,380	a	A	5,900	a	A	7,280	a	A	380	b	B
High seeding rate	1,250	a	A	5,470	a	A	6,710	a	A	650	a	A
Broadcast	1,220	b	B	4,800	b	B	6,030	b	B	390	b	B
Drilled	1,410	a	A	6,570	a	A	7,960	a	A	640	a	A
No nitrogen	1,300	b	B	4,730	b	B	5,590	b	B	520	a	A
Nitrogen	1,330	a	A	6,630	a	A	8,050	a	A	500	a	A
C.V.	14.1%			17.8%			16.2%			17.0%		

The high rate of chemical treatment gave a total yield higher, though not significantly so, than cultivation without MCA.

The low rate of chemicals failed to give an adequate kill of pasture, and the total yield from this treatment is lower, though not significantly different from the high rate of chemicals and cultivation without MCA.

Weeds (mainly *Polygonum persicaria*) were prevalent on some cultivated plots. Good control was obtained with MCA and cultivation plus MCA gave a significantly higher yield (1 per cent level) than other treatments.

There was no marked effect due to seeding rate.

Drilling was better than broadcasting, the differences in yield being greatest in the high rate of chemical treatment.

In general there was a good response to nitrogen, but it was no greater on the chemical than on the cultivated plots.

2. Turnip Trial (Hardy Green Globe)

The seed was sown on 24/10/58 at 16 1-3 oz and 32 2-3 oz/acre and the crop harvested in January 1959.

The following is the statistical analysis of the yields obtained in dry matter lb/acre.

A. Cultivation: No weed control	2,290	b	A	2,180	a	A	4,470	a	A	18	a	A
B. Cultivation + MCA	2,460	b	A	2,140	a	A	4,590	a	A	17	a	A
C. Dalapon 5 lb + Amitrol 1 lb	780	c	B	850	b	B	1,640	b	B	15	a	A
D. Dalapon 10 lb + Amitrol 2 lb	3,410	a	A	2,240	a	A	5,650	a	A	8	b	B
Low seeding rate	2,180	a	A	1,630	b	A	3,810	a	A	11	b	B
High seeding rate	2,290	a	A	2,080	a	A	4,370	a	A	18	a	A
Broadcast	2,020	b	B	1,760	b	A	3,770	b	B	14	a	A
Drilled	2,460	a	A	1,950	a	A	4,410	a	A	15	a	A
No nitrogen	1,870	b	B	1,400	b	B	3,280	b	B	14	a	A
Nitrogen	2,600	a	A	2,300	a	A	4,910	a	A	15	a	A
C.V.	15.4%			19.8%			16.7%			14.3%		

The main feature of this trial was the good yield from the high rate of chemical treatment, higher, though not significantly so, from both cultivated treatments.

The low rate of chemical failed to kill the pasture and the yield obtained was poor, significantly lower than other treatments at the 1 per cent level.

Weeds were only a problem on a few cultivated plots, and MCA made little difference to yields.

Seeding rate made little difference to yields on either cultivated or chemical plots.

Drilling gave a significantly higher (1 per cent level) total yield than broadcast.

Nitrogen also gave a significant increase (1 per cent level) in yield.

In both the above trials conditions were very good for the chemical treatments. Rain followed soon after sowing and there was adequate rain through the growing season.

Three similar trials have been carried out at Marton Experimental Area on Marton silt loam.

1. Swede Trial (Sensation) 1958-59

The design of this trial was similar to the Rukuhia trials, but there was only one cultivated treatment with no weedkiller. There were four replications of treatments.

The seed was sown on 11/12/58 (five days after spraying in chemical treatments) and the swedes harvested in late July 1959. The seeding rates were: Low, 1 lb broadcast and 12 oz drilled; high, 2 lb broadcast and 24 oz drilled.

The following is the statistical analysis of yields:

Treatment	Bulbs d.m. lb/ac.	5%	1%
A. Cultivated	4,130	a	A
B. Sprayed (dalapon 5 lb + amitrol 1 lb)	2,360	b	A
C. Sprayed (dalapon 10 lb + amitrol 2 lb)	3,600	ab	A
Broadcast	3,040	b	B
Drilled	3,690	a	A
Low seeding rate	3,250	a	A
High seeding rate	3,480	a	A
No nitrogen	3,100	b	A
Nitrogen	3,620	a	A
C.V.	28.7%		

The fertility of the area on which the trial was conducted was variable and the high rate of chemical treatment was penalised, as two of the four blocks fell in the low fertility area. These two blocks had much poorer crops than on cultivated plots, whereas the swedes on the other high chemical blocks equalled those on cultivated plots. In spite of this the total yield was not significantly below the cultivated treatment.

The low rate of chemical again gave a poor yield, the kill of pasture being inadequate.

Weeds (mainly *Polygonum persicaria*) may have reduced yields slightly on two of the four cultivated blocks.

Drilling again outyielded broadcasting, with the greatest difference on chemical plots.

Nitrogen increased yields only slightly and there was no significant difference due to seeding rates.

Rain fell soon after sowing in this trial and the season was not unduly dry.

Two further trials were conducted at Marton in the 1959-60 season. The layouts were the same as in the above trial, except that there were only two main treatments (no low rate of chemical) and six replicates.

2. Chou Moellier Trial (Medium Stem) 1959-60

The seed was sown on 17 and 18/11/59 (eight days after spraying the chemical treatments) and the trial was harvested in mid July 1960. The seeding rates were: Low, 3 lb broadcast and 2 lb drilled; high, 6 lb broadcast and 4 lb drilled.

The following is the statistical analysis of yields in green weight tons/acre (dry matter figures were not to hand in time):

Treatment	Leaves	5%	1%	Stems	5%	1%	Total	5%	1%
A. Cultivation	11.40	a	A	20.04	a	A	31.45	a	A
B. Dalapon 10 lb + amitrol 2 lb	11.11	a	A	16.05	b	B	27.16	b	A
Broadcast	11.28	a	A	17.30	b	A	28.59	a	A
Drilled	11.23	a	A	18.80	a	A	30.02	a	A
Low seeding rate	11.47	a	A	18.01	a	A	29.48	a	A
High seeding rate	11.04	a	A	18.09	a	A	29.13	a	A
No nitrogen	10.47	b	B	17.34	b	A	28.09	b	B
Nitrogen	11.77	a	A	18.75	a	A	30.52	a	A
C.V.	10.8%			14.2%			11.4%		

The yield of stems on the sprayed treatment was significantly lower (at 1 per cent level) than cultivated, and total yield was lower at the 5 per cent level.

Only nitrogen treatments showed a significant difference in yield (1 per cent level), nitrogen outyielding no nitrogen.

3. Swede Trial (Sensation) 1959-60

This trial was sown and harvested at about the same dates as the chou moellier trials, the seeding rates being the same as in the previous Marton swede trial.

The following is the statistical analysis of yields in green weight tons/acre and number of bulbs/acre:

Treatment	Bulbs tons/ac.	5%	1%	No. of Bulbs 1,000/ac.	5%	1%
A. Cultivation	17.3	a	A	65.7	a	A
B. Dalapon 10 lb + amitrol 2 lb	19.72	a	A	51.1	b	B
Broadcast	17.09	b	B	48.2	b	B
Drilled	20.55	a	A	68.5	a	A
Low seeding rate	19.10	a	A	46.8	b	B
High seeding rate	18.54	a	A	70.0	a	A
No nitrogen	19.11	a	A	59.6	a	A
Nitrogen	18.53	a	A	57.2	a	A
C.V.	13.7%			19.9%		

The yield of bulbs from the chemical treatment was higher, though, not significantly so, than the cultivated treatment.

Drilled outyielded broadcast, but there was little difference between seeding rates and levels of nitrogen.

The 1959-60 season over which these two trials were conducted was very dry. There was little rain for some time after seeding and conditions were dry until late autumn.

DISCUSSION

The results show clearly that good crops of brassicas can be grown without cultivation; root crops perhaps particularly so. The trials mentioned have all been carried out in the North Island, but good crops of swedes, turnips, and chou moellier have been grown by the method at Invermay Research Station. It is likely that good results can be obtained under quite a wide range of climatic conditions.

We have little information yet on soil type, but Marton silt loam is quite a heavy soil and one on which cultivation would be expected to prove beneficial.

Sowing in chemically killed turf is somewhat more hazardous for seed than with normal cultivation, as the seed has little cover. For this reason rain soon after sowing will improve results, particularly where the seed is sown broadcast. With drilled seed a little improvement in the machinery used would make sowing in chemically killed turf no more hazardous than in cultivated soil. Drilling is, of course, preferable, but where seed must be broadcast a higher seeding rate than normal is probably the best insurance against adverse weather. The trials have been conducted in varying seasons and good results obtained under dry and moist conditions. Also if the crop obtained is light, the ground cover between crop plants is clover and grass which later constitutes additional feed and not weeds.

Fertiliser requirements on land of moderate to high fertility do not seem to be any higher for the method than for cultivation. Nitrogenous fertilisers may give higher yields for some crops, but do not seem to be any more necessary than for cultivation.

The aspect of the work that needs much more investigation is the follow through from crop back into pasture. In districts where spring sowings are not satisfactory the best approach may be through a second crop such as turnips and then sow to pasture the following autumn.

CONCLUSION

Trial work conducted so far has shown that good crops of brassicas can be grown in chemically killed turf. We now need to establish under how wide a range of soil and climatic conditions these results can be achieved and also to extend the work with other crops. At present the high rates of chemicals required for turf destruction may limit the use of the method, but there is every hope of more efficient and cheaper chemicals in the future.

REFERENCES

1. George R. Free, *Agricultural Engineering* Feb. 1960 p. 96.
2. J. H. Davidson and K. C. Barrons "Down to Earth" Vol. 10, No. 3, p. 2.
3. S. N. Dawes, *Proceedings 11th N.Z. Weed Control Conference*, p. 109.
4. L. J. Matthews, *Proceedings 12th N.Z. Weed Control Conference*, p. 43.

DISCUSSION

Q.—I prefer cultivation for levelling effects of paddock.

A.—I do not consider chemical ploughing will replace ploughing for all requirements, levelling, etc.

Q.—I have had trouble with palatability of turnips under chemical ploughing.

A.—The trials were not grazed.

Comment: There was no difference in grazing preference at Rukuhia.

Q.—What is the cost of chemical ploughing versus normal cultivation?

A.—This is hard to answer. Cultivation cost varies greatly; chemical cost is fixed, but is high.

Comment: Cultivation and weedkiller costs are similar, as crops established by normal cultivation method usually require treating with a chemical.

Comment: At Invermay no palatability differences were picked up, and chemically ploughed trials usually were cleaner than cultivated. Bulbs sit well up on turf, allowing more efficient feeding. Disc drill is not satisfactory.

Q.—Why the big difference between the number of bulbs (18 versus 8) in one trial?

A.—Poorer germination on chemical treated plots than on cultivated. Chemical treated plants were slower maturing than drilled or cultivated.

Q.—Can chemical ploughing go from a pasture through a root crop back to pasture without cultivation?

A.—Not much work done, but pasture should be able to be resown chemically if necessary after roots.

Comment: There is a long term trial at Marton that may give the answer but it is too early yet for comment on the Marton trial. Chemical ploughing will extend locality where crops can be grown.

Q.—What is the highest yield of swedes or turnips under chemical ploughing?

A.—About 30 tons per acre in North Island trials. There are no comparisons with Southland yields.