No.6 THE CONTROL OF THISTLES (SILYBUM AND ONOPORDUM) BY PERENNIAL PASTURE SPECIES

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SUMMARY

Experiments conducted in the South-West Slopes and Southern Tablelands regions of New South Wales have shown that lucerne and Phalaris tuberosa effectively control Silybum after the first year of establishment. The use of 2,4-DB in reducing weed competition in the year of establishment is suggested.

Five perennial grasses, viz. Phalaris tuberosa, Lolium perenne (Clunes), Dactylis glomerata (C.P.I. 2145), Festuca arundinacea (C.P.I. 1499) and Bromus inermis (C.P.I. 7073) have been tried against Onopordum, the most effective competitor in the first year being Dactylis glomerata. The use of amino-triazole, at ½ a pound per acre, on the young grasses, considerably depressed numbers and yields of thistles and increased yield of the grasses.

1. INTRODUCTION

Silybum marianum (L) Gaertn. and Onopordum spp. (O. acanthium L. and O. illyricum L. and supposed hybrids) though of only restricted, but certainly increasing, distribution in the Southern Tablelands and South-West Slopes regions of New South Wales - in contrast to the much wider distribution of Carthamus lanatus L. and Cirsium vulgare (Savi) Ten. - are of considerable importance as they form very dense infestations in many of the more fertile and/or highly improved areas. Infestations generally originate at and spread from sheep and cattle camping sites.

Silybum marianum is an autumn-winter-spring growing annual which sends up flowering stalks in October. The main germinating period is in the first six months of the year. Onopordum spp. are biennials which, provided rainfall is adequate, are capable of germinating in profusion at any time of the year. The strongest growth occurs in middle to late

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spring. Flowering begins in late November to early December and continues over an extended period. Rosettes commonly oversummer.

In the case of Silybum it was proposed to test, in a replicated trial, whether lucerne and phalaris once established in a badly infested area could effectively suppress or prevent invasion by the thistle. The perennials were to be compared with annual species, viz., wimmera rye grass and subterranean clover in this respect. In order to give the sown species a good chance of becoming established it was planned to remove the thistles by hand in the first season. If it could be shown that lucerne and Phalaris were effective, particular attention would then be paid to difficulties in the year of establishment.

It was proposed also to try a number of perennial grass species against Onopordum. In this case, because numbers of thistles were expected to be too great to make removal by hand practicable, and also because this could never be really effective on account of the power of the thistle to regenerate from the hypocotyl region, a herbicide would have to be found to suppress the thistles in the first year.

2. EXPERIMENTAL

(a) Silybum

The experiments on control of Silybum have been carried out between Yass and Cowra ($34\frac{1}{4}^{o}$S.) on a very fertile, medium to heavy textured red soil derived, at least in part, from diorite. The area which carried a dense cover of Silybum in early 1958 is essentially a sheep-camping site and carries a big range of annuals commonly associated with such areas. These include, amongst others, Capsella bursa-pastoris (L.) Medic., Sisymbrium officinale (L.) Scop., Papaver hybridum L., Polygonum aviculare L., Chenopodium carinatum R. Br. and Chenopodium album L. Monthly rainfall data for the experimental period are given in Table 1.

Table 1.

Monthly Rainfall Data

	Mar	Apr	May	Jne	Jly	Aug	Sept	Oct	Nov	Dec	Jan	Feb
1958-9	277	56	244	163	158	386	143	305	161	225	97	412
1959-60	477	423	58	212	119	73	111	394	159	12	325	83

Mean seasonal temperatures (maxima and minima) for the area estimated from data for Yass and Cowra (Commonwealth of Australia, 1956) are given in Table 2.

Table 2.

Mean Seasonal Temperatures

	Autumn (March-May)	Winter (June-August)	Spring (Septr-Novr)	Summer (Decr-Feby)
Mean max.	74°F	58	74	87
Mean min.	47°F	37	45	58

Plots were sown to lucerne (Hunter River), Phalaris tuberosa (Commercial), subterranean clover (Mt. Barker), Phalaris and subterranean clover, wimmera rye grass and wimmera rye grass and subterranean clover, in a replicated trial in autumn (22nd May) 1958. Lucerne and Phalaris were sown also in spring (1st October) 1958.

On the autumn-sown plots, thistles were cut at ground level in the spring of 1958. No significant difference between sown species in terms of fresh weight of thistles produced was evident. After the very wet summer-autumn period in 1959 thistles were again harvested and fresh weights obtained, on 27th April 1959. Counts of thistles were made on the 10th March and on 27th April. Results (means of square root transforms) are given in Table 3.

Table 3.

Thistle Yields and Counts (Autumn, 1959)

Sown species	Yield of thistles 27/4/59 Means of $\sqrt{\text{data}}$		Counts of thistles Means of counts made on 10/3/59 and 27/4/59 $\sqrt{\text{data}}$	
Phalaris	5.3		30.5	
Phalaris-sub clover	3.7	S.D.	26.3	
Wimmera rye	15.3	5.4 (5%)	38.7	S.D.
Wimmera rye-sub clover	17.7	7.6 (1%)		9.3 (5%)
		11.0 (1%)	40.2	12.5 (1%)
Sub clover	17.0		52.0	16.6 (.1%)
Control - no sown species	13.0		40.5	
Lucerne	0		0	

The lucerne plots showed complete control of thistles, the Phalaris plots considerable reduction over thistles in the plots sown to annuals. The actual fresh weights of thistles varied from 0 in lucerne and 1 to 2 tons per acre in the phalaris plots to about 11 tons per acre in the annual plots. The actual numbers of thistles varied from 0 in lucerne and 20 to 25 per square yard in the phalaris plots to 30 to 60 per square yard in the annual plots. The depression of yield of thistles in the phalaris plots would appear to be due more to direct competition between phalaris and thistles than to reduction in numbers. The number of thistles in all plots showed a slight reduction between early March and late April - mean √data 10/3/59 41.5, 27/4/59 34.6 least S.D. 5.5 (5%), probably due to competition between the thistles themselves. The differences measured in the harvest of autumn 1959 have been maintained under conditions of mowing and intermittent heavy grazing.

Of the species sown in the spring lucerne was the only one to survive despite good early establishment of both. The lucerne gave complete control of thistles at the time of the autumn 1959 harvest of the plots sown in autumn 1958. All the Phalaris plants died in the hot months December and January and were replaced by a dense cover of Chenopodium carinatum which delayed germination of thistles. The thistles, however, grew profusely later in the year.

Lucerne and Phalaris have also given almost complete control of thistles after the first year of establishment, during which thistles were cut at ground level, in plots sown in autumn 1959.

Two experiments have been carried out on practical elimination of thistles in the year of establishment of lucerne and Phalaris.

In 1959, lucerne was sown in the autumn (17th April) and in the spring (14th August), half of the sutumn-sown plots being sprayed with 1 pound of 2,4, dichloro phenoxybutyric acid (2,4-DB) in the form of the sodium salt on the 6th August. All plots were harvested in the middle of November, the mean yields of lucerne (oven dry weight) being:

Autumn sown		Spring sown
Unsprayed	Sprayed	
1.7 cwt/acre	9.5 cwt/acre	4.2 cwt/acre

There was a considerable response in the autumn-sown sprayed lucerne and the spring-sown lucerne outyielded the autumn-sown unsprayed.

In 1959, Phalaris was sown in the autumn (17th April) and sprayed on August 14th with ¼ and ½ pound per acre of 2,4-D and 4-chloro, 2-methyl phenoxyacetic acid (MCPA) and with ½ and 1 pound of 2,4-DB and 4-chloro, 2-methyl phenoxybutyric acid (MCPB) all in the form of the sodium salt. Counts of Phalaris plants were made in May 1960. The establishment of Phalaris was very poor and patchy in this experiment but the results indicate that 2,4-DB and, to a less extent, 2,4-D could probably be used to advantage in such a situation.

(b) Onopordum

The experiments on control of Onopordum have been carried out at Lake Bathurst (35°S.) near Goulburn on a light-textured grey soil which has supported subterranean clover for many years. The thistles in this area are assumed to be hybrids between O. acanthium and O. illyricum. Lepidium hyssopifolium Desv. is very abundant also.

Plots were sown to five perennial grasses, viz. Phalaris tuberosa (Commercial), Lolium perenne (Clunes), Bromus inermis (C.P.I. 7073), Festuca arundinacea (C.P.I.1499) and Dactylis glomerata (C.P.I. 2145) both in the autumn (12th May) and in the spring (7th September) of 1959. The three latter species have shown promise under grazing conditions at Canberra.

The autumn and spring-sown plots were sprayed with ½ pound of amino triazole (amitrol) per acre on 23rd September and 10th November respectively. In preliminary experiments amitrol, at a rate of ½ pound per acre, had shown promise against Onopordum seedlings.

Thistles were counted and harvested in all autumn sown plots in December 1959, and in the sprayed plots also, in February 1960 and April 1960. Thistles were counted and harvested in the spring-sown plots in December 1959. Grasses in all plots were harvested in December 1959.

The rainfall over the experimental period, though high, has been very erratic and is tabulated together with sowing, spraying and harvesting dates in Table 4.

TABLE 4.

Sowing, Spraying and Harvesting Dates

1959	March 1 April 3	915
	April 14 - April 25	20
	May 12	Autumn sowing
	May 19 - June 13	64
	June 23 - July 21	873
	August 8 - September 7	97
	September 7	Spring sowing
	September 15 - Septr 20	74
	September 23	Spraying of sutumn-sown plots
	October 4 - November 8	1045
	November 10	Spraying of spring-sown plots
	November 13 - Novr 30	227
	December 5 - Decr 12	53
	December 4 - Decr 18	Harvesting of thistles and grass in autumn and spring-sown plots
1959-60	December 26 - Feby 15	387
1960	February 17	Harvesting of thistles in autumn-sown plots
	February 27 - April 28	236
	April 29	Harvesting of thistles in autumn-sown plots

Mean seasonal temperatures (maxima and minima) for Goulburn (Commonwealth of Australia, 1956) are given in Table 5.

TABLE 5.

Mean Seasonal Temperatures

	Autumn (March-May)	Winter (June-August)	Spring (Sept-Novr)	Summer (Decr-Feby)
Mean max.	68°F	54	69	81
Mean min.	47°F	37	45	55

The results of harvest and counts are given in Tables 6 (autumn-sown) and Table 7 (spring-sown).

TABLE 6.

Autumn-sown plots

Grass Yields, Thistle Yields and Numbers
December, 1959

	Plots sown to	Lolium	Dactylis	Bromus	Festuca	Phalaris	No sown grass
Grass Yields (cwt.d.m./acre)	Unsprayed	10.7	12.4	3.3	1.8	1.4	
	Sprayed	24.8	22.7	10.6	7.6	5.9	
Thistle Yields (cwt.d.m./acre)	Unsprayed	4.6	2.7	7.3	7.5	5.1	8.7
	Sprayed	1.2	1.3	2.2	1.5	1.9	2.7
Thistle numbers (sqr. yd.)	Unsprayed	55	31	57	51	40	66
	Sprayed	31	11	29	21	27	32

Thistle Yields

(cwt.d.m./acre) December, 1959, February and April, 1960

Sprayed plots sown to	December	February	April
Lolium	1.2	4.6	4.5
Dactylis	1.3	1.5	1.8
Bromus	2.2	5.1	3.7
Festuca	1.5	3.5	4.5
Phalaris	1.9	4.6	5.7
No sown grass	2.7	6.5	7.1

Thistle Numbers (sqr.yd.)

December, 1959, February and April, 1960.

Sprayed plots sown to	December	February	April
Lolium	31	18	10
Dactylis	11	8	8
Bromus	29	19	18
Festuca	21	8	16
Phalaris	27	21	20
No sown grass	32	16	14

TABLE 7.

Spring-sown plots

Grass Yields, Thistle Yields and Numbers, December, 1959

	Plots sown to	Lolium	Dactylis	Bromus	Festuca	Phalaris	No sown grass
Grass Yields (cwt.d.m./acre)	Unsprayed	6.5	5.6	3.3	1.9	2.0	
	Sprayed	10.3	10.5	4.2	2.8	2.8	
Thistle Yields (cwt.d.m./acre)	Unsprayed	8.8	8.7	12.5	12.5	13.0	11.3
	Sprayed	3.5	2.8	4.7	6.8	4.6	5.0
Thistle numbers (sqr.yd.)	Unsprayed	46	41	39	35	48	42
	Sprayed	32	18	34	35	29	38

In the autumn-sown plots the marked effect of amitrol in depressing numbers and yield of thistles is easily seen and the response in terms of grass yield is quite striking. Lolium perenne and Dactylis glomerata are clearly the best grasses in

terms of yield after the first season. In the summer period, however, Lolium has lost ground in that the dry weight of thistles has increased markedly, whereas that in the Dactylis plots has kept relatively constant. There has been slight mortality of thistles over the summer period.

In the spring-sown plots Lolium and Dactylis again have proved to be most successful. The reduction of thistles in the spring-sown grasses was not so great as in the autumn-sown plots. Amitrol is apparently not so effective against the thistles during their period of most active growth.

There is no doubt that Dactylis glomerata C.P.I. 2145 appears to be the most promising of the grasses tried against Onopordum and present indications, after a heavy grazing of all plots in early May 1960, suggest that Dactylis will maintain its superior position.

3. DISCUSSION

(a) Silybum

Moore (1953) suggested that invasion of Silybum marianum could be prevented by the use of high producing perennial pastures such as lucerne or Phalaris tuberosa. The experiments reported here have demonstrated a high degree of suppression of thistles by these two species. In the case of lucerne thistles may be excluded altogether. The annual species tried proved to be quite ineffective, the explanation of their failure probably lying in the fact that Silybum seedlings are able to become well established with little competition from these species. The ability of lucerne and Phalaris to make growth quickly after late summer or autumn rains is undoubtedly an important factor in their success. Competition by these perennials for moisture is obviously important - contrast, the 11 tons fresh weight of thistles, about 90% of which is water, in the annual plots with 1-2 tons or less in the case of Phalaris and lucerne. Perhaps the poorer moisture status of the surface two-three inches under lucerne is the explanation for the relative degree of absence of thistles when compared with Phalaris. Moisture samples taken 2 days and 9 days after 150 points of rain in the autumn of 1960 showed the following moisture contents under sub-clover, Phalaris and lucerne:

	Sub-clover	Phalaris	Lucerne
2 days after rain	17.1%	17.2%	12.8%
9 days after rain	12.0%	11.1%	8.1%

Competition for nitrogen is unlikely to be an important factor, at least during the early stages of growth of thistles. The nitrogen content of soil from the experimental area is high (0.2 to 0.4%) and available nitrate measured in the autumn of 1960 was high in all plots (about 40 parts per million in the surface 3 inches on 3rd February and about 100 p.p.m. on 24th March).

The most difficult period with Phalaris and lucerne is undoubtedly in the year of establishment, not only because of the presence of the thistle but also because of the presence of other weeds associated with the thistle in such areas. Spring-sowing of lucerne may often be quite successful, without any control measures having to be taken. The thistles germinate only in very small numbers in the spring but, in some seasons, spring-summer growing weeds, e.g. Chenopodium spp. and Polygonum aviculare may afford considerable competition. Autumn sowing of lucerne with the early use of 2,4-DB would, however, appear to be more profitable. Phalaris establishment in the autumn has been relatively poor and the use of 2,4-DB or other herbicide to reduce weed competition would appear to be necessary. Mowing of both lucerne and Phalaris in the spring generally leads to satisfactory stands in the succeeding year but first year production may often be negligible. That Phalaris sown in the spring of 1959 failed completely, despite good establishment, makes it unwise to recommend spring sowing of Phalaris in areas with summers at least as hot as the experimental area. Perhaps late winter-early spring sowing is worth trying.

(b) Onopordum

The success of Lolium perenne (Clunes strain) and Dactylis glomerata (C.P.I.2145) in suppressing Onopordum is undoubtedly due, in part, to their early vigour. Both species have the capacity to form low spreading plants quickly in the colder part of the year. Under the favourable moisture conditions experienced in the spring both species made considerable growth. Lolium was less effective than Dactylis in the summer. It had dried off completely by the end of December while Dactylis kept green until late January.

Autumn sowing of plots has proved to be much more successful than spring sowing. In the spring, growth of young thistles is very rapid, while in the winter, growth is very slow.

Nitrate analyses made on 3 inch soil samples taken on 4th February 1960 from the autumn-sown plots showed that

nitrate levels in the Dactylis plots were appreciably lower than those in the other sampled plots. The means of analyses in parts per million, were Lolium 7.2, Dactylis 4.7, Phalaris 8.1 and unsown 8.3 (least S.D.5%-2.1, 1% 3.1). Similar differences have been shown in the spring-sown plots. The total nitrogen content of soil from the experimental area is about 0.15%. It can probably be safely inferred that Dactylis competes vigorously with the thistle for nitrogen. The gross nitrogen feeding capacity of Dactylis glomerata is well-known. In the very wet spring moisture can not be considered to have limited growth of grasses or thistles.

The poor showing of Phalaris tuberosa, the most commonly sown perennial grass in this region, must be noted. This can perhaps be mainly attributed to its poor establishment.

Difficulties during establishment of Lolium and Dactylis have been largely overcome by the use of amitrol. Subterranean clover which was abundant in the experimental area was certainly reduced by the application of amitrol, but this was probably advantageous in that the grasses were given a greater opportunity of becoming well established.

4. CONCLUSION

The use of perennial species in the control of Silybum and Onopordum has been clearly demonstrated and there is every reason to suppose that perennial species to control other species of annual and biennial thistles could be found, at least where climatic conditions are favourable. The need for herbicides to enable the perennial to compete more effectively with the thistles and other commonly associated weeds, must be emphasised.

5. ACKNOWLEDGMENTS

The author wishes to thank Mr. P. Stanley and Mr. J. Maple-Brown who made their properties available for the experiments; Dr. J.A. Carnahan and Messrs. J.D. Fitzsimon, D. Kelo, B. Quinlan and J.A. Robertson for assistance in the field, and Mr. J.R. Twine and Dr. J.R. Simpson for total nitrogen and nitrate analyses. Agricultural Services Pty. Ltd., Imperial Chemical Industries of Australia and New Zealand Ltd. and Timbrol Company kindly supplied the herbicides used.

6. REFERENCES

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