PASTURE MANAGEMENT WITH PARAQUAT IN TARANAKI

P. C. PALMER

ICI (N.Z.) Ltd., Palmerston North

Summary

The trials reported investigate the spring use of paraquat, in association with fertilizer application and broadcast seed, for the management of Taranaki pastures containing *Agrostis* spp., *Holcus lanatus*, *Anthoxanthum odoratum* and *Cynosurus cristatus*. Results with the chemical are better if soil fertility is moderate to high, when a satisfactory clover (*Trifolium* spp.) response is obtained following spraying. At the higher fertility site, the 2 oz paraquat, plus 6 cwt of potassic-superphosphate treatment is described as most promising.

INTRODUCTION

PASTURE MANAGEMENT practices based on the use of fertilizer and stock alone, have not proved to be adequate in dealing with the problem of ingress grasses in permanent pastures in high rainfall areas of Taranaki — that is, in those areas receiving in excess of 70 in. rainfall per annum.

Agrostis tenuis and *A. stolonifera* are the most serious ingress grasses, but sweet vernal (*Anthoxanthum odoratum*), Yorkshire fog (*Holcus lanatus*), *Poa trivialis* and *Poa pratensis* also occur.

The application of high rates of potassic-superphosphate coupled with winter management practices, such as mob wintering between electric fences, have failed to remove these grasses, which present a significant restraint on further attempts to increase stock production per acre.

Many pastures in this district with a long history of high rates of fertilizer application are characterized by poor white clover (*Trifolium repens*) vigour, little ryegrass (*Lolium* spp.) and a matt of *Agrostis* spp., sweet vernal and Yorkshire fog.

The use of paraquat in association with fertilizer and stock management was suggested as a possible solution to the problem.

This paper reports results obtained so far from a series of pasture field trials laid down to obtain quantitative data on this use of paraquat in the Taranaki district.

A comparison based on pasture production and composition was made between rates of fertilizer and rates of paraquat with and without over-sown seed.

EXPERIMENTAL

Three plot trials were laid down in Taranaki during the spring of 1967. Trials I and II were on dairy properties at Cardiff and Inglewood, respectively, and Trial III on a sheep property at Tututawa.

The discovery of a root knot nematode (Grandison, pers. comm.) on the site of Trial III has caused the postponement of mowing in the meantime.

The factors included in the trials were paraquat rates of nil, 2 and 4 oz (all rates in active ingredient per acre), with rates of fertilizer 30% potassic superphosphate of nil, 3, 6 and 12 cwt per acre.

Grasslands 'Ariki' ryegrass (*Lolium* hybrid) seed was broadcast at rates of nil and 15 lb per acre on the basis of a "split-plot" design.

Treatments were replicated four times at Trial I and five at Trial II in randomized blocks using plots of 15 ft × 4 ft at Trial I and 20 ft × 4 ft at Trial II.

An alternative mowing and grazing technique (Lynch, 1960) was used to measure dry matter production.

Point analysis was used to estimate pasture composition prior to the application of treatments, herbage dissection, however, being carried out on subsequent production cuts.

TRIAL I: CARDIFF, BURRELL VOLCANIC ASH SOIL.

This site is located just below the National Park boundary at an altitude of 1,400 ft and has an annual rainfall of more than 150 in. It was chosen to investigate the use of paraquat plus fertilizer in Taranaki under low soil fertility conditions.

Some conventional improvement has been started here — *i.e.*, potassic superphosphate at 2 to 3 cwt per acre had been applied in recent years but production is not high at 180 lb of butterfat per acre.

The paraquat and fertilizer treatments were applied on October 17, 1967, and the seed hand-broadcast on October 20, 1967.

Following treatment, the trial was closed to stock and was cut for dry matter production on November 28, 1967. After grazing and trimming, it was again closed on December 5, 1967.

A second cut was taken on January 9, 1968, at which time samples for herbage dissection were collected.

Grazing was followed by trimming and the trial was closed again on January 17, 1968, for a further cut and herbage dissection on April 1, 1968.

TRIAL II: INGLEWOOD, BURRELL VOLCANIC ASH SOIL

Having had a longer history of topdressing, this site is of higher fertility than that used for Trial I.

The paraquat and fertilizer treatments were applied on October 4, 1967, and seed broadcast on October 26, 1967.

Immediately after treatment, the trial was trimmed, closed and then mown for dry matter production on October 26, 1967 (unsprayed plots only). The second cut was taken on November 29, 1967, when all plots were harvested.

After grazing and trimming, further cuts for dry matter estimation and herbage dissection were taken on January 9, February 23 and May 23, 1968.

RESULTS

PRIOR COMPOSITION

The compositions of the pastures prior to treatment are shown in Table 1.

TABLE 1: PASTURE COMPOSITION OCTOBER 17, TRIAL I;
SEPTEMBER 29, TRIAL II

(Cover hits per 50 points)

<i>Species</i>	<i>Trial I</i>	<i>Trial II</i>
Ryegrass	2	6
White clover	11	6
<i>Agrostis</i> spp.	24	22
Other grasses*	8	11
Weed	5	5
Cocksfoot (<i>Dactylis glomerata</i>)	0	1
Moss	14	0
Bare ground and litter	9	6

* Other grasses include:

Trial I: Yorkshire fog, *Bromus mollis*, Crested dogstail (*Cynosurus cristatus*), sweet vernal and *Poa trivialis*.

Trial II: *Poa trivialis*, Yorkshire fog, *Bromus mollis*, *Poa pratensis* and sweet vernal.

The predominant ingress-grasses at both sites were *Agrostis* spp. with a smaller amount of Yorkshire fog, *Bromus mollis*, *Poa trivialis*, crested dogstail and sweet vernal. The proportion of ryegrass (2–6 cover hits per 50 points) was low, but slightly higher at Trial II. Clover was poor at both sites.

PASTURE COMPOSITION: TRIAL I, CARDIFF

The dry matter results per treatment from the first mowing are shown in Table 2.

At this mowing there has been an initial suppression due to paraquat, a slight fertilizer response, and no effect due to oversown seed.

Table 3 shows total yield at the second harvest.

Again there is no oversowing effect, a depression due to paraquat and a response to fertilizer in total yields, the latter showing essentially that the paraquat depression is appreciable only when the high rate of fertilizer is applied also.

TABLE 2: DRY MATTER PRODUCTION (lb/acre)
OCTOBER 17 TO NOVEMBER 28, 1967

<i>Treatment</i>	<i>D.M. Production</i>	
	<i>With Seed</i>	<i>Without Seed</i>
paraquat		
nil	1,347	1,144
2 oz	226	229
4 oz	118	215
Fertilizer (per acre)		
nil	1,347	1,144
3 cwt	1,495	1,459
6 cwt	1,189	999
12 cwt	1,330	1,290

These differences are significant.

Table 4 summarizes the individual species production between December 5, 1967, and January 9, 1968.

The main species only are shown with the "with seed" and "without seed" figures averaged.

The low-producing grasses except *Agrostis* spp. were markedly reduced by paraquat, but *Agrostis* spp. were not, except with the high rate of paraquat especially in the absence of fertilizer. White clover was increased by fertilizer, but not by paraquat alone. The clover response differs from that obtained at Trial 2.

TABLE 3: TOTAL DRY MATTER PRODUCTION (lb/acre)
DECEMBER 5 TO JANUARY 9

Treatment (per acre)		D.M. Production	
Paraquat (oz)	Fertilizer (cwt)	With Seed	Without Seed
0	0	1,583	1,452
2	0	1,319	1,138
4	0	984	1,081
0	3	1,611	1,547
2	3	1,288	1,238
4	3	1,076	1,229
0	6	1,669	1,841
2	6	1,672	1,551
4	6	1,304	1,319
0	12	1,694	1,590
2	12	1,211	1,166
4	12	1,215	982

TABLE 4: SUMMARY TABLE OF DRY MATTER PRODUCTION
(lb/acre) FROM INDIVIDUAL SPECIES DECEMBER 5
TO JANUARY 9, 1968

Treatment (per acre)		D.M. Production		
Paraquat (oz)	Fertilizer (cwt)	White Clover	<i>Agrostis</i> spp	Other Grasses*
0	0	240	720	450
2	0	240	560	110
4	0	250	390	40
0	3	370	740	380
2	3	350	620	80
4	3	320	520	70
0	6	510	740	340
2	6	400	840	190
4	6	420	590	80
0	12	410	640	520
2	12	280	630	100
4	12	230	570	120

* Sweet vernal, Yorkshire fog, *Poa pratensis*, *Poa trivialis* and crested dogtail.

TABLE 5: TOTAL DRY MATTER PRODUCTION (lb/acre)
JANUARY 17 TO APRIL 1, 1968

(Mean of 4 Replicates)

<i>Treatment (per acre)</i>		<i>Total D.M. Production</i>
<i>Paraquat (oz)</i>	<i>Fertilizer (cwt)</i>	
0	0	1,601
2	0	1,620
4	0	1,277
0	3	1,336
2	3	1,354
4	3	1,377
0	6	1,516
2	6	1,754
4	6	1,444
0	12	1,494
2	12	1,491
4	12	1,590

There was virtually no ryegrass in any of the treatments at this stage. Total yield at the third harvest is shown in Table 5.

The yields in Table 5 are an average of the plus and minus seed subplots of each main treatment. Analysis of these results showed that none of the main effects was significant, although showing an obvious trend.

The high order paraquat $\times$ fertilizer $\times$ seed interaction was just on the 5% significance level, but with no supporting evidence from its component main effects, it has been rejected.

Only slight differences occur for individual species and, although these were in the same direction as for the January 9 mowing — *i.e.*, a reduction in “other grasses” and *Agrostis* spp. — none of these was significant. The contribution of ryegrass to total production was still very low.

TRIAL II: INGLEWOOD.

Dry matter production at the first mowing, November 29, 1967, showed a small response to 3 and 12 cwt of fertilizer, an initial suppression due to paraquat, and no effect due to broadcast seed.

An analysis of total dry matter yield at the January 9, 1968, cut, showed a highly significant fertilizer response but no other significant effect (Table 6). Paraquat suppression appeared to be past. There was a slight increase observed on the plots receiving paraquat, compared with those which did not, but the effect was not significant.

However, there were marked differences in the yields of some species, these following the pattern of a reduction in low-producing grasses compensated by an increase in clover on the paraquat treated plots, and the general fertilizer response already discussed (Table 7).

The white clover response is greater to paraquat than to fertilizer at this site (*cf.* Trial I) and *Agrostis* spp. have been reduced to a much greater degree. “Other grasses” and ryegrass spp. follow a similar pattern to Trial I.

TABLE 6: DRY MATTER YIELD OF MAIN EFFECTS
DECEMBER 5, 1967, TO JANUARY 9, 1968

Rate of Fertilizer (cwt)	D.M. Yield (lb/acre)
0	1350 bc
3	1440 bBc
6	1610 aAB
12	1640 aA
CV	12.8%

TABLE 7: SUMMARY TABLE OF DRY MATTER PRODUCTION
(lb/acre) FROM INDIVIDUAL SPECIES DECEMBER 5, 1967,
TO JANUARY 9, 1968

Treatment (per acre) Paraquat (oz)	Fertilizer (cwt)	White Clover	D.M. Production Agrostis spp.	Other Grasses	Ryegrass spp.
0	0	190	630	280	90
2	0	400	460	60	150
4	0	350	230	60	140
0	3	250	660	270	100
2	3	400	580	90	100
4	3	440	390	60	60
0	6	230	680	260	140
2	6	550	670	130	140
4	6	650	420	50	110
0	12	330	610	350	110
2	12	510	520	150	100
4	12	600	360	50	50

The ryegrass content was fairly low, and no differential effects show up on this species. Broadcast seed has had no effect.

The predominant species was still *Agrostis* with a significant response to "some" fertilizer, but no difference between rates, and a depression from paraquat. Although the interaction did not reach significance, the major depression occurred with high paraquat, no fertilizer.

The low-producing species were significantly suppressed by paraquat and the white clover approximately doubled by high paraquat and increased 50% by high fertilizer.

There was also an increase in weeds and *Lotus* spp. with paraquat presumably taking advantage of the opened sward in the same way as the clover.

An analysis of main effect yields at the May 23 harvest showed a significant fertilizer response to 6 and 12 cwt. The paraquat main effects and the interaction did not reach significance. These main effects are shown in Table 8.

The best yielding treatments were 2 oz/6 cwt and 12 cwt, each showing a yield of 1,320 lb D.M./acre; but in terms of composition the 2 oz/6 cwt treatment was the better of the two. The 12 cwt treatment contained more *Agrostis* spp. and "other grasses" but less of the more desirable ryegrass

TABLE 8: MAIN EFFECT MEANS MAY 23, 1968

					<i>lb D.M./acre</i>
paraquat (oz):					
0	....	....	....	....	1,090 aA
2	....	....	....	....	1,090 aA
4	....	....	....	....	990 aA
Fertilizer (cwt):					
0	....	....	....	....	910 bB
3	....	....	....	....	950 bB
6	....	....	....	....	1,190 aA
12	....	....	....	....	1,170 aA
CV	....	....	....	....	14.1%

TABLE 9: DRY MATTER PRODUCTION MARCH 1, 1968,
TO MAY 23, 1968

<i>Species</i>					<i>Treatment</i>	
					<i>2 oz/6 cwt</i>	<i>12 cwt</i>
Ryegrass	....	....	....	....	253	171
Cocksfoot	....	....	....	....	163	39
<i>Agrostis</i>	....	....	....	....	302	407
Other grasses*	....	....	....	....	247	391
White clover	....	....	....	....	139	145
<i>Lotus</i> spp.	....	....	....	....	18	46
Weeds	....	....	....	....	229	120
Total yield	....	....	....	....	1,321	1,319

* Other grasses include sweet vernal, Yorkshire fog, *Poa pratensis*, *Poa trivialis*, and crested dogstail.

and cocksfoot and less weeds. White clover was similar in both treatments. The dry matter production per species in these two highest yielding treatments is shown in Table 9.

The trials described are continuing and further work is proposed for the spring of 1968.

DISCUSSION

The differences in response of ingress grasses to paraquat on the two trials described are considered to be very largely related to the degree of clover response obtained following treatment. Clover recovery is likely to be affected by the previous history of potash and phosphate application, the number of clover plants existing, and the altitude of the site.

Reference to the results for Trial I (the low fertility high altitude site), where only a small suppression of ingress grasses was obtained, shows that an initial small clover response was obtained from fertilizer and to a lesser extent paraquat at the January 9 harvest. By the second harvest, April 1, 1968, these responses were not evident.

At Trial II (higher fertility), however, large clover responses were obtained over the first summer on the paraquat and paraquat plus fertilizer treatments, particularly the latter, and here the suppression of ingress grasses was more permanent.

A satisfactory clover response following spraying has two effects; first, it provides competition to the ingress grasses, and, secondly, it would be expected to increase the level of available soil nitrogen.

With regard to the build-up of available soil nitrogen over the summer following spraying, this factor is important if it is accepted that ingress grasses are better able to compete than ryegrass species under conditions of low available soil nitrogen. If the nitrogen status of the soil is increased by the clover response obtained following spraying, then ryegrass species would have a better chance of competing, particularly if the ingress grasses have been kept suppressed by clover over the summer.

This ryegrass could come from two sources, either from oversown seed or from the original pasture, taking advantage in the latter case of the chemical's selectivity. This recovering ryegrass would provide a further competitive factor to the ingress grasses.

At the low fertility site, little ryegrass was present at treatment (2 cover hits per 50 points) and broadcast seed failed to establish, consequently the contribution of ryegrass to the sward has remained virtually nil. At this site, therefore, the factors of clover competition with its associated nitrogen fixation, together with the establishment of recovery of ryegrass, have been absent, making the return of the ingress grasses relatively easy.

At the higher fertility site, however, clover recovery following spraying was vigorous on the paraquat plus fertilizer plots and the competition this provided to re-establishing ingress grasses was probably very significant.

The resident population of ryegrass at this site, although small, was greater than at Trial I, and this recovered following spraying, and, although not increased by oversown ryegrass, was sufficient to survive and take advantage of the build-up of available soil nitrogen.

This increase in ryegrass is shown in Table 9.

At Trial II, the 2 oz/6 cwt treatment looks the most promising. By the end of May it compared with the 12 cwt treatment, each having a total yield of 1,320 lb D.M. per acre. From a composition point of view, however, the 2 oz/6 cwt treatment was superior, containing less *Agrostis* spp. and other grasses and more desirable grasses such as ryegrass and cocksfoot. There was also an increase in weeds on the 2 oz/6 cwt treatment.

This trial work is continuing and will be extended during the spring of 1968. Seed establishment was disappointing so comparisons between drilling and broadcasting will be looked at in next year's work. On low fertility areas containing very little ryegrass, the satisfactory establishment of oversown seed following spraying is likely to be more important than when paraquat is used under moderate to high fertility conditions.

ACKNOWLEDGEMENTS

Thanks are due to P. C. Watt and B. O'Connor; B. Bennett (Inglewood) and B. Bass (Cardiff); S. A. Mackenzie and C. Christie, for helpful comment and interest, and Mrs. Galway for the herbage dissection work; also to T. G. Robertson for statistical analysis and W. F. Leonard for assistance with the preparation of this paper.

REFERENCE

Lynch, P. B., 1960: *N.Z. Dept. Agric. Bull. No. 399.*