

OBSERVATIONS ON THE USE OF PREPLANT HERBICIDES IN PASTURE ESTABLISHMENT IN THE WET TROPICS

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SUMMARY

Trials on red basaltic rain-forest soils in the Innisfail district of North Queensland showed that establishment of a guinea grass (*Panicum maximum*)/centro (*Centrosema pubescens*) mixture was improved by using preplant herbicides to control broad-leaved weeds.

Best results were obtained when herbicides were applied to young weed seedlings rather than onto the soil before emergence of weed seedlings.

Damage to pasture seedlings through residues from soil-persistent chemicals did not appear to be a major problem if planting was delayed for a week or more after spraying. Prometryne residues did, however, cause some chlorotic symptoms in centro seedlings.

Herbicides tested were: 2,4-D amine, 2,4-D ethyl ester, 2,4-D butoxyethanol ester, monuron, prometryne, diquat, and a diquat/paraquat mixture.

I. INTRODUCTION

Many of the molasses grass (*Melinis minutiflora* Beauv.) and legume-deficient pastures growing on rain-forest soils along the wet tropical coast of North Queensland are not fully productive. Attempts by landholders to cultivate and replant such areas with superior pasture species have met with varying success. One of the causes of slow pasture establishment has been claimed to be strong competition from broad-leaved weeds.

Walsh (1959) and Saint-Smith (1964) have briefly mentioned the problem of pasture legume damage caused through the indiscriminate use of post-emergence herbicides. Bailey (1965) discussed the problem more fully, and from field data reported that 2,4-D amine, 2,4-D ethyl ester and diquat were the least damaging herbicides tested for post-emergence spraying in a

newly established guinea grass (*Panicum maximum* Jacq.)/centro (*Centrosema pubescens* Benth.) pasture. Riepma (1965), working on rubber plantation cover crops, found that centro was little affected by a post-emergence application of neburon.

In 1963 the Herbicide Research Unit of the University of the West Indies (Anon. 1963) reported from green-house work that 2,4-DB, MCPB, ametryne, linuron and 2,2-DPA were promising preplant herbicides which could be safely used before sowing kudzu (*Pueraria phaseoloides* Benth.).

This paper discusses three field investigations which were carried out in an attempt to find suitable preplant herbicide treatments to aid pasture establishment on the red basaltic rain-forest soils of the Innisfail district of North Queensland.

The trials were located at the Queensland Department of Primary Industries Sub-station at Utchee Creek (trials 1 and 2) and in the East Palmerston area (trial 3). Soils were similar, the two Utchee Creek soils being red-brown sandy clay loams and the East Palmerston a red-brown clay loam. Available phosphate in the top 6 in. was very low in all, ranging from 14 to 24 p.p.m. P_2O_5 .

II. EXPERIMENTAL

(a) Trial 1, 1962-63

Land preparation.—The ground, which had been cultivated out of old pasture, was worked to a fine seedbed before the herbicides were applied.

Treatments.—Herbicide mixtures as shown in Table 1 were applied with an Oxford Precision Sprayer on two occasions before sowing the pasture. Sprays were applied at 20 gal/ac and 30 lb/sq in to plots measuring 32 ft x 6 ft on December 20, 1962 (early sprays) or January 3, 1963 (late sprays). There were four replications of each treatment in a randomized block design and each replicate included two unsprayed plots.

Early sprays were applied to a weed-free soil surface 2 days after the final cultivation, while at the time of applying the late sprays weed seedlings were just beginning to appear. At both times of spraying the soil was moist from recent rain.

Planting.—Seed was broadcast on January 10, 1963. Because of rapid drying of the soil surface it was considered advisable to plant further centro seed and lightly rake it in: this was done on January 15, 1963. Centro was planted at a total of 30 lb/ac, a heavy seeding rate being used so that the extent of centro damage through herbicide residues could be accurately measured by plant counts. Guinea grass was sown at 2 lb/ac. An excellent stand of centro resulted but the Guinea grass density was rather low.

Weather.—Fifteen inches of rain were recorded between the time of applying the early sprays and raking the seed in, and 9 in. fell between the time of the late spray application and raking. High-intensity rains during the third week of January caused some rill erosion in the trial area.

Plant counts and yield estimates.—Plant counts were recorded in three 10 sq lk quadrats per plot over the period January 31 to February 4, 1963. At the time of counting, the established weed population (Table 1) on the unsprayed plots consisted of 89.2% spiny-head sida (*Sida acuta* Burm.), 3.4% species of *Ageratum*, 2.3% foetid cassia (*Cassia tora* L.) and the balance miscellaneous weed species. In mid April 1963 the area was rotary-slashed to a height of approximately 15 in. and three 10 sq lk quadrats cut from each plot for yield estimate on May 15, 1963.

Results.—Weed counts and pasture yield are shown in Table 1.

TABLE 1
TRIAL 1: WEED COUNTS AND PASTURE YIELDS

Treatment	Weed Counts (no./30 sq lk)			Herbage D.M. Yields (lb/ac)		
	Estab- lished Weeds**	Total Weed Counts		Centro	Guinea	Total
		Equiv.	Trans.			
*Monuron, 2 lb a.i./ac	0	32	5.68	1,542	588	2,130
*Prometryne, 2 lb a.i./ac	0	50	7.09	1,145	947	2,092
*2,4-D ethyl ester, 2 lb a.e./ac	0	30	5.56	1,279	718	1,997
*2,4-D butoxyethanol ester, 2 lb a.e./ac	0	52	7.25	1,292	654	1,946
*2,4-D amine, 4 lb a.e./ac	0	46	6.80	1,346	587	1,933
†2,4-D ethyl ester, 2 lb a.e./ac	6.5	69	8.31	1,020	892	1,912
Hand-weeded	1.5	74	8.64	1,078	818	1,896
†2,4-D amine, 2 lb a.e./ac	16.0	55	7.45	1,089	757	1,846
†Monuron, 2 lb a.i./ac	11.0	61	7.86	838	846	1,684
†2,4-D amine, 4 lb a.e./ac	16.0	50	7.08	768	911	1,679
*Superphosphate, 3 cwt/ac	31.0	101	10.10	891	776	1,667
*Diquat, ½ lb ion/ac + non-ionic wetter	0	65	8.07	1,083	567	1,650
*2,4-D amine, 2 lb a.e./ac	2.0	64	8.00	779	725	1,504
†2,4-D butoxyethanol ester, 2 lb a.e./ac	10.5	75	8.69	962	439	1,401
†Prometryne, 2 lb a.i./ac ‡	14.5	55	7.43	912	468	1,380
†Superphosphate, 3 cwt/ac	48.0	157	12.57	458	688	1,146
Untreated	44.0	109	10.46	765	246	1,012
Necessary differences for sig- nificance	Not analysed	5%	3.30	502	N.S.	797
		1%	4.40	669		1,063
Necessary differences for sig- nificance involving untreated controls		5%	2.86	435		691
		1%	3.81	580		920

† Applied December 20, 1962.

* Applied January 3, 1963.

** Weeds past cotyledonary stage of growth. Total weed counts transformed ($\sqrt{x + \frac{1}{2}}$) for analysis

‡ Some prometryne residue accidentally left in spray container; actual rate estimated at ½ lb a.i./ac

Analysis of variance revealed no differences in guinea grass and centro numbers between treatments, indicating that the establishment of sown species had not been adversely affected by herbicide residues persisting in the soil. The late prometryne treatment did, however, cause some chlorosis of centro leaves, but by harvest time the plants had recovered and appeared normal.

(b) Trial 2, 1964-65

Purpose.—In view of the comparatively low price of 2,4-D and because landholders are familiar with this herbicide, it was considered desirable to investigate the persistence of 2,4-D amine under local field conditions.

Land preparation.—The ground had been cultivated out of old pasture and a well-prepared moist seedbed was available at time of spray application.

Treatments.—Pasture establishment and growth on plots treated with 2,4-D amine was compared with that on unsprayed plots, different pairs of plots being planted at intervals after spraying the soil surface. The herbicide was applied at 2 lb of acid-equivalent per acre in a volume rate of 20 gal/ac and at 30 lb/sq in. pressure with an Oxford Precision Sprayer on January 2, 1965. Plots measuring 40 ft x 6 ft were arranged in fully randomized blocks with a planted 2-ft wide buffer strip running longitudinally between plots.

Weather.—Rainfall totals between the time of spraying and each of the various planting times were 0.2, 0.3, 3.6, 10.3 and 13.1 in. respectively.

Planting.—Centro and guinea grass were sown at rates of 10 and 20 lb/ac and superphosphate broadcast onto all plots at 4 cwt/ac at planting time. Planting times were 1, 2, 4, 8 and 16 days after spraying the soil surface. Centro and guinea grass seed was taken from the same commercial seed lots for all plantings. Satisfactory grass and legume stands were obtained at each planting and the trial was kept reasonably free from weeds by periodic hand-weeding.

Plant counts and yield estimates.—Pasture plant counts were taken on March 8 and 9, 1965, guinea grass numbers being recorded in three 10 sq lk quadrats in each plot and centro in three 25 sq lk quadrats per plot. The pasture was neither grazed nor slashed before being sampled for yield on May 19, 1965. Two 25 sq lk quadrats were cut from each plot at harvest time.

Count and yield data are presented in Table 2.

TABLE 2
TRIAL 2: PASTURE PLANT COUNTS AND PASTURE YIELDS
(a) Guinea Grass

Data Recorded	Treatments Tested	No. of Days Between Spraying and Planting					Mean
		1	2	4	8	16	
Counts (no./75 sq lk*)	No spray ..	63.8	56.9	101.9	68.1	85.6	75.2
	2,4-D ..	81.2	58.1	148.7	58.8	116.9	92.7
	Mean ..	72.5	57.5	125.3	63.4	101.2	83.9
Dry-matter yields (lb/ac)	No spray ..	2,879	3,231	3,319	3,422	2,366	3,044
	2,4-D ..	3,388	3,683	3,357	3,026	2,532	3,197
	Mean ..	3,134	3,457	3,338	3,224	2,449	3,120
Counts		Individual		Spray Means		Planting Time Means	
Necessary differences for significance	{ 5% 1% S.E.	63.1		N.S.		44.7	
		85.3		..		60.3	
		±21.8		±9.7		±15.4	
Yields		Individual		Spray Means		Planting Time Means	
Necessary differences for significance	{ 5% 1% S.E.	1,401		N.S.		999	
		1,908		..		1,349	
		±487		±218		±344	

(b) Centro

Data Recorded	Treatments Tested	No. of Days Between Spraying and Planting					Mean
		1	2	4	8	16	
Counts (no./75 sq lk) . .	No spray ..	33.2	26.2	29.5	25.5	22.2	27.3
	2,4-D ..	17.7	16.5	15.5	25.5	32.5	21.5
	Mean ..	25.5	21.4	22.5	25.5	27.4	24.4
Dry-matter yields (lb/ac)	No spray ..	77.7	75.5	45.1	87.7	84.0	74.0
	2,4-D ..	41.6	55.2	43.0	57.9	97.1	59.0
	Mean ..	59.6	65.4	44.0	72.8	90.6	65.5
Counts		Individual		Spray Means		Planting Time Means	
Necessary differences for significance	{ 5% 1% S.E.	N.S.		N.S.		N.S.	
		±6.3		±2.8		±4.5	
		
Yields		Individual		Spray Means		Planting Time Means	
Necessary differences for significance	{ 5% 1% S.E.	N.S.		N.S.		N.S.	
		±23.9		±10.7		±16.9	
		

* Guinea grass counts converted to no./75 sq lk for comparison with centro counts.

(c) Trial 3, 1964-65

Purpose.—Promising observations with mixtures of the bipyridylum herbicides diquat and paraquat during 1963-64 prompted further investigations with these chemicals in the 1964-65 season. The most attractive feature of these two herbicides is their negligible residual effect in the soil. Paraquat was included in the mixture to control a small number of volunteer molasses grass seedlings present in the trial area.

Treatments.—Spray equipment and cultivation methods commonly used by land-holders in the area were employed. Sprays were applied with a motor-driven knapsack mister at 8 gal/ac.

Land preparation.—The trial was established on an old molasses grass/calopo (*Calopogonium mucunoides* Desv.) pasture. Cultivation was done with a set of offset scalloped discs which produced a rough, poorly compacted seedbed.

Plot size was 40 ft x 15 ft and although care was taken some spray drift occurred between plots. To minimize the effect of this, observations were confined to the central 30 ft x 9 ft area in each plot, as far as possible.

Table 3 summarizes the spraying and planting schedule and shows the treatments used.

TABLE 3

TRIAL 3: SPRAYING AND PLANTING SCHEDULE

Treatment	Date of Spraying in January 1965	Size of Dicotyledonous Weeds at Spraying Time	Date of Planting in January 1965
Untreated	5
2,4-D amine, 2 lb a.e./ac, early ..	5	None present	19
2,4-D amine, 2 lb a.e./ac, late ..	14	Cotyledon to 2 true leaves ..	28
Diquat/paraquat, 2 oz ion/ac* ..	26	Cotyledon to 4 in. tall	28
Diquat/paraquat, 4 oz ion/ac ..	26	Cotyledon to 4 in. tall	28
Diquat/paraquat, 8 oz ion/ac ..	26	Cotyledon to 4 in. tall	28
Diquat/paraquat, 16 oz ion/ac ..	26	Cotyledon to 4 in. tall	28

* 1 : 1 mixture of diquat and paraquat plus non-ionic wetter

Planting.—Guinea grass and centro were both planted at 5 lb/ac and superphosphate broadcast at 3 cwt/ac. The establishment of sown species on all plots was poor, faulty seedbed preparation and grass seed of only fair quality being contributing factors.

Plant counts and yield estimates.—Plant counts were recorded on March 22 and 23, 1965, and the trial slashed to an even height with a rotary slasher on May 26, 1965. The weed population by count on the unsprayed plots was 60.1% urena (*Urena lobata* L.), 33.2% spiny-head sida, 2.5% flannel-weed (*Sida cordifolia* L.), 1.6% species of *Ageratum* and the balance miscellaneous weed species. Figure 1 shows a portion of the trial prior to slashing.



Fig. 1.—Trial 3, photographed May 1965. Urena growing on an untreated plot is shown in the background. Weed seedlings on the foreground section were controlled with a 1:1 diquat/paraquat spray at 2 oz ion/ac before planting the pasture.

The diameter of primary stems of urena was measured approximately 1 in. above the soil surface in each of the unsprayed and 2,4-D early plots on September 14 and 15, 1965. Thirty measurements were recorded in each plot by means of vernier calipers. The average dry-matter yield of individual guinea grass plants was estimated by clipping 14 plants to ground-level in each plot on September 15, 1965. Because of unsatisfactory growth on all plots, no attempt was made to take centro yield data.

Results.—Table 4 shows the results of plant counts taken in March 1965. Guinea grass yields and the number of guinea grass plants on each plot at harvest time are presented in Table 5.

TABLE 4

TRIAL 3: WEED COUNTS AND PASTURE PLANT COUNTS, MARCH 1965

Treatment	Broad-leaved Weed Counts (no./40 sq lk)				Pasture Plant Counts (no./100 sq lk)			
	Total		<i>Ageratum</i> spp.		Centro		Guinea Grass	
	Equiv.	Trans.*	Equiv.	Trans.	Equiv.	Trans.	Equiv.	Trans.
Untreated	207	14.39	3	1.92	22	4.72	9	3.05
2,4-D early	116	10.81	6	2.59	12	3.59	4	2.06
2,4-D late	59	7.70	17	4.15	10	3.20	8	2.93
Diquat/paraquat, 2 oz/ac ..	73	8.57	13	3.66	9	3.00	9	3.10
Diquat/paraquat, 4 oz/ac ..	54	7.37	11	3.46	14	3.82	9	3.11
Diquat/paraquat, 8 oz/ac ..	75	8.69	28	5.39	14	3.85	10	3.19
Diquat/paraquat, 16 oz/ac ..	62	7.90	10	3.23	15	3.89	6	2.62
Necessary differences for	0.96		2.01		1.00		N.S.	
significance	1.32		2.76		1.37			

* All count data transformed ($\sqrt{x + \frac{1}{2}}$) for analysis

TABLE 5

TRIAL 3: GUINEA GRASS COUNTS AND YIELDS, SEPTEMBER 1965

Treatment	Guinea Grass Counts (no./270 sq ft)		Average D.M. Weight of Individual Guinea Grass Plants (g)	Calculated D.M. Yield of Guinea Grass (lb/ac)
	Equiv.	Trans.*		
Untreated	49	7.01	10.89	190
2,4-D early	14	3.84	9.17	44
2,4-D late	29	5.43	39.78	411
Diquat/paraquat, 2 oz ion/ac ..	41	6.46	42.80	625
Diquat/paraquat, 4 oz ion/ac ..	35	5.97	40.38	503
Diquat/paraquat, 8 oz ion/ac ..	40	6.37	50.22	715
Diquat/paraquat, 16 oz ion/ac ..	41	6.46	46.51	679
Necessary differences for significance ..	1.93		18.43	Not analysed
	2.65		25.25	

* Transformed ($\sqrt{x + \frac{1}{2}}$) for analysis.

III. DISCUSSION

Tables 1, 4 and 5 show that pasture establishment can be severely hampered by strong weed growth. Although the untreated plots in trial 1 carried weed seedlings at planting time, it was shown in trial 3 that even when the ground surface in the untreated plots was completely weed-free at planting, subsequent guinea grass growth was markedly checked by weed competition. In spite of the

low levels of available phosphate in these soils, it was found that superphosphate alone was not particularly effective in overcoming the pasture check from weed growth (trial 1), suggesting that competition for other factors such as moisture and light was also important.

Trials 1 and 3 demonstrated that under weedy conditions pasture establishment can benefit through the use of preplant herbicide treatments. Most herbicides tested were effective in reducing weed numbers, best results usually being obtained when chemicals were applied to young seedlings rather than onto a clean soil surface. This was clearly illustrated in trial 3 by the 2,4-D early and 2,4-D late treatments. In the same trial, diquat/paraquat mixtures compared favourably with 2,4-D for weed control ability. Effective spray coverage appeared to be important in determining the success of the bipyridylum herbicides.

As might be anticipated, herbicide treatments interfered with the natural weed balance. In trial 3 the reduction of urena and spiny-head sida favoured the establishment of species of *Ageratum* (Table 4), and all plots apart from the untreated and 2,4-D early became dominated by this weed until it eventually died out in October-November 1965. Stem diameter measurements of urena in the same trial showed significant ($P < 0.05$) differences between the untreated and 2,4-D early treatments, the respective measurements being 7.38 ± 0.34 mm and 9.11 ± 0.34 mm. Presumably the 2,4-D treatment reduced the urena density sufficiently to encourage more vigorous growth in surviving plants.

In no trial could reductions in pasture numbers or yield be directly attributed to herbicide residues in the soil. The chlorotic symptoms in centro caused through prometryne residues have already been mentioned. Trial 2 suggests reductions in centro counts and yields in plantings made 8 days and earlier after 2,4-D spraying (Table 2b). Differences were, however, not statistically proven. In an earlier pot trial (Bailey 1964), using a similar soil, it was found that centro growth was markedly suppressed in plantings made immediately after spraying the soil with 2,4-D at 2 lb of acid-equivalent per acre, but damage was greatly reduced by delaying planting for 7 days. No obvious growth suppression was, however, noted in surviving centro plants growing on 2,4-D treated soil in the field. Table 2a shows that guinea grass establishment and growth were unaffected by 2,4-D residues in the soil.

The number of guinea grass plants which established in trial 2 was greatly influenced by planting time. A visual comparison of guinea grass establishment with rainfall data showed no clearcut relationship between the two; a combination of factors no doubt influenced grass establishment. Planting time did not affect centro establishment in trial 2, but in trial 3, if the assumption is made that there were no soil residues from the diquat/paraquat mixture, there is a suggestion that planting time may have been an influencing factor in centro establishment. From a cost point of view, 2,4-D amine was the most attractive chemical tested.

IV. ACKNOWLEDGEMENTS

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