HERBICIDE TRIALS IN NATAL SUGAR CANE, 1964-65

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Introduction

This paper deals with the results of four herbicide trials, harvested recently, and also presents the salient points from a number of other trials planted towards the end of 1964. Descriptions of the experiments which have been harvested were given by Gosnell and Thompson (1964).

All herbicides were applied on an 18 inch swath on the row only, and the equivalent full cover rates of application for 4 ft. 6 in. rows would therefore be three times those quoted. Inter-row cultivation was carried out by tractor or mules. Costs of handweeding were estimated according to the density and types of weeds present, and a spraying charge of R0.50 per acre was added to the herbicide costs in order to obtain a valid economic comparison of chemical and conventional methods of weed control.

All rates of herbicides are expressed in quantity of commercial material per acre and details of herbicide formulations are given in Appendix I. Yields of cane and sucrose are expressed in short tons per acre.

Experimental Results

Experiment I

Paraquat with and without TCA and Diuron Treatments on Watergrass (7 x 4 Randomized Blocks)

An extremely dense growth of *Cyperus esculentus* covered the young cane and provided ideal conditions for the application of paraquat four weeks after planting.

Five treatments containing paraquat were compared with two treatments of hand weeding only. An excellent scorch of watergrass in the paraquat treatments was followed by uniform regrowth. The plots receiving paraquat only were hand weeded 8 weeks after planting and those receiving paraquat and TCA or diuron were weeded 11 weeks after planting. Treatments, costs and results are given in Table 1.

TABLE 1

Experiment I: Effects of Paraquat, with and without TCA and Diuron

First Treatment	Weeks After Planting	Second Treatment	Weeks After Planting	Cost (Rand)	Cane Yield	Stalks per Acre x 10^{-3}	% Sucrose	Sucrose Yield
¾ pt Paraquat + 5 lb TCA	4	HW	11	6-43	50.5	55.6	13.1	6.60
¾ pt Paraquat + 1 ½b diuron	4	HW	11	8-31	47.0	58.0	13.8	6.52
1½ pt Paraquat	4	HW	8	6-55	45.9	54.9	13.3	6.09
1 pt Paraquat	4	HW	8	5-79	42.8	51.0	13.7	5.86
Hand Weeding (HW)	4	HW	8	11-00	41.5	48.6	13.7	5.73
¾ pt Paraquat	4	HW	8	5-02	40.8	52.1	14.1	5.73
Hand Weeding	6	HW	11	12-00	40.1	50.7	14.6	5.84
Mean, Herbicide treatments					45.4	54.3	13.6	6.16
Mean, Hand Weeded treatments					40.8	49.6	14.2	5.78
C.V. %					13.1	5.7	2.4	13.9
Significance of Herbicide vs. Hand Weeding					NS	**	*	NS
Least Significant Diff. (5%)					NS	4.5	NS	NS
(1%)					NS	6.2	NS	NS

Hand weeding costs were based on 16 man days per acre for weeding very dense watergrass after 4 weeks, 18 man days after 6 weeks, and 6 man days per acre for the second treatments after 8 and 11 weeks. Hand weeding labour was charged at a rate of R0.50 per man day.

The use of herbicides resulted in a very considerable reduction in cost, and in addition, the mean yield from the sprayed plots was 4.6 tons cane greater than that from the hand weeded plots. This difference was almost significant at the 5 per cent level. There were no significant differences in cane yield among the herbicide treatments, but the addition of TCA or diuron tended to produce higher yields. Increasing rates of paraquat also tended to give increasing cane yields, although the weed scorch was visually similar at all rates.

The reason for the trend towards higher yields from paraquat treated plots compared with hand weeded plots may be found in the higher stalk populations due to the paraquat treatments. This effect of paraquat has been noted previously (Gosnell and Thompson, 1965). Hand weeding may also have caused physical damage to the young cane and hence reduced the yields compared with those of the sprayed treatments.

Paraquat caused a slight but significant reduction in sucrose per cent cane in this trial; this effect has not been found previously. There were no significant differences between the yields of sucrose per acre for the different treatments but trends were similar to those of the cane yields.

Bromacil ½ lb (R2-30) 12 weeks after planting on Rosehill sandy loam.

Bromacil 1 lb (R4-60) 10 weeks after planting on a Waldene sandy clay loam.

Experiment II

Time of Application of Paraquat (4 x 5 Randomized Blocks)

Standard applications of one pint of paraquat per acre on the row only were applied on two occasions, the second application being made four weeks after the first to suppress the regrowth of *Cyperus*. Spraying was carried out at 6 a.m., 10 a.m., 2 p.m. and 6 p.m. on each day and visual evidence of an increased scorch of both cane and weeds with evening spraying compared with morning spraying was noted previously (Gosnell and Thompson, 1964). Repeated spraying with paraquat would not normally be recommended due to the rather severe scorch of cane at the later stage. The results are shown in Table 2.

TABLE 2

Experiment II: Effects of Time of Application of Paraquat

Time of Spraying	Stalks/ac x 10^{-3}	Cane Yield	Sucrose % Cane	Sucrose Yield
6 a.m. . .	47.7	24.4	12.0	2.92
10 a.m. . .	42.9	22.3	11.7	2.58
2 p.m. . .	44.1	19.5	12.5	2.43
6 p.m. . .	42.0	22.4	11.9	2.64
C.V. % . .	8.6	16.6	4.3	16.1
Significance .	NS	NS	NS	NS

There were no significant effects due to treatments and it may be surmised that the value of the improved scorch of watergrass due to the evening treatments was offset by greater damage to the cane. In fact, the early morning spraying was as effective as spraying at other times of day, and may even have been better.

Experiment III

Irrigated Herbicide Trial (4 x 4 Quadruple Lattice and 7 × 4 Youden Square)

In this trial, optimum soil moisture conditions were assured by irrigating at frequent intervals after both the pre- and post-emergence herbicide applications. The site of the pre-emergence experiment was apparently more fertile than that of the post-emergence experiment as both cane and weeds appeared to be more vigorous. This would account for the higher yield of cane in the hand weeded treatment and the lower yield in the unweeded treatment in the pre-emergence compared with the post-emergence section, although they were adjacent to each other. The results are shown in Table 3.

Under the optimum soil moisture conditions maintained in this experiment, simazine and atrazine gave excellent visual control of all weeds except *Cyperus spp.* for nearly five months, and final yields of both cane and sucrose were not significantly below those of the hand weeded treatments. Diuron at 1½ lb. was nearly as effective, but gave yields which were significantly poorer than those obtained from hand weeding, and

TABLE 3

Experiment III: Costs and Effects of Pre-emergence Treatment

Treatment	Cost (Rand)	Cane Yield	Sucrose % Cane	Sucrose Yield
Hand Weeded 3 times	7–00	60.6	13.6	8.20
Simazine 1½ lb . .	3–43	53.1	14.1	7.45
Atrazine 1½ lb . . .	3–43	52.6	13.5	7.13
Diuron 1½ lb . . .	3–79	49.7	13.5	6.70
Diuron 1 lb . . .	2–97	41.9	13.7	5.73
Diuron ⅔ lb . . .	2–15	39.8	13.9	5.49
No Weeding . . .	—	20.3	13.8	2.76
C.V. %		12.1	2.2	11.5
L.S.D. (5%) . . .		9.1	NS	1.18
(1%) . . .		12.7	NS	1.65

lower rates of diuron resulted in progressively lower yields. Even at the lowest rate, ⅔ lb. diuron, the cane yield was approximately double that of the no weeding treatment, whilst hand weeding gave three times the yield of no weeding. It should be noted that in all other experiments where the triazines have been used pre-emergence, they have been far less successful, presumably due to inadequate soil moisture. The results of the post-emergence section are shown in Table 4.

Outstanding weed control for 6 months after planting was obtained with bromacil at 1½ lb. but its effect on cane was also visually severe and this caused a reduction in yield of 12 tons of cane per acre compared with hand weeding. Bromacil at ⅔ lb. and diuron at ⅔ and 1½ lb. all maintained good weed control for 5 months and gave cane yields 4 to 5 tons below the yield in the hand weeded plots. The addition of paraquat to these herbicides gave only a slight improvement in weed control under optimum soil moisture conditions, and this was more than offset by damage to the cane. This amounted to approximately 3 tons cane per acre. However even these treatments were not significantly different from hand weeding. Linuron gave effective control for about 3½ months after planting, and cane yields were acceptable when linuron was used in combination with paraquat. The initial effect of linuron was better than that of diuron, especially on *Cyperus spp.*, but the short residual effect combined with some slight damage to cane makes this herbicide inferior to diuron under irrigated conditions, although it may still be useful under dryland conditions. Propanil (marketed as Stam 34) and TCA gave only fair results.

An interesting comparison of the effects of diuron pre-emergence and post-emergence has been made in Table 5.

Diuron 1½ lb (R3-29) 10 weeks after planting on a Waldene sandy clay loam.

No Weeding 10 weeks after planting on a Waldene sandy clay loam.

TABLE 4

Experiment III: Costs and Effects of Post-emergence Treatments

Herbicide	Cost (Rand)	Cane Yield	Sucrose % Cane	Sucrose Yield
Hand Weeded 3 times	7–00	51.5	14.1	7.26
Diuron ¾ lb	2–15	47.6	13.5	6.41
Diuron 1½ lb	3–79	46.5	14.2	6.53
Bromacil ¾ lb	3–57	46.4	14.1	6.51
Diuron ¾ lb + Paraquat ¾ pt	3–65	43.9	13.8	6.05
Bromacil ¾ lb + Paraquat ¾ pt	5–08	43.0	14.0	6.00
Linuron 1.4 pt + Paraquat ¾ pt		42.4	13.9	5.88
Propanil 6¾ pt + 2, 4–D amine 1 pt	9–22	41.9	13.9	5.78
Bromacil 1½ lb	6–64	39.7	13.7	5.44
Linuron 1.4 pt		39.2	14.6	5.72
Linuron 2.8 pt		35.6	14.2	5.03
Propanil 3½ pt + 2, 4–D amine 1 pt	5–03	33.6	14.4	4.86
TCA 5 lb + Paraquat ¾ pt	3–45	32.3	13.9	4.23
Propanil 10 pt + 2, 4–D amine 1 pt	13–39	32.0	14.0	4.47
No Weeding	—	27.3	14.3	3.90
TCA 5 lb	1–95	22.6	14.0	3.19
C.V. %		15.8	3.3	16.1
Least Significant Difference (5%)		8.8	NS	1.25
(1%)		11.7	NS	1.66

TABLE 5

Experiment III: Yield of Cane from Diuron Treatments

Treatment	¾ lb Diuron	1½ lb Diuron	HW
Yield pre-emergence	39.8	49.7	60.6
Yield post-emergence*	47.6	46.5	51.5
Reduction cf. hand weeded, pre-emergence	20.8	10.9	—
Reduction cf. hand weeded, post-emergence	3.9	5.0	—

* with 0.5% WK surfactant.

The important conclusion which may be drawn is that diuron can be most advantageously used post-emergence at a lower rate than is required pre-emergence.

None of the herbicides had any effect on sucrose per cent cane, and the sucrose yield results were therefore very similar to the cane yield results in both the pre- and post-emergence experiments.

Conditions were optimum for flowering throughout the cane belt in the autumn of 1964, and a flower count was made in the herbicide trial in July since large plot differences were evident. The results are shown in Table 6.

Whilst there was a high variability in the flower counts, the effects of treatments in the post-emergence section were highly significant, and it can be seen that those treatments giving good weed control produced the lowest number of flowers, whilst treatments giving poor weed control, such as no weeding and TCA, flowered profusely. There did not appear to be an effect due to any particular chemical in reducing flowering, so it may be assumed that limited flowering was associated with better grown cane. Due to a mechanical breakdown of the irrigation plant, insufficient water was applied in March, 1964 at about the time of floral initiation. The ensuing rapid exhaustion of the available soil moisture in clean plots with a high degree of canopy formation may have been responsible for the reduced degree of flowering.

Experiment IV

Herbicide Screening Trial (Two 4 x 4 Triple Lattices)

This experiment was sited on a poorly drained Waldene sandy clay loam. Soil moisture conditions alternated from very dry to very wet, providing a severe test for the herbicides and causing generally

Development of *Panicum maximum* 10 months after planting on a Fernwood sand.

Bromacil 1½ lb (R6-90) 10 months after planting on a Fernwood sand.

poor cane growth. In the pre-emergence section, replication III was omitted from the final analysis due to the unrepresentative weed population and cane growth in an area of particularly poor drainage.

Yield and harvested stalk count data are presented in Table 7.

TABLE 6

Experiment III: Flower Counts in July 1964

Treatment	Flowers per Acre	Log Trans-formation
Pre-Emergence		
Hand Weeded	250	1.778
Atrazine 1½ lb	280	1.602
Simazine 1½ lb	350	1.681
Diuron 1 lb	750	1.778
Diuron ⅔ lb	830	2.812
Diuron 1⅓ lb	930	2.892
No Weeding	2300	4.851
C.V. %		69.8
Significance		NS
Post-Emergence		
Diuron ⅔ lb	200	1.204
Bromacil 1½ lb	580	2.996
Bromacil ⅔ lb + Paraquat ⅔ pt	680	2.885
Hand Weeded	880	2.723
Linuron 1.4 pt + Paraquat ⅔ pt	930	2.748
Bromacil ⅔ lb	1080	3.526
Diuron ⅔ lb + Paraquat ⅔ pt	1130	4.251
Diuron 1⅓ lb	1430	3.149
Propanil 10 pt + 2, 4–D amine 1 pt	1750	4.584
Propanil 6⅔ pt + 2, 4–D amine 1 pt	1880	4.243
Linuron 2.8 pt	2150	3.927
TCA 5 lb + Paraquat ⅔ pt	2550	5.568
Linuron 1.4 pt	2630	5.594
Propanil 3½ pt + 2, 4–D amine 1 pt	3230	5.916
No Weeding	3750	6.232
TCA 5 lb	3900	6.139
C.V. %		45.7
Least Significant Difference (5%)		2.678
(1%)		3.540

TABLE 7

Experiment IV: Costs and Effects of Pre-emergence Treatments

Treatment	Cost (Rand)	Cane Yield	Stalks/ Acre x 10^{-3}
Hand Weeding 3 times	8–00	22.0	41.8
2, 3, 6-TBA + MCPA 12 pt	5–00	18.1	34.2
'Dacthal' 5 lb		17.2	31.2
'Tordon' 2 pt		16.8	30.2
'Tordon' ⅔ pt		15.3	35.2
'Tordon' 1⅓ pt		15.0	31.0
2, 4–D amine 1½ pt	1–02	14.6	27.1
2, 3, 6-TBA + MCPA 4 pt	2–00	14.1	30.2
Prometone 1 lb	2–75	13.6	29.8
'Tordon' ½ pt		13.5	32.0
Prometryne 2 lb	5–00	11.7	35.6
Ametryne 2 lb	5–00	11.2	28.0
Prometone 2 lb	5–00	10.6	24.6
Ametryne 1 lb	2–75	10.2	27.4
No Weeding	—	9.1	23.2
Prometryne 1 lb	2–75	8.6	28.0
C.V. %		17.1	11.8
Least Significant Difference (5%)		5.0	7.7
(1%)		7.0	10.6

Under the extremely dry conditions which occurred for the first two weeks after planting, none of the pre-emergence treatments was entirely successful. However, two treatments gave useful results with yields not significantly lower than the hand-weeded control plots. The herbicide mixture 2, 3, 6-TBA +MCPA ('Fisons 1815') was the most promising, giving general control of broad-leafed weeds and grasses, but not watergrass.

'Dacthal' controlled annual grasses very well, but had no effect on broad-leafed weeds. Of the remaining treatments, 'Tordon' gave appreciable control of the broadleaf species only. The triazines were all disappointing, presumably due to the dry soil conditions.

In general the treatments which exercised a degree of weed control also resulted in higher stalk populations, which must have contributed to the higher cane yields.

The results obtained in the post-emergence part of the experiment are shown in Table 8.

TABLE 8

Experiment IV: Costs and Effects of Post-emergence Treatments

Treatment	Cost (Rand)	Cane Yield	Stalks/ Acre x 10^{-3}
Bromacil 1½ lb + Paraquat ⅔ pt	8–14	24.3	44.3
Bromacil 2 lb	9–70	22.5	47.3
Bromacil 1½ lb	6–63	22.2	43.1
Hand Weeded 3 times	8–00	22.0	43.9
Linuron 2.8 pt		20.9	40.5
'Tordon' ⅔ pt + Paraquat ⅔ pt		20.0	38.3
Bromacil ⅔ lb	3–57	18.9	39.5
'Tordon' ½ pt + Paraquat ⅔ pt		17.6	36.7
Dichlobenzamide 1 lb + Paraquat ⅔ pt		17.0	35.3
Dichlobenzamide ½ lb + Paraquat ⅔ pt		16.3	34.7
Bromacil ⅔ lb + Paraquat ⅔ pt	5–08	16.2	34.0
Propanil 6⅔ pt + 2, 4–D amine 1 pt	9–22	15.7	33.6
Linuron 1.4 pt		15.5	30.9
Linuron 1.4 pt + Paraquat ⅔ pt		14.9	33.8
Dichlobenzamide 2 lb		14.8	29.2
No Weeding	—	8.4	21.1
C.V. %		23.8	19.2
Least Significant Difference (5%)		7.1	11.8
(1%)		9.6	15.9

Bromacil was the outstanding herbicide and in spite of marked damage to the cane at 2 lb. per acre, this treatment resulted in yields as high as those from plots which were hand weeded three times. Bromacil at 1½ lb. per acre was the most successful treatment, especially in combination with paraquat. All three of these treatments were thus at least as effective and cost about the same as three hand weedings. Bromacil at ⅔ lb. per acre exerted appreciable but not adequate weed control. Linuron at 2.8 pints per acre also gave encouraging results; no damage to cane was visible and early weed control was good, but the residual effect was not equal to that of bromacil. The lower rate of linuron was quite inadequate. 'Tordon' with paraquat also gave fairly good results. 'Tordon' con-

tributed mainly to residual broad-leaf weed control and grass weeds were prevalent. Dichlobenzamide and propanil gave inadequate weed control, but cane yields were sometimes significantly better than those from the no weeding plots.

The effects of herbicides on stalk populations were very similar to those on yield. The no weeding plots and populations which were less than half those in hand weeded and bromacil 1½ lb. and 2 lb. plots. This was one of the main contributory factors to the increased yields in the treated plots.

Recently Planted Trials

Six trials have recently been established to compare levels of bromacil from ½ lb. to 2 lb. per acre in the row only on soil types varying from a recent sand to a doleritic clay loam. Visual observations on these trials confirm the results of the harvested experiments which showed that more than 1 lb. per acre of bromacil causes considerable damage to sugarcane, except on the heavier soils. The importance of soil organic matter in adsorbing soil-applied herbicides has been well established (Upchurch and Mason 1962, Hartley 1964). Table 9 shows the organic matter contents of six soils in eight experiments together with the visual scoring for cane vigour in plots receiving various rates of bromacil. (O = complete suppression of cane, 9 = vigorous growth).

TABLE 9

Soil Organic Matter Content and the Effects of Bromacil on Cane

Site	Soil Type	Organic Matter %		Cane Vigour Rating at Difference Rates of Bromacil					
		0-3 ins.	3-6 ins.	½ lb	¾ lb	1 lb	1½ lb	1½ lb	2 lb
Tugela*	Fernwood sand	1.12	1.12	8	–	7	–	6	–
La Lucia	Clansthal loamy sand	1.74	1.19	7	–	5	–	3	3
Mtunzini	Rosehill sandy loam	2.02	2.09	7	–	4	–	3	3
Chaka's Kraal	Williamson sandy loam	2.23	2.30	7	–	5	–	4	3
Chaka's Kraal	Williamson sandy loam	2.54		–	8	–	4	–	–
Mt. Edgecombe	Waldene sandy clay loam	3.74		–	8	–	7	–	5
Mt. Edgecombe	Waldene sand clay loam	3.90	3.42	–	–	8	–	–	–
Mt. Edgecombe	Rydalvale clay loam	5.51	5.16	9	–	9	–	8	8

* Cane 8 months old at time of application of bromacil.

Initial conclusions regarding bromacil damage to cane are that the chemical is safe on any soil type at ½-¾ lb. per acre row only. Damage is noticeable but not severe at 1 lb. on soils having organic matter contents below about 3 per cent, and is severe at rates of 1½-2 lb. on these soils. On soils with organic matter above 3 per cent, rates of 1-1½ lb. appear to be safe, and higher rates may possibly also be safe on heavier soils. In contrast to experience with paraquat, it also appears that damage is less when bromacil is applied to old cane than to young cane. The efficiency of weed control appears to be less affected by soil type than is the damage to cane, possibly due to differences in the rooting habit of cane and weeds. Commercially acceptable weed control was obtained generally at rates of 1 lb. per acre, except where *Panicum maximum* or *Flaveria contrayerba* were present. Higher rates usually gave complete suppression of weeds whilst lower rates gave weed control which was considerable but not quite commercially acceptable. The addition of 1 lb. diuron to ½ lb. bromacil per acre gave encouraging results under wet conditions, and the use of a mixture of ⅔ pint paraquat and ½ lb. bromacil per acre was successful where watergrass was dense.

Six other uracils are under trial at present, and several are giving encouraging results. U732 and U733 appear slightly more effective than bromacil, while U766 and U767 appear slightly less effective but cause less damage to cane.

Dalapon at 2 lb. per acre in the row only gave fairly good control of watergrass in several experiments, but has caused extensive damage to cane on a Fernwood sand, fairly severe damage on a Rosehill sandy loam and moderate damage on a Williamson sandy loam.

Provided soil moisture has been adequate, diuron applied post-emergent at 1-1½ lb. per acre with surfactant has given extremely good control of all weeds except dense stands of watergrass, and no damage to cane has been observed.

The methylmercaptotriazines, ametryne and prometryne, which have recently been shown to undergo selective bio-decomposition in sugarcane (HSPA 1963) have given fair results but weed control in two trials was not commercially acceptable. No damage to cane has been noted when they were applied post-emergent.

The duration of weed control with pre-emergence herbicides has been disappointing. The most effective

treatments were 2, 3, 6-TBA + MCPA at 8 pints, and fenac at 3-6 pints, although visual damage to cane was noted at the higher rate of fenac. Two related substituted ureas norea (7531) and 7175, atrazine, and CP31393 (a chloro-acetanilide), all give fair weed control but none of these can be generally recommended at present.

In one trial, paraquat was sprayed on ratoon cane on a Clansthal loamy sand which had been heavily dressed with filter cake from the carbonatation process. When the paraquat was applied, the cane was recovering from the yellow stages of iron chlorosis, caused by the rise in soil pH after the heavy filter cake application. Following the usual scorch of the cane the regrowth was slower than usual, and the cane was subjected a second time to the effects of iron chlorosis. By this time the unsprayed plots had completely recovered from chlorosis. The sprayed cane thus received a double setback and paraquat would not now be recommended for use on fields where iron chlorosis is prevalent.

Another interesting observation made where paraquat and bromacil (at all levels from $\frac{1}{2}$ to 2 lb. per acre) were applied together, was that the scorch caused by paraquat was delayed by the addition of bromacil. In a trial where dull weather conditions continued for several days after spraying, cane in plots which received paraquat only or paraquat + 2, 4-D amine was fully scorched after two days, whereas the cane sprayed with paraquat and bromacil was green for three days and did not develop a full scorch until five days after spraying. This phenomenon is explained by the fact that any inhibitor of photosynthesis retards the reduction of the paraquat radical which precedes scorching, and therefore allows maximum absorption of the herbicide into the tissue. Studies with mixtures of C^{14}-labelled paraquat and bromacil are now being carried out to determine whether or not more effective translocation of paraquat is obtained by this means.

Conclusions

Four experiments including paraquat treatments were harvested, and the results, together with those of two other trials reported elsewhere (Gosnell and Thompson, 1964, 1965) lead to the conclusion that when paraquat is applied under the correct conditions, negligible damage to cane results. In a number of instances yields were slightly but not significantly higher than the yields from hand weeded treatments. This is probably due either to the damage to cane incurred during hand weeding, or to the increased cane stalk populations which are consistently obtained following paraquat application. Paraquat should be applied to dense stands of *Cyperus spp.*, well advanced into the flowering stage, when the cane is young.

Should the cane growth be too far advanced, inter-row spraying with $1\frac{1}{2}$-2 pints paraquat per acre to the base of the cane has proved successful on a field scale. In general, paraquat at 2 pints per acre full cover or $\frac{2}{3}$ pint per acre on the row only has given good results. Where the *Cyperus* population is only light and other weeds predominate, paraquat is not recommended.

The results of two trials using bromacil, and the observations made on six other experiments planted recently, lead to the conclusion that bromacil may be recommended for general use under a wide range of soil moisture conditions, provided that the recommended rates of application are accurately adhered to in order to avoid damage to cane. At present, recommended rates are (i) on sandy soils with organic matter contents less than 3 per cent, $\frac{1}{2}$-$\frac{3}{4}$ lb. bromacil per acre in the row only, (ii) on medium to heavy soils with organic matter contents greater than 3 per cent, 1-$1\frac{1}{3}$ lb. bromacil per acre in the row only.

Bromacil has the advantage that it may be applied at any stage from pre-emergence to very late post-emergence. Indications are that late applications damage the cane less, being opposite to paraquat in this respect. A wide range of weeds is effectively controlled by these rates of bromacil, but where *Cyperus spp.* predominate, a mixture of paraquat and bromacil is recommended.

Diuron plus surfactant has again given outstanding results post-emergence when soil moisture conditions are adequate, and this herbicide should be widely used in irrigated fields and on dryland when a reasonable amount of rain has fallen or appears imminent. Diuron does not control *Cyperus spp.* as effectively as bromacil, but it controls most other weeds extremely well and has the major advantage that no damage to cane has yet been found under local conditions. Rates of 1-$1\frac{1}{3}$ lb. diuron in the row only are sufficient, and a surfactant is essential (WK was used in the experiments). A mixture of 1 lb. diuron and $\frac{1}{2}$ lb. bromacil has given excellent results in two trials.

Several other herbicides have given good results, but cannot yet be recommended. Linuron is more effective than diuron under dry conditions and appears to give rather better initial results on watergrass.

However, its residual effect is considerably shorter than that of diuron, and bromacil has given better results in general. Several new uracils have given promising results in two trials. Atrazine and simazine have been outstanding in one trial, but the results in other trials are not so favourable. The mixture of 2, 3, 6-TBA and MCPA appears to be the most effective pre-emergent herbicide under variable soil moisture conditions, but further results are required before it can be recommended.

As a result of good weed control with a number of treatments including diuron, bromacil, hand weeding, atrazine and simazine, there was very much less flowering with these treatments than in plots where the weeds were inadequately controlled. As already mentioned, this was probably a soil moisture effect due to the greater canopy in the clean plots.

Summary

Results of four trials harvested recently and observations on current trials have been reported. When paraquat was sprayed on dense *Cyperus sp.* in plant cane at rates of $\frac{2}{3}$-$1\frac{1}{3}$ pint per acre row only, alone and in conjunction with TCA or diuron, followed by

hand weeding of the regrowth, the yield of cane (45.4 tons per acre) was nearly significantly better than the yield after two hand weedings (40.8 tons per acre). The cost of the herbicides was substantially lower than that of hand weeding. Sucrose per cent cane was reduced from 14.2 to 13.6, but the mean sucrose yields of all paraquat treated plots (6.16 tons per acre) was slightly higher than the yield from the hand weeded plots (5.78 tons per acre). No significant differences in cane yield were found when spraying was carried out at 6 a.m., 10 a.m., 2 p.m. and 6 p.m. but an increased scorch of both cane and weeds occurred with the later sprayings.

Under irrigation best results were obtained with diuron (+ surfactant) at $\frac{2}{3}$-$1\frac{1}{3}$ lb. per acre row only, and with bromacil at $\frac{2}{3}$ lb. Diuron proved more useful as a post-emergence than pre-emergence spray and was effective at lower rates when used post-emergence. On soils with organic matter contents higher than 3 per cent, damage to cane from bromacil was noticeably less than on soils with lower organic matter contents. Current recommendations are that 1-$1\frac{1}{3}$ lb. bromacil per acre in the row only should be applied on soils having more than 3 per cent organic matter content, and $\frac{1}{2}$-$\frac{3}{4}$ lb. on other soils. Weed control with bromacil under a wide range of soil moisture conditions was good.

Simazine and atrazine gave excellent results pre-emergence in one trial. Linuron, various uracils and 2, 3, 6-TBA + MCPA. were all promising, but none of these herbicides can be recommended as yet.

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APPENDIX I

Herbicides Used

Short Chemical Name	Commercial Formulation	Composition
2, 3, 6 — TBA + MCPA	Fisons 1815	0.48 lb a.e. + 1.5 lb a.e. per gall.
2, 4-D Amine	Fernimine Selective	5 lb a.e. per gall.
Ametryne	Ametryne 50W	50% a.i.
Atrazine	Atrazine 80W	80% a.i.
Bromacil	Hyvar X	80% a.i.
—	CP 31393	65% a.i.
Dacthal	Dacthal	75% a.i.
Dalapon	Dowpon S	85% a.i.
Dichlobenzamide	WL 5792	50% a.i.
Diuron (=DCMU)	Karmex	80% a.i.
Fenac	Weedac	1.85 lb per gall.
Linuron	Lorox L	3.2 lb a.i. per U.S. gall.
Norea	Herban (H7531)	80% a.i.
—	7175	50% a.i.
Paraquat	Gramoxone	2 lb a.i. per gall.
Prometone	Prometone 50W	50% a.i.
Prometryne	Prometryne 50W	50% a.i.
Propanil	Stam FW734	2 lb a.i. per U.S. gall.
TCA	Tricate	94% a.i.
'Tordon'	Tordon	2 lb a.i. per U.S. gall.
—	Uracil 732	80% a.i.
—	Uracil 733	80% a.i.
—	Uracil 766	80% a.i.
—	Uracil 767	80% a.i.

N.B.—a.e. = acid equivalent a.i. = active ingredient

Surfactants used

Agral '90' is non-ionic and contains an alkylated phenol-ethylene oxide condensate; 92% a.i.

WK is non-ionic and contains the dodecyl ether of polyethylene glycol.

Mr. Thompson (in the chair): Mr. Gosnell's paper is very interesting because in the past we have tried the systemic herbicides which have been used very effectively overseas in sugar cane lands. We have used CMU, DCMU, simazine, atrazine, ametryne and prometryne and under our varying climatic conditions we have not been confident in recommending these generally to the farmer.

Our attitude has always been that the contact herbicide was the one for our conditions. We had PCP and paraquat and both of these have served a purpose.

We did not visualise having a herbicide that would control our weeds completely and adequately but bromacil appears to do so.

The farmer must be careful in noting, however, that the amount to be used is critical, more so than when using PCP or paraquat.

There still appears to be some doubt about the effect of bromacil on Cyperus Species.

Mr. Pearson: Good results seem to be obtained with small amounts of bromacil.

However, the labourer in the field may use a knapsack spray and although you can calibrate him at first to give the necessary half pound per acre, by the end of the day he is most likely applying four pounds an acre.

Is there any way this can be applied by tractor, in line only, whereby the rate of application can be governed by the speed of the tractor?

Mr. Brassey: Fit a hose-pipe to each spray. The hose-pipe is held by a field labourer walking alongside the tractor and in this way the inter-row is not sprayed at all, rather as is done with cotton.

Mr. Simpson: It seems a vital point that we do not have a wide margin of safety with bromacil.

There are many different types of appliance which will give a calibrated output but the one mentioned seems very slow.

Further investigation must be made of the effect of bromacil on Cyperus watergrass. Paraquat has done a lot in controlling watergrass. Diuron and paraquat together might be an ideal weed control for cane.

In a trial at Illovo eighteen months ago conditions were very dry for six weeks after planting. Diuron was used for pre-emergent treatment, with MCPA and paraquat, and proved most effective, and also safe.

Mr. Gosnell: Under many conditions I would still recommend the use of diuron in preference to bromacil. But where soil moisture is inadequate bromacil is preferable.

Many farmers probably do not have accurate means of applying herbicides, therefore, provided soil moisture conditions are suitable, diuron is a much safer herbicide for them to use. One pound per acre, row only, with a wetter, should be applied post-emergence.

If watergrass is predominant, diuron may be used with paraquat, but in these conditions a mixture of bromacil and paraquat would be better.

Mr. Cownie: Is there a residual effect of herbicides in the soil over a number of seasons?

Mr. Gosnell: It has been shown that there is no residual effect a few weeks after application of 2, 4-D but with more recent herbicides we do not know. This point has not been investigated locally because owing to trashing in the cane belt we only apply herbicides about every eight years. If we start burning, or cutting earlier, then we might have to apply herbicides every twelve or eighteen months and this question will become of paramount importance.

Dr. Cleasby: Chemicals offer one important way of controlling weeds. In past years when insufficient attention was given to weed control it is frightening to think of the loss in yield.

Weed control is one of the primary problems of sugar cane agriculture particularly as we rely today on hand labour.

A long term solution to the weed problem will be a combination of mechanical cultivation and chemical control. The weed killers will be required after the mechanical cultivation, i.e. as post-emergent treatment.

Mr. Gosnell: I agree that the answer will probably be a combination of mechanical and chemical weed control. When considering the row, presumably mechanical control will only be applied in the early stages by a rod type of weeder and the chemical weed control will be applied later, on a row only basis.

However, the decisive factor is economic. In each field the decision must be made; is it cheaper to control by hand, machine or by chemicals?