

THE RESULTS OF HERBICIDE TRIALS CONDUCTED IN THE CANE BELT OF NATAL, 1962/63

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Summary

Three herbicide screening trials, nineteen regional trials and three subsidiary trials were conducted during 1962-63, covering a wide range of environmental conditions and weed populations in the Natal cane belt. The outstanding herbicide was Paraquat which gave good post-emergent control of the two most important weeds, *Cyperus esculentus* and *Panicum maximum*, as well as the majority of other weed species. The symptoms of severe cane leaf scorching observed after Paraquat applications soon disappeared, and ratings for cane vigour after three months showed Paraquat treated cane to be among the best. Paraquat is at present too expensive for field recommendations. Diquat gave fairly good control of most weeds except grasses; Dalapon was useful where grasses were the main problem; and DCMU gave good results where soil conditions were uniformly moist, whilst it also seemed to improve cane vigour. Of the remaining herbicides, CMU, Stam 34 and Kuron showed some promise, whilst Eptam gave such good control of *Cyperus esculentus* that further work with this chemical is planned to reduce or eliminate its depressing effect on sugarcane.

Introduction

The principles of screening available herbicides and attempting to adapt the most promising formulations to conditions in Natal were pursued during 1962 and early 1963. The experimental programme included three general herbicide trials in which wide ranges of herbicides were tested at different rates and in various combinations, using both "row only" and "complete cover" applications. In addition, nineteen regional trials were laid down on farms and estates along the length of the cane belt to study selected herbicides under as wide a range of environmental conditions as possible. Finally, three observational trials were conducted on the Mount Edgecombe farm to investigate particular properties of the contact herbicides.

Since a considerable number of chemical compounds were involved in the programme as a whole, it may be of value to classify them by groups, both according to chemical composition and their effects on weeds, as follows:

1. Phenoxyaliphatic acids: 2,4-D (2,4-dichlorophenoxyacetic acid) and MCPA (4-chloro-2 methylphenoxyacetic acid) are well established herbicides which find principal application in pre-emergent control of broad leaved plants and seedling monocotyledons. Post-emergent control of some broad leaved species is also effective. Kuron, which contains 2-(2,4,5-trichlorophenoxy) propionic acid, is a recently developed pre-emergent herbicide, described by Valdez-Pages and Jordan (1961).

2. Chlorinated Aliphatic acids: TCA (trichloroacetic acid) and Dalapon (2,2-dichloropropionic acid) are both well known and effective grass killers with a more limited action on Cyperaceae. TCA is absorbed mainly from the soil, whereas Dalapon is absorbed directly by the leaf as well as from the soil, the leaf action being the more effective of the two. These two chemicals can be classified as post-emergent systemic herbicides.

3. Substituted Ureas: CMU (N-(4-chlorophenyl)-N,N'-dimethylurea and DCMU (N-(3,4-dichlorophenyl)-N,N'-dimethylurea) have been used mainly for pre-emergent work, and they control a wide range of weeds provided that the soil is sufficiently moist to allow solution and subsequent uptake of these relatively insoluble materials. CMU has a solubility of 230 ppm. and DCMU a solubility of 42 ppm. (Woodford, 1960.)

4. Symmetrical Triazines: Simazine (2-chloro-4,6-bis(ethylamino)-1,3,5-triazine) and atrazine (2-chloro-4-methylamino-6-isopropylamino-1,3,5-triazine) are almost insoluble pre-emergent herbicides which can control a wide range of weeds, mainly broad leaved. The solubility of simazine is 3.5 ppm. and that of atrazine 70 ppm. (Woodford, 1960.)

5. Diquaternary Salts: Diquat (1,1'-ethylene-2,2'-dipyridylium dibromide) and Paraquat (1,1'-dimethyl-4,4'-dipyridylium di(methyl sulphate)) are post-emergent weed killers, both systemic and contact in action.

6. Substituted Phenols: PCP (Pentachlorophenol) is an accepted post-emergent contact herbicide. Geeltox, containing DNBP (2-s-butyl-4,6-dinitrophenol) is also a post-emergent contact herbicide.

7. Miscellaneous formulations:

(a) Eptam (Ethyl-N,N-dipropyl-thiolcarbamate) may be used as a pre-planting treatment in the soil, and is very effective against Cyperaceae. (Crafts 1961.)

(b) Stam 34 (N-(3,4-dichlorophenyl) propanamide) is used as a post-emergent treatment, mainly in rice lands, and is effective against many monocotyledons.

(c) Weedazol or Amitrole (3-amino-1,2,4-triazole) is a systemic herbicide which may be used either pre-ploughing or post-planting to control grasses.

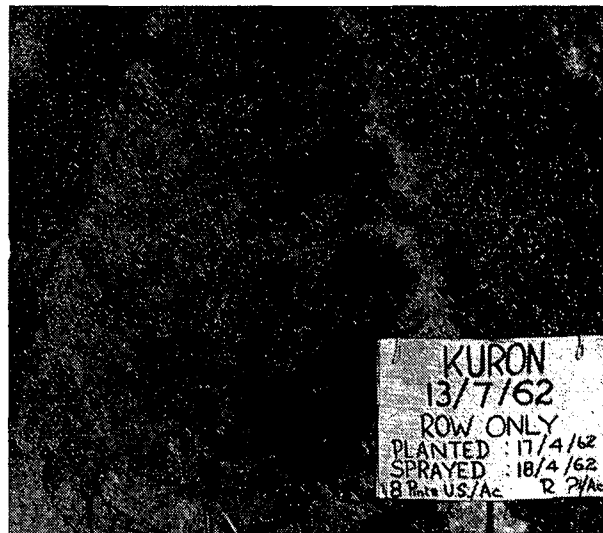
(d) Fenac (2,3,6-trichlorophenylacetic acid) is a pre-emergent herbicide described by Bridge (1960).

Procedures

The plot size throughout the general and regional trials was 1/100th acre, and each experiment had four replications. The row width was always 4 ft. 6 ins. The diluted herbicides were sprayed from a two or three-nozzle boom, fitted with ceramic N-jets, and



1. Mtunzini: Note mixed populations of annual grasses and broad leafed weeds.



2. Mtunzini: Good weed control; cane retarded.



3. Mtunzini: Good weed control; cane vigorous.

connected to a hand-operated pressure knapsack. The width of the swath was controlled simply by varying the height of the boom above ground level. In the first general trial, "row only" treatments were regarded as being one fourth of the "full cover" treatments, but thereafter as a more realistic one third of full cover. The volume rate of application was approximately 30 gallons per acre throughout.

All of the experiments were terminated when the effects of the herbicides had been lost. This was done in preference to maintaining plots heavily infested with weeds which constituted a source of contamination for the rest of the field. The hand weeded treatments in most cases received two hand weedings at an estimated total cost of R4.00 per acre for labour.

Where "row only" treatments were employed to reduce the cost of the chemical treatment as much as possible, the intention was to cultivate the inter-row in the normal manner over the entire experimental site, either with mule or tractor cultivators. This procedure tended to fill the sprayed furrow with fresh soil containing viable weed seeds during each cultivation, and pre-emergent treatments suffered particularly in this respect. On the general experiment at Mtunzini the high ridges between deeply drawn furrows could not be satisfactorily negotiated by the tractor cultivator, and even when the two outer shoes were removed from a mule drawn Uba cultivator, filling of the furrow was most marked. In the regional trials the furrows were generally shallower and normal cultivation impaired the effects of the herbicides to a lesser extent, but it seems obvious that, if "row only" herbicide applications are to be successfully integrated with inter-row cultivations, then special implements and techniques will have to be developed.

A standard system of scoring was used to evaluate the results of the experiments. This consisted of visual ratings from 0 to 9 for both weed control and cane vigour, i.e. 0/0 represented no weed control and complete suppression of the cane, whilst 9/9 represented perfect weed control and maximum cane growth. Commercially acceptable weed control would be rated at approximately 7 or above. Ratings were usually made concurrently by four independent observers.

Results

1. *First General Herbicide Trial:* This was planted on the Chaka's Kraal Experimental farm on the 8th January, 1962. The cane variety was N:Co.376. The main weed species were *Cyperus esculentus* and *Portulaca oleracea*. The treatments, together with the scoring which was carried out a month after planting, are given in next column:

Treatment	Amount of commercial material/ac.	Mean weed control rating	Mean cane vigour rating	Approx. cost of chem/ac.
Part I: Pre-emergent (Sprayed 8.1.62)				
Eptam, full cover ..	5 pts.	8	2	R 14-40
DCMU, full cover ..	4 lbs.	8	9	12-20
Eptam, row only ..	1½ pts.	7	4	3-60
CMU, row only ..	1 lb.	7	8	3-05
CMU, full cover ..	4 lbs.	7	8	12-20
DCMU, row only ..	1 lb.	5	7	3-05
Simazine, full cover	4 lbs.	5	7	8-60
MCPA, full cover ..	6 pts.	3	7	2-21
Fenac, row only ..	2½ pts.	2	6	2-85
Simazine, row only	1 lb.	2	6	2-15
Fenac, full cover ..	10 pts.	2	7	11-40
2,4-D Ester, full cover	6 pts.	2	6	2-21
2,4-D Amine, full cover	5 pts.	2	6	1.84
Control, no weeding	—	0	5	—
Part II: Post-emergent Contact (Sprayed 26.1.62)				
Paraquat	4 pts.	6	7	12-00
Diquat	2 pts.	5	7	3-75
Geeltox	12 pts.	4	6	6-45
Stam 34	12 pts. (US)	3	5	3-00
PCP+2,4-D Ester ..	2 galls.+ 3 pts.	2	5	2-09
PCP	4 galls.	2	4	1-96
Control, no weeding	—	0	3	—
Part III: Post emergent Systemic (Sprayed 26.1.62)				
PCP+2,4-D+TCA	2 galls.+ 3 pts.+ 7½ lbs.	3	5	4-19
Weedazol	2 galls.	3	5	17-60
Dalapon	7½ lbs.	2	4	7-50
TCA	15 lbs.	2	4	4-50
Control, no weeding	—	0	4	—

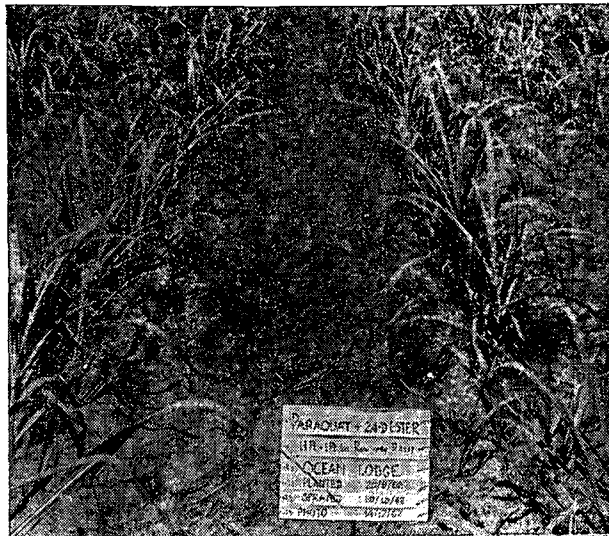
All of the post-emergent treatments were applied on a full cover basis. A further scoring for cane vigour some three weeks later gave very similar results. Extremely good results were obtained in this trial with DCMU and CMU. These can be attributed to the high rainfall over the period creating optimum soil moisture conditions. Eptam also gave excellent control over *Cyperus spp.*, but caused severe depression of the young cane growth and even appeared to inhibit germination entirely from some setts. After 14 months, however, these effects of Eptam were not visually apparent on the site of this experiment.

The only other treatments to show promise were Diquat and Paraquat, the latter particularly giving commercially acceptable control for five weeks after spraying, almost eight weeks after planting. The remarkably quick and complete recovery of the cane from a severe initial burn due to these chemicals was also first observed in this experiment. Photographs of the most effective treatments were included in an article by Thompson (1962).

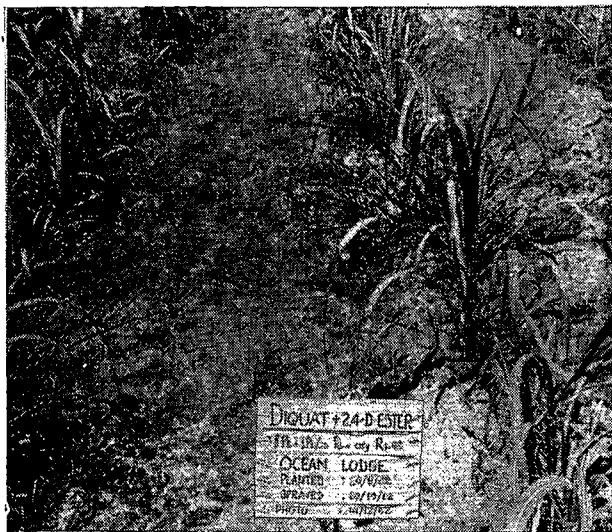
2. *Second General Herbicide Trial:* This was planted on the Mtunzini Propagation Farm on 17th and 18th April, 1962. The means of four ratings which were



4. Ocean Lodge, near Stanger: *Datura stramonium* with Cyperaceae and grasses blow.



5. Ocean Lodge: Good weed control, cane tillering well.



6. Ocean Lodge: Good weed control except for *Panicum maximum*,

carried out during the period 9½ to 14 weeks after planting have been calculated and are given below for each of the various treatments:

Treatment	Amount of commercial material/ac.	Mean weed control rating	Mean cane vigour rating	Approx. cost of chem/ac.
Part I: Pre-emergent, row only (Sprayed 18.4.62)				
Hand-weeded ..	—	7.6	7.9	R
Kuron	8 U.S. pts.	7.6	6.6	?
DCMU	1½ lbs.	6.1	8.2	4-07
CMU	1½ lbs.	5.9	8.4	4-07
2,4-D Amine ..	1½ pts.	2.5	7.7	0-61
Eptam	1 pt.	0	4.3	2-88
Part II: Post-emergent, full cover (Sprayed 13.6.62)				
Hand-weeded ..	—	8.1	6.2	R
Paraquat	6 pts.	7.4	4.5	18-00
Paraquat+2,4-D Ester	4 pts.+3 pts.	6.8	3.1	13-10
Paraquat	4 pts.	6.4	4.4	12-00
Paraquat	2 pts.	4.9	3.8	6-00
Diquat+2,4-D+TCA	2 pts.+3 pts.+7½ lbs.	4.8	4.0	6-95
Diquat+2,4-D Ester	2 pts.+3 pts.	4.7	4.4	4-85
Diquat	2 pts.	4.1	5.3	3-75
Diquat	1 pt.	3.4	5.4	1-87
Diquat	3 pts.	3.1	3.6	5-62
2,4-D+TCA ..	3 pts.+15 lbs.	2.6	5.3	5-60
2,4-D+Dalapon ..	3 pts.+7½ lbs.	2.2	5.0	8-97
Nil	—	0.3	3.4	—
Post III: Post emergent, row only (Sprayed 13.6.62)				
Hand-Weeded ..	—	5.6	8.3	R
Paraquat+2,4-D Ester	1½ pts.+1 pt.	7.8	4.3	4-37
Paraquat	2 pts.	6.3	5.9	6-00
Paraquat	¾ pt.	5.5	5.9	2-00
Paraquat	1½ pts.	5.4	6.3	4-00
Diquat	¾ pt.	5.3	6.4	1-25
Diquat	1 pt.	5.1	5.9	1-87
Diquat+2,4-D Ester	¾ pt.+1 pt.	4.8	5.9	1-62
Diquat+2,4-D+TCA	¾ pt.+1 pt.+2½ lb.	3.6	5.9	2-32
Diquat	¾ pt.	2.8	6.6	0-62
2,4-D+TCA ..	1 pt.+5 lbs.	2.4	7.6	1-87
2,4-D+Dalapon ..	1 pt.+2½ lbs.	0.6	6.3	2-99
Nil	—	0.2	6.1	—

This experiment might appear to have been planted out of season, but the Middle Ecca soils in the Mtunzini area reportedly became waterlogged during the wet summer season, and an autumn plant is recommended to avoid this condition by taking advantage of reliable but lighter winter rains. In the event, both weeds and cane grew very slowly in the experiment, as illustrated in three of the accompanying photographs, and the periods of weed control effected should not be regarded as normal for spring or summer conditions.

The scoring show that Paraquat achieved consistently the best weed control of the post-emergent group, and the optimum treatment would appear to

be 1½ pts. Paraquat+1 pt. 2,4-D Ester per acre applied to the row only. Diquat also gave encouraging results, but TCA and Dalapon were disappointing. Of the pre-emergent treatments Kuron at a high rate gave good weed control but it caused some suppression of cane growth. DCMU and CMU both gave appreciable weed control and improved cane growth (see photographs).

Initially, the weed population was mainly *Commelina nudiflora*, but later a fairly general population of broad leaved weeds and grasses, especially *Digitaria horizontalis*, developed.

Paraquat and Diquat caused an initial setback to the cane, but the recovery from this is illustrated in the following table, where mean ratings over the 16-20 week period are shown:

Treatment	Cane Vigour Ratings	
	Full cover	Row only
Hand-weeded	7.4	8.1
All Diquat treatments	6.9	7.7
All Paraquat treatments	7.2	7.6
Nil	2.6	4.9

The improvement in cane vigour after severe scorching by the Paraquat treatments, together with the maintenance of an acceptable degree of weed control for a long period are shown in Figure I. In contrast, the control exerted by Diquat was poorer and declined over the period shown.

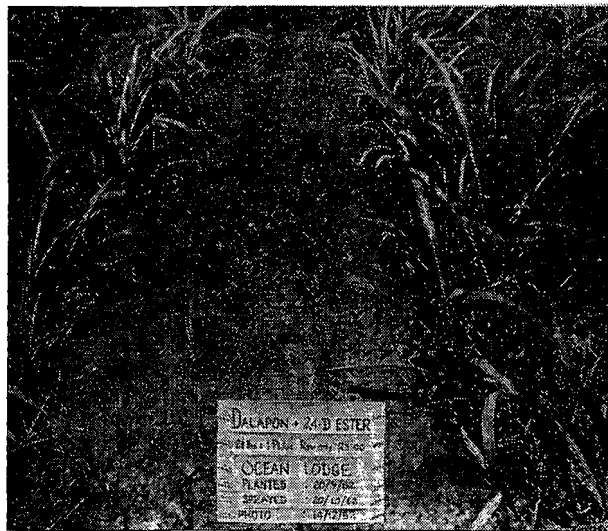
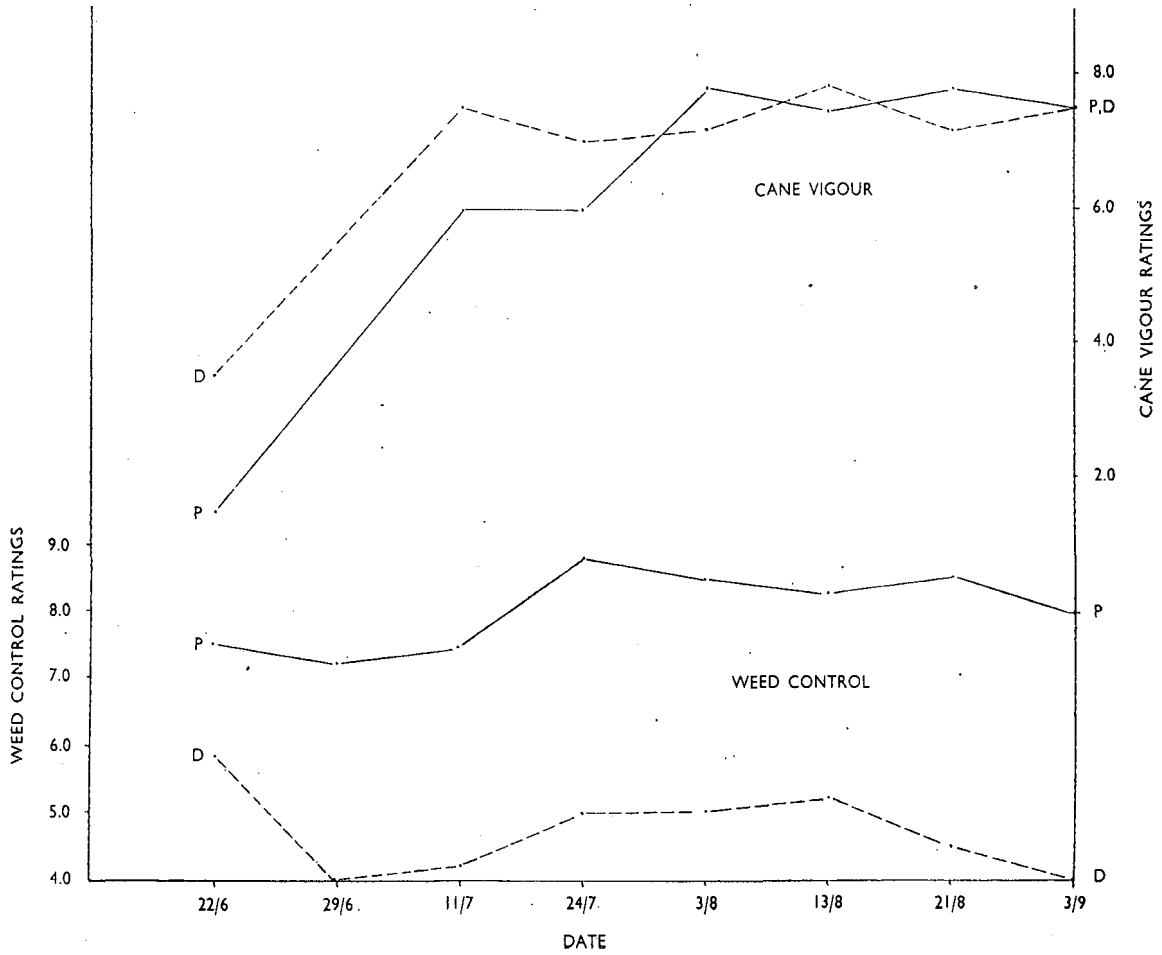
3. *Third General Herbicide Trial:* This was planted on 14th December, 1962, on the Mount Edgecombe Farm, and included the following treatments:

Treatment No.	Treatment	Amount of commercial material per acre	Approx. cost of chemical per acre
Part I: Pre-emergent			
1.	Control, no weeding	—	R
2.	Control, hand-weeded	—	—
3.	Eptam+2,4-D Amine	2 pts.+1 pt.	6-12
4.	Kuron	6 pts.	?
5.	DCMU	4 lb.	12-20
6.	Simazine 80 w	4 lb.	8-80
7.	Atrazine 80 w	4 lb.	8-80
8.	2,4-D Amine	5 pts.	1-84
Part II: Post-emergent			
1.	Control, no weeding	—	R
2.	Control, hand-weeded	—	—
3.	Diquat+2,4-D Ester	3 pts.+1 pt.	5-99
4.	Paraquat+2,4-D Ester	4 pts.+1 pt.	12-37
5.	PCP+2,4-D Ester ..	4 galls.+1 pt.	2-44
6.	DCMU+2,4-D Ester	4 lb.+1 pt.	12-57
7.	Stam 34+2,4-D Ester	10 pts.+1 pt.	3-37
8.	Dalapon+2,4-D Ester	7½ lb.+1 pt.	8-24
9.	TCA+2,4-D Ester ..	15 lb.+1 pt.	4-87
10.	TCA+PCP+2,4-D Ester	10 lb.+2 gall.+1 pt.	4-35
11.	Dalapon+PCP+2,4-D Ester	5 lb.+2 gall.+1 pt.	6-60
12.	TCA+Diquat+2,4-D Ester	10 lb.+1 pt.+1 pt.	5-25
13.	TCA+Paraquat+2,4-D Ester	10 lb.+2 pts.+1 pt.	9-37

Figure 1

COMPARATIVE DEGREES OF WEED CONTROL AND EFFECTS ON SUGAR CANE VIGOUR FOR DIQUAT (D) AND PARAQUAT (P)

SPRAYED : 13/6/62



7. Ocean Lodge: Grasses well controlled, poor control of Cyperaceae.

The weed population in this experiment was predominantly *Cyperus esculentus*, and *C.rotundus* also occurred. Other weeds were *Eleusine indica*, *Amarantus spp.*, *Oxalis spp.*, *Bidens pilosa* and *Sorghum verticilliflorum*.

The Eptam was applied on 14th December, 1962, prior to planting. The remaining pre-emergent treatments were applied on 15th December and the post-emergent treatments on 5th January, 1963. DCMU was tested as a post-emergent herbicide for the first time, following reports of success in experiments in Trinidad (Laurie and Vlitos, 1962). The Eptam treatment reduced the population of Cyperaceae but allowed a considerable number of broad leafed weeds to develop, despite the post-planting application of 2,4-D. The remaining pre-emergent treatments achieved no practical degree of control at any stage.

Ratings were carried out on 23rd January, 1963, but effective control of weeds lasted in some of the post-emergent treatments until about the end of February. Rainfall over the various periods was as follows:

	Rain Inches	No. of days on which rain fell
Pre-planting 1st — 13th Dec. . .	0.80	7
Pre-emergence 14.12.62—4.1.63	1.93	7
Post-emergence 5.1.63—31.1.63	8.14	14
1.2.63—28.2.63	2.32	8

From these data it is apparent that the post-emergent treatments operated under far more favourable conditions of soil moisture than the pre-emergent treatments, and this is reflected in the following average results:

Herbicides	Weed Control Rating	Cane Vigour Rating
Hand-weeded	8.4	6.8
TCA+Paraquat	8.2	6.6
TCA	7.4	6.2
TCA+PCP	7.2	6.2
DCMU	7.0	7.3
Paraquat	7.0	5.8
Dalapon+PCP	6.8	5.9
TCA+Diquat	6.4	6.8
Stam 34	6.4	6.0
PCP	6.4	5.9
Diquat	6.4	6.8
Dalapon	6.0	7.2
Control, no weeding	1.6	6.6

The most successful treatment under the moist soil conditions which were obtained was TCA plus Paraquat, which at the end of February was still giving a better control of weeds than two hand weedings. Several other combinations of systemic and contact postemergent herbicides also gave good results. At R9.37 per acre, the TCA plus Paraquat combination is not economically warranted but on the row only at a

third of this cost it might well be considered. TCA used alone gave good results, but the variability of its effects in other trials precludes its being recommended generally at this stage. DCMU as a post-emergent treatment gave good results under the wet conditions in contrast with its almost complete ineffectiveness when sprayed pre-emergent under dry conditions. The high cost of DCMU and its dependence on suitably moist soil conditions must exclude it from consideration at present except for irrigated lands. Dalapon was inferior to TCA in this trial, but nevertheless exerted fairly substantial weed control. The straight contact herbicides were less effective than usual, presumably due to the fact that conditions for regrowth were excellent. The best contact treatment, as in almost all other trials, was Paraquat, whilst Stam 34 also gave reasonable control for a longer period than did PCP.

Most of the herbicides had little effect on cane vigour. DCMU appeared to improve the condition of the cane, but Dalapon may have suppressed cane growth at a later stage than the time of rating. Paraquat, Diquat, PCP and Stam all scorched the cane leaves, but recovery by the crop was quick.

4. *Regional Herbicide Trials.*—During the 1962 planting season nineteen regional trials were established on growers properties throughout the cane belt from Port Shepstone to Umfolozi, covering almost every major soil type and numerous different weed populations. The trials included the following "row only" treatments, the inter-rows being cultivated as in normal farm practice.

Treatment	Amount of commercial material per acre	Approx. cost of chemical per acre
		R
1. Hand-weeded	—	—
2. Nil	—	—
3. DCMU	1½ lb.	4-07
4. 2,4-D Amine	1½ pts.	0-61
5. Kuron	2 pts.	?
6. Diquat+2,4-D Ester	¾ pt.+1 pt.	1-62
7. Paraquat+2,4-D Ester	1½ pt.+1 pt.	4-37
8. Dalapon+2,4-D Ester	2½ lb.+1 pt.	3-00

Treatments 3, 4 and 5 were pre-emergent, spraying taking place as soon after planting as possible. Treatments 6, 7 and 8 were post-emergent, being applied when the weeds were 2 to 4 inches high. This was usually 4 to 6 weeks after planting.

Ratings for weed control and cane vigour were carried out regularly, and these have been grouped into the following periods after planting: (a) 2 to 5 weeks, (b) 5½ to 9 weeks, and (c) 9½ to 14 weeks. After 14 weeks, effective weed control had been lost in all experiments, which were then hand weeded. A post-cleaning rating for cane vigour was carried out in some cases at 16 weeks after planting. The general results were as follows:

Treatment	Weed Control Rating			Cane Vigour Rating			
	2-5	5½-9	9½-14	2-5	5½-9	9½-14	Post-cleaning
Hand-weeded ..	4.9	6.6	7.0	5.5	5.8	7.1	7.7
Nil	3.7	2.0	0.9	4.8	3.6	4.4	4.3
DCMU	5.0	3.8	3.1	5.5	4.5	5.5	4.7
2,4-D Amine ..	5.5	4.0	3.2	5.1	4.4	4.2	3.9
Kuron	5.4	3.7	3.0	4.9	4.2	5.1	3.7
Diquat	—	4.5	3.9	—	3.8	5.0	5.0
Paraquat	—	6.1	5.8	—	4.9	5.5	6.6
Dalapon	—	4.5	4.7	—	4.3	5.4	7.0

The results naturally varied from experiment to experiment according to the type of weed population and the environmental conditions, particularly the soil moisture conditions after spraying. However, certain general conclusions may be drawn from the ratings and observations made during the experiments.

In general, pre-emergent herbicides were unsuccessful in exerting any appreciable weed control except where soil conditions were suitably moist or where there were few monocotyledons present. Under wet conditions, DCMU gave fairly good weed control and usually resulted in even greater cane vigour than that observed in the hand-weeded plots. Under dry conditions, however, DCMU achieved relatively little control. Broad leafed weeds as well as grasses and sedges from seed were controlled by 2,4-D for a short period only. Kuron controlled a fairly wide spectrum of grasses and broad leafed weeds for a longer period than did 2,4-D, but gave somewhat erratic results. It achieved no control of Cyperaceae.

For commercial weed control under Natal conditions it would thus appear that post-emergent herbicides are more promising. They have the considerable advantage that they are not as dependent upon weather conditions after spraying. Paraquat gave easily the best weed control for a sufficient long period after spraying to be regarded as a likely material for successful commercial use. It controlled almost all types of weeds effectively, and is particularly valuable for its good control of Cyperaceae. It scorches the cane quite severely, but the rate of recovery is remarkably good, and tillering appears to be increased. The ratings show that Paraquat gave both the best weed control and the highest cane vigour of all treatments except hand weeding. Unfortunately its cost is very high at present, and this precludes its commercial application as yet.

Diquat gave reasonably good results, but its effect on grasses particularly is poorer than that of Paraquat. Diquat also scorches the cane, but recovery is quick. In view of its relatively low cost, this material could perhaps be recommended for temporary weed control when a weeding programme falls behind schedule, but it is not predicted that the results will always be satisfactory.

Dalapon gave reasonable control where grasses were the main problem, but little or no control of broad leafed weeds was obtained and the effect on

Cyperaceae was poor. It also appeared to stunt the cane growth in some experiments.

The most troublesome weeds encountered during the regional trials were *Cyperus esculentus* and *Panicum maximum*. Other *Cyperus* species such as *C. rotundus*, and other grasses such as *Eleusine indica*, *Panicum laevifolium*, *Sorghum verticilliflorum* and *Digitaria horizontalis* were also common. The grasses were generally best controlled by Dalapon, although both Paraquat and Kuron also gave good results. Cyperaceae were in general well controlled by Paraquat except under very wet conditions when DCMU was particularly effective. Broad leafed weeds included *Commelina spp.*, *Amarantus spp.*, *Bidens pilosa*, *Siegesbeckia orientalis*, *Physalis minima*, *Portulaca oleracea* and *Datura stramonium*. These did not present such a problem, however, and most were easily killed by Paraquat, Diquat, Kuron and to a varying degree by DCMU and 2,4-D.

5. *Observational Trials with Contact Herbicides.*—Since light intensity has been reported to affect the results to be obtained with Diquat and Paraquat, an observational trial was laid down during May, 1962, to compare the effects of Diquat, Paraquat and PCP applied at 6 a.m., 8 a.m., 10 a.m. and 12 noon. The twelve plots sprayed on a single day were regarded as a replication, and successive replications were sprayed on the 1st, 23rd, 24th and 25th May. The rates of application of the chemicals were:

Diquat ..	2 pts./ac.
Paraquat ..	4 pts./ac.
PCP ..	4 galls./ac.

The PCP used on 1.5.62 had very little apparent effect on the weeds present, and further work was delayed until 23.5.62 when a fresh consignment of PCP had been obtained. The predominant weeds on the experimental site, a cane break on the Mount Edgecombe farm, were *Amarantus spinosus*, *Bidens pilosa*, *Cyperus spp.*, *Chenopodium murale*, *Eleusine indica*, and *Eragrostis ciliaris*.

The general weather conditions obtaining during the spraying periods were as follows:

6 a.m.	Medium or heavy dew, no wind, clear sky. Before sunrise. Screen temperatures 10.7 - 12.6°C.
8 a.m.	Light dew, no wind, clear sky. After sunrise but in shade. Screen temperatures 16.9 - 18.2°C.
10 a.m.	No dew, slight wind, clear sky, no shade. Screen temperatures 23.8 - 24.8°C.
12 noon	No dew, slight wind, clear sky, no shade. Screen temperatures 25.3 - 27.7°C.

Ratings for weed control were as follows:

Treatment	6 a.m.	8 a.m.	10 a.m.	12 noon
Diquat	4	4	5	5
Paraquat	7	7	8	8
PCP	0	0	1	1

From these data it does appear that both Diquat and Paraquat improved slightly in their effects on weeds as the mornings progressed, but whether this was due to increasing light intensity, the absence of dew after 8 a.m., or even rising temperatures has not been shown. The fresh consignment of PCP was unfortunately as ineffective as the first, and the results with this chemical were therefore of little interest.

As Paraquat was known to be an expensive material, it was also decided to test possible combinations of Paraquat and Diquat which might give effective weed control at a more reasonable cost. The combinations used in unreplicated plots on the same weed species as the previous experiment, and sprayed on 1.5.62, were as follows, together with the average weed control ratings for the various treatments:

Treatment	Pts. Diquat/ac.	Pts. Paraquat/ac.	Rating
1	1	0	4.0
2	1	$\frac{1}{4}$	4.0
3	1	$\frac{1}{2}$	4.0
4	1	1	5.0
5	1	2	5.0
6	2	0	4.0
7	2	$\frac{1}{4}$	4.0
8	2	$\frac{1}{2}$	4.0

The degree of weed control in none of these plots approached that obtained with 4 pints of Paraquat per acre, and the testing of Diquat/Paraquat cocktails was therefore not pursued.

A third observational test on a cane break was sprayed on 1.5.62. This was designed to compare various levels of Diquat and Paraquat, with and without 3 pints of 2,4-D Isopropyl ester per acre. The weed population on the site of this experiment was largely *Cyperus spp.* and annual grasses. The treatments and ratings are given in the following table:

Treatment per acre	No. 2,4-D	With 2,4-D
Diquat, $\frac{1}{4}$ pt.	0.8	3.7
Diquat, $\frac{1}{2}$ pt.	3.3	5.0
Diquat, 1 pt.	5.0	6.3
Diquat, 2 pts.	6.0	7.0
Paraquat, 1 pt.	6.0	7.0
Paraquat, 2 pts.	7.0	7.7
Paraquat, 4 pts.	7.8	8.2
Mean	5.1	6.4

The addition of 2,4-D to both chemicals so consistently improved the efficiency of treatment that it was decided on these grounds to include the 2,4-D Ester with the Diquat and Paraquat applications in the Regional Herbicide Trials.

General Discussion

There are probably two main reasons for the fact that herbicides have not yet found widespread acceptance in Natal. Firstly, herbicide activity has been shown to be extremely dependent on soil moisture

conditions (Upchurch, 1957, Splittstoesser and Derscheid, 1962), and the unreliability of rainfall in the cane belt militates against consistent results being obtained with materials which must enter or stay in solution in the soil to be absorbed through the roots. Under irrigated conditions this severe limitation falls away almost entirely.

Secondly, the relatively low cost of labour automatically rules out all but the cheapest of herbicides, except when labour availability becomes a problem. This is in contrast to Hawaii (Hanson, 1962) where over half a million acres are sprayed annually, each field receiving an average of five applications at a total cost of about R50 per acre. A typical programme there might consist of a first spray with DCMU, a second with Atrazine, a third with TCA + 2,4-D, and fourth and fifth applications dependent upon weed populations.

It therefore appears that the ideal local requirement at present is an inexpensive herbicide which is effective under a wide range of soil moisture conditions and in controlling a wide range of broad leafed weeds, grasses and sedges. The conclusion reached after conducting the fairly exhaustive experiments described in this paper is that no available material meets all of these requirements, but that Paraquat does so in all respects except cost. There remains, however, considerable scope for further investigation since other available formulations have had effects which might well be adapted to particular problems. The use of Dalapon on an intensive scale in areas infested with *Panicum maximum* is an example, whilst the excellent control of *Cyperus spp.* by Eptam can scarcely be overlooked as long as watergrass remains a major problem.

The necessity for identifying the conditions under which particular results are obtained can only be emphasized. Whilst the inconsistency of many of the results may be ascribed to varying soil moisture conditions, an interesting further factor is the organic matter content of the soil. Recent work has shown that the effectiveness of a large number of soil applied herbicides, including DCMU, Eptam, Simazine, Dalapon and 2,4-D was inversely correlated with the organic matter content of the soil. For equal toxicity, approximately five times more herbicide was required at 20 per cent organic matter than at 4 per cent. (Upchurch and Mason 1962, Jordan and Day 1962.) Since the major soils in the Natal sugar belt vary from 1 to 8 per cent organic matter (Beater, 1962), variable results with constant rates of herbicides are to be expected.

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Mr. N. C. King: Could the amount of water used with the herbicide per acre be reduced, and would there be any advantage in reducing it?

Mr. Thompson: No work has been carried out on this subject as yet, but it would obviously be to the advantage of the farmer if he could reduce the amount of water he had to haul. This haulage was a considerable item in the economics and organisation of herbicide usage.

Mr. Sherrard asked if any herbicide was particularly effective against watergrass growing in a lawn.

Mr. Thompson replied that Eptam had proved to be very effective against *Cyperus Esculentus*, but whether or not there was a practical means of applying this material to a lawn, and whether or not it would affect *Cynodon Dactylon* as well perhaps Mr. King could say.

Mr. King said he did not think it a very practicable proposition on lawn.

Mr. Wilson asked if Paraquat was translocated in the plant to any extent.

Mr. Thompson: Paraquat is translocated and the extent to which this occurs depends upon how quickly the sprayed parts of the weed actually die. It has been suggested that quick drying under conditions of bright sunshine could limit translocation, and that late evening spraying might prove to be most effective in allowing translocation take place.

Mr. Pearson remarked that the use of herbicides in proximity to cotton should be practised with care. Cotton 200 yards away from one of the general herbicide trials was affected by 2 4-D.

Dr. Cleasby: Reglone (Diquat) was very effective against watergrass on a commercial scale in the field at Tongaat.