PRELIMINARY INVESTIGATIONS INTO THE COMPETITIVE EFFECTS AND CONTROL OF *CYPERUS ROTUNDUS* L. IN SUGARCANE FIELDS

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Abstract

Preliminary results of four experiments designed to determine the competitive effects of *Cyperus rotundus* L. on sugarcane and to investigate methods of controlling this weed, are reported. A trial in which a plant crop of varieties N13 and N8 was grown under rainfed conditions showed that competition from *C. rotundus* caused decreases in yield of 85 and 83% respectively. In a second trial under irrigation, stalk elongation and tillering were slower in plots of plant cane which contained *C. rotundus*. Methods of re-establishing sugarcane which showed effective control of *C. rotundus* include: minimum tillage with a second application of glyphosate (Roundup), conventional tillage with a single or repeated application of Roundup onto emerged *C. rotundus* plants; and to a lesser extent, the use of Eptam Super at the time of planting.

Two trials in ratoon cane showed that many treatments provide short term control of *C. rotundus* populations, even in the following ratoon. The best treatments were repeated applications of Roundup, hexazinone (Velpar) and MSMA, and hand hoeing. The growth of ratoon sugarcane was not improved by controlling *C. rotundus*, but no treatment eliminated *C. rotundus* completely. Crop growth will be monitored in subsequent ratoons to assess the effect of reduced *C. rotundus* populations.

Introduction

Cyperus rotundus L. (purple nutsedge) is a weed of some 52 crops in 92 countries and is regarded as the world's worst weed (Holm *et al*[3]). In South Africa it occurs in heavy and light soils in both the northern irrigated areas and the warm coastal rainfed areas where 100% ground cover is common.

A number of crops are affected by the severe competition of this weed (Holm *et al*;[3] Meissner *et al*[4]) and in sugarcane, decreases in yield of 75% in Argentina and 38% in Australia (even with cultivation) have been reported (Holm *et al*[3]). Large reductions in yield caused by the weed have been reported from Mauritius.[5]

The results of research in South Africa suggested that good control of emerged *C. rotundus* plants could be achieved with 2,4-D and paraquat (Gosnell & Thompson[2]) and pre-emergence control could be achieved with EPTC (Eptam Super) and butylate in plant cane (Thompson & Gosnell;[6] Turner[7]). *C. rotundus* was however not eradicated and relatively high rates of 2,4-D (5,3 kg ae/ha) were required for acceptable control.

The purpose of the four experiments reported here was to determine the competitive effects of the weed on the plant crop of varieties N13 and N8 grown on a weak sandy soil with rainfall only and on the plant crop of variety NCo 376 grown under irrigation on a sandy loam soil. Various methods of controlling the weed were evaluated by determining their effects on the yields of ratoon crops of variety N8 on a coastal sandy soil and variety N52/219 under irrigation on a sandy loam soil.

Experimental Procedure

Details of the site, soil type, variety, crop and rainfall are presented in Table 1.

A randomised block design with one to six replications was used in all experiments. The gross size of the plots used in experiments to measure the effects of competition in plant cane, ranged from four rows 16 m long to four rows 6 m long. The three or four interrow areas used for the weed control experiments were 4 m long. The two outer rows and one metre from each end of the remaining rows were discarded at the time of harvesting in the experiments designed to study the effects of weed competition on crop yield. For comparison, an unsprayed control strip at least one metre wide was left at the end of every plot in the weed control experiments.

In all four experiments, a lever-operated knapsack sprayer fitted with an APM Green Albuz floodjet was used. The nozzle was held between the cane rows except when glyphosate (Roundup) was used to kill sugarcane or *C. rotundus*, when the spray was directed over the cane or *C. rotundus*. Immediately after Eptam Super was applied, tractor-drawn or hand held motorised rotary hoes were used to incorporate the product into the soil.

Weed control was assessed either by visual ratings of percent control relative to unsprayed areas, or by means of sample counts of *C. rotundus* plants in a 200 mm × 200 mm area. Where subterranean parts of plants were counted, the size of the sample was 200 mm × 200 mm × 150 mm.

Crop growth was measured regularly in all experiments. Plant height was measured from ground level to the top visible dewlap of 20 randomly selected stalks in each plot and the stalks in one net row of each plot were counted. Where the cane was harvested and weighed, a sample of 12 stalks was taken from each plot for sucrose analysis.

TABLE 1

Experiment details

Experiment No.	Site	Soil type		Variety	Crop	Irrigated or rainfed	Rainfall % of LTM*	Total rainfall plus irrigation (mm)
		Series	Clay %					
1A	Umdloti : Natal Estates	Clansthal	6	N13	Plant	Rainfed	60	508
1B	Umdloti : Natal Estates	Clansthal	6	N8	Plant	Rainfed	60	428
2	Hluhluwe : Glen Park Ests	Oakleaf	13	NCo 376	Plant	Irrigated	60	Up to 5,5 mths 561
3	Mt Edgecombe : Natal Estates	Fernwood	7	N8	Ratoon	Rainfed	63	—
4	Hluhluwe : Glen Park Ests	Oakleaf	20	N52/219	Ratoon	Irrigated	60	—

* LTM = long term mean

Experiment 1A and 1B

The site at Umdloti had been treated with glyphosate to remove *Cynodon dactylon* which had died and the area became infested with *C. rotundus*. In Experiment 1A variety N13 was used and the treatments were:

1. *C. rotundus* plants and tubers were left to grow and compete with sugarcane.
2. *C. rotundus* plants and tubers removed to a depth of 150 mm by sieving the soil.

In Experiment 1B with variety N8,

1. *C. rotundus* plants were left to grow and compete with sugarcane.
2. *C. rotundus* plants were treated three times with Roundup prior to planting.

In the 'no *C. rotundus*' plots, any plants which germinated subsequently were removed by hand. All plots were treated with alachlor (Lasso) plus atrazine at planting to control grass and broadleaf weeds and any subsequent grass and broadleaf weeds which grew were removed by hand.

The soil in '*C. rotundus*' plots was disturbed with hand hoes to simulate the sieving operation in the 'no *C. rotundus*' plots in case disturbing the soil reduced the damage to cane by parasitic nematodes. The nematicide aldicarb was applied to all plots.

Furrows were drawn and planting was done by hand. Cane setts were planted end-to-end in a double row at a depth of approximately 100 mm.

Experiment 2

Treatments are shown in Table 2.

The young ratoon crop on the site of the experiment was infested with *C. rotundus* to which a herbicide mixture based on paraquat had been applied once. All the cane on the site was cut back and the cane in the plots for the minimum tillage treatment was left to grow. The other plots were ploughed as indicated in the table of treatments. *C. rotundus* grew again and was dense in the minimum tillage plots.

Planting was done by hand after ridging with a three furrow tractor-drawn ridger. Standard Fertilizer Advisory Service analytical data were used for determining the fertilizer requirements.

The plots consisted of four rows 32 m long; half of each row was treated to control *C. rotundus* and the other half was not treated. Two sample areas each consisting of two 6 m long rows in each sub-plot were used for measuring crop growth and assessing the population of *C. rotundus*.

Experiment 3

Treatments are listed in Table 3.

TABLE 3

Treatments used in Experiment 3

Treatments	Rate in kg or ℓ ai or ae/ha	Comments
1 (Ioxynil + 2, 4-D)	1,05	
2 MCPA + surfactant (S)	2,8	
3 MCPA + S	4,0	
4 Ametryne + (ioxynil + 2, 4-D)	2 + 0,875	Single applications on 25 October
5 Ametryne + MSMA	2 + 2,88	
6 Ametryne + MSMA	1 + 1,44	
7 (Ioxynil + 2, 4-D)	0,875 + 2,88	
8 MSMA	2,88	
9 MCPA + paraquat	1,6 + 0,6	
10 Hexazinone/hexazinone	0,675/0,54	
11 Hexazinone/diuron + (ioxynil + 2, 4-D)	0,675/2,0 + 0,875	Split applications on 16 September and 11 November
12 Diuron + (ioxynil + 2,4-D) (repeated)	2,0 + 0,875/2,0 + 0,875	
13 Hexazinone/hexazinone	0,338/0,338	
14 Glyphosate (Roundup)	10% solution	Applied with a brush

TABLE 2

Treatments used in Experiment 2

Treatments	No. of sub-plots	Weed control programme	Tillage procedure
Control : Plough (*C. rotundus* left to compete)	2	Hand weeded of grass and broadleaf	No soil disturbance after Roundup application. Ridged directly into soil
Treated : Plough + Roundup on *C. rotundus* (1 application)	1	Dual + ametryne + paraquat/diuron + (ioxynil + 2, 4-D)	
Treated : Plough + Roundup on *C. rotundus* (2 applications)	1		
Control : Plough (*C. rotundus* left to compete)	2	Hand weeded of grass and broadleaf	
Treated : Plough + Eptam Super at planting	2	Diuron + (ioxynil + 2, 4-D)(2 applications)	Rotary hoe for incorporation into soil
Control : Plough (*C. rotundus* left to compete)	2	Hand weeded of grass and broadleaf	
Treated : Plough + Dual + ametryne + paraquat	2	Diuron + (ixoynil + 2, 4-D) (2 applications)	
Control : Min. tillage-1 R/up application (*C. rot.* left to compete)	1	Hand weeded of grass and broadleaf	No soil disturbance
Treated : Min. tillage-1 R/up application + Eptam Super on row	1	Diuron + (ioxynil + 2, 4-D)(2 applications)	In-row incorporation only
Control : Min. tillage-2 R/up applications (*C. rot.* left to compete)	1	Hand weeded of grass and broadleaf	No soil disturbance
Treated : Min. tillage-2 R/up applications + Eptam Super on row	1	Diuron + (ioxynil + 2, 4-D) (2 applications)	In-row incorporation only

Notes on treatments:

1. All furrows in plots were drawn by a three furrow tractor-drawn ridger body.
2. Plough treatment consisted of a cross ripping (in two directions) and two subsequent discing operations except in treatment A which had only one discing operation.
3. Regrowth of *C. rotundus* was extensive where Roundup had been applied so another 6 ℓ/ha was applied to one plot of each treatment.
4. Where Eptam Super was used in minimum tillage plots, furrows for planting did not always follow through the treated area only. A hand held motorised rotary hoe was used to incorporate the herbicide into the soil.
5. Where Eptam Super was used in ploughed plots, a tractor-drawn rotary hoe was effective in incorporating the herbicide into the soil and also produced an extremely fine soil tilth.

A ratoon crop of variety N8 was growing on the weak sandy soil of this site in which the infestation of *C. rotundus* was very heavy. Treatments were applied on three occasions and rainfall received during these periods is given in Table 4.

TABLE 4

Weather conditions during and after spraying on three dates

Date of spraying	Rainfall (mm)				Sunshine hours on day of spray
	Day of Spray	Days to first rain	Amount of first rain	Within two weeks	
16 September 1982	3,0	0	3,0	3,4	0,4
25 October 1982	1,6	0	1,6	150,8	10,0
11 November 1982	0	6	1,6	5,9	6,8

All weeds other than *C. rotundus* were removed by hand. *C. rotundus* populations above and below the ground and the growth of the crop were assessed at intervals after treatment. Then (seven months after the first treatment) the plots in which the two treatments were most effective, were sampled and the viability of the tubers tested by replanting them in pots and watering them. Tubers from two soil samples (200 mm × 200 mm × 150 mm) from each treatment were used and the number of tubers which subsequently germinated were counted.

Experiment 4

Treatments are listed in Table 5.

TABLE 5

Treatments used in Experiment 4

Treatments	Explanation
1 Untreated	To allow full *C. rotundus* competition
2 Hand hoe repeatedly	Conducted four times at 2-3,5 week intervals to simulate mechanical cultivation. Conducted on interrow plants only
3 Ametryne + (ioxynil + 2, 4-D) repeated	Repeated twice. Rates ai/ha = 1,75 + 0,77
4 Alachlor + 2, 4-D + paraquat followed by ametryne + (ioxynil + 2, 4-D)	Rates ai/ha = 1,99 + 1,22 + 0,26 and 1,75 + 0,77 respectively
5 MSMA repeated	Repeated twice. Rates ai/ha = 2,52
6 Glyphosate repeated	Repeated three times. Rates 10% solution Applied with nylon brush and wiped onto interrow weeds only In-row weeds removed by hand pulling

A ratoon crop of variety N52/219 was harvested at the end of October 1982 and the field was used for this experiment. Treatments were applied between the cane rows to control as many *C. rotundus* plants as possible. In treatment 6 Roundup was applied to plants in the interrow only so that the cane crop was not damaged.

The degree of control of *C. rotundus* was assessed prior to the formation of the leaf canopy and after harvesting, any residual effects were examined. Crop growth was measured throughout the growing period and will be continued in subsequent ratoons to try to determine whether there will be any benefit in crop growth due to the residual control of *C. rotundus*.

Results

Experiment 1

- *C. rotundus* control

TABLE 6

***C. rotundus* plant and tuber populations at the time of planting or spraying glyphosate and shortly before and after harvesting on 30 September 1983**

Treatments	Experiment 1A					Experiment 1B				
	Plants-m2			Tubers-m3		Plants-m2			Tubers-m3	
	At plant	8 Aug 1983	3 Oct 1983	At Plant	3 Oct 1983	At spray	8 Aug 1983	3 Oct 1983	At spray	3 Oct 1983
C. rotundus	94	431	472	6 434	16 102	}300*	360	422	}8 798	17 430
No *C. rotundus*	13	—	10	1 584	0		—	18		5 810

* Plant and tuber populations before spray were means of samples from all plots

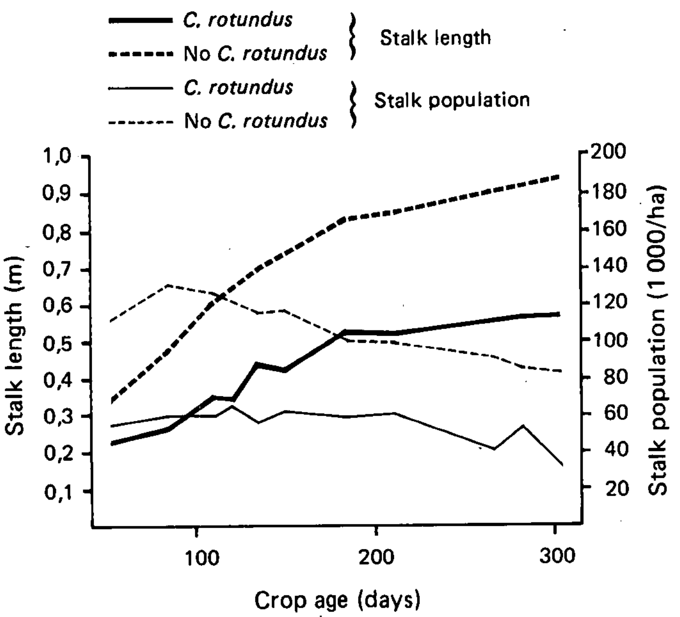


FIGURE 1 Effect of treatments on length and population of stalks in Experiment 1A

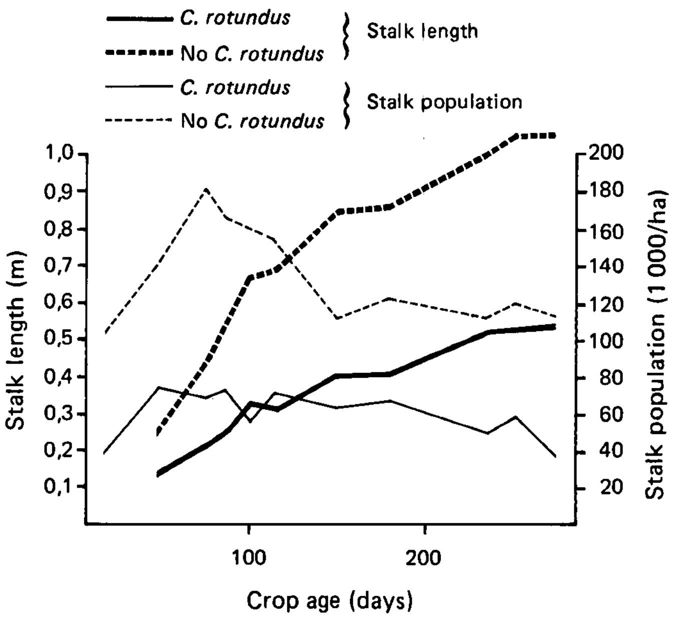


FIGURE 2 Effect of treatments on length and population of stalks in Experiment 1B.

Sieving the top 150 mm of soil was effective in reducing the number of *C. rotundus* plants but they were not eliminated completely. Roundup applications in Experiment 1B were less effective in controlling *C. rotundus* and spot spraying was necessary on two occasions after the initial treatment. Population counts after harvesting indicate the degree of control achieved.

- Crop growth

Germination of cane was slower in plots with *C. rotundus* and the production of tillers was retarded in both varieties.

The differences between the effects of treatments on the number and length of stalks were obvious throughout the growth period of the crop. Variations in stalk population can be attributed partly to damage caused by termites in plots of both treatments.

- Yield data

Yields were low even where there was no *C. rotundus*. The cane yielded 2,9 tons per hectare per month in Experiment 1A and 2,7 tons per hectare per month in Experiment 1B. These yields were however reduced by 83 and 85% respectively as a result of competition from *C. rotundus*. The effect of the weed may have been exacerbated by stress because the crop received only 60% of the average rainfall during its growth period.

Experiment 2

- *C. rotundus* control

C. rotundus was well controlled only by treatments which included glyphosate. Two applications of glyphosate were more effective than a single application to newly emerged *C. rotundus* both after ploughing, and particularly in the minimun tillage plots. This could have been because coverage of *C. rotundus* plants in the interrow was poorer when sprays were directed over the cane row. Other reasons could have been the length of time between the first spray and planting and the fact that not all the tubers had germinated when the plot was first treated.

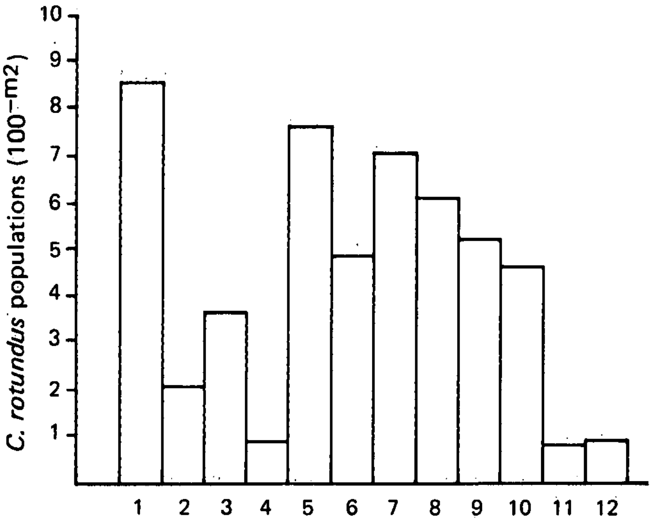
- Crop growth

TABLE 7

Harvest results, Experiment 1

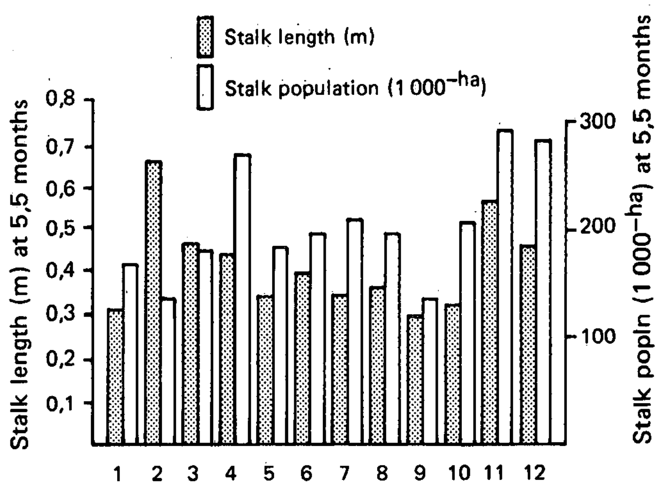
Treatments	Experiment 1A (N13)					Experiment 1B (N8)				
	Yield			Stalk length (m)	Stalk popn. (1000-ha)	Yield			Stalk length (m)	Stalk popn. (1000-ha)
	Cane t-ha	Suc % cane	Suc t-ha			Cane t-ha	Suc % cane	Suc t-ha		
C. rotundus	5,3*	11,35	0,66*	0,57**	33	3,82**	10,02	0,4**	0,54**	37**
No *C. rotundus*	30,7	12,65	3,94	0,94	83	25,0	10,97	2,74	1,055	113
CV %	45	5,9	47,8	3,9	45	17,6	6,2	19,0	10,4	17,1

* Statistically significant at the 5% level
** Statistically significant at the 1% level



1 = Plough
2 = Plough + 1 Roundup spray
3 = Plough
4 = Plough + 2 Roundup sprays
5 = Plough
6 = Plough + Eptam Super
7 = Plough
8 = Plough + Dual + ametryne + paraquat
9 = Minimum tillage (1 Roundup spray)
10 = Minimum tillage + Eptam Super (1 Roundup spray)
11 = Minimum tillage (2 Roundup sprays)
12 = Minimum tillage + Eptam Super (2 Roundup sprays)

FIGURE 3 *C. rotundus* populations: mean of counts on three sampling dates.



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9 = Minimum tillage (1 Roundup spray)
10 = Minimum tillage + Eptam Super (1 Roundup spray)
11 = Minimum tillage (2 Roundup sprays)
12 = Minimum tillage + Eptam Super (2 Roundup sprays)

FIGURE 4 Crop measurements at 5,5 months of age.

After 5,5 months, there were marked differences between treatments in the length and population of cane stalks. Stalks were generally longer where glyphosate had been applied to *C. rotundus* or in the minimum tillage system where only the repeat application resulted in a marked improvement. Applications of Eptam Super in conventionally tilled plots resulted in longer stalks but had a detrimental effect on cane growth in minimum tillage plots where glyphosate was applied twice. Stalks in plots which had been treated with Dual plus ametryne plus paraquat were only slightly longer than those in the unsprayed plots.

- *C. rotundus* infestation and crop growth

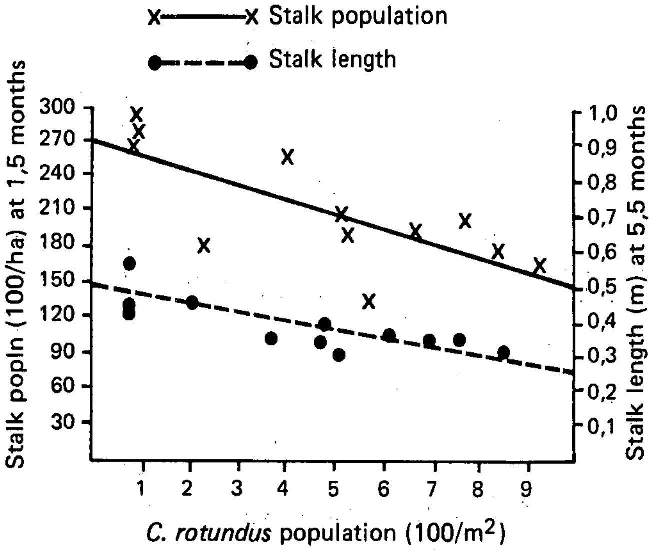

FIGURE 5 Relationship between *C. rotundus* population and (1) length and (2) population of stalks.

The relationship between *C. rotundus* infestation (using the mean of plant population counts made on four occasions) and crop measurements is shown in Figure 5. It was expected that germination of cane would be affected by competition from *C. rotundus*. The population at an early stage (1,5 months) provides an indication of the effects on germination. The results show that there is a distinct decrease in crop growth with increasing infestations of *C. rotundus*, while a marked increase in crop growth appears to be associated with low populations of the weed.

Experiment 3

TABLE 8

***C. rotundus* populations and visual ratings of *C. rotundus* in Experiment 3**

Treatments	Ratings (% control)			Counts plant^{-m2} as % of unsprayed 4 Feb
	11 Nov	13 Dec	4 Feb	
1 (Ioxynil + 2, 4-D)	50	60	10	80
2 MCPA + S (full rate)	45	34	0	106
3 MCPA + S (high rate)	57	41	10	74
4 Ametryne + (ioxynil + 2, 4-D)	52	37	1	95
5 Ametryne + MSMA (full rate)	40	15	2	92
6 Ametryne + MSMA (half rate)	12	12	0	82
7 (Ioxynil + 2, 4-D) + MSMA	57	32	0	106
8 MSMA	42	17	0	77
9 MCPA + paraquat	32	29	0	105
10 Hexazinone repeated	—	50	56	38
11 Hexazinone/diuron + (ioxynil + 2, 4-D)	—	74	21	64
12 Diuron + (ioxynil + 2, 4-D) repeated	—	45	1	107
13 Hexazinone repeated (low dose)	—	22	10	49
14 Glyphosate	—	—	61	23

Generally, the level of control of *C. rotundus* was unacceptable commercially, although all treatments provided some measure of control for at least one month. Hormone mixtures provided some control while the effect of MSMA mixtures was very short-lived. Repeated treatments of hexazinone or glyphosate provided the best control and a marked reduction in the number of *C. rotundus* plants was apparent in these treatments in February, three months after the second application. A sample taken in February showed that there were no fewer tubers after the treatments but their viability had been affected.

TABLE 9

Germination of tubers from plots treated with glyphosate and hexazinone, expressed as a percentage of germination of tubers from unsprayed plots

Treatments	Tuber germination (% of unsprayed control)
Hexazinone (sprayed twice)	72
Glyphosate	58

Despite the slight reduction in viability (Table 9) it could not be concluded that the treatments had prevented or eliminated any *C. rotundus* competition. Crop measurements show that there was no marked difference in crop growth between treatments which is to be expected because no treatment controlled *C. rotundus* adequately and any control which was obtained, was probably too late to affect cane growth.

Ametryne or MSMA caused severe scorching in variety N8 but this effect eventually disappeared.

Experiment 4

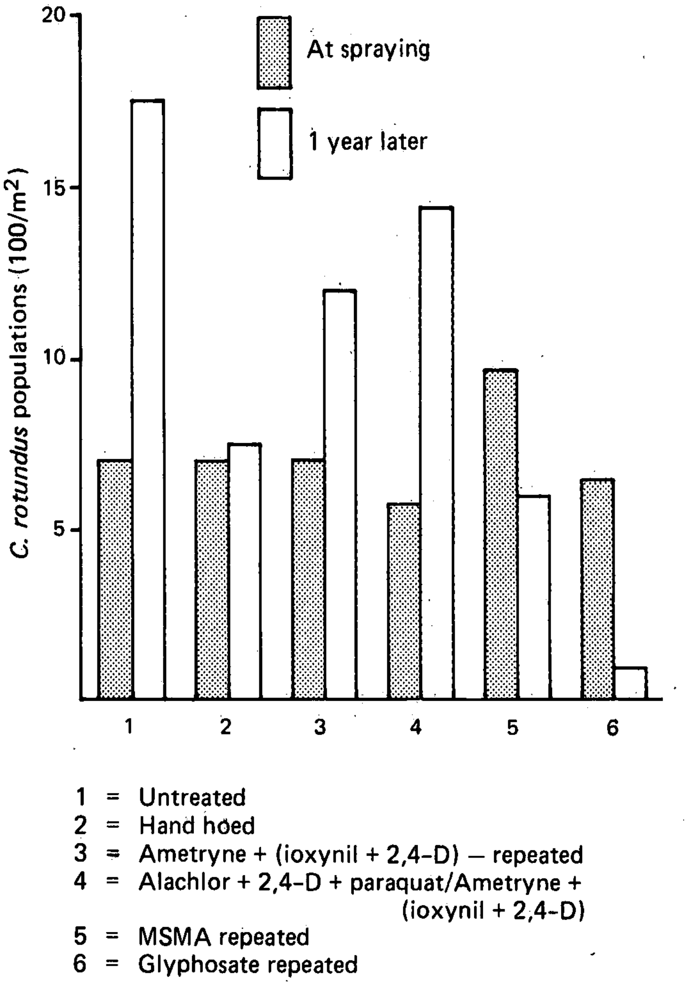

FIGURE 6 *C. rotundus* populations at spraying and one year later (two months after harvest).

- *C. rotundus* control

From Figure 6 it can be seen that *C. rotundus* populations more than doubled from one crop to the next in untreated plots. Populations were smaller in all treated plots than in the untreated plots but only repeated MSMA or glyphosate treatments resulted in a decrease with time in *C. rotundus* populations. In the treatment involving hand hoeing, populations were held at the same level. Plants in the rows were not controlled in the plots treated with glyphosate because the spray swath was restricted to the interrow for fear of damaging the cane.

- Crop growth

TABLE 10

Crop measurements at 9 months of age and visual ratings of *C. rotundus* control (mean of four assessments on 20 Dec, 7 Jan, 20 Jan and 8 Feb)

Treatments	Ratings (% control)	Crop measurements	
		Stalk length (m)	Stalk popn. (1000-ha)
1 Unsprayed control	2,3	2,13	111
2 Hand hoe	51,0	2,16	97
3 Ametryne + (ioxynil + 2, 4-D) repeated	33,0	2,10	93
4 Alachlor + 2, 4-D + paraquat/ametryne + (ioxynil + 2, 4-D)	29,0	2,14	96
5 MSMA repeated	51,0	2,17	89
6 Glyphosate	80,0	2,14	94

The differences in crop growth between treatments were probably due more to natural variability than to effects of the treatments. There were no obvious benefits to crop growth from controlling *C. rotundus.*

Discussion

Competitive effects Severe reductions in yields of plant crops of varieties N8 and N13 were caused by competition from *C. rotundus* on weak sandy soils under rainfed conditions. Crop growth measurements suggest that the weed may have less effect on NCo 376 grown under irrigation. Thus a variable response to *C. rotundus* competition in plant cane can be expected.

In ratoon cane, there was no obvious effect of competition from *C. rotundus.* However the difficulty of eliminating *C. rotundus* from the 'no *C. rotundus*' plots before any adverse effects could occur, meant that true comparisons could not be made in these experiments. If there were any benefits from controlling *C. rotundus* they may have been offset by damage to the sugarcane by the herbicide treatments. However measurements suggest that crop growth was not markedly affected by the herbicide treatments, so the competitive effects of *C. rotundus* may have been very limited in the two experiments on ratoon cane. These experiments will be monitored during the next ratoon crop where the residual effects from some treatments have almost eliminated *C. rotundus* competition.

Weed control

Application of glyphosate to emerged plants was the most successful method of *C. rotundus* control. A single or repeated application after conventional plough-out was very successful while two applications in minimum tillage plots were even better. It is very difficult to eradicate *C. rotundus* with glyphosate (Doll *et al*[1]) and repeated applications are extremely expensive. It is useful for controlling weeds in the interrow of ratoon cane but is ineffective for weeds in the rows where control is probably more important.

Weed control and improvement in crop growth in plant cane was limited when EPTC was used shortly before planting. In ratoons, treatment with glyphosate and repeated applications of MSMA were able to reduce the weed population from one crop to the next and this may have a beneficial effect on the growth of the following ratoon crop. Single applications of MSMA were not effective.

The long term residual action of a herbicide such as hexazinone applied to the soil appeared to reduce plant populations when the treatment was repeated but again there was no advantage to the growth of that particular ratoon. Any benefits in the following ratoon will be recorded.

Conclusions

Plant cane may suffer severely from the effects of competition from *C. rotundus* but this may vary depending on conditions, eg moisture stress is likely to increase the effect. The most suitable method for re-establishing cane fields infested with *C. rotundus* appears to be the use of glyphosate on newly emerged *C. rotundus* plants after conventional plough-out. Further work is necessary to investigate rates and methods of application for the best results.

The effects of *C. rotundus* on ratoon cane are difficult to elucidate and herbicide applications to control the weed in ratoon cane should be made with care and with the knowledge that resulting damage to the crop may offset the advantage due to treatment.

REFERENCES

1. Doll, J. D. & Piedrahita, W. (1982). Effect of glyphosate on the sprouting of *Cyperus rotundus* L. tubers. *Weed Res Vol* 22: 123-128.
2. Gosnell, J. M. & Thompson, G. D. (1967). The effects of herbicides on *Cyperus* spp. *Proc S Afr Sug Technol Ass* 41: 169-177.
3. Holm, L. G., Plucknett, D. L., Pancho, J. V., Herberger, J. P. (1977). *The world's worst weeds.* The University Press of Hawaii, Honolulu.
4. Meissner, Ruth, Nel, P.C., Smith, N. S. H. (1980). The influence of red nutgrass (*Cyperus rotundus*) on growth and development of some crop plants. *Proc 3rd Weeds Conf of S Africa:* 39-51.
5. MSIRI Ann Rep 1980, 1981.
6. Thompson, G. D. & Gosnell, J. M. (1963). The results of herbicide trials conducted in the cane belt of Natal 1962/63. *Proc S Afr Sug Technol Ass* 38: 166-175.
7. Turner, P. E. T. (1983). Eptam Super and Sutan Plus for control of *Cyperus rotundus* L. in plant crops of sugarcane. *Proc S Afr Sug Technol Ass* 57: 131-133.