

# ENHANCED EFFICACY FROM THE ADDITION OF THE ADJUVANT FRIGATE TO ROUNDUP FOR KILLING SUGARCANE

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## Abstract

The effect of adding Frigate<sup>(R)</sup>, an adjuvant developed primarily for use with the isopropylamine salt of glyphosate (Roundup)<sup>(R)</sup>, to improve the eradication of ratoon sugarcane under minimum tillage is discussed. Results are presented from replicated trials conducted over three seasons evaluating the effects on cane regrowth of adding Frigate to recommended and low rates of Roundup. Results are also reported from 15 field-scale observation trials which confirmed the findings from the replicated trials. The addition of Frigate at a concentration of 0,5% of the total spray volume consistently enhanced herbicidal activity when Roundup was used in the application range 6 to 10 l ha<sup>-1</sup>.

## Introduction

The eradication of sugarcane using Roundup in the minimum tillage system for replanting cane fields has shown increasing acceptance on the erodible slopes in the coastal areas of Natal. The advantages of minimum tillage compared with conventional land preparation have been widely discussed. Recent droughts and torrential rains have demonstrated convincingly the necessity for implementing this practice on a larger scale. Further acceptance would be encouraged if the reliability of the treatment with Roundup, especially at lower rates, could be enhanced.

Extensive research and development in Europe and Canada has indicated that the addition of the adjuvant Frigate to the isopropylamine salt of glyphosate (Roundup) enhances the activity of the herbicide. This has been demonstrated for Couch grass *Agropyron repens* (Turner and Loader,<sup>4</sup> Orson<sup>2</sup>) and due to the mode of action at certain rates and under certain conditions, reduced rates of Roundup have proved successful.

Work at Reading University (Midgley<sup>1</sup>) with <sup>14</sup>C labelled glyphosate and Frigate on *Agropyron repens*. *Elymus repens* has demonstrated that the addition of the adjuvant significantly increases the uptake of glyphosate into the leaf. With the addition of Frigate there is a marked increase in the amount of glyphosate found in the cuticle (120 times), and in the leaf tissue (18 times) when compared with glyphosate used alone. It has been shown that the waxy cuticle is an important barrier to the uptake of glyphosate. Improved penetration of this layer and the resulting rapid uptake of glyphosate by the plant minimises the adverse effects of rain in the period immediately following application.

It was considered important to investigate the effect of Frigate on the activity of Roundup at recommended and reduced rates when applied to sugarcane in minimum tillage situations.

Eight fully replicated small plot trials have been conducted over the past three seasons, in addition to a large number of field-scale observation trials.

## Method

### Replicated small plot trials

During the 1982/83 season, three trials were conducted with each treatment replicated four times in a randomised block

design. Plots consisted of five rows 10 m long with the three central rows being used for evaluation. The sugarcane varieties NCo 376 and N55/805 were sprayed when the mean leaf height was between 450 and 650 mm. Roundup was applied at 6 to 10 l product ha<sup>-1</sup> with and without the addition of Frigate, the rates of which varied between 0,5 and 1,5% of the total spray volume. The treatments were applied using pressurized or manually operated knapsack sprayers fitted with floodjet nozzles and delivering approximately 300 l ha<sup>-1</sup> at an operating pressure of 100 kPa. The sprays were directed over the upper leaves of the cane row.

In the following season a further three replicated trials of similar design were sprayed. Generally Roundup was applied at 6,7 and 8 l ha<sup>-1</sup> alone or with Frigate at 0,5 and 1,0% of the total spray volume. The spray volumes were varied (100, 283 and 333 l ha<sup>-1</sup>) by using different floodjets fitted to a constant pressure sprayer.

Two further small plot trials were conducted in the spring of the 1984/85 season. Application volumes were constant at 300 l ha<sup>-1</sup>, with Frigate being tested only at the single concentration of 0,5% of total spray volume.

The results were assessed using a visual rating of percentage cane killed to assess initial efficacy, and subsequently the cane regrowth up to four months after treatment was assessed.

### Observation field-scale trials

Due to the diversity of climatic and soil conditions, cane varieties, application methods, equipment and the follow-up operations normally encountered, it was considered necessary to monitor the activity of Frigate with Roundup when applied by growers to commercial fields of cane.

Selected growers were supplied with small quantities of Frigate. Depending upon local experience and the cane variety involved, Frigate was added at the rate of 0,5% to the total spray volume (1,5l /300 l spray mixture ha<sup>-1</sup>). The application rate of Roundup was reduced by 2 l ha<sup>-1</sup> below the rate normally used.

A total of 28 observation sites sprayed mainly during summer on areas ranging from 0,1 to 1,0 ha was monitored within the coastal sugarcane belt. Comparisons could be made between Roundup with and without Frigate, with the application rates of Roundup being set by the sugarcane grower according to his local experience within the range 6 to 10 l ha<sup>-1</sup>. Treatments were applied by means of knapsack sprayers or by hand-lances connected to tractor-mounted equipment. Application volumes were about 300 l ha<sup>-1</sup> and sprays were directed over the rows. In most cases the cane leaves had reached a height of about 500 mm and tillering was well advanced.

The treatments were evaluated for cane regrowth at varying intervals after application using the hoe unit method of assessment of live shoots. Ten sites within each treatment area

Frigate<sup>(R)</sup> is the registered trademark of SDS Biotech (U.K.) Ltd. and contains 500 g Tallow amine ethoxylate l<sup>-1</sup>

Roundup<sup>(R)</sup> is the registered trademark of Monsanto and contains 359 g acid equivalent glyphosate l<sup>-1</sup>

were randomly selected and an effective row length of 100 m assessed per treatment. The areas receiving different treatments were always adjacent to one another and treatments were usually applied on the same day.

*Hoe unit method of assessment*

It was necessary to develop a practical quantitative system that allowed acceptable regrowth limits to be defined on a percentage basis. The hoe unit is a 250 mm length of cane row within which the actual number of live shoots is not considered to be important, as the presence of one shoot (or more) is recorded as a positive count or one hoe unit. It is furthermore assumed that this surviving cane stool would in practice be removed by the single hoe action of one operator.

In the replicated trials, cane regrowth was evaluated over 8 m in each of the three central rows of a plot. A length of string 8 m long divided into 250 mm sections was placed next to the row of sprayed cane and the total number of sections or hoe units having shoots (regrowth) was recorded. Therefore, 24 m per plot replicated four times was equivalent to an effective row length of 96 m per treatment. With four hoe units per metre there were a total of 384 hoe units per treatment (384 = 100% regrowth). A total of less than 40 hoe units recorded per treatment (ie about 10% regrowth) was regarded as being a commercially acceptable kill.

In the observation trials, an effective row length of 100 m (400 hoe units possible) was assessed per treatment at each site and the same threshold of 10% regrowth was taken as being commercially acceptable.

**Results**

*Replicated trials*

Regrowth figures expressed as hoe units for two trials conducted in 1982/83 are summarised in Tables 1 and 2.

**TABLE 1**

Regrowth of sugarcane variety NCo 376 following treatment during cool growing conditions (August 1982)

Treatment	Dose (l ha <sup>-1</sup> )	Mean % cane regrowth	
		84 days	120 days
Roundup	6	8	16
	7	7	14
	8	8	14
	9	5	11
Roundup + Frigate	10	6	13
	6 + 3	6	13
	7 + 3	5	12
	8 + 3	4	11
Roundup + Frigate	9 + 3	5	11
	10 + 3	3	10
	7 + 4.5	5	12
Roundup + Frigate	9 + 4.5	6	10

**TABLE 2**

Regrowth of sugarcane variety N55/805 following treatment during warm growing conditions (November 1982)

Treatment	Dose (l ha <sup>-1</sup> )	Mean % cane regrowth	
		82 days	120 days
Roundup	6	6	10
	8	5	8
	10	3	5
Roundup + Frigate	6 + 1,5	4	6
	6 + 3	4	7
	8 + 1,5	3	5
	8 + 3	2	4
	10 + 3	1	2

In the third trial during this season it was possible to make only a visual assessment of the initial kill of the sugarcane. No meaningful differences between treatments were noted and as the degree of regrowth could not be assessed the trial is not discussed further.

The results of two replicated trials conducted during the 1983/84 season are presented in Table 3. Cane in the third trial was well tillered and was sprayed under very hot mid-summer conditions. All treatments proved extremely effective with negligible regrowth.

**TABLE 3**

Initial cane kill and regrowth in two trials with variety NCo 376 sprayed under warm conditions

Treatment	Dose (l ha <sup>-1</sup> )	Trial I - Coastal		Trial II - Midlands
		Mean % kill 35 days after treatment	Mean % regrowth 67 days after treatment	Mean shoots per metre 40 days after treatment
Roundup (HV)*	6	94	19	2,3
	7	95	11	1,3
	8	98	9	1,3
	9	-	-	1,1
Roundup + Frigate (HV)*	6 + 1,5	96	9	1,6
	6 + 3	94	12	1,1
	7 + 1,5	92	10	1,4
	7 + 3	97	7	1,6
	8 + 1,5	92	6	1,0
	8 + 3	-	-	1,8
9 + 1,5	-	-	0,7	
Roundup (LV)**	6	88	17	1,8

\* HV high volume 300 l ha<sup>-1</sup>  
\*\* LV low volume 100 l ha<sup>-1</sup>

**TABLE 4**

Cane regrowth recorded at 15 observation sites during 1983/84

Treatment	Dose (l ha <sup>-1</sup> )	Cane % regrowth per trial site															Mean % regrowth ± 70 days after treatment
		Site no.															
		4	5	9	10	11	12	15	16	17	18	19	23	25	26	27	
Round up	8	8	8	3	15	0	4	22	4	2	6	11	2	2	5	3	6,3 5,5
Roundup + Frigate	6 + 1,5	2	10	19	10	1	3	5	2	4	4	9	2	1	6	4	
Details of trial		81	77	55	107	49	49	75	56	64	77	50	57	85	96	89	
Days after treatment		Nov	Oct	Nov	Sep	Nov	Nov	Dec	Nov	Dec	Nov	Nov	Dec	Nov	Nov	Nov	
Time of treatment		376	376	376	310	376	376	376	376	376	376	376	376	N7	376	376	
Cane variety		376	376	376	310	376	376	376	376	376	376	376	376	N7	376	376	

Results from one of the two replicated trials conducted in the 1984/85 season showed a similar trend of a better kill when Frigate was added, but no response to adjuvants was evident in the second trial. These results are shown in Figure 1.

#### Observation trials

The results recorded from 15 of the 28 large-scale observation trials where the effects of Roundup at 6 l + Frigate 1,5 l ha<sup>-1</sup> were compared with adjacent treatments of Roundup at 8 l ha<sup>-1</sup> are shown in Table 4. A considerable amount of data were obtained for other comparisons and from the remaining trial sites but these cannot be discussed meaningfully as there was insufficient replication of individual dosage rates for the determination of reliable regrowth figures.

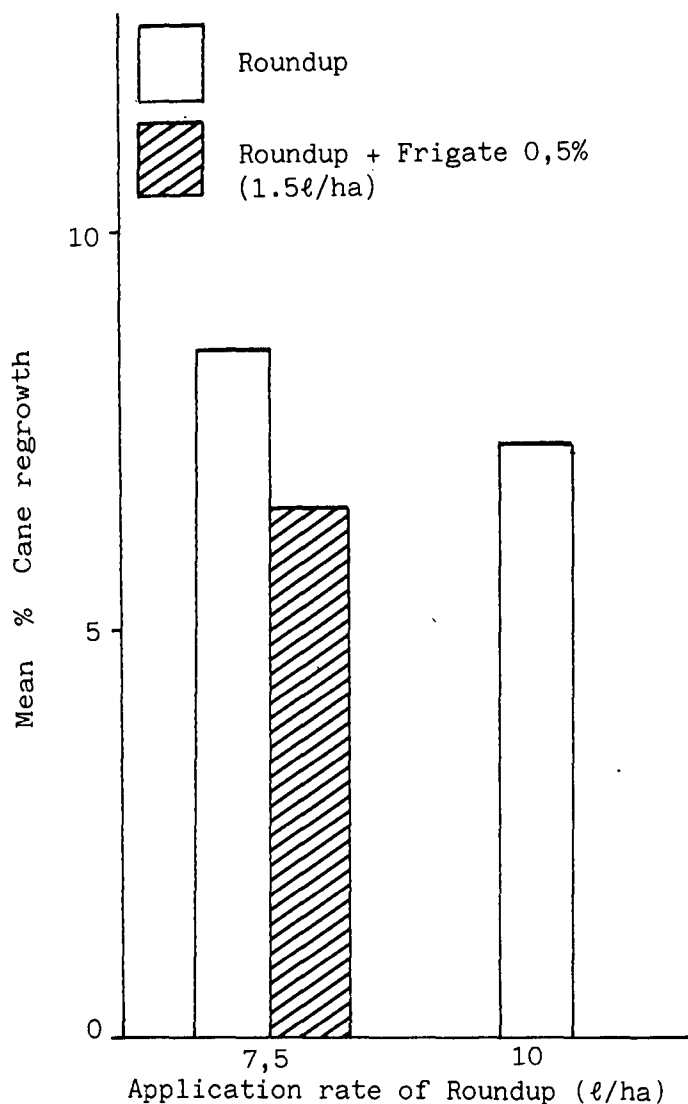


FIGURE 1 Cane regrowth 49 days after a spring spray application. N55/805 sprayed 12/10/84.

#### Discussion

It has been demonstrated (Turner<sup>5</sup>) that the efficacy of Roundup when applied as an eradicated spray on cane is adversely affected under certain conditions of season, dosage rate, and active growth stage of ratoon crop. The results from the late winter application in August 1982 shown in Table 1 tend to support this view, but nevertheless demonstrate a positive effect from Roundup alone and the Roundup + Frigate treatments. Roundup applied alone at the reported rates did not provide an acceptable kill when assessed four months after application. The addition of Frigate invariably improved the

activity of Roundup, except at the 9 l ha<sup>-1</sup> dose when Frigate had no effect. All rates of Roundup with Frigate were commercially unacceptable although the kill at the higher rates was almost acceptable.

When similar treatments were applied under the more suitable conditions of late spring the results were better. From Table 2 it will be seen that all treatments gave acceptable control of cane four months after application. A clear response to increasing rates of Roundup with or without Frigate was evident, and in all cases Frigate improved the activity of Roundup. No meaningful conclusions could be drawn regarding the concentrations of Frigate in the total spray volume, 1% (or 3 l ha<sup>-1</sup>) being about equal in activity to 0,5% (or 1,5 l ha<sup>-1</sup>).

The results, summarised in Table 3, from replicated trials of the 1983/84 season also demonstrated improvement in the activity of Roundup due to Frigate. The addition of Frigate at 1,5 l ha<sup>-1</sup> improved the efficacy of the treatments for both high and low Roundup rates. The application of Roundup at 6 l ha<sup>-1</sup> in a lower spray volume (100 l ha<sup>-1</sup>) was better than the same dose in the normal spray volume (300 l ha<sup>-1</sup>) but the adjuvant effect of Frigate outweighed this benefit.

One of the 1984/85 season trials, summarised in Figure 1, demonstrated clearly the improved reliability of the Roundup effect early in the season when Frigate at 0,5% by volume was added, although no response was evident in the other trial, probably because it was sprayed before full tillering occurred.

In some trials, an occasional negative response was recorded with increasing rates of Roundup when Frigate was added at concentrations higher than 0,5% (or 1,5 l ha<sup>-1</sup>). It has been suggested (Spranklin<sup>3</sup>) that this may be due to the high combined level of surfactant and adjuvant present in the spray mixture reducing translocation, notwithstanding an increase in the actual penetration of the leaf surface.

Under varied commercial application conditions the results obtained on a large number of sites adequately confirmed the findings of the replicated trials.

Although assessments were made on the 15 field sites over a wide time period (50 to 110 days after spraying), there were virtually no differences in efficacy between Roundup used alone at 8 l ha<sup>-1</sup> and Roundup used at 6 l ha<sup>-1</sup> together with Frigate at 1,5 l ha<sup>-1</sup>. It is unfortunate that Roundup at 6 l ha<sup>-1</sup> alone was not included in the field-scale observations. Under the summer conditions when most of the treatments were applied to well-tillered crops, it is possible that low rates of Roundup alone might also have proved satisfactory. Nevertheless, very acceptable results were achieved, with and without Frigate resulting in only a 5 to 6% regrowth about 70 days after application. Experience has shown that greater reliance can be placed on results obtained more than 65 days after spraying.

#### Conclusions

Results from field-scale observation trials confirmed replicated trial results and showed that under most conditions the activity of Roundup was enhanced by the addition of the adjuvant Frigate at 0,5% total spray volume.

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