COMPARISON OF DIFFERENT HERBICIDES FOR SINGLE STEM *EUCALYPTUS MACARTHURII* CUT STUMP CONTROL

K. M. Little[1,*] & G. J. van den Berg[2]

[1]*Institute for Commercial Forestry Research, P.O. Box 100281, Scottsville 3209, Republic of South Africa*
[2]*Sappi Forests Research, ,P.O. Box 473, Howick, 3290, Republic of South Africa*

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LITTLE, K. M. & VAN DEN BERG, G. J. 2007. Comparison of different herbicides for single stem *Eucalyptus macarthurii* cut stump control. Many cold tolerant eucalypts, *Eucalyptus macarthurii* in particular, coppice vigorously following harvesting, and in contrast to *E. grandis* are proving difficult to kill by existing cut stump control methods. Based on past research, selected herbicides were tested on single stem *E. macarthurii* trees that had not been coppiced in Paulpietersburg, South Africa. Triclopyr (amine salt) either alone, or in combination with glyphosate (as a soluble concentrate, or water dispersible granule), and metsulfuron-methyl at two different rates in combination with glyphosate (as a water dispersible granule) were tested to determine if any of these combinations were able to kill the stumps. At the rates tested all herbicides killed 88–95% of the stumps when compared with the control (no herbicides applied). This result has important commercial implications as it will allow forest companies the flexibility to choose herbicide combinations based on environmental criteria, cost constraints, restriction regarding use and the registration of the products tested.

Keywords: Triclopyr, glyphosate, metsulfuron-methyl, coppice, sprouts, stool, cut surface

LITTLE, K. M. & VAN DEN BERG, G. J. 2007. Perbandingan keberkesanan beberapa racun rumpai untuk dirian tunggal *Eucalyptus macarthurii* bagi kawalan batang. Kebanyakan pokok *Eucalyptus* yang tahan sejuk khasnya *E. macarthurii* menghasilkan pucuk baru dengan banyak selepas pembalakan. Berbeza dengan *E. grandis*, pucuk baru *E. macarthurii* susah dibunuh menggunakan kaedah kawalan batang yang sedia ada. Berdasarkan kajian yang lalu, racun rumpai terpilih diuji keberkesanannya terhadap *E. macarthurii* di Paulpietersburg, Afrika Selatan. *Eucalyptus macarthurii* yang diuji ialah dirian tunggal yang belum pernah ditebang kopisnya. Triklopir (garam amina) sahaja, atau dalam kombinasi dengan glifosat (sebagai larutan pekat atau granul bersebarkan air) dan metsufuron-metil pada dua kepekatan dalam kombinasi dengan glisofat (sebagai granul bersebarkan air) diuji untuk menentukan kombinasi yang dapat membunuh batang *E. macarthurii.* Semua racun rumpai pada semua kepekatan yang diuji membunuh 88–95% daripada batang berbanding dengan kawalan (tiada racun rumpai). Kajian ini mempunyai implikasi komersial yang penting. Syarikat berasaskan hutan bebas memilih kombinasi racun rumpai berdasarkan kriteria persekitaran, kos serta sekatan terhadap penggunaan dan pendaftaran produk yang diuji.

INTRODUCTION

Eucalyptus grandis was introduced into South Africa late in the 19th century, initially as a source of timber for the mining industry (Poynton 1979), and by the late 1980s was the eucalypt most commonly planted for pulp. In 1984 the major timber companies expanded their plantation forestry into the colder, frost-prone highland areas of western KwaZulu-Natal, the north-Eastern Cape and south-eastern Mpumalanga Highveld. As *E. grandis* is not tolerant to severe frost, cold tolerant species were planted in these areas as alternatives (Schönau & Gardner 1991). Of the cold tolerant eucalypts, *E. macarthurii* and *E. nitens* were the most widely planted.

Due to the types of buds found in eucalypts (epicormic buds and/or lignotubers), most have the ability to regenerate coppice shoots after felling (Florence 1996). Depending on a number of criteria, the stepwise and selective thinning of these coppice shoots can be used for the re-establishment of commercial plantations (Little 2000, Little & du Toit 2003, Little 2004). Although the coppicing of some of these cold tolerant eucalypts is a viable option (Little & Gardner 2003), the availability of improved genetic material as well as a refinement in site–species matching (Swain & Gardner 2003) has resulted in potentially larger gains being

*E-mail: keith@icfr.unp.ac.za

obtained in timber volume from these two sources than that from regeneration by coppice. If the sites previously planted with eucalypts and/or managed for regeneration by coppice are to be replanted, it is necessary to kill the existing stumps to remove any competitive effect that the coppice may have on the newly planted seedlings (Minko & Flinn 1981, Brice-Bruce 1983, Selander & Chomba 1989, Little *et al.* 1996). In addition, it is preferable to kill the stumps before replanting commences as the rapid initial growth of the coppice may require earlier control than would be required for normal weeding operations. The height of the coppice would necessitate the nozzles being raised during spraying of herbicides, increasing the risk of damage to seedlings through spray drift (Morze 1971).

Over time, various methods have been tested for killing *E. grandis* stumps in a clear fell situation and include the application of herbicides: to the freshly cut surface and or the basal portion of the remaining stem; to either a partial or complete axe frill (basal frill); or to the coppice foliage (Morze 1971, Little & Eccles 2000, Little 2003). Although coppice shoots can also be removed manually with a bush knife or axe, this is not seen as a viable option due to the number of repeated operations required to control the rapid coppice regrowth (Little & Eccles 2000, Little 2003).

Many of the cold tolerant eucalypts, *E. macarthurii* in particular, coppice vigorously (Little & Gardner 2003), and according to the South African forest industry are proving difficult to kill in contrast to *E. grandis*. Based on past work carried out on the killing of eucalypt stumps (Little *et al.* 2000, Little & Eccles 2000, Little 2003), a trial was initiated on single stem *E. macarthurii* trees which had not been coppiced.

MATERIALS AND METHODS

Description of trial site

A trial was initiated at felling on 16-year-old, first rotation *E. macarthurii* of single stem origin. The stand was situated on level ground at an altitude of 950 m asl on a Central Timber Co-operative plantation near Paulpietersburg in KwaZulu-Natal (29° 23' S and 30° 45' E). The climate is classified as warm temperate with a mean annual precipitation of 849 mm and temperature of 17.3 °C.

Trial design and treatments

The trial consisted of six treatments, including a control treatment whereby no herbicides were applied (Table 1), which were applied to four blocks using a random complete block design. Each plot consisted of 10 stumps with the herbicides applied only to those stumps that were living prior to felling. The herbicides were applied to the cambium of the cut surface within 15 min of felling using a Solo®435 backpack sprayer with a Delavan® CE 1 solid cone nozzle regulated at 100 KPa.

Coppice assessments and data analysis

Before the trees were felled, the diameter at breast height (dbh) was measured. After the trees were felled, the height above ground of each stump (stump_ht) and the diameters of the cut surfaces (stump_cut_surface) were measured. The stump_cut_surface was calculated as the mean of two readings, the first taken through the widest part of the stump and the second

Table 1 Different herbicides for killing first rotation *Eucalyptus macarthurii* stumps in Paulpietersburg, South Africa

Treatment (Herbicide)	Formulation type	Pure active ingredient (g l^{-1})	Rate of herbicides applied in trial (%)
None	–	–	–
Triclopyr (amine salt)	Soluble concentrate (sl)	360	3
Triclopyr (amine salt) +	Soluble concentrate (sl)	360	1
glyphosate (isopropylamine salt)	Soluble concentrate (sl)	360	3
Triclopyr (amine salt) +	Soluble concentrate (sl)	360	1
glyphosate (sodium salt)	Water dispersible granule (wg)	500	3
Metsulfuron-methyl (sulfonylurea) +	Wettable powder (wp)	600	0.075
glyphosate (sodium salt)	Water dispersible granule (wg)	500	2.5
Metsulfuron-methyl (sulfonylurea) +	Wettable powder (wp)	600	0.075
glyphosate (sodium salt)	Water dispersible granule (wg)	500	5

All herbicides treatments were applied with 0.5 % Actipron Super® in water.

perpendicular to the first reading. After felling the presence or absence (presence_absence) and the distribution of coppice around the stump (stump_quarter) were recorded at 3.5 and 9 months. For stump_quarter, each stump was divided into quarters and the presence of coppice recorded in each, the sum of which were then analysed.

To determine the effectiveness of the treatments, 9-month plot means in terms of presence_absence and stump_quarter were analysed using Genstat® for Windows™ (Lane & Payne 1996) with ANOVA and ANCOVA. To meet the requirements for valid analyses of variance, square root transformations were used to normalize the data (Gomez & Gomez 1984). Where significant differences were detected, treatment differences were further investigated using least significant differences (Steel & Torrie 1980).

RESULTS AND DISCUSSION

All herbicides killed 88–95% of the stumps, as compared with the control (Figure 1). As the size of the stump determines the quantity of herbicide applied, dbh, stump_ht and stump_cut_surface measures (Table 2) were used as co-variates to account for any relationship between stump morphometry and the incidence of coppice. This would have provided useful information on determining maximum thresholds, in terms of stump size, above which a particular treatment would not work (indicating that insufficient herbicide was applied relative to the size of the stump). Due to the effectiveness of the herbicides (regardless of stump size), these co-variates were not significant. The average stump diameter for the 16-year-old *E. macarthurii* trees used in this trial was 21 cm (Table 2). Herbicide screening trials by Sealander and Chamba (1989) as well as Little and Eccles (2000) on single stem *E. grandis* of similar stump diameters as those used in this trial (22.6 and 19.2 cm respectively) yielded similar results (i.e. most of the stumps were killed). This may indicate that the rates of herbicide used in this trial were already at or above the optimum for stumps within this size range. Whether similar results would be obtained for larger diameter stumps which had not been coppiced or for stumps resulting from a single coppice rotation need to be determined.

Analyses of the presence_absence and stump_quarter produced similar responses, with differences between the herbicides accounting for 94 and 82% of the variation in the data sets (Table 3). Although the presence_absence of coppice on stumps is a useful measure, its usefulness is further extended through the dividing of stumps into quarters and the partitioning of any coppice accordingly (stump_quarter). All herbicide treatments were equally effective in reducing coppice as compared with the control (Figures 1 and 2). This indicates that the rates tested were

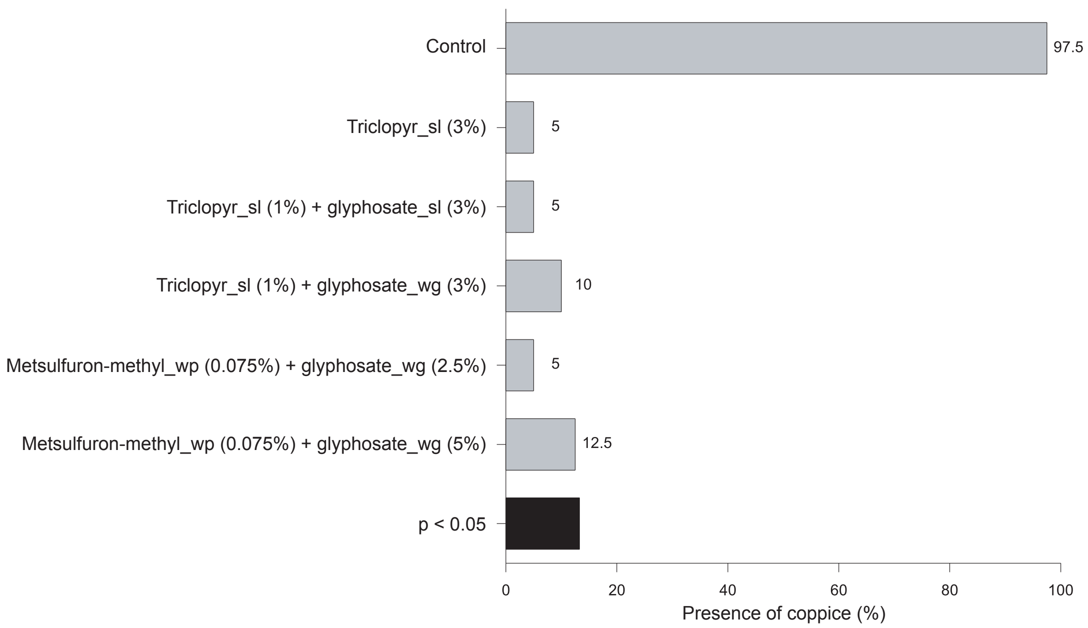

Figure 1 The presence of coppice when assessed at nine months to assess different herbicides for killing first rotation *Eucalyptus macarthurii* stumps

adequate or could potentially be lowered. This result has important commercial implications as it will allow forest companies the flexibility to choose herbicide combinations based on internal policies, environmental constraints and costs.

No significant differences occurred between the use of the two formulations of glyphosate (soluble concentrate or water dispersible granule) in combination with triclopyr, indicating that depending on preference, either combination would be suitable for the killing of cut stumps (Figures 1 and 2).

Table 2 Summary of data in a trial to compare herbicides for killing first rotation *Eucalyptus macarthurii* stumps in Paulpietersburg, South Africa

Variate measured	Mean	Range	Standard error
Dbh (cm)	17.66	13.74–22.00	0.21
Stump_ht (cm)	14.63	4.57–34.43	1.22
Stump_cut_surface (cm)	21.32	15.64–26.32	0.26

Table 3 Analysis of variance for 9-month data in a trial to compare herbicides for killing first rotation *Eucalyptus macarthurii* stumps in Paulpietersburg

Source of variation	Df	Mean squares	
		presence_absence	stump_quarter
Blocks	3	0.474 (1.4)	0.00833 (2.7)
Herbicides	5	32.481** (94.2)	0.24838** (82.0)
Residual	15	1.519 (4.4)	0.04634 (15.3)
Total	23		
		Summary of data	
Grand mean		4.33	2.296
Standard error		0.872	0.1522
Coefficient of variation (rep × units stratum)		28.5	9.4
Bartlett's test for homogeneity of variance (Chi-squared with 5 df)		0.244ns	0.102ns

** significant at $p < 0.01$, ns = not-significant
Values in parentheses indicate the percentage variation accounted for in each data set.

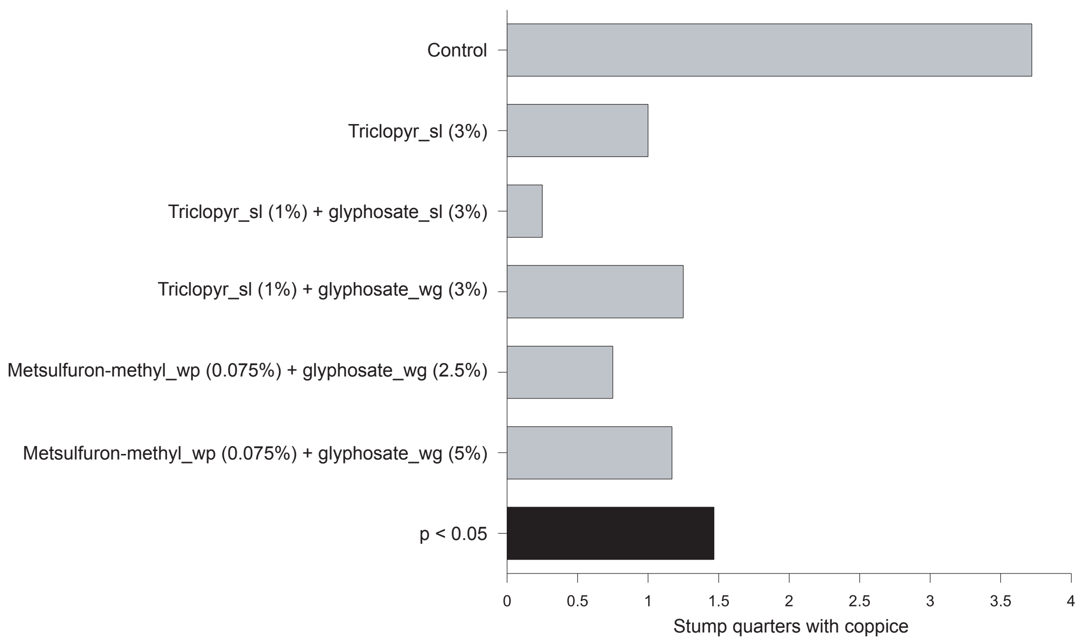

Figure 2 The number of stump quarters with coppice (square root transformed) when assessed at nine months to assess different herbicides for killing first rotation *Eucalyptus macarthurii* stumps

CONCLUSIONS

The most suitable method of killing *E. macarthurii* stumps would be the method which is cost effective, whereby the stump is killed in a one off application and the newly planted seedlings are not damaged. When applied to the cut surface within 15 min of felling, all the herbicides and herbicide combinations tested in this trial killed 88–95% of the stumps when compared with the control (no herbicides applied). All herbicide treatments were equally effective, but environmental criteria, cost constraints, restrictions regarding use and the registration of the products tested (in particular that of triclopyr + glyphosate) will determine which one is selected.

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