Chemical control of harungana (*Harungana madagascariensis*) shrubs in Queensland

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Summary

Harungana (*Harungana madagascariensis* Lam. ex Poir), an aggressive exotic pioneering tree species, is currently invading the Wet Tropics World Heritage areas of north Queensland. A chemical trial involving ten herbicides was undertaken to identify effective chemicals to control harungana. For each herbicide, high volume foliar applications of two concentrations were applied. Of the ten herbicides tested, metsulfuron methyl, dicamba, imazapyr and glyphosate produced 100% mortality, at the rates applied, and the higher rate of fluroxypyr and 2,4-D/picloram killed greater than 95% of the treated plants. Metsulfuron and dicamba were the most target specific, while imazapyr, fluroxypyr, 2,4-D/picloram and glyphosate had greater impact on non-target, native flora.

Introduction

Harungana (*Harungana madagascariensis*) is a native of tropical Africa and the islands of Madagascar and Mauritius (Keay *et al.* 1960). In these regions it grows as a pioneering species on the margins of rainforests, in areas where rainfall exceeds 1300 mm and to altitudes of 1800 m (Humphries and Stanton 1992). The climatic and altitudinal range tolerated in its natural habitat suggests that the majority of the wet tropics of north Queensland, Australia, from Cooktown to Ingham, may be at risk from this species. A study on the influence of disturbance on the regeneration of tropical trees following forestry practices in the Kakamega forest of West Kenya found harungana to be one of the dominant species in early succession (Tsingalia 1990). Micronesia have included harungana on their list of invasive weeds of concern (Pacific Island Ecosystem at Risk project web site: http://www.hear.org/pier/outsidem.htm) and Binggeli (Woody Plant Ecology web site: http://members.tripod.co.uk/WoodyPlantEcology/invasive/index.html) lists harungana as one of the world's moderately invasive woody plants.

Harungana can grow either as a tree reaching 15–20 m in height or as a multi-stemmed shrub when stems are broken at the base. It is capable of forming dense thickets from root suckers, leading to exclusion of all other vegetation. Harungana is readily recognized by its broadly ovate opposed leaves, which exude bright orange latex when cut. The lower leaf surface is covered with fine rusty-brown hairs, whilst the upper leaf surface is hairless and dark green. New growth is arrow-shaped and apricot in colour. Flowering may occur several times per year with a peak from October to November. Flowers are small, white and borne in dense clusters at the end of branches. Large numbers of 3 mm diameter spherical fruits follow, turning brown when ripe. Seeds are spread by small birds, although the rate of spread from established trees appears relatively slow (Koerber 1999).

In the Wet Tropics of north Queensland, harungana grows in a range of situations, from well-drained granitic and metamorphic soils to areas with impeded drainage on alluvium. It favours drains, roadsides and rainforest edges (Csurhes and Edwards 1998). It is now spreading in the Babinda area where it forms dense stands to the exclusion of native species (Humphries *et al.* 1991). This is especially the case after an area has been disturbed by events such as cyclone damage, landslip or clearing activities along the fringe of the Wet Tropics World Heritage areas. Its rate of spread, as estimated by a computer model is however, slow (Koerber 1999). Harungana is a characteristic pioneer rainforest species, being dependent on light for germination, rapid germination and growth, and large soil seed bank (Koerber 1999).

Anecdotal evidence suggests that harungana has been present in the Wet Tropics area of Queensland for over 100 years. The first herbarium record listing harungana as a naturalized plant was in 1937 from Frenchman's Creek near Babinda (Humphries and Stanton 1992). No information exists on the reasons for its introduction to Australia. It is believed that the resin, leaves, bark, and roots have some medicinal properties and can reduce blood glucose (United States Patent: 5,837,255 web site: http://216.155.31.18/patents/us%20patent%205,837,255.htm). Harungana timber is used as building poles in Uganda (People and plants online: Sustainable use of wood products web site: http://www.rbgkew.org.uk/peopleplants/wp/wp4/sustain.htm). The plant's current distribution is on the lower slopes of the Bellenden Ker Range, north of Babinda and the western slopes of Graham Range, north-east of Babinda. Outlying populations occur south to Bramston Beach and Miriwinni. Harungana is a P2 declared plant under the *Rural Lands Protection Act* (1985) thus requiring eradication of the plant from Queensland.

To date, no previous foliar applied herbicides have been trialed on harungana in Queensland. A harungana eradication program by staff of the Queensland Department of Environment and Heritage (P. Thompson, personal communication), and trials by Swarbrick (1993b,c) used the stem injection method to chemically control harungana.

This paper reports on a study to identify effective foliar chemicals that can be applied to control small to medium-size (less than 3 m tall) harungana plants.

Materials and methods

A field experiment to determine the effect of foliar-applied herbicides on harungana plants growing in a mesophyll vine forest was conducted in July 1995 on the western slopes of Graham Range, north-east of Babinda in far north Queensland (17° 18' 31"S, 145° 57' 42"E). All treatments were applied to individual plants that were actively growing and ranging in height from 0.2 to 2.8 m. The temperature at treatment application ranged from 25 to 30°C, relative humidity 75 to 85%, and there was a slight south-easterly wind of 0 to 5 knots and no cloud cover.

Detail on measurements

This experiment evaluated ten herbicides each at two concentrations, foliar-applied to ten tagged plants for each treatment. All plants were measured for height and basal diameter (at ground level) prior to treatment. Each treatment was replicated three times in a complete randomized block design. At final assessment (470 days after treatment) the main stem and taproot of plants recorded as dead were cut to ensure no live tissue remained.

Non-target plant species within two metres of the treated plants were also monitored for any off-target damage from herbicide application.

Spray equipment and application

A 20 litre, 12-volt electric powered back-carried spray unit with adjustable solid cone nozzle and operating pressure of 200 kPa was used to apply herbicide treatments in the experiment. Each plant was sprayed to the point where the spray mixture dripped from the foliage. All solutions contained 0.2% (v/v) non-ionic surfactant (BS1000). Herbicides and doses tested on harungana are shown in Table 1. Rates selected are based on label recommendations for control of other shrub species.

Statistical analysis

Percentage plant mortality was subjected to an analysis of variance after an arcsine transformation and means separated by Fisher's protected least significant difference (LSD) test. Height and basal diameter data were each pooled and divided into three size classes (<1.5, <2, and >2 m for height; and <10, <15, and >15 mm basal diameter) for each treatment prior to fitting polynomial regressions of percentage mortality vs. height or basal diameter.

Results

Harungana was effectively controlled (100% kill) by the herbicides glyphosate, imazapyr, and metsulfuron at both rates (Table 2) within all size classes tested. Dicamba killed 100% of the treated plants at the higher rate, while >95% were controlled at the lower rate. Fluroxypyr and 2,4-D / picloram were greater than 95% effective when applied at the higher rate. Herbicide contractors and land managers commercially accept plant mortality greater than 95% as an effective control level in the field (Harvey 1987).

Clopyralid and 2,4-D butyl ester were ineffective at controlling harungana at the doses tested with mortality values of 0 and 1%, respectively. The Dicamba treatment that contained 100 g of dicamba per 100 litre spray solution effectively controlled 98% of the harungana whilst the Pasture-Master treatment that contained 140 g of dicamba plus 350 g 2,4-D per 100 litre spray solution recorded only 1% mortality. Both treatments had dicamba present as the dimethylamine salt. The presence of 2,4-D in the Pasture-Master spray mix appeared to reduce harungana control.

Regression analysis of pooled data indicated negative trends (from small to large size classes) between mortality and plant height and between mortality and basal diameter. The differences however, were not statistically significant.

Fluroxypyr, glyphosate, imazapyr, and 2,4-D / picloram over-spray resulted in mortality of non-target understorey species (brown salwood (*Acacia aulacocarpa*), sarsaparilla (*Alphitonia* sp.), hard milkwood (*Alstonia muellerana*), blue tongue (*Melastoma affine*), ivory basswood (*Polyscias australiana*), sumac (*Rhus taitensis*), and umbrella tree (*Schefflera actinophylla*)). Minimal damage to non-target species was observed following application of metsulfuron and dicamba treatments.

September 2000 retail prices were used to determine the cost of 100 litres of spray solution and ranged from $4.88 to $59.04 (Table 1) depending on the herbicide and dose rate. Prices were based on purchases of 20 L or more (or, in the case of metsulfuron, at least 1 kg).

Table 1. Herbicides and dose rates tested on harungana (*Harungana madagascariensis*). Herbicide costing per 100 litres of spray solution (herbicide concentration diluted with water) based on retail prices for September 2000.

Herbicide (active ingredient)	Trade Name	Rates applied (g active ingredient per 100 L spray solution)	Cost ($) per 100 L spray solution
2,4-D Butyl ester	AF Rubber Vine Spray	400, 800	4.88, 9.72
2,4-D / Dicamba	Pasture-Master[A]	175 / 70, 350 / 140	Not available
2,4-D / Picloram	Tordon 75-D	150 / 37.5, 300 / 75	17.85, 35.70
Clopyralid	Lontrel L	100, 200	11.33, 22.67
Dicamba	Dicamba	100, 200	7.25, 14.50
Fluroxypyr	Starane 200	100, 200	13.63, 27.25
Glyphosate	RoundUp	180, 360	5.00, 10.00
Imazapyr	Arsenal	100, 200	29.52, 59.04
Metsulfuron	Brush-Off	6, 12	5.80, 11.60
Triclopyr / Picloram	Grazon DS	100 / 33.3, 200 / 66.7	11.95, 23.90

[A] Product currently not available.

Table 2. Harungana (*Harungana madagascariensis*) mortality, near Babinda, following application of foliar-applied herbicides. Basal diameter and height measurements were recorded immediately prior to treatment.

Herbicide (active ingredient)	Rates applied (g active ingredient per 100 L spray solution)	Mortality[A] (%)	Basal Diameter Range (cm)	Height Range (m)
2,4-D / Dicamba	175 / 70	25 e	5.1–30.8	0.2–2.7
2,4-D / Dicamba	350 / 140	1 f	8.1–30.1	1.5–2.2
2,4-D Butyl ester	400	0 f	6.5–24.3	0.7–2.4
2,4-D Butyl ester	800	1	7.9–20.1	0.6–2.4
2,4-D / Picloram	150 / 37.5	60 cd	8.2–33.4	0.7–2.6
2,4-D / Picloram	300 / 75	96 b	8.8–25.4	0.7–2.5
Clopyralid	100	0 f	6.4–32.2	0.7–2.8
Clopyralid	200	0 f	9.5–22.6	1.1–2.5
Dicamba	100	98 ab	8.6–15.1	1.0–2.1
Dicamba	200	100 a	3.1–27.1	0.2–2.6
Fluroxypyr	100	73 c	6.6–20.1	0.5–2.3
Fluroxypyr	200	99 ab	7.3–42.5	0.7–2.7
Glyphosate	180	100 a	7.1–17.5	0.5–2.7
Glyphosate	360	100 a	7.4–26.2	1.2–2.5
Imazapyr	100	100 a	8.7–25.1	1.5–2.5
Imazapyr	200	100 a	6.3–25.2	0.6–2.5
Metsulfuron	6	100 a	7.1–24.3	0.9–2.5
Metsulfuron	12	100 a	5.7–21.6	0.6–2.6
Triclopyr / Picloram	100 / 33.3	53 d	6.2–27.2	0.7–2.3
Triclopyr / Picloram	200 / 66.7	43 d	5.1–32.3	0.5–2.3
Control	–	0 f	7–23.5	0.5–2.3

[A] Back-transformed means followed by a common letter do not differ significantly according to Fisher's protected LSD test (P=0.05).

Discussion

The field experiment indicated that of the ten foliar applied herbicides tested, glyphosate, imazapyr, metsulfuron, and dicamba were capable of giving 100 per cent control of harungana plants less than 3 m tall. Greater than 95% control was observed for 2,4-D / picloram and fluroxypyr at the higher rate tested. Based on minimal off-target damage and cost of application (<$7.50 per 100 litre spray mix), metsulfuron and dicamba are the preferred foliar herbicides for controlling harungana.

The key to any effective weed control program is to have a range of techniques available that can be utilized depending on where the weed is growing, the weed's density, and the plant's stage of development. For example, while foliar applied herbicides may be a cost effective option for controlling regrowth, this technique may not be appropriate for use on large mature plants due to difficulties in spraying. For mature trees, techniques such as stem injection may be the preferred option. Swarbrick (1993c), trialed five herbicides (glyphosate (36% a.i.), fluroxypyr

(0.6% a.i.), triclopyr (1.2% a.i.), triclopyr/picloram (5% triclopyr/2.5% picloram a.i.), and metsulfuron (0.06% a.i.)) on fifteen harungana plants (5 m tall) by placing 2 ml of herbicide mix in stem cuts at 5 cm spacings. Metsulfuron was the only herbicide that killed all three treated plants. Cost of metsulfuron per cut excluding labour was 0.12 cents. A commercial stem injection trial in 1993 along the lower slopes of the Bellenden Ker Range north of Babinda by the Queensland Department of Environment and Heritage using triclopyr/picloram (5% triclopyr/2.5% picloram a.i.) applied as a double frill stem injection method controlled all treated harungana plants (P. Thompson, personal communication).

Control of harungana is possible as its rate of spread, as estimated by a computer model, is slow (Koerber 1999). Harungana's distribution remains localized between the eastern slopes of Mt. Bellenden Ker and the Coral Sea (Swarbrick 1993a). Most of these satellite infestations are associated with initial gaps in the forest canopy created by human activity (logging or disturbance by machinery) or by nature (cyclones).

A harungana eradication program involving stem injection by the Queensland Department of Environment and Heritage was in place for six years and by 1998, approximately 60% of known infested areas had been treated (P. Thompson, personal communication). From 1998 to the present time no follow-up control nor any new areas have been treated. A further three to five year herbicide program that includes minimal disturbance from machinery could effectively control the harungana population of the Wet Tropics. The cost of further control has been estimated at $500 000 (P. Thompson, personal communication). Treating plants prior to flowering (peak flower production is October to November) would reduce seed production and minimize seed dispersal by water and frugivorous birds. Unfortunately harungana seeds are readily available for purchase over the internet (160 000 seeds per kilogram) at a price of 400 French francs per kilogram, and potentially may lead to the establishment of new satellite populations in the wetter (>1500 mm annual rainfall) tropical areas of Australia. A national register of current and potentially invasive weeds to Australia (Western Australia's Department of Agriculture, Weed Science Permitted and Exclusion List web site: http://www.agric.wa.gov.au/progserv/plants/weeds/weedsci.htm), linked to a database of the suppliers of these plants, would help the importation screening required by the Australian Customs Service, Australian Quarantine and Inspection Service, and Australia Post to reduce the incidence of unwanted plant species entering Australia.

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