The chemical control of the environmental weed basket asparagus (*Asparagus aethiopicus* L. cv. *Sprengeri*) in Queensland

R.C. Breaden, **T.R. Armstrong** and **D. Hinchliffe**, Department of Natural Resources and Mines, Alan Fletcher Research Station, PO Box 36, Sherwood, Queensland 4075, Australia.

Summary

A replicated trial to determine effective chemical control methods for the invasive species, basket asparagus (*Asparagus aethiopicus* L. cv. *Sprengeri*) was conducted at Currumbin Hill, Queensland, from June 1999 to August 2000. Four herbicides (metsulfuron-methyl, dicamba, glyphosate and diesel) were applied at different times of the year (winter, spring, summer and autumn). Neat diesel applied to adult crowns effectively killed basket asparagus. However, germination of basket asparagus and other weeds was not prevented. An overall spray of 0.06 g metsulfuron-methyl (0.1 g Brush-Off®) + 1 mL BS 1000® L^{-1} water gave slower but more selective long-term control of basket asparagus when compared to diesel, especially when applied in winter and spring. High rates of foliar applied dicamba were most effective in spring and glyphosate splatter gunned on base of stems in autumn. The combination of increased selectivity, ease of application and likelihood of reduced environmental impacts on native plants, other than coast she-oak (*Casuarina equisetifolia* L. var. *incana* Benth.), of metsulfuron-methyl makes it more suitable for controlling large infestations of basket asparagus.

Introduction

Basket asparagus (*Asparagus aethiopicus* L. cv. *Sprengeri*) is a member of the asparagus family (Asparagaceae). It is native to Cape Province and Natal, Republic of South Africa (Anon 1987) where it is found naturally in coastal ecosystems such as dunes, open rocky areas and woodlands (Jessop 1996). Basket asparagus was introduced into Australia during the last years of the nineteenth century, and according to Parsons and Cuthbertson (1992), the initial spread was largely due to the widespread sale of nursery stock and subsequent dumping of garden waste in natural areas adjoining residential areas. Today it is still commonly grown as a garden ornamental and is popular for use in outdoor hanging baskets and cut flower/foliage arrangements.

Basket asparagus is an erect or sprawling perennial herb with many stems growing from a central crown. The leaves are reduced bract-like scales and alternate, with the terminal branchlets being very narrow, flat, needle-like and in clusters of three. Flowers are creamy-white, bell-shaped and about 3–5 mm long (Parsons and Cuthbertson 1992). Axillary racemes are formed and appear intermittently from October through to June.

Basket asparagus produces up to 600 fleshy red drupes (berries) per plant at any one time (Bowden and Rogers 1996). Drupes are produced for several months of the year, although some can appear on the plant all year round. Each drupe contains one to three black seeds, usually 3–4 mm in diameter. If soil moisture levels are adequate, germination may occur at any time of the year. However, there is a major flush of germination in spring and a smaller flush in autumn (Parsons and Cuthbertson 1992). Birds find the fleshy fruits attractive, and species such as Lewin's honeyeater *(Meliphaga lewinii* Swainson) and olive-backed orioles (*Oriolus sagittatus* Latham) have been reported feeding on the fruits (Stansbury and Vivian-Smith 2003).

The roots of basket asparagus are both fibrous and tuberous. Adventitious roots form a dense mat just below the soil surface (Stanley and Ross 1989) and tubers are formed 9–14 days after germination (Bowden and Rogers 1996). Tubers are produced directly on the fleshy rhizomes (Parsons and Cuthbertson 1992), and research to date shows that they are not reproductive organs. Bowden and Rogers (1996) state that the tubers are water storage organs that enable the plant to survive during dry periods. Vivian-Smith (unpublished data) also found that in a controlled irrigated environment (tunnel), detached tubers do not re-sprout.

Stem development occurs from the crown of the plant. Armstrong and Buchanan (2000) found that where plant crowns were completely removed from their tubers and inverted (turned upside down) on impervious surfaces, all plants died. Re-establishment occurred where crowns with tubers remained in direct contact with the soil surface (Armstrong and Buchanan 2000).

Basket asparagus is a shade tolerant plant that grows well under a closed canopy of trees (Parsons and Cuthbertson 1992). In addition to this, it also grows abundantly in southeast Queensland on exposed rocky headlands (Bowden and Rodgers 1996). Basket asparagus performs well in poor or sandy soil in open woodlands, rainforests, frontal dunes, coastal heath, and sandy coastal fringes (Armstrong *et al.* 1999).

With a mass of underground organs and the production of dense cover, basket asparagus has the ability to completely suppress other species (Parsons and Cuthbertson 1992). Bowden and Rogers (1996) found that the area beneath mature basket asparagus was devoid of other plant species. As a result, this species is considered to be a serious environmental weed in southeast Queensland and coastal New South Wales, and has a ranking of 23/200 based on its impact and invasiveness (Batianoff and Butler 2002). The species has also established in Victoria and is a declared noxious weed on Lord Howe Island (Parsons and Cuthbertson 1992).

Metsulfuron-methyl is the only active ingredient currently registered for the control of basket asparagus in Queensland (stated as 'registered products containing 600 g kg^{-1} as the only active constituent') (INFOPEST 2003). However, for the sustainable management of basket asparagus, a range of cost effective control methods and successful herbicide options are preferred, especially as metsulfuron-methyl is suspected of causing die back of coast she-oaks if their root zones overlap with treated areas.

Preliminary screening field trials undertaken at Currumbin Hill from 1997 to 1998 indicated that applications of 60 g metsulfuron-methyl (Brush-Off®) + 1 L BS 1000® 1000 L^{-1} water ha^{-1}, 2 kg dicamba (Banvel® 200) 1000 L^{-1} water ha^{-1} or neat diesel (cut stump or basal bark) applied liberally to the crown provided efficient and effective control of basket asparagus (Armstrong *et al.* 1999). These treatments were applied in summer and reduced remaining live crown numbers by more than 90%. However, it was suggested that other rates of metsulfuron-methyl and dicamba be assessed (Armstrong *et al.* 1999). Glyphosate, 2,4-D ester, amitrole + ammonium thiocyanate, and fluroxypyr ester were also tested in the earlier screening investigation with limited success (Armstrong *et al.* 1999).

In this investigation, our aims were to determine the most effective herbicide, technique and rate (refinement of earlier screening trials) in terms of mortality, selectivity and observations on regeneration of native vegetation; and the most effective season for application.

Materials and methods

The experiment was conducted at Currumbin Hill Environmental Park in southeast Queensland (153°29′4″ E, 28°7′50″ S). This coastal headland vegetation is predominantly native pink box (*Lophostemon confertus* R.Br.), dog wood (*Jacksonia scoparia* R.Br.), barbwire vine (*Smilax australis* R.Br.) and blady grass (*Imperata cylindrica* (L.) Raeusch). Introduced species also present at the site include camphor laurel (*Cinnamomum camphora* (L.) Nees and Eberm.), Easter cassia (*Senna pendula* var. *glabrata* (Vogel) Irwin and Barneby) and ochna (*Ochna serrulata* (Hochst.) Walp.).

The experiment had a randomized block design. Six herbicide treatments and a control were applied at different seasons: winter (June), spring (September), summer (December) and autumn (March) (Table 1). In each season, there were five replicate blocks containing 35 plots, each 3 m × 4 m (5 replicates × 7 treatments per season). Within each treatment plot, three plants were tagged and assessed monthly.

A conventional knapsack sprayer was used for the foliar spray treatments (about 1000 L water ha^{-1}) and a splatter gun for full coverage of the base of stems for glyphosate and crowns for diesel. Herbicide rates were chosen on the basis of findings from the screening trial (e.g. the rates of metsulfuron-methyl and dicamba) (Armstrong *et al.* 2000) and effective rates for other rhizomatous environmental weeds (e.g. climbing asparagus (*Asparagus africanus* Lam.) (T. Armstrong personal observations)). Herbicide damage was assessed visually using a phytotoxicity scale where rating 1 = crown death, 2 = brown to ground level, 3 = defoliated green stems, 4 = foliage yellowing, and 5 = green and healthy. Percent basket asparagus cover was also measured for each plot by a qualitative visual assessment.

The results were analysed using Systat™ 10 GLM module using a repeated measures analysis for each season. The phytotoxicity ratings were treated as dependent variables corresponding to the independent variable 'treatment'. A one-way analysis of variance was performed to compare response outcomes, with the final assessment as the dependent variable and treatment as the independent variable. Repeated measure analyses applied initial percent basket asparagus cover × treatment interaction as a covariate to the model.

The trial plots were set out on 11 May 2000, with treatments applied from June 2000 in cloudy conditions. The winter investigation had the longest duration of almost 19 months, with seven assessment times. These were conducted at 0, 30, 67, 111, 250, 378 and 553 days after treatment (DAT). The autumn investigation had the shortest duration (eight months), with four assessment times conducted at 0, 76, 160 and 251 DAT. The spring and summer investigations were conducted over 16 and 11 months respectively, having four assessment times. These were conducted at 0, 185, 212 and 487 DAT for spring and 0, 41, 176, and 351 DAT for summer.

Results and discussion

For each of the seasonal applications there were significant ($P < 0.01$) differences in herbicide treatment, assessment interval and their interaction (response profile through time) (Table 2). The most effective treatment, showing the highest mortality regardless of season applied, was the splatter gun application of neat diesel to crowns (Figure 1). However, many seedlings established among and around the treated (dead) crowns, indicating that follow-up applications would be required. Neat diesel is also less desirable for operators and the environment than selective herbicides. The next most effective herbicide, killing all treated plants, was metsulfuron-methyl. When this herbicide was applied at either rate (0.06 or 0.09 g L^{-1} water), it was the most selective herbicide trialled, leaving existing native trees, shrubs and local ground covers listed above to revegetate the area. Added benefits of Brush-Off are that it is both a non-scheduled poison (i.e. not toxic to mammals etc.) and very economical.

Glyphosate was most effective when applied in autumn. Glyphosate applied in spring appeared successful until 312 DAT, when basket asparagus had regenerated. Dicamba showed mixed results; the lower rate (1 g L^{-1} water) was more effective when applied in autumn, and the higher rate (2 g L^{-1} water) was more effective in spring. When dicamba was applied in summer (at both application rates), high plant phytotoxicity was evident 176 DAT. However by 351 DAT, plants were regrowing. The use of glyphosate and dicamba in winter appeared to have the least phytotoxic effect.

Conclusion

The use of selective herbicides to control invasive weeds is vital in sensitive coastal areas, where mechanical disturbance causes bank destabilization, especially on dunes and coastal headlands typical of many coastal areas such as Currumbin Hill. For this reason, two aspects of herbicide control were investigated. Firstly, the effectiveness of a particular herbicide and rate in controlling basket asparagus and secondly, the most effective season for application. All of the herbicides used in this study resulted in phytotoxic effects upon basket asparagus, but their effectiveness varied with rate and season.

The results of this study confirm those of the preliminary work by Armstrong and Buchanan (2000) – that diesel and metsulfuron-methyl are generally the most effective herbicides to control basket asparagus, irrespective of the season applied. Diesel killed all treated adult crowns but many

Table 2. Summary of significance (P) and degrees of freedom (df).

	Winter		Spring		Summer		Autumn	
Terms	P	df	P	df	P	df	P	df
Treatment	<0.01	6	<0.01	6	<0.01	6	<0.01	6
Assessment	<0.01	5	<0.01	3	<0.01	3	<0.01	3
Assessment × treatment	<0.01	30	<0.01	18	<0.01	18	<0.01	18

Table 1. Herbicide treatments applied to basket asparagus (*A. aethiopicus* cv. *Sprengeri*).

Trade name	Active ingredient and strength (g L^{-1})	Application method and rate (product L^{-1} water)	Active ingredient rate (L^{-1} water)	Adjuvant rate (L^{-1} water)
Brush-Off	600 g metsulfuron-methyl kg^{-1}	Foliar spray at 0.1 g	0.06 g	BS 1000 at 1 mL
Brush-Off	600 g metsulfuron-methyl kg^{-1}	Foliar spray at 0.15 g	0.09 g	BS 1000 at 1 mL
Banvel 200	200 g dicamba	Foliar spray at 5 mL	1 g	Agral 600 at 2 mL
Banvel 200	200 g dicamba	Foliar spray at 10 mL	2 g	Agral 600 at 2 mL
Glyphosate 360	360 g glyphosate	Basal bark application at 111 mL	40 g	Agral 600 at 40 mL
Diesel	Neat diesel	Crown application	neat	–
–	–	Control	–	–

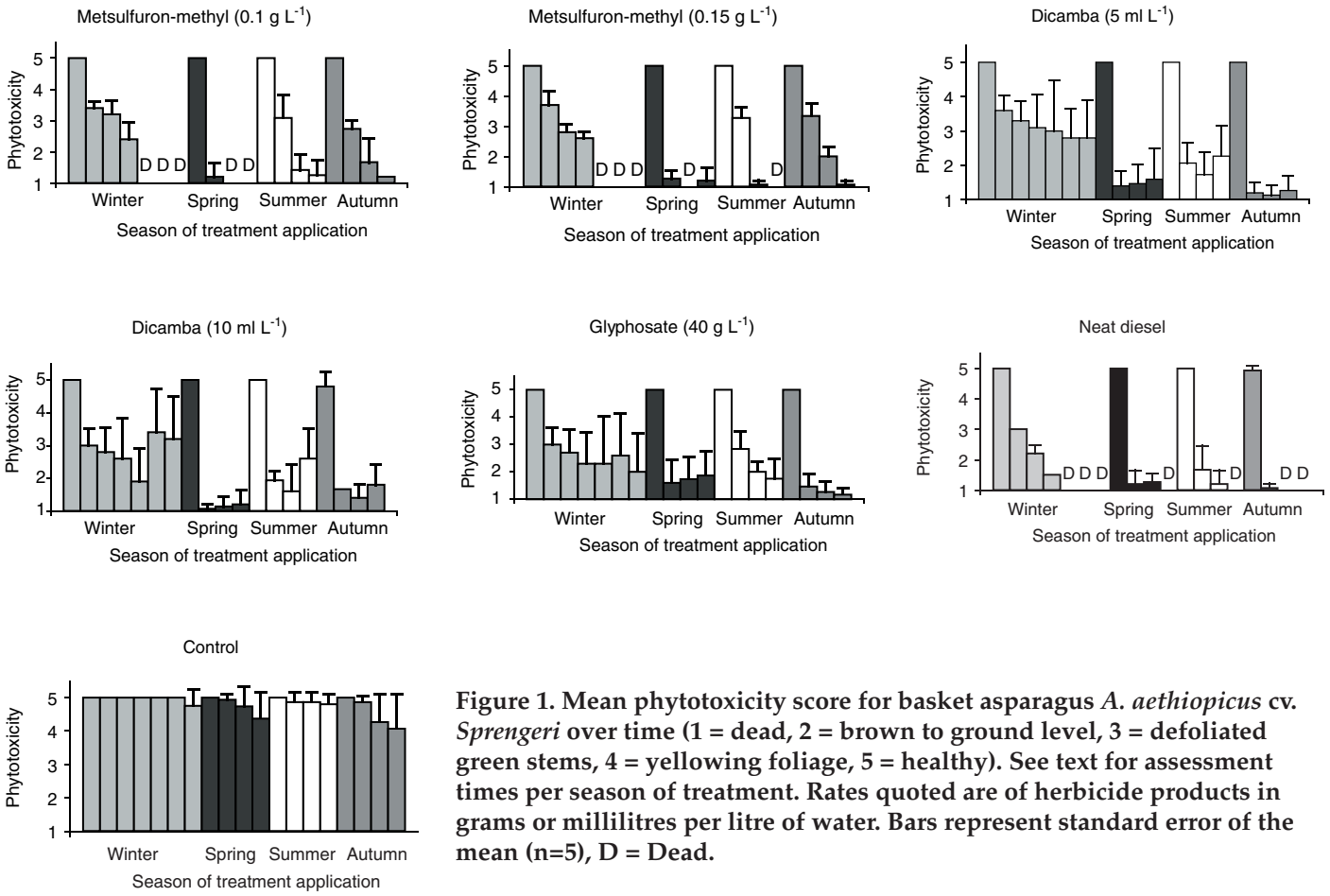

Figure 1. Mean phytotoxicity score for basket asparagus *A. aethiopicus* cv. *Sprengeri* over time (1 = dead, 2 = brown to ground level, 3 = defoliated green stems, 4 = yellowing foliage, 5 = healthy). See text for assessment times per season of treatment. Rates quoted are of herbicide products in grams or millilitres per litre of water. Bars represent standard error of the mean (n=5), D = Dead.

seedlings established and then dominated the treated area. Therefore follow-up foliar applications would be required. Metsulfuron-methyl at 0.06 g (0.1 g Brush-Off) + 1 mL BS L^{-1} water was slow acting, but gave the best long-term selective control of basket asparagus, especially if applied in winter. Dicamba and glyphosate can also be successful in basket asparagus control if applied during seasons that optimize their response. For these herbicides, the most effective treatments were 1 g dicamba (5 mL Banvel 200) L^{-1} water in autumn, 2 g dicamba (10 mL Banvel 200) L^{-1} water in spring, and splatter gun on basal stems of 40 g glyphosate (111 mL Glyphosate 360) L^{-1} water in autumn.

As part of a follow-up control strategy for basket asparagus, management of the seed bank would be beneficial. To reduce re-infestation by weedy seedlings and encourage native regeneration, an area free of susceptible coast she-oaks could be re-treated with metsulfuron-methyl at 0.06 g (0.1 g Brush-Off) L^{-1} water. Regeneration and replanting of sensitive areas with local species should also be encouraged to help out-compete such weeds. Other measures, including the use of weed mat or mulch to suppress basket asparagus re-establishment, may also assist in its control.

Acknowledgments

The authors would like to thank Sonja Prior, Alison Buchanan and Tanya McAndrew for their assistance in planning and setting out this replicated trial. Earl Sparkes assisted in the statistical analysis and interpretation. Dane Panetta and Gabrielle Vivian-Smith provided input into draft versions of this text.

References

Anon. (1987). 'Flora of Australia, Volume 45 Hydatellaceae to Liliaceae'. (Australian Government Publishing Service, Canberra).

Armstrong, T. and Buchanan, A. (2000). Basket asparagus, *Asparagus aethiopicus* var. *Sprengeri* (syn. *Asparagus densiflorus*) and its control. Proceedings of the Sixth Queensland Weed Symposium, Caloundra, July 2000, pp. 25-29. (Queensland Weed Society Inc., Brisbane).

Armstrong, T., Prior, S. and Buchanan, A. (1999). Results of screening trials on controlling basket asparagus, *Asparagus aethiopicus* var. *sprengeri* (syn. *Asparagus densiflorus*). Unpublished report, Department of Natural Resources, Brisbane Australia.

Batianoff, G.N. and Butler, D.W. (2002). Assessment of invasive naturalized plants in south-east Queensland. *Plant Protection Quarterly* 17, 27-34.

Bowden, D. and Rogers, R.W. (1996). *Protasparagus densiflorus*: an environmental weed of coastal vegetation reserves. *Pacific Conservation Biology* 2, 293-8.

INFOPEST (2003). 'Infopest – Agvet chemical encyclopedia March 2003'. (Queensland Department of Primary Industries, Brisbane).

Jessop, J.P. (1996). The genus *Asparagus* in Southern Africa. *Bothalia* 9, 31-96.

Parsons, W.T. and Cuthbertson, E.G. (1992). 'Noxious weeds of Australia'. (Inkata Press, Melbourne).

Stanley, T.D. and Ross, E.M. (1989). 'Flora of south-eastern Queensland, Volume 3'. (Queensland Department of Primary Industries, Brisbane).

Stansbury, C.D. and Vivian-Smith, G. (2003). Interactions between frugivorous birds and weeds in Queensland as determined from a survey of birders. *Plant Protection Quarterly* 18, 157-65.