EVALUATION OF ALTERNATIVE METHODS OF WEED CONTROL IN MUNICIPAL AREAS

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Abstract Efficacy and efficiency of various methods of weed control in a variety of public utility areas in the ACT was assessed. Certain treatments were compared in Spring and in Autumn. Applications of the equivalent of 1.08 kg a.i. ha^{-1} (3.0 L product ha^{-1}) glyphosate (Roundup Biactive®) herbicide in Spring and 2.16 kg a.i. ha^{-1} (6.0 L product ha^{-1}) glyphosate (Roundup Biactive®) in Autumn using conventional and low drift hydraulic nozzles with and without 1% v/v vegetable oil adjuvant (Codacide® oil), a Nomix™ CDA applicator and the rotary wick applicators Weedbug®, Handybug and Gutterbug were compared with weed control provided by flame (Weeddragon Jet 4 flame weeder) and high temperature water, Steamwand™ or Waipuna™ with and without a foam layer. Treatments were applied to the same range of weeds in municipal situations including hard-standing areas such as a concrete-lined stormwater channel, kerb and gutter, vegetation around obstacles in turfgrass and car park areas.

The five spray methods of application for glyphosate herbicide tested in various situations provided complete control of paspalum (*Paspalum dilatatum*), tall fescue (*Festuca arundinaceae*), silver grass (*Vulpia* spp.) flatweed (*Hypochoeris radicata*), wireweed (*Polygonum aviculare*), barnyard grass (*Echinochloa crus-galli*) and white clover (*Trifolium repens*) and good to very good control of storksbill (*Erodium* sp.) for at least 60 days after treatment (DAT) in Spring and in Autumn. Very good to excellent control of umbrella sedge (*Cyperus eragrostis*) was obtained in a stormwater channel situation.

Weed control provided by the three types of rotary wick wiper applicator machines using glyphosate was complete for at least 60 DAT and comparable to spray treatments for tall growing species including paspalum, tall fescue and umbrella sedge and for low growing species including white clover and wireweed in a concrete lined channel. In a hard standing area the control of tall growing species was complete whilst the control obtained for the low growing species including clover and flatweed was poor to good due to the lack of contact of the wiping surfaces with the weed. The use of the Weedbug applicator in a concrete-lined stormwater channel and the Gutterbug in kerb and gutter provided good weed control overall.

Neither the addition of 1% v/v dilution of a vegetable oil adjuvant, Codacide or the type of spray nozzle had any significant effect on the speed of development of symptoms on weeds or their final control level. However, a sharper definition of the sprayed swath was produced in treatments applied using the low drift Turbo Teejet® nozzle, Roundnozzle™ 25 and the Nomix CDA applicator compared to sprayed treatments using a conventional flat fan nozzle. A similar effect was achieved with the treatments where Codacide oil was added to the glyphosate sprayed using a conventional nozzle. This is consistent with the measurement of a significantly lower percentage of driftable droplets (fines) in studies conducted with these or similar products. The substitution of an air induction nozzle (Roundnozzle 25) or conventional drift reduction nozzle (Turbo Teejet) for standard flat fan nozzles on the spray equipment did not generally result in any loss of performance of glyphosate herbicide for the range of weed species, despite the production of larger spray droplets,

The use of flame for weed control provided poor to moderate control of most of the weed species for no more than 30 DAT in the trials. Application of high temperature water using the Steamwand or Waipuna applicators provided poor to moderate control of most weeds in most situations. Operational efficiency was lower than other methods evaluated.

Preliminary assessment of the efficiency of weed control operations in respect of time confirms the superiority of applications using either a hand-held spray lance or boom or the Weedbug applicator. The performance of the Gutterbug applicator in kerb and gutter situations was comparable to spray treatments.

INTRODUCTION

A series of trials were established in October, 1998 and certain aspects were further evaluated in March, 1999 to compare alternate methods of weed control in a variety of public utility areas. Alternatives to the current practice of application of glyphosate herbicide using standard flat fan nozzles were evaluated for efficacy and efficiency with the view of developing practices that limited off-site impacts of weed control operations, maximized operator safety and provided cost-effective protection of municipal assets.

MATERIALS AND METHODS

The trials established in October, 1998 compared an application of the equivalent of 1.08 kg a.i. ha^{-1} (3.0 L product ha^{-1}) glyphosate (Roundup Biactive) herbicide with weed control provided by flame and high temperature water. The trials that were established in March, 1999 compared an application of the equivalent of 2.16 kg a.i. ha^{-1} (6.0 L product ha^{-1}) glyphosate (Roundup Biactive) herbicide. Treatments applied to the same range of annual and perennial weeds in municipal situations were:

Hardstanding areas including vegetation around obstacles in turfgrass - glyphosate applied using flat fan nozzle, Turbo Teejet nozzle, Roundnozzle 25, Weedbug, Handybug, custom glyphosate formulation applied with CDA Nomix applicator, Flame, Steamwand, Waipuna and Waipuna foam system.

Kerb and gutter - glyphosate applied using flat fan nozzle, Turbo Teejet nozzle, Roundnozzle 25, Gutterbug, Handybug, custom glyphosate formulation applied with CDA Nomix applicator, Flame, Steamwand, Waipuna and Waipuna foam system.

Concrete-lined stormwater channel - glyphosate applied using Flat fan, Turbo Teejet nozzle, Roundnozzle 25, Weedbug, Handybug, Steamwand, Waipuna and Waipuna foam system.

Sprayed treatments of herbicide were applied using a hand held gas propelled sprayer fitted with a short section boom with tapered flat fan nozzle (SS11001) or drift reduction nozzle (Turbo Teejet (TT11002 VP) and operated to produce a calibrated output of 90 and 150 L ha^{-1} respectively. A single nozzle was substituted for applications in the kerb and gutter situation. Other treatments were applied using either a single air induction nozzle (Roundnozzle 25) or a CDA (NoMix) which was calibrated to produce the equivalent output of glyphosate compared to applications using the hydraulic nozzle. A vegetable oil adjuvant (Codacide) was also included as a tank mix at the rate of 1% v/v with glyphosate treatments applied with the flat fan and drift reduction nozzles to provide a comparison with the identical treatments applied without the adjuvant.

The tractor mounted rotary wick wiper Weedbug and the hand-held Handybug comprising a single disc driven by a small 2-stroke engine were used for treatments in the hard-standing areas and in the stormwater channel. The Gutterbug and Handybug were used for treatments in kerb and gutter situations. In all situations, a 1:1 solution of Roundup Biactive to water was applied with a rotating disc adjusted where possible to ensure that the wiping surfaces were clear of the underlying surface by at least 10mm.

High temperature water was applied using either Steamwand or Waipuna systems. These are similar applicators that apply the heated water to the weed under the applicator head to subject the leaf surface to a temperature of nearly 100°C. The Waipuna foam system delivered a foam comprising a heated (85-95°C) solution of water and an alkyl polyglycoside foaming agent that was applied to weeds. The foam is aimed at retaining the heat applied to the site for a longer period.

Flame treatments were applied with a special discharge nozzle driven by liquid propane with the operator moving the nozzle slowly across target weeds until visible desiccation was evident but not to the point of total destruction of leaf tissue.

Treatments were applied in a Randomized Complete Block or Modified Randomized Complete Block design (kerb and gutter site) with 3 replications. Plot size was kerb 0.5 × 20m, hard-standing 2 × 10m and 4 × 15m concrete channel. A visual assessment of weed control was carried out at 7, 15, 30 and 60 days after treatment (DAT) in Spring and in Autumn using the SWSS plant assessment percentage scale, where 0=no effect and 100=complete control compared to an untreated plot (Anon., 1986). Average values were derived for each treatment. Weed plants were actively growing and at flowering stage in most instances. The visual rating although subjective and not statistically analysed allows an effective assessment of the plant responses.

RESULTS AND DISCUSSION

The five spray methods of application for glyphosate herbicide tested in various situations provided complete control of paspalum (*Paspalum dilatatum*), tall fescue (*Festuca arundinaceae*), silver grass (*Vulpia* spp.), flatweed (*Hypochoeris radicata*), wireweed (*Polygonum aviculare*), barnyard grass (*Echinochloa crus-galli*) and white clover (*Trifolium repens*) and good to very good control of storksbill (*Erodium* sp.) for at least 60 days after treatment (DAT) in Spring and in Autumn. Excellent control of umbrella sedge (*Cyperus eragrostis*) was obtained in a stormwater channel situation from the various spray applications of glyphosate.

Neither the addition of 1% v/v dilution of a vegetable oil adjuvant, Codacide or the type of spray nozzle had any significant effect on the speed of development of symptoms on weeds or their final control level. However, a sharper definition of the sprayed swath was produced in treatments applied using the low drift Turbo Teejet nozzle, Roundnozzle 25 and the Nomix CDA applicator compared to sprayed treatments using a conventional flat fan nozzle. A similar effect was achieved with the treatments where Codacide oil was added to the glyphosate sprayed using a conventional nozzle. This is consistent with the measurement of a significantly lower percentage of driftable droplets (fines) in studies conducted with these or similar products. The substitution of an air induction nozzle (Roundnozzle 25) or conventional drift reduction nozzle (Turbo Teejet) for standard flat fan nozzles on the spray equipment did not generally result in any loss of performance of glyphosate herbicide for the range of weed species, despite the production of much larger spray droplets particularly for the air induction nozzle.

Weed control provided by the three types rotary wick wiper applicator machines using glyphosate was complete at 60 DAT and comparable to spray treatments for tall growing species including paspalum, tall fescue and umbrella sedge and for low growing species including white clover and wireweed in a concrete lined channel. Similar results were obtained with the Gutterbug in the kerb and gutter situation, although weed control for low growing flatweed plants was good but not complete. At these locations it may have been that the wiper was able to be located closer to the flat concrete surface compared to the parkland sites where operational conditions require the applicator to be set not less than 10-15 mm above the ground surface for the wick to remain clean.

In a hard standing area the control of tall growing species was complete whilst the control obtained for the low growing species including clover and flatweed was poor. The use of the Weedbug applicator in a concrete-lined stormwater channel and the Gutterbug in kerb and gutter provided good weed control overall. Added to this acceptable weed control is the potential offered by these machines for the virtual elimination of herbicide applied to non-target surfaces and lower herbicide residues in stormwater as indicated by Wood (1996). The effectiveness of the rotary wiper system could be compromised in situations where there is a significant proportion of weeds having a prostrate habit (e.g. flatweed).

The use of flame for weed control provided poor to moderate control of most of the weed species for no more than 30 DAT in the trials where this method was evaluated. Though the times taken for treatment were considerably longer compared to spray application, it can only be assumed that, although the manufacturer's instructions were observed, insufficient time was allowed to provide for desiccation of a sufficient proportion of plant foliage to ensure plant death. Moderate to good control of silver grass and flatweed however, was obtained for 30 DAT indicating that for some species at least, flame weeding may be effective. It is possible in view of these results that a better outcome could be obtained if flame was applied for a considerably longer time to ensure complete burning-off of above ground foliage. However, this is unlikely to be cost-effective in most situations.

Application of high temperature water using the Steamwand provided poor control and the Waipuna applicator provided moderate control of most weeds in most situations with the exception of silver grass (not in kerb and gutter) where very good control was obtained. The Waipuna system provided complete initial desiccation of all weeds except barnyard grass when assessments were carried out at 7 DAT. Control of most species was poor to moderate at 30 DAT due to regrowth, except for white clover where good control was obtained by 60 DAT. Application of the high temperature water and foam using the Waipuna unit was inferior to the Waipuna system on all weeds tested with poor to moderate control at 15 DAT and strong regrowth giving poor weed control at 30 DAT. This was attributed to the lower operating temperature of the prototype foaming unit compared to the conventional Waipuna system.

It is possible that the temperature of the water and duration of its exposure to the plants was insufficient to provide plant death particularly on hard surfaces where the temperature of the soil supporting weed root systems may not have been increased significantly. The Steamwand and the Waipuna systems may be more successful in areas where soil temperatures at and directly below the surface can be raised sufficient to provide some destruction of root as well as above ground leaf tissue. Therefore the high temperature water treatment of weeds may be best suited to garden beds where the application of non-selective herbicides requires the greatest care.

One outcome of the trials is that in the ACT application specifications for contractors will be changed to require the use of drift reduction nozzles such as the Turbo Teejet for glyphosate application when spraying certain urban hard standing areas. Also the use of the Gutterbug applicator should be further evaluated for weed control in kerb and gutter.

Preliminary Assessment of Operational Efficiency
The preliminary assessment of efficiency has been based on the measured time required in the application of each treatment but has not also evaluated the energy requirements such as fuel. Both the flame and high temperature water systems were 10 to 20 times less efficient for continuous broadcast treatment compared to hand boom or Weedbug application of glyphosate herbicide. Calculated operational efficiency of flame and steam was 0.04 ha hr^{-1} compared to up to 0.8 ha hr^{-1} for hand boom or Weedbug application of glyphosate (based on ground speed of 5 km hr^{-1} and swath width of 2 metres and 80% operational time).

With both the flame and high temperature water systems the efficiency of spot applications on a unit area basis in kerb and gutter, and channel drain is likely to be higher, but still considerably less than the application of glyphosate herbicide. The CDA Nomix applicator is at least as efficient as a hand boom applicator in respect of time where a swath width not exceeding the operational specifications for this applicator is treated, with the additional advantages of the elimination of down-time for preparing a spray solution and limiting operator exposure to herbicide concentrates.

The operational efficiency of the Weedbug or Gutterbug applicator is likely to be slightly superior to any tractor or truck mounted boom for the application of glyphosate in a hard standing area such as kerb and gutter. These units can be operated under virtually any wind conditions since application does not involved the release of spray onto the weed target.

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