A REVIEW OF NON-SELECTIVE WEED CONTROL IN NEW ZEALAND

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Summary

A general review of non-selective weed control practices in New Zealand is presented. Major use areas and associated problem weeds are described. The increasing use of residual type herbicides is illustrated. The properties and deficiencies of individual compounds and various mixtures are described and comparative field performance data from three trials are presented. The low solubility of simazine and its suitability for use close to ornamental plantings are described. Preliminary field results with a new substituted urea herbicide NIA 11092 and a substituted pyridine "Daxtron"* are presented.

INTRODUCTION

IN NEW ZEALAND, non-selective weedkillers have become widely accepted by the railways and highways authorities, drainage and catchment boards, local bodies, forest operators, industry, farmers and home-owners, as an efficient and economical means of ridding non-crop land of unwanted vegetation.

This paper is designed to present an up-to-date general review of the non-selective weed control field in New Zealand based on the writer's observations, user comments and field trials. Problems arising from the use of various weedkillers and some comments on performance of new compounds are also discussed.

MAJOR FIELDS OF USAGE

The growing demand for non-selective herbicides in New Zealand during the past 10 years is illustrated in Fig. 1. An increasing demand for the long-acting weedkillers has developed recently but residual compounds have only a limited place in the warmer, high rainfall areas in the North Island.

RAILWAYS

The New Zealand Railways Department is the largest single user of non-selective weedkillers in the country and over the past ten years has employed a wide range of chemicals and mixtures of chemicals on its tracks and yards. Initially, short term weedkillers were employed and treatments were generally applied twice per year in late spring and autumn. More recently, residual herbicides have been included in all mixtures in combination with knockdown chemicals such as 2,2-DPA/amitrole and 2,2-DPA/2,4-D. This very significant change has been made in an effort to secure at least twelve months control from a

*Registered trademark of the Dow Chemical Company.

single application. In general, the results obtained have justified the change despite the specialized weed problems associated with ballast and the continuing pressure of weed reinfestation associated with the benevolent New Zealand climate.

Railway weed control practices are discussed in more detail by Kennedy (1967).

LOCAL BODIES

The comparatively early and widespread acceptance of non-selective chemical weed control by almost all local bodies in New Zealand is unique. New Zealand is probably the world's largest user of non-selective herbicides on a "potential sprayable area" basis. Use of these herbicides is especially concerned with controlling or eradicating weeds from footpaths and kerbsides in urban areas. In addition, storage yards, recreation areas, dog dosing strips, building surrounds, drains, and waterways are maintained in acceptable condition with weedkillers by these organizations.

Fig. 1: Relative increase in non-selective herbicide usage over 11 years, taking the base year 1967 as representing 50.

"Chemical grading" on highways is a technique which is being used increasingly by local bodies. Residual herbicides alone or in mixture with knockdown chemicals are being used to maintain gravel road shoulders instead of using the traditional mechanical grader.

The many disadvantages of the grader and the increasing costs of grading have highlighted the need for alternative techniques. Ideally, a sterilant chemical such as simazine is applied to the freshly graded stone surface which is quite free of all weed growth. It can be maintained so for up to a year with dosages down to 4 lb of simazine in the cooler, dry South Islands districts. (All rates are expressed in lb active ingredient per acre.)

Another comparatively new use for non-selective herbicides which has emerged in recent years is the suppression of bracken fern (*Pteridium esculentum*) and mixed woody weeds on roadsides, railways, and waste areas with mixtures of contact and hormone type weedkillers. Low rates of sodium chlorate (20 to 40 lb) in mixture with a fire suppressant applied in combination with 2,4,5-T has been most widely used for this purpose, but more recently paraquat/2,4,5-T mixtures have been employed with very satisfactory results. Application usually in mid- to late summer, by means of large, fast moving vehicles fitted with boomless swath spraying equipment, offers very considerable economies over hand or mechanical cutting. With sodium chlorate/2,4,5-T mixtures, grasses are only temporarily affected and a grass-dominant plant cover is encouraged. Although suppression rather than outright eradication is achieved initially, the widespread acceptance of this technique by rural roading authorities testifies to its effectiveness in a continuing weed control programme.

CHEMICALS

As yet, the single ideal non-selective weedkilling chemical has not been discovered and it has therefore been necessary to select from the "less-than-ideal" presently available. Even the most broad spectrum weedkiller is selective to some plant species, and, because plant populations in New Zealand are invariably complex, there has developed a range of chemical mixtures with a broad but not always complete weed control spectrum. If maximum cost efficiency is to be obtained, it is therefore necessary to have a sound knowledge of any product's performance under varying conditions of plant composition, rainfall pattern and soil types throughout New Zealand.

Of the short-term or knockdown herbicides, 2,2-DPA, amitrole, paraquat, 2,4-D, and in one specialized situation sodium chlorate, are the most commonly used weedkillers. As a very high percentage of non-selective weedkiller spray applications are made in urban areas, non-hormone herbicides have gained favour. Of these, 2,2-DPA and to a lesser extent paraquat for grass control, also amitrole for both broadleaf and grass weed control, are the most commonly used. A proprietary mixture of 2,2-DPA/amitrole at 7.5 + 5 lb is the most widely used weedkiller for short-term, non-selective weed control in New Zealand.

Residual weedkillers used in New Zealand for non-selective control are at present almost confined to diuron, simazine and the more recent development, bromacil. Many other compounds, mainly substituted ureas and triazines, have been evaluated, but apart from monuron and atrazine, which once found a limited place, none has been found to have superior properties to those now in use.

Of the three commonly used residual weedkillers, only bromacil is effective when used alone on established vegetation as it exhibits a high level of both post-emergence and residual toxicity to a wide range of plant species. However, the new compound "Daxtron" exhibits even greater initial toxicity to a wide range of established plants than bromacil and NIA 11092 also shows marked knockdown activity for a substituted urea compound, especially on grasses. Both diuron and simazine require to be applied in mixture with knockdown chemicals such as 2,2-DPA plus amitrole or plus 2,4-D when treating established weed populations.

Of the three compounds, simazine is the most persistent and the least water soluble. Under conditions of high rainfall and heavy pressure of weed germination, simazine generally provides longer weed control than the other compounds. In lower rainfall areas weed pressure is normally less, and, if the season of moisture stress follows application, the differences in length of residual control of all three compounds depend mainly on the major potential species attempting to re-invade the site first. The acute toxicity of bromacil to established grass and broadleaf vegetation does not appear to be greatly reduced by hardened growth conditions induced by moisture stress prior to treatment. This is not always the case with additives such as 2,2-DPA, amitrole and 2,4-D used with diuron and simazine.

The extremely low solubility of simazine (3.5 ppm), together with its ability to be readily absorbed on soil colloids, makes it the outstanding residual weedkiller which can be used safely where the roots of neighbouring trees and shrubs extend into the treatment zone. The elimination of this hazard has obvious advantages in both urban and rural areas where a very wide range of desirable species must be considered.

PROBLEMS

Probably the greatest deficiency of presently available non-selective weedkillers is in the control of summer-growing grass weeds such as the paspalums (*P. dilatatum* and *P. distichum*), kikuyu (*Pennisetum clandestinum*) and the annual summer grasses (*Digitaria sanguinalis* and *Panicum* spp.). In the warmer part of the North Island (excluding Hawke's Bay, Wairarapa and Wellington), these grasses can make any total weed control programme difficult to accomplish. These perennial species cannot be controlled economically with residual weedkillers, and foliar absorbed, translocated materials generally have insufficient persistence to control the summer grasses which germinate from early summer to early autumn. Established paspalum resprouting from root crowns and growing vigorously during the warm months has proved very difficult to kill.

Results from trials to date indicate that non-sterilant treatments of mixtures containing 2,2-DPA and amitrole applied in late November-December period are necessary if maximum summer control of paspalum and kikuyu is to be achieved. However, this early summer application to paspalum can only be regarded as a "hold down" treatment until the more effective autumn application is made. If a moist, warm summer follows application, the continuing germination of summer grasses can become a recurring problem, often necessitating further treatment.

The organic arsenate salts, MSMA and DSMA, have been used to remove paspalum from turf selectively. Recent trials in Auckland and New Plymouth suggest that further work is warranted to evaluate the materials in admixture with dalapon/amitrole and/or residuals in non-selective situations. In a New Plymouth trial the substituted pyridine

"Daxtron" at 8 lb applied in late March and repeated in late November has killed mature paspalum. Any such promising leads warrant more intensive investigation.

Another problem weed found in North Island industrial and local body situations is prostrate amaranthus (*Amaranthus deflexus*) which grows prolifically in warmer summer months. This weed shows a surprising degree of tolerance to a wide range of weedkillers. A diuron/2,2-DPA/ amitrole mixture applied in the late spring on early active growth at 16 lb total active has given satisfactory control, as has "Daxtron" alone at 4 lb.

Other resistant species which can appear following a non-selective weed control programme notably include docks (*Rumex* spp.), buttercups (*Ranunculus* spp.), dandelion (*Taraxacum officinale*), yarrow (*Achillea millefolium*), Californian thistle (*Cirsium arvense*), *Paspalum distichum* and bracken fern. Docks, yarrow and Californian thistle can be controlled by the addition to mixtures of amitrole-T at 4 lb. *Paspalum distichum* is also reasonably controlled by amitrole-T at 6 lb applied in mid- to late summer plus a further treatment of 6 lb one month later. Buttercups and dandelions require to be treated with hormone type weedkillers.

THE FUTURE

The continued use of wide range but not complete spectrum non-selective weedkillers in situations blessed with high fertility, adequate moisture and an even, temperate climate can be fraught with hazard. Inevitably, there will gradually develop populations of weed species tolerant to presently available herbicides. Only the continuing development of new compounds and herbicide mixtures will prevent these species from assuming serious weed proportions. Fortunately, promising new herbicides are already being evaluated and others will certainly follow. Among the interesting new compounds under trial in New Zealand are included the substituted urea NIA 11092 and "Daxtron".

EXPERIMENTAL

Applications were made with an Oxford Precision Sprayer operated at 30 lb/sq. in. and applying 64 gal per acre in two spray passes. A blended non-ionic surfactant, Multifilm X-77, was included in all treatments at 0.125% v/v. Treatments in Trials 1 and 2 were replicated three times and Trial 3 twice. Visual ratings were made on a 0-10 scale (0 = no control, 10 = complete kill) by at least two independent observers.

TRIAL 1

The trial site was on a pasture, New Plymouth black loam soil. The vegetation at treatment time was up to 4 in. high, in active growth and consisting of paspalum, cocksfoot (*Dactylis glomerata*), perennial ryegrass (*Lolium perenne*), Yorkhire fog (*Holcus lanatus*), narrow-leaf plantain (*Plantago lanceolata*), white clover (*Trifolium repens*), yarrow.

Mixtures containing simazine/2,2-DPA/amitrole, bromacil/2,2-DPA/amitrole, and "Daxtron" gave a high level of knockdown at the first rating 4 weeks after treatment (Table 1). Bromacil alone has been less effective than when used in admixture with 2,2-DPA/amitrole in total weed control over the winter. After 20 weeks, simazine/2,2-DPA/amitrole

TABLE 1: RESIDUAL WEED CONTROL—TRIALS 1 AND 2

Trial 1—New Plymouth, original treatment March, 1966.

Trial 2—Retreatment of half plots from Trial 1—November, 1966.

Treatment (lb)	Total Control (Weeks)					
	Trial 1			Trial 2		
	4	20	32	3	20	24*
Simazine 8/2,2-DPA 5.3/amitrole 2.5	7.3	7.2	4.0	7.3	4.2	0
Diuron 8/2,2-DPA 5.3/ amitrole 2.5	—	—	—	8.0	2.6	0.2
Bromacil 8/2,2-DPA 5.3/amitrole 2.5	7.7	3.3	1.3	7.2	6.1	0.6
Bromacil 8	4.1	0.8	0.5	6.6	6.7	0.2
Diuron 4/2,2-DPA 11/2,4-D 2.4	—	—	—	5.2	0.2	0
NIA 11092 8/2,2-DPA 5.3/amitrole 2.5	5.3	4.2	2.1	8.3	5.8	0.6
"Daxtron" 8.0	6.8	2.0	1.7	9.2	6.7	7.4

*Paspalum control only.

was maintaining the most effective control, while all other treatments were failing as spring growth began. The new substituted urea NIA 11092 combined with 2,2-DPA/amitrole gave reasonable control of both grasses and broadleaf species except narrow-leaf plantain.

At the 32-week rating, paspalum regrowth had commenced and sterilant control of the summer growth in all plots had collapsed and was unacceptable. With the collapse of the residual control from Trial 1, half of each of the plots was retreated to compare any cumulative effects.

TRIAL 2

Three weeks after application, a high level of brown-off was obtained with all residual treatments, especially with "Daxtron" 8 lb (Table 1). Twenty weeks after treatment, there was a considerable variation in the plots, depending on the degree of paspalum infestation. "Daxtron" had root-killed paspalum, but was insufficiently residual at this stage to prevent germination of seedlings. All other residual treatments failed completely on paspalum.

TRIAL 3

The trial site was along a roadside on Waimakariri gravel based soil. Vegetation was up to 18 in. high in active spring growth and comprised a mixture of grasses including cocksfoot, couch (*Agropyron repens*), sterile brome (*Bromus sterilis*) and browntop (*Agrostis tenuis*) with the broadleaf species white clover, yarrow, tares (*Vicia sativa*), narrow leaf plantain, docks, perennial ryegrass and dandelion.

All treatments with the exception of diuron/2,2-DPA/2,4-D gave acceptable brown-off 8 weeks after treatment (Table 2). Under the dry summer conditions, simazine/2,2-DPA/amitrole and bromacil 8 lb alone maintained outstanding general weed control for 26 weeks. "Daxtron" alone at 4 lb also proved quite residual and at 2 lb improved the residual control of 2,2-DPA/amitrole. A proprietary diuron/2,2-DPA/2,4-D mixture did not give acceptable residual control on this site, probably on account of inadequate initial knockdown.

TABLE 2: RESIDUAL WEED CONTROL—TRIAL 3
(Christchurch—October, 1966)

Treatment (lb)	9Z	Mean Control (Weeks)		
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Simazine 8.0/2,2-DPA 5.3/amitrole 2.5		8.8	9.5	9.3
2,2-DPA 7.4/amitrole 5.0		8.2	4.5	2.7
"Daxtron" 2.0/2,2-DPA 7.4/amitrole 5.0		9.6	8.3	6.0
"Daxtron" 4.0		9.4	9.3	7.7
Diuron 4.0/2,2-DPA 11.1/2,4-D 2.4		6.5	6.4	3.5
Bromacil 8.0		9.4	10.0	9.7

This illustrates that diuron is a sterilant chemical which is most effectively used to hold down the regrowth vegetation rather than to control it initially. "Daxtron" has proved to be a broad spectrum, rapid acting herbicide with medium-term residual activity when used at quite low rates. Present evidence points to its possible use in mixtures rather than as a specific herbicide for the control of difficult species such as *paspalum*, docks and prostrate *amaranthus*.

DISCUSSION

On the credit side, non-selective weedkillers have proved that they can offer a cost competitive alternative to traditional weed control methods. The increasing cost of machinery for roadside maintenance and the need for more productive employment of labour suggest tremendous increases in the use of chemicals for this work alone. The development of improved chemicals and an understanding of their properties, greater skills in their use and in the equipment to apply them are continuing. Growth suppression and plant cover manipulation rather than total kill are avenues worthy of exploration in efforts to control weed vegetation on non-cropped areas.

The exceptional growth conditions experienced in most parts of New Zealand mean that unwanted vegetation is a viable, constantly increasing entity—not some static thing. Non-selective weed control is a continuing process in which chemicals have proved their worth and will continue to do so with increasing momentum.

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REFERENCE

Kennedy, D., 1967: *Proc. 19th N.Z. Weed & Pest Control Conf.*: 24.