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A REVIEW OF NOVEL TECHNIQUES IN HERBICIDE USAGE

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Summary

Novel techniques in herbicide usage are being developed to increase the selectivity of herbicides, to reduce the amount of herbicide used and the cost of weed control. These techniques can be grouped into those involving application equipment, and those involving additives to the herbicide formulations. Recirculating sprayer and wiper applicators are used to control weeds taller than the crop. Activated carbon can be used to protect crops from weeds of the same species or genus and has a potential usage in seed production.

INTRODUCTION

Novel techniques in herbicide usage are being developed to increase the selectivity of herbicides, to reduce the amount of herbicide used and hence the cost of weed control. The development of such techniques has been in response to some of the following economic and environmental factors. Development of new herbicides is expensive, commonly costing in excess of \$13 million for research and development, plus \$30 million if a new manufacturing plant is required. Many older herbicides cost less than half the price of new herbicides (Table 1). New, selective herbicides are not likely to be developed for many crops in New Zealand unless the herbicide has a market in one of the major crops of the developed world, such as corn, soybeans, cotton or small grain cereals. Most herbicides are synthesized from petroleum derivatives, a finite resource of increasing cost. The percentage of the herbicide reaching the target weed species can be low.

Table 1. Relationship between the year of development and retail price of some herbicides.

Herbicide	Year of introduction ¹	1979 price (\$NZ/kg ai)
2,4-D	1942	9
amitrole	1954	16
simazine	1956	15
paraquat	1958	33
bentazon	1968	61
glyphosate	1971	63
ethofumesate	1974	64

¹ Data from Hubert and Worthing (1977).

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Table 2. Novel techniques that require specialized application equipment.

Application technique	Comments
Controlled drop application (CDA)	Uniformed sized droplets produced by revolving head. Reduces drift, and amount of water required (Farmery 1978).
Recirculating sprayer	Spray herbicide horizontal to, and above crop. Controls weeds taller than crop. Herbicide not intercepted by weeds is caught and recirculated. (McWhorter 1970).
Wiper - applicators	Revolving roller wipes herbicide onto weeds taller than the crop (Irons and Burnside 1978). Ropes wipe herbicide onto weeds that are taller than crop. (Dale 1979).
Electrostatic droplets	Spray droplets inductively charged and preferentially attracted to plant surface. Reduced amount of herbicide required (Law 1977).
Herbigation	Herbicide mixed with irrigation water. Reduce cost of application (Horowitz and Bucsbaum 1978).
Seed treatments	Seed used as carrier for herbicide. EPTC pelleted lucerne and bean seeds gives control of grasses and other sensitive species in vicinity of seed row. Potential uses include home garden and third world agriculture (Dawson 1978). Seed impregnated with antidote to herbicide. Naphthalic anhydride increases tolerance of some species to herbicides or CGA 43089 to increase sorghum tolerance to metalochlor (Nuffeler <i>et al</i> 1978).
Activated carbon (AC)	A slurry of activated carbon is sprayed in a narrow band above the seed row at planting. Subsequently diuron or other herbicides are applied to control weeds emerging between bands (Lee 1973).

Novel techniques developed in recent years can be grouped under two headings; those involving application equipment (Table 2) and those involving additives to the herbicide formulation (Table 3). Several of these techniques that have potential uses in New Zealand, are discussed below.

HEIGHT SELECTIVITY

The development of glyphosate, with its foliar absorption, systemic non-selective properties, has led to development of applicators that selectively apply herbicide to weeds taller than the crop. In pastures, and small seed crops a number of weed species, including Californian thistle (*Cirsium arvense*) and ragwort (*Senecio jacobaea*), are taller than the crop at certain growth stages.

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Table 3. Novel techniques involving additives to the herbicide formulations

Antidotes	Increase crop tolerance by altering physiological response of crop e.g. R-25788 added to EPTC (Lay <i>et al</i> 1975).
Controlled release	Herbicide chemically bound or physically dissolved in polymers or microencapsulated. Released by diffusion or degradation of polymer. Suitable for aquatic weed control, delayed incorporation of volatile herbicides such as butylate or EPTC (Doane <i>et al</i> 1977), or extending the time period that a phytotoxic quantity of herbicide is retained in the soil. (Schreiber 1976)
Microbial inhibitor	A microbial inhibitor extends the time period that prophan and chlorprophan are active in the soil (Deli 1978).
Drift retardants	Thickening agents reduce the proportion of fine droplets (Arvier 1976).
Additives to enhance activity	Various inorganic salts including ammonium sulphate (Turner 1976) or organic oils (Nalewaja <i>et al</i> 1978) increase spray retention or uptake of herbicides.

The recirculating sprayer sprays narrow jets of herbicide across the top of the crop. Herbicide not intercepted by weeds taller than the crop, is caught and recirculated. Edmond (1955) attempted to control docks (*Rumex obtusifolius*) in a New Zealand pasture using 2,4-D applied by a recirculating sprayer but the concept did not catch on. With the development of glyphosate the recirculating sprayer concept was "rediscovered" (McWhorter 1970) and several models are now available (Supak and Abernathy 1977).

Several applicators that wipe herbicide directly onto weeds have been developed in recent years. The roller applicator consists of a carpet-covered roller soaked with herbicide (Irons and Burnside 1978). By revolving the roller a film of herbicide is retained in a manner analogous to turning a knife laden with runny honey. The rope-wick applicator is a low cost machine developed by Dale (1979). The applicator consists of a horizontal PVC pipe with sealed ends that forms a herbicide reservoir and a series of nylon ropes that emerge from within the pipe and run along its surface. While present models have been tractor mounted I envisage a hill country model mounted between bicycle wheels and pulled by horse or motor cycle. Another variation of the wiper concept is a herbicide soaked sponge on an endless belt that passes through a herbicide reservoir (Welker 1978).

Both recirculating sprayer and wiper applicators use low rates of glyphosate, often 0.1 kg/ha, depending on weed density. Although glyphosate has been used in most experiments, other foliar applied non-selective herbicides can be used (Dale 1979). Calibration, particularly for research purposes has been difficult, and requires measurements of ground velocity, roller sizes, revolution speeds, herbicide dilution, and quantity of herbicide used. The latter is difficult since rope-wicks or carpet rollers hold herbicide not released onto plants. From a use view point there have been legal problems in the USA, because of the need to set crop tolerances for glyphosate in a whole range of crops.

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ACTIVATED CARBON BANDING

Activated carbon (AC) is a highly porous, carbonaceous material that will absorb and inactivate many herbicides (Hassler 1963). Techniques using AC to increase herbicide selectivity include dipping roots of transplants into an AC slurry (Kratky *et al* 1970), pelleting seeds with AC (Nangju *et al* 1973) and spraying an AC band above the seed row at planting (Lee 1973). In Oregon AC banding, followed by broadcast diuron applications is used in the annual establishment of 6 000 ha grass seed, especially turf-types where a premium is paid if the harvested crop is certified weed-seed free. The banding technique also shows promise for the control of volunteer legumes in legume seed crops (Rolston *et al* 1979). In New Zealand, AC has a potential usage in seed production, particularly in the multiplication of nucleus and breeders generations of seed crops, including clover varieties which may be contaminated by the establishment of volunteers arising from hard seed in the soil, in high value crops where selective herbicides are not available, and in the evaluation of cultivars.

Activated carbon is very abrasive and reactive with aluminium. Centrifugal pumps and stainless-steel nozzle tips are essential for the application of AC bands. A further refinement in the AC banding technique is the application of spots of AC, as small as 2.5 x 2.5 cm. Solenoid nozzles can be co-ordinated to place spots over the seeds (Chandler *et al* 1978).

Rates of AC of 200 to 400 kg/ha within the band are required for protection, giving actual use rates of 20 to 50 kg/ha depending on crop row width and AC band width. In ryegrass seeds crops 300 kg/ha of AC in a 2.5 cm band will give protection from 3 kg/ha of diuron. With ryegrass in 35 cm row widths this requires an actual use rate of 21 kg/ha, at a cost of \$1.50/kg. In New Zealand, activated carbon is not presently manufactured and the economics of its use are not known.

The use of recirculating sprayers, weed wipers and AC banding techniques for weed control in pasture and seed production is currently under investigation at Grasslands Division, DSIR.

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