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## GENERAL ARTICLES

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### Conservation tillage using Roundup

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#### Introduction

Various systems of conservation tillage have been under development for many years in Australia, but it is only recently that they have been adopted on a significant scale. Development began in the late 1950s with work by ICI Australia Ltd on the non-residual knockdown herbicides paraquat and diquat. These herbicides paved the way for the use of herbicides instead of cultivation before sowing crops. The systems developed in the southern (winter rainfall) areas of Australia are described by McNeil (1978) and Ellington and Reeves (1978), and are known as 'direct drilling' and as 'reduced' or 'minimum cultivation'. These systems are considered to be suitable for large areas of southern New South Wales, Victoria, South Australia, and Western Australia, where there is no need for fallowing to conserve moisture because rainfall is winter dominant with more than 460 mm annually.

The increased adoption of conservation tillage in recent years has been for a number of reasons, the most common of which appears to be the influence of the cost of fuel on the cost of cultivation. Fuel prices increased by 216% between 1976 and 1980, and are unlikely to fall. Excessive cultivation of soil has led to problems of deteriorating soil structure and soil erosion, which have also prompted the adoption of reduced cultivation. The reduction in time involved in sowing a crop by direct drilling has also enabled farmers to sow larger areas and to sow crops closer to the optimum sowing date.

#### Roundup in conservation tillage

The use of glyphosate (as Roundup herbicide) has hastened the adoption of conservation tillage in certain areas of Australia. Glyphosate is a foliar-applied translocated herbicide which controls many annual and perennial weeds and has no soil residual activity (Sprankle *et al.*, 1975), which makes it suitable for use to within a few days of sowing wheat, barley and other crops.

This herbicide was first reported as suitable for the control of annual ryegrass (*Lolium rigidum*), capeweed (*Arctotheca calendula*), barley grass (*Hordeum leporinum*) and *Erodium* spp. before the direct drilling of cereals into stubble or pasture by Seeney and Eady in 1978, and has been under development for minimum tillage systems since 1972. Trials and commercial applications since then have demonstrated its ability to control a wide range of weeds under a wide range of conditions. In particular, the control of perennial weeds such as *Phalaris aquatica* and *Oxalis pes-caprae* (Fellowes, 1979) allows the adoption of reduced cultivation techniques in areas previously considered to be unsuitable (Ellington and Reeves, 1978).

Recent trials have also indicated promising control of sorrel (*Rumex acetosella*), skeleton weed (*Chondrilla juncea*), Patersons curse (*Echium lycopsis*) and spiny emex (*Emex australis*), and further development offers the prospect of at least suppressing these problem weeds.

The ability of glyphosate to provide excellent weed control when ap-

plied in volumes as low as 10 L ha<sup>-1</sup> also protects the clean water supplies. Its ability to control prolific weed growth where hard grazing is not practicable or desirable gives greater flexibility to conservation tillage systems.

In the southern (winter rainfall) areas of Australia, there are three main systems for using glyphosate before sowing wheat, oats and barley — direct drilling, reduced cultivation and seedbed salvage.

#### DIRECT DRILLING

Direct drilling is usually in to previous crop stubbles or short rotational annual pastures. In annual pasture situations and in problem paddocks, such as those with poor drainage, it may be difficult to achieve a suitable seedbed in one pass, and in this case a reduced cultivation system is used.

The first step in direct drilling stubbles is good distribution of straw from the header. Heavy stubbles are commonly burnt to remove the straw as a physical obstacle to combine penetration, and burning is also advocated by some to reduce the potential for disease carryover. Where suitable trash clearance equipment is available it may be desirable to retain stubble to assist in erosion control and moisture retention; glyphosate provides excellent weed control in retained stubble situations.

Annual weeds and pasture species can be used for grazing prior to spraying, so paddocks which were previously worked up under a conventional system can thus provide extra feed. Very hard grazing is not necessary, since the translocated action of glyphosate ensures complete control of existing plants. An average weed height of 6 to 8 cm is ideal to provide sufficient leaf area to absorb the herbicide, but more advanced and vigorous growth may require higher rates of application.

Spraying should be planned for an appropriate interval before the intended sowing date. For light weed infestations and on light friable soils, sowing may be carried out satisfactorily three or more days after spraying. Where there is a dense weed cover, a period of 10 to 14 days or longer should be allowed to permit breakdown of the weeds and facilitate penetration by the combine.

For mixed weed infestations, Roundup is applied at 1.0 to 1.5 L ha<sup>-1</sup>. Application should be made either in 60 to 100 L ha<sup>-1</sup> of clean

water using standard boom sprayer equipment or in 10 to 15 L ha<sup>-1</sup> of water by aircraft. Sowing depth, crop varieties and rates of seed and fertilizer need not be different from those used in conventional practice.

Rigid tine spring release combines are preferred to give good soil penetration and uniform depth of seeding, although spring tine combines in good condition may be suitable, particularly on more friable soils. Combines may be used with a full set of tines, or the working tines may be removed or lifted according to individual preference. Harrows behind the combine are recommended to break down large clods. Where previous local experience is available glyphosate may be used before sowing with triple disc drill equipment.

### REDUCED CULTIVATION

Reduced cultivation is recommended for long rotation pastures where prolonged grazing or dense root growth has consolidated the soil, as well as in other situations which prevent satisfactory seed placement with a single pass of the combine. Annual grasses and broad leaved weeds can be controlled with 1.0 to 1.5 L ha<sup>-1</sup> of Roundup, and phalaris and subterranean clover with 1.5 L ha<sup>-1</sup>. The procedure is basically the same as for direct drilling; three or more days after spraying, the soil should be cultivated with one or two passes of a tined implement to achieve the soil condition suitable for seeding.

### SEEDBED SALVAGE

During conventional seedbed preparation weeds may emerge between cultivations, and under wet conditions they can be difficult to kill mechanically. Since glyphosate may be applied by aircraft, spraying need not be delayed by wet soil conditions. Rates of Roundup as low as 0.5 L ha<sup>-1</sup> may be used (Fellowes *et al.*, 1979), and depending on soil condition and weed density, crops may be sown within three days of spraying unless further cultivation is needed to achieve a suitable seedbed.

Recommendations for the use of Roundup in conservation tillage are currently being expanded to allow its use before planting most other crops. Conservation tillage is also being developed in the northern (summer rainfall) areas of Australia, where the technique generally involves the replacement of cultivation by repeated applications of herbicides to kill weeds during the summer and

autumn periods. This helps to conserve soil moisture and to reduce erosion, thereby extending the benefits of conservation tillage to other areas of Australian agriculture.

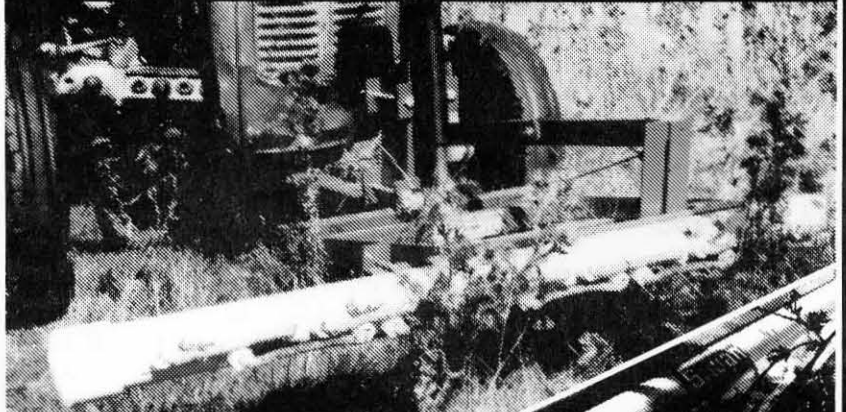
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