GENERAL ARTICLES

Pasture topping using Roundup herbicide

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Annual grasses such as annual ryegrass (*Lolium rigidum* Gaudin), brome grasses (*Bromus* spp.) barley grass (*Hordeum leporinum* Link) and silver grasses (*Vulpia* spp.) often comprise a substantial portion of the pasture growth in the cereal crop–pasture ley rotation of southern Australia. These species are often valuable pasture plants, but in subsequent crops they may become serious problem weeds causing reduced crop yields.

Annual ryegrass used to be considered the major annual grass weed because the other species rarely caused a serious problem in crops provided adequate and timely cultivation was practised prior to sowing. Annual ryegrass can now be controlled effectively by pre-emergent and post-emergent herbicides. Over the last decade barley grass, brome grasses and silver grasses have become significant problem weeds in cereal crops as there are no effective in-crop herbicides available for their control. The recent trend to minimum cultivation to reduce crop establishment costs and conserve soil structure may also have contributed to the increase in prominence of these annual grasses, some of which germinate over an extended period in autumn and winter.

Most of the annual grass plants that germinate in arable crops come from seed produced in the preceding year. Management procedures that prevent grass seed formation in the pasture phase of the cereal crop–pasture ley rotation may therefore provide a means of reducing high grass densities in subsequent crops.

Pasture topping

The concept of controlling annual weeds in the year prior to cropping is not new. Long (9-12 month) fallows largely prevent annual weed seed formation provided intensive grazing or mechanical slashing are used at the flowering and seeding stages during spring to reduce the seed burden returned to the soil. These techniques are not always successful, however, with failure to maintain clean fallows, inadequate grazing pressure or slashing in rocky or uneven country resulting in unacceptable levels of seed set.

Agricultural chemicals were first used for pasture topping in southern Australia in the early 1960s when ICI Australia Ltd developed the desiccant grass herbicide paraquat. Significant reductions in the amount of viable seed set were demonstrated when annual grass pastures were sprayed with paraquat at the late seeding stage. The use of chemicals for pasture topping was, however, limited in many areas of southern Australia until recently due to the high cost of chemicals relative to conventional methods of topping.

Pasture topping with Roundup

Efficacy

Field trials in 1980 suggested that the translocated herbicide Roundup (360 g L^{-1} glyphosate) halted the growth and affected the seed set of annual weeds sprayed in the spring. Large scale evaluation of the use of rates of 100–750 mL ha^{-1} for pasture topping occurred in 1981 and 1982 throughout southern Australia, and showed that in the year after treatment with 300–450 mL ha^{-1} of Roundup the populations of barley grass, bromes and silver grasses were reduced by up to 98%. Annual ryegrass populations were reduced by as much as 90% and similar reductions were recorded for capeweed (*Arctotheca calendula* (L.) Levyns) treated with Roundup at these rates in the preceding spring.

Past experience with Roundup in conservation tillage indicated that ryegrass was a more robust target weed than the softer broader leafed grasses like bromes and barley grass. While treatment with 300–450 mL ha^{-1} of Roundup resulted in optimum reductions of all the annual grasses, the higher rates were necessary in situations where ryegrass was dominant. Better results were also achieved when 450 mL ha^{-1} of Roundup was used in dense infestations of annual grasses. In 23 trials conducted in southern Australia in 1981 and 1982 the reductions recorded in the population of the annual weeds cited ranged from 41% to 98% in the year following treatment with 300–450 mL. The level of efficacy achieved depended on the density of the weed infestation and the timing of application in relation to the stage of growth of the annual weeds treated.

Timing

The application of low rates of Roundup to bromes and barley grass in the late boot to head-emerged stages generally reduced the population of these grasses by more than 85% in the following year, while treatment of annual ryegrass in the early head to anthesis stages resulted in the greatest reduction in the subsequent year's population of this species. Similar results were obtained when silver grass was treated between anthesis and the milky dough stages, whilst application of Roundup at flowering was necessary to achieve the maximum reduction in plant numbers of capeweed. At this timing the susceptibility of capeweed is similar to that of bromes and barley grass.

To accommodate this information in a single recommendation for the four annual grasses it was concluded that these species should be treated from the early head to milky dough stages, which coincides with the translocation of plant assimilates (and absorbed

glyphosate) to the seed. For capeweed it was recommended that treatment should occur at full flowering.

Surfactant addition

The efficacy of the Roundup at 300-450 mL ha^{-1} was not consistently improved by the addition of surfactant, although at some sites improved results of 15% were achieved. Differences in the spray volumes used (30–100 L ha^{-1}) probably caused this result and the addition of 0.25% w/v of a non-ionic surfactant was recommended in situations where spray volumes greater than 50 L ha^{-1} were used so that optimal levels of surfactant were maintained in the spray solution.

Grazing

Pasture topping and stock grazing generally occur together in practice. In trials in 1981 and 1982 no advantage was gained by heavy grazing prior to treatment with Roundup, and in some instances where this occurred poorer results were obtained because stock failed to graze the trial areas evenly. The most consistent results were obtained when stock was removed at least three weeks prior to grass head development. This allowed grasses to develop naturally and resulted in a high proportion of grass heads in the early head to milky dough stages. It is recommended that grazing be delayed for one day after pasture topping to allow adequate absorption and translocation of the herbicide.

Benefits of pasture topping

Crop yield increases

In large scale trials in Western Australia plots that were pasture topped with the recommended rate of Roundup herbicide in 1981 outyielded the untreated plots in 1982 by 22%–95%. Other pasture topping techniques have also resulted in yield increases of 0–100% or more relative to no treatment in the year prior to cropping. This wide range of yield responses is probably due to the varying weed killing efficiency of cultivation at crop establishment and to the varying competitiveness of annual grasses depending on planting date and growing conditions.

Grazing benefits

The flexibility of application timing with Roundup (early head to milky dough) provides a number of grazing benefits. Treatment at the early timing halts grass development and seed formation, so that grass seeds in the eyes and pelts of stock is not generally a problem. Field observations showed that grasses treated with Roundup at the pasture topping period are grazed by stock in preference to non-sprayed areas, in some instances leading to overgrazing. A limited number of trials have shown that the protein content and percentage digestibility is retained in sprayed grasses but that they rapidly decrease in pastures that are not sprayed as the grasses mature and seed formation occurs. Further trial work is required to quantify this effect.

In areas where continuous pasture for stock grazing occurs, pasture topping is a means of reducing the proportion of undesirable annual grasses or capeweed in the pasture in the year following treatment.

Pasture topping and conservation tillage

In the first year after pasture topping the reductions in annual grass and capeweed populations not only reduce in-crop competition but also reduce the annual weed burden prior to sowing. The technique is therefore a useful adjunct to conservation tillage allowing fewer tillage operations prior to sowing, or in the case of direct drilling the complete replacement of cultivation by herbicides. With less time required for cultivation, sowing can occur at the optimum period.

Repeated cultivation prior to sowing has been the most common method of controlling sequential germinations of bromes, barley grass and silver grasses in the past. Since there are no in-crop herbicides that effectively control these species, pasture topping provides the means of adopting a conservation tillage technique of crop establishment in areas where these grasses predominate.

Effect on pasture legumes

The application of Roundup during floral development of undesirable annual grasses and broadleaf weeds coincides with the maturity of pasture legumes. Some reduction in pasture legume seed set may consequently be expected, even though legumes often exhibit considerable tolerance to higher rates of Roundup in the vegetative stage of growth.

Two important physiological stages of legume development occur during the period corresponding to pasture topping treatment–flowering and pod filling. In trials carried out in 1981 and 1982 the application of 300–600 mL ha^{-1} of Roundup to pre-flowering and flowering subterranean clover resulted in average reductions of up to 45% in plant numbers in the year following treatment. Treatment in the pod filling stage generally resulted in reductions of 15%–30%. No consistent pattern was observed, however, and at some sites an increase in clover population occurred. These results not only reflect the direct effects of Roundup on clover seed set but also the effect of legume population increases due to reduced competition from annual grasses and capeweed. In the areas where pasture topping is used in continuous pasture for grazing, reductions in legume seed set may be offset in the following season by increased legume vigour and development due to reduced grass competition.

The majority of pasture topping use is expected to be in the last pasture year of the cereal crop–pasture ley rotation, and in this situation the effect of some reduction in legume seed set would be minimized by undersowing a pasture legume with the last crop in the rotation, a practice commonly used in most areas of southern Australia.

Pasture topping of annual weeds in pasture legume seed crops is not considered appropriate and is not recommended.

Conclusions

Pasture topping in the last year of pasture before cropping is a useful weed management technique for decreasing the level of viable seed and reducing the weed burden of capeweed and four major annual grass weeds in the following crop. Such an approach allows more timely sowing and effectively reduces in-crop infestations of these weeds, particularly where conservation tillage techniques of crop establishment are used.

Trial work has demonstrated that low rates of Roundup herbicide (300–450 mL ha^{-1}) applied in spring to annual ryegrass, brome grasses, barley grass and silver grasses in the early head to milky dough stages and to capeweed when flowering will effectively halt grass and capeweed development and reduce the level of viable seed set by these weeds. This technique is a management option that allows the reduction of an undesirable weed burden in the year prior to cropping. The integration of this technique with other crop herbicide programmes is recommended for general weed control.

The use of Roundup for pasture topping is a more flexible means than others currently available due to the relatively wide application timing possible and the translocated mode of action of glyphosate.