Herbicide techniques for thistle management

J.J. Dellow, NSW Agriculture, Co-operative Research Centre for Weed Management System, Agricultural Research and Veterinary Centre, Forest Road, Orange, New South Wales 2800, Australia.

Summary

The thistle species causing major problems in the farming and pastoral areas of New South Wales are saffron thistle (*Carthamus lanatus*), black/spear thistle (*Cirsium vulgare,* variegated thistle (*Silybum marianum*), scotch and Illyrian thistle (*Onopordum* spp.) and nodding thistle (*Carduus nutans* ssp. *nutans*). Many other species are causing more localized problems. St. Barnaby's thistle (*Centaurea solstitialis*) is appearing as a more widespread problem. Herbicides when used in isolation and not as part of an integrated control program have generally given ineffective long-term control. Herbicides integrated into cropping and perennial pasture improvement programs, livestock grazing strategies (spray-graze technique) and selective control in establishing and established pastures are all important considerations for long-term effective control.

Introduction

The thistle species which are considered to be most widespread and causing concern in pastoral, cropping and non-agricultural land of New South Wales are *Carthamus lanatus* (saffron), *Cirsium vulgare* (black/spear), *Silybum marianum* (variegated), *Onopordum acanthium* (scotch), *Onopordum illyricum* (Illyrian) and *Carduus nutans* spp. *nutans* (nodding). In their references on widespread and troublesome thistle species, Groves and Kaye (1989), Medd (1981) and Sindel (1991) also include *Carduus pycnocephalus* (slender) and *Carduus tenuiflorus* (winged slender).

The biology of each species also varies considerably from short-season annuals, annual/biennials through to biennials (Groves and Kaye 1989). The response to herbicide control appears, to some extent, to be attributable to the annual or biennial growth habit of the species. Biennial species such an *Onopordum* spp. appear to be much more difficult to control (Dellow unpublished).

The essential part of any effective control program is the integration of control options based on perennial and competitive pastures (Sindel 1991, Popay and Medd 1995). This paper discusses herbicide application, as part of an integrated control program, either at lethal levels or sub-lethal levels as part of a spray-graze program.

Herbicide use

In New South Wales there are herbicides registered for all the thistle species discussed in this paper (Dellow 1995). However, one of the major factors affecting the efficacy of a herbicide is the time of application which is greatly dependent on the biology of the species. Popay and Medd (1995) observed in the case of biennials such as *C. nutans*, that a single herbicide application in spring was more effective than an autumn application; because of winter vernalization. Plants emerging in spring would remain vegetative until adequately vernalized during the following winter. Herbicide trials carried out in the Oberon district (Milne 1996) in spring 1995 demonstrated the efficacy of the relatively 'soft' herbicide MCPA on *C. nutans*. The success of the control is attributed to correct time of spraying, favourable seasonal conditions and correct herbicide choice. It confirms research conducted by NSW Agriculture on the Central and Northern Tablelands since 1983. *O. acanthium* and *O. illyricum* behave in a similar manner to *C. nutans* (Groves and Kaye 1989) and consequently, if a single herbicide application was undertaken, then a spring application would be considered the best option.

Annual thistles are more seasonal than the biennials (Sindel 1991) and are best controlled by herbicides in autumn after germination has occurred. Efficacy of herbicide is likewise very dependent on the growth size of the plant, growing conditions and stress factors caused by insects or disease. Once plants have passed the rosette stage and are commencing to elongate they become much more difficult to control. The choice of herbicide and application rate is greatly dependent on the thistle species, the plant's growth stage, the composition of the companion pasture and the density of the thistle population (Dellow 1995). Herbicides which are least detrimental to the legume component of a pasture are generally the least effective for thistle control; particularly the strongly perennial species such as *Onopordum* spp. (Dellow unpublished).

The consequence of non target herbicide damage (to companion pasture) is a very important management consideration. A manager who has a difficult control option such as the control of *Onopordum* spp. must first consider the choice of perennial pasture species which will not only afford long term thistle competition and quality livestock forage, but will also possess the capability of withstanding damage from the less selective and more highly efficacious herbicides. Strongly perennial and persistent pasture species such as *Phalaris aquatica* are the essence of effective weed control programs; particularly for perennial weed species (Campbell and McDonald 1979).

The effect of herbicides on the non-target pasture species is an important management aspect which is often little considered. Whether herbicide applications are single or repeated applications over several seasons, there is little data to demonstrate the long term effect. Graziers who have often repeated applications of non-selective herbicides such as dicamba for the control of *C. nutans* often report the long term detrimental affect on the legume component of the pasture (Dellow unpublished).

Spray graze technique

The technique of applying sub-lethal applications of phenoxy herbicides such as MCPA, 2,4-D amine and 2, 4-DB amine in conjunction with heavy stocking rates of grazing livestock (sheep) has been a long accepted control method (Dellow 1995). The spray-graze technique is registered in New South Wales for control of *C. lanatus, C. vulgare, C. pycnocephalus, C. tenuiflorus* and *S. marianum*. By using this technique the subsequent non-target damage to the legume component of the pasture is minimized. The spray-graze technique often does not have as wide an acceptance as it deserves. Factors which had been detrimental to its more widespread acceptance are that sheep are the only effective livestock, very heavy stocking rates are necessary for short periods (8–10 times normal stocking rate and often paddock size is inadequate to manage such stocking rates), or insufficient livestock numbers are available.

The technique, like all long term control programs relies on the presence of a competitive pasture to replace the weed. Often the grazier does not either have a sufficiently competitive pasture or the managerial ability to both control the weed and manage the pasture. Anecdotal evidence suggests the spray-graze technique would be equally effective on *C. nutans* and *Onopordum* spp.

Spray topping

Spray topping is generally considered a 'salvage' operation using a 'knock-down herbicide' (paraquat) to destroy flower heads and hence prevent seed set of *C. lanatus.* The herbicide application is made after the thistle has bolted and is timed to coincide with 10% of the flowers just commencing to show yellow flower colour (Dellow 1995). Preliminary trial work (Milne personal communication) in central west New South Wales indicates the technique is also effective on *Centaurea solstitialis.*

Discussion

As with all weeds, any one technique for the control of thistles, such as herbicide application, is ineffective if not used with other techniques and management strategies in an integrated program. For several thistle species such as *C. vulgare* and *S. marianum*, herbicides used in an integrated program provide satisfactory control. However, for the biennial species such as *Onopordum* spp. the effectiveness of herbicide is wanting. For species such as *C. nutans*, trial work (Milne 1996) has shown that herbicides can be extremely successful if the correct rate and timing is observed.

The philosophy of integrated weed control is generally little understood by many graziers and to a lesser extent by agricultural extension personnel. Many control programs are often unsuccessful because one single technique, such as herbicide application is used in isolation without consideration of a long term integrated strategy. Biological control is another important aspect of thistle control (Woodburn and Briese 1996) which requires research to fit it into an overall control program.

References

Campbell, M.H. and McDonald, W.J. (1979). Replacing a nitrophilous weed association with *Phalaris aquatica* and *Medicago sativa* on non-arable land. *Australian Journal of Experimental Agriculture and Animal Husbandry* 19, 448-53.

Dellow, J.J. (1995). Weed control in Lucerne and Pastures 1995–96. NSW Agriculture booklet.

Groves, R.H. and Kaye, PE. (1989). Germination and phenology of seven introduced thistle species in southern Australia. *Australian Journal of Botany* 37, 351-9.

Medd, R.W. (1981). Distribution of some *Carduus, Cirsium, Onopordum* and *Silybum* species in New South Wales, Australia. Proceedings of the 8th Asian-Pacific Weed Science Society Conference, pp. 161-5.

Milne, B.R, (1996) Nodding thistle (*Carduus nutans*) control. NSW Agriculture Booklet, pp. 60-1.

Popay, A.I. and Medd, R.W. (1995) *Carduus nutans* L spp. *nutans. In* 'The Biology of Australian Weeds', Volume 1, eds. R.H. Groves, R.C.H. Shepherd and R.G. Richardson, p. 29. (R.G. and F.J. Richardson, Melbourne).

Sindel, B.M. (1991). A review of ecology and control of thistles in Australia. *Weeds Research* 31, 189-201.

Woodburn, T.L. and Briese, D.T. (1996). The contribution of biological control to the management of thistles. *Plant Protection Quarterly* 11, 250-3.

The relevance of variation in thistles to herbicidal control

J.R. Peirce, Agriculture Western Australia, 3 Baron-Hay Court, South Perth, Western Australia 6151, Australia.

Summary

Variation in thistles is the result of environmental, morphological and genetic factors. The success of any strategy for thistle control could depend on one or all of these factors and on the thistle species concerned. Seasonal rainfall and temperature patterns can have a significant bearing on the behaviour of many of the thistle species common to Australia. The intensity and frequency of rainfall events can markedly affect the emergence and establishment behaviour at the early part of the growing season and the amount and germinability of the seeds formed at the end of the season. The ability of some thistle species to form biennial and perennial plants that flower over a long period results in the production of large numbers of seeds. When these seeds germinate over an extended period in a single season, the seedlings pose a managerial problem and cause economic constraints through the cost of repeated herbicide or cultural treatments. In addition, the ability of thistles to produce seeds with the potential to remain dormant over several seasons adds to the cost of any control strategy. The presence of genetically distinct forms or 'ecotypes' in several of the thistles is well documented, but there have been very few studies of the responses of these forms to cultural and chemical treatments. Studies in future should consider the morphological and physiological features of the various thistles and investigate methods to improve herbicidal control without reduced production caused by damage to the infested pasture or crop.

Introduction

Research some years ago reported differential responses to 2,4-D of some ecotypes of Canada thistle *Cirsium arvense* (L.) Scop. from locations in North Western United States of America (Hodgson 1964). Although it was indicated that further investigations were to be initiated into herbicide responses, no reference to further work on this topic by that author has been found.

More recently intraspecific variation between populations of nodding thistles *Carduus nutans* L. ssp. *nutans* in the form of resistance to the phenoxy herbicides 2,4-D and MCPA has been reported from New Zealand by Harrington (1990) and Popay and Medd (1990). The resistant populations were deemed to be just as ecologically fit as the non tolerant populations. As a result of this, chemical control strategies had to be changed to apply herbicides that were more damaging to legume based pastures.

A review on ecology and control of thistles in Australia by Sindel (1991) mentions the variability within and between species but there were few references on the influence of this variability on control using herbicides. As a result of the limited information regarding the influence of variation within a thistle species on the success of herbicide treatments, much of this paper will deal with the obvious effects within and to a lesser extent between thistle species.

Morphological variation

Thistles can range in height from about 5 cm for stemless thistle *Onopordum acaulon* L. up to 180 cm for variegated thistle *Silybum marianum* J. Gaertn. (Parsons and Cuthbertson 1992). Variation in height either between or within a species poses a problem when applying herbicides by boom sprayers as the correct spray overlap cannot be achieved. This tends to lead to some strips being overdosed with chemicals while others receive sub lethal amounts. Additionally many of thistles are so tall that it is impossible to raise a conventional boom sprayer high enough to travel over the top of the infestation, and other methods for applying the chemical may be more appropriate.

The surface features of rosette and stem leaves and bracts surrounding the flowers could play an important part in herbicide retention and penetration. Evidence suggests that the droplet size has an important bearing on the amount of chemical taken in from various leaf surfaces (Hess *et al.* 1974). Small droplets are usually ineffective on very hairy plants because most of the droplets are retained on hairs with very little reaching the leaf surface. Larger droplets have a better chance of reaching the leaf surface of hairy plants because they shatter on the hairs, allowing some of the smaller droplets formed to contact the surface. The reverse can occur with smooth plant surfaces. Large droplets shatter and bounce or collect into larger deposits which can run off.

Translocated herbicides, such as glyphosate, 2,4-D or MCPA and contact herbicides such as diquat, paraquat and bromoxynil applied in small droplets (low