Recent advances in weed control in non-crop areas

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SUMMARY

Non-crop areas include roadsides, rights-of-way, aquatic situations, lawns, parks and industrial areas. Environmental, as well as economic constraints, have affected the vegetation management practices carried out in such areas in recent years. There has been increased emphasis on precision application techniques, and on the use of formulations to reduce effects on non-target organisms. There has been much re-evaluation of existing chemicals, perhaps because very few new chemicals useful in such areas have become available. One of the few is glyphosate, a herbicide of considerable value in non-crop situations. Also, some of the newer growth regulating chemicals appear promising.

INTRODUCTION

Non-crop areas where weeds may be a problem include roadsides, rights-of-way, aquatic situations, lawns, gardens, parks, golf courses and industrial sites. It is important to control weeds in such areas for aesthetic reasons, for safety and health reasons, to minimize maintenance costs and to prevent the spread of the weeds from non-crop areas into cropland. In some situations complete control (eradication) of all plant life in an area is desirable; in others, selective weed control is the objective. In the latter cases it is usual to use weed control methods that will allow desirable grasses to take over the area.

In recent years, environmental as well as economic constraints have affected the vegetation management practices carried out in non-crop areas. There has been increased emphasis on precision application techniques, and on the use of formulations that reduce the possibility of damaging non-target organisms. Aerial application of herbicides to many non-crop areas has continued to expand, partly because there has been greater availability of techniques that will reduce herbicide drift. Similarly, although restrictions have been placed on the application of chemicals into water in most countries, there has been an expansion in the use of herbicides to control aquatic vegetation. Mechanical methods of weed control have been modified to improve efficiency, notably in aquatic situations, for brush control, and on rights-of-way. Considerable research is being carried out on biological control methods with some success on perennial weeds and on aquatic vegetation.

Overall, there has been a definite increase in the use of an integrated approach to weed control to reduce possible adverse environmental effects from the repeated use of a single method. Also, an integrated approach is less costly, and possibly more effective, than chemical, mechanical or biological methods used alone.

Herbicides and plant growth regulators for non-crop vegetation management

In many areas, the older herbicides such as 2,4-D or 2,4,5-T, chlorates or borates, simazine or atrazine, monuron or diuron, amitrole or 2,2-DPA, paraquat or diquat, and the organic arsenicals are still used to give excellent vegetation control. Depending on the concentration used, and whether used in mixtures with other herbicides, either short term or long term control may be obtained (Klingman et al, 1975). Also, of course, mixtures of two or more of these herbicides may be designed to give control of specific weeds and grasses, or to give eradication of all vegetation.

The newer herbicides that have been used in non-crop areas include glyphosate, tebuthiuron, thiazfluron, ametryn, asulam, and fosamine. Also, certain plant growth regulators that are effective in retarding, rather than killing vegetation, have been used in recent years. A brief description of each of these new chemicals is given below.

Glyphosate (N-(phosphonomethyl) glycine) may prove to be one of the most important new chemicals developed during the past decade. Indeed, the total use of glyphosate in the next few years could be such that only atrazine and 2,4-D would exceed it (Stephenson, 1977). Its usefulness is related to the following properties:

(a) It is non-selectively toxic to most plants

(b) It readily penetrates plant foliage and moves symplastically to underground stems and roots

(c) There is little evidence of detoxification through metabolism in terrestrial plants, and

(d) It is rapidly inactivated on contact with soil by adsorption after which it is degraded by micro-organisms within a few to several months.

These properties allow it to be used to non-selectively kill existing weeds and vegetation just prior to seeding an area to a crop or other desired vegetation. As a directed spray it is becoming important in many horticultural crops such as orchards and vineyards. Its use is likely to be expanded to include perennial weed control on industrial land and railways (Sarfaty and Scherp, 1973), brush control under power lines, aerial applications for controlling hardwoods in conifer release programs, control of cattails and willows in drainage and irrigation ditches, and direct application to water for aquatic weed control in lakes and ponds. It could also become a major herbicide around the home for weed control in sidewalks and patios, under fences, adjacent to walls, and around trees (Hodkinson, 1975).

Most of the early research on glyphosate was related to its activity in perennial weeds and to its use in terrestrial situations. Because of its anticipated entrance into water via brush control and forestry uses, and its likely direct application for aquatic weed control, there has recently been more research on its possible effects on aquatic ecosystems (Folmar, 1977). Work of the type carried out by Comes et al, (1976) is particularly interesting. They sprayed the banks of dry irrigation canals in the fall, then measured the quantity of glyphosate in the irrigation water next spring.

They detected neither glyphosate nor the soil metabolite aminomethylphosphonic acid in the first flow of water through the canals, although they did detect both chemicals in soil samples collected the day before the canals were filled. When glyphosate was added to the water in two canals, they found more than half of the applied herbicide in the water 8.0 or 14.4 km downstream from the point of introduction. The authors concluded that some substances suspended or dissolved in the water may have been responsible for the loss by absorbing or interacting with the glyphosate.

Tank mixes of low rates of glyphosate with other herbicides have given a wider spectrum of broadleaf weed control in western Canada than glyphosate alone (Lindwall, 1977). However, reduced glyphosate activity was noted particularly at the lower rates (0.28 kg/ha) as a result of tank mixing additives or other herbicides. Hard water severely reduced or eliminated the effectiveness of glyphosate, and ammonium sulphate was found to enhance its activity - both with rates of glyphosate of 0.28 kg/ha or less.

Tebuthiuron (N-(5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea) is a non-selective herbicide used for long lasting total vegetation control. At low rates it may also be used for selective control in sugar cane and for controlling woody plants in pastures. It may be applied before or after weed emergence. It should not be applied to soil areas penetrated by the roots of desirable plants, or to areas where the chemical could move by washing with heavy rains or eroded soil into contact with desirable plants

Tebuthiuron formulated in 20% pellets has been widely tested for brush control. In most experiments the pellets were applied using a helicopter. Excellent control of several species of both hardwoods and softwoods was noted three years after treatment (McLaughlin, 1977). Brush control with tebuthiuron takes from a few months to three years depending on the rate of herbicide used, brush species present, rainfall, size of brush and time of application. The deep rooted species live longest after treatment. For total vegetation control, tebuthiuron formulated as a 5% pellet was slower acting than either a 5% granular or an 80% wettable powder formulation. However, all three formulations gave excellent control of perennial weeds and grasses. Grasses tend to recover quickly and fill in the treated area. Effects on grasses may be reduced by dormant season applications (Warner et al, 1977). Breakdown of the chemical in soil is mainly through microbial degradation.

Thiazfluron (N,N'-dimethyl-N'-(5-trifluoro methyl-1,3,4-thiadiazolyl-(2))-urea) is a non-selective, soil active, substituted urea herbicide. Its use and activity are similar to those of tebuthiuron.

Ametryn (2-ethylamino)-4-(isopropylamino-6-methylthio-S-triazine) is a contact herbicide that may be used on annual broadleaf weeds and grasses on non-cropland areas. It also may be used as a directed post emergence application in crops such as corn, sugar cane and bananas.

Asulam (methyl sulfanilylcarbamate) is translocated in the phloem of treated plants to meristematic areas. It is effective on perennial and annual grasses. It also may be used to control bracken when in full frond (Jackson, 1977).

Fosamine (ammonium ethyl carbamoylphosphonate) effectively controls a number of woody species including oaks, ash, hickory, maple and alder. Cedar and white spruce are tolerant. Pine can be controlled in spring if a surfactant is added. Thorough coverage is essential. Woody plants treated with fosamine die very slowly - sometimes woody stems may live two years or longer after treatment (Stephenson, 1977).

Triclorpyr (3,5,6-trichloro-2-pyridyloxyacetic acid) can be regarded as a chemical hybrid of 2,4,5-T and picloram. It is more active than picloram on some species of hardwood such as ash (*Fraxinus* spp.) and less active on conifers. It does not persist as long in the soil as picloram. Application as basal bark treatments in oil have been shown to be effective at 2 to 4 g/ℓ (Guggenmoos and Stephenson, 1977).

Plant growth regulators - Maleic hydrazide and chlorflurenol have been used either alone or in combination to retard the growth of grasses (and some broadleaf weeds) on roadsides, rights-of-way and in hard-to-mow areas of golf courses and in parks. Weed control may be enhanced by the addition of 2,4-D. Both these growth regulators are effective but bring about some discolouration of the desirable grasses. Thus, new compounds have been tested, with one - methafluoridamid - showing great promise (Makowski and Switzer, 1978; Switzer, 1977). At 0.5 kg/ha this chemical inhibited regrowth of bluegrass (*Poa pratensis* L.) and fescue (*Festuca rubra* L.) by more than 70% (in terms of dry weight) for over a month with only slight discolouration. Best results were obtained from early spring applications. Mixtures of methafluoridamid with 2,4-D and/or dicamba gave excellent broadleaf weed control as well as grass retardation. This chemical would seem to have considerable potential for future use around buildings, along fences and in hard-to-mow areas of golf courses, as well as on roadsides and ditch banks.

Brush control

The herbicide 2,4,5-T has been used widely in the past, either alone or in combination with 2,4-D, for effective control of brush growing on roadsides, rights-of-way, rangeland and in fence-rows (Klingman et al, 1975). Dicamba, fenoprop and picloram also are not effective. More recently tebuthiuron, karbutylate, triclopyr, thiazfluron and fosamine have been added to the list of herbicides effective on various species of woody plants.

There have been major improvements in machinery for brush control as well as developments in herbicides. Notably, rotary mowers that will cut brush up to 5 to 7 cm in diameter and 5 m in height are now being used. In the Canadian province of New Brunswick, a public utilities company is using these brush mowers in conjunction with pelletted picloram to avoid drift. Control using this technique has been adequate for a three year period (Stephenson, 1977).

In rangeland, burning may be more effective when coupled with the use of herbicides, as the herbicide opens up the canopy releasing fuel to facilitate the burning (Scifres and Merkle, 1975). Burning is carried out 18 to 24 months after aerial application of the herbicides.

Basal spray applications to brush have been used to help avoid drift and to get away from the unsightly appearance of roadsides and rights-of-ways that result from overall spraying of the foliage. The herbicide (usually 2,4-D/2,4,5-T or, more recently, trichlorpyr) is applied to the lower 1 m of the stems in an oil/surfactant mixture. Lower volumes are required than in overall spraying and the technique is particularly useful in situations where previous spraying has reduced the density of the brush. Also, spraying can be carried out at most times of the year, even in temperate areas.

Vegetation management

The philosophy of vegetation management on rights-of-way and roadsides has changed in recent years from one emphasizing total cutting by manual and/or mechanical means to selective cutting and selective control with herbicides. This change has been brought about because of the high cost of manual labour and the longer lasting control brought about by chemicals. However, since rights-of-way are relatively narrow and extend through many sensitive areas, the use of herbicides on such areas has frequently been the subject of public debate and controversy. This increased concern about environmental quality has led to increased emphasis on the accuracy of application and the use of techniques and formulations that reduce or eliminate damage to off-target organisms. For example, pelletted formulations of herbicides are now being applied to the centre of rights-of-way by fixed-wing aircraft, followed by application of liquid formulations to the edges by means of helicopters or by ground applicators (Allen, 1977). Soil applied chemicals in pelletted or granular form not only are safer from a drift standpoint but also extend the time of year that application can be made in comparison to foliar applications.

Greater use is now being made of non-residual herbicides on those areas where there is a possibility of run-off or erosion, and lower rates of the "soil sterilant" herbicides are now being used coupled with follow-up treatments to eliminate specific weed escapes.

Various spray additives have been developed in recent years to reduce the possibility of drift by increasing the viscosity or density of the spray (Stephenson et al, 1977). These additives are particularly useful for roadside spraying in areas where there are nearby susceptible crops. Examples of such chemicals registered in Canada are Bivert PH, Norbak-60, or Nalco-Trol (Ontario Ministry of Agriculture and Food, 1978). The use of these chemicals and appropriate sprayer nozzles has allowed an increase in sprayer vehicle speeds, and the use of lower volumes of spray material. Thus, total cost of spraying has been reduced.

Recent research in sprayer nozzle design has been aimed at the development of nozzles that produce uniform droplets large enough to limit spray drift and small enough to give good coverage. Low pressure fan nozzles have been developed which have internal metering orifices that reduce the pressure within the nozzle. The spray liquid is then discharged through a large elliptical orifice to form a flat fan spray pattern (Bouse, 1976).

Helicopters have been used more widely in recent years for application of herbicides to non-crop areas because of the greater placement precision possible. However, the high cost of helicopter operation still restricts their use to areas where the possibility of herbicide damage to adjacent crops is high. In other situations, fixed-wing aircraft fitted with applicators designed for either liquid or granular formulations of herbicides are satisfactory. Drift from fixed-wing aircraft application can be appreciably reduced if nozzles are used that produce large droplets and if a visco-elastic additive (such as Nalco-Trol) is used (Akesson and Yates, 1976).

Aquatic situations

There has been a considerable expansion in the use of herbicides and other methods to control unwanted vegetation in water and near water. Developments in chemicals include the use of slow release granular formulations, growth retardants, and new herbicides such as glyphosate, ametryn and chelated copper compounds. There has been increased emphasis on biological methods including the use of herbivorous fish, insects (for alligator weed (*Alternanthera philoxeroides* (Mart.) Griseb.) and water hyacinth (*Eichhornia crassipes* (Mart.) Solms) and replacement of nuisance species with more acceptable competitive species (MacKenzie, 1977). In general, an integrated approach to aquatic weed control seems to be gaining acceptance, and more thought is being given to the management of aquatic vegetation rather than eradication.

Control of emerged vegetation such as cattails (*Typha* spp.) *Phragmites* spp., water lilies (*Nymphaea* spp.), water hyacinth, and reed canarygrass (*Phalaris canariensis* L.) has been the subject of considerable research in recent years (Bambang et al, 1975; Mueller and Lembi, 1976; Riemer, 1976).

Herbicides such as glyphosate, ametryn, 2,2-DPA and paraquat have been found to be effective on the treated plants. Additional work is required on the effects of the use of such herbicides in the aquatic environment.

The mixing of herbicides with asphalt used to line irrigation ditches and canals is an interesting new development (MacKenzie, 1977). Similar mixtures have been tested for use on driveways, roadsides and around fenceposts to resist weed invasion (Gigax and Burnside, 1977). Bromacil and tebuthiuron were found suitable for mixing with asphalt for weed control along highways.

CONCLUSION

Many advances have been made in weed control in non-crop areas in recent years. New herbicides have been developed, application methods have been made more efficient, and considerable new knowledge about the problem weeds has been accumulated. Overall there has been an increased awareness and concern for changes in the environment that might be brought about during, and after, the weed control procedures.

Future advances will be affected by the ever increasing demands of society that there be no environmental hazards associated with the use of herbicides. Registration of new chemicals will become more difficult, particularly for non-crop weed control where the cost/benefit of herbicide application is not easily estimated. Also, data on which registrations are based may be more difficult to obtain in the future as there will be fewer weed scientists working on non-crop problems if there is a continuation of the recent shift in priorities toward crop oriented research.

REFERENCES

Akesson, N.B. and Yates, W.E. (1976).- Recent developments in the application of herbicides by aircraft. Weeds Today, Winter, 6-8.

Allen, B.M. (1977).- Personal communication. Ontario Hydro, Totonto.

Bambang, Guritno and Pheang, C.T. (1975).- Response of water hyacinth (*Eichhornia crassipes*) and *Salvinia molesta* D.S. Mitchell to ametryn, paraquat and glyphosate. *Proceedings 3rd Indonesian Weed Sci. Conf.* 315-327.

Bouse, L.F. (1976).- Select spray nozzles to minimize herbicide drift. Weeds Today, Winter, 11-13.

Comes, R.D., Bruns, V.F. and Kelley, A.D. (1976).- Residues and persistence of glyphosate in irrigation water. *Weed Sci.* 24 : 47-50.

Folmar, L.C. (1977).- The toxicity of glyphosate to aquatic fauna. Abstr. Weed Sci. Soc. Am., 63.

Gigax, D.R. and Burnside, O.C. (1977).- Herbicide phytotoxicity, movement and persistence in asphalt. *Weed Sci.* 25 : 426-430.

Guggenmoos, S. and Stephenson, G.R. (1977).- Evaluation of various auxin herbicides as basal treatments in oil for brush control. Res. Rep. Canada Weed Committee, East. Sect. 247-248.

Hodkinson, H.D. (1975).- The use of glyphosate salt for weed control in amenity and non-crop areas. *Proceedings 12th British Weed Cont. Conf., Brighton,* 1974, 1003-1013.

Jackson, L.P. (1977).- Asulam for control of bracken fern. Res. Rep. Canada Weed Committee, East. Sect. 235.

Klingman, G.C., Ashton, F.M. and Noordhoff, L.J. (1975).- Weed Science : Principles and Practices. John Wiley and Sons Inc., New York, pp 431.

Lindwall, C.W. (1977).- Control of weeds on summerfallow. Res. Rep. Canada Weed Committee, West. Sect. 215.

MacKenzie, D.L. (1977).- Personal communication. Ontario Ministry of the Environment, Toronto.

Makowski, E.J. and Switzer, C.M. (1978).- Effects on methafluoridamid on turfgrass. Abstr. Weed Sci. Soc. Am., Dallas, Texas.

McLaughlin, M.F. (1977).- Tebuthiuron 20% pellets for brush control. Res. Rep. Canada Weed Committee, West. Sect. 252.

Mueller, M.R. and Lembi, C.A. (1976).- Herbicide treatments for cattails, spatterdock and reed canarygrass. *Proceedings N. Cent. Weed Cont. Conf.* 30 : 169.

Ontario Ministry of Agriculture and Food (1978).- Guide to Chemical Weed Control. O.M.A.F. Publication 75, pp 103.

Riemer, D.M. (1976).- Long term effects of glyphosate applications to *Phragmites*. *Jnl. of Aquatic Plant Management*, 39-43.

Sarfaty, A.B. and Scherp, L.A. (1973).- Preliminary investigations in Australia and New Zealand with the mono (isopropylamine) salt of glyphosate. *Proceedings 4th Asian-Pacific Weed Sci. Soc. Conf.* , *Rotorua*, 209-214.

Scifres, C.J. and Merkle, M.G. (1975).- Herbicides and good management improves range pastures. Weeds Today, Spring, 5-7.

Stephenson, G.R. (1977).- Personal communication. Department of Environmental Biology, University of Guelph.

Stephenson, G.R., Pelly, E., Desai, P.D. and Curtis, L.R. (1977).- Evaluation of Nalco-Trol and Bivert TDN for reducing herbicidal drift in roadside spraying. Abstr. Weed Sci. Soc. Am., 59.

Switzer, C.M. (1977).- The use of growth regulating chemicals in turf. Abstr. III International Turfgrass Soc. Conf., Munich, Germany, pp 86.

Warner, L.C., Bjerregaard, R.S., McNeill, K.E. and Keaton, J.A. (1977)- Tebuthiuron for rangeland brush control. Abstr. Weed Sci. Soc. Am., 54.