

The Use of Herbicides in Irish State Forests

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ABSTRACT

A brief account is given on the history of the use of herbicides in State forests. The differentiation into contact, translocated and residual herbicides is explained. This is followed by a description of the attributes of the main herbicides and quantities presently being used by the Forest and Wildlife Service and their recommended rates of use. The types of applicators used are also referred to.

INTRODUCTION

Weed control is a fundamental requirement of forest plantation establishment. The control or removal of competing plants is essential to favour the survival, health and growth of young trees. Weeds compete with the crop for light, nutrients and moisture. Later in the crop's life certain weeds, namely rhododendron and laurel, if left uncontrolled, cause problems of accessibility and increase the cost of all silvicultural operations. High costs in establishing plantations cause a severe reduction in overall profitability or net discounted revenue of the crop. Herbicides, when applied correctly, provide cheap and effective control of competing vegetation and thus their increasing popularity both in the public and private forestry sectors.

HISTORICAL

From about the mid 1950s ploughing for cultivation, drainage and weed suppression was common practise. Planting on cultivated bare ribbons encouraged quick establishment of trees. This in turn reduced the need for extensive weed control. Prior to the early 1960s weed control problems were dealt with manually using hooks with some control being carried out mechanically. However, certain vegetation types such as rhododendron (*Rhododendron ponticum* L.) and furze (*Ulex europaeus* L.) were troublesome and expensive to control. Following the introduction of GRAMOXONE (paraquat) a campaign to control furze was undertaken. Subsequently GRAMOXONE was used to control grasses and herbaceous weeds. It was also used to control heather

(*Calluna vulgaris* (L.) Hull) in Sitka spruce crops (*Picea sitchensis* (Bong.) Carr) which had gone into "check" i.e. a state of growth stagnation. GRAMOXONE was tested against rhododendron but because it was a contact herbicide it only defoliated the branches without having any effect on the root system. The big breakthrough for the control of rhododendron did not come until the introduction of 2,4,5-T in 1972. This herbicide gave excellent control of this species and was used extensively for the following nine years. However, it was withdrawn from use by the Forest and Wildlife Service in 1980 because of public unease about its possible side effects. It was superseded by the herbicide ROUNDUP. Other herbicides, both liquid and granular were tested during the 1970s, the more successful being 2,4-D for control of heather and ASULOX for the control of bracken (*Pteridium aquilinum* (L.) Kuhn). Granular herbicides did not come into favour for two main reasons: the unavailability of an applicator which would give an even spread of granules and as a result increased mortality of young transplants due to too high doses accumulating around some of the trees.

TYPES OF HERBICIDES

It is useful at this stage to make some general differentiations between the various herbicides. They can be divided into three main groups:

contact	}	applied to foliage
translocated		
residual		applied to soil

A *contact* herbicide affects or kills only that part of the plant's foliage to which it is directly applied. It does not have any lasting or residual effect in the ground as it is strongly adsorbed onto soil particles. The herbicide will therefore have no effect on deep rooted/rhizomatous plants e.g. GRAMOXONE is such a herbicide.

A *translocated* herbicide is one which when it is absorbed by a plant's foliage is conveyed within the plant to both its shoots and roots. Once part of the plant receives a sufficient dose of herbicide the rest of the plant will succumb. Some of these herbicides can be taken up by plant roots. A number of others, for example ROUNDUP, have no soil activity whatsoever.

A *residual* herbicide is one which when washed into the surface layers of soil is taken up by plant roots and by subsequent germinating weed seeds. Effective for a period of months, the herbicide will kill existing vegetation and keep the area weed free for a period of time, e.g. GARDOPRIM 500FW, ATRAFLOW. These herbicides have low water solubility and also a tendency to adhere to soil particles, which results in very little leaching down through the soil or laterally into watercourses. Where the soil is a peat or has a layer of peat on it, residual herbicides are more strongly adsorbed by the peat and therefore higher dose rates may be needed.

It should be noted that a herbicide may not fall distinctly into one or other of the above groups i.e. the herbicide may have both systemic and residual properties.

The main herbicides presently used by the Forest and Wildlife Service are:

Trade Name	Chemical Name	Vegetation Controlled
ATRAFLOW (50% w/v atrazine)	Atrazine	Soft grasses/rushes annual broadleaved weeds
GARDOPRIM 500FW (50% w/v terbutylazine)	Terbutylazine	Soft grasses/rushes annual broadleaved weeds
ROUNDUP (36% w/v glyphosate)	Glyphosate	Almost all weed species
SILVAPRON D (40% w/v 2,4-D)	2,4-D	Heather
ASULOX (40% w/v asulam)	Asulam	Bracken

CHARACTERISTICS OF INDIVIDUAL HERBICIDES

ATRAFLOW (Atrazine)

This herbicide gives effective control of grass/rush vegetation for one growing season and sometimes retards the growth of weeds into the second year. The herbicide is mainly residual—it is taken up via the roots but some foliar uptake can occur. Thus the vegetation need not have grown very much at the time of spray application. If rain occurs soon after spraying there should be no loss of herbicide

effectiveness. It can be applied as a pre or post-planting spray to all conifers before bud break — it leads to some scorching of the new foilage after this time and is thus not recommended for spraying during the growing season. Broadleaved tree species can only be treated during dormancy.

GARDOPRIM 500FW (Terbuthylazine)

This herbicide is closely related to ATRAFLOW. Its properties therefore are similar, the main difference being that:

- (1) all of the commercially grown conifers species can be over-sprayed at any time of the year i.e. during the dormant and growing seasons. It can thus be over-sprayed on many ATRAFLOW sensitive species.
- (2) it is even less water soluble than ATRAFLOW and thus less likely to leach into ground water and/or into streams and rivers.

GARDOPRIM is particularly useful in that a forester with a potential grass or grass/rush problem in his coniferous tree crop, can decide during the growing season whether an application of this herbicide is needed or not.

ROUNDUP (Glyphosate)

This is a translocated herbicide which controls a very broad spectrum of weed species. The herbicide is taken in through the foliage and conveyed around the plant by its vascular system.

Therefore it works best when the vegetation is at its most active growth, before flowering and when the weather is warm and there is adequate soil moisture. If spraying is done during a period of prolonged drought the effectiveness of the herbicide will be significantly reduced. ROUNDUP when applied with water only, needs a rain free period of at least 6 hours and preferably 24 hours to be absorbed fully by the plant. It appears that the use of additional surfactants or additives can enhance the rainfastness and/or efficacy of this herbicide. One of the products showing particular promise is called 'Mixture B'. (Tabbush; Turner; Sale, 1986). ROUNDUP has minimal soil activity.

ROUNDUP is primarily a herbicide for use in preplanting situations. For instance on a reforestation site containing mixed habaceous and woody weed species it should be sprayed in the summer prior to planting. The site will probably be re-invaded with grasses the following spring but that vegetation can be dealt with by other herbicides either pre or post-planting.

As a post-planting treatment in conifers it can be used only when trees are protected from the spray, or in the dormant season between hardening off of the leader growth in autumn and the start

of bud swell the following spring. However, in the latter situation the vegetation may be too dormant to be effectively treated.

ROUNDUP is not metabolised by plant tissue. However, on contact with the soil it is strongly adsorbed to soil particles and therefore is relatively immobile in the soil — thus it cannot be taken up by plant roots. This strong adsorption means that runoff into streams is almost negligible. The herbicide is rapidly biodegraded by soils and water micro-organisms into natural products i.e. carbon dioxide, water, nitrogen and phosphorus.

SILVAPRON D(2,4-D)

This herbicide has been used for a number of years to kill heather in checked Sitka spruce plantations. Uptake of 2,4-D by plants occurs through leaves, stems and roots. It is transferred within the plant to regions of growth where it interferes with normal growth processes. Plants metabolise, 2,4-D readily to various degradation products.

In soil, the herbicide generally has a short persistence (one month or less). It tends to be mobile and is primarily degraded by microbial activity. Similarly in streams or rivers it is again degraded by micro-organisms which, along with dilution, is the major means for its loss of activity in aquatic systems.

Research Branch of the Forest and Wildlife Service has been recommending since 1983 that the application of nitrogen at the rate of 434kg urea or 727kg calcium ammonium nitrate per hectare to checked Sitka spruce is a far more cost effective and beneficial method of releasing the spruce than applying 2,4-D (Griffin; Carey; McCarthy, 1984).

It should be remembered that the problem of spruce in 'check' can be caused also by a lack of phosphorus in the soil or the uneven application of phosphate at planting. In such a situation the application of either 2,4-D, or nitrogen, or both, will be of little benefit unless the phosphate is applied beforehand. One can recognise phosphorus deficiency in a plantation by the trees being stunted but with obvious leaders, the needles are short and dull green. The crop will also probably be uneven in height. The problem of phosphorus deficiency can be overcome by applying 350kg of rock phosphate/ha.

ASULOX (Asulam)

This is another translocated herbicide which is absorbed primarily by a plant's foliage although it can have appreciable activity through the soil. It is used to control bracken infested sites. It should, where possible, be applied in the summer prior to

planting because its effects are not apparent until the following spring — after spraying the bracken in July it will die down in its normal fashion in autumn, but in the following spring only 10 per cent of the previous year's number of fronds will emerge. After 4 to 5 years the bracken will have fully re-established itself. However, the trees should be adequately established at that stage. If a tree crop has been planted it can be oversprayed with ASULOX with very slight or negligible damage to the trees; the bracken canopy will usually prevent the herbicide from reaching the underlying crop. However Western hemlock and willows are sensitive to ASULOX and therefore should not be sprayed. The persistence of the herbicide in the soil is short as it is rapidly degraded by micro-organisms. Also it has low water solubility and therefore leaching into streams is not a problem.

TRENDS IN HERBICIDE USAGE

Table 1 below gives the quantities of herbicides used to service the needs of forest management over the past four years.

Table 1: Quantities (in litres) of the main herbicides used by Forest Management during the period 1983-1986.

Herbicide	Year			
	1983	1984	1985	1986
ATRAFLOW	2,553	1,655	8,046	12,670
GARDOPRIM 500FW*	—	—	7,185	20,082
ROUNDUP	5,996	5,145	3,060	7,150
SILVAPRON D	2,223	45	990	2,140
ASULOX	812	1,225	970	1,725

Total cost of all herbicides purchased in 1986 = £297,006.

*Herbicide tested in Research Trials (Forest and Wildlife Service) in 1983 and 1984.

Source: Supplies Section, Forest and Wildlife Service.

While the trends are somewhat erratic, possibly due to herbicides being held over from one year into the next, there has been a very significant increase in the use of residual herbicides i.e. ATRAFLOW and GARDOPRIM 500FW over the past two years; they are particularly suited to forestry because they control the grass or grass/rush type vegetation for the full (growing) season.

ROUNDUP, because of its ability to control such a broad spectrum of weeds, has maintained its high profile among the herbicides and is likely to continue to do so because of the rapidly increasing amount of land for reforestation. While the use of ASULOX is likely to increase somewhat, it will mainly be limited to afforestation sites; on reforestation sites with bracken in mixture with other weeds ROUNDUP would be required. The use of SILVAPRON D is expected to fall off because it is not as cost effective as applying nitrogen to release checked spruce crops.

STORAGE

In general it is preferable to use herbicides in the year of purchase. If they have to be held over into the following year they should be stored in a dark frost free shed.

OPERATOR SAFETY

The operator should wear the following items when handling the concentrate or during spraying of herbicide:

- specialised spraying suit
- faceshield
- mist respirator mask
- protective gloves
- rubber boots

He should have access to an adequate supply of clean water — so that he can wash his hands before smoking or before having a meal. Water should be available for washing when the spraying is done. Also water is needed to wash off any of the herbicides if they accidentally splash onto the skin or into the eyes of the operator.

MAMMALIAN TOXICITY

Atrazine (ATRAFLOW), terbutylazine (GARDOPRIM 500FW), Glyphosate (ROUNDUP), Asulam (ASULOX), are rated in the lowest mammalian toxicity class while 2,4-D (SILVAPRON D) falls into the second lowest class (Anon 1982). However Silvapron D, at the concentrations encountered in forests, has virtually no effect on most birds, fish, insects and soil organisms (Turner 1977). In practical terms the herbicides used at present are very safe in respect to man and the environment.

HERBICIDE APPLICATORS

Knapsack sprayer

This has been the traditional applicator used by the Forest and Wildlife Service. High volumes of water are used when applying

Table 2: Recommended Rates of Application of Herbicides

Vegetation Type	Herbicide	Time of Application	Spot (1.3m diam.)	Litres/Treated ha. Band (1.2m width)	Overall
Grass/Rush	ATRAFLOW	Feb. — Prior to bud break	} 5.3	9.6	16
	GARDOPRIM 500FW	February — July			
Herbaceous Broad-leaved Weeds	ROUNDUP	June - July Before flowering	—	—	3.0
Bracken	ASULAM	July - August	—	—	7.0 + 3.0 of surfactant oil (no water required)
	ROUNDUP	July - August	—	—	2.0
Heather	SILVAPRON D	July - August	—	—	12.5 (No water required)
Woody Weeds	ROUNDUP	June - August	—	—	4.0
Rhododendron	ROUNDUP	June - August pre-planting. March - April September - November post-planting.	A concentration rather than a rate per ha is recommended i.e. 1 litre of herbicide to 2 litres of water using Micron Herbi/Ulva 8 sprayer. Therefore with a full cover of rhododendron at 1 metre high approximately 10 L of herbicide would be required.		

Notes:

ATRAFLOW
&
GARDOPRIM
500FW

On a site where there is a heavy mat of dead vegetation or moss, or lop-and-top from previous harvesting, this residual herbicide should be applied using a minimum of 100 litres total mixture (herbicide plus water) per treated hectare. The reason for the increased amount of water is to get the herbicides to their site of action i.e the soil. Where the site does not present the above constraints the herbicide can be applied using the hand-held Micron Herbi/Birky/Knapsack sprayer with a very low volume nozzle, using 1 part herbicide to 2 parts water.

ROUNDUP

Normally applied as an overall spray, with water. When using Micron Ulva 8 usually made up to 10 litres total mixture per hectare, and 40 litres when using the Micron Herbi. For conventional hydraulic sprayers a water volume of between 80-250 l/ha is recommended.

herbicides at 500 litres per hectare (1/ha). Recently, very low volume (VLV) nozzles were introduced which fit standard knapsacks and reduce the total volume output per hectare to 32, 64 and 126 litres for the VLV 50, 100, 200 nozzles respectively. Thus the knapsack is a versatile applicator and can be used for spot, band and overall spraying.

Micron Herbi and Micron Ulva 8

These applicators were first tested by Research Branch of the Forest and Wildlife Service in 1976. Since then, they have become quite popular because of the very low volumes necessary to apply per hectare and also the lightness of the machines. Both have spinning discs which produce a very fine spray — the discs are powered by eight HP2 batteries.

The Herbi is generally used for band spraying of residual herbicides (along tree rows) using total volumes of 20 to 30 litres per hectare. It produces a swath width of 1.2 metres. The applicator is also used for overall spraying at volumes of 40 l/ha.

The Ulva 8 is used for incremental drift spraying of bracken, woody and herbaceous vegetation. Paths are made in the vegetation at right angles to the prevailing wind direction and at between 3 and 5 metres apart. The operator then traverses the paths holding the head of the machine high above the vegetation and uses a light wind to drift the spray back over it. The total volume normally applied is 10 l/ha.

Birky

This recently introduced applicator has characteristics of both the knapsack and the Micron machines. It has a pneumatically driven disc which produces a very fine spray — no batteries are required as the air pump is operated by a hand lever. The tank capacity is 5 litres and it produces a swath width of 1.6 metres.

Spot Gun

This is a modified version of the veterinary drench gun. It applies a precise dose of up to 20 millilitres to each spot to be treated; the tank holds 5 litres. It is particularly suited to applying residual herbicides to the area immediately around planted trees. It can be further modified, using a plastic hollow cone to protect young trees, so as to enable the forester to apply certain non-selective herbicides which could not be otherwise applied during the growing season. The spot gun is very economical with regard to herbicide as it gives out the accurate dosage required per hectare.

Boom Sprayer

Since 1985 the Forest and Wildlife Service has purchased 3 boom sprayer units; two of them are tractor mounted, the other was designed to fit onto the carriage of a Bruunett forwarder. All the units are fitted with Micron 'Micromax' spray heads which allow for effective application of translocated herbicides in small volumes i.e. 40 l/ha. One of the units has been modified to incorporate the conventional hydraulic spraying system which is generally more appropriate when applying residual herbicides. The length of boom is limited to around 9 metres because of the swaying that occurs when machines are traversing ditches, drains, tree stumps, and lop-and-top. The units are of great benefit in treating, both quickly and evenly, large areas of afforestation and reforestation sites, providing the terrain is not too rough. However it is important that the vegetation be at the correct stage of development and that weather conditions are suitable.

CONCLUSIONS

The use of herbicides is likely to increase significantly in the Forest and Wildlife Service over the next decade because of their cost effectiveness. On a typical grass/rush site type applying a residual herbicide by spot treatment costs £46/ha inclusive of labour — with manual control this figure would be between £125 to £190. Manually cleaning a bracken site would cost in the region of £250/ha and this would need to be repeated for a number of years. Controlling bracken chemically would involve one spraying and cost £130. On good fertile sites where woody weeds are a problem the cost of manual cleaning each year can reach over £300 and the operation may need to be repeated for three to five years. Such areas can be treated with herbicide pre-planting for £147 but may need one follow-up treatment with residual herbicide costing £46.

Which system, manual or herbicidal, would you choose?

Mention of product or sprayer by name does not imply endorsement by the Forest and Wildlife Service of any product or sprayer to the exclusion of others which may be suitable.

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