Wild Lowbush Blueberry IPM

Weed Management Guide

New Nouveau Brunswick CANADA

Agriculture, Fisheries and Aquaculture

Agriculture, Pêches et Aquaculture

IPM

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(2005)

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INTRODUCTION

The weed flora in blueberry fields is unique compared to that found in other agricultural fields. Producers manage a native perennial crop that grows in low pH soils where there is neither associated tillage nor cultivation. Weeds which prefer low pH soils and the same habitat as blueberries thrive if not controlled. These weeds can shade and compete with the crop, reduce bud/flower production and yield, reduce quality and can interfere with harvesting.

The origins of a field often determines the weed flora. Fields developed from abandoned hayfields or pastures typically have a large number of grasses and herbaceous perennial weeds. Fields developed from woodland, however, often have plants commonly associated with the woodland undergrowth such as bunchberry, ferns, lambkill, rhodora, and other woody plants and shrubs.

A year 2000 weed survey recorded more than 250 species in blueberry fields, compared to only 115 species from a 1985 survey. Many traditional woody weeds have decreased due to herbicide use, but this has been off-set by greater numbers and incidences of other weeds, particularly herbaceous annuals and perennials. Not all are considered weedy but some like lamb's-quarters, sow-thistles, goat's-beard and herbicide resistant fescue grasses, have the potential of becoming major problems.

This change in weedy vegetation resulted from herbicide use, especially hexazinone (Velpar/Pronone). Other contributing factors have been changes in production practices that allow weeds to spread and thrive, such as, the increased use of fertilizers, shift towards mowing from burning, and the use of mechanical harvesters and other equipment that spreads weeds.

In the future, growers can expect an increasingly diverse weed flora. Few new herbicides are likely to be introduced. Thus, it is important to understand the activity and limitations of available herbicides and to use herbicides in conjunction with other practices to manage weeds.

A blueberry weed management program should follow the principles of Integrated Pest Management (IPM). IPM is a pest management strategy that integrates preventive, cultural, mechanical, biological and chemical control methods to achieve a sustainable production system that balances economic, health and environmental concerns. IPM is based on dynamic principles rather than a definitive set of rules and can vary from farm-to-farm or even from field-to-field.

A weed management program that follows the principles and practices of IPM is often referred to as an integrated weed management (IWM) program.

COMPONENTS OF AN INTEGRATED WEED MANAGEMENT PROGRAM

I. WEED IDENTIFICATION AND BIOLOGY

When planning a weed management program, blueberry producers must first be able to identify the weeds present in each of their fields. It is also important to know the life cycle of the weeds in order to understand their reproductive strategy and how best to approach their control.

Based on life cycle, weeds within wild blueberry fields can be categorized as annuals, biennials or perennials. Additionally, flowering plants can be broadly classified as dicots (broadleaves) and monocots. There are also primitive plants that do not produce flowers. Plants can also be grouped into herbaceous (non-woody) and woody species. Knowing how plants are classified or grouped helps to understand similarities and differences between them.

A) Annuals

Annuals reproduce only by seed and complete their life cycle in less than one year. Most annuals found in lowbush blueberry fields are **summer annuals** that germinate in the spring, produce flowers and seed and die in late summer or fall. These include such weeds as lamb's-quarters, hemp-nettle, cow-wheat and grasses like witch grass.

There are also a few **winter annuals** found in blueberry fields. Winter annuals germinate in the fall, over-winter in a seedling or rosette stage and produces flowers and seeds the following summer and then dies. Winter annuals include such weeds as chickweed and Canada fleabane. Annuals are becoming increasingly common in blueberry fields. They grow rapidly, produce large amounts of seed and require control in both the prune and crop year. Control methods must focus on preventing annuals from producing and dropping seed.

B) Biennials

Biennials complete their life cycle in two years. They produce a low-growing rosette of basal leaves with a taproot that over-winters. Biennials 'bolt' to produce a flowering stalk, set seed and die in the second year. Examples include evening primrose, wild carrot and goat's-beard. Biennials are also becoming increasingly common.

C) Perennials

Perennial weeds live for more than two years. These weeds are the most common in blueberry fields and generally the most difficult to control. They can be either herbaceous or woody.

Perennial weeds may reproduce primarily by seed (daisy); by both seed and rootstocks (sheep sorrel); or primarily by vegetative means (bunchberry). Many perennial weeds grow in the same manner as the blueberry plant. Therefore, some of the production practices that promote blueberry growth (e.g. pruning) also promote these weeds. Perennials which are low growing and spread vegetatively by interconnected underground root systems are the most difficult to control and cannot be controlled by hand-weeding. Some perennials can be controlled with selective or non selective herbicides, but for many, there are no satisfactory controls.

D) Flowering plants

Flowering plants produce seed and can be divided into broadleaved species or **dicots** (with two seed leaves) and **monocots** (with one seed leaf). Dicot leaves have a branching network of veins and flowers with petals, although these can be inconspicuous (alders, lamb's-quarters). Monocots have leaves with parallel veins. With the exception of lilies and related plants, monocots have flowering heads of many small, reduced flowers (or florets) without petals that produce a single seed**.**

Monocots include:

- **grasses** – annuals or perennials with jointed stems that are usually hollow and round in cross section;
- **sedges** – usually perennial plants that form tussocks with leaves that are V-shaped and stems that are triangular in cross section;
- **rushes** – annuals and perennials with tussocks of needle-like leaves that are round, jointless and hollow in cross section.

E) Non-flowering plants.

There are also primitive, non-flowering plants that reproduce by microscopic spores that include ferns, horsetails and mosses. Ferns (with stalks and fronds) and horsetails (with narrow leaves in whorls at joints of hollow stems) spread by underground rhizomes and are difficult to control. Mosses are tolerant to all herbicides but may be suppressed by fire.

Most weed guides do not include many of the important blueberry weeds. One excellent illustrated publication for identification of blueberry weeds is:

Weeds of Eastern Canadian Blueberry Fields by M.G. Sampson, K.V. McCully and D.L. Sampson. NSAC Bookstore, Truro, N.S. 229 pp.

II. SCOUTING AND WEED MAPPING

Scouting and proper weed identification go hand-in-hand and are the foundation of any integrated weed management program.

Scouting involves walking your blueberry field(s) in a pattern (e.g. "W" pattern) thereby allowing you to monitor for potential weed problems over the entire field(s). Scouting also provides an opportunity to evaluate your weed control program, and to look for any herbicide injury.

Mapping the fields for weeds from year-to-year is helpful in monitoring changes in weed species, weed densities, and distribution, as well as, providing an opportunity to plan your future weed control strategy. Scouting also provides an opportunity to identify and target new invasive weed species that have the potential to become serious weed problems in the future. The management strategy must target the dominant weeds and prevent the spread of others.

The following should be documented when scouting and mapping:

- ***the weed species and its life cycle*** (annual, biennial, perennial).
- ***the size or growth stage of the weed*** (seedling, small, medium, large, flowering, seed formed, seed dropped).
- ***the density of the weed*** (counts or categorize as low, medium, high).
- ***the distribution*** (uncommon, scattered throughout, a few patches, numerous patches, common throughout; or estimate the percent blueberry field covered per weed).
- ***the location of the weed infestations on a field map.***
- ***the date of scouting.***

Weed scouting in **sprout fields** should be done:

I. just before blueberry emergence to monitor for bunchberry presence and growth stage;
II. soon after blueberry emergence to monitor for potential grass problems;
III. late June - early July for weeds growing above the blueberry plants that would be susceptible to wiping treatments;
IV. late summer-early fall for wiping and evaluating the current year's weed control program and also for planning next year's weed control program.

Weed scouting in **crop fields** should be done:

I. before blueberry buds swell if fruiting year Velpar applications are required;
II. mid-May to mid-June to scout for grasses;
III. mid-July to harvest to determine presence, densities and location of weeds for fall treatments or next year's weed control program.

Special note should be made of any new weeds not previously observed and of weeds that appear to be increasing significantly in distribution and density. Weeds which may be undesirable for reasons other than competition should also be noted (e.g. weeds flowering during pollination, weeds known as alternate hosts for insects or diseases, or weeds which can interfere with harvesting).

III. WEED THRESHOLDS AND ACTION LEVELS

Thresholds have not been determined for weeds growing in New Brunswick blueberry fields. As a result, the decision to target a weed for control must be based on knowledge of the weed within your farming system. From a strictly economic perspective, there is no reason to apply control measures unless the weed population inflicts crop damage greater than the cost of the control measure. To make knowledgeable decisions, growers must scout and monitor their fields and continuously observe weeds and evaluate their effect on the crop.

Sometimes decisions to control weeds may be made even when the cost of control is greater than the losses resulting from weed competition. For example, weeds may have to be controlled despite low densities when they interfere with harvest, act as alternate hosts for insect pests or diseases, attract bees during pollination, or if they have a high potential to cause future problems if not controlled.

IV. CONTROL METHODS

With the information gathered through scouting and the knowledge about the weeds present in your fields, you can make the decision as to whether or not a weed should be targeted for control. If action is warranted, it is important to choose the methods that optimize costs and effectiveness, while minimizing potential adverse effects. The most economical and effective blueberry weed management programs combine preventive, biological, cultural, mechanical and chemical practices.

A) Preventive

Preventive weed control includes all practices that prevent the introduction and spread of weeds into a blueberry field. It is therefore important to be aware of activities which can introduce new weeds and try to prevent them from being introduced. This will help minimize the buildup and spread of new weed introductions.

An important preventive practice is to clean equipment between fields. This is important as weed seeds and other plant parts can attach to equipment and soil and be transported by farm equipment. This is a particular problem with mowers, wipers and harvesters. Tractors and land leveling equipment should also be cleaned.

Preventing seed production will also help prevent

weeds from spreading. Keeping weeds under control in ditches, field edges, and roadsides can minimize the introduction of new problem weeds.

Weeds can also be introduced into blueberry fields through the use of weedy straw used for burning. It is critical that growers obtain as weed-free straw as possible. Purchase straw from a reputable source and, if possible, visit the grain field before harvest to check for weeds.

B) Cultural

Cultural practices that encourage a vigorous, dense and healthy crop contributes to reducing weed pressures as a result of less bare ground being exposed. The use of wood chips, sawdust or bark mulch can reduce weed problems and encourage clone expansion into bare areas. Bare areas can also be planted with blueberry plants to increase crop cover. The presence of some grasses, especially in bare spots, reduces invasion of broadleaved weeds and encourages blueberry expansion. Excessive fertilizer rates that promote weed growth and vigour should be avoided.

C) Biological

Biological weed control is the deliberate use of highly selective enemies to reduce the population of a target weed to an acceptable level. In Atlantic Canada, there have been releases of either insects or pathogens against some weed species, e.g. St. John's wort, Canada thistle, perennial sowthistle, toadflax, and several others. However, biological control is generally most effective on introduced, non-native species in relatively undisturbed, pesticide-free agricultural habitats, e.g. pastures and rangelands. Therefore, the prospects for biological weed control in lowbush blueberry is limited, although naturally occurring disease epidemics have been observed to give significant control of some weeds in some years, e.g. St. John's wort and bracken fern. The use of insecticides and fungicides within blueberry fields also makes the use of insects and pathogens as biological control agents more challenging.

D) Mechanical

Mechanical methods of weed control include such practices as hand-pulling, pruning (mowing/burn) and clipping.

1. *Hand-pulling*

Hand-pulling is one of the oldest methods of weed control and is most effective against annuals, biennials and perennial seedlings. Established perennials can only be controlled effectively if the entire root system is removed. This is difficult and not possible in most instances. Hand-pulling perennials can be effective in preventing seed production, however.

If fields have both flowering and non-flowering weeds, flowering weeds should be removed first in order to prevent seed formation. It is also important to remove them from the field, as many can still produce viable seed when lying on the soil surface. Hand-pulling is easier when the soil is wet.

2. *Pruning (mow/burn)*

Although the main purpose of pruning is to rejuvenate blueberry plants, it also aids in control of some weeds. Burning will control coniferous species and some shallow rooted grasses. The top growth of many woody and herbaceous perennials are generally killed by burning but underground parts resprout. Burning also reduces the return of many weed seeds from mature plants to the soil, and will kill many of the weed seeds present near the soil surface. Frequently however, only partial or erratic control results. Burning or mowing alone may promote growth of many perennial weeds with extensive underground root systems by releasing apical dominance.

Although mowing may give some short-term suppression of perennial weeds, it is generally not recommended as the sole method of control. Weeds must be mowed or cut several times during the season to ensure suppression. Species such as maple, birch and willow should be cut back to the ground level. Regrowth from the roots is common and frequently results in additional cuttings.

3. *Selective mid-season clipping*.

Species clipped in June, July and August for a few seasons may help suppress weeds to acceptable levels. Clipping weeds every mid-summer has also been found to help control or suppress bracken fern, sweet fern, bayberry, *Prunus spp*., lambkill, wild rose, and others. Bracken fern should be cut just as the fronds unfold, at least two times, at four-to-six week intervals.

Clipping the tops off weeds before seeds ripen prevents seed formation and helps reduce future weed problems. Flowering weeds should be clipped before weeds which have not yet flowered.

For weeds growing above the blueberry canopy selective clipping can be performed with "whipper-snippers" or other such similar equipment. Alternatively, non-woody weeds can be clipped through whipping. Hand clippers can also be used to target individual low growing weeds. Clipping is, however, labour intensive and does not generally result in permanent control.

E) Chemical

The use of herbicides to control weeds in blueberry fields is an important component of an integrated weed management program. However, herbicides cannot be used as a cure-all for poor management. Herbicides must be used responsibly and judiciously and as just one component within an overall program. No single herbicide or combination of herbicides will control every weed within a blueberry field. Furthermore, excessive weed control that results in long-term bare ground should be avoided as it leads to soil erosion and impairs blueberry clone expansion.

Herbicides used within blueberry fields are either **selective** or **nonselective**. Following labeled rates and recommendations, selective herbicides control specific weeds without significantly injuring blueberry plants. Some selective herbicides (e.g. Velpar) are safe only at prescribed rates and times of application. If excessive rates are applied they are no longer selective and can cause severe crop injury. Nonselective herbicides kill both weeds and crop plants (e.g. Roundup) and caution must therefore be exercised when applying them.

Blueberry herbicides are applied either **pre-emergence** (applied *before* any blueberry plant or weed foliage emerges); or **post emergence** (applied *after* blueberry plant and weed foliage has emerged). Pre-emergence herbicides provide residual control, whereas post emergence treatments provide little or no residual control.

To keep fields relatively clean growers need both a "**base program**" and a "**clean-up program**". The base program refers to the primary method relied on to control most weeds. For blueberry growers, Velpar is relied on most frequently to provide this base level of weed control. The clean-up program relies on herbicides such as Ultim, Venture L, Spartan, Roundup, Lontrel or Banvel II to target specific weeds that escape the base program.

Even when label instructions are followed, not all weeds will be controlled. Each herbicide controls only specific weed species, and if timing and rates are not followed, control may be poor. In addition, other factors can also reduce weed control. For example, if heavy rains follow pre-emergence applications on sandy soils, some herbicides may leach away from the weed seed germination zone. Likewise for post emergence herbicides, if rain-free periods are not respected, control can be reduced.

If labeled weeds have emerged, a pre-emergence herbicide may not be effective. If emerged weeds are too large, control with post emergence herbicides will be reduced.

Control from herbicides can also be reduced if weeds are under stress. For example, drought stress can cause weeds to form thicker layers of wax on leaf surfaces thereby reducing herbicide uptake.

HERBICIDE USE

1. METHODS OF APPLICATION

There are several methods of applying herbicides depending on the properties of the herbicide and target weed. The label gives detailed instructions on mixing and application of each product and should be carefully followed to ensure applications are safe and effective. The following gives general information on methods of applying the approved herbicides discussed in *Notes on Herbicides Registered for Use in Wild Blueberry.*

A) Overall Broadcast Spray

Overall broadcast spraying involves the use of boom sprayers to apply herbicides uniformly over entire fields or large areas. Irregular spray applications can be avoided by the use of flagging tape, foam markers, appropriate dyes or GPS systems. To apply the herbicides at the recommended rate, the equipment must be calibrated and in proper working order.

An overall broadcast spray is recommended for treating areas with a uniform rate of herbicide, such as pre-emergence applications of Velpar in the spring

of the sprout year. Broadcast applications can also be made to large infestations of some species, such as treating large infestations of sweet fern or lambkill in the fall of the crop year with Banvel II. Pronone 10G can also be applied as a broadcast treatment by using a granular applicator such as a Vicon spreader.

B) Foliar Applications on Brush

Herbicide applications to fully expanded leaves of brush species can be useful where there are limited numbers of escaped brush species. Unless otherwise stated on the label, applications should be limited to bushes that are less than 2 meters in height. If higher, they should be cut and the regrowth treated.

Foliar applications are generally the most effective just after full leaf expansion in late spring or early summer. Applications made to actively growing bushes will be the most effective under good growing conditions and adequate soil moisture. If foliage remains green and in good condition on some species (e.g. alders, bayberry, sweet-fern, willows and others), effective applications can also be made in early fall after harvest. There may be less herbicide injury to blueberry plants if applications are made after blueberry foliage has turned red and begun to drop, but careful application is still required.

Coverage should be uniform and thorough to wet all leaves and stems. Mix with water only and spray until wet, but avoid spraying to runoff. Extreme caution must be used with any non-selective herbicide as any spray contacting blueberry plants can cause severe injury or death.

C) Stump Treatments

Stump treatments involve herbicide applications to tree stumps that were recently cut. Best results are usually obtained on stumps 5 cm across or larger (refer to individual labels). All exposed bark, roots, and cut surfaces should be wet thoroughly either by painting or spraying.

Most of the stump treatments will control crown suckering species (e.g. birches, maples, pin cherries) but there may be regrowth of species that sucker from lateral roots (e.g. poplars).

Stump treatments can be applied any time of the year, including the winter months as long as snow or water does not prevent application. Trash from brush cutting operations such as sawdust, leaves, branches, etc. should also be removed from the base of the stumps before treating. Unless otherwise stated, applications should be made to freshly cut stumps.

For old stumps it is best to drill several holes or split the stump with a wedge before applying the treatment. Care must be taken to ensure that all cut stems in a clump have been treated, or regrowth can result. Dye can also be added to the mixture to help ensure all exposed surfaces of the stump have been treated, and stumps do not get retreated or skipped.

Unless otherwise stated on the label, the herbicides used as stump treatments should be applied in diesel oil, fuel oil, kerosene, vegetable or mineral oil to help penetrate the exposed bark and cut surfaces (environmentally, mineral oil or vegetable are the preferred choices).

A stump treatment is a safe and effective way of controlling bushes and small trees. 2,4-D (low volatile ester formulation) or Garlon 4 in oil can be either sprayed or painted onto freshly cut stumps and exposed roots. Many woody weeds are affected by these treatments, and on certain species, stump treatments are more effective than foliage applications. Crop damage can be minimized by careful application. Killed stumps will decay faster. If regrowth appears it should be treated with an appropriate herbicide. Note that 2,4-D alone and Garlon 4 are registered for general weed control and used in preparing land for blueberry production. These products are not registered for use in producing blueberry fields and can cause crop damage if applied directly to actively growing blueberry plants.

D) Basal Bark Treatments

Many shrubs and small trees (up to 15 cm diameter) can be controlled by spraying or wiping the basal parts of their stems or tree trunks from the soil level up to a height of 50 cm or as recommended on the label. Treatments are applied in diesel oil, fuel oil, kerosene, vegetable or mineral oil as recommended on the label (environmentally, mineral or vegetable oils are the preferred choice). Low volatile esters of 2,4-D or Garlon 4 in oil can also be used for basal bark treatments.

Old or rough bark requires more volume than young or smooth bark. Treatments can be applied any time of the year except when snow or water prevents application to the lower trunk and exposed roots. Basal bark treatments are advantageous because the

entire shrub or tree does not require spraying. Use a nozzle that forms a very narrow band or stream when spraying basal bark treatments.

E) Directed Spot Sprays

The objective of directed spot spraying is to apply herbicides to the weed foliage while avoiding contact with the blueberry foliage. Depending on the product used and the time of application, blueberry plants can be injured or killed if the foliage is sprayed. Applications are often made in the summer of the sprout year, and these can result in crop injury. Alternatively, evergreen species, such as lambkill, can be sprayed with Banvel ll in the fall after blueberry leaf drop (see *Notes on Herbicides Registered for Use in Wild Blueberry*). Furthermore, many species such as alders, sweet-fern, bayberry, and blackberry retain their leaves in a viable condition longer than the harvested blueberries and can be treated in the fall after blueberry leaf drop. Spot sprays can be applied with either backpack or handheld sprayers or by operating a handgun from a line connected to a tractor-mounted sprayer.

F) Roller and Wiper Applications

There are several roller-type applicators now available, including several tractor-mounted models and small one-man portable machines for use in small fields. The herbicide is slowly delivered to an absorbent covered drum that wipes and transfers herbicide to the foliage of tall weeds. In order to improve coverage most rollers must be operated relatively slowly. Wipers are also available that do not have a rotating drum. Wiping in two directions improves coverage and results in better control. Do not wipe in a second direction until the herbicide from the first pass has dried.

Wiping and rolling methods can be used where weeds are taller than the blueberry plants. A commercially available “hockey-stick” applicator has been used effectively for applying Roundup and similar products within small areas.

2. SPRAYER CALIBRATION

Broadcast herbicide applications should be made with an accurately calibrated boom sprayer. Backpack and airblast sprayers should not be used for broadcast herbicide applications as coverage and distribution will not be uniform.

Blueberry plants can be injured if too much herbicide is applied. Calibrating the sprayer regularly is therefore extremely important. Complete directions on sprayer calibration and calculating the amount of herbicide required can be found in the New Brunswick Department of Agriculture, Fisheries and Aquaculture’s **Sprayer Calibration Factsheet** (ISBN 1-55048-806-6) or in the **Guide to Weed Control** (Publication 75) from the Ontario Ministry of Agriculture and Food.

The sprayer must be set up and operated to provide the correct amount of spray overlap. Overlap within a boom swath depends on both nozzle spacing and boom height. The boom should be adjusted to the appropriate height above the target, either the ground for pre-emergence applications or the weed canopy for post emergence applications. Overlap between boom swaths can result in a double application and crop injury. GPS systems and various boom-end marking systems (e.g. foam markers) can be used to delineate the outer edge of the swath pass.

Herbicides are usually applied with flat fan nozzles. Nozzles such as the Delevan Raindrop nozzles or the air induction (venturi) type nozzles are effective. Cone-type nozzles are not recommended as spray pattern and distribution are poor at the lower pressures required for herbicide applications. Sprayer pressure should not exceed 276 kPa (40 psi) for herbicide applications.

Calibration of fertilizer spreaders for Pronone 10G application is equally important.

3. BEST MANAGEMENT PRACTICES

Blueberry growers can respond to the public’s concern for the environment in a proactive manner by adopting Best Management Practices (BMP). Best Management Practices are recommendations and guidelines to help growers make sound environmental decisions in their farming operation.

They are a combination of management, cultural, and structural practices that are considered effective and economical in reducing environmental impacts. They provide opportunities for growers to evaluate and choose the best management practices that are most appropriate for their own operation. It is important to keep in mind that many of the production and management activities that blueberry growers practice influences not just themselves but their neighbours and community. Anything that can be achieved to prevent environmental pressures will make their own operation and the blueberry industry

more sustainable.

It is important that growers identify problem areas within their operation and select and implement the appropriate changes. Examples of Best Management Practices include:

- match appropriate herbicide rates with soil type
- do not apply herbicides within 50 m of water bodies
- do not mix or load near water, bring the water to the sprayer
- do not apply herbicides to rock formations and exposed ledges as they may provide a direct channel to groundwater
- scout fields and spray only when and where necessary
- avoid spraying if heavy rainfall or winds are forecast
- use an anti-backflow device when filling sprayers from a water source to prevent contamination from backflow
- make sure your sprayer or spreader is calibrated properly and accurately
- leave an untreated vegetation strip near any water sources to act as a buffer and filter
- read and follow all instructions as stated on the labels

The use of hexazinone (Velpar DF, Pronone 10G) has been associated with groundwater contamination and soil erosion. A factsheet "**Best Management Practices for Velpar/Pronone (C4.5.0)**" has been prepared to help minimize these problems and is available from New Brunswick Department of Agriculture, Fisheries and Aquaculture. It is important that these be followed to safeguard the use of this herbicide.

NOTES ON HERBICIDES REGISTERED FOR USE IN WILD BLUEBERRY

Note: Herbicide label information overrides any discrepancies between information presented in this guide and the label. Herbicides are presented in alphabetical order and rates are given in kilograms or litres of commercial product. Additional information on weed susceptibility, herbicide use and toxicity are given in tables that follow.

1. atrazine

Atrazine will no longer be registered for use in wild blueberries following the 2005 season

Atrazine is a pre-emergence residual herbicide registered for use in the **spring of the sprout year**. Applications must be made following the pruning operation but before new shoots or leaves emerge. Applications made after shoot or leaf emergence may result in serious crop injury. Rainfall is required to activate atrazine.

Although atrazine is registered in Canada, it is not registered on wild blueberries in the United States. As a result, there are no US atrazine residue levels (import tolerances) established for blueberries. Shipments of blueberries with atrazine residues can be refused entry into the U.S. As a result, Canadian processors who have markets in the U.S. have been requesting that growers not use atrazine. They have indicated that they will not purchase blueberries that have been grown on atrazine-treated fields, even though it is a registered product in Canada. Check with your buyer to determine if they will buy blueberries from fields treated with atrazine before you use this product.

Examples of atrazine products and rates currently registered for use in lowbush blueberries are provided in Table 2. Consult individual product labels for specific mixing instructions and other precautions.

Broadcast applications of atrazine will control or suppress most native grasses, some rushes and

sedges, some herbaceous broadleaved weeds like sheep sorrel, hawkweeds, some goldenrods and others (See Table 1). Atrazine does not control any woody species or black bulrush. It controls or suppresses some Velpar-tolerant native grasses, e.g. blue grasses and fescues. Atrazine is most effective in relatively clean fields with a mixture of grasses and herbaceous broadleaved weeds.

Weed control may be poor on soils with high organic matter (>10%) or in dry years. Atrazine should not be used on coarse textured soils low in organic matter (less than 2%), on wet areas, on rocky, uneven terrain where it cannot be applied accurately, or on areas subject to erosion.

2. dicamba (BANVEL II , ORACLE)

Dicamba is the active ingredient found in Banvel II and Oracle herbicides. They are non-selective broadleaf herbicides which, when applied to the foliage, is absorbed by the leaf and translocated throughout the plant.

Banvel II and Oracle can be applied alone or in combination with 2,4-D L.V. (low volatile) ester as either an overall **broadcast or spot spray**. Banvel II/Oracle or Banvel II/Oracle plus 2,4-D L.V. ester can cause serious damage to lowbush blueberries if applied directly on actively growing blueberry plants, or if applied improperly. **Significant delays in emergence, the spring following application, have been observed particularly where mowing has replaced burning. Growers should experiment on a small area for the first time until they become familiar with the use of this treatment.**

Broadcast application.

1. Banvel II or Oracle alone. For control of lambkill and suppression of sweet-fern, apply Banvel II (480 g/L) or Oracle (480 g/L) at a rate of 4.6 to 7.1 L/ha (1.9 to 2.9 L/acre). Application must be made in the **fall of the fruiting year** while the target weed is still moderately green **but after 90% of the blueberry plants have dropped their leaves**. If possible, fall pruning should be carried out 4 to 5 weeks after spraying. If spring pruning is followed, it should be done as early as possible to reduce the chance of injury to the blueberry plants. Banvel II or Oracle should be applied in 550 L of water per hectare. Rainfall within 4 hours of application may reduce effectiveness.

2. Banvel II/Oracle + 2,4-D L.V. ester. For additional control of broadleaf weeds, Banvel II or Oracle may be mixed with 2,4-D L.V. ester (600 g/L) and applied in the **fall of the crop year.** Apply Banvel II or Oracle at 2.3 L/ha (0.93 L/acre) with 2,4-D L.V. ester (600 g/L) at 5.7 L/ha (2.3 L/acre). The same precautions and recommendations for the use of Banvel II/Oracle alone also applies to the Banvel II/Oracle + 2,4-D L.V. ester mix.

Spot spray application.

During site preparation, Banvel II or Oracle can be applied as a spot spray to control Velpar resistant weeds such as maple, alders, willows and honeysuckle. Apply 2.1 L of Banvel II or Oracle per 1000 L of water. Contact with actively growing blueberry plants must be avoided or severe injury or death will result.

3. GARLON 4 (triclopyr)

Garlon 4 is registered for the control of woody weed species during field site preparation as either a **basal bark** or **stump treatment**. Blueberry plants are very sensitive and may be killed if Garlon 4 comes in contact with the plants.

On newly cleared sites, Garlon 4 can be used to control alder, ash, birch, poplar, pin cherry, maples, and other woody species. Some species (e.g. red maple and choke cherry), are more difficult to control and may require retreatment the following year. Only one application per year is permitted. **Applications can be made at any time of the year**. Rainfall within 2 hours of application may reduce effectiveness.

Basal bark application. For basal bark applications prepare a 1 to 5% solution where 1 to 5 L of Garlon 4 is mixed with enough oil to make 100 L of solution. This is sprayed on the basal or lower 50 cm of trunks up to 15 cm in diameter and to any roots that may be exposed. The oil can be diesel, kerosene, fuel oil, vegetable or mineral oil.

Stump treatment application. For stump treatments prepare a 20 to 30% mix, where 20 to 30 L of Garlon 4 is mixed with enough oil to make 100 L solution. All exposed bark, roots and cut surfaces should be wet thoroughly either by painting or spraying. This solution can also be applied to the base of suckers or saplings with a small brush for effective control of many species.

4. glyphosate (e.g. Roundup, etc)

There are a number of commercial products currently registered for use in wild blueberry that contain the active ingredient glyphosate, e.g. Roundup Original, Roundup Transorb, Roundup WeatherMax, Touchdown 480, Touchdown IQ, Credit, Vantage, Vantage Plus, Factor and Glyfos. Although glyphosate is common to each of these products, the salt formulation and surfactants present in these products may vary. Differences in weed control between these products are generally considered minimal by many weed scientists.

Glyphosate has a role in the preparation of fields for blueberry production and also as a spot or wiper treatment in established fields. Glyphosate can only be used in blueberry fields if it is selectively applied to the weed foliage. Blueberry plants are very sensitive to glyphosate treatments and contact will result in blueberry plant injury or death.

Glyphosate is absorbed into the foliage and translocated throughout the plant killing both above and below ground growing points. It is **generally most effective when applied in June through August to fully expanded and actively growing foliage.**

Glyphosate is effective against most broad leaved species including maple, beech and ash. It is not effective as a stump or bark treatment as it does not readily penetrate bark. Glyphosate has no activity when applied to the soil and provides no residual weed control.

Gyphosate can be applied selectively, either as a directed spot spray or as a wiping treatment. Rainfall within 2 to 6 hours may reduce effectiveness (varies with product, check specific labels).

Spot Spray. Apply a 1% to 2% solution of commercial glyphosate product (Roundup WeatherMax, apply a 0.67% to 1.34 % solution) to the foliage of woody weeds in the sprout year (a 2% solution is equivalent to 2L of product in 98L of water). Ensure uniform coverage and apply enough product to wet the leaves but not to the point of runoff.

Roller and Wiper Treatments. The use of glyphosate in rollers or wipers is an effective way to control weeds growing above the blueberry plants.

For roller applicators, prepare a 5 to 10% solution by mixing 0.5 L to 1.0 L of herbicide with enough water to make 10 L of solution (Roundup WeatherMax, prepare a 3.3-6.7% solution (0.33 to 0.67 L with enough water to make 10 L of solution)). Roller speed should be maintained at 50 to 150 rpm.

For wick or other wiper applicators, mix 1L of herbicide with 2L of water to prepare a 33% solution (Roundup WeatherMax, mix a 22% solution (0.57 L in 2 L of water)).

Not all glyphosate products are registered for use in rollers or wipers and rates may vary between products. Please consult the glyphosate label for more specific information before using in this manner.

Most actively growing herbaceous and woody weeds with the exception of conifers are sensitive to glyphosate, provided there is adequate coverage.

Glyphosate mixed and applied in hard water is known to result in reduced weed control as a result of less absorption. For optimal results glyphosate should therefore be applied in soft water. The addition of ammonium sulfate to hard water can however, counteract the negative action of the hard water and improve weed control.

Consult the label for additional information on the use of individual glyphosate products.

5. KERB 50-W (propyzamide)

Kerb 50-W is a soil active herbicide that will control or suppress many perennial grasses, including Venture L and Velpar-tolerant fescues. It controls no woody species and has little activity on broadleaved species. It also does not control poverty oat grass.

Kerb 50-W is registered for use at 3.25 to 4.5 kg/ha (1.3 to 1.8 kg/acre) in **late October and November of either the sprout or crop year**. Lowbush blueberry is very tolerant to Kerb 50-W. Applications should be made when the ground is cool but before it freezes. Rainfall is required to move Kerb into the soil where it is active.

6. LONTREL 360 EC (clopyralid)

For the control of tufted vetch apply Lontrel 360 EC in **late spring of the sprout year when vetch is in the**

early flowering stage. Tufted vetch is very sensitive to Lontrel 360 at almost any growth stage but applications in July and August have resulted in yield loss. Often there are no obvious visible crop injury symptoms following application, but there may be a reduction in bloom and blueberry canopy the following crop year, particularly if late applications were made. In extreme cases, there may be malformations of the blossoms. Late applications of Lontrel 360 may interfere with the development of the fruit bud. Lontrel 360 should never be applied in fruiting blueberry fields.

Early application also provides a longer period of weed control and will prevent seed production. Lontrel 360 generally gives excellent control of established tufted vetch but it gives no control of seedlings that emerge after application. Seedlings of tufted vetch grow and become established very quickly, but acceptable control should last until harvest.

Only one application per year is permitted. Small infestations can be treated with backpack or hand-gun applicators; larger infestations can be treated with a calibrated boom sprayer. Applications should only be made to areas infested with vetch and application to the crop should be avoided as much as possible.

When using a hand gun or backpack sprayer to treat small infestations, apply Lontrel 360 herbicide at a rate of 42 ml per 1000 m^2 area in 200 L of water. When applying with a boom sprayer to treat larger infestations, apply 420 ml per hectare (2.5 acres) in 150 to 200 L of water**.**

7. simazine

Simazine 80W (1.7 to 2.5 kg/ha; 0.69 to 1 kg/acre) and Princep Nine-T (1.5 to 2.0 kg/ha; 0.6 to 0.8 kg/acre) are registered for use in lowbush blueberries. These herbicides should be applied in a minimum water volume of 300 L/ha. Historically, these herbicides have not been frequently used within the blueberry industry. As a result, the weed spectrum controlled by these herbicides is not well documented. Woody weeds will not be controlled with simazine, nor will most established perennial weeds

Simazine 80W and Princep Nine-T can be applied in **late fall or early spring when blueberries are still dormant.** Only one application is permitted per season. Apply the lower rates on coarse sandy soil and the higher rates on clay soils and soils high in organic matter. Rainfall is required to activate simazine. Crops must not be harvested within 60 days of application.

8. SINBAR 80 WP (terbacil)

Sinbar 80 WP is primarily effective against grasses and hay-scented fern, but is also effective against lamb's-quarters and other annual broadleaf weeds. Sinbar is residual and provides control of many later germinating weeds. It is not recommended to continuously apply Sinbar as a broadcast application as this will generally promote goldenrods, sheep-sorrel, asters, and other tolerant broad-leaved weeds.

Apply Sinbar 80 WP at 1.5 to 2.5 kg/ha (0.6 to 1 kg/acre) in the **spring of the sprout year, after the pruning operation, but before new blueberry shoots or leaves emerge**. Later applications may cause crop injury. Sinbar can be applied to cultivated lowbush blueberries in late fall of the crop or sprout years when blueberry plants are dormant. Apply the lower rates on coarse sandy soil and the higher rates on clay soils and soils high in organic matter.

Moisture within 2 weeks of application is required to activate Sinbar. Apply Sinbar within 24 hours of mixing as product degradation may result.

9. SPARTAN 75 DF + Agral 90 (tribenuron methyl)

A) Broadcast applications for bunchberry control

Spartan is a post emergent herbicide that must be absorbed through emerged weed foliage to be effective. Proper application timing is critical with this herbicide and will directly influence the level of bunchberry control and crop injury.

For bunchberry control in the **spring of the sprout year**, apply Spartan 75 DF at 40 g/ha (16 g/acre) with 0.2%v/v Agral (200 mL per 100 L water) in 150 to 250 L water per hectare. Spartan 75 DF may degrade in water and should be applied on the day it is mixed. Disperse the DF granules in a small amount of water before adding them to the spray tank to ensure the herbicide is thoroughly in suspension. Add Agral 90 after Spartan is well mixed and in suspension. Only one application per year is permitted.

For best results, applications should be made when the majority of the emerged bunchberry plant leaves have unfolded to form a 45 degree angle, but no later than when the first white blossoms are visible on the most advanced plants. Bunchberry plants generally turn pinkish red to yellow following spraying but may take weeks to die down. If Spartan 75DF + Agral 90 applications are made too late, bunchberry plants turn red and remain so for the entire season and reduced control can be expected. If Spartan 75DF + Agral 90 is applied too early, bunchberry regrowth can be expected later in the season. Rainfall within 4 to 6 hours after application may also reduce control.

In the year following Spartan 75DF application, some bunchberry regrowth can be expected, but densities will be much lower than pre-treatment levels. It may be necessary to use Spartan 75DF in following sprout years to maintain bunchberry control levels.

Spartan 75DF + Agral 90 should also be applied before blueberry sprout regrowth exceeds 2 cm in height. Some stem height reduction with yellowing and reddening of the blueberry leaves might be observed for 6 to 8 weeks after application, particularly if there has been prolonged cool temperatures or wide fluctuations in day and night temperatures just prior to or soon after treatment. Blueberry plants recover and fruit bud numbers and potential yields are not generally affected. Recommended fertilizer applications before or after Spartan 75DF + Agral 90 applications may be beneficial.

Applications made at later stages of blueberry development or applications in spring-burnt fields are **not** recommended due to potential crop injury and potential yield reductions.

When used in the manner described above, Spartan 75DF has generally resulted in "good" to "excellent" control (70 to 90%) of bunchberry in fields with minimal effect on the crop.

B. Spot applications

Spartan 75 DF can also be used as a directed spot spray with a backpack sprayer, or handgun **to control alders, bracken fern, wild rose and yellow loosestrife**. Mix 2.5 g of Spartan 75 DF plus 20 mL Agral 90 for every 10 L of water and spray to thoroughly wet the foliage. **Apply only during the summer of the sprout year when the foliage is fully expanded. Alders and wild rose can also be controlled with early fall applications** as they retain their leaves longer. Bracken fern shows few symptoms after application but control the following year is excellent. Foliage of the other species turns yellow/ red and the stem terminals die soon after application.

Blueberry plants growing among treated weeds generally show few symptoms. However, when the crop is sprayed directly it may be stunted with reduced bloom and yield. Spartan 75 DF should therefore not be applied broadcast at these times. Control of other species has been erratic (vetch, poplars, willows, goldenrods and fly honeysuckle) and others are resistant (chokepear, bayberry, black bulrush, sweet fern, and birch). Spartan 75 DF may degrade in water and should be applied the same day it is mixed.

10. ULTIM 75 DF + Agral 90 (nicosulfuron/rimsulfuron)

For control of black bulrush, apply Ultim 75 DF plus Agral 90 in **June of the sprout year**. Apply **when the first flower heads begin to emerge from the bulrush tussock**. Ultim 75 DF should be applied as a directed spot spray to thoroughly wet the bulrush foliage. Control may be erratic or unsatisfactory from later applications or if the bulrush is under stress (e.g. drought stress). Stunting and yield loss may occur when blueberry plants are sprayed directly, but with careful application, injury is minimal to those plants growing among the bulrush.

Ultim is a contact herbicide and will not provide residual control of grass or broadleaf weed seedlings that may germinate after application.

Ultim 75 DF is prepackaged in water soluble bags containing 33.7 g commercial product, or enough to mix 800 L of spray solution. This is equivalent to 4.2 g per 100 L of spray solution. Ultim 75 DF should always be applied with 0.2% Agral 90 surfactant (equivalent to 2 L per 1000 L water or 200 mL per 100 L water). Disperse the DF granules in a small amount of water before adding them to the spray tank to ensure the herbicide is thoroughly in suspension. Add the surfactant after Ultim is well mixed and in suspension.

Ultim spray solutions should be used within 24 hours of mixing or product degradation may occur. Mix no more than can be used in one day. Rainfall within 2 to 4 hours after application may reduce Ultim effectiveness.

11. VELPAR DF AND PRONONE 10G (hexazinone)

A. Formulations

Two commercial formulations containing the active ingredient hexazinone are available: Velpar DF, a 75% dry flowable granule that is mixed with water and Pronone 10G, a 10% solid granule. Velpar DF/Pronone 10G are pre-emergence residual herbicides applied for the control of many grasses, broadleaf weeds, and woody weeds.

Pronone 10G is approved only for sprout year applications and is applied with a calibrated fertilizer spreader, such as the Vicon spreader. Patchy crop injury or control indicates uneven distribution of granules. Pronone 10G consists of clay granules impregnated with the herbicide that is released by leaching following rainfall. Control may therefore be poor during dry weather, but gradual release may prolong and improve control of some species.

If blueberry sprouts or leaves have emerged, the risk of crop injury is much less from Pronone 10G applications than from liquid sprays of Velpar DF. However, herbaceous weed control is generally better with pre-emergence applications of Velpar DF than with Pronone 10G. When using Velpar DF, follow label instructions to ensure the dry flowable granules completely disperse in the spray tank before application.

B. Sprout year applications

Velpar DF is registered for use in the sprout year at 1.92 to 2.56 kg/ha (0.78 to 1.0 kg/acre) and Pronone 10G at 14 to 20 kg/ha (5.7 to 8.0 kg/acre). The high rate is recommended for use in weedy or new fields to control common herbaceous and woody weeds and the low rate is recommended for maintenance weed control in relatively clean fields. Applications should be made in the spring after the pruning operation, but before new sprouts or leaves emerge. Apply Velpar DF in at least 200 litres of water per hectare.

Crop tolerance to Velpar DF is generally greatest and weed control the best when applications are made soon after pruning but before new blueberry sprout emergence or new leaf growth. Best results occur when the herbicide is present in the root zone during active growth of the target weeds. There is no difference in tolerance between mowed and burned blueberry plants.

Applications made after the foliage has emerged can cause serious leaf burn. Crop injury has consistently been associated with late applications. However, blueberry plants on sandy or shallow soils, or those weakened by heavy weed competition or frost heaving, may be more prone to hexazinone injury than those in vigorous stands.

Hexazinone is principally a soil acting herbicide that is leached by rain into the root zone. Herbicide activity is affected by too little or too much rainfall and by soil texture. Lower rates are used on light textured soils and higher rates are used on heavier soils and in high organic matter soils.

Hexazinone is very water soluble and subject to leaching and lateral movement. Therefore, do not apply to gravely soils or those on steep slopes or to roadways or other areas subject to erosion in the absence of plant cover. Follow *Best Management Practices* to minimize the risk of contaminating water sources (See page 10).

Experience has shown that blueberry rhizomes do not colonize ground kept bare by repeated hexazinone use. Hexazinone is an important tool in developing blueberry fields and managing weeds, but over-use that results in bare ground may lead to soil erosion and prevent clone expansion.

On mature, well-established fields, it is suggested that growers experiment with different hexazinone rates in order to determine the minimal effective rate for the weed types present. In some instances, it may be feasible to even skip hexazinone applications or just treat known problem areas.

For growers who are concerned that unmanageable weed populations may result if hexazinone applications are skipped, it is suggested that only a small area of their field be left untreated. If successful, the untreated area could be expanded the following cycle.

C. Velpar DF in the fruiting year

An application of 1.3 kg/ha (0.53 kg/acre) Velpar DF can be made in the spring of the crop year when sensitive weed species could affect the developing crop or harvest efficiency. It is recommended that this treatment be applied only to those areas of the field where weed density will cause yield losses or harvesting problems.

This treatment will control or suppress most goldenrods, asters, sheep sorrel, some annual broadleaved weeds and most grasses that have not developed hexazinone tolerance. Timing of application is critical. Applications should be made no later than the early bloom stage before the flower buds separate and show the white floral tube. This corresponds to when the bud scales are separating or the F1 and F2 developmental stages as found in the *Monolinia* blight control fact sheets. This generally occurs no later than mid May. Later applications can result in serious crop injury and much reduced yield. This treatment should only be used on soils with a well-developed organic layer and should not be used on sandy or gravely soils.

D. Response of weeds to hexazinone

Repeated hexazinone use has lead to many changes in the weed flora of blueberry fields. It is now difficult to predict the response of some species to hexazinone.

The susceptible/tolerant ratings of common weed species in Table 1 are based on early trials in fields with little or no previous exposure to hexazinone and may be most applicable to new fields. The susceptibility of some species has changed with long-term exposure to hexazinone (or reduced rates) in the following ways:

- *Incomplete control*. Majority of seedlings and immature plants may be killed but mature plants recover from initial injury and reproduce, especially in the fruiting year. Examples are many perennial herbaceous species: black bulrush, black knapweed, St. John's wort, goldenrods, vetch, ferns, and others. Incomplete control increases as growers decrease the herbicide rate, hence the increase in sheep sorrel and narrow-leaved goldenrod.

- *Inherent tolerance*. Like the blueberry plant, many other plant species are tolerant to labeled rates of hexazinone, e.g. bunchberry, bayberry, chokeberry, yellow loosestrife, lilies and orchids, and others. Some 'new' weeds like goat's-beard and sow-thistle appear to have inherent hexazinone tolerance.

- *Developed tolerance*. Many native grasses have developed hexazinone tolerant populations with repeated exposure, as have some annual ones like witch grass. There is no evidence that populations of herbaceous broadleaved weeds have developed tolerance, or if the decreased control of some woody weed species (e.g. wild rose, bristly sarsaparilla, blackberry) results from decreased rates of herbicide or increased tolerance.

- *Germination patterns*. Although residual, hexazinone may only provide several months weed control. Many weed species germinate and establish later, e.g. some grasses, vetch, chickweeds and others. Annual weeds germinate in both the sprout and fruiting year, e.g. lamb's-quarters, witch grass, and hemp-nettle. Observing emergence patterns can help determine why some weed species are not controlled.

It is clear that many weed problems cannot be solved with hexazinone use. Growers must adapt their control strategy to control these escaping species.

12. VENTURE L (fluazifop-p-butyl)

Venture L can be applied broadcast in the **late spring of both the sprout and fruiting year** for post emergent control or suppression of certain annual and perennial grasses. Degree of control will depend upon their level of susceptibility to the herbicide (see Box below) and the rates applied.

Susceptible annual grasses like witch grass or native perennials like rough hair grass can be controlled (i.e. killed) with Venture L, but many native grasses (e.g. poverty oat grass and blue grasses) are more tolerant and are only suppressed. Suppressed grasses are severely stunted and flowering and vigor is greatly reduced for at least one season. The presence of these suppressed species, particularly in bare areas of blueberry fields, is beneficial and may enhance expansion of blueberry clones and reduce soil erosion. Other grasses are highly tolerant.

Apply 1 L/ha (0.4 L/acre) Venture L **post emergence** for control of annual grasses at the 2 to 5 leaf stage (e.g. witch grass and fall panicum) and for rough hair grass control. Apply 2 L/ha (0.8 L/acre) Venture L for the suppression of quack grass, poverty oat grass, blue grasses and other perennial grasses. Apply when perennial grasses have 10 cm of new leaf growth – usually in late May or early June. These applications are useful in some grass-infested fields during the crop year to increase harvest efficiency.

Applications made to grasses greater than 20 cm in height or grasses that have reached the heading stage will not be adequately controlled or suppressed. Venture L should be applied in 100 to 200 L of water per hectare. Blueberry plants are very tolerant to Venture L, even during bloom.

Venture L requires a minimum 2 hour rain-free period after application and has no activity in the soil. The preharvest interval is 60 days. Venture L does not control rushes, sedges nor any broad-leaved weeds.

Response of some grasses to Venture L:

- Susceptible species:
  - Rough hair grass (tickle grass)
  - Wooly panicum
  - Witch grass
  - Most other annual grasses
- Suppressed species:
  - Poverty oat grass
  - Quack grass
  - Canada blue grass
  - Fowl-meadow grass
  - Kentucky blue grass
  - Mexican muhly grass
- Tolerant species:
  - Colonial bent grass
  - Sheep and hair fescue
  - Red fescue
  - Sweet vernal grass

Table 1. Effect of herbicides on some common blueberry field weeds.

Control ratings in this chart are provided to facilitate choosing the best treatment and are not a guarantee of performance. Factors such as weather, stage of growth, herbicide rate, and differences in tolerance among populations or biotypes etc. can influence presented ratings

WEED	PRE-EMERGENCE					POST EMERGENCE						
	atrazine	Kerb 50WP	simazine	Sinbar 80WP	Velpar/ Pronone	Banvel II / Oracle	glyphosate (Roundup and others)	Garlon 4	Lontrel 360 EC	Spartan 75DF	Ultim DF	Venture L
Grasses + bulrush												
Black bulrush	t	t	t	t	v	t	s		t	t	s	t
Browntop	s		s	s	s	t	v	t	t	t		s
Canada blue grass	s			s	s	t	v	t	t	t	v	sd
Hair fescue		s		v	s[4]	t	v	t	t	t		t
Kentucky blue grass	v				s[4]	t	v	t	t	t		sd
Mexican muhly grass	t			sd	v[4]	t	v	t	t	t		sd
Poverty oat grass	v	t	t	s	s[4]	t	v	t	t	t	sd	sd
Quack grass	sd	v	t	sd	sd	t	v	t	t	t	sd	sd
Rough hair grass (tickle)	s			s	s[4]	t	v	t	t	t	sd	s
Witch grass	t		t	s	v[4]	t	v	t	t	t		s
Herbaceous broadleaf weeds												
Asters	s	t		t	v	s	s		v	v		t
Bracken fern	t		t	t	v		s		t	s	t	t
Bunchberry	t	t	t	t	t		N/A		t	s[1]	t	t
Cow wheat					t		N/A				t	t
Goldenrods	sd	t	sd	t	v	s[1]	s		v	v	sd	t
Lamb's quarters	s[2]		s[2]	s	v	s	s		t		sd	t
Ox-eye daisy	sd			t	s	s	s		v			t
Sheep sorrel		sd	t	t	v	s	N/A		v		sd	t
Spreading dogbane	t		t	t	t	s	s		t	t	t	t
St. John's wort	t	t	t	t	t	s	s		t	t	t	t
Vetch	t	t	t	t	t	s	v		s	v	sd	t
Wild lily of the valley	t		t	t	t		NA		t	t	t	t
Yellow loosestrife	t		t	t	t	s	s			s	t	t
Woody weeds												
Alder	t	t	t	t	t	s	s	s		s	t	t
Barrenberry	t	t	t	t	t	s	s		t	t	t	t
Birch	t	t	t	t	s	s	s	s	t	t	t	t
Black huckleberry	t	t	t	t	t	t	s	t	t	t	t	t
Cherry (Prunus spp)	t	t	t	t		s	s	v	t		t	t
Lambkill	t	t	t	t	s[1]	s	v		t	t	t	t
Maple	t	t	t	t	t		s	s[3]	t	sd	t	t
Poplar	t	t	t	t	v	s	s	s	t	v	t	t
Rhodora	t	t	t	t	s[1]	s	v		t	t	t	t
Sweet fern	t	t	t	t	t	s	v		t	t	t	t
Wild rose	t	t	t	t	t	s	v	s	t	s	t	t
Willow	t	t	t	t			v	s	t	v	t	t

Ratings: s – susceptible; t- tolerant; sd- suppressed; v- variable; N/A not applicable (e.g. too low to wipe)

[1] may require additional applications in following cycles for satisfactory control

[2] as long as not triazine resistant

[3] red maple requires high rate and possible retreatment

[4] Velpar tolerant populations of these species have been found

Table 2. Selective and non-selective herbicides registered for broadcast applications in wild blueberry in Canada.*

Common name	Product	Product rates		Water volume	Application timing
		kg or L / hectare	kg or L / acre		
Soil-applied residual herbicide treatments					
atrazine	Aatrex L, Aatrex 480 Atrazine 500 Atrazine 600 Atrazine 80WP Aatrex Nine-0 Atrazine 90WG	8.3 L/ha 8.0 L/ha 6.7 L/ha 5.0 kg/ha 4.4 kg/ha 4.4 kg/ha	3.36 L/ac 3.2 L/ac 2.7 L/ac 2.0 kg/ac 1.78 kg/ac 1.78 kg/ac	Min 150 L/ha (13 gal/ac)	Spring, after prune, before new blueberry plant growth emerges
hexazinone	Pronone 10G Velpar 75 DF	14-20 kg/ha 1.92-2.56 kg/ha	5.7-8.1 kg/ac 0.78-1.0 kg/ac	Min 200 L /ha (18 gal/ac)	Spring, after prune, before new blueberry plant growth emerges
	Velpar 75 DF	1.3 kg/ha	0.53 kg/ac		Early spring of fruiting year
propyzamide	Kerb 50 WP	3.25-4.5 kg/ha	1.3-1.8 kg/ac	300-500 L/ha (27-45 gal/ac)	Late fall of fruiting or sprout year, after blueberry plant defoliation
simazine	Simazine 80 WP, Princep - Nine-T	1.7-2.5 kg/ha 1.5-2.0 kg/ha	0.69-1.0 kg/ac 0.6-0.8 kg/ac	300 L/ha (27 gal/ac)	Late fall, after blueberry plant defoliation; or spring, after prune, before new blueberry plant growth emerges
terbacil	Sinbar 80 WP	1.5-2.5 kg/ha	0.6-1.0 kg/ac	Min 200 L/ha (18 gal/ac)	Spring, after prune, before new blueberry plant growth emerges. Fall for select clone blueberries
Selective, over-the-top, foliar herbicide treatments					
fluazifop-P- butyl	Venture L	1-2 L/ha	0.4-0.8 L/ac	100-200 L/ha (9-18 gal/ac)	Late spring, prune and crop year
tribenuron-methyl	Spartan 75 DF + Agral 90	0.040 kg/ha (40 g/ha) + 200 ml Agral 90 per 100L water	0.016 kg/ac (16g/ac) + 200 ml Agral 90 per 100L water	150-250 L/ha (13-22 gal/ac)	Late spring, prune year. Apply when bunchberry leaves unfold to form a 45 degree angle and before blueberry plant regrowth exceeds 2cm in height
Non-selective, over-the-top herbicide treatments					
dicamba	Banvel II / Oracle	4.6-7.1 L/ha	1.9-2.9 L/ac	550 L/ha (50 gal/ac)	Fall of fruiting year after 90% blueberry plant leaf drop
dicamba+ 2,4-D	Banvel II or Oracle + 2,4-D LV ester 600 (Low volatile ester formulations only)	2.3 L/ha + 5.7 L/ha	0.93 L/ac + 2.3 L/ac	550 L/ha (50 gal/ac)	Fall of fruiting year after 90% blueberry plant leaf drop

* Consult 'Notes on Herbicides' and the product label for more specific information. Selective herbicide treatments can be applied with little risk of crop injury provided label instructions are followed; non-selective herbicide treatments can injure or kill the crop if it comes in contact with the herbicide spray.

Table 3. Selective and non-selective herbicides registered for spot spray or wiper applications in wild blueberry in Canada *.

Common name	Product(s)	Type of application	Herbicide mixture (g or L product)	Time of application
Selective herbicide treatments				
clopyralid	Lontrel 360 EC	Spot Sray	spot application: 42 ml in 200 L water per 1,000 m^2 Larger infestations: 420 ml per ha in 150-200 L water	Sprout year -June or when tufted vetch is early bloom. Later applications may result in yield reductions the following year.
nicosulfuron/ rimsulfuron	Ultim 75 DF + Agral 90	Spot spray	4.2 g in 100 L water plus 200 ml Agral 90 per 100 L water	Early summer of prune year
tribenuron methyl	Spartan 75 DF + Agral 90	Spot spray	2.5 g in 10 L water plus 20ml Agral 90 per 10 L water	Summer or early fall of prune year. Varies with weed targeted.
Non-selective spot and wiper herbicide treatments				
dicamba	Banvel II / Oracle	Spot spray	2.1 L per 1000 L water	Site preparation
glyphosate	Roundup Original, Roundup Transorb, Roundup WeatherMax, Glyfos, Touchdown 480, Touchdown IQ, Vantage, Vantage Plus, Credit, Factor	Spot spray	1 to 2% solution (1 - 2 L in enough water to make 100 L solution) (Roudup WeatherMax - 0.67 to 1.34% solution)	Site preparation, sprout year, after harvest
		Roller	5 to 10% solution (0.5 to 1.0 L product in enough water to make a 10 L solution) (Roundup WeatherMax, 3.3 to 6.7% solution (0.33 to 0.67 L enough water to make a 10 L solution))	
		Wiper	33% solution (1 part product:2 parts water) (Roundup WeatherMax, - 22% solution – 0.57 L in 2 L of water)	
triclopyr	Garlon 4	Spot spray or paint brush	1% - 5% in oil (**bark**)	Any time of the year
			20% - 30% in oil (**stumps**)	
2,4-D LV ester	Numerous trade names	Spot spay	Consult individual labels	Site preparation, non crop

* Consult 'Notes on Herbicides' and the product label for more specific information. Selective herbicide treatments can be applied with little risk of crop injury provided label instructions are followed; non- selective herbicide treatments must be applied only to the weeds as blueberry plants that come in contact with the herbicide may be injured or killed.

Table 4. Residual soil activity, foliar activity, rain-free period, pre-harvest interval, winter storage requirement and bee toxicity of herbicides registered for use in wild blueberry.

Herbicide	Residual soil activity[1]	Foliar activity[2]	Rain-free period[3] (hours)	Pre-harvest interval[4] (PHI) (days)	Winter storage[5]	Bee toxicity[6]
atrazine	yes	yes	0	N/A*	B – liquids C – for DF	Relatively non toxic
Banvel II	limited	yes	4	N/A	B	Relatively non toxic
2,4-D LV ester	no	yes	2	N/A	C	Relatively non toxic
Garlon 4	no	yes	2	N/A	B	Relatively non toxic
Kerb 50-W	yes	no	0	N/A	C	Relatively non toxic
Lontrel 360 EC	no	yes	4 to 6	N/A	A	Relatively non toxic
Pronone 10G	yes	no	0	N/A	C	Relatively non toxic
Roundup	no	yes	4-6	Non crop year	B	Relatively non toxic
simazine	yes	no	0	60	C	Relatively non toxic
Sinbar 80 WP	yes	limited	0	N/A	C	Relatively non toxic
Spartan 75DF	no	yes	4-6	N/A	C	Relatively non toxic
Ultim DF	no	yes	2-4	N/A	C	Relatively non toxic
Velpar DF	yes	limited	0	N/A	C	Relatively non toxic
Venture L	no	yes	2	60	C	Relatively non toxic

***N/A – none available**

1. **Residual soil activity**. Indicates whether or not later emerging susceptible weeds will be controlled. Herbicide remains active in the soil and controls weeds as they germinate for some time after application. Reference*: Vencil, K.V. 2002. Herbicide Handbook. Lawrence, KS: Weed Science Society of America.493 p.*

2. **Foliar activity.** Indicates whether or not susceptible emerged weeds will be controlled following application. The herbicide is absorbed through the leaves. Reference*: Vencil, K.V. 2002. Herbicide Handbook. Lawrence, KS: Weed Science Society of America.493 p.*

3. **Rain-free period.** The period of time in which the herbicide must be applied before rainfall. If rainfall occurs during the rain-free period, control may be significantly reduced. Reference*: Ontario Ministry of Agriculture and Food. 2004. Guide to Weed Control 2004/2005 - Publication 75. Toronto, ON: Queens Printer for Ontario. 348 p.*

4. **Pre-harvest interval (PHI).** The period of time in which the herbicide must have been applied before harvest is permitted. Reference: *Individual Product Labels*

5. **Winter storage.**
   - **A.** Do not allow to freeze
   - **B.** Preferably should not freeze. If frozen, return to original state by allowing product to warm to 10 to 20 ^{o}C and agitate thoroughly before use.
   - **C.** Not usually damaged by freezing. Store in a cool, dry place.

   Reference*: Ontario Ministry of Agriculture and Food. 2004. Guide to Weed Control 2004/2005 – Publication 75. Toronto, ON: Queens Printer for Ontario. 348 p.*

6. **Bee toxicity**. Degree of toxicity to bees. Reference: *Extoxnet : http://ace.orst.edu/info/extoxnet/ghindex.html*

Table 5. Oral and dermal $LD_{50,}$ restricted entry interval, herbicide movement rating and average soil half-life of herbicides registered for use in wild blueberry.

Herbicide	Oral LD $_{50}$[1] (rat) (mg/kg)	Dermal LD $_{50}$[2] (rabbit) (mg/kg)	Restricted entry interval (REI) period (hours)[3]	Herbicide movement rating[4]	Average soil half- life [5] (days)
atrazine	1600	>5000	12	high	60
Banvel II	3512	> 2000 (rat)	24	very high	14
2,4-D LV ester	1380	>2020	12	moderate	10
Garlon 4	1581	>2000	12	low	30
Kerb 50 W	>5000	>2000	24	low	60
Lontrel 360 EC	>5000	>5000	12	low to moderate	14-56
Pronone 10G	> 5000	>2500	24	very high	90
Roundup	> 5108	>5000	12	extremely low	47
simazine	>5000	>2000	12	high	60
Sinbar 80 WP	5000-7500	>5000	12	very high	120
Spartan 75 DF	>5000	>2000	12	moderate	12
Ultim DF	>5000	>2000	12	high	21
Velpar DF	1310	>5000	24	very high	90
Venture L	2451	>2076	12	very low	15

1. **Oral LD $_{50}$** (Lethal Dose $_{50}$). The oral LD $_{50}$ is the amount of chemical that is lethal to half (50%) of the experimental animals fed the chemical, in this case rats. The smaller the LD $_{50}$ value, the more toxic the pesticide. See Table 6 for categories of acute toxicities. *Reference: Agrichemical Warehousing Standards Association. 2003. MSDS Reference Canadian Crop Protection Products. Hensall, ON: North American Compendiums Ltd. 679 p.*

2. **Dermal LD $_{50}$** (Lethal Dose $_{50}$). The dermal LD $_{50}$ is the amount of chemical that is lethal to half (50%) of the experimental animals when applied to the skin, in this case rabbits. The smaller the LD $_{50}$ value, the more toxic the pesticide. See Table 6 for categories of acute toxicities. *Reference: Agrichemical Warehousing Standards Association. 2003. MSDS Reference Canadian Crop Protection Products. Hensall, ON: North American Compendiums Ltd. 679 p.*

3. **Restricted entry interval (REI).** The time in hours before it is considered safe to re-enter a field that has been treated with the product without wearing personal protective equipment. Reference: *Meister, R.T. (ed). 2002. Farm Chemicals Handbook. Willoughby, OH: Meister Publishing Company. 840 p.*

4. **Herbicide movement rating.** Rates the potential of pesticides to move toward groundwater. It is related to a pesticide's physical and chemical properties, its persistence and sorption in the soil. Reference: *Vogue, P.A., E.A. Kerle and J.J. Jenkins. 1994. OSU Extension Pesticide Properties Database. http://ace.orst.edu/info/npic/ppdmove.htm.*

5. **Average soil half- life**. This is a measure of pesticide persistence in the soil. It is the time that it takes a pesticide to degrade to half of the original concentration. The typical half-life is an approximation and may vary greatly between soil types and climates. *Vogue, P.A., E.A. Kerle and J.J. Jenkins. 1994. OSU Extension Pesticide Properties Database. http://ace.orst.edu/info/npic/ppdmove.htm.*

Table 6. Categories of acute toxicities*

Hazard Rating	Signal Word Required on Label	Oral LD_{50} (mg/kg)	Dermal LD_{50} (mg/kg)	Inhalation LC_{50} (mg/l)	Approximate oral dose that can kill an average person
Extremely toxic	Danger *(POISON! Skull & Crossbones)	From 0 to 50	From 0 to 200	From 0 to 0.2	A few drops to 5mL (or a few drops on the skin)
Very toxic	WARNING!	From 50 to 500	From 200 to 2,000	From 0.2 to 2	Over 5mL to 30 mL
Moderately toxic	CAUTION!	From 500 to 5,000	From 2,000 to 20,000	From 2.0 to 20	Over 30 mL to 0.5 litre
Slightly toxic	CAUTION!	More than 5,000	More than 20,000	More than 20	Over 0.5 litre or 0.5 kg

* Taken from NB General Pesticide Safety Manual. Sexsmith and McCabe 1992

Poison Control Centres

New Brunswick	Dial **911** and ask for Poison Information
Newfoundland	Dr. Charles A. Janeway Child Health Care Centre, St. John's Telephone: (709) 722-1110
Nova Scotia	The Izaak Walton Killam Hospital for Children, Halifax Telephone: (902) 428-8161, 1-800-565-8161
Prince Edward Island	The Izaak Walton Killam Hospital for Children, Halifax Telephone: 1-800-565-8161

Environmental Emergencies (Pesticide Spills)

Transport Canada Regional Operations Centre (24 hours)	
New Brunswick, Nova Scotia and PEI.	Telephone 1-800-565-1633
Newfoundland (Coast Guard)	Telephone (709) 772-2083

Helpful Conversions

kPa X 0.14 = pounds per square inch (psi)
hectares X 2.47 = acres
kilograms X 2.2 = pounds
1,000 grams (g) = 1 kilogram (kg)

millilitres X 0.035 = fluid ounces
litres X 35 = fluid ounces
litres X 0.22 = imperial gallons
1,000 millilitres (ml) = 1 Litre (L)

kilograms per hectare X 0.89 = pounds per acre
kilograms per hectare X 0.40 = kilograms per acre
litres per hectare X 14.17 = fluid ounces per acre
grams per hectare X 0.015 = ounces per acre
litres per hectare X 0.40 = litres per acre
litres per hectare X 0.09 = gallons per acre