



## Strawberry IPM Weed Management Guide



Recommendations in this Guide are given for general information only. All herbicides used must be applied in accordance with label directions. By editing this publication, the New Brunswick Department of Agriculture, Aquaculture and Fisheries does not offer any warranty or guarantee and does not assume liability for crop loss, animal loss, health, safety, or environmental hazards caused by the listed herbicides or practices. Trade names used in this Guide are given as a convenience to producers and are neither an endorsement of the product nor a suggestion that similar products, not mentioned, are not as effective.

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### Introduction

Weed control is one of the greatest challenges facing strawberry growers. Since strawberry plants are relatively slow growing and are poor competitors, weeds quickly invade and establish within bare areas. Strawberry fields are kept in production for several years and weed populations change within the fields, from annuals in the first year to a mixture of annuals and perennials in the following years. Management practices can influence the types of weeds observed.

A good weed management program is required to control weeds over the life of the strawberry planting. This program starts at least one year before planting and continues throughout the duration of the planting. It does not rely on any one control method, but instead is based on 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 incorporates the use of dynamic principles rather than a definitive set of rules. IPM can vary from farm-to-farm or even from field-to-field. A weed management program following the principles and practices of IPM is often referred to as an integrated weed management program.

### Components of an Integrated Weed Management Program

#### *I. Weed Identification and Biology*

When planning your integrated weed management program, a crucial first step is to properly identify your weeds. By knowing the weeds present in your fields you can gather information on their life cycle and biology, and have a better understanding of how the weeds reproduce and survive and what is required to control them. The New Brunswick Department of Agriculture, Aquaculture and Fisheries maintains an integrated pest management image bank on the [www.gnb.ca/agriculture](http://www.gnb.ca/agriculture) website, available by clicking [here](#). This bilingual site contains images of diseases, insects, weeds and other disorders affecting New Brunswick's strawberry crop. Most images are available in both low and high resolutions. The site can be accessed by three different methods: 1) the **Browse** feature where a pest category and/or crop can be selected to find the appropriate images, 2) the **Search** feature using a key word search or 3) the **Complete Listing** showing all images in the bank. Clients with slower Internet connections should only use lower resolution images to avoid long download times. Other excellent weed identification resources are available through [www.weedinfo.ca](http://www.weedinfo.ca) (available on-line [here](#)) or "Identification Guide to the Weeds of Quebec" by C.J. Bouchard and R. Néron, ISBN 2-89457-174-7.

Based on life cycles, weeds within strawberry fields can be classified as annuals (summer or winter), biennials, or perennials.

#### *A) Summer Annuals*

Summer annuals germinate in the spring and summer, produce vegetative growth, flower, set seed, and die, all within the same growing season. Summer annuals include many of our most common farm weeds such as lamb's-quarters, hempnettle and corn spurry. Common summer annual characteristics include rapid growth and prolific seed production. This rapid weed growth, early in the season, is detrimental to strawberry plants, especially during the planting year when summer annuals predominate in the field. Summer annuals can be controlled by combined use of herbicides and tillage. Summer annual seedlings can also emerge in the fall but these plants are usually killed by frost.

### ***B) Winter Annuals***

Winter annuals germinate from late August through early November and over-winter in the form of rosettes, which are circular clusters of leaves around the stem at ground level. The following spring, these small compact plants bolt (grow very quickly), flower, produce seed, and later die. Winter annual weeds must be controlled during late summer and early fall before or soon after emergence. Chemical controls applied in late fall or early spring are usually not effective on established rosettes. Winter annual weeds commonly found in strawberry fields include shepherd's-purse, field violet, common groundsel and common chickweed. Most weeds that behave as winter annuals can also germinate in early spring when soil temperatures are low and then act as summer annuals.

### ***C) Biennials***

Biennial weeds germinate in the spring, grow vegetatively during the first growing season, over-winter as a rosette, then flower, produce seed and die during the second growing season. Examples of biennial weeds are wild carrot, evening primrose and common mullein. Biennial weeds do not usually cause serious weed problems in strawberry fields. Control is most effective in the first growing year of their life cycle.

### ***D) Perennials***

Once established, perennial weeds persist year after year and are the most difficult to control. Perennials can reproduce vegetatively and by seed. New plants can be produced from the growth of specialized reproductive structures like rhizomes, tubers, stolons or rootstocks. Some perennials, like ox-eye daisy and dandelion, persist as individual plants and are called simple perennials. Simple perennials spread primarily by seed, but can reproduce by vegetative means when the root is cut up and spread by tillage practices. Other perennial weeds known as creeping perennials, like Canada thistle and quack grass, produce large clones (colonies) or groups of plants that arise from spreading underground rootstocks or rhizomes. Creeping perennials such as sheep sorrel, creeping buttercup, vetch and toadflax that readily reproduce by both seed and vegetative means are more difficult to control.

To establish a strawberry planting free of quack grass and other perennials, the vegetative structures of the weeds should be destroyed prior to planting. This can be done through the use of herbicides and tillage. Perennial seedlings in strawberry fields should be controlled as they emerge because perennials are easier to control while they are small. Dandelions and toadflax germinate profusely in late spring and early summer, whereas ox-eye daisy and sheep sorrel germinate mainly during early fall. Appropriate pre-emergence herbicide levels that are effective for weed seedling control must be present in the soil in both spring and fall to control newly germinated perennials.

## ***II. Scouting***

Scouting and proper weed identification form the foundation of any integrated weed management program. Scouting involves walking your strawberry fields in a pattern (e.g. "M" pattern). This allows you to monitor for potential weed problems across your entire field(s). By mapping the fields for weeds from year to year, you can monitor changes in weed species, weed densities, and distribution. Your management strategy must target the control of dominant weeds, while preventing the spread of others.



The following information should be documented when scouting and mapping:

- Weed species and their life cycles -annual, biennial, perennial.
- Size or growth stage of the weed -seedling, small, medium, large, flowering, seed formed.
- Density of the weed populations- counts, or categorize as light, moderate, severe.
- Distribution - uncommon, scattered throughout, a few patches, numerous patches, common throughout.
- Location of the weed infestations on the map.

In the planting year, scouting should start soon after planting and continue throughout the season. Fields should be checked every two to three weeks throughout the summer, and at least once a month in the fall.

In the fruiting years, scouting should be done at least four times during the growing season. The first scouting should be done in early spring, soon after mulch removal; the second just prior to renovation; the third in late summer; and the fourth in October. Monitoring at these times will help you predict which weeds may cause problems in the future and allow you time to devise a weed control strategy for these weeds. In addition, scouting also provides the information to evaluate the effect of previous control measures.

In addition to scouting for weeds, any observed herbicide injury to the strawberry plants should be noted and mapped. Once this is done the cause of the injury should be determined and recorded for future reference (e.g. sensitive cultivar, rate too high for soil type, calibration error, etc.)

### ***III. Weed Thresholds and Action Levels***

Little research has been conducted on weed threshold levels in strawberries. As a result, the decision to target a weed for control must be based on knowledge of the weed within your farming system. From an economical perspective, there is no reason to apply control measures unless the weed population inflicts crop damage greater than the cost of the control measure. Growers must routinely scout and monitor their fields and observe weeds and their competitive effect on the crop to make a knowledgeable decision on weed control actions.

In some instances, the decision to control a weed will have to be made even when the cost of control may be more than the immediate damage inflicted by the weed. For example, the success of U-pick operations is often related to weed-free picking conditions and general aesthetics. Furthermore, some weeds are alternate hosts for insects or diseases, or may interfere with the proper application of other pesticides. Strawberry growers will have to evaluate the weed problem on their farm and determine when and at what level weed control is required. Understanding the biology, survival mechanisms and reproductive capabilities of the weeds, allows you to be able to predict potential long-term effects of a weed that is not controlled.

### ***IV. Control Methods***

By knowing which weeds are present on your farm as well as other useful information gathered through monitoring, you can make the decision as to whether or not a weed(s) should be targeted for control. If action is required, it is important to choose methods that optimize costs and effectiveness of control while minimizing any adverse effects. The most economical and effective strawberry weed management program combines preventive, cultural, biological, mechanical and chemical practices.

### **A) Preventive**

It is important to follow practices that prevent the introduction and spread of weeds. You should be aware of activities which can introduce new weeds and take action to control them as they first appear, minimizing any build-up and spread of new weed introductions.

Preventing seed production helps to prevent weeds from spreading. Keep weeds in ditches, field edges, under fences and roadsides under control and this will minimize the introduction of new problem weeds. It is also advisable to keep the area around ponds as clean as possible. The use of appropriate filters or screens will also help prevent weed seed spread through the irrigation system.

Cleaning farm equipment between fields is another important preventive practice since weed seeds and roots can attach to soil and equipment, and be transported by the farm equipment. This is a particular problem with tillage and cultivation equipment, as well as renovation equipment.

Weeds are often introduced into strawberry fields through the use of weedy straw used for mulching. It is critical that growers obtain as weed-free straw as possible. Purchase your straw from a reputable source and, if possible, visit the grain field where the straw will come from before harvest to check for weeds.

### **B) Cultural**

Cultural controls involve the manipulation of common strawberry cropping practices to favour the development of a healthy and vigorous strawberry plant that can out compete the weeds or withstand some weed competition. The sooner strawberry rows fill in, the more competitive the strawberry plants will be.

It is important to select sites that have no history of perennial weeds or where weeds have been previously controlled. Other important practices include the selection of cultivars that grow well in your area, early planting, use of proper plant and row spacing, timely and proper application of fertility, timely irrigation, proper renovation of beds, and timely and effective pest control. Certain weeds can be more associated with certain soil conditions. Goldenrods, sheep sorrel, corn spurrey and toadflax tend to be associated with sandier soils while growth of creeping buttercup and smartweed is encouraged in poorly drained soils. Adjust control methods according to the soil and moisture status of the field.

### **C) Biological**

Biological weed control is the deliberate use of highly selective natural enemies to reduce the population of a target weed to an acceptable level. This control method does not generally produce immediate or rapid results but may provide a permanent solution for persistent and widespread weed problems. Biological weed control usually involves the use of insects or pathogens. They are weed specific and will not attack other weeds or crop plants.

It is unlikely that biological controls will completely eradicate weed species associated with strawberry production. However, in combination with other control methods, biological control can help prevent seed production and reduce the overall vigour of the weed. Canada thistle, perennial sowthistle, toadflax, St. John's-wort and scentless chamomile have been targeted for biological weed control through the release of various insects or pathogens in Atlantic Canada. The use of insecticides and fungicides within strawberry fields makes the use of insects and pathogens as biological control agents more challenging.

### ***D) Mechanical***

Mechanical methods of weed control include such practices as tillage, hand weeding, hoeing, and mowing.

#### **1. Tillage**

Tillage can pull weeds from the soil, bury them, cut them, or weaken them by injuring the root and/or top growth. In general, the younger and smaller the weeds, the easier they are to control. The more established the weed and root system, the more difficult they are to control. Annuals and biennials are generally easier to control with tillage than perennial weeds. Control of established perennial weeds with tillage is difficult and usually involves trying to deplete the weed's root reserves through continuous destruction of the top growth.

Perennial weeds, which have extensive, deep root or rhizome systems, are more difficult to control than those with shallow, less extensive root or rhizome systems. Since tillage can break up and spread weeds around fields, it is also important to prevent the re-establishment of these weeds through additional tillage or other control methods.

Cultivation is an important tillage practice. In general, shallow cultivation is preferred over deep cultivation. The first cultivation of the season takes place between the plants and rows. As runners fill in the rows, cultivation between the plants becomes impossible and is limited to between the rows. In addition to providing weed control, tillage is also used to train runners back into the row to set properly. After runners are set, cultivation should continue in the direction in which the runners are set. As the runners root, the rows will get wider and the area requiring cultivation will be reduced. Cultivation should start close to the strawberry plants and move outward as the strawberry row expands.

Cultivation should continue throughout the season, as required, and may also be necessary when herbicide effectiveness has been lost. It may also be necessary to cultivate prior to applying a herbicide that is not effective on emerged weeds. Cultivation following after-harvest renovation is another option for weed control. Growers can start to cultivate once the rows have been narrowed. In very weedy strawberry fields, it is helpful to renovate and narrow the rows to 30 to 36 cm (12–14 inches).

#### **2. Hand-weeding.**

It will be necessary to hand weed if strawberry fields are to be weed-free. Chemical, biological, preventive or mechanical control alone will not control all weeds. Hand-weeding is important and often makes the difference between clean and weedy strawberry fields. Hand weeding is, however, time consuming and expensive. Growers must determine the level of weeds that can be tolerated in the field without suffering an economic loss. Examples of hand-weeding include hand-pulling and hoeing.

**a) hand-pulling.** Hand-pulling is one of the oldest methods of weed control. It is most effective against annual and biennial weeds, or perennial seedlings. Established perennials can only be controlled if the entire root system is removed. This is difficult and not always possible. Hand-pulling perennials can also be effective in preventing seed production. Hand-pulling is easier when the soil is wet, following a rain or after irrigating.

If fields have both flowering and non-flowering weeds, remove flowering weeds first. This avoids the formation and dropping of seeds. Following weeding, it is important to remove flowering plants from the field, as many can still produce viable seed when laying on the soil surface.

**b) hoeing.** In the planting year, hoeing is an important part of any strawberry weed management program. It is generally used in conjunction with tillage and herbicides to control escapes. Hoeing can be effective in controlling annual weeds, many biennials, and seedling perennials, but is only partially effective on established perennials. Annual broadleaf weeds are easier to control with hoeing than are annual grasses. With annual grasses, the cut should be made below the soil surface to prevent regrowth from the crown. This approach is not as important with annual broadleaf weeds.

A biennial weed's susceptibility to hoeing depends largely upon its stage of development. Biennials with little or no taproot development are easier to control than those with well-developed taproots. Some well-established biennials can reproduce from buds if the root is not removed. Perennial weed seedlings are controlled like annuals. Established perennials require continuous hoeing at intervals of 1 to 2 weeks during the growing season if control is to be successful.

### 3. Mowing.

Mowing is usually practiced in strawberry production as a renovation procedure, not as a weed control method. Mowing has limited value for weed control, and is used primarily as a means to prevent seed production or to restrict vegetative growth above the strawberry plants.

Mowing is sometimes used prior to harvest to clip off weeds that are growing above the strawberry canopy. This may be done for aesthetic reasons or to prevent seed production. It is also recommended to mow field edges and parking areas to prevent the spread of unwanted weeds. Timing of mowing around the strawberry field is important however, as mowing could encourage insect pests to move into the strawberry field.

### F) Chemical

The use of herbicides to control weeds in strawberry fields is an important component of an integrated weed management program. No single herbicide or combination of herbicides will control every weed within a strawberry field. Herbicides cannot be used as a cure-all for poor management. If herbicides are to be used, they must be used responsibly and judiciously. Herbicides are only one component of the overall weed management program.

Herbicides used within strawberry fields are either selective or non-selective. Following labelled rates and recommendations, selective herbicides control specific weeds, without significantly injuring strawberry plants. Some selective herbicides (e.g. Sinbar) are safe only at prescribed rates. If excessive rates are applied, they are no longer selective and can cause severe crop injury. Non-selective herbicides can kill both weeds and crop plants (e.g. Roundup) and caution must be exercised when applying them.

Strawberry herbicides are applied either pre-plant incorporated (ppi - applied before planting and mechanically incorporated into the soil); pre-emergence (pre - applied after strawberry plants are planted, but before weeds emerge); or post emergence (post - applied after planting and after weeds have emerged). The ppi and pre treatments provide residual control, where the herbicide remains active in the soil for a period of time. Post treatments provide little or no residual control.

To keep fields relatively weed free, 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. Sinbar, Devrinol, and Princep Nine-T (simazine) are used most frequently for a base program. The clean up program consists of herbicides such as Lontrel, 2,4-D amine, Kerb, Roundup, Goal, Venture L, and Poast Ultra to control specific weeds that escape the base program.

Even though label instructions are followed, not all weeds will be controlled. Each herbicide controls only specific weed species. 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-emergent applications on sandy soils, some herbicides may leach away from the weed seed-germinating zone. Likewise for post emergent herbicides, if rain-free periods are not respected, control can be reduced.

If labelled weeds have emerged, a pre-emergence herbicide will not be effective. If emerged weeds are too large, control from post emergent 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.

### Site Selection and Preparation

Proper site selection and preparation are critical to the successful establishment and long-term productivity of strawberry plantings. A mistake inexperienced growers often make is to plant strawberries into old sod fields with inadequate or no site preparation. Weeds, grubs, and cutworms are frequent problems in fields that are not properly prepared. Fields which have not been part of an annual cropping rotation should be prepared at least one year in advance, and preferably two.

By selecting fields that have not had a history of serious perennial weed problems, and using non-selective herbicides, tillage and /or smother crops can help reduce weed problems in the early years following planting. For example, strawberry growers could:

**Year 1.** Apply glyphosate (i.e. Roundup etc.) in the fall and then plow.

**Year 2.** Summer fallow all summer, or summer fallow part of the summer and plant a smother crop such as buckwheat or ryegrass. If necessary, glyphosate (i.e. Roundup etc) could be applied again in the fall.

**Year 3.** Plant strawberries

Modifications to this example can be made to suit your individual situation. Strawberry growers must also keep in mind the potential for disease and other pest problems that may be introduced with any rotational crop, including cover crops.

### Herbicide Application and Calibration

Herbicides must be applied with an accurately calibrated boom sprayer. Backpack and air-blast sprayers should not be used for broadcast herbicide applications as coverage and distribution will not be uniform. Strawberries can be injured if too much herbicide is applied. Calibrating the sprayer frequently is extremely important. Complete directions on sprayer calibration and determination of the amount of herbicide required can be found in the New Brunswick Department of Agriculture, Aquaculture and Fisheries' Sprayer Calibration Fact Sheet ([C.1.2](#)) or in the Guide to Weed Control-Publication 75 from the Ontario Ministry of Agriculture, Food and Rural Affairs available [here](#).

The nozzles must be set up and operated to provide the right amount of spray overlap. Some overlap is needed between nozzles; however, excessive overlap between boom swaths can result in a double application and cause crop injury. 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. Various boom-end-marking systems (e.g. foam markers) can be used to delineate the outer edge of the swath pass. It is recommended that growers consider the number of rows that their sprayer will cover when determining how many strawberry rows to plant in a particular area.

Herbicides are usually applied through 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. For herbicide applications, sprayer pressure should not exceed 276 kPa (40 psi) unless otherwise recommended by the equipment manufacturer.

### Herbicide Injury

Herbicide injury on strawberry plants is common, particularly on light soils. Most injury can be traced to using too high of a rate on light soils, improper timing of applications, improperly calibrated sprayers, improper sprayer overlap, sensitive cultivars and weak plants growing under unfavourable conditions. In most cases, the grower has some control over these factors. Any factor that injures or weakens the crop (other pests, winter injury, exposure of crowns and root systems as a result of erosion, improper fertility, wet spots in the field, etc.) will make the crop more susceptible to injury. Conversely, healthy established strawberry plants are most capable of tolerating recommended herbicide treatment rates.

Newly planted and actively runnering strawberries are especially sensitive to herbicides. Crop tolerance to herbicides increases in late summer and fall. This corresponds to the time when pre-emergence herbicides can be used to control many winter annual and perennial weeds. Growth regulator herbicides should not be applied when flower buds are forming.

Strawberry plants on light, sandy soils require less herbicide than those on heavier soils for comparable levels of weed control. Strawberries growing on soils low in organic matter are especially prone to herbicide injury. Accordingly, lower rates of herbicide should be used on fields low in organic matter (less than 2%).

It is important not to exceed the maximum recommended annual application rates and to fully understand and follow the instructions on the product labels in order to minimize the risk of crop injury. Do not expect herbicides to control all weed problems. Some hand work and cultivation will be required to obtain good weed control. More information on herbicide injury is found in the fact sheet available [here](#).

### Notes on Herbicides Registered for Use in Strawberry

**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. 2,4-D amine (*several brand names*)

2,4-D amine is absorbed through the foliage. It kills weeds by interfering with a number of physiological processes that control growth and development of the plants. Typical effects of 2,4-D amine on weeds and the crop include twisting and bending of the stems and leaves. It has no significant soil activity. Use only the amine formulation of 2,4-D as other formulations can cause crop injury. 2,4-D amine may be sold under a number of different names but is most often available as 2,4-D amine 500 or 2,4-D amine 600.

**Planting Year:** 2,4-D amine is registered for use 2 to 4 weeks after planting, but before runners root. The registered rate for this timing is 1 L/ha (0.4 L/acre) for the 500 formulations and 0.8 L/ha (0.32 L/ac) for the 600 formulations. This rate is less than the renovation rate. This treatment timing is not frequently used by strawberry growers, as many growers feel strawberry injury levels are too high. Distortion of the leaves and new runners are common, but temporary. Do not use 2,4-D

amine if early runners are starting to root. Growers should only treat small areas on their different cultivars, until they are familiar with its use. This treatment can provide control of susceptible weeds which have emerged following planting.

**Fruiting Years:** 2,4-D amine can be applied soon after harvest is complete (during renovation) in order to control susceptible established broadleaved weeds. Apply 2,4-D amine 500 at 2.0 L/ha (0.8 L/acre) or 2,4-D amine 600 at 1.7 L/ha (0.69 L/ac) for control of dandelion, plantain, burdock, wild carrot, primrose, daisy fleabane and many annual seedlings. Established perennial weeds that 2,4-D amine will not control include: toadflax, buttercup, yarrow, ox-eye daisy, hawkweed, sheep sorrel and many others. It is recommended that strawberry growers mow the strawberry plant leaves a few days later, **2 to 3 days after application**, in order to minimize 2,4-D amine movement into the strawberry crown and new runners. This treatment may cause temporary distortion of strawberry leaves. Do not apply between mid-August and fall dormancy because of possible damage to flower bud formation.

Apply 2,4-D amine in 100–200 L of water per hectare (40 to 80 L/acre). When applying 2,4-D amine, use low pressure and coarse spray droplets to minimize drift, as nearby crops may be extremely sensitive. Careful cleaning of the tank is also critical following the use of 2,4-D, as it is difficult to clean out and may affect other crops sprayed with the same sprayer.

## 2. Authority (sulfentrazone)

Authority is a selective, soil applied herbicide for the control of wild buckwheat, lambs quarters, pigweed, groundsel and other broadleaf weeds. Authority may be applied as a broadcast spray or as a banded treatment. Applications should be made to dormant strawberry plants and only once per production season. The recommended timing is to apply to dormant plants before spreading mulch in the late fall. Spring applications may be made during dormancy to established plantings only, very soon after straw removal and before new growth resumes. Applications to strawberry plants with emerged growth are not recommended due to leaf burning and possible stand loss. Not all strawberry varieties have been evaluated for crop safety, so first use of Authority should be limited to a small sample of plants to confirm tolerance. Consult your plant supplier for information on variety tolerance.

Use 0.22 to 0.29 L/ha (0.09-0.12 L/ac) of Authority per application, depending on soil organic matter and texture. Use the higher rates within the rate range for soils with pH less than 7.0 and organic matter greater than 3%. Do not use on coarse soils classified as sand which have less than 1% organic matter. Do not apply in fine textured soils with less than 1.5% organic matter. Do not apply in any type of soils with an organic matter content greater than 6%. Do not use on soils with a pH of 7.8 or greater. Refer to the product label for specific rate recommendations and weeds controlled. The pre-harvest interval is 70 days.

Apply in a water volume of 200 to 400 L per hectare. Do not apply to saturated soils. When soils are wet, do not apply if heavy rainfall is expected within 24 hours. Do not apply to frozen soil. Do not use flood irrigation to activate the product.

Authority is taken up by plant roots and shoots. Moisture is required to activate the herbicide in the soil. Adequate moisture of at least 18 mm is required within 14 days after application for optimal control. If adequate rainfall is not received in a timely fashion, irrigate with a minimum of 18 mm of water. When activating moisture is delayed, a reduced level of weed control may occur.

Authority is persistent in the soil. The total amount available in any given soil is determined by the interaction of soil type (mainly clay content), percent organic matter, soil pH, soil moisture and application rate. Both clay and organic matter bind Authority, making it less available to plants. As

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soil pH increases, availability of Authority in the soil increases. Irrigation with highly alkaline water (pH above 7.5) may increase the amount of Authority available in soil solution and may cause an adverse crop response. Residual weed control may be reduced when the herbicide is applied where heavy crop residue exists (such as leaves, straw and /or weeds). Follow the re-cropping restrictions on label.

Apply no more than 0.292 L/ha of Authority per season in a single field. Do not continually apply Authority to the same field for multiple seasons. Do not apply Authority to fields treated in the previous year (only apply Authority in one field season over a two year period). Authority may leach through the soil and into the water table, especially in sandy soils or in areas where the depth to the water table is shallow. Only apply one treatment of a Group 14 soil-residual herbicide per season to avoid crop injury and/or soil residual issues. Soil residual Group 14 herbicides include Authority, Chateau and Goal.

### 3. *Betamix β EC (desmedipham/phenmedipham)*

Betamix β is registered in newly transplanted strawberry fields. Use in the year of planting only. Betamix β will control lambs quarters, pigweeds, wild buckwheat, foxtail, mustards and other small weed species. This herbicide acts as an herbicide bridge from pre-plant treatments to later herbicide treatments applied after the transplants are well established. This product has not been used extensively in the Maritime region.

**Planting Year:** Apply Betamix β following transplanting at a rate of 1.15-1.75 L/ha as a broadcast spray in 100 – 200 L of water. The first spray must be applied when the earliest weeds have reached the cotyledon stage. Repeat applications at 5 to 7 days intervals following the first application, or when another flush of weeds germinates. Apply a maximum of 3 applications per season. Do not spray in excess of a total of 5.25 L/ha of Betamix β per season. Do not harvest berries from varieties bearing fruit in the first year of planting.

The stage of growth of the weeds is very important for satisfactory control. For best results spray when the weeds are between the cotyledon and 2-leaf stage. Best results are obtained when the weeds are actively growing and are not under water or heat stress. Betamix β has limited soil activity, so re-application will be required as new weeds germinate.

Since not all strawberry varieties have been tested for tolerance to Betamix β, first use of this herbicide should be limited to a small area of each variety to confirm tolerance prior to adoption as a general field practice. Additionally, consult your plant supplier for information on the tolerance of specific strawberry varieties. Betamix β may cause temporary chlorosis or tip burn on strawberry plants. Plants should resume normal growth within 7 to 21 days.

### 4. *Chateau WDG (flumioxazin)*

Chateau is effective as a pre-emergence herbicide for control of selected grass and broadleaf weeds, where control is most effective when applied to clean, weed-free soil surfaces. Only apply to coarse and medium textured soils, with <5% organic matter. Chateau should be applied prior to weed emergence in enough water to ensure thorough coverage. The use rate is 210 g/ha (80 g ac) for control of pigweeds, lamb's quarters, nightshades and dandelion and will suppress green foxtail. Do not apply on soils with > 5% OM, or fine-textured soils. Chateau can only be applied once in a season.

**Late Fall:** Broadcast applications can be made to dormant strawberries in the late fall. Severe crop injury can result if applications are made to non-dormant plants. Chateau must be applied to dormant strawberry plants when no new growth is present. Strawberry plants should have many



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red leaves and have a flattened crop appearance when Chateau is applied. Chateau will remain active in the soil and control weeds in the following spring.

**Row Middles:** Applications to row-middles can occur during the season using a hooded or shielded sprayer. Unacceptable crop injury, including yield loss, may occur if this product comes into contact with non-dormant structures. Do not apply after fruit set. Only use this treatment if you have the proper application equipment.

For residual weed control, moisture is necessary to activate Chateau in soil. Dry weather, following applications of Chateau, may reduce effectiveness. However, when adequate moisture is received after dry conditions, Chateau will control susceptible germinating weeds. Chateau may not control weeds that germinate after application but before an activating rainfall/irrigation or weeds that germinate through cracks resulting from dry soil. When adequate moisture is not received after application, weed control may be improved by irrigation with at least ½ cm of water. Weed control will be reduced if there is mechanical incorporation into the soil or if emerged weeds are controlled by cultivation.

Crop injury may occur from applications made to poorly drained soils and/or applications made under cool, wet conditions. Severe crop injury will result when soils are flooded following applications of Chateau. Risk of crop injury can be minimized by using on well-drained soils. Spray equipment must be thoroughly cleaned after Chateau use to ensure that herbicide residue in the sprayer does not harm subsequent crops. Only apply one treatment of a Group 14 soil-residual herbicide per season to avoid crop injury and/or soil residual issues. Soil residual Group 14 herbicides include Authority, Chateau and Goal.

### 5. Dacthal W-75 (*chlorthal dimethyl*)

Dacthal gives good control of germinating annual grasses, field violet and purslane but gives no control of most other common broadleaf weeds. It has limited foliar activity and provides poor control of most emerged weeds. It will control field violet in the cotyledon (seed leaf) stage.

**Planting Year:** Dacthal can be applied before planting as a pre-plant incorporated treatment or soon after planting as a pre-emergence treatment. The registered rate is 13.5 kg/ha (5.5 kg/acre).

**Fruiting Years:** Dacthal can be applied in the early spring or fall prior to mulching at 9.0 to 13.5 kg/ha (3.6 to 5.5 kg/acre). Spring applications must be applied before the first bloom.

Apply Dacthal in at least 225 L of water per hectare (90 L/acre). This herbicide should be thoroughly mixed before application. Dacthal is effective only if the application is followed by rain or irrigation. Dacthal is only active in the soil where it acts by killing germinating seeds. Strawberries are very tolerant to Dacthal applications.

### 6. Devrinol 50 DF (*napropamide*)

Devrinol can be used to control germinating volunteer cereals, annual grasses (annual blue grass, foxtails, barnyard grass, large crabgrass) and some broadleaf weeds (chickweed, groundsel, pineapple-weed, redroot pigweed, prostrate knotweed, purslane, lamb's-quarters). Creeping buttercup can also be controlled up to the seedlings cotyledon stage.

**Planting Year:** Devrinol can be applied either soon after planting before weeds emerge, late summer after the desired number of daughter plants has rooted or in the fall prior to mulching. Only one application per year is permitted.

**Fruiting Years:** Devrinol may be applied either in the spring after mulch removal but prior to bloom (should not be necessary if applied previous fall); in late summer; or in the fall prior to mulching. Only one application per year is permitted.

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Apply Devrinol in the planting or fruiting years at 9 kg/ha (3.6 kg/acre) before weeds emerge. Apply in 200 to 900 L of water per hectare (80 – 364 L/acre). Make applications to clean cultivated beds. Leaf litter or straw in the field at application may result in reduced control.

Devrinol is only active in the soil, and acts by inhibiting root growth of susceptible weeds. Incorporation by cultivation, or by 5 cm of irrigation or rainfall, is essential. If no rainfall or irrigation occurs within a week of application, cultivation (2.5 to 5 cm deep) will be necessary to incorporate the herbicide into the soil. Devrinol should not be applied to frozen soil.

Devrinol should not be applied during active runnering and daughter plant establishment, as rooting may be inhibited. This injury can be minimized under dry soil conditions if irrigation follows soon after herbicide application. Delay application until the desired number of daughter plants has been established.

### 7. Dual II Magnum (*s-metolachlor*)

Dual II Magnum is registered for control of American nightshade, Eastern black nightshade, crab grass, barnyard grass, fall panicum, foxtails, witch grass, yellow nut sedge (pre-plant incorporated only), and for suppression of redroot pigweed. Dual II Magnum's strength is generally on control of annual grasses. Pre-emergent applications sometimes provide better control of nightshades than pre-plant incorporated applications. Dual II Magnum is registered for use at 1.25 to 1.75 L/ha (0.5 to 0.7 L/acre). The higher rate is recommended when the weed pressure is high. Apply in a minimum of 150 L water per hectare (60 L/acre). Do not apply Dual II Magnum to the cultivar Joliette.

**Planting year:** Apply as a pre-plant incorporated or pre-emergent treatment after planting. Only one application per year is permitted. Some initial injury may result but it is temporary and does not reduce yields the following year. If Dual II Magnum is used, do not harvest berries from any variety in the planting year.

**Fruiting year:** Apply after mulch removal but before weed emergence. One application per year is registered with a 30 day pre-harvest interval. Since not all strawberry cultivars have been tested for tolerance to Dual II Magnum, as a general field practice, first use should be limited to a small area of each variety to confirm tolerance prior to adoption. Also, consult your variety supplier for information on the tolerance of specific strawberry cultivars to Dual II Magnum.

For pre-plant incorporation applications, immediate incorporation is not necessary but should occur within 10 days. Incorporation can be achieved with "S" or "C" tine cultivators set to incorporate to a maximum depth of 10 cm at a minimum travel speed of 10 km/hr. Tandem discs (max 18 cm spacing between discs) set to a maximum depth of 10 cm at a maximum travel speed of 6 km/hr, or power driven equipment set to a maximum depth of 5 cm at any travel speed, can also be used. A one pass incorporation is all that is necessary.

For pre-emergence applications of Dual II Magnum, in either the planting or fruiting years, apply to firm, lump-free soil. In order to be activated, rainfall or a shallow incorporation must occur within 10 days of application.

### 8. Glyphosate (*many formulations*)

The active ingredient in Round-up, Touchdown, Credit, Factor, Glyphos, Sharpshooter, Vantage and Polaris is glyphosate, among other trade names. Although glyphosate is common to each of these products, the salt formulation and surfactants present may vary. Differences in weed control between these products are generally considered minimal.

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Glyphosate kills susceptible plants by inhibiting growth. Treated plants become pale green and slowly turn brown. Glyphosate will damage or kill most green plants and must therefore be used in a manner to avoid spray contact or drift onto strawberry plants or other crops.

**Site Preparation:** Glyphosate is used mainly for site preparation in the year(s) prior to planting. It must be applied to actively growing weeds at the appropriate growth stage as specified on the labels. Glyphosate is absorbed by the foliage and translocated to above and below ground growing points.

For long-term quack grass and perennial weed control, glyphosate should be applied at 5.0 to 7.0 L/ha (2.0 to 2.8 L/acre) for 360 g/L formulations. Rates up to 12 L/ha (4.85 L/acre) can be applied if weed pressures are high and difficult-to-control weeds are present. Lower rates can be used but are only effective against annual weeds. These rates also provide short-term (seasonal) control of quack grass and other perennial weeds. Quack grass should have 3 to 5 leaves present before application. Generally perennial broadleaf weeds are most sensitive near flowering.

Where dandelions are a serious weed problem, mix 2,4-D amine 500 at 2.2 L/ha (0.9 L/acre) with one of the glyphosate products. Fields treated with glyphosate can be tilled as early as 3 days (72 hours) after application, with little loss in weed control. Otherwise, it is recommended that fields not be tilled until 5 to 7 days following application. This allows for adequate translocation and maximum weed control. Do not delay tillage until field vegetation turns brown, as this may reduce control.

Glyphosate should be applied in 50 to 200 L water per hectare (20-80 L/acre). Lower water volumes (50 to 100 L/ha) will usually provide the best results. If higher water volumes (>100 L/ha) are used, then surfactants are recommended to improve control.

If glyphosate is mixed and applied in hard water, reduced weed control may occur as a result of less absorption. Therefore, for optimal results, glyphosate should be applied in soft water. The addition of ammonium sulfate to hard water can counteract the negative action of the hard water and improve weed control.

**Planting and fruiting years:** Glyphosate can also be applied as a spot spray or "wiper" application to control tall weeds growing amongst the strawberry plants. Glyphosate products can be applied in a 33% solution (i.e. 1 part herbicide to 2 parts water) for use in a wiper, or as a 1 to 2 % solution in a hand-held sprayer. Glyphosate can not be applied within 30 days of harvest. Extreme caution must be taken to ensure that glyphosate does not contact strawberry foliage. Daughter plants are particularly sensitive and can translocate the herbicide to other untreated plants.

### 9. Goal 2XL (oxyfluorfen)

**Planting and Fruiting years:** Goal 2XL is registered for use as a fall treatment prior to mulching for the control of wood sorrel (oxalis) and field pansy (field violet). Purslane, red root pigweed, wild buckwheat, lamb's quarters and goosefoot are also listed on the label as being controlled. In some research trials, groundsel was also controlled.

Goal must be applied to dormant strawberry plants when no new growth is present. Strawberry plants should have many red leaves and have a flattened appearance when Goal 2XL is applied. Only one application per year is permitted.

Goal 2XL is registered for use at 1 L/ha (0.4 L/acre) in 500 L/ha water (200 L/acre). Goal 2XL does not provide long-term residual weed control. An additional, residual, soil-applied herbicide (e.g. Sinbar, Princep Nine-T, Devrinol) should still be applied. The pre-harvest interval for Goal 2XL is 150 days. Only apply one treatment of a Group 14 soil-residual herbicide per season to avoid crop

injury and/or soil residual issues. Soil residual Group 14 herbicides include Authority, Chateau and Goal.

### 10. Kerb SC (propyzamide)

**Fruiting Years:** Kerb applied at 2.8 L per hectare (1.1 L/acre) in late fall prior to mulching and freeze-up, will provide short-term control of most established perennial grasses, including quack grass. Control is often lost around mid-summer or under conditions of high fertility. Apply Kerb in 300 to 500 L of water per hectare (120- 200 L/acre). Kerb inhibits cell division in roots and shoots of over-wintering susceptible weeds. It is only active when applied to the soil.

Kerb also controls established chickweeds, and may provide some suppression of sheep sorrel, stitchwort, field horsetail and creeping buttercup. Kerb gives no control of most other broadleaf weeds and should be used in sequence with one of the other residual herbicides for broad spectrum control. Best results are obtained when soil temperatures are low but above freezing, and when soil moisture is high.

Because of the risk of crop injury, use on newly planted beds only when buttercups, chickweed, stitchwort or sheep sorrel are major problems. Apply only to patches of sensitive weeds, if possible. Kerb injury is less likely in beds being carried over after an initial harvest. Rates and soil types must be respected.

### 11. Lontrel 360 (clopyralid)

Lontrel is a growth regulator herbicide that works similar to 2,4-D amine. It will control or suppress a number of important annual and difficult-to-control perennial weeds. Lontrel is particularly effective against weeds in the legume, composite and smartweed families, such as vetch, daisy and sheep sorrel, respectively. However, not all members of these families are equally sensitive. For example, dandelion control is sometimes unsatisfactory and only the highest recommended rates suppress ox-eye daisy and sheep sorrel. Lontrel will not control mustards, chickweeds, corn spurry, St. John's-wort, bladder campion, white cockle, toadflax, field pansy, plantain, buttercup or any grasses.

**Fruiting Years:** Lontrel is registered for use after harvest at renovation. Apply immediately after harvest, **wait 7 to 10 days** and then mow. Do not apply Lontrel after mid-August because of possible effects on runner development and flower bud formation. Later applications of Lontrel may cause crop damage resulting in reduced yields in the season following treatment.

Lontrel application rates are 0.56 to 0.83 L/ha (0.23 to 0.33 L/acre) in 150 to 200 L water per hectare (60 to 80 L/acre). It should not be tank-mixed with other herbicides or pesticides. Species like vetch and groundsel can be controlled at the lower rate, while species like sheep sorrel and daisy require the higher rate. Lontrel will kill underground rootstocks of sensitive weeds like vetch and Canada thistle, and will strongly suppress flowering and vegetative growth of less sensitive ones like ox-eye daisy and sheep sorrel.

A 4 to 6 hour rain-free period is required after application for maximum control. Lontrel should be applied only once per year. Lontrel does not provide residual control of emerging weeds and must therefore be applied directly to the foliage. When Lontrel is applied properly, strawberry plants generally show satisfactory tolerance. Lontrel should not be applied when fruit buds are being initiated.

Lontrel may induce a slight malformation of new foliage. Injured leaves are often narrow with a rough appearance. Petals often appear reddish in colour and sepals may bend back. Occasionally, early 'wild- type' flowers have been noticed which abort without setting fruit. Early season varieties



such as Veestar and Annapolis may be more susceptible to injury. Earlier fruiting and larger early yields have been recorded in trials following Lontrel use.

### 12. Poast Ultra + Merge (*sethoxydim*)

**Planting and Fruiting Year:** Poast Ultra is registered for post-emergent control of annual grasses (i.e. barnyard grass, crab grass, fall panicum, witch grass, yellow and green foxtail), wild oats, volunteer cereals, and quack grass, in both the planting and fruiting years. Poast Ultra is translocated through the grass plants and provides no residual control of later emerging grasses. Poast Ultra will not control broadleaf weeds or sedges. Following Poast Ultra applications, susceptible grasses immediately stop growing and turn yellow, to purple, to brown over a 7 to 21 day period. Regrowth of quack grass is common but generally not significant until 6 to 8 weeks after treatment.

For annual grasses, apply Poast Ultra at 0.32 L/ha (0.13 L/acre) + Merge or Assist at 1.0 L/ha (0.4 L/acre) when grasses are at the 1 to 6 leaf stage (2 to 5 is optimal). For volunteer cereal control, apply Poast Ultra at 0.47 L/ha (0.19 L/acre) + Merge or Assist at 1.0 L/ha (0.4 L/acre) to actively growing volunteer cereals at the 1 to 6 leaf stage (2 to 5 is optimal). For quack grass control, apply Poast Ultra at 1.1L/ha (0.45 L/acre) + Merge or Assist at 1.0 to 2.0 L/ha (0.4 to 0.8 L/acre) to actively growing quack grass up to the 3 leaf stage (8 to 12 cm in height).

Apply Poast Ultra in 50 to 200 L of water per hectare (20-80 L/acre). Apply the higher water volume and surfactant rate for a high weed population or when quack grass is present. Use the lower Merge or Assist rates at water volumes from 50 to 100 L/ha and the higher rate from 100 to 200 L/ha.

It is recommended that Sinbar not be applied within 2 weeks before or after Poast Ultra applications or crop injury may result.

### 13. Princep Nine-T 90% DG (*simazine*)

Princep Nine-T kills susceptible weeds by inhibiting photosynthesis. It is mainly active in the soil where it is absorbed by roots and translocated to the leaves where photosynthesis takes place. Princep Nine-T does not control emerged weeds; therefore, it should be applied after a thorough cultivation and before additional weeds emerge.

Soil pH and organic matter influence the activity of Princep Nine-T. Activity tends to increase on soils with higher pH. Strawberry plant injury has been observed on soils having a pH greater than 5.6. Since injury is not always observed, other factors may be involved. Do not use Princep Nine-T on soils containing less than 2% organic matter. It is recommended that Princep Nine-T be tested on a small area before wide spread use. Strawberry plants injured by Princep Nine-T develop chlorotic (yellow) and necrotic (dead) leaves. Apply Princep Nine-T in a minimum of 300 L of water per hectare (121 L/acre). Moisture is required for activation.

**Planting Year:** One application of Princep Nine-T can be made during the planting year, either 4-6 weeks after planting or in the late summer. Apply 0.56 kg/ha (0.23 kg/acre) 4 to 6 weeks after transplanting, following a cultivation and/or hand weeding to remove any emerged weeds. This treatment will control many annual broadleaf weeds as they emerge. Alternatively, an application of 0.56 kg/ha (0.23 kg/acre) can be made in late summer through early fall, around Labour Day. Application should be made before new weed germination is obvious and will control germinating winter annuals and seedlings of some perennial weeds. Emerged weeds will not be controlled.

**Fruiting Years:** Princep Nine-T can also be used in fruiting fields following post-harvest renovation or during late fall. Apply 0.9 to 1.12 kg/ha (0.36 to 0.45 kg/acre) for either application.

Use the higher rate on heavier clay soils or soils with a high organic matter content. Use lower rates on sandy soils and soils that are low in organic matter.

### 14. Sinbar WDG (*terbacil*)

Sinbar kills susceptible weeds by inhibiting photosynthesis. Like Princep Nine-T, its main route of entry to plants is from the soil through the root system. Rainfall is required within 2 weeks to activate Sinbar. Weeds and strawberry plants injured by Sinbar develop chlorotic (yellow) and necrotic (dead) leaves.

Soil organic matter and soil texture have a major influence on Sinbar activity. A given rate of Sinbar will be more effective on weeds, and potentially more injurious to the crop on a sandy, low organic matter soil than on a silt or clay loam soil with a high organic matter content. Lower rates should be used on sandy soils and those low in organic matter. Do not use on soils containing less than 2% organic matter.

Sinbar has some foliar activity and will control some seedling weeds when applied early post-emergence. It is also residual in the soil and controls susceptible weeds that germinate later. When used sequentially as described below, Sinbar can provide season-long weed control of susceptible weeds. Sinbar controls many annual broadleaf weeds, annual grasses, and volunteer cereals germinating from seed.

The margin of safety to the crop is narrower with Sinbar than with other herbicides. Temporary minor injury may occur after application, but the risk of injury is reduced if 1 to 2 cm of rain or irrigation follows immediately after application. An accurately calibrated sprayer and proper application technique to avoid excessive over-lap is extremely important. Crops that are under stress, e.g. from producing a heavy crop, a pest infestation or winter injury, may be severely damaged by Sinbar. Certain cultivars like Kent, Micmac, Bounty, Annapolis, Glooscap, Cavendish, Earlidawn and Midway are more sensitive than others to Sinbar. Cautions regarding soil texture and reduced rates should be closely observed when using Sinbar with these cultivars, especially on light soils. Sinbar should be tested on limited areas to determine the tolerance of new varieties.

**Planting year:** Sinbar can be applied at 0.28 to 0.55 kg/ha (0.11 to 0.22 kg/acre) four to six weeks after planting to control summer annual broadleaf weeds and grasses. The site should be hand weeded and cultivated before application, as emerged weeds are less susceptible. If susceptible weeds have emerged, only very small weeds will be controlled. Generally, the low Sinbar rate should be used to minimize risk of crop injury. This application should provide good residual weed control through mid to late summer. Sinbar may inhibit rooting of daughter plants; therefore, application must be done before new daughter plants start to root. Shallow cultivation to control weeds and train runners will not reduce Sinbar effectiveness.

A second 'booster shot' application of 0.18 to 0.28 kg/ha (0.07 to 0.11 kg/acre) can be applied in late summer after the desired number of daughter plants have rooted, but no later than mid-September, to provide control of fall germinating annual and perennial weeds.

A third application of 0.55 to 0.85 kg per hectare (0.22 to 0.34 kg/acre) can be made in late fall prior to mulching to provide residual control of germinating weeds the following spring and summer. Apply lower rates in areas with a risk of winter injury or to weak plantings. Crop tolerance is greatest when the plants are dormant, which usually occurs following a heavy fall frost.

Sinbar may be used in sequence with applications of either Princep Nine-T or Devrinol. This sequence may reduce the likelihood of injury with Sinbar because total usage will be lower. Additionally, herbicide rotation will increase the likelihood that species missed by Sinbar (or another herbicide in the sequence) will be controlled and not become serious problems.

**Fruiting years:** During the harvest year Sinbar can be applied at 0.28 to 0.35 kg/ha (0.11 to 0.14 kg/acre) in the spring after mulch removal. Strawberry plants tend to be more sensitive to spring applications. This treatment should only be used if there are significant numbers of germinating summer annual weeds and strawberry plants have over-wintered well. If the plants are whitish/yellow and appear weak following mulch removal, delay application for 5 to 7 days. Apply the low rate if Sinbar was applied the previous fall. A spring application is generally not required following a fall application under most soil and environmental conditions.

Following renovation, Sinbar can be applied at 0.70 to 0.85 kg /ha (0.28 to 0.34 kg/acre) to control germinating summer annuals and fall germinating weeds. Delay this application until germination of weeds is obvious. If 2,4-D was applied at renovation, delay Sinbar application until plants have recovered from any stress (approx. 2 weeks).

A late fall treatment of Sinbar at 0.55 to 0.85 kg per hectare (0.22 to 0.34 kg/acre) will provide residual weed control the following spring. Apply lower rates in areas with a risk of winter injury or to weak plantings. Strawberry plants are generally most tolerant to this timing.

Apply Sinbar in at least 300 L of water per hectare (120 L/acre). Do not apply Sinbar within 2 weeks before or after an application of Venture L or Poast Ultra applications as crop tolerance to Sinbar may be reduced.

### **15. Treflan 480 EC, Bonanza 480 EC, or Rival 500 EC (trifluralin)**

Trifluralin is the active ingredient in Treflan, Bonanza, and Rival. Trifluralin will control annual grasses, volunteer cereals and some broadleaf weeds, including lamb's quarters, redroot pigweed and chickweed.

**Planting Year:** Trifluralin must be applied before planting to a thoroughly prepared seedbed and incorporated by double discing or harrowing with an "S" tine harrow at right angles or by using a power cultivator such as a rototiller (1 direction). Incorporation is an essential part of application and should take place as soon as possible, but no later than 24 hours after application. Incorporate 7.5 to 10 cm (3 to 4 in.) into soil free of clumps or previous crop residue. Trifluralin works most effectively in warm, moist soils with a dry soil surface.

Trifluralin inhibits cell division in the emerging shoots of germinating weed seeds and has no foliar activity. Apply Treflan 480 EC from 1.2 to 2.3 L/ha (0.48 to 0.93 L/acre); Rival 500 EC from 1.2 to 2.2 L/ha (0.48 to 0.89 L/acre); or Bonanza 480 from 1.25 to 2.3 L/ha (0.5 to 0.93 L/acre). Use the higher rates on heavier clay soils. Apply trifluralin products in at least 100 L of water per hectare (40 L/acre). Trifluralin will not control established weeds. Weed control may be poor in heavy clay or cold, wet soils. Over-application may delay establishment of runner plants.

### **16. Venture L (fluazifop-p-butyl)**

**Planting and Fruiting Years:** Venture L was previously sold under the name of Fusilade II 125 EC. It is registered for the control of emerged annual grasses, volunteer cereals and quack grass in either the planting or fruiting years.

For barnyard grass and volunteer cereals, apply Venture L at 0.8 L/ha (0.32 L/acre) between the 2 and 5 leaf stage. Apply 1.0 L of Venture L per hectare (0.4 L/acre) for foxtail control at the 2 to 4-leaf stage and at the 2 to 5-leaf stage for control of crab grass, fall panicum, and old witch grass. For quack grass control, apply Venture L at 2 L/ha (0.8 L/acre) when quack grass is growing actively and at the 3 to 5-leaf stage. Suppression of top growth will be obtained with the 1 L/ha (0.4 L/acre) rate. Control will be reduced in well-established beds where quack grass rhizomes have not been fragmented by tillage or if application is made at an inappropriate stage of growth.

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Apply Venture L in 100 to 200 L water per hectare (40–80 L/acre). Venture L will not control broadleaf weeds or sedges. Venture L must not be applied to strawberries within 30 days of harvest. Venture L applications should not be made when strawberries are in bloom.

Venture L will not injure strawberries by itself; however, severe crop injury has occurred when Venture L was tank-mixed or used in close sequence with Sinbar. It is recommended that Venture L not be applied within 2 weeks before or after Sinbar applications or crop injury may result. Caution should also be exercised when using Princep Nine-T in close sequence with Venture L. Injury symptoms are typical for Sinbar i.e. yellowing and/or browning of leaf tissue. Venture L appears to interfere with the strawberry plants normal ability to metabolize Sinbar.

Venture L is absorbed through the leaves, and translocated to the areas of active growth where it inhibits further growth. It is a slow acting herbicide. Injury symptoms on susceptible grasses may take up to two weeks to become apparent. Growth, however, stops soon after application. Early injury symptoms on grasses include cessation of growth and a gradual change of foliar color to yellow or purplish-green to brown. Under poor growing conditions, quack grass may not completely 'burn down'. Venture L is less effective if grasses are under stress or are too large.

### Notes on Herbicide Tables

Information in the following tables is provided to facilitate choosing the best treatment and is not a guarantee of performance. Producers should refer to the product label for more specific information. Factors such as weather, stage of growth, herbicide rate and difference in tolerance among plant populations can influence the information presented.

Information listed in this guide is provided to growers for their convenience. Pesticides must be applied according to label directions. Please refer to the product label before application and for more information on each product. Label information overrides any discrepancies between information presented in this guide and the label. Label information can be found at the Health Canada Pesticide Label Search, available on-line at <http://pr-rp.hc-sc.gc.ca/lr-re/index-eng.php>.

**Pre-plant** herbicides are applied before or soon after strawberry transplanting. They can only be used in establishment years.

**Soil active** herbicides are mainly active within the soil and will provide residual control of weeds as they germinate. In most cases, they should be applied before weeds emerge. These herbicides have good to marginal strawberry tolerance, depending on application timing. They can be applied at times when strawberries are actively growing.

**Post-emergence** herbicides are applied after weeds are emerged and actively growing, according to the appropriate weed stage. These herbicides can be applied during active strawberry growth, provided label directions are followed.

**Late Fall** herbicides are soil active herbicides which may cause significant crop injury if they are not applied to dormant strawberries. They should be applied before mulching in the fall and should not be applied during periods of active strawberry growth.



Table 1. Effect of Herbicides on Common Weeds.

Ratings	Pre-Plant		Soil Active					Post-Emergence					Late Fall			
	Glyphosate	Treflan/Bonanza	Dacthal	Devrinol	Dual II Magnum	Princep Nine-T	Sinbar	2,4-D amine	Betamix β	Lontrel	Poast Ultra	Venture L	Authority	Chateau	Goal 2 XL	Kerb
<p>E - Excellent                      G - Good                      F - Fair                      P - Poor                      ? - Possibly Active                      - - Unknown</p>																
<b>Annuals</b>																
<a href="#">annual grasses</a>	E	E	G	E	E	G	G	P	F	P	E	E	F	F	P	E
<a href="#">chickweed</a>	E	G	G	G	-	E	E	P	-	P	P	P	F	-	P	E
<a href="#">cleavers</a>	E	-	-	-	-	-	-	P	-	-	P	P	F	F	F	-
<a href="#">corn spurry</a>	E	F-G	F	F-G	P	G	F-G	P	-	P	P	P	F	-	P	G
<a href="#">cudweed</a>	E	-	-	E	-	E	E	F	-	E	P	P	-	-	P	-
<a href="#">dwarf snapdragon</a>	F-G	-	G	-	-	-	P	P	-	-	P	P	-	-	-	-
<a href="#">field violet</a>	E	?	E	P	-	F	F-G	P	-	P	P	P	-	-	G	-
<a href="#">groundsel</a>	E	P	P	F-G	-	P	F	F	-	E	P	P	F-G	F-G	F-G	-
<a href="#">hemp-nettle</a>	E	F-G	P	-	-	G	G	P	-	P	P	P	-	-	P	-
<a href="#">lamb's quarters</a>	E	G	G	G	F-G	E	E	E	G	P-F	P	P	G	G	G	-
<a href="#">mustards</a>	E	P	P	P	P	E	E	E	G	P	P	P	F	-	G	P
<a href="#">nightshade</a>	E	P	P	-	G	F	P	P	F	F	P	P	G	E	G	-
<a href="#">pineappleweed</a>	E	-	-	-	-	-	F-G	G	-	E	P	P	F-G	-	P	-
<a href="#">purslane</a>	F	-	G	-	-	-	-	F	-	-	P	P	F	-	G	-
<a href="#">ragweed</a>	E	-	P	G	F	E	E	G	F	E	P	P	-	G	G	-
<a href="#">redroot pigweed</a>	E	G	F	G	G	E	G	G	G	P	P	P	G	G	G	-
<a href="#">scentless chamomile</a>	E	-	P	-	-	-	G	P	-	G	P	P	F	-	P	-
<a href="#">shepherd's purse</a>	E	P	P	-	P	E	G	G	-	P	P	P	F	-	G	-
<a href="#">smartweed</a>	E	G	P	P-G	P	E	E	F-G	F	G	P	P	F	-	G	-
<a href="#">volunteer grain</a>	E	E	G	E	?	G	G	P	-	P	E	E	P	-	P	E
<a href="#">wild buckwheat</a>	E	P	P	-	P	F	G	P	G	G	P	P	G	-	G	-
<b>Perennials</b>																
<a href="#">buttercup</a>	G	F	P	G	P	P	P	P-F	-	P	P	P	-	-	P	F-G
<a href="#">Canada thistle</a>	E	P	-	F	P	-	F	G	-	E	P	P	-	-	F	-
<a href="#">daisy</a>	G	-	P	P	P	F-G	F	P	-	G	P	P	-	-	F	P
<a href="#">dandelion</a>	F	-	G	P	P	G	F-G	F-G	-	G	P	P	-	F	P	P
<a href="#">goat's beard</a>	E	-	-	-	P	-	-	F	-	G	P	P	-	-	P	P
<a href="#">ground-ivy</a>	F	P	-	-	-	-	-	P	-	-	P	P	-	-	-	-
<a href="#">horsetail</a>	P	-	P	P	P	P	-	P	-	P	P	P	-	-	P	F-G
<a href="#">mouse-eared chickweed</a>	E	F	E	-	-	-	-	P	-	P	P	P	-	-	-	-
<a href="#">plantain</a>	E	-	-	P	P	G	G	G	-	P	P	P	-	-	P	P
<a href="#">quackgrass</a>	E	P	P	P	P	P	F	P	-	P	G	G	P	-	P	G
<a href="#">sheep sorrel</a>	G	-	-	P	P	G	G	F	-	G	P	P	F	-	F	F-G
<a href="#">sow-thistle</a>	E	P	-	F	P	-	F	F	-	G	P	P	F	-	F	-
<a href="#">St. John's wort</a>	E	P	P	P	P	P	P	P	-	P	P	P	-	-	P	P
<a href="#">stitchwort</a>	E	P	P	P	P	P	F-G	P	-	P	P	P	-	-	P	F-G
<a href="#">toadflax</a>	F-G	-	?	P	P	P	P	P	-	P	P	P	?	-	P	P
<a href="#">tufted vetch</a>	F	P	P	P	P	P	P	F-G	-	E	P	P	-	-	P	P
<a href="#">yarrow</a>	G	-	-	-	P	-	E	P	-	G	P	P	-	-	P	P
<a href="#">yellow wood-sorrel (oxalis)</a>	G	?	-	P	P	-	F-G	P	-	F	P	P	G	-	G	P

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, etc. can influence presented ratings.

**Table 2. Herbicides Registered for Broadcast Application in the Planting Year**

Active Ingredient	Product	Product Rate		Application Timings	Water Volume	Application Notes (see label for additional information/precautions)
		kg or L / ha	kg or L / ac			
<b>Pre-Plant Herbicides</b>						
glyphosate	Various	5-12 L/ha (360 g/L form.)	2-4.9 L/ac (360 g/L form.)	Before Planting	50-200 L/ha (5-18 gal/ac)	Injures strawberry plants which come in contact. 30 day pre-harvest interval for spot applications.
s-metolachlor	Dual II Magnum	1.25-1.75 L/ha	0.5 – 0.7 L/ac	Before Planting	Min 150 L/ha (14 gal/ac)	Rainfall or incorporation required within 10 days for activity.
trifluralin	Treflan, Bonanza, Rival	1.2-2.3 L/ha	0.5-0.97 L/ac	Before Planting	Min 100 L/ha (9 gal/ac)	Rate depends on product and soil type. Adequate incorporation is required for weed control.
<b>Soil Active Herbicides</b>						
chlorthal dimethyl	Dacthal	13.5 kg/ha	5.5 kg/ac	Near Planting	Min 225 L/ha (20 gal/ac)	Before or soon after planting.
napropamide	Devrinol	9 kg/ha	3.6 kg/ac	Once per Year	200-900 L/ha (18-81 gal/ac)	One application per year, either after transplanting, late summer (Labour day) or late fall.
simazine	Princep Nine-T	0.56 kg/ha	0.23 kg/ac	4-6 wks after Planting or Late Summer	Min 300 L/ha (27 gal/ac)	Apply to soil with pH < 5.6 and more than 2% O.M. One application per year.
terbacil	Sinbar WDG	0.28-0.55 kg/ha	0.11-0.22 kg/ac	4-6 wks after Planting	Min 300 L/ha (27 gal/ac)	Rate depends on application timing and soil type. Refer to guide or product label. Strawberries are most tolerant in late fall, some varieties more sensitive.
		0.18-0.28 kg/ha	0.07-0.11 kg/ac	Late Summer		
		0.55-0.85 kg/ha	0.22-0.34 kg/ac	Before Mulch		
<b>Post Emergence Herbicides</b>						
2,4-D amine	2,4-D amine	500: 1.0 L/ha 600: 0.8 L/ha	500: 0.4 L/ac 600: 0.32 L/ac	2-4 wks after Planting	100-200 L/ha (9-18 gal/ac)	Use can cause significant injury. Apply before runners root.
desmedipham/ phenmedipham	Betamix β	1.15-1.75 L/ha	0.47-0.71 L/ac	After Planting	100-200 L/ha (9-18 gal/ac)	Re-apply with new weed growth. Maximum 3 applications per season. New plantings only.
fluazifop-p- butyl	Venture L	0.8-2 L/ha	0.32-0.8 L/ac	Once per Year	100-200 L/ha (9-18 gal/ac)	Control of grasses only. Low rate for annual grass control. Do not use Sinbar for 2 weeks before or after application.
sethoxydim	Poast Ultra + Merge/Assist	0.32-1.1 L/ha + 1-2 L/ha Merge or Assist	0.13-0.45 L/ac + 0.4-0.8 L/ac Merge or Assist	Once per Year	50-200 L/ha (5-18 gal/ac)	Control of grasses only. Low rate for annual grass control. Do not use Sinbar for 2 weeks before or after application.
<b>Late Fall Herbicides</b>						
flumioxazin	Chateau WDG	0.21 kg/ha	0.085 kg/ac	Before Mulch	Min 100 L/ha (9 gal/ac)	Only apply to coarse to medium textured soils with < 5% O.M. Only apply to dormant strawberry.
oxyflurofen	Goal 2XL	1 L/ha	0.4 L/ac	Before Mulch	500 L/ha (45 gal/ac)	Fall treatment prior to mulching. Apply to dormant plants when no new growth present.
propyzamide	Kerb SC	2.8 L/ha	1.1 L/ac	Before Mulch	300-500 L/ha (27-45 gal/ac)	Best when soil temperatures are low, but above freezing, with high soil moisture.
sulfentrazone	Authority	0.22-0.29 L/ha	0.09-0.12 L/ac	Before Mulch	200-400 L/ha (18-36 gal/ac)	Apply to dormant strawberries. Only apply once in two years. Follow soil type restrictions on label.

**Table 3. Herbicides Registered for Broadcast Application in the Fruiting Year**

Active Ingredient	Product	Product Rate		Application Timing	Water Volume	Pre Harvest Interval (Days)	Application Notes (see label for additional information/precautions)
		kg or L / ha	kg or L / ac				
<b>Soil Active Herbicides</b>							
chlorthal dimethyl	Dacthal	9-13.5 kg/ha	3.6-5.5 kg/ha	Early Spring and/or Before Mulch	Min 225 L/ha (20 gal/ac)	None available	Late fall or early spring before bloom
napropamide	Devrinol	9 kg/ha	3.6 kg/ac	Once per Year	200-900 L/ha (18-81 gal/ac)	None available	One application per year, either early spring, late summer (Labour Day) or late fall
s-metolachlor	Dual II Magnum	1.25-1.75 L/ha	0.5 – 0.7 L/ac	Early Spring	Min 150 L/ha (14 gal/ac)	30	PRE to weeds soon after mulch removal, rainfall or incorporation required within 10 days for activity.
simazine	Princep Nine-T	0.9-1.8 kg/ha	0.36-0.72 kg/ac	After Mowing or Before Mulch	Min 300 L/ha (27 gal/ac)	None available	After renovation or late fall, one application per year. Apply to soil with pH < 5.6 and more than 2% O.M.
terbacil	Sinbar WDG	0.28-0.35 kg/ha	0.11-0.14 kg/ac	Early Spring	Min 300 L/ha (27 gal/ac)	None available	Rate depends on application timing and soil type. Refer to guide or product label. Strawberries are most tolerant in late fall, some varieties more sensitive.
		0.70-0.85 kg/ha	0.28-0.34 kg/ac	After Mowing			
		0.55-0.85 kg/ha	0.22-0.34 kg/ac	Before Mulch			
<b>Post Emergence Herbicides</b>							
2,4-D amine	2,4-D amine	500: 2 L/ha 600: 1.7 L/ha	500: 0.8 L/ac 600: 0.69 L/ac	Before Renovation	100-200 L/ha (9-18 gal/ac)	None available	Apply after harvest and wait 2-3 days to renovate field. Treatment may cause temporary leaf injury.
clopyralid	Lontrel	0.56-0.83 L/ha	0.23-0.33 L/ac	Before Renovation	150-200 L/ha (14-18 gal/ac)	None available	Apply after harvest and wait 7-10 days to renovate field.
fluazifop-p-butyl	Venture L	0.8-2 L/ha	0.32-0.8 L/ac	Once per Year	100-200 L/ha (9-18 gal/ac)	30	Control of grasses only. Low rate for annual grass control. Do not use Sinbar for 2 weeks before or after application.
sethoxydim	Poast Ultra + Merge/Assist	0.32-1.1 L/ha + 1-2 L/ha Merge or Assist	0.13-0.45 L/ac + 0.4-0.8 L/ac Merge or Assist	Once per Year	50-200 L/ha (5-18 gal/ac)	25	Control of grasses only. Low rate for annual grass control. Do not use Sinbar for 2 weeks before or after application.
<b>Late Fall Herbicides</b>							
flumioxazin	Chateau WDG	0.21 kg/ha	0.085 kg/ac	Before Mulch	Min 100 L/ha (9 gal/ac)	None available	Only apply to coarse to medium textured soils with < 5% O.M. Only apply to dormant strawberry.
oxyflufen	Goal 2XL	1 L/ha	0.4 L/ac	Before Mulch	500 L/ha (45 gal/ac)	150	Apply to dormant plants when no new growth present.
propyzamide	Kerb SC	2.8 L/ha	1.1 L/ac	Before Mulch	300-500 L/ha (27-45 gal/ac)	None available	Best when soil temperatures are low, but above freezing, with high soil moisture.
sulfentrazone	Authority	0.22-0.29 L/ha	0.09-0.12 L/ac	Before Mulch	200-400 L/ha (18-36 gal/ac)	70	Apply to dormant strawberries. Only apply once in two years. Follow soil type restrictions on label.

**Table 4. Planting Year Herbicide Options**

Herbicide Timing and Weed Problem	Pre-Plant	At Transplanting	2-4 Weeks after Transplanting	4-6 Weeks after Transplanting	Late Summer	Late Fall
Post emergent grass and broadleaf weed control	Glyphosate (Broadcast)		Glyphosate (Wiping, spot spray)			
Soil applied grass and broadleaf weed control (from seed)	Treflan/Bonanza (1) Dual II Magnum (1) Dacthal (1)	Dual II Magnum (1) Dacthal (1)	Devrinol (1)	Princep Nine-T (1) Sinbar	Devrinol (1) Princep Nine-T (1) Sinbar	Devrinol (1) Chateau (1) Sinbar, Kerb Authority (1)
Post emergent grass control			Venture L (1,2) Poast Ultra (1,2)			
Post emergent broadleaf weed control		Betamix $\beta$	2,4-D amine (1)			Goal 2XL (1)

Note: (1) Only one application per year permitted

(2) Observe caution regarding applications in sequence with Sinbar

**Table 5. Fruiting Year Herbicide Options**

Herbicide Timing and Weed Problem	Early Spring	Renovation (Prior to Mowing)	Soon After Renovation	Late Summer	Late Fall
Post emergent grass and broadleaf weed control	Glyphosate (Wiping, spot spray)	Glyphosate (Wiping, spot spray)		Glyphosate (Wiping, spot spray)	Glyphosate (Wiping, spot spray)
Soil applied grass and broadleaf weed control (from seed)	Devrinol (1) Dual II Magnum (1) Sinbar Dacthal		Princep Nine-T (1) Sinbar	Devrinol (1)	Devrinol (1) Princep Nine-T (1) Sinbar Authority (1) Dacthal, Kerb Chateau (1)
Post emergent grass control	Venture L (1,2) Poast Ultra (1,2)	Venture L (1,2) Poast Ultra (1,2)		Venture L (1,2) Poast Ultra (1,2)	
Post emergent broadleaf weed control		Lontrel (1) 2,4-D amine (1)			Goal 2XL

Note: (1) Only one application per year permitted

(2) Observe caution regarding applications in sequence with Sinbar

Respect Pre-Harvest Intervals when applying herbicides before harvest



Table 6. Additional Information for Herbicides Used on Strawberry

Active Ingredient	Product	Group	Hazard	Protection Equipment	Buffer Zone (metres)		Restrictions (hours)		Herbicide Activity		Leaching Potential	Bee Toxicity	Winter Storage
					Water <1m	Terrestrial Habitat	Rain-free Period	Re-Entry Interval	Foliar	Soil			
2,4-D amine	2,4-D amine	4	Warning	d f g j	1	1	4	12	yes	no	moderate	low	B
chlorthal dimethyl	Dacthal	3	Caution	a f g m	-	-	0	12	no	yes	very low	low	C
clopyralid	Lontrel	4	Caution	b f j	-	2	4	12	yes	no	low to moderate	low	A
desmedipham/phenmedipham	Betamix β	5	Warning	a f g j	1	1	6	24	yes	no	low	low	C
fluazifop-p-butyl	Venture	1	Caution	b e h j	15	15	2	12	yes	no	very low	low	C
flumioxazin	Chateau	14	Caution	d f g m	3	10	0	12	limited	yes	low	low	C
glyphosate	Various	9	Caution	a f j	15	15	1-6	12	yes	no	extremely low	low	B
napropamide	Devrinol	15	Warning	b f g	1	15	0	12	limited	yes	moderate	low	C
oxyflurofen	Goal 2XL	14	Danger	d f h j	10	7	3	24	yes	limited	extremely low	low	A
propyzamide	Kerb SC	15	Caution	d f h	-	5	0	24	limited	yes	low	low	A
s-metolachlor	Dual II Magnum	15	Danger	a g l	29	-	0	12	no	yes	moderate to high	low	B
sethoxydim	Poast Ultra	1	Caution	d f h j	0	1	1	12	yes	no	low	low	B
simazine	Princep Nine-T	5	Warning	d f h j	1	10	0	12	no	yes	high	low	C
sulfentrazone	Authority	14	Caution	a f g	1	10	0	12	limited	yes	moderate	low	B
terbacil	Sinbar	5	Caution	a g j	10	35	0	12	limited	yes	very high	low	C
trifluralin	Treflan, Rival, Bonanza	3	Caution	a f	55	1	0	12	no	yes	very low	low	A

**Pre Harvest Interval (PHI):** The minimum number of days between the last application of the pesticide and harvest.

**Protection Equipment:** a - long-sleeved shirt and long pants, b - coveralls or disposable spray suit, d - coveralls or disposable spray suit over long sleeved shirt and pants, e - waterproof gloves, f - chemically-resistant gloves, g - shoes plus socks, h - chemically resistant footwear plus socks, j - protective eye wear, l - chemically resistant head gear for overhead application, m - approved respirator, n - chemical-resistant spray suit.

**Winter Storage:** Winter storage requirement codes are: **A** - Do not allow to freeze, **B** - Preferably should not freeze. If frozen, return to original state by allowing product to warm to 10-20°C and agitate thoroughly before use, **C** - Not usually damaged by freezing. Store in cool dry place.

Pesticide Emergency Information	
Poison Control Centres	
New Brunswick	Dial 911, ask for Poison Information
Newfoundland	Dr. Charles A. Janeway Child Healthcare Centre, St. John's (709) 722-1110
Nova Scotia Prince Edward Island	The Izaak Walton Killam Hospital for Children, Halifax 1-800-565-8161
Environmental Pesticide Spill	
New Brunswick Prince Edward Island Nova Scotia	1-800-565-1633
Newfoundland	1-800-563-9089
Pesticide Websites	
Pesticide Label Search	
<a href="http://pr-rp.hc-sc.gc.ca/lr-re/index-eng.php">http://pr-rp.hc-sc.gc.ca/lr-re/index-eng.php</a>	
Drift Mitigation	
<a href="#">Buffer Zone Calculator Link</a>	

Helpful Conversions	
Units	
kPa x 0.14 = pounds per square inch	
hectares x 2.47 = acres	
kilograms x 2.2 = pounds	
1000 grams (g) = 1 kilogram (kg)	
millilitres x 0.035 = fluid ounces	
litres x 35 = fluid ounces	
litres x 0.22 = imperial gallons	
1000 millilitres (mL) = 1 Litre (L)	
°F = (°C x 9/5) + 32	
°C = (°F-32) x 5/9	
miles per hour x 1.61 = km per hour	
5 mL = 1 tsp	
Volume per Area	
kg per ha x 0.89 = pounds per ac	
kg per ha x 0.40 = kilograms per ac	
g per ha x 0.015 = ounces per ac	
tonnes per ha x 0.45 = tons per ac	
L per ha x 0.40 = litres per ac	
L per ha x 0.09 = gallons per ac	
L per ha x 14.17 = fluid ounces per ac	
L per ha x 0.71 = pints per acre	
mL per ha x 0.015 = fl. ounces per ac	
L per ha x 0.11 = US gallons per ac	
L per ha x 0.86 = US pints per ac	

Abbreviations	
Formulation	Measurements
DF Dry flowable	ac acre
EC,E Emulsifiable concentrate	g gram
F Flowable	g.a.e. grams acid equivalent
G Granular	ha hectare
L Liquid	kg kilogram
LV Low Volatile	kPa kilopascal
SC Suspension concentrate	L litre
Sn Solution	m metre
SP Soluble Powder	mL millilitre
WDG Water Dispersible	psi pounds per square inch
WP,W Wetable Powder	% v/v percent volume to volume
WSP Water Soluble Pouches	
Personal Protection Equipment	
Gloves	
e - waterproof gloves f - chemical resistant gloves	
Head and Lung	
j - eye protection, application m - approved respirator	
l - chemically resistant headgear for overhead application	
Clothes	
a - long-sleeved shirt/pants b - coveralls or disposable spray suit	
d - coveralls or disposable spray suit over long sleeved shirt/pants	
n - chemical-resistant spray suit	
Footwear	
g - shoes plus socks h - chemically resistant footwear plus socks	

**Hazard:** The signal words Danger, Warning and Caution appear on the pesticide label and indicate the level of hazard associated with handling or using the product. Products bearing the signal word **Danger** have an extreme or high hazard rating. Products labeled **Warning** have a moderate hazard rating and a **Caution** warning is associated with a low level of hazard. The degree of hazard may be due to toxicity, flammability, explosiveness or corrosiveness.

**Group:** Weed Science Society of America's nationally accepted grouping of herbicides based on site of action.

**Buffer Zones:** Distance between the closest point of direct pesticide application and the nearest downwind edge of sensitive terrestrial habitats (such as grasslands, forested areas, shelter belts, woodlots, hedgerows, riparian areas and shrublands) and sensitive freshwater habitats (such as lakes, rivers, sloughs, ponds, prairie potholes, creeks, marshes, streams, reservoirs and wetlands). Water < 1m refers to wet areas with less than 1 meter of water depth. All buffer zones are for boom sprayers unless indicated. A buffer zone calculator is available [here](#).

**Rain-free Period:** The recommended minimum time in hours between pesticide application and rain. If rain occurs during the rain-free period, pest control may be significantly reduced.

**Restricted-Entry Interval (REI):** The minimum time in hours before you can enter a field that has been treated with the pesticide without wearing appropriate protective equipment.

**Leaching Potential:** The potential for a pesticide to be leached or carried by surface run-off is determined by characteristics of both the pesticide and the field. Surface slope, proximity to surface water, low organic matter content, depth to aquifer and heavy rainfall are some of the factors which lead to run-off and leaching problems when combined with pesticides of a moderate to high leaching potential.

**Herbicide Activity: Foliar** – Indicates whether or not susceptible weeds will be controlled by herbicide contact with above ground plant tissue (leaves). **Soil** – Indicates whether or not late emerging susceptible weeds will be controlled as they germinate from the soil by residual herbicide activity for some time after application.

**Bee Toxicity:** Degree of toxicity to honey bees. If possible, all pesticide applications should be avoided during times of bee activity within fields, such as mid-day during bloom periods.