
STRAWBERRY IPM

- WEED MANAGEMENT GUIDE



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INTRODUCTION

One of the greatest challenges facing strawberry growers is weed control. Strawberry plants are relatively slow growing and are poor competitors. As a result, weeds quickly invade and establish within bare areas. Strawberries are also particularly subject to weed infestations because they are kept in production for several years. During that time, weed populations change within strawberry fields, from annuals in the first year to a mixture of annuals and perennials in the following years. Management practices also influence weed shifts and types of weeds observed.

To control weeds over the life of the strawberry planting, a good weed management program must be devised. This program starts at least one year before planting and continues throughout the duration of the planting. A good program does not rely on any one control method, but instead it must encompass a multitude of control measures.

A strawberry 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.

When developing a weed management program following the principles and practices of IPM it 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, one of the crucial first steps 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.

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

A) Annuals

Annual weeds can be classified as either summer or winter annuals. Many weeds can act as both. In order to devise an effective weed control program, it is important to distinguish between the two.

1. 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.

A common characteristic of summer annuals is a rapid rate of growth and prolific seed production. This rapid early weed growth is detrimental to strawberry plants, especially during the planting year when summer annuals predominate. Summer annual seedlings that emerge in the fall are usually killed by frost. Summer annuals can be controlled by combined use of herbicides and tillage.

2. Winter annuals

Winter annuals germinate from late August through early November and over-winter as small plants called rosettes. The following spring, winter annuals bolt (grow very quickly), flower, produce seed, and later die. Most weeds that behave as winter annuals can also germinate in early spring when soil temperatures are low and then act as summer annuals.

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 and common chickweed.

B) Biennials

Biennial weeds germinate in the spring, grow vegetatively during the first growing season, overwinter as a rosette, 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.

C) Perennials

Perennial weeds persist year after year and are the most difficult to control once established. All 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 like Canada thistle and quack grass produce large clones (colonies) or patches of plants that arise from spreading underground rootstocks or rhizomes. These are called creeping perennials. Creeping perennials such as sheep sorrel and toadflax, readily reproduce by both seed and vegetative means and are more difficult to control.

To have a strawberry planting free of quack grass and other perennials, the vegetative structures should be destroyed prior to planting. This can be done through the use of herbicides and tillage.

Perennial seedlings in strawberry fields must be controlled as they emerge by cultivation and/or pre-emergence herbicides. Dandelions and toadflax germinate profusely in late spring and early summer, whereas ox-eye daisy and sheep sorrel germinate mainly during early fall. An appropriate pre-emergence herbicide must be present in the soil at levels effective for control of seedlings at both times of the year.

Three excellent publications used in the identification of weeds are:

1. WEED IDENTIFICATION GUIDE (ISBN 0-88871-171-9)

The Bookstore
Nova Scotia Agricultural College
P.O. Box 550
Truro, N.S. B2N 5E3
(902) 893-6728 (phone)
(902) 893-6515 (fax)
email: abrownfulton@nsac.ns.ca

2. ONTARIO WEEDS Publication 505 (ISBN 0-7729-9691-1)

Government Information Centre
1 Stone Rd. W., Ground Floor,
Guelph, ON. N1G 4Y2
(519) 826-3700 (phone)
email: products@omaf.gov.on.ca

3. IDENTIFICATION GUIDE TO THE WEEDS OF QUEBEC (ISBN 2-89457-174-7)

Distribution de Livres UNIVERS
845, rue Marie-Victorin
Saint-Nicolas (Quebec) G7A 3S8
1-800-859-7474 (phone)
(418) 831-4021 (fax)
email: d.univers@videotron.ca

II. SCOUTING

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

Scouting involves walking your strawberry fields in a pattern (e.g. "M" pattern) which allows you to monitor for potential weed problems across your entire field(s). Mapping the fields for weeds from year to year is helpful in monitoring changes in weed species, weed densities, and distribution. The management strategy must target the dominant weeds, while preventing the spread of others.

The following should be documented when scouting and mapping:

- ***the weed species with its life cycle*** - annual, biennial, perennial.
- ***the size or growth stage of the weed*** - seedling, small, medium, large, flowering, seed formed.
- ***the density of the weeds*** - counts, or categorize as light, moderate, severe.
- ***the distribution*** - uncommon, scattered throughout, a few patches, numerous patches, common throughout.
- ***the location of the weed infestations on a map.***

For **planting year** strawberries, 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**, strawberry scouting should be done at least four times during the growing season. The first scouting should be in early spring soon after mulch removal, the second just prior to renovation; the third in late summer, and the fourth in October. By monitoring at these times it will help you predict which weeds may cause problems in the future and provide you time to devise a weed control strategy for the observed weeds. In addition, scouting will provide an opportunity to evaluate previous control measures.

In addition to scouting for weeds, any herbicide injury observed 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

There has been little research 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. In order to make a knowledgeable decision, growers must be scouting and monitoring their fields and continuously observing weeds and their competitive effect on the crop.

In some instances, weed control decisions will have to be made even when the cost of controlling a weed may be more than the immediate damage inflicted by the weed. For example, the success of U-pick operations are 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 their weed problem and determine when and what level of weed control is required for their own farm. By understanding the biology, survival mechanisms and reproductive capabilities of the weeds, one must also be able to predict potential long-term effects of a weed that is not controlled.

IV CONTROL METHODS

With the knowledge of the weeds present on your farm and 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 the methods that optimize costs and effect, while minimizing any adverse effects. The most economical and effective strawberry weed management program combines preventive, cultural, biological, mechanical and chemical practices.

A) Preventive

Preventive weed control includes all practices that prevent the introduction and spread of weeds. It is therefore important to be aware of activities which can introduce new weeds and to control them as they first appear. This will help minimize any buildup and spread of new weed introductions.

Another preventive practice is to clean farm equipment between fields. This is important as 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.

Preventing seed production will also help prevent weeds from spreading. Keeping weeds in ditches, field edges, under fences and roadsides under control can minimize the introduction of new problem weeds. It is also advisable to keep the edge around ponds as clean as possible and to use

appropriate filters or screens to help prevent weed seed spread through the irrigation system.

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 before harvest to check for weeds.

B) Cultural

Cultural controls involve the manipulation of common strawberry cropping practices to favour the crop over competing weeds. The objective is to encourage the development of healthy and vigorous strawberry plants which can withstand some weed competition or out compete the weeds. The sooner strawberry rows fill in, the more competitive the strawberry plants.

Examples of important practices in the successful establishment of strawberries include: selecting sites that have no history of perennial weeds or where they have been previously controlled, selecting cultivars that grow best in your area, early planting, using proper plant and row spacing, timely and proper fertility, timely irrigation, proper renovation of beds, and timely and effective pest control.

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. It 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, however.

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 root reserves through continuous destruction of the top growth.

Perennial weeds, which have an extensive and deep root or rhizome system, are more difficult to control than those with a shallow, less extensive root or rhizome system. 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.

After planting, cultivation is an important tillage practice. Early season cultivation takes place between the plants and rows. As runners fill in, cultivation between the plants becomes impossible and takes place only between 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 strawberry rows widen with the rooting of runners, the area actually being cultivated will be reduced.

Cultivation should continue throughout the season as required and may also be necessary when herbicide effectiveness has been lost. A clean cultivation prior to the application of a herbicide that is not effective on emerged weeds may also be required. In general, shallow cultivation is preferred over deep cultivation.

Cultivation following after-harvest renovation is another option. Once the rows have been narrowed, growers can start to cultivate. In very weedy strawberry fields, it is helpful to renovate and narrow the rows to 30 to 36 cm (12 – 14 inches). Cultivation should start close to the strawberry plants and move outward as the strawberry row expands.

2. Hand-weeding.

Hand-weeding is necessary if weed-free strawberry fields are to be obtained. Chemical, biological, preventive or mechanical control alone will not control all weeds. Hand-weeding is important and often the difference between clean and weedy strawberry fields. It is, however, time consuming and expensive. Growers must determine how clean their fields must be in order to not suffer 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 and 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 possible in many instances. However, hand-pulling perennials can be effective in preventing seed production.

If fields have both flowering and non-flowering weeds, flowering weeds should be removed first in order to avoid the formation and dropping of seeds. It is also important to remove flowering weeds from the field, as many can still produce viable seed when laying on the soil surface. Hand-pulling is easier following a rain or after irrigating when the soil is wet.

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 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 practiced in strawberry production as a renovation procedure and not usually as a weed control method. Mowing has limited value, as a method of 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. Mowing field edges and parking areas to prevent the spread of unwanted weeds is also recommended. Timing of mowing around strawberry fields is important however, as mowing could encourage insect pests to move into the strawberry field.

E) CHEMICAL

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

Herbicides used within strawberry fields are either selective or nonselective. Following labeled 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 however, they are no longer selective and can cause severe crop injury. Nonselective herbicides can kill both weeds and crop plants (e.g. Roundup) and caution must be exercised when applying them.

Strawberry herbicides are applied either preplant 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, whereas the post 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. 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, 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-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 labeled 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 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.

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

- 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.
- Year 2. 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 airblast 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 therefore 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, Fisheries and Aquaculture **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 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).

NOTES ON HERBICIDES REGISTERED FOR USE IN STRAWBERRIES

***Note:** Herbicide label information over- rules 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. See Table 1 for weeds susceptibility to the herbicides listed below, and Tables 2 and 3 for planting year and fruiting year herbicide options respectively. See tables 4 and 5 for specific characteristics and requirements for the listed strawberry herbicides.*

1. Dacthal 75WP (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 therefore provides poor control of most emerged weeds. It will control field violet in the cotyledon (seed leaf) stage, however.

Planting Year. Dacthal can be applied **before planting** as a pre-plant incorporated treatment or **soon after planting** as a pre-emergence treatment. Registered rates are 13.5 to 15.5 kg/ha (5.5 to 6.25 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).

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.

2. 2,4-D amine 500 (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.

Planting Year. 2,4-D amine 500 is registered for use **2 to 4 weeks after planting**, but before runners root. The registered rate for this timing is 1.1 L/ha (0.45 L/acre), and 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. 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) for control of dandelion, plantain, burdock, wild carrot, primrose, daisy fleabane and many seedling annuals. 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 4 to 6 days after application in order to

minimize 2,4-D amine movement into the strawberry crown and new runners.

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.

3. Devrinol 50 DF (napropamide)

Devrinol can be used to control germinating volunteer cereals, annual grasses (e.g. annual blue grass, foxtails, barnyard grass, large crabgrass) and some broadleaf weeds (e.g. 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 daughter plants have 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.

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).

Devrinol should never be applied during active runnering and daughter plant establishment, as rooting may be inhibited. 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.

4. 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 (preplant incorporated only), and for suppression of redroot pigweed. Dual II Magnum's strength is generally on annual grasses. Pre-emergent applications sometimes provides better control of nightshades than preplant incorporated applications.

Planting year. Dual II Magnum is registered for use at 1.25 to 1.75 L/ha (0.5 to 0.7 L/acre) either as a **preplant incorporated** or **pre-emergent treatment after planting**. Only one application per year is permitted. Apply in a minimum of 150 L water per hectare (60 L/acre). Some initial injury may result but it is temporary and does not reduce yields the following year. The higher rate is recommended where the weed pressure is high. Do not apply Dual II Magnum to the cultivar Joliette.

For preplant incorporation applications, immediate incorporation is not necessary. 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, apply to firm, lump-free soils. In order to be activated, rainfall or a shallow incorporation must occur within 10 days of application.

5. 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 crop 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.

6. Kerb 50 WP (propyzamide)

Fruiting Years. Kerb applied at 2.25 kg per hectare (0.9 kg/acre) in **late fall** prior to mulching and freeze-up, will provide short-term control of most established perennial grasses, including quack grass. Control often breaks 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 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 therefore 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, however.

Kerb inhibits cell division in roots and shoots of over-wintering susceptible weeds. It is only active when applied to the soil.

7. Lontrel 360 EC (clopyralid)

Lontrel is a growth regulator herbicide that works similar to 2,4-D amine. Lontrel is particularly effective against weeds in the legume, composite and smartweed families, such as vetch, daisy and sheep sorrel, respectively. It will control or suppress a number of important annual and difficult-to-control perennial weeds. However, not all members of the legume, composite and smartweed 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.

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 is to be applied only once per year. Lontrel does not provide residual control of emerging weeds and must therefore be applied directly to the foliage.

Strawberry plants generally show satisfactory tolerance to Lontrel when applied properly. 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 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.

8. 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 high density weeds and quack grass. 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.

9. 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's and strawberry plant injury has been observed on soils having a pH greater than 5.6. Injury is not always observed however, and other factors may be involved.

Do not use Princep Nine-T on soils containing less than 2% organic matter. It is recommended that you test Princep Nine-T on a small area before wide spread use. Strawberry plants injured by Princep Nine-T develop chlorotic (yellow) and necrotic (dead) leaves.

Planting Year. Two applications of Princep Nine-T can be made during the planting year.

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.

A second application of 0.56 kg/ha (0.23 kg/acre) can be made **in late summer through early fall** to control germinating winter annuals and seedlings of some perennial weeds. Emerged weeds will not be controlled. Moisture is required for activation.

Fruiting Years. Princep Nine-T can also be used following **post-harvest renovation** and during **late fall** in fruited fields. Apply 0.9 to 1.8 kg/ha (0.36 to 0.72 kg/acre) at each 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. Do not exceed 3.0 kg/ha (1.2 kg/acre) total application in one growing season.

Apply Princep Nine-T in a minimum of 300 L of water per hectare (121 L/acre).

10. Roundup Original, Roundup Transorb, Touchdown 480, Touchdown IQ, Credit, Vantage, Vantage Plus, Factor and Glyphos (glyphosate)

The active ingredient in ROUNDUP ORIGINAL, ROUNDUP TRANSORB, TOUCHDOWN 480, TOUCHDOWN IQ, CREDIT, VANTAGE, VANTAGE PLUS, FACTOR and GLYFOS is glyphosate. 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.

Site Preparation. Glyphosate is used mainly for site preparation 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.

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 on to strawberry plants or other desirable vegetation.

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). 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 and for providing short-term (seasonal) control of quack grass and other perennial weeds.

Quack grass should have 3 to 5 leaves present before application. Most perennial broadleaf weeds are most sensitive near flowering.

Where dandelions are a serious 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 worked 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 to allow 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.

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.

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.

11. Sinbar 80 WP (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 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, and Cavendish 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 they must be very small to 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, but no later than **mid-September**, to provide control of fall germinating annual and perennial weeds. A third application of 0.65 to 0.85 kg per hectare (0.26 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.

Sinbar may be used in sequence with applications of either Princep Nine-T or Devrinol. This 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**. 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. This treatment should only be used if there are significant numbers of germinating summer annual

weeds and strawberry plants have overwintered well. Strawberry plants tend to be more sensitive to spring applications.

Following **renovation**, Sinbar can be applied at 0.65 to 0.85 kg /ha (0.26 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 0.65 to 0.85 kg per hectare (0.26 to 0.34 kg/acre) will provide residual weed control the following spring. 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 of Venture L/Fusilade II or Poast Ultra applications, as crop tolerance to Sinbar will be reduced.

12. Treflan 480 EC, Bonanza 400 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 rotovator (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 1.25 to 2.4 L/ha (0.5 to .97 L/acre); Rival 500 EC from 1.2 to 2.2 L/ha (0.48 to 0.89 L/acre); or Bonanza 400 from 1.5 to 2.75 L/ha (0.6 to 1.1 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.

13. 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.

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 translocates 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.

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, sensitive cultivars and weak plants growing under unfavorable 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 strawberries are most capable of tolerating recommended herbicide treatment rates.

Newly planted and actively running strawberries are especially sensitive to herbicides. Crop tolerance 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.

Light, sandy soils require less herbicide than 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%).

To minimize the risk of crop injury it is important to not exceed the maximum recommended annual application rates and to fully understand and follow the instructions on the product labels. Do not expect herbicides to control all weed problems. Some hand work and cultivation will be required to obtain good weed control.

Table 1. Effect of herbicides on some common 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, etc. can influence presented ratings.

WEED	PRE-PLANT		PRE-EMERGENCE						POST EMERGENCE				
	Glyphosate (Roundup and others)	Treflan/ Rival/ Bonanza	Dacthal	Dual II Magnum	Keib	Sinbar	Devrinol	Princep Nine-T	2,4-D amine 500	Venture L	Poast Ultra	Lontrel	Goal
PERENNIALS													
buttercup	G	F	P	P	F-G	P	G	P	P-F	P	P	P	P
daisy	G	-	P	P	P	F	P	F-G	P	P	P	G	P
dandelion	F	-	G	P	P	F-G	P	G	F-G	P	P	G	P
goat's-beard	E	-	-	P	P	-	-	-	F	P	P	G	P
horsetail	P	-	P	P	F-G	-	P	P	P	P	P	P	P
plantain	E	-	-	P	P	G	P	G	G	P	P	P	P
quack grass	E	P	P	P	G	F	P	P	P	G	G	P	P
sheep sorrel	G	-	-	P	F-G	G	P	G	F	P	P	G	P
St. John's-wort	E	P	P	P	P	P	P	P	P	P	P	P	P
stitchwort	E	P	P	P	F-G	F-G	P	P	P	P	P	P	P
toadflax	F-G	-	?	P	P	P	P	P	P	P	P	P	P
tufted vetch	F	P	P	P	P	P	P	P	F-G	P	P	E	P
yarrow	G	-	-	P	P	E	-	-	P	P	P	G	P
yellow wood-sorrel	G	?	-	P	P	F-G	P	-	P	P	P	F	G
ANNUALS													
annual grasses	E	E	G	E	E	G	E	G	P	E	E	P	P
chickweed	E	G	G	-	E	E	G	E	P	P	P	P	P
corn spurry	E	F-G	F	P	G	F-G	F-G	G	P	P	P	P	P
cudweed	E	-	-	-	-	E	E	E	F	P	P	E	P
field violet	E	?	E	-	-	F-G	P	F	P	P	P	P	G
groundsel	E	-	P	-	-	F	F-G	P	F	P	P	E	G?
hempnettle	E	F-G	P	-	-	G	-	G	P	P	P	P	P
lamb's quarters	E	G	G	F-G	-	E	G	E	E	P	P	P-F	G
mustards	E	P	P	P	P	E	P	E	E	P	P	P	P
nightshade	E	P	P	G	-	P	-	F	P	P	P	F	G
pineapple weed	E	-	-	-	-	F-G	-	-	G	P	P	E	P
purslane	F	-	G	-	-	-	-	-	F	P	P	-	G
ragweed	E	-	P	F	-	E	G	E	G	P	P	E	P
redroot pigweed	E	G	F	G	-	G	G	E	G	P	P	P	G
scentless chamomile	E	-	P	-	-	G	-	-	P	P	P	G	P
shepherd's-purse	E	P	P	P	-	G	-	E	G	P	P	P	G
smartweed	E	G	P	P	-	E	P-G	E	F-G	P	P	G	P
volunteer grain	E	E	G	?	E	G	E	G	P	E	E	P	P
wild buckwheat	E	P	P	P	-	G	-	F	P	P	P	G	G

Control Ratings E – Excellent; G – Good; F – Fair ; P – Poor ; ? - Possibly effective ; (-) unknown

Table 2. Planting year herbicide options.

HERBICIDE TIMING AND WEED PROBLEM	PREPLANT	AT TRANS-PLANTING	2-4 WEEKS	4-6 WEEKS	LATE SUMMER	LATE FALL
Post emergent grass and broadleaf weed control	Glyphosate (e.g. Roundup, Touchdown, Glyfos)		Glyphosate (e.g. Roundup, Touchdown, Glyfos) (wiping or spot spray)*	→		
Soil applied grass and broadleaf weed control (from seed)	Treflan/Rival/Bonanza* Dual II Magnum* Dacthal*	Dacthal*	Devrinol* Dual II Magnum*	Sinbar Princep Nine-T	Sinbar Princep Nine-T Devrinol*	Sinbar Devrinol*
Post emergent grass control			¹ Venture L* ¹ Poast Ultra*	→		
Post emergent broadleaf weed control			2,4-D amine*			Goal 2XL*

* only one application per year permitted

¹ Observe caution regarding applications in sequence with Sinbar.

Table 3. 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 (e.g. Roundup, Touchdown, Glyfos) (wiping or spot spray)*	Glyphosate (e.g. Roundup, Touchdown, Glyfos) (wiping or spot spray)*		Glyphosate (e.g. Roundup, Touchdown, Glyfos) (wiping or spot spray)*	Glyphosate (e.g. Roundup, Touchdown, Glyfos) (wiping or spot spray)*
Soil applied grass and broadleaf weed control (from seed)	Sinbar Devrinol* Dacthal		Sinbar Devrinol* Princep Nine-T	Devrinol *	Devrinol* Princep Nine-T Sinbar Dacthal Kerb*
Post emergent grass control	¹ Venture L* ¹ Poast Ultra*	¹ Venture L* ¹ Poast Ultra*		¹ Venture L* ¹ Poast Ultra*	Kerb*
Post emergent broadleaf weed control		Lontrel* 2,4-D amine*			Goal 2XL*

* Only one application per year permitted.

** respect preharvest intervals when applying herbicides before harvest

¹ Observe caution regarding applications in sequence with Sinbar.

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 strawberries.

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
2,4-D amine 500	no	yes	4	N/A*	A	Relatively non toxic
Dacthal 75WP	yes	no	0	N/A	C	Relatively non toxic
Devrinol 50 DF	Yes	limited	0	N/A	C	Relatively non toxic
Dual II Magnum	yes	no	0	N/A	B	Relatively non toxic
Goal 2XL	limited	yes	3	150	A	Relatively non toxic
Kerb 50 WP	yes	limited	0	N/A	C	Relatively non toxic
Lontrel 360	no	yes	4 to 6	N/A	A	Relatively non toxic
Poast Ultra	no	yes	1	25	B	Relatively non toxic
Princep Nine-T	yes	no	0	N/A	C	Relatively non toxic
Roundup	no	yes	varies	30	B	Relatively non toxic
Sinbar 80 WP	yes	limited	0	N/A	C	Relatively non toxic
Treflan	yes	no	0	N/A	A	Relatively non toxic
Venture L	no	yes	2	30	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 have been applied before rainfall. If rainfall occurs during the rain-free period, control may be significantly reduced. Reference: *Ontario Ministry of Agriculture, Food and Rural Affairs. 2002. Guide to Weed Control – Publication 75. Toronto, ON: Queens Printer for Ontario. 331 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 °C and agitate thoroughly before use.
 - C** - Not usually damaged by freezing. Store in a cool, dry place.
 Reference: *Ontario Ministry of Agriculture, Food and Rural Affairs. 2002. Guide to Weed Control – Publication 75. Toronto, ON: Queens Printer for Ontario. 331 p.*
- 6. Bee toxicity.** Degree of toxicity to bees. Reference: *Exttoxnet : <http://ace.orst.edu/info/exttoxnet/ghindex.html>*

Table 5. The oral and dermal LD₅₀, restricted entry interval, herbicide movement rating and average soil half-life of herbicides registered for use in strawberries.

Herbicide	Oral LD ₅₀ ¹ (rat) (mg/kg)	Dermal LD ₅₀ ² (rabbit) (mg/kg)	Restricted- entry interval (REI) ³ (hours)	Herbicide movement rating ⁴	Average half- life ⁵ (days)
2,4-D amine 500	625-950	>1000	48	moderate	<10
Dacthal 75 WP	>10,000	>10000	12-24	very low	60-100
Devrinol 50 DF	5000	>4640	12	moderate	70
Dual II Magnum	2267	2020	12	moderate to high	43
Goal 2XL	>2000	>2999	24	extremely low	20-35
Kerb 50 WP	>5000	>2000	24	low	60
Lontrel 360 EC	>5000	>5000	12	low to moderate	14-56
Poast Ultra	>4000	>5000	12	low	4-11
Princep Nine-T	>5000	>2000	12	high	60
Roundup	> 5000	>5000	12	extremely low	47
Sinbar 80 WP	5000-7500	>5000	12	very high	120
Treflan	3738	>5000	12	very low	100 -120
Venture L	2451	>2076	12	very low	15

- 1. Oral LD₅₀** (Lethal Dose₅₀). The oral LD₅₀ 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 LD₅₀ value, the more toxic the pesticide. See Table 6. *Reference: Agrichemical Warehousing Standards Association. 2003. MSDS Reference Canadian Crop Protection Products. Hensall, ON: North American Compendiums Ltd. 679 p.*
- 2. Dermal LD₅₀** (Lethal Dose₅₀). The dermal LD₅₀ 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 LD₅₀ value, the more toxic the pesticide. See Table 6. *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 pesticides 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 toxicity*

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 2000	From 0.2 to 2	Over 5mL to 30 mL
Moderately toxic	CAUTION!	From 500 to 5000	From 2000 to 20,000	From 2.0 to 20	Over 30 mL to 0.5 litre
Slightly toxic	CAUTION!	More than 5000	More than 20,000	Greater 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 <i>Telephone: (709) 722-1110</i>
Nova Scotia	The Izaak Walton Killam Hospital for Children, Halifax <i>Telephone: (902) 428-8161, 1-800-565-8161</i>
Prince Edward Island	The Izaak Walton Killam Hospital for Children, Halifax <i>Telephone: 1-800-565-8161</i>

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

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)

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