



Chapter 7

Weed Management in Strawberries

The strawberry plant is shallow rooted and is a poor competitor against weeds for sunlight (for growth and flower buds), nutrients, and moisture. Weeds can reduce yields up to 40% or more. Harvesting fruit by hand presents a challenge when weeds are present. Where customers pick their own berries, weed-free fields are important for repeated sales and customer satisfaction. A weed control program integrates knowledge of how weeds enter the field (prevention of infestation), cultural control practices, and chemical control.

General Information and Guidelines

The primary goal of weed management is to optimize yield by minimizing weed competition. Weeds reduce yields by competing with the crop for water, light, and nutrients. Weeds intercept crop protectant sprays, preventing penetration to crop foliage. Weeds may promote development of disease by maintaining high humidity in the crop canopy, and some species are alternate hosts for pathogens and insect pests. Timely cultivations, wise use of herbicides and mulches, and prevention (never letting weeds go to seed) are integral parts of a good weed management system.

Among the factors that can influence weed control are the species present, their stage of growth when controls are applied, crop competition, soil characteristics, and rainfall or irrigation. Understanding how each of these aspects may affect weed control will enable the grower to develop an effective weed-management program. In addition, the weed-management program must be thought of as a continuous management effort and not as a seasonal duty. Make it a practice to record any changes in predominant weed species and to modify the control program in response.

Often, repeated use of one successful control technique can lead to shifts in composition of the

weed community. This happens when weeds that are not controlled by the technique in use (these species are referred to as escapes) become the most prevalent species in time. When weed shifts occur, or preferably before they become serious, change the control tactic to one that will control escapes.

Obviously, the ability to correctly identify weeds is essential to selection and proper use of controls. Images of many of the most common weed problems in strawberry crops can be found in Ohio State University Extension Bulletin 861, *Midwest Small Fruit Pest Management Handbook*.

Weed Identification and Scouting

Identifying weeds is essential so that the right control tactic can be used. Several excellent guides to weed identification are available. One we have found particularly useful is *Weeds of the Northeast*, published by Comstock Press. On-line weed identification guides can be found on most university Internet sites.

Patches of perennial weeds must be located and identified so that rhizomes, stolons, and rootstocks can be destroyed by herbicide spraying and cultivation well in advance of planting. Problem annuals may also be identified during the pre-planting year, and controls, such as summer fallow, can be used to reduce weed seed in the soil before planting. Scout for weeds every year.

In the establishment year, scouting should begin in spring, even before planting, so that prevalent annual weeds can be identified and controls planned. After planting and in fruiting years, scout for weeds whenever fields are scouted for insects and diseases or at least weekly during May to early July and again in late August to late October.

Pay careful attention to problem weeds in the field at harvest time as many controls can be

implemented during renovation. Scout renovated fields carefully in late summer and early fall when many winter annuals germinate. Scouts should watch for occurrence of new and invasive weeds and perennials such as quackgrass and Canada thistle at all scouting opportunities. Record the distribution of each species as:

- General = found throughout the field
- Local = found in a small portion of the field
- Spotty = found in just a few places.

Also record the density of each species as:

- 1 = Scattered, just a few weeds
- 2 = Slight, 1 weed per 6 feet of row
- 3 = Moderate, 1 weed per 3 feet of row
- Severe = More than 1 weed per 3 feet of row.

Pay special attention to low spots, wet areas, and field margins where new weed problems develop first. Many species will fall into the General category and will be the primary targets of the weed-control program.

Local distribution may indicate that the species has been recently introduced to the field, and eradication by preventing seed production may be possible.

Spotty distribution of common weeds, such as lambsquarters, may indicate that herbicide resistant bio-types have developed, in which case herbicides with alternate modes of action should be adopted.

Take samples of weeds that cannot be identified in the field. Small weeds (less than 1-inch high) can usually be dug up with a small amount of soil attached to, and protecting, the roots. Samples should be placed in an inflated zip-lock bag and placed in a cooler for later identification. In some instances, it may be necessary to plant unknown seedlings in the greenhouse and allow them to size up before identification can be made.

Action thresholds for weeds have not been established for strawberry crops. Strawberry crops do not compete well with most weeds, and maintenance of nearly weed-free conditions is important for optimum production. Therefore, it is best to prevent weed seed production within

the berry field, thereby reducing future weed problems.

Combining cultivation, hand weeding, and herbicide use is essential to maintain good weed control. Cultivation, hoeing, and hand weeding are most effective when weeds are small (less than 1/2 inch in height). Herbicides should be selected and applied at the appropriate timing to control the most dominant species.

But, remember that species occurring in small numbers that are not controlled may quickly become the dominant species! Therefore, carefully remove weeds that tolerate herbicides before they go to seed, thereby preventing buildup of resistant species.

Cultural Controls

Cultural controls are those good agricultural practices that minimize the growth of weeds, while optimizing crop growth. Many decisions and practices influence the effectiveness of cultural controls. These include:

• Site Selection

Select well-drained, coarse-textured soils, that are free of perennial weeds. Repeated tillage and cultivation one or two years before planting reduces perennial and annual weeds. If a field has been in sod or pasture for several years, cultivation reduces grubs that feed on strawberry roots and can reduce plant vigor and cause the loss of plants. After cultivation, plant a crop that does not increase verticillium wilt disease, nematodes, or insects. For strawberries, consider a grain crop such as wheat, which can be used for straw mulch for winter protection and disease control in the berry crop.

• Crop Rotation

The seeds of annual weeds in the soil (the weed seed bank) can be reduced by planting a series of annual crops prior to planting berries. Field or sweet corn is an excellent rotational crop because cultivation and chemical weed control can reduce weeds. With sweet corn, the crop is harvested by early August, making the field available for winter cover crops or additional chemical weed control, cultivation, or fumigation in the fall before spring planting.

Successive grain crops or rotating from legumes to grain and to strawberries are rotations that have been used successfully.

Be sure to use herbicides in the preceding crop that will not leave a high residual in the soil when strawberries are planted six to 12 months later. Inserting a period of summer fallow the year before planting can be very effective in reducing the number of annual weed seeds in the soil. Summer fallow consists of tillage and cultivation to prepare a good seed bed for germination of weed seed followed by harrowing or light disking whenever a flush of weeds occurs. To be effective, harrow when weed seedlings are in the cotyledon stage.

- **Soil Fertility and Water Use**

Provide the optimum fertilization for the berry crop, based upon testing the soil before planting. Consider drip irrigation that will place irrigation water and nutrients in the zone of crop roots while minimizing availability to weeds growing between the rows.

- **Cultivar Selection**

Plant only adapted, vigorous transplants that will compete with weeds. Consider that some crop cultivars vary in sensitivity to certain herbicides.

- **Planting Density**

Dense plantings compete best with weeds.

- **Mulches**

Black or opaque plastic can be used to prevent weed growth for one or more years. Straw and various other mulches can prevent or reduce weed growth, depending on the amount used.

- **Sanitation and Prevention**

The old adage that says *One year's seeding, seven year's weeding!* should be heeded by every berry grower. Preventing new weeds from invading the farm and minimizing or eliminating seed production in the field will prevent future weed problems.

Prevention of weeds is best practiced by careful attention to cultural practices, such as cleaning equipment before moving it into the field, using

clean straw mulch, and preventing annual weeds from producing seeds. Pay careful attention to any weed that is new on the farm; it may soon be your worst weed problem if it goes to seed. Ensure that straw used to mulch strawberries is weed free; for instance, grow your own straw and practice excellent weed control throughout its production.

Mechanical Controls and Hand Weeding

Hand hoeing and mechanical cultivation are important components of weed management in berry crops, particularly during the establishment year. Cultivate and hoe carefully to prevent damage to the root systems and above-ground portions of the strawberry plants. Remove all established weeds between the rows and within rows during establishment in order to obtain maximum sunlight for growth. Maintaining full sunlight throughout the establishment year is essential to obtain maximum flower bud formation.

In strawberries, mechanical cultivation between rows is necessary to train runners during the establishment year and to maintain a row width of 12 to 18 inches at renovation, with no more than 20 to 24 inches in early September.

Weed Control with Herbicides

Herbicides are selective; there will always be some escapes; and these, if not controlled, will in time become the dominant weeds in the field. To prevent this, do not depend exclusively on herbicides. Cultivate, hoe, and pull escapes. Rotate crops and be sure to use herbicides with differing modes of action in rotational crops.

There are several types of herbicides. Regardless of the type of herbicide, improper concentration, improper calibration, or overlapping the spray can cause reduced yields and death of plants.

Terms Used to Describe Herbicides

- **Selective** — A selective herbicide (*e.g.*, 2,4-D) will only control certain species or only one type of weed.
- **Non-selective** — A herbicide that kills all plants, both crops and weeds (*e.g.*, Roundup).

- **Contact** — A herbicide that kills only the parts of the plant on which it is sprayed (*e.g.*, Gramoxone and Liberty).
- **Systemic** — A herbicide that is applied to an actively growing weed; it is absorbed through the leaves or the roots and moves to other areas of the plant.
- **Residual** — A herbicide that is applied to the soil and remains in the soil for one to several months, or more than a year, continuing to control weeds and potentially damage crops.
- **Preplant (PREPLANT)** — A herbicide applied to weed foliage before crops are planted, as in site preparation.
- **Preemergence (PRE)** — A herbicide applied to the soil before weed (and/or crop) emergence.
- **Postemergence (POST)** — A herbicide applied to the foliage of weeds.

Herbicides are usually formulated as wettable powders (*e.g.*, 50 WP), emulsifiable concentrates (*e.g.*, 2 EC), aqueous suspensions (*e.g.*, AS), or granulars (*e.g.*, 10 G). Granular formulations improve the ease of application and minimize contact of herbicides with crop foliage.

Preemergence herbicides are applied before weeds emerge above the soil surface. Postemergence herbicides are applied after weeds have emerged. Residual herbicides are usually applied preemergence to weed-free soil in the spring. Residual herbicides may control weeds for one month, for three to six months, or longer. Some herbicides, including those used on berries, may persist long enough to damage crops planted one or more years after their last use. The best control is achieved when the application is not impeded by trash or actively growing ground cover.

Preemergence herbicides may be selective or non-selective, depending upon the rate applied. A post-emergence recommendation indicates that application typically consists of a systemic herbicide and should be applied to actively growing weeds in order for the herbicide to be absorbed by the weed leaves. However, a non-systemic herbicide, such as Gramoxone, is also applied postemergence to weed foliage. Good coverage is essential because the herbicide does not move. Gramoxone, Liberty, and Roundup

Ultra are non-selective and must be directed away from the crop or applied before planting.

Selective herbicides only control certain species of weeds; for instance, Poast, Fusilade, and Select only control grasses and can be safely applied to the foliage of strawberry.

Systemic herbicides generally need to be applied when plants are actively growing. This means that the weeds are young, not bearing seeds, and are growing under good soil moisture and moderate temperature conditions. Plants under these conditions are not under stress, have their stomates open, and are respiring normally. For the best control, applications should be made with day-time temperatures of 55 to 75°F and with six to eight hours drying time (without irrigation or rainfall) for maximum absorption by the weed.

Consult the label or technical bulletin for the range of weeds controlled. Also check the broadcast rate for different types of weeds. Read all precautions for each crop.

What Rate Should Be Used When a Range Is Provided?

Generally, heavier soils require more herbicide than lighter soils, because in heavier soils the chemicals are adsorbed by clay particles and organic matter. The presence of trash on the soil surface can lower the effectiveness of applied herbicides. Therefore, control may be reduced if the herbicide is applied over mulching materials. In the effective use of herbicides, there is no substitute for thorough knowledge of soil and herbicide characteristics.

Selective herbicides will control certain weed species while being ineffective on others. Weeds not controlled are called escapes, and if the herbicide program is not changed, in time the escapes will become the prevalent weeds in the field. For this reason, it is essential to accurately identify the weeds in your field and select herbicides that will control those weeds according to the information on the product label.

Be sure to read and understand the label before using any herbicide. Failure to follow label directions is illegal and may result in crop damage or poor weed control. Preventing injury to the crop plant depends on applying the right herbicide

at the correct time and rate of application. Weak, unhealthy, or injured plants can be damaged by herbicides. Environmental conditions that stress the crop may also predispose the crop to herbicide injury.

If you choose to try a new herbicide or alter your existing weed-control program, try the proposed program on a limited area first. This will help you decide whether the new program is compatible with the ongoing production system. In addition, it will allow for changes and refinement before full-scale use.

Herbicide rates listed on the product label and in this bulletin are for broadcast applications. Reduce rates proportionally for banded or strip applications. For best results with herbicides, follow the manufacturer's application directions regarding rates, additives, soil type, soil moisture conditions, stage of weed growth, environmental conditions, and product limitations.

Certain herbicides listed in this publication may be discontinued by the manufacturer and thus may no longer be available. Using remaining stocks on dealers' shelves or stored on the farm is encouraged and legal.

Trade names are used for identification. No product endorsement is implied, nor is discrimination intended against similar materials not mentioned. Extension and the participating universities make no warranty or guidance of any kind, expressed or implied, concerning the use of these products.

Herbicide Injury

Strawberry injury resulting from the use of herbicides is common, particularly on light soils. Most herbicide injury can be traced to using too high a rate on light soils, incorrect timing of sprays, incorrectly calibrated sprayers, sensitive cultivars, and weak plants growing under unfavorable conditions. The grower usually has some control over these factors. Any factor that injures the crop (other pests, winter injury, exposure of crowns and root systems as a result of erosion, improper mineral nutrition, wet spots in the field, etc.) will make the crop more susceptible to injury.

Newly planted strawberries are especially sensitive to herbicides. Crop tolerance increases in late summer and fall. This corresponds to the time when preemergence herbicides can be used to control many winter annual and perennial weeds.

Remember that 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, growers must be careful not to exceed maximum recommended annual application rates. They should fully understand and follow the instructions on the product labels. Do not expect herbicides to control all weed problems. Understand that hand weeding and cultivation will be required to obtain complete weed control. Weakened plants are more susceptible to herbicide injury. Conversely, healthy strawberry plants are most capable of tolerating recommended treatment rates.

Be cautious with tank-mixes. Severe Sinbar-type injury has occurred when certain postemergence grass herbicides and Sinbar were tank-mixed or even applied in close sequence.

Uniform application is absolutely necessary if herbicides are to provide the desired results. Variations in the spray pattern, speed of the rig, worn nozzle tips, etc., may change the application rate sufficiently to damage the crop or reduce weed control. Devrinol, Dacthal, and Sinbar are wettable powders that do not dissolve in water. These herbicides form a suspension in water that can only be maintained by constant agitation in the spray tank. Consequently, you must take several precautions to maintain a uniform application.

Precautions

1. Screens in the line should be no more than 50 mesh to avoid clogging.
2. The material will settle to the bottom of the tank if not constantly agitated. Either continuous mechanical agitation by paddles in the tank or hydraulic agitation by return flow jets (pressure regulator by-pass) is necessary.

3. Wettable powders are abrasive; therefore, do not use these herbicides in gear, roller, or impeller pumps. The clearances in these positive displacement pumps are close; they wear quickly when abrasives are pumped.
4. Wettable powders wear nozzles readily. Brass nozzles wear sooner than polymer and stainless steel nozzles. Because of wear, the amount of spray being pushed through the nozzle will gradually increase. The spray rig must be properly designed and calibrated often (approximately every 20 hours of use with brass nozzles) if you are to be sure of the amount of material being applied per acre.

Herbicides recommended in this guide are referred to by their brand name, and application rates are provided in the actual amount of product per acre. The guide provides enough information to assist you in selecting a herbicide for a particular crop and weed situation. For complete information, it will be necessary to consult the label.

Too often growers neglect the label until something goes wrong. Wouldn't it be better to spend 20 minutes reading the label in advance and thereby preventing problems from ever developing? Labels contain explicit directions on using herbicides correctly and indicate all weeds that are controlled.

Full text labels and Material Safety Data Sheets (MSDS) should be available from your pesticide dealer. The MSDS information can also be obtained for most herbicides over the Internet from company web sites or from compilers such as CDMS, Inc. (<http://www.cdms.net/pfa/LUpdateMsg.asp>).

Herbicides used to control weeds in strawberry plantings are applied:

- PREPLANT — Preplant treatments applied before the crop is planted.
- PRE — Preemergence treatments, applied at the time of planting or some time before weed seedlings emerge.
- POST — Postemergence treatments, applied after planting and after weed seedlings have emerged.

Mixing two or more herbicides may improve control and the spectrum of weeds controlled (Table 7-1), while minimizing required rates. However, do not mix herbicides unless the mixture is approved on at least one label of the products intended for use.

Strawberries can be injured by residues of herbicides used in preceding rotational crops that still remain in the soil. Herbicides used to control weeds in corn and soybeans are most likely to carry over and damage strawberries. A few herbicides will damage strawberries two or more years after they were last used. If you purchase or rent new land, be sure to ask the owner or manager about herbicides used in previous years — the farther back, the better! Labels contain information on permissible rotational crops and the required time interval between use and rotational crops.

A bioassay is the simplest and most cost-effective method to check for herbicide carry-over. To do this, collect, at random, soil from all areas of the field in question. Sample the root zone, typically 6 inches deep. Each test requires about 1 gallon of soil. Ends of fields, knolls, and low areas often have higher residues and may need to be tested separately.

From a nearby area, collect a second sample of the same soil that was not treated with herbicide and use this for a control (for comparison) soil. If untreated soil is not available, add 1 teaspoon of activated charcoal per quart of dry soil and mix thoroughly. Activated charcoal can be purchased at most drug stores.

Three or four pots of the test and control soils should be made and seeded out to oats, radish, and lentils. Place the pots in a warm, sunny location and monitor seedling growth for symptoms. If any injury is noted, then contact your pesticide dealer or local Extension specialist for advice on the probable sensitivity of strawberry.

Table 7-1. Herbicide Efficacy Against Common Weeds in Strawberries.

Common Weeds	Herbicides					
	Postemergence			Preemergence		
	Select	2,4-D	Poast	Devrinol	Dacthal	Sinbar
Perennial Grass						
Quackgrass	E	N	G	N	N	P
Bluegrass	G	N	P	N	N	P
Yellow Nutsedge	P	F	N	P	N	F
Perennial Broadleaf Weeds						
Dandelion	P	E	N	N	N	F
Clovers	P	E	N	N	N	F
Thistle	P	G	N	N	N	N
Curley Dock	P	G	N	N	N	N
Annual Grasses						
Crabgrass/Foxtails/	E		E	E	E	F
Barnyard Grass	E	N	E	E	E	F
Oats or Rye (from mulch)	E	N	E	E	E	F
Annual Broadleaf Weeds						
Lambsquarters	P	E	N	F	G	E
Redroot Pigweed	P	E	N	F	G	G
Galinsoga	P	G	N	G	P	G
Yellow Wood Sorrel	P	P	N	P	G	F
Chickweeds	P	F	N	E	G	E
Purslane	P	G	N	G	G	G
Shepherd's Purse	P	G	N	P	P	E
Carpetweed	P	G	N	G	G	G
Horseweed	P	G	N	N	N	G
Common Groundsel	P	F	N	F	P	F
Field Violet	N	P	N	P	G-E	F-G

E = Excellent; G = Good; F = Fair; P = Poor; N = No Control

Herbicide Application

Strawberries can be easily injured if too much herbicide is applied. To prevent this, calibrate the sprayer frequently and adjust nozzle tips to the proper height above soil level. Herbicides should be applied with a boom sprayer. Backpack and airblast sprayers should not be used because they will not give uniform application.

An excellent fact sheet from Ohio State University Extension that provides detailed information on this subject is AEX-520, *Boom Sprayer Calibration*. This fact sheet can be downloaded from the Internet at <http://www.ohioline.osu.edu/aex-fact/0520.html> and Ohio residents can also obtain it from most county offices of OSU Extension.

Controlling Weeds Before Planting

Many of the worst weeds found in berry crops are perennials such as quackgrass, johnsongrass, yellow nutsedge, Canada thistle, and field bindweed. Perennials spread and reproduce mainly by underground rootstocks or rhizomes and are very difficult to control once berry crops are planted. Therefore, eliminate all perennial weeds before establishing a new planting by using a planned program of tillage, rotational crops, and herbicides (Table 7-2).

Time and money spent before planting will eliminate the need for more costly and on-going weed control methods during the establishment and production years. In addition, without the presence of competing perennial weeds, there will be a greater potential for vigorous, healthy establishment of the strawberry crop.

Glyphosate — hereafter referred to as Roundup or Touchdown (many formulations and brands are available though most simply refer to this herbicide as Roundup) — applied directly to the foliage of perennial weeds before plowing is the most effective means of control. Roundup application must be timed correctly and the right rate used for the perennial weeds you are trying to control.

Most perennials are best controlled with fall-applied Roundup. Grasses should be at least 8 inches tall when treated. An extended period

of drought just before spraying may adversely affect control. Spring applications are effective on grasses but do not provide as good control of broadleaf perennials as fall applications.

Descriptions of the perennial weeds presented here were extracted from the *Ohio Perennial and Biennial Weed Guide*, which is available on the Internet at www.oardc.ohio-state.edu/weedguide/. In the recommendations for controlling these weeds, application rates are provided for two of the most common formulations of glyphosate. The use of these brand names does not imply an endorsement of these over other glyphosate products, or a criticism of those products that are not named.

Canada Thistle

Canada thistle can be treated in the flower bud to flowering stage in early summer or in late summer and fall during the rosette to flower bud stage. In fallow fields, stop tillage in late July and allow thistles to regrow for at least five weeks. Apply Roundup Ultra or Touchdown before a killing frost and when Canada thistle regrowth reaches the flower bud stage or is at least 10 to 12 inches high. Apply Roundup Ultra at 2 to 3 quarts per acre in 5 to 10 gallons of water or Touchdown at 2 quarts per acre. Spot sprays of a 2% solution (0.5 pints in 6 gallons of water) of either herbicide will also be effective.

Field Bindweed

Field bindweed is a twining perennial vine. Characteristics distinguishing it from other vines include arrowhead-shaped leaves, thin stems, pinkish petals fused into funnel-shaped flowers, the presence of small bracts attached to flower stalks about an inch below the base of the flower, a perennial taproot, and invasive rhizomes (horizontal underground stems). The plant reproduces by seeds and regenerates new plants from adventitious buds on roots and rhizomes.

Field bindweed must be treated when it is actively growing and at or beyond bloom. Fall treatment is best, but apply herbicides before a killing frost. Apply Roundup Ultra at 3 to 4 quarts or Touchdown at 5.33 pints per acre. Spot spray with a 2% solution of either product.

Table 7-2. Herbicides for Perennial Weed Control the Year Before Planting and for Spot Treatment.

Prevalent Weeds	Timing of Treatment ^a	Herbicide/Acre ^b
Canada thistle	Bud to early bloom stage; regrowth in autumn following tillage.	<ul style="list-style-type: none"> • Roundup 2 to 3 qt. or 2% spot spray.
Field bindweed	When plants are at or past full bloom and before killing frost.	<ul style="list-style-type: none"> • Roundup 3-4 qt. or 2% spot spray; • 2,4-D 1 pt. or Banvel 8 oz. + Roundup 1 qt.^c
Horsenettle	Late bud to flowering	<ul style="list-style-type: none"> • 2.5-4 qt. Roundup; • Banvel or 2,4-D ester at 2 qt.
Dogbane	Late bud to flowering stage	<ul style="list-style-type: none"> • Roundup at 3.25 qt.; • Roundup 1 qt. + 1 pt. 2,4-D; • Roundup 1 qt. + Banvel 1/2 pt.
Poison Ivy	7/1 to 9/15	<ul style="list-style-type: none"> • Roundup 2.5 to 5 qt.; • Banvel 1 qt. + Roundup 2 qt.; • Crossbow 2 qt.
Quackgrass	Spring — 8" tall to heading or Fall — 8" tall regrowth	<ul style="list-style-type: none"> • Roundup 1 to 2 qt.
Wild brambles	Bud to bloom stage	<ul style="list-style-type: none"> • Banvel 1 qt. + Roundup 1 qt. • Crossbow 6 qt. (1 to 1.5% solution)
Swamp smartweed	7/1 to 9/15	<ul style="list-style-type: none"> • Banvel 8 oz. + Roundup 1 qt.

^a With the exception of quackgrass, apply before frost.

^b Adding a surfactant to these herbicides will improve their effectiveness; Roundup already contains a surfactant. Rates are given in amounts of commercial product per acre.

^c Apply Roundup with Banvel or 2,4-D where several weed species are present. Roundup alone is best applied on tall weeds, applied in 5 to 10 G of water per acre with surfactant and ammonium sulfate.

Follow label recommendations. Do not apply Banvel, 2,4-D, or Crossbow near brambles or grapes.

Avoid drift. Apply spot treatments using low pressure or a wick applicator.

Horsenettle

Horsenettle is a perennial that spreads through creeping rootstocks, in addition to reproduction by seed. A main distinguishing feature of horsenettle is the bristly stem, which is covered with hairs and spines. Leaves are alternate, oblong, and lobed, with yellow prickles on the petioles, midrib, and veins. The plant produces juicy, yellow berries that are about 1/2-inch in diameter and contain the seeds.

Horsenettle is found mainly in no-till fields and is difficult to control. It typically emerges after crop planting, and postemergence herbicides are only marginally effective.

Apply Roundup Ultra at 2.5 to 4 quarts per acre or use a 2% solution for spot treatment, when most of the plants have reached the bud to flowering stage. Banvel at 2 quarts per acre or 2,4-D ester at 2 quarts per acre when horsenettle is in the late bud to flowering stage can also be effective. Control ranges from fair to good with these treatments.

Hemp Dogbane

Hemp dogbane is a tall-growing perennial broadleaf weed often mistaken for common milkweed. It spreads by seed and over-wintering rootstocks. In Ohio, hemp dogbane tends to appear in areas that have not been tilled for a number of years.

Apply Roundup Ultra at 3.25 quarts per acre or a 2% solution for spot treatment when dogbane is in the late bud to flower stage of growth. Roundup and 2,4-D can also be used effectively at 1 quart plus 1 pint per acre, respectively. Treatments following crop harvest or mowing should be delayed until weeds regrow to a mature stage.

Poison Ivy

Poison ivy is a deciduous woody perennial distinguished by its leaves that have three leaflets. The stalk attached to the middle leaflet is considerably longer than that attached to either of the two outer leaflets. Poison ivy grows in a variety of forms, including trailing, shrubby, or a vine.

Reproduction is primarily by seeds that are dispersed by birds and animals. Also, it may spread by rhizomes (horizontal underground

stems). Stems are capable of forming roots and sending out new shoots when in contact with soil.

Apply Roundup Ultra at 2.5 to 5 quarts per acre to thoroughly wet the foliage but do not spray to run-off. Banvel at 1 quart per acre plus Roundup at 2 quarts per acre may also be effective.

Quackgrass

Quackgrass is a creeping, sod-forming perennial grass, characterized by its straw-colored, sharp-tipped rhizomes (horizontal underground stems) and the pair of whitish-green to reddish, claw-like structures (auricles) that clasp the stem at the top of the sheath. It reproduces through seed and creeping rhizomes. This species can form large patches.

When killing sod, use Roundup Ultra at 2 quarts per acre or Touchdown at 3.33 pints per acre. Use the 1-quart-per-acre rate of Roundup Ultra in 5 to 10 gallons of water per acre on land that has been in row crops. Spray when the grass is about 8 inches high and wait at least three full days (72 hours) but generally not more than seven days before plowing.

Fall frosts before spraying will not affect control provided at least 60% of the foliage is still green when you spray. If planning a spring application, do not fall plow; simply wait until quackgrass reaches the right growth stage (four to five new leaves) and spray.

Swamp Smartweed

A native of North America, swamp smartweed is a highly variable perennial. It exhibits two forms, terrestrial and aquatic. For this reason, the plant will invade shores, wet prairies, swamps, ponds, ditches, and quiet streams. However, it is quite common for plants to grow in drier soil.

Swamp smartweed reproduces using rhizomes (rootstocks) and seeds. Plants normally grow from two-feet to three-feet tall. The stems are usually unbranched and thicken to form nodes at the leaf joints. Swamp smartweed blooms from July to September. The spreading root system allows for competition with other plants while making it difficult to kill the plants. Apply Roundup plus Banvel at 1 quart and 1/2 pint per acre, respectively.

Yellow Nutsedge

Yellow nutsedge is an erect, grass-like perennial, characterized by its shiny yellowish-green leaves, triangular stem, golden-brown flower head, and shallow rhizomes (horizontal underground stems) that produce many nut-like tubers. Young seedlings are often confused with grasses. This species reproduces primarily by tubers and less often by seeds. Rhizomes help to enlarge patches. Nutsedge persists by producing nutlets that grow at the end of rhizomes.

Nutsedge emergence continues summer-long as more nutlets break dormancy and shoots emerge from expanding rhizomes. New nutlets begin to form on the end of rhizomes soon after shoot emergence in the spring. Nutsedge control with herbicides is rarely or never complete because insufficient herbicide translocates into the nutlets.

Attack nutsedge one or two years before planting berries using an integrated approach. Apply preplant glyphosate on small nutsedge plants (control with Roundup Ultra is best when nutsedge is 6 to 12 inches high; earlier applications will provide some suppression — Monsanto Research) and/or till before planting.

For one or two years before planting berries, plant competitive crops and use close spacings. Plant and harvest early season crops before nutsedge emerges, then plant crops with selective herbicides later, around the anticipated time of nutsedge emergence. Selective herbicides can be used for seasonal control in corn, soybeans, dry and snap beans, potatoes, and green peas. Finally make use of post-harvest tillage and summer fallow. Yellow nutsedge is sensitive to dense shade, thus close spacing of crops such as pumpkins will minimize growth and nutlet formation.

If you do not already have nutsedge in a field, prevent its introduction. Wash all soil from recently purchased equipment before allowing it on your farm. If you have some infested fields and others that are not, or if your equipment is used on fields of other farmers, be sure to wash all soil off the equipment before using it on land that is nutsedge-free.

Nutsedge has also been introduced in transplants, nursery stock, and seed potatoes. Make sure all transplant materials were produced under nutsedge-free conditions.

Wild Brambles

Brambles are a diverse group of perennial herbs, shrubs, or trailing vines that are noted for their prickly stems and berry-like, usually edible, fruits. They can reproduce by many different methods including seeds, root sprouts, underground stems (rhizomes), and branches that root at the tips (stolons).

In some species, individual stems live only two years, but new stems are continually produced. In all species, roots are perennial; apply Roundup Ultra plus Banvel at 2 quarts plus 1 quart per acre, respectively. Spray foliage till wet but not to runoff.

Water Volumes and Adjuvants with Glyphosate

Low water volumes of 5 to 10 gallons per acre provide best weed control. If higher water volumes must be used, use the maximum rate of glyphosate for the weed to be controlled. At high water volumes, adding a non-ionic surfactant at 0.5% (one pint in 25 gallons) or ammonium sulfate (2 to 4 pounds per acre) to the spray mix will improve control. Always add ammonium sulfate to the water before adding glyphosate.

Hard water with more than 500 parts per million of calcium or magnesium will usually reduce glyphosate activity. If hard water must be used, keep the volume low (five gallons per acre) or increase the rate of herbicide. Use clean water. Silt, clay, and organic debris in water will also reduce glyphosate activity.

Table 7-2 provides information on use of herbicides to control perennial weeds during the year before planting and for spot treatment.

Herbicides for Strawberries the Year of Planting

The weed control program should aim to promote vigorous crop growth and have the field relatively free of weeds by the time mulch is applied in late fall. This usually requires the use of cultivation in conjunction with herbicides. However, fields that have been fumigated at herbicidal rates should not require a herbicide application during the spring and summer of the establishment year.

Cultivation is especially important to prevent the rapid growth of annual weeds during the first several weeks after planting as the crop establishes. Many growers do not use herbicides on newly planted fields until early fall. Herbicides that can be used during crop establishment will control germinating or very small seedlings but are ineffective on established weeds.

Weed emergence will usually occur within one to two weeks of planting. Dacthal or Sinbar can be applied immediately after transplanting. Dacthal does not control emerged weeds but is especially effective in preventing establishment of field violet and some annual grasses. Sinbar will control small emerged weeds and control germinating broadleaf weeds for several weeks after application. Hand weeding and cultivation will be required to maintain complete control during the establishment period.

Cultivation is most effective when weeds are very small and should occur each time emerging weeds are observed between the rows. Cultivation at weed emergence can be shallow, which will prevent buried weed seed from being brought to the surface where germination is then likely to occur. Shallow cultivation also minimizes dilution of preemergence herbicides by deep mixing in the soil. A wiggle-hoe can be used to cultivate weeds between rows and between strawberry plants within rows.

Poast can be used at any time during the establishment year to control seedling annual grasses and perennials such as quackgrass and Johnson grass. An adjuvant is always required with Poast. Fusilade and Select can also be used for grass control during the establishment (non-bearing) year. Both products offer similar control to Poast. Prism is the only grass herbicide that is highly effective on annual bluegrass.

Cooler weather in late summer and early fall will trigger germination of fall annual weeds and many perennials. Matted rows of strawberry should be filled in by early fall; therefore, it will not be possible to control weeds occurring this time of year with cultivation. An application of Sinbar or Sinbar plus Devrinol at this time will minimize weed establishment. Usually, new plantings should be treated no later than mid-September. Devrinol controls annual grasses and a number of summer and winter annuals, including common

groundsel. The herbicide acts primarily through soil uptake and requires irrigation or rain to be effective. Under dry conditions if rainfall does not occur within 7 days of application and irrigation is not available, a shallow cultivation will help activate Devrinol.

Sinbar in fall of the planting year will improve control of seedling winter annuals and perennials over that obtained with Devrinol. Do not tank-mix Sinbar with any grass herbicide or apply a grass herbicide within six weeks after applying Sinbar or severe crop injury may occur. Of all the herbicides used in strawberry production, Sinbar is most likely to cause crop damage. Strawberry plants that are under stress are most likely to be injured. Certain varieties such as Jewel are more sensitive to Sinbar than others. Growers should be sure the variety(ies) they are growing are tolerant of Sinbar prior to using this herbicide.

In late fall, just before mulching, Sinbar and/or Devrinol can be applied to provide residual control of weeds, including volunteer cereals, during the fruiting season. These applications may follow earlier applications of Sinbar or Devrinol provided the cumulative dosage used over the course of two or more sequential treatments does not exceed the total annual dosage permitted by the label.

The spray schedule (Table 7-3) lists the choice of treatments that can be used to control specific weeds or weed groups at various treatment times throughout the season. Apply only one herbicide or herbicide combination (tank-mix) at each application time. Growers must be careful not to exceed the maximum application rate or total number of applications per season for a particular product.

Herbicides for Established Plantings

An early spring herbicide, applied soon after removing mulch in the fruiting year may be necessary to control germinating summer annual weeds when a late fall application of Sinbar or Devrinol was not used (Table 7-4). Dacthal should be applied as soon as the winter mulch is removed and can be applied again at renovation. Devrinol

Table 7-3. Recommended Herbicides for Strawberries: THE YEAR OF PLANTING.

Weeds	Timing of Treatment	Herbicide/Acre
Preemergence		
Annual grasses, some broadleaves	Anytime before or after transplanting.	• Dacthal W-75, 8-12 lb.
Annual grasses, some broadleaves	After adequate number of runners have rooted, or in late fall.	• Devrinol 50WP, 4-8 lb; irrigate within 2-3 days.
Broadleaf weeds, some grasses	After transplanting, but before rooting of runners.	• Sinbar 2-3 oz, followed immediately by rainfall or irrigation equal to 1/2 - 1".
Winter annual weeds	Late summer/ early fall.	• Sinbar 2-6 oz, followed immediately by rainfall or irrigation equal to 1/2 - 1".
Postemergence		
Grasses	When grasses are 2-8" tall (before seed head formation).	<ul style="list-style-type: none"> • Fusilade DX, 16-24 oz + 2 pt crop oil concentrate/25 gal. or 1/2 pt nonionic surfactant/25 gal. • Poast 2 pt + 2 pt crop oil concentrate. • Select, 8 oz + 1 quart crop oil concentrate/A; apply no more than 32 oz/season.
Nonselective (kills all)	Before weed growth is 6". Directed spray only (do not spray strawberry plants).	• Gramoxone Extra, 1.5 pt. in 20-60 gal water + non-ionic surfactant. Directed spray only.
Nonselective (kills all)	Late summer-fall (August – mid-September).	• Roundup Ultra, 1-3 qt. <i>Directed spray or wiper only.</i>

may be applied anytime before bloom but will only be effective on emerging seedling weeds. Poast or Select may be used in the spring.

Renovation and late fall treatments are used to clean-up the field for the next year, to maintain a sufficient concentration of residual herbicide near the soil surface to control germinating weeds in the late summer/early fall, and to provide residual control through the following spring/early summer. Growers should pull or spot spray weeds that have established during the planting year and the picking season.

2,4-D amine (Formula 40) should be applied at renovation, after the final harvest to control broadleaf weeds. It is very effective on most

annuals and also controls dandelions and plantain. It will not control red sorrel, yellow toadflax, and field violet. Strawberry beds should be mowed within three days of applying 2,4-D, rows narrowed if necessary, and fertilized. Within two weeks of applying 2,4-D, apply Sinbar at 2 to 6 oz/A. If late summer annual and winter annual weeds are likely to be a problem, use the higher rate. Remember that Sinbar is the most likely herbicide to injure strawberries and must be used with caution and knowledge. Strawberry plants may be stressed at this time of year, following an especially heavy harvest or because of pest problems such as strawberry mite, and more sensitive to herbicide injury.

Shallow cultivate renovated beds if necessary to control seedling weeds between the rows and apply Poast or Select for grass control on an as-needed basis. Do not use these herbicides within six weeks of applying Sinbar.

As in the planting year, cooler weather of early fall will trigger germination of winter annuals and some perennial weeds. To minimize their

establishment, apply Devrinol no later than mid-September as soil residues from renovation applications of Sinbar and/or Dacthal are declining in effectiveness. Late fall applications of Sinbar and Devrinol may be used just before mulching provided the cumulative usage during the growing season has not exceeded the total amount that can be used.

Table 7-4. Recommended Herbicides for ESTABLISHED STRAWBERRY PLANTINGS.

Weeds	Timing of Treatment	Herbicide/Acre
Preemergence		
Annual grasses, some broadleaves	Late fall or early spring.	• Dacthal W-75, 8-12 lb.
Annual grasses, some broadleaves	Fall or early spring.	• Devrinol 50WP, 4-8 lb; irrigate within 2 to 3 days.
Broadleaf weeds, some grasses	Renovation, before new growth begins. Late fall, just before mulching.	• Sinbar 4-8 oz. • Sinbar 4-8 oz.
Postemergence		
Dandelions, other broadleaves	Renovation (before mowing).	• 2,4-D (Formula 40) 1-3 pt.
Annual and perennial grasses	When grasses are 2-8" tall, before seed head formation.	• Poast 2 pt + 2 pt crop oil concentrate; • Select, 8 oz + 1 qt crop oil concentrate/A; apply no more than 32 oz/season.
Nonselective (kills all).	When weeds are 6" or less.	• Gramoxone Extra, 1.5 pt in 20 to 60 gal water + non-ionic surfactant.