

Berry crops can be injured by residues of herbicides used in preceding rotational crops, residues that still remain in the soil. Herbicides used to control weeds in corn and soybeans are most likely to carry-over and damage berry crops. A few herbicides will damage berry crops 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. Collect a second sample from a nearby area 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 the symptoms described in the table. If any injury is noted, then contact your pesticide dealer or local Extension specialist for advice on the probable sensitivity of berry crops.

Herbicide Application

Berry crops 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. Calibration of boom sprayers and mixing of pesticides are described in Chapter 8 of this publication. 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 root stocks 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. 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 small fruit 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, nor 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.

Horse Nettle

Horse nettle is a perennial that spreads through creeping rootstocks, in addition to reproduction by seed. A main distinguishing feature of horse nettle 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. Horse nettle 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 horse nettle 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 which 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 Round Ultra is best when nutsedge is 6 to 12 inches high; earlier applications will provide some suppression — *Monsanto Research*) and/or tillage 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 emergency. 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 Roundup/Touchdown (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 6-3 provides information on use of herbicides to control perennial weeds during 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.	• Roundup 2 to 3 qt. or 2% spot spray
Field bindweeds	When plants are at or past full bloom and before killing frost.	• Roundup 3-4 qt. or 2% spot spray; • 2,4-D 1 pt. or Banvel 8 oz. + Roundup 1 qt. ^c
Horse nettle	Late bud to flowering	• 2.5-4 qt. Roundup; • Banvel or 2,4-D ester at 2 qt.
Dogbane	Late bud to flowering stage	• 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	• 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	• Roundup 1 to 2 qt.
Wild brambles	Bud to bloom stage	• Banvel 1 qt. + Roundup 1 qt. • Crossbow 6 qt. (1 to 1.5% solution)
Swamp Smartweed	7/1 to 9/15	• 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 weeds 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.		

Herbicide Types

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., 10G). The formulation of a herbicide improves mixing with water, allowing the herbicide



to remain in suspension (does not precipitate into the bottom of the tank), and helps it to adhere to the plant or soil surface. 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 berry crops.

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°F 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 *misses*, and if the herbicide program is not changed, in time the *misses* 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. (See *Monitoring Pests and Making Control Decisions*, page 6). 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, which 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 are no



longer 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

Crop 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 berry crops 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. Berry crops 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 berry 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.

Methods of Application

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, Karmex, Kerb, Sinbar, and some formulations of Simazine 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, too. 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.

Soil Fumigation

Soil fumigation kills most weed seeds, plant pathogens, nematodes, and insects in the soil. Fumigants may be applied as granular or liquid formulations. After application, true fumigants volatilize to form gases; other pesticides used in a similar manner may remain mixed with soil water. When using soil fumigation, consider the following points:

- **Target pests.** Rates vary for different target pests. In general, nematodes and soil insects are

