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

killed at lower rates than weed seeds and fungal or bacterial pathogens.

- **Soil texture.** As the microscopic spaces between soil particles get smaller and less abundant (as in heavy or compacted soils), fumigant rates must be increased to overcome reduced or slower diffusion and penetration. On heavy soils, rototilling (when dry) can increase the pore space of the soil, improving the effectiveness of subsequent fumigation.
- **Soil temperature.** For effective fumigation, soil temperature at a depth of 6 inches must be at least 50ºF. Higher soil temperatures favor greater volatilization of fumigants and greater movement through soil spaces.
- **Soil organic matter.** Decomposed organic matter improves soil structure and generally helps fumigant dispersion in the soil. However, very high amounts of organic matter may adsorb or tie up a fumigant, reducing its effectiveness. Fresh (undecomposed) crop debris may hinder fumigant dispersion in the soil and may also harbor insects and pathogens that escape the fumigant. Organic matter is most beneficial when it is thoroughly decomposed.
- **Soil moisture.** Fumigants move in soil water and must enter the soil solution to contact and kill pests. Moderate levels of soil moisture therefore aid in obtaining effective fumigation.

During or immediately after application of soil fumigants, the soil surface should be sealed to prevent the fumigant chemical from escaping into the air too rapidly. This can be done by rolling, irrigating, or covering with a tarp or plastic. At least two to three days of fumigant activity and at least four to 14 days of venting (for fumigant dissipation) should elapse between application of fumigants and planting. A three- to four-week interval is better. For this reason, fall is usually the best time to fumigate. Spring fumigation can be very effective, however, if soils are warm enough and the proper preplant interval is observed. Avoid plowing too deeply after fumigation so that untreated soil is not mixed with treated soil near the surface. Shallow plowing or tilling with clean equipment is recommended. See Table 8-8 (on page 207) for a summary of the characteristics of common soil fumigants.

Preplant Cover Crops

Seeding a preplant or green-manure cover crop on a site the year before planting is an excellent way to improve soil organic matter content. After a season of growth, the green manure is plowed or otherwise incorporated into the soil where it decomposes and adds organic matter to the soil. Benefits of preplant cover crops are greatest when:

- The soil is sandy and organic matter content is low.
- No animal manure is available to add to soil.
- The cover crop is a legume, which offers a good source of nitrogen.

Most cover crops perform best under the same general range of soil nutrients and conditions required by brambles. Small grains or vigorous sod grasses take considerable amounts of nitrogen from the soil but release it back slowly as they decompose. In accordance with soil test results before planting the cover crop, add 40 to 50 lbs. of nitrogen per acre and adjust soil pH, potassium, and phosphorus. These practices will help establish the preplant cover crop and promote more rapid decomposition when it is incorporated, preventing nitrogen drag (a lack of available nitrogen) when brambles are planted the following spring.

Since preplant cover crops are not intended to become permanently established, minimum seeding rates are usually recommended by suppliers to produce an acceptable turf stand. Where a dense, vigorous cover is needed to suppress weeds, higher seeding rates of cover crops such as buckwheat, rye, annual ryegrass, or sudan grass will maximize weed suppression and contribute much organic matter to the soil.

Preplant cover crops are usually plowed under in the late fall or early spring prior to planting. Those with low nitrogen content (most grains and dry grasses) should be plowed under in the fall to allow adequate time for decomposition and to prevent a lack of soil nitrogen needed by newly planted brambles. Leguminous cover crops contain more nitrogen and can be turned down in early spring, a month or so before planting brambles.

Usually, preplant cover crops are incorporated into the soil by plowing, disking, or rototilling before