

2009

Weed Control Guide for Vegetable Crops



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Herbicide Information

Some herbicides containing the same active ingredients but having different trade names are marketed by more than one company. Also, some herbicides are produced in several formulations. Products recommended in this bulletin are commonly used formulations of common herbicides. Other products and formulations may be equally good. Check labels on containers to determine that the product is labeled for your intended target crop and the amount of product to use per acre.

Pesticide Information

This publication contains pesticide recommendations based on research and pesticide regulations. However, changes in pesticide registrations occur frequently. Some pesticides mentioned may no longer be available, and some may no longer be legal in your state. The use of a pesticide in a manner not consistent with the label can lead to injury of crops, humans, animals and the environment, and can lead to civil fines and/or condemnation of the crop. If you have questions about the legality and/or registration status of pesticides, contact your county Extension office, pesticide dealer or manufacturer.

To protect yourself, others and the environment, always read the label before applying any pesticide.

2009 Weed Control Guide

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Environmental Protection and Herbicide Use

Profitable crop production depends on effective weed control. Weeds reduce crop yields by competing with crops for water, nutrients and light. Some weeds release toxins that inhibit crop growth, and others may harbor insects, diseases or nematodes that attack crops. Weeds often interfere with harvesting operations, and sometimes contamination with weed seeds or other plant parts may render a crop unfit for market.

An effective weed control program includes environmentally sound cultural, mechanical and chemical weed control methods. The increasing concern with pesticide residues in the environment, food and groundwater make it especially important that growers use herbicides as efficiently as possible. Crop rotation, cultivation, use of cover and companion crops, and use of different herbicides help avoid buildup of resistant weeds and pesticide residues in the soil.

Pesticides and the Environment

Groundwater is stored in water-bearing geological formations called **aquifers**. It moves through aquifers and is obtained at springs, streams or wells. Many people obtain their drinking water from wells. Well water is groundwater.

The upper level of the saturated zone in the soil is called the **water table**. The water table depth fluctuates, depending on the amount of water removed from the ground and the amount of water added by recharge.

Both surface water and groundwater are subject to contamination by **point and non-point source pollution**. Point source contamination refers to movement of a pesticide into water from a specific site. Non-point source contamination generally results from land runoff, precipitation, acid rain or percolation rather than from discharge at a single location.

Several factors influence the fate of herbicides in groundwater.

Adsorption is the binding of chemicals to soil particles. The amount and persistence of pesticide adsorption varies with pesticide properties, soil moisture, soil pH and soil texture. Soils high in organic matter or clay are the most adsorptive; coarse, sandy soils are much less adsorptive.

A soil-adsorbed herbicide is less likely to volatilize, leach or be degraded by microorganisms. It is also less available for absorption by plants.

Volatilization occurs when a solid or a liquid turns into a gas. A pesticide in a gaseous state can be carried away from the treated area by air currents. This is called **vapor drift**. Unlike the drift of sprays and dusts that can sometimes be seen during application, vapor drift is invisible.

Avoid applying volatile herbicides when conditions favor volatilization, such as temperature inversions. Herbicide labels usually mention the potential for volatility of herbicides. Volatilization can sometimes be reduced through the use of low volatile formulations or soil incorporation of the herbicide.

Photodegradation is the breakdown of herbicides by the action of sunlight. Herbicides applied to foliage or the soil surface may be broken down by exposure to light. Soil incorporation can reduce herbicide exposure to sunlight.

Microbial degradation occurs when microorganisms such as fungi and bacteria use a herbicide as a food source. Conditions that favor microbial growth include warm temperatures, favorable pH levels, adequate soil moisture, oxygen and fertility. Adsorbed herbicides are more slowly degraded because they are less available to some microorganisms.

Chemical degradation is the breakdown of a herbicide by soil processes not involving a living organism. Adsorption of the herbicides, soil pH, soil temperature and moisture influence the rate of degradation. Some

herbicides are more rapidly degraded on low pH soils.

Absorption is the process by which plants and microorganisms take up chemicals. Once absorbed, most herbicides are degraded within plants. Residues may persist inside the plant or be released back into the environment as the plant decays.

Runoff moves herbicides in surface water, either mixed in the water or bound to soil particles. The amount of herbicide runoff depends on the grade or slope of the field, the type of soil, the amount of rainfall (especially close to the time of application) and properties of the herbicide. For example, a herbicide applied to a saturated clay soil is highly susceptible to runoff. Established vegetation or plant residues reduce runoff.

Herbicide runoff is greatest when heavy rainfall occurs shortly after application. No-tillage, minimum-tillage and soil incorporation reduce runoff. Surface grading, drainage ditches and dikes, and the use of border vegetation can help reduce herbicide movement into surface water.

Leaching is the movement of herbicides through the soil into groundwater. Several factors influence leaching, including water solubility of the herbicide, soil structure and texture, and persistence of herbicide adsorption to soil particles. If a herbicide is strongly adsorbed to soil particles, it is less likely to leach, regardless of its solubility, unless the soil particles themselves move with the water flow.

Keeping Herbicides Out of Groundwater and Surface Water

It is very difficult to purify or clean contaminated groundwater or surface water. Management practices can be implemented to effectively reduce pesticide runoff and leaching and protect groundwater and surface water.

- **Use integrated crop management practices**—Minimize herbicide use by combining chemical control with other pest management practices such as tillage, cultivation, crop rotation and pest scouting.
- **Reduce compaction**—Surface water runoff increases when soils are compacted.
- **Rotate crops**—Crop rotations may provide more surface crop residue and may reduce the application of the same pesticides to a field.
- **Use conservation tillage practices**—Include no-till, minimum-till, cover crops, grass waterways and buffer strips.
- **Consider the geology of your area**—When planning herbicide applications, be aware of the water table depth and the permeability of the geological layers between the surface soil and groundwater.
- **Select herbicides carefully**—Choose herbicides with the least potential for leaching into groundwater or for runoff into surface water.
- **Transport pesticides safely**—Have pesticides delivered directly to your pesticide storage facility to avoid liability and potential accidents and spills in transit whenever possible. U.S. DOT shipping rules must be followed for transporting large quantities of pesticides, including proper placarding of the vehicle, liability insurance, special handling requirements, etc.
- **Follow label directions**—The label carries crucial information about the proper rate, timing and placement of the herbicide.
- **Calibrate accurately**—Equipment should be calibrated carefully and often.
- **Measure accurately**—Concentrates need to be carefully measured before they are placed into the spray tank. Do not “add a little extra” to ensure the herbicide will do a better job.
- **Avoid back-siphoning**—The end of the fill hose should remain above the water level in the spray tank at all times to prevent back-siphoning of

chemical into the water supply. Use an anti-backflow device when siphoning water directly from a well, pond or stream. These practices also reduce the likelihood of the hose becoming contaminated with herbicides.

- **Consider weather and irrigation**—If you suspect heavy or sustained rain, delay applying herbicides. Control the quantity of irrigation to minimize the potential for herbicide leaching and runoff.
- **Avoid spray drift and volatilization**—Do not spray when the wind is greater than 10 miles per hour and/or weather conditions (e.g., inversions) are conducive to pesticide drift from the target area. Make every effort to AVOID PESTICIDE DRIFT!
- **Clean up spills**—Avoid spills. When they do occur, contain and clean them up quickly with an absorbent material such as cat litter. Chemicals spilled near wells and sinkholes can move directly and rapidly into groundwater. Chemicals spilled near ditches, streams or lakes can move rapidly into surface water.
- **Change the location of mixing areas**—Mix and load pesticides on an impervious pad, if possible. If mixing is done in the field, change the location of the mixing area regularly. Do not mix herbicides adjacent to the water source, and do not let the water run inadvertently onto the soil near the mixing area. This will increase herbicide leaching and/or runoff.
- **Dispose of wastes and containers properly**—All herbicide wastes must be disposed of in accordance with local, state and federal laws. Pesticide containers are considered hazardous waste until they are cleaned or disposed of properly. When possible, reduce the number of pesticide containers by using bulk or returnable containers. All pesticide containers can be rendered non-hazardous waste by triple rinsing (or equivalent). The rinsate should be added to the spray tank. After triple rinsing, perforate both ends so the container cannot be reused.

All metal and plastic triple-rinsed containers should be recycled, if possible. If this option is not available, dispose of them in a state-licensed sanitary landfill. Dispose of all paper containers in a sanitary landfill or a municipal waste incinerator.

Do not bury or burn any pesticide containers. Do not reuse any empty pesticide containers for any purpose.

- **Store herbicides away from water sources**—Herbicide storage facilities should be situated away from wells, cisterns, springs and other water sources. Pesticides must be stored in a facility that will protect them from temperature extremes, high humidity and direct sunlight. The storage facility should be heated, dry and well ventilated. It should be designed for easy containment and cleanup of pesticide spills and made of materials that will not absorb any pesticide material that leaks out of a container. Store only pesticides in such a facility and always store them in their original containers.

Do not store any protective clothing or equipment in the pesticide storage facility. Store herbicides separately from insecticides and fungicides to avoid contamination of one material by another and accidental misuse.

Keep the facility locked at all times when not in use to prevent animals, children and irresponsible adults from entering and becoming poisoned. Post the facility as a *Pesticide Storage Facility* — to warn others that the area is off-limits. Maintain an accurate inventory of the pesticides stored in the facility at all times in case of emergency.

Always read and follow the *Storage and Disposal* section of pesticide labels for specific storage and handling instructions.

For additional information on pesticide storage, refer to Midwest Plan Service Bulletin 37, *Designing Facilities for Pesticide and Fertilizer Containment*, available from Agriculture and Biosystems Engineering Dept., 122 Davidson Hall, Iowa State University Ames, IA

50011; and Michigan Bulletin E-2335, *On-Farm Agrichemical Storage and Handling*.

Your state's water resources currently provide a vast supply of clean water for agriculture, homes and industry. They can ensure high water quality for future needs only if they are protected now. Be sure to understand how your activities, including herbicide usage, can affect them.

Michigan Groundwater Stewardship Program (MGSP)

The Michigan Groundwater Stewardship Program (MGSP) is a cooperative effort designed to reduce the risks of groundwater contamination associated with the use of pesticides and nitrogen fertilizers. The MGSP has been authorized through the year 2010 by the state legislature. It is funded by assessments on the sale of nitrogen fertilizers and pesticides. The assessment generates \$3.5 million each year that is used to deliver educational programs, technical assistance and cost-share programs that meet the needs and interests of pesticide and fertilizer users. Local MGSP's, usually associated with a county MSU Extension or Conservation District office, provide assisted farmstead pollution risk assessments (Farm*A*Syst and Field*A*Syst) and help in developing a groundwater stewardship plan, provide cost-share funds that are used to install groundwater stewardship practices, and conduct educational workshops and on-farm demonstrations.

The MGSP also sponsors the Spill Response Program (1-800-405-0101) to assist individuals dealing with pesticide, fertilizer and manure spills; Clean Sweep to dispose of unused and unwanted pesticides safely; container recycling to assist in the safe disposal of plastic pesticide containers; and the Michigan Emergency Tube project, which provides an emergency preparedness plan that helps meet the legal requirements of SARA Title III. Growers who participate in some of these programs are also eligible to obtain pesticide recertification credits.

Contact your MSU Extension, Conservation District or USDA NRCS representative to learn more about the MGSP serving your county.

Pesticide Emergency Preparedness

When purchasing a pesticide, obtain a specimen label from the dealer and keep it on file on the farm. This label will be available immediately if an emergency involving a pesticide occurs. Take the label along to a medical treatment center if an individual has suffered pesticide poisoning.

Read and observe closely the *Precautionary Statements* section of the label. Make sure that several people are aware of and can administer treatments for pesticide poisoning contained in the *Statement of Practical Treatment* on the label. (See also section on SARA Title III.)

Handling and Mixing Pesticides

Always wear protective clothing and equipment when handling, mixing and applying pesticides and during cleanup of application equipment. Always wear the personal protective equipment specified on the pesticide label.

Mix pesticides downwind and below eye level. Avoid excessive splashing and sloshing. If pesticides are spilled on you, wash them off immediately with lots of water and change your clothing. Resume spraying only after cleaning up any spills. Try to use closed handling/mixing systems when appropriate.

Keep unauthorized persons out of the area in which you handle pesticides.

Cleaning Pesticide Application Equipment

Follow all specific label directions for cleaning application equipment. It is important to clean weed control sprayers after use, especially if they are used for more than one crop and for application of insecticides and fungicides. The need for extensive cleaning can be minimized if one sprayer is dedicated to herbicide application only.

Do not use a sprayer to apply insecticides or fungicides if the sprayer has been used to apply 2,4-D-type herbicides.

When cleaning a sprayer used only for herbicide application, usually only water rinsing is necessary. Rinse the whole sprayer with water, inside and out, including boom, hoses and nozzles. Partially fill the spray tank with water and keep the pump running so that the water is circulated throughout the entire system. Spray the water through the nozzles. Apply the rinsate to cropland not exceeding labeled rates. Repeat the process when changing herbicides and at the end of each day.

Clean sprayers completely when changing from herbicides to other pesticides. Add 1 gallon of ammonia to 100 gallons of water. Pump it through the system. Leave the cleaning solution in the sprayer system for at least two hours and then pump it out through the nozzles. Do not apply the washing solution to crops. Rinse the system with water after draining the rinsate. Do not leave pesticide solution or cleaning solution in the tank overnight.

Protect Non-target Organisms

Applying pesticides carelessly can harm non-target organisms that are beneficial to agriculture and our environment. The best way to avoid injury of beneficial insects and microorganisms is to minimize pesticide use. Selective pesticides should be used whenever possible and applied only when necessary as part of a total pest management program.

Pesticides can be harmful to all kinds of vertebrates such as **fish** and **wildlife**. Most recognizable are the direct effects from acute poisoning. Fish kills often result from water pollution by a pesticide (usually insecticides). Pesticides can enter water via drift, surface runoff, soil erosion and leaching.

Bird kills from pesticides can occur when birds ingest the toxicant in granules, baits or treated seed; are exposed directly to the spray; consume a treated crop; drink and use contaminated water; or feed on pesticide-contaminated prey.

Worker Protection Standard

New federal rules for farm worker protection have been in effect since 1995. The Worker Protection Standard (WPS) covers pesticides that are used in the production of agricultural plants on farms and in forests, nurseries and greenhouses. The operators of these businesses are required to provide employees with:

- Information in the form of pesticide safety training, pesticide safety poster, access to labeling information and access to an application list of pesticide treatments on the establishment.
- Protection to ensure that employees will be protected from exposures to pesticides. Employers are required to prohibit handlers from applying pesticides in any way that will expose workers or others, exclude workers from areas being treated with pesticides, exclude workers from areas that remain under a restricted entry interval (REI), protect early entry workers who are doing permitted tasks in an area under REI, notify workers about treated areas, monitor handlers who are using highly toxic pesticides and provide instruction for use of personal protective equipment.
- Mitigation in the form of decontamination sites for washing up in the field and emergency assistance to make transportation available to a medical facility in the event of a pesticide-related injury or illness.

Details for compliance with the Worker Protection Standard as well as other regulations affecting worker safety can be obtained at your county MSU Extension office.

Right-to-Know

Plan to conduct a farm worker Right-to-Know training program for all your employees. Use this training time to maintain and improve safety procedures for using agricultural chemicals on your farm. Contact your county Extension agent to assist you in setting up a right-to-know employee training program.

Record Keeping

The 1990 Farm Bill requires that all applicators who apply restricted use pesticides (RUP) keep records and maintain them for two years. Records to be kept include:

- Brand name or product name and the EPA registration number.
- Total amount of the product used.
- Size of the area treated.
- Crop, commodity, stored product or site to which the pesticide was applied.
- Location of the application.
- Month, day and year of the application.
- Name and certification number of the applicator or applicator's supervisor.

Any record form is acceptable as long as the required data are included. Penalties are up to \$500 for the first violation and up to \$1,000 for subsequent violations. Provisions for protecting the identity of the individual producers are included in the law. Commercial applicators must furnish a copy of the required records to the customer of the RUP application.

Endangered Species Act

To minimize the adverse impact of pesticides on endangered species, the EPA initiated the Endangered Species Act. The Michigan Department of Natural Resources (MDNR) administers the Michigan Endangered Species Act and maintains the federal and state endangered species lists in the state. Pesticide applications are a potential problem, particularly affecting birds, butterflies and moths. Alteration of the farm landscape can also negatively affect resident endangered species.

The Environmental Protection Agency (EPA) has determined threshold pesticide application rates that may affect listed species. This information is or will be included on pesticide labels. Counties with vulnerable endangered or threatened species will be identified on pesticide labels. Farmers must take the initiative and consult with the MDNR and the Fish and Wildlife Service (FWS) to be

sure there are no endangered species in their area. The Nature Conservancy, a private land and habitat conservation organization, is working with the MDNR and the FWS and is conducting a landowner contact program to work with landowners who own property important for endangered species protection.

SARA Title III Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Law under SARA Title III requires farmers to notify their State Emergency Response Commission (SERC), Local Emergency Planning Committee (LEPC) and local fire department that they store extremely hazardous materials along with the name and telephone number of the facility representative. Check with your state Department of Environmental Quality or Extension to receive a list of EPA established "extremely hazardous substances" and their threshold planning quantities.

The LEPC and fire chief may request maps of your storage facility and detailed lists of materials you store.

This law also requires, in the event of a spill, that the SERC, LEPC and National Response Commission be notified. The reportable quantities for spills is much less than for storage and can be obtained from the above sources. See Extension bulletin E-2575 for more details on SARA Title III and a list of commonly used extremely hazardous substances.

Right-to-Farm Act

Farmers in Michigan are protected from nuisance lawsuits under the Right-to-Farm Act if they follow specific acceptable management practices. The Generally Accepted Agricultural and Management Practices for pesticide utilization and pest control, nutrient utilization and manure management have been completed and are revised annually. Contact your Extension agent or regional office of the Michigan Department of Agriculture to obtain copies.

Spraying Equipment

A weed control sprayer should be made of non-corrosive materials, be easy to clean and have the following features:

- A tank with a volume of 100 to 300 gallons to reduce filling and mixing operations.
- A pump with a capacity of at least 10 gallons per minute and pressure up to 100 pounds per square inch (PSI).
- An agitation system—The bypass from the pressure control is a good source of agitation. Direct the agitation line into the bottom of the tank. Make sure there is always some agitation in the tank.
- Screens—There should be 50-mesh screens in the intake line and at each nozzle.
- Pressure gauge—A pressure gauge calibrated to 100 PSI should be mounted on the boom as near to the nozzle as possible.
- Boom—The boom should be adjustable from 18 to 36 inches above the ground. It should be built so that it contains shock absorbers to keep it level when going over rough ground.
- Nozzles—Flat fan nozzles with 73 to 95-degree angles are best suited for most weed control work. Nozzle volume can vary from 1 to 10 gallons

per minute, depending on the application; 8002 and 8004 are good general-use nozzles.

Sprayer Calibration

One of the most important factors in effective weed control is accurate calibration of the equipment. The following steps can be used as a guide to calibrate a ground sprayer.

1. **Determine** the desired application volume of the carrier (usually water) in gallons per acre (GPA). A rate of 10 to 30 GPA at 30 to 40 PSI is sufficient for most weed control applications.
2. **Adjust** the boom height so that the spray overlaps about 30 percent at the ground (or other surface to be sprayed). With 80-degree nozzles, this places the nozzles about 20 inches apart on the boom and 20 inches above the sprayed surface. Check each nozzle at the recommended pressure for output. Replace any defective nozzles and screens.
3. **Fill** the spray tank and system with water.
4. **Spray** a measurable area in the field at a fixed speed and at the desired pressure. Spray at least 20 percent of the total tank volume and at least 2 acres of area.

5. **Measure** the volume of water (in gallons) needed to refill the tank.

6. **Determine** the area (in acres) that was test sprayed using the following formula: length of area sprayed (in feet) X boom width (in feet) ÷ 43,560 = acres sprayed.

7. **Divide** the volume sprayed by the area sprayed to obtain the actual output of the sprayer in gallons per acre.

8. **Make adjustments** to tractor speed, pressure or nozzle size, and repeat steps 3 to 7 to change the application rate.

9. **Calculate** the amount of formulated pesticide needed to treat the desired area.

Band application—The expense of herbicide application can be reduced by spraying bands over the crop rows rather than the whole field (broadcast application). When spraying in bands, adjust the amount of herbicide for the area actually sprayed, rather than the total acreage. The amount of chemical per gallon of carrier will remain the same. Use even spray nozzles (e.g., 8004E) rather than tapered spray nozzles (e.g., 8004) for band applications.

Key to Abbreviations in This Publication

a = acre	NIS = non-ionic surfactant
ae = acid equivalent	OM = organic matter
ai = active ingredient	oz = ounce/ounces
AMS = ammonium sulfate	pt = pint/pints
AS = aqueous suspension	PHI = preharvest interval
COC = crop oil concentrate	POST = postemergence
DF = dry flowable	PPI = preplant incorporated
DG = dispersible granule	PRE = preemergence
DS = dry soluble	PSI = pounds per square inch
E or EC = emulsifiable concentrate	qt = quart/quarts
ES = emulsifiable solution	RUP = restricted, use pesticide
F = flowable	SL = soluble liquid
gal = gallon/gallons	S or SP = soluble powder
G = granule	UAN = urea ammonium nitrate, 28%
lb = pound/pounds	W or WP = wettable powder
L = liquid	WSG = water-soluble granule
ME = microencapsulated	yr = year

Table 1. Herbicide formulations, sources, toxicity, runoff and leaching potential, and REI.

Common Name	Trade Name ¹ and Manufacturer	Formulations	Runoff/Leaching ² Potential	LD ₅₀ mg/kg ³		REI ⁴
				Oral	Dermal	
• acetachlor	HARNESS (Monsanto)	7E	3/2	1849	>5000	12 hrs
	SURPASS (Dow AgroSciences)	6.4E	3/2	1426-1942	>2240	12 hrs
• alachlor	MICRO-TECH (Monsanto)	4E	3/2	>5000	>2000	12 hrs
• atrazine	several	4L	2/1	1075-1886	>3100	12 hrs
bensulide	PREFAR (Gowan)	4E	1/2	704-819	>2000	12 hrs
bentazon	BASAGRAN (Arysta)	4SL	3/1	2063	>10000	48 hrs
bromacil	HYVAR X (DuPont)	80W	2/1	1300-2000	>2000	12 hrs
bromoxynil	BUCTRIL (Bayer CropScience)	4E	2/3	505	>2000	24 hrs
carfentrazone	AIM (FMC)	1.9EW	3/3	4077	>4000	12 hrs
clethodim	SELECT MAX (Valent)	0.97E	3/3	>5000	>5000	24 hrs
clomazone	COMMAND (FMC)	3ME	3/2	>5000	>5000	12 hrs
clopypalid	STINGER (Dow AgroSciences)	3L	3/1	>5000	>5000	12 hrs
	CLOPYR AG (United Phosphorus)	3L	3/1	>5000	>2000	12 hrs
cycloate	RO-NEET (Helm)	6E	3/2	3140-3690	>4640	12 hrs
dicamba	BANVEL (Arysta) CLARITY (BASF)	4L	3/1	2629-3512	>2000	24 hrs
dimethenamid-P	OUTLOOK (BASF)	6E	3/2	695	>2000	12 hrs
diquat	REGLONE (Syngenta)	2L	1/3	886	>5050	24 hrs
diuron	KARMEX (DuPont)	80DF	2/2	>5000	>5000	12 hrs
EPTC	EPTAM (Gowan)	7E	3/3	1325	2750	12 hrs
	ERADICANE (Gowan)	6.7E	3/3	2000-2875	>4000	12 hrs
ethalfluralin	CURBIT (UAP)	3E	1/3	3267	>5000	24 hrs
ethofumesate	NORTRON (Bayer CropScience)	4SC	3/2	>2010	>4100	12 hrs
fluazifop-P	FUSILADE DX (Syngenta)	2E	2/3	>5000	>2000	12 hrs
flumioxazin	CHATEAU (Valent)	51WDG	2/3	>5000	>2000	12 hrs
fluroxypyr	STARANE ULTRA (Dow AgroSciences)	2.8L	3/2	>500	>5000	24 hrs
fluthiacet-methyl	CADET (FMC)	0.91EC	3/3	2537	>2020	12 hrs
fomesafen	REFLEX (Syngenta)	2E	2/1	>2000	>2000	24 hrs
foramsulfuron	OPTION (Bayer CropScience)	35WDG	3/2	3881	>5000	12 hrs
fosamine	KRENITE (DuPont)	4L	3/3	>5000	>5000	12 hrs
glufosinate	RELY 200 (Bayer CropScience)	1.67L	3/3	1910-2170	1380-1400	12 hrs
glyphosate	ROUNDUP (Monsanto)	4L	1/3	>5000	>5000	12 hrs
	TOUCHDOWN (Syngenta)	4L	1/3	>5000	>5000	12 hrs
halosulfuron	PERMIT (Gowan)	75WDG	3/2	1287	>5000	12 hrs
	SANDEA (Gowan)	75WDG	3/2	1287	>5000	12 hrs
hexazinone	VELPAR (DuPont)	90SP	2/1	4120	>5000	24 hrs
imazapyr	ARSENAL (BASF)	2AS	2/1	>2000	>5000	12 hrs
imazethapyr	PURSUIT (BASF)	2L	2/1	>5000	>5000	4 hrs
linuron	LOROX (DuPont)	50DF	2/2	4060-4833	>2000	24 hrs
MCPB	THISTROL (Nufarm)	2L	3/3	4738	>2000	12 hrs
s-metolachlor	DUAL MAGNUM (Syngenta)	7.62E	2/1	3425	>2000	24 hrs
mesotrione	CALLISTO (Syngenta)	4L	3/3	>5000	>5000	12 hrs
metribuzin	SENCOR (Bayer CropScience)	75DF	3/1	1449-2365	>5000	12 hrs
napropamide	DEVRIINOL (United Phosphorus)	50DF	2/2	>5000	>5000	12 hrs
naptalam	ALANAP (Chemtura)	2L	3/1	>5000	>20000	48 hrs
nicosulfuron	ACCENT (DuPont)	75 WDG	3/1	>5000	>2000	4 hrs

(continued on next page.)

¹ Trade names and formulations of herbicides are given for the convenience of the users. Other formulations of the same herbicides, or other herbicides with the same active ingredients also may be labeled for use on certain crops. The mention of trade names does not imply that they are endorsed or recommended over those of similar nature not listed.

² 1=high, 2=intermediate, 3=low. These leaching/runoff potential ratings are from the NRCS WIN-PST Pesticide Properties Database at www.wcc.nrcs.usda.gov/pestmgmt/sp2_main.html.

³ The LD₅₀ is a standard toxicological term which indicates the number of milligrams (mg) of pesticide per kilogram (kg) of test animal body weight required to kill 50 percent of a test animal population. Values less than 10 indicate extremely high toxicity to mammals. The LD₅₀ data were obtained from the Material Safety Data Sheets.

⁴ REI=Restricted Entry Interval for the Worker Protection Standard.

• RESTRICTED USE PESTICIDES (RUP). All or certain formulations of these herbicides have been classified as RUP and are available only to certified applicators.

Table 1. Herbicide formulations, sources, toxicity, runoff and leaching potential, and REI (cont).

Common Name	Trade Name ¹ and Manufacturer	Formulations	Runoff/Leaching ² Potential	LD ₅₀ mg/kg ³		REI ⁴
				Oral	Dermal	
norflurazon	SOLICAM (Syngenta)	80DF	2/2	1140	>2000	12 hrs
oryzalin	SURFLAN (United Phosphorus)	4AS	3/3	5000	>5000	24 hrs
oxyfluorfen	GOAL XL, GOALTENDER (Dow AgroSciences)	2E, 4SC	2/3	2985-4594	>4000	24 hrs
• paraquat	GRAMOXONE MAX (Syngenta)	3L	1/3	310	>2000	24 hrs
	FIRESTORM (Chemtura)	3L	1/3	283	>2000	24 hrs
pendimethalin	PROWL, PROWL H2O (BASF)	3.3E, 3.8CS	1/3	>5000	>5000	24 hrs
phenmedipham	SPIN-AID (Bayer CropScience)	1.3E	2/3	4000	>8700	24 hrs
primisulfuron	BEACON (Syngenta)	75DG	3/1	>5050	>2010	12 hrs
prometryn	CAPAROL (Syngenta)	4L	2/2	>5000	>5000	24 hrs
• pronamide	KERB (Dow AgroSciences)	50W	2/1	>5000	>10000	24 hrs
pyrazon	PYRAMIN (Arysta)	68DF	3/2	1160	>2000	12 hrs
quizalofop	ASSURE II (DuPont)	.88E	1/2	4100-5900	>2000	12 hrs
rimsulfuron	MATRIX (DuPont)	25DF	3/2	>5000	>2000	4 hrs
sethoxydim	POAST (BASF)	1.5E	3/3	4285-5000	>4000	12 hrs
sulfentrazone	SPARTAN (FMC)	4F	2/1	2084	>2000	12 hrs
sulfometuron	OUST (DuPont)	75DG	3/2	>5000	>5000	4 hrs
tembotrione	LAUDIS (Bayer CropScience)	3.5 SC		1750	>5000	12 hrs
terbacil	SINBAR (Tessenderlo Kerley, Inc.)	80W	2/1	500-2784	>5000	12 hrs
topramezone	IMPACT (AMVAC)	2.8L		>2000	>2000	12 hrs
triclopyr	GARLON (Dow AgroSciences)	4L	2/1	1338-1581	>2000	12 hrs
trifluralin	several	4E	1/3	3700	>5000	12 hrs
2,4-D	FORMULA 40 (Riverdale)	3.8L	3/2	866-1058	>2000	48 hrs
	WEEDAR 64 (Nufarm)	3.8L	3/2	1161	1544	48 hrs
2,4-D + triclopyr	CROSSBOW (Dow AgroSciences)	3L	2/2	1000-2590	>5000	-

¹ Trade names and formulations of herbicides are given for the convenience of the users. Other formulations of the same herbicides, or other herbicides with the same active ingredients also may be labeled for use on certain crops. The mention of trade names does not imply that they are endorsed or recommended over those of similar nature not listed.

² 1=high, 2=intermediate, 3=low. These leaching/runoff potential ratings are from the NRCS WIN-PST Pesticide Properties Database at www.wcc.nrcs.usda.gov/pestmgt/sp2_main.html.

³ The LD₅₀ is a standard toxicological term which indicates the number of milligrams (mg) of pesticide per kilogram (kg) of test animal body weight required to kill 50 percent of a test animal population. Values less than 10 indicate extremely high toxicity to mammals. The LD₅₀ data were obtained from the Material Safety Data Sheets.

⁴ REI=Restricted Entry Interval for the Worker Protection Standard.

• RESTRICTED USE PESTICIDES (RUP). All or certain formulations of these herbicides have been classified as RUP and are available only to certified applicators.

Table 2. Effectiveness of preplant incorporated and preemergence herbicides on weeds.

HERBICIDE (TRADE NAMES)	BARNYARDGRASS	CRABGRASS	FALL PANICUM	FOXTAILS	QUACKGRASS	COMMON LAMBSQUARTERS	COMMON PURSLANE	COMMON RAGWEED	GALINSOGA	MUSTARDS, WILD RADISH	NIGHTSHADES	PROSTRATE SPURGE	REDROOT PIGWEED	SMARTWEEDS	VELVETLEAF	YELLOW NUTSEDGE
ATRAZINE	G	F	P	G	G	E	E	E	G	E	E	G	E	E	F	F
ALANAP	P	P	P	P	P	G	F	F	F	F	P	P	G	G	G	P
CALLISTO	N	N	N	N	N	G	N	G	G	P	G	P	G	G	G	N
CAPAROL	F	G	F	F	P	E	G	G	F	G	G	G	E	F	F	P
CHATEAU	G	G	G	G	N	E	G	F	G	E	E	E	E	F	G	N
COMMAND	G	G	G	G	P	G	E	G	G	F	P	F	P	F	E	P
CURBIT	E	E	E	E	P	G	G	P	P	F	F	P	G	G	P	P
DEVRIKOL	E	E	E	E	P	P	G	P	P	P	P	P	G	P	P	P
DUAL	E	E	E	E	P	F	F	P	G	P	G	G	G	F	P	G
EPTAM	E	E	E	E	G	G	P	F	F	F	F	P	G	F	F	G
GOAL	P	F	P	F	P	G	E	G	G	G	G	F	E	G	G	P
HARNESS/SURP	E	E	E	E	N	G	G	F	F	P	G	F	G	F	P	F
KARMEX	E	F	F	E	P	E	E	E	G	G	G	F	E	E	F	P
KERB	F	F	P	F	G	F	G	F	P	P	P	F	P	F	P	P
LASSO	E	E	E	E	P	F	G	F	G	P	G	G	E	F	P	F
LOROX	G	F	F	E	P	E	G	E	G	G	G	G	G	G	F	P
MATRIX	G	F	F	G	P	F	G	F	F	G	P	F	G	F	P	F
OUTLOOK	E	E	E	E	N	P	G	P	G	F	G	G	G	F	N	G
PERMIT, SANDEA	P	P	P	P	P	G	F	G	G	G	P	F	E	G	G	G
PREFAR	E	E	E	E	P	P	P	P	P	P	P	P	G	P	P	P
PROWL	E	E	E	E	P	G	F	P	F	P	P	G	G	F	F	P
PYRAMIN	F	F	F	F	P	E	G	G	P	G	G	F	G	G	P	P
RONEET	E	E	F	E	P	F	F	F	F	P	P	P	G	P	F	F
SENCOR	G	F	G	G	P	E	E	E	E	E	P	G	G	E	G	P
SINBAR	G	G	G	G	F	E	G	G	G	E	G	F	G	G	G	P
SOLICAM	E	E	E	E	F	F	F	G	G	E	F	G	F	G	F	F
SPARTAN	F	G	G	G	P	G	G	F	G	F	G	G	E	G	G	F
SURFLAN	E	E	E	E	P	G	G	F	F	F	F	F	G	F	P	P
TREFLAN/TRILIN	E	E	E	E	P	F	F	P	P	P	P	P	G	P	P	P

E = Excellent, G = Good, F = Fair, P = Poor, N = None, — = insufficient data. Weed control will vary with soil type and weather.

Table 3. Effectiveness of postemergence herbicides on weeds.

HERBICIDE (TRADE NAMES)	BARNYARDGRASS	CRABGRASS	FALL PANICUM	FOXTAILS	QUACKGRASS	COMMON LAMBSQUARTERS	COMMON PURSLANE	COMMON RAGWEED	GALINSOGA	MUSTARDS, WILD RADISH	NIGHTSHADES	PROSTRATE SPURGE	REDROOT PIGWEED	SMARTWEEDS	VELVETLEAF	YELLOW NUTSEDGE
ACCENT	E	P	E	E	G	F	N	P	N	N	P	N	E	G	F	F
AIM	N	N	N	N	N	G	N	F	P	P	G	F	G	F	G	N
ASSURE	F	F	G	G	F	N	N	N	N	N	N	N	N	N	N	N
ATRAZINE	G	G	F	G	G	E	E	E	G	E	G	G	E	E	G	G
BANVEL/CLARITY	P	P	P	P	P	G	G	G	G	G	G	G	G	G	G	P
BASAGRAN	P	P	P	P	P	G	G	G	G	G	F	P	P	E	G	G
BEACON	P	P	G	F	G	F	N	E	N	F	G	N	E	G	G	F
BUCTRIL	P	P	P	P	P	E	P	G	G	G	G	F	F	G	G	P
CADET	N	N	N	N	N	G	N	N	N	N	G	N	G	N	G	N
CALLISTO	N	N	N	N	N	G	N	P	G	G	G	P	G	G	G	N
CAPAROL	F	F	F	F	P	E	G	E	G	G	G	G	E	F	F	P
CHATEAU	N	N	N	N	N	E	E	G	G	E	E	G	E	G	G	P
2,4-D	P	P	P	P	P	E	P	E	G	G	E	E	E	F	F	P
DISTINCT	P	P	P	P	P	G	G	G	G	G	G	G	G	G	G	P
FUSILADE	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
GOAL	P	P	P	P	P	F	E	G	F	F	G	P	E	F	G	P
GRAMOXONE	E	E	E	E	E ¹	E	E	E	G	E	E	G	E	E	G	G ¹
IMPACT	G	G	F	F	N	G	P	G	F	G	G	G	G	F	G	N
LAUDIS	G	G	P	G	N	G	P	G	G	G	G	P	G	G	G	N
LOROX/LINEX	F	F	F	G	P	E	G	E	G	G	G	G	E	E	F	P
MATRIX	G	G	G	G	F	F	F	F	F	G	P	G	G	F	F	F
NORTON	P	P	P	F	N	F	F	P	P	G	G	F	P	G	P	F
OPTION	G	F	G	G	G	G	P	G	F	G	G	P	G	P	G	N
PERMIT, SANDEA	P	P	P	P	P	P	P	G	G	G	P	G	E	G	G	G
POAST	G	G	G	G	F	N	N	N	N	N	N	N	N	N	N	N
REFLEX	P	P	P	P	N	P	E	G	G	E	G	F	E	P	P	N
ROUNDUP	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F
SELECT	G	G	G	G	F	N	N	N	N	N	N	N	N	N	N	N
SENCOR	F	F	F	G	P	E	E	E	E	E	P	G	G	E	G	P
SINBAR	F	P	F	P	P	E	E	G	G	E	G	G	G	G	F	P
SPARTAN	P	P	F	F	P	G	F	F	F	P	G	F	E	G	G	F
SPINAID	P	P	P	P	P	G	G	G	G	G	F	F	P	G	P	P
STARANE	N	N	N	N	N	G	F	G	F	F	F	N	P	F	G	N
STINGER	P	P	P	P	P	P	P	G	G	P	F	P	P	F	P	P

E = Excellent, G = Good, F = Fair, P = Poor, N = None, — = insufficient data. Weed control will vary with soil type and weather.

¹Kills top growth only.

Weed Control Recommendations for Vegetable Crops

Crop	Weed Problem	Chemical	Lb Active Ingredient/Acre	Product/Acre	Remarks and Limitations
ASPARAGUS (Seed beds for crown production)	Preemergence annuals	terbacil (SINBAR 80W)	0.5-1.2	0.62-1.5 lb	Spray 300 lb/acre activated charcoal in a 1-inch band over rows at planting. Then apply Sinbar. One-half inch of moisture within 2 weeks of application will improve control. Do not use on soils with less than 1% organic matter. Do not plant any crop other than asparagus within 2 years of application.
	Emerged annuals	paraquat (GRAMOXONE MAX 3L)	0.64-1	1.7-2.7 pt	Apply after weeds emerge but before asparagus emerges. Include 1 pt NIS 100 gal of spray mix.
	Pre- or postemergence broadleaves	linuron (LOROX 50DF)	0.5-1.5	1-3 lb	PREEMERGENCE: Plant seed 1-1.5 inches deep; spray a 1-inch band of activated charcoal over the rows at a rate of 300 lb/acre of actual area sprayed (15 lb/acre with 20-inch rows). Broadcast 2 lb of Lorox (1 lb ai) over the field. POSTEMERGENCE: When fern is 6-18 inches high and weeds are not over 4 inches high, broadcast 1-2 lb Lorox (1/2-1 lb ai). Do not exceed a total of 2 lb ai/acre/year.
	Postemergence broadleaves and nutsedge	halosulfuron (SANDEA 75W)	0.023-0.047	0.5-1 oz	Apply after fern is 6 weeks old. Do not apply more than 2 oz/acre/year. Do not add adjuvant. Make 2 applications for nutsedge control.
	Postemergence grasses	sethoxydim (POAST 1.5E)	0.19-0.38	1-2 pt	Apply to actively growing grasses. Include 1 qt COC/acre. Maximum 5 pt/acre/year and 2 applications.
		fluzifop-P (FUSILADE DX 2E)	0.25-0.38	1-1.5 pt	Include 1 qt COC or 1 pt NIS/acre. Use high rate on quackgrass.
ASPARAGUS (Newly planted crowns)		clethodim (SELECTMAX 0.97 E)	0.068-0.12	9-16 fl oz	Include 0.25% NIS/acre. Maximum of 64 fl oz/acre/yr. 1-day PHI.
	Germinating or emerged broadleaves	linuron (LOROX 50 DF)	1-2	2-4 lb	PREEMERGENCE: Broadcast 2-4 lb Lorox (1-2 lb ai) before crop emergence. POSTEMERGENCE: When fern is 6-18 inches high and weeds are not over 4 inches high, broadcast 2 lb Lorox (1 lb ai). Do not exceed a total of 2 lb ai/acre/year.
	Postemergence broadleaves and nutsedge	halosulfuron (SANDEA 75W)	0.023-0.047	0.5-1 oz	Apply after fern is 6 weeks old. Do not apply more than 2 oz/acre/year. Do not add adjuvant. Make 2 applications for nutsedge control.

Postemergence grasses	sethoxydim (POAST 1.5E)	0.19-0.38	1-2 pt	Apply to actively growing grasses. Include 1 qt COC/acre. Maximum 5 pt/acre/year and 2 applications.
	fluzifop-P (FUSILADE DX 2E)	0.25-0.38	1-1.5 pt	Include 1 qt COC or 1 pt NIS/acre. Use high rate on quackgrass.
	clethodim (SELECTMAX 0.97 E)	0.068-0.12	9-16 fl oz	Include 0.25% NIS/acre. Maximum of 64 fl oz/acre/yr. 1-day PHI.
EMERGED ANNUALS				
Emerging annuals	paraquat (GRAMOXONE MAX 3L)	0.64-1	1.7-2.7 pt	Apply before crop emergence or after the last harvest after all spears have been removed. Include 1 pt NIS/100 gal. 6-day PHI. RUP.
Preemergence annuals	diuron (KARMEX 80DF)	0.8-3	1-4 lb	Apply after mowing fern in spring and after harvest. Use low rate on sandy soil. Do not exceed 6 lb product/acre/year. Use low rate if in combination with Lorox, Sencor or Sinbar. 6-8 weeks residual activity.
	norflurazon (SOLICAM 80DF)	2-4	2.5-5 lb	Apply in fall after chopping fern or in spring before emergence. Use lower rate on coarse, sandy soil. Apply only once per season. 1-2 months' residual activity. Suppresses nutsedge. 14-day PHI.
	flumioxazin (CHATEAU 51 WDG)	0.192	6 oz	Make one application at least 14 days before spear emergence. Good control of most annual broadleaves and grasses. 6-8 weeks of horseweed control. May cause some scoring of early spears after heavy rain.
	s-metolachlor (DUAL MAGNUM 7.6E)	1.26-1.9	1.33-2.0 pt	Apply before asparagus and weeds emerge in spring, or after the harvest season. Needs moisture for activation. 16-day PHI. 1 application/crop. See: www.farmassists.com . SLN label.
	metribuzin (SENCOR 75DF)	0.5-1	0.67-1.3 lb	Apply after mowing fern in spring and after harvest. Do not exceed 2.6 lb product/acre/year. Good sandbur control. Use low rate if in combo with Karmex. 6-8 weeks residual activity. 14-day PHI.
	sulfentrazone (SPARTAN 4F)	0.14-0.375	4.5-12 fl oz	Apply in spring before crop emerges. Use low rate on light soil. Do not use on soils with <1% OM. Max. 12 fl oz/acre in 1 application/year. 14-day PHI.
	terbacil (SINBAR 80W)	0.5-1.2	0.62-1.5 lb	Apply after mowing in spring. Do not use on light sandy soil. Do not exceed 1.5 lb product/acre/year. Do not plant other crops within 2 years of last application. 5-day PHI.
Preemergence broadleaves, crabgrass	mesotrione (CALLISTO 4L)	0.094-0.241	3-7.7 fl oz	Apply before spear emergence in spring or after final harvest. Add COC or NIS to improve burndown of emerged weeds. Do not exceed 7.7 fl oz/acre/yr. A post-harvest application may cause some fern bleaching. Controls most annual broadleaves.
Postemergence broadleaves	halosulfuron (SANDEA 75W)	.023-.047	0.5-1 oz.	Apply anytime during the season to kill nutsedge or broadleaves. Use drop nozzles in standing fern. Do not include NIS in spray mix during harvest. Maximum 2 oz/acre/year in 2 applications. 1-day PHI.
	linuron (LOROX 50DF)	1-2	2-4 lb	Apply before or after crop emergence. Use high rate preemergence. Do not exceed 4 lb ai/acre/year. 6 weeks' residual activity. 1-day PHI.
	2,4-D amine salts (FORMULA 40) (3.8L)	1.4-1.9	1.5-2 qt	Apply before, during or after the harvest season when weeds are growing rapidly. During harvest, spray soon after a pick to minimize crop injury. In fern, use drop nozzles. 3-day PHI.

(continued)

Crop	Weed Problem	Chemical	Lb Active Ingredient/Acre	Product/Acre	Remarks and Limitations	
ASPARAGUS (Established one year or more) (continued)	Postemergence broadleaves	dicamba (CLARITY 4L) (BANVEL 4L)	0.25-0.5	0.5-1 pt	Apply to actively growing weeds immediately after a harvest. Use high rate for control of perennial weeds. Apply in tank mix with 2,4-D or glyphosate for control of Canada thistle or field bindweed. Discard crooked spears at harvest. Do not exceed 1 pt/acre/year. 24-hr PHI.	
		clopyralid (CLOPYR AG 3L)	0.19-0.25	8-10.7 fl oz	Apply before or during harvest. Maximum of .67 pt/acre/year. May cause some crooking of spears. Controls Canada thistle, mareetail, mayweed, nightshade, plantain, smartweeds. Avoid application 2 years in succession. 2-day PHI.	
		fluzifop-P (FUSILADE DX 2E)	0.25-0.38	1-1.5 pt	Apply to actively growing grasses. Include NIS or COC. Maximum 3 pt/acre/year. 1-day PHI.	
	Postemergence grasses	sethoxydim (POAST 1.5E)	0.19-0.38	1-2 pt	Apply to actively growing grasses. Include 1 qt COC in 20 gal water/acre. Maximum 5 pt and 2 applications/year. 1-day PHI.	
		clethodim (SELECTMAX 0.97 E)	0.068-0.12	9-16 fl oz	Include 0.25% NIS/acre. Maximum of 64 fl oz/acre/yr. 1-day PHI.	
		glyphosate (ROUNDUP 4L) (TOUCHDOWN 4L)	1-4	1-4 qt	PREEMERGENCE: Apply at least 7 days before asparagus emergence. SPOT TREATMENT: Apply immediately after a clean harvest. Do not treat more than 10% of total field area. 5-day PHI. POSTHARVEST: Apply immediately after the last harvest and all spears have been removed, or allow fern to develop and apply to soil as a shielded or directed spray. Do not allow herbicide to contact emerged spears or fern.	
	BEANS (Snap, Lima)	Emerging weeds before crop emergence	paraquat (GRAMOXONE MAX 3L)	0.49	1.3 pt	Apply before or after seeding but before crop emergence. Include 1 pt NIS/100 gal. RUP.
			glyphosate (ROUNDUP 4L)	2	2 qt	Apply to 8- to 10-inch quackgrass in the fall or spring prior to planting. Allow at least 5 days before plowing. Include 1 pt NIS/acre.
		Preemergence grasses and broadleaves	EPTC (EPTAM 7E)	3	3.5 pt	SNAP BEANS only. Apply before planting and incorporate 2-4 inches immediately. For dry conditions.
			pendimethalin (PROWL 3.8ACS)	0.95-1.42	2-3 pt	Apply before planting and incorporate 1-2 inches deep. Use high rate on soils with 3% or more organic matter.
Emerging weeds before crop emergence		s-metolachlor (DUAL MAGNUM 7.6E)	0.95-1.9	1-2 pt	Use lower rate on sandy soils with less than 3% organic matter. Incorporate 1-2 inches before planting or apply preemergence.	
		trifluralin (TRIFLALIN 4E)	0.5-0.75	1-1.5 pt	Apply before planting. Incorporate into soil 2-3 inches soon after spraying. Use lowest rate on sandy soils. Does not control ragweed.	
		clomazone (COMMAND 3ME)	0.15-0.25	0.4-0.67 pt	Apply to soil surface after seeding. Use lower rate on coarse soils. Controls velvetleaf and galinsoga. 45-day PHI.	
		imazethapyr (PURSUIT 2L)	0.023-0.031	1.5-2 fl oz	Apply PPI or PRE after seeding. Use low rate for snapbeans and on sandy soils. Do not apply after June 30. 30-day PHI. OBSERVE CROP ROTATION RESTRICTIONS ON LABEL.	
		halosulfuron (SANDEA 75W)	0.023-0.047	0.5-1 oz	Apply after seeding and before cracking. Maximum 1 oz/crop cycle; maximum 2 oz/acre/year in 2 crop cycles. 30-day PHI.	

Preemergence annuals	fomesafen (REFLEX 2L)	0.25-0.375	1-1.5 pt	Good precontrol of most annual broadleaves. Max. of 1.5 pt pre and post in one year. Do not apply more than once in 2 years to any soil. 30-day PHI. Most vegetable crops have an 18-month rotational restriction.
Postemergence broadleaves	bentazon (BASAGRAN 4L)	0.75-1	0.75-1 qt	Apply after beans have more than 1 expanded trifoliolate leaf to prevent crop injury. Two applications are needed for nutsedge and Canada thistle control. Do not apply more than 2 qt/acre/year.
	imazamox (RAPTOR 1 AS)	0.031	4 fl oz	Raptor must be applied in tank mix with Basagran. Apply to beans with at least 1 trifoliolate leaf and before bloom. Include 0.25% NIS in spray mix. Good control of several broadleaves and grasses.
	halosulfuron (SANDEA 75 W)	0.023-0.035	0.5-0.67 oz	Apply after bean 2 trifoliolate leaf stage, but before flowering. Controls nutsedge. Do not exceed 1 oz/acre/year. 30-day PHI.
Postemergence grasses	fomesafen (REFLEX 2L)	.125-.25	0.5-1 pt	Apply to beans with at least 1 trifoliolate leaf. Maximum of 2 applications and 1.5 pt/acre/year. Include 0.25% NIS/acre. Do not apply to land more than once in 2 years. Most vegetable crops have an 18-month rotational restriction. 30-day PHI.
	sethoxydim (POAST 1.5E)	0.19-0.28	1-1.5 pt	Dry and succulent beans. Apply to actively growing grasses. Maximum of 4 pt/acre/year. Add 1 qt COC/acre. 15-day PHI for succulent beans and 30 days for dry beans.
	quizalofop (ASSURE II 0.88E) (TARGA)	0.04-0.08	6-12 fl oz	SNAP BEANS only. Apply to actively growing grasses in 10-20 gpa. Include 1 qt COC or .5 pt NIS/acre. 30-day PHI.
Preemergence and postemergence annuals	clethodim (SELECTMAX 0.97 E)	0.068-0.12	9-16 fl oz	Include 0.25% NIS/acre. One application per year. 21-day PHI.
	pyrazon (PYRAMIN 68DF)	3.1-3.7	4.6-5.4 lb	Apply from planting until weeds are 2 inches high. On muck soils, better control is obtained by spraying small weeds after beets have 2 true leaves. Include 1 qt COC/acre.
	ethofumesate (NORTRON 4 SC)	1.9 pre .16-.33 post	3.75 pt pre 5.25-10.5 fl oz post	Apply to soil after seeding, or to beets with 2-8 leaves. Maximum of 6 pt/acre/year. Good control of lambsquarters, nightshades, smartweeds, mustards.
Preemergence annuals	cycloate (RO-NEET 6E)	3-4	2-3 qt	Apply before planting. Incorporate 2-3 inches after spraying. Use lowest rate on sandy soils. Not effective on muck soils.
	s-metolachlor (DUAL MAGNUM 7.6E)	0.63-1.26	0.67-1.33 pt	Apply to soil after seeding. Apply 0.5 inch irrigation to dry soil after application. Avoid use on soils with <1.5% OM. Use high rate on muck soils with >20% OM. See: www.farmasslist.com to obtain label.
Postemergence broadleaves	phenmedipham (SPIN-AID 1.3E)	1	3 qt	Apply after beets have 4 true leaves. Use no more than 22 gal spray solution per acre. Do not apply if beets are under any type of stress. See label for weeds controlled and precautions. Does not control redroot pigweed. 60-day PHI.
Postemergence grasses	clopyralid (STINGER 3L)	0.188	8 fl oz	Apply before beets are 4 inches tall. Kills composite weeds and nightshade. 30-day PHI.
	sethoxydim (POAST 1.5E)	0.19-0.47	1-2.5 pt	Apply to actively growing grasses. Use high rate on perennial grasses. Maximum of 3 pt/acre/year. Include 1 qt COC/acre. 60-day PHI.
	clethodim (SELECT MAX 0.97E)	0.068-0.12	9-16 fl oz	Apply to actively growing grasses. Maximum 64 fl oz/acre/year. Include 0.25% NIS/acre. 30-day PHI.
Emerged annuals and perennials	glyphosate (ROUNDUP 4L)	2-3	2-3 qt	Apply to emerged perennials before planting in the spring or after harvest in the fall. Check label for best time of year, stage of growth and rate for each weed.

BEETS, RED

Crop	Weed Problem	Chemical	Lb Active Ingredient/Acre	Product/Acre	Remarks and Limitations
BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER (Seeded or transplanted)	Emergent weeds before crop emergence	paraquat (GRAMOXONE MAX 3L)	0.49	1.3 pt	Apply before transplanting or before or after seeding but before crop emergence. Include 1 pt NIS/100 gal. RUP.
	Preemergence grasses and broadleaves	trifluralin (TREFLAN 4E) (TRILIN 4E) napropamide (DEVIRINOL 50DF)	0.5-1 1-2	1-2 pt 2-4 lb	Apply and incorporate 2-3 inches before seeding or transplanting. Use low rate on sandy soils. Not effective on muck soils. Trifluralin may stunt transplanted crops or delay emergence of seeded crops when soil temperature is below 60° F. Apply before seeding or transplanting and incorporate 1-2 inches. May be applied after planting. Irrigate within 24 hours and soak soil 2-4 inches. Most effective in combination with Goal.
		s-metolachlor (DUAL MAGNUM 7.6E)	0.48-1.2	0.5-1.3 pt	Apply to soil surface before transplanting or within 48 hours after transplanting. Do not tank mix with Goal for post transplant application. See: www.farmassist.com to obtain label. 60-day PHI.
		clomazone (COMMAND 3ME)	0.25-0.5	0.7-1.3 pt	CABBAGE only. Apply before or after seeding or before transplanting. Use low rate for seeded cabbage. May cause early stunting or discoloration of cabbage. Controls velvetleaf. Observe rotational restrictions. 45-day PHI.
	Preemergence broadleaves	oxyfluorfen (GOAL 2XL)	0.25-0.5	1-2 pt	TRANSPANTED only. Apply to soil after final tillage but before transplanting. Do not apply after transplanting. Use low rate on coarse, sandy soil. If plants contact treated soil, some foliar burn may occur. Do not use on brussels sprouts. Use with trifluralin or napropamide.
		sulfentrazone (SPARTAN 4F)	0.07-0.188	2.25-6 fl oz	PROCESSING CABBAGE. Apply before transplanting or as a directed spray between rows after transplanting.
	Postemergence broadleaves	clopyralid (STINGER 3L)	0.094-0.188	4-8 fl oz	Apply at any crop stage. Kills composite weeds, legumes, nightshade. Maximum 2 applications and 8 fl oz/acre/year. 30-day PHI.
	Postemergence grasses	sethoxydim (POAST 1.5E) clethodim (SELECT MAX 0.97E)	0.19-.28 0.068-0.12	1-1.5 pt 9-16 fl oz	Apply to actively growing grasses. Use high rate on perennial grasses. Maximum of 3 pt/acre/year. Include 1 qt COC/acre. 30-day PHI. Include 0.25% NIS/acre in spray mix. Maximum 64 fl oz/acre/year. 30-day PHI.
	Postemergence perennials	glyphosate (ROUNDUP 4L)	2-3	2-3 qt	Apply to emerged perennials before planting in the spring or after harvest in the fall. Check label for best time of year, stage of growth and rate for each weed.

CARROT

Preemergence annuals	linuron (LOROX 50DF)	0.5-1	1-2 lb	PREEMERGENCE: Apply after seeding but before carrots emerge. Use low rate on light soils and higher rate on clay or muck.
	s-metolachlor (DUAL MAGNUM 7.6 E)	0.48-1.9	0.5-2.0 pt	Mineral soil: .5-1 pt/acre. Muck soil: 1.3-2 pt/acre. Apply after seeding and before carrots emerge. One application per crop. Wait 5 days after seeding barley before application. See: www.farmassists.com to obtain SLN label.
	pendimethalin (PROWL H20 3.8 ACS)	0.95	2.0 pt	Apply after seeding as a broadcast or at layby as a directed spray. Plant barley cover crop 7 days before application. Needs water for activation. 60-day PHI.
Postemergence broadleaves	trifluralin	0.5-1	1-2 pt	Mineral soil only. Apply before planting and incorporate 2-3 inches soon after spraying. Use low rate on sandy soils.
	linuron (LOROX 50DF)	0.75-1	1.5-2 lb	Broadcast after carrots are 3 inches high. Do not apply when temperature is above 85°F. Do not apply at pressure above 40 PSI. Do not mix with other pesticides or surfactants. Do not apply within 14 days of any other pesticides when carrots are under stress. Do not exceed 2 lb ai/acre/year. 14-day PHI.
	metribuzin (SENCOR 75DF)	0.25	0.33 lb	Broadcast when carrots have 5-6 leaves. Do not apply during cool, cloudy weather or when temperature is above 85°F. Do not mix with other chemicals. Do not apply within 14 days of any other pesticides when carrots are under stress. Do not apply more than once per season. 60-day PHI.
Postemergence grasses	fluzifop-P (FUSILADE DX 2E)	0.16-0.19	10-12 fl oz	Apply to actively growing grasses. Do not apply more than 6 pt/acre/year. Include 1 qt COC or 1 pt NIS/acre. 45-day PHI.
	sethoxydim (POAST 1.5E)	0.19-0.47	1-2.5 pt	Apply to actively growing grasses. Include 1 qt COC/acre. Maximum total of 5 pt/acre. 30-day PHI.
	clethodim (SELECT MAX 0.97E)	0.068-0.12	9-16 fl oz	Apply to actively growing grasses. Maximum 64 fl oz/acre/year. Include 0.25% NIS/acre. 30-day PHI.
Postemergence perennials	glyphosate (ROUNDUP 4L)	2-3	2-3 qt	Apply to weeds before planting in the spring or after harvest. Apply between carrot rows as shielded or wiper application. 14-day PHI.
Preemergence grasses, yellow nutsedge	s-metolachlor (DUAL MAGNUM 7.6E)	0.95-1.9	1-2 pt	Apply before or immediately after transplanting. Use high rate on muck soils. Follow with 0.25 inch water within 7 days. 62-day PHI. See: www.farmassists.com to obtain label.
	prometryn (CAPAROL 4L)	1-2	1-2 qt	Make 1 application 2-6 weeks after transplanting but before weeds are 2 inches tall. Do not exceed 2 lb ai/acre/year.
	linuron (LOROX 50DF)	0.75-1	1.5-2 lb	Apply after transplanting but before celery is 8 inches tall. Do not exceed 40 PSI pressure. Do not apply when temperatures exceed 85°F, and do not mix with wetting agents or other pesticides.
Postemergence grasses	sethoxydim (POAST 1.5E)	0.19-0.28	1-1.5 pt	Apply to actively growing grasses. Include 1 qt COC/acre. Maximum total of 3 pt/acre/season. 30-day PHI.
	clethodim (SELECT MAX 0.97E)	0.068-0.12	9-16 fl oz	Apply to actively growing grasses. Maximum 64 fl oz/acre/year. Include 0.25% NIS/acre. 30-day PHI.
Postemergence perennials	glyphosate (ROUNDUP 4L)	2-3	2-3 qt	Apply to emerged perennials before planting in the spring or after harvest in the fall.

CELERY
(Transplanted)

Crop	Weed Problem	Chemical	Lb Active Ingredient/Acre	Product/Acre	Remarks and Limitations
CHINESE VEGETABLES	Preemergence	trifluralin (TREFLAN 4E)	0.5-0.75	1-1.5 pt	Chinese cabbage. Apply and incorporate before planting. Use low rate on sandy soil. Treflan may cause stunting in cold soils.
		s-metolachlor (DUAL MAGNUM 7.6E)	0.48-1.26	0.5-1.33 pt	CHINESE CABBAGE. Apply to soil surface before transplanting, or broadcast over plants within 48 hrs after transplanting. 60-day PHI. See: www.farmanassist.com to obtain SLN label.
	Postemergence grasses	bensulide (PREFAR 4E)	5-6	5-6 qt	Apply preplant or preemerge. Incorporate or water in. See label for crops included.
		sethoxydim (POAST 1.5E)	0.19-0.28	1-1.5 qt	Chinese cabbage, Chinese broccoli. Apply to actively growing grasses. Include 1 qt COC/acre. Maximum 3 pt/acre/year. 30-day PHI.
		clethodim (SELECT MAX 0.97E)	0.068-0.12	9-16 fl oz	Apply to small grasses. Maximum 64 fl oz/acre/year. Include 0.25% NIS/acre in spray mix. 14-day PHI.
		paraquat (GRAMOXONE MAX 3L)	0.49	1.3 pt	Apply before or after planting but before corn emerges to kill emerged weeds. RUP.
CORN (Sweet, Pop)	Preemergence	atrazine (AATREX 4L)	1-2	1-2 qt	Apply soon after planting. Observe rotation restrictions. RUP.
		alachlor (MICRO-TECH 4E)	2-4	2-4 qt	Apply soon after planting and before weeds emerge. Controls primarily grasses. RUP.
	Emergent annuals	s-metolachlor (DUAL MAGNUM 7.6E)	1.2-1.9	1.3-2 pt	Apply soon after planting and before weeds emerge. Controls primarily grasses. Some nutsedge activity.
		acetachlor (SURPASS 6.4EC) (HARNESS + 7E)	0.8-3	1-3.75 pt 0.9-3.4 pt	May be preplant incorporated or applied to surface after planting. Check label for rate for soil type. Controls many broadleaves and grasses. RUP.
		dimethenamid-P (OUTLOOK 6E)	0.56-0.98	12-21 fl oz	Apply PPI or PRE. Check label for rate for soil type. Some hybrids may be sensitive. Controls many broadleaves, grasses and nutsedge. 50-day PHI.
		pendimethalin (PROWL 3.8ACS)	0.7-1.9	0.75-2 qt	Apply from early postemergence up to 24-inch-tall corn. Use drop nozzles for better soil distribution. No activity on emerged weeds. Use low rate on light soil. Controls annual grasses, wild proso millet.
		EPTC (ERADICANE 6.7E)	4-6	4.75-7 pt	Apply and incorporate in same pass. Most effective on light soils. Controls annual grass, nightshades, nutsedge.

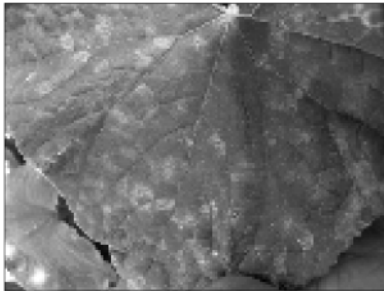


The Vegetable Crop Advisory Team Alert newsletter

Dependable pest management information from MSU Extension

The CAT Alert is MSU Extension's targeted advice for growing vegetables under Michigan conditions

The *Vegetable CAT Alert* newsletter is very timely with articles posted to the web the same day they are received from authors. Our print version is created from articles collected throughout the week. We look at conditions in surrounding states, data on trends from past years, insect trap catches, disease forecasting tools, and the reports of our agricultural meteorologist to predict what your pest management needs will be.



Stay on top of nutrient management, downy mildew in cucurbits, European corn borer management, special pesticide registrations and updates for successful cover crops.



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New weather resource available

MSU's Enviro-weather web site provides current weather data and forecasts, integrated pest management models, and decision making tools. View the web site at:
www.enviroweather.msu.edu





PESTICIDE EMERGENCY INFORMATION

For any type of an emergency involving a pesticide, immediately contact the following emergency information centers for assistance.

Current as of November 2008



Human Pesticide Poisoning

POISON CONTROL

From anywhere in the United States, call

1 - 8 0 0 - 2 2 2 - 1 2 2 2

Special Pesticide Emergencies

Animal Poisoning

Your veterinarian:

Phone No. _____

or

Animal Poison Control Center (\$55 consultation fee per case)

***1-888-426-4435**

www.aspca.org

Phone No. _____

and

***911**

Pesticide Fire

Local fire department:

Phone No. _____

and

***911**

Traffic Accident

Local police department or sheriff's department:

Phone No. _____

and

MDEQ Pollution Emergency Alerting System (PEAS):

***1-800-292-4706**

also

***1-800-405-0101**

Michigan Department of Agriculture Spill Response (for fertilizer, pesticide, and manure spills)

Environmental Pollution

District Michigan Department of Environmental Quality (MDEQ) Office Phone No.

Phone No. _____

and

MDEQ Pollution Emergency Alerting System (PEAS):

***1-800-292-4706**

also

***1-800-405-0101**

Michigan Department of Agriculture Spill Response (for fertilizer, pesticide, and manure spills)

Pesticide Disposal Information

Michigan Clean Sweep, Michigan Department of Agriculture Environmental Stewardship Division.

Monday – Friday: 8 a.m.–5 p.m.

(517) 335-2874

National Pesticide Information Center

Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Oregon State University
7 days a week; excluding holidays 6:30 a.m. – 4:30 p.m. Pacific Time Zone

1-800-858-7378

FAX: 1-541-737-0761

Web: npic.orst.edu

* Telephone Number Operated 24 Hours