



EXTENSION BULLETIN E-434

1982 WEED CONTROL GUIDE for Field Crops

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1982 WEED CONTROL GUIDE FOR FIELD CROPS

HERBICIDE SAFETY

1. Read label on the container carefully.
2. Use herbicides only on crops listed on the product label.
3. Apply at time and rate recommended.
4. Drift from any herbicidal spray may injure nearby crops; therefore, do all spraying on calm days.
5. A hood or shield built over the boom will help control drift.
6. Do not spray 2,4-D within ½ mile of grapes or tomatoes. (State law prohibits use of 2,4-D esters in certain areas.)
7. Calibrate your sprayer carefully.

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Weed Control Guide for Field Crops

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THE MAIN REASON for cultivating crops is to control weeds. Chemicals (herbicides) often control weeds at a considerable savings over cultivation costs, and in some cases herbicides control weeds that cannot be controlled by normal tillage practices. However, tillage is the only practical control measure in some situations.

Cultural Control

Minimum tillage aids in control of annual weeds. The loose soil surface left by this method makes for a dry topsoil layer which discourages growth of weed seedlings.

The field cultivator equipped with duckfoot or wide shovels is one of the best tools for the control of weeds with deep roots, such as bindweed and thistles. Use the disk or springtooth harrow just before the duckfoot shovel if the soil is firm and needs loosening. Unplowed fields of quackgrass can be effectively controlled by a well-constructed field cultivator with narrow shovels if the operation is repeated often and if the season is dry.

The rotary hoe, spiketooth harrow, and weeder are effective on annual weed seedlings in row crops. Use these tools just after planting, while the crop is coming up or just after it is up. For effective weed control, use these tools when the weed seedlings are just coming through the ground; weeds with much top-growth may not be controlled.

Plowing is usually necessary to kill and bury a heavy weed growth. Fall plowing brings roots and root-stocks to the surface where they are injured by winter freezing.

Chemical Weed Control

Many chemical weed-killers are now available. Selective control of weeds in crops may be obtained by either foliage sprays (postemergence) or application of the chemicals to the soil either as preplanting or preemergence sprays.

Preplanting sprays sometimes are applied to the weed before plowing (quackgrass).

Preplant incorporated sprays are incorporated into the soil prior to planting. This is best done by tilling in two different directions. Incorporation is necessary to prevent losses of volatile herbicides (ex. Treflan, Eptam) and increases or assures the activity of other soil applied herbicides.

Some advantages of preplant soil incorporation of herbicides are:

- (1) No weed competition to the crop with early control of weeds;
- (2) Weeds already controlled in cases where wet weather later delays cultivation or spraying;
- (3) Less reliance on rainfall to position some herbicides in the soil. Generally more reliable weed control than preemergence sprays;
- (4) Much more effective control of some perennial weeds (nutsedge) than with preemergence sprays.

Some disadvantages of preplant incorporation of herbicides are:

- (1) Incorporation operation represents added cost and fuel usage in herbicide application;
- (2) Soil compaction is increased by the incorporation operation;
- (3) Herbicide may be diluted by improper incorporation (too deep) resulting in reduced weed control;
- (4) "Streaking" pattern of good and poor weed control can result from incomplete incorporation. Cross-wise incorporation helps prevent this problem.
- (5) Planting operations may be slowed somewhat due to herbicide application and incorporation operation.

Preemergence sprays are applied after planting but before the crop appears above ground.

Some advantages of preemergence herbicide applications are:

- (1) No weed competition to the crop with early control of weeds;
- (2) Weeds already controlled in cases where wet weather later delays cultivation or spraying;
- (3) Planting and herbicide application may be done in one operation;
- (4) In the case of corn, herbicides can be used which will not present a hazard to nearby 2,4-D sensitive crops and plants.

Some disadvantages of preemergence herbicide applications are:

- (1) Preemergence applications are generally ineffective under dry soil conditions. Some preemergence herbicides are ineffective if dry conditions persist for only a few days; other herbicides may give weed control after as much as 10 days to 2 weeks of dry weather;
- (2) On sandy soils, heavy rains may leach the herbicide down to the germinating crop seed and cause injury;
- (3) Perennial weeds usually are not controlled by preemergence herbicide applications.

Postemergence sprays have the advantage of use in emergencies since they are not applied until the weeds are up. They can be used on any soil type, and soil moisture conditions are not a problem. However, in some cases there is greater risk of crop injury. Post-emergence sprays should not be applied when the plants are already wet with dew or rain. Post-emergence sprays are usually more effective (though also more injurious to the crop) at high temperatures.

Temperature greatly influences the effectiveness and volatility of many postemergence herbicides. Ideally, postemergence herbicides should be applied when temperatures range between 65 and 85° F. Low temperatures (below 60° F) may result in reduced weed control, while temperatures above 85° F may result in crop injury. Late afternoon herbicide applications are less likely to result in herbicide injury than are early morning applications. Early morning application predisposes the crop plant to danger periods of high temperatures, which increases the potential for herbicide injury.

Volatile herbicides such as dicamba (*Banvel*) or ester formulations of 2,4-D or MCP may vaporize at temperatures as low as 70° F. Once they are vaporized, wind may move sufficient vapors to areas with sensitive crops to cause crop injury. Extreme caution is required when applying postemergence herbicides near sensitive crops. Amine formulation eliminates the danger of vapor drift; however, spray drift (droplets) may still occur. Reduce the possibility of spray drift by using a maximum of 35 pounds pressure, maintaining proper spray boom height and by using fan type nozzles rather than the hollow cone type.

Herbicide Incorporation

Herbicides are incorporated into the soil for several reasons. Some herbicides must be incorporated to overcome volatility or photodecomposition losses which would occur if the materials were left on the soil surface. Other herbicides are incorporated to insure good activity in the absence of the rainfall otherwise required to move the herbicide into the weed seed germination zone. This is often referred to as herbicide "activation." Incorporation is also often required to obtain perennial weed control from soil applications of herbicides.

The most consistent incorporation (no streaking), especially when using a disk or field cultivator alone, is achieved with two passes at an angle to each other. However, new tillage implements have made one-pass incorporation of herbicides a possibility. Many growers are asking what is the best way to achieve one-pass incorporation.

Soil Conditions

Although a majority of the questions concerning incorporation concern the best implement to use for

one-way incorporation, soil condition influences the success of incorporation more than the tool used. The reliability of one-pass incorporation will also be influenced by the tillage system used.

In clean tillage (low crop residue) situations, pre-emergence applications made on wet soil will likely perform as well or better than two-pass incorporated treatments. One-pass incorporation is not a good approach with less than optimum soil tilth.

High crop residue levels (corn stalks disked or chisel plowed with one or two secondary tillage operations) make one-pass incorporation difficult. If the residue level is great enough to clog the incorporation tool, two-pass incorporation is advisable. The soil should also have good tilth, as outlined above.

Where ridges are left from fall plowing or use of a chisel plow in the spring, it is advisable to level the ground before herbicide application. Streaking is favored by application of the herbicide to rough ground.

Incorporation Implements

Disks, especially large tandem disks, are poor tools for incorporation. Depth and ridging are difficult to control. Non-uniform distribution of the herbicide in the soil is a distinct possibility with a disk.

A disk does have a place for special applications, particularly the use of Eradicane to control quackgrass. The disk does a good job of chopping the quackgrass rhizomes required for good Eradicane activity. The disk should be operated at a depth of 4 to 5 inches and a speed of 4 to 6 mph. Incorporation must be done in two directions.

A field cultivator can give acceptable one-pass incorporation of herbicides if special care is taken to set-up and operation. Wide sweeps, set-up so they meet, give better incorporation than points. Shanks should be close enough to give this, and three sets of sweeps are also required. It is important to follow with a leveling tool, such as a flex tine drag or spring tooth harrow, to smooth out ridges behind the cultivator.

The speed of the cultivator should be at least 6 mph, depth 3 to 4 inches. Actual incorporation will occur at one-half the tool depth. Caution must be taken not to run the rear portion of the cultivator lower than the front. If the back of the tool is lower, untreated soil can be brought to the surface burying the herbicide.

Danish type harrows equipped with "S" tines and rolling baskets can do a good job of one-pass incorporation. Rolling baskets outperform other trailing operations.

Operation considerations are similar to those with the field cultivator. Again, good soil tilth is a prerequisite for one-pass incorporation.

PTO driven tools do a good job of one-pass incorporation. However, their application in Michigan may

be limited. These tools are operated at lower speeds and do not have the tool width the other implements can have.

Principles of Chemical Control of Weeds

1. Weeds are easiest to kill when they are small seedlings and when conditions favor rapid growth. Crop plants also are most easily injured under these conditions. Selective sprays (see Table 1) will control the weeds with little or no injury to the crop.

2. Time of spraying and rate of applications are very important. Spraying at the wrong time often results in poor weed control and greater crop injury. No crop plant is completely resistant to injury from herbicides. Too much chemical will cause damage.

3. With most preemergence herbicides, do not cultivate for at least 3 weeks after preemergence spraying unless weeds appear that are resistant to the chemical. If weeds appear and dry weather persists for 2 weeks after herbicide application, rotary hoe or cultivate shallow. Delay cultivation after post-emergence herbicide applications for at least 2 or 3 days (7 to 10 days following 2,4-D application in corn) to allow the chemical to move into stems and roots of the weed plants.

4. No one chemical used as a selective spray will kill all species of weeds. Therefore, select the right chemical for the job. The first step for successful weed control is to identify the weed species present. Some weeds are resistant to all of the present selective sprays.

5. Read current labels carefully and never apply a chemical at rates higher than recommended on the label. Use chemicals only on crops for which they are recommended on the label. Store chemicals in a room not subject to freezing temperatures and away from seed, fertilizer and other pesticides.

Herbicide Combinations

Two or more herbicides are often applied as a tank mix or in separate applications to give more consistent or broader spectrum weed control. Combinations are also used to decrease herbicide residue (for example, atrazine carryover) or to obtain adequate season-long control.

Only recommended or labeled herbicide combinations should be used. Growers and applicators are responsible for poor weed control, crop injury or herbicide residue from herbicides labeled for single application but used in combinations.

Pesticide — Fertilizer Compatibility

Combinations of herbicides, insecticides and/or fungicides applied in either water or liquid fertilizer carriers decrease trips over the field and application costs;

however, compatibility is critical. Always test the compatibility of each mixture to be applied and follow label instructions.

A simple compatibility test requires only a glass quart jar and the pesticides and liquid fertilizer to be mixed. Place one pint of liquid fertilizer in the quart jar and add two teaspoons of the liquid pesticide. If the pesticide is a wettable powder, add two teaspoons of powder to sufficient water to form a slurry and add the slurry to the fertilizer. Cover the jar, shake well, and observe the mixture for 30 seconds. Check the mixture again after 30 minutes. If the mixture does not separate, it is compatible; however, check each batch of liquid fertilizer, as they may vary in mixing properties. Also, check compatibility if water source changes, as water pH and mineral content influence compatibility.

If more than one pesticide is to be mixed with liquid fertilizer or water, the pesticides should be premixed in liquid fertilizer or water and tested for compatibility by mixing appropriate proportions of all components. The combination should be thoroughly agitated before each additional pesticide is added, and a specific mixing order should be followed. Generally, unless label directions state otherwise, add the pesticides being tested in the following order: first—wetttable powders, second—flowables, third—water solubles, fourth—surfactants and emulsifiable concentrates. Spray tanks should be at least half filled with carrier before the pesticide premixes are added. If the mixture foams excessively, separates or becomes syrupy, do not apply the mixture. Compatibility agents are available which may be added to improve mixing ability.

Even if all components appear compatible, the field tank mixture will require constant, vigorous agitation to prevent separation or improper pesticide distribution in the tank. Be sure the entire tank is agitated and mixed before spraying. Do not store pesticide mixtures overnight unless they are constantly agitated. Best results are obtained by applying the entire mixture in one day. (See Extension Bulletin E-1268)

Additives for Herbicide Use

During the development of an herbicide, a major effort of the chemical company is expended on the formulation of the active ingredient to optimize performance, mixing, and handling under diverse conditions. Every commercially available herbicide formulation contains its own particular set of additives to accomplish this purpose. However, sometimes additional additives are required for specific applications or when compatibility or mixing problems occur. The herbicide label will describe the need and use of these additives. The indiscriminate use of additives should be avoided since they may not improve herbicide performance and may actually reduce weed control or cause crop injury.

Additives can be referred to as "adjuvants." This merely denotes an added ingredient. Surface active additives are called surfactants. Therefore, all surfactants are also additives or adjuvants. All herbicide formulations contain surfactants. Emulsifiable concentrates contain emulsifiers which aid in the dispersion of the formulation into the water phase. Wettable powders contain wetting agents and dispersants which facilitate moistening the tiny particles and prevent clumping. Postemergence herbicides, such as 2,4-D and Roundup, contain wetting agents which help spread the spray over the leaf surface.

When to Use Additives

Some herbicides may be applied either to the soil or postemergence so the addition of a surfactant is left to the user. Sometimes additives are only required for postemergence treatments made during adverse climatic conditions. In other cases, the nature of the herbicide may necessitate addition of the surfactant to the spray mix rather than the formulation. The herbicide label always gives directions for such additive requirements.

Although claims have been made for additives increasing the effectiveness of soil-applied herbicides, there is no independent data to support these claims. Research in this area was conducted at several universities across the country. These experiments failed to show any benefit from the inclusion of spray additives with soil applied herbicides. Additives are used with postemergence applications to aid coverage of leaf surfaces and increase penetration into the leaf. Use of additives for soil applications of herbicides can help prevent clogging of lines and nozzles.

Concentrated Crop Oils

"Concentrated" oil additives contain higher percentages of emulsifier, combinations of oil, or differing emulsifiers and surfactants than the crop oils or vegetable oils previously used. Concentrated crop oils are generally recommended at a rate of 1 quart per acre.

These additives are recommended for use with post-emergence applications of atrazine and Basagran. They should also be used in postemergence applications on sugarbeets when large weeds are present or the weeds are not vigorously growing. Aatrex and Basagran labels contain directions on the use of additives.

There is a greater risk for crop injury when using additives with postemergence atrazine applications. Injury is frequently associated with cold, wet or cloudy conditions. The injury appears as a temporary stunting plus necrosis of the leaf margins. Banvel, 2,4-D, or Bladex should not be included in a spray mix of atrazine plus crop oil concentrate or severe injury to the corn may occur.

The use of crop oil concentrate is recommended with Basagran to insure good coverage of the weed foliage.

Basagran requires good coverage for optimum weed control. Soybean injury can be increased with the addition of crop oil concentrate to Basagran sprays. When soybeans are growing poorly or were injured from soil applied herbicides, care must be exercised in the use of Basagran plus crop oil concentrate.

Adjuvants, Surfactants, Wetting Agents, Soaps

Many spray additives are currently available and many exaggerated claims have been made for them. In most cases, these materials are no better than crop oil concentrates. In fact, under poor environmental conditions for postemergence weed control, the crop oil concentrates can be slightly superior. Remember that any benefit comes only in postemergence applications, not soil applied herbicides. Also, they aid performance of the herbicide in adverse conditions but are not a way to use less herbicide.

The Bladex 80W label calls for the addition of a surfactant or vegetable oil for postemergence applications under droughty conditions. Weeds can harden off in this type of environment and become more difficult to kill. However, because of the increased chance of crop injury and the infrequency of these conditions in the spring, additions of surfactants or oils are not recommended for postemergence Bladex 80W use in Michigan.

The Paraquat CL label calls for the addition of a nonionic surfactant (Ortho X-77). Good coverage is required for this contact herbicide. When paraquat is sprayed with fertilizer solution, be sure the rate of surfactant is increased as outlined on the label.

Roundup is formulated with a surfactant and further additives should not be made to avoid excessive leaf run-off. The addition of a defoaming agent can be a help if excessive foaming is a problem. This is explained in the "Mixing" portion of the Roundup label.

Compatibility Problems

Compatibility problems in tank mixing herbicides usually occur when mixing directions are not followed. Mixing two herbicides in concentrated form, adding an EC to the spray tank first rather than first suspending the wettable powder, insufficient agitation, excessive agitation, and air leaks are some of the causes of compatibility problems. Problems are much more likely when mixing herbicides with fluid fertilizer. The fertilizer solution is already loaded to near capacity with nutrients. Adding a herbicide to the already loaded solution may cause problems. Also, the fertilizer may interfere with the herbicide formulation additives. Since fertilizer may vary greatly from batch to batch, the only safe procedure is to test for compatibility in a small container before mixing a large quantity. If compatibility problems are encountered, the addition of compatibility agents may help.

Foaming is usually due to excessive agitation or a bypass line that empties above the spray solution level in the spray tank. When foaming is a problem, addition of a defoamer can help.

Preslurry the powder if you have problems in getting a wettable powder to wet and become suspended. Adding a wetting agent to the spray tank will sometimes correct a floating powder problem.

Definitions

1. *Adjuvant*—Any substance which enhances the herbicide effectiveness, an “added ingredient.”
2. *Surfactant*—A surface active material which can facilitate emulsifying, dispersing, spreading, wetting, sticking, or other surface-modifying characteristics of herbicide solutions.
3. *Emulsifier*—Promotes the suspension of one liquid in another.
4. *Wetting Agent*—Reduces water surface tension causing better contact between spray solution and treated solution (*Spreader*).
5. *Soap*—Sodium or potassium salts of fatty acids. Can form insoluble materials in hard water. *Detergents* are synthetic materials used for cleaning.
6. *Sticker*—Deposit builder, increases herbicide adhesion to plant surface.
7. *Defoaming Agent*—Self-explanatory.
8. *Compatibility Agent or Cosolvent*—May aid in dispersion of otherwise incompatible mixture.

Soil Type and Organic Matter

Soil texture (sand, silt, clay) and organic matter influence the effectiveness of soil-applied herbicides. Herbicide rate recommendations in this bulletin are given for medium-textured soils with greater than 3% organic matter. Clay and organic matter adsorb herbicides, making them less available to germinating weeds and crop plants. Soils with high clay and organic matter content require greater herbicide rates for adequate weed control. Sandy soils with low organic matter content require careful herbicide rate selection to avoid crop injury.

Soil pH can influence the activity of soil applied herbicides. Some herbicides (metribuzin) are more available at higher soil pH. Rates must be reduced to avoid crop injury. Knowledge of the soil pH is needed for proper rate determination.

Organic matter analysis is available through county offices of the Cooperative Extension Service or directly through the MSU Soil Testing Laboratory. Organic matter analysis may be determined on soil samples submitted for N-P-K analysis for an additional charge. Organic matter levels change slowly and may need to be checked every four years.

Organic matter analyses are only as accurate or representative as the soil sample, so each field should be checked individually. See Extension Bulletin E-498, *Sampling Soils*, for proper soil sampling procedure.

Follow herbicide label recommendations and adjust herbicide rate for soil texture and organic matter as specified on the label.

Herbicide Residues and Bioassay

With the advent of preplant and preemergence herbicides which give season-long weed control, the accumulation of herbicides in the soil and their influence on subsequent crops in the rotation have become important in crop management. This is particularly true since atrazine has come into common use on corn. However, when used at recommended rates in seasons of normal rainfall and temperature, most recommended herbicides for field crops do not present a problem on crops planted the following season. Exceptions are listed in “Remarks” column of Table 1.

There have been reports of injury to crops following atrazine applications on corn. There is more likely to be a problem with herbicide residues in a season of limited rainfall and cool temperatures, due to the slow dissipation of the herbicide. (See Extension Bulletin E-1213)

Carry-over problems have been most commonly reported for two groups of herbicides, the triazines (ex. atrazine) and the dinitroanilines. If soybeans follow corn, or sugar beets follow a crop treated with dinitroaniline and if herbicide carry-over is a possibility, a bioassay late in the fall prior to freeze-up or early in the spring may indicate whether enough herbicide is present to harm the crop. A herbicide bioassay is a means of biologically measuring the level of herbicide in the soil. The bioassay procedure is a relatively simple test but a few basic steps should be followed.

1. Collect soil from several locations in the field as when taking soil samples. Reliability of the assay depends on accurate sampling. Sample soil to the depth the field has been tilled. Approximately 5 lb. of soil are needed for each sample. Collect an equal amount of soil from an adjacent field where it is *known* no herbicide has been applied. This second sample is used as a “check.”
2. Start bioassay within one or two weeks after soil is collected to prevent the loss of herbicide under warm conditions. If the assay cannot be run immediately, store the soil in a cool place, or even allow it to freeze.
3. If soil is wet, allow it to dry so that it may be worked easily. If the soil is cloddy, crush the clods but do not pulverize.

4. Partially fill two 1-qt. containers with soil, one with the soil being tested and the other with soil from the "check" field. Punch holes in the bottom of the containers to allow drainage. Tin cans or milk cartons make satisfactory containers.
5. Plant 15 seeds of a sensitive crop in each container and cover with ½ inch of soil. Wet the soil but do not saturate. Oats are very sensitive to both triazines and dinitroanilines, and sugar beets and sorghum are extremely sensitive to dinitroanilines. Place exactly the same number of seeds in each container. By knowing the exact number of seeds planted, seedling emergence can be measured. Do not plant too many seeds or the seedlings may compete for the herbicide and decrease the injurious effects.
6. Place containers in a warm place (70 to 75° F), preferably in a window to receive as much sunlight as possible. Additional artificial light should also be supplied to obtain approximately a 15-hour day length. Water plants sparingly, but do not let soil dry out.
7. Determine plant emergence, and monitor plant growth for at least three weeks after planting. Compare "check" plants with those in the soil being tested.
8. Atrazine injury may cause yellowing of the oat leaves, with the plant becoming droopy and finally dying, or if carry-over is marginal, stunting may occur. Stunting can be determined by a comparison with "check" plants. Dinitroaniline injury may result in a decrease in seedling emergence and/or stunting of the sugar beet or sorghum.
9. If any evidence of herbicide carry-over is observed, it is advisable to plant a resistant crop.

Weed Sprayers

Crop injuries often result when sprayers used for weed control are also used for disease and insect control. Some chemicals are more difficult to wash from a sprayer than others, and wooden tanks are more difficult to clean than steel tanks. Hand sprayers of 3- or 4-gal. capacity are suitable for small areas of 1 acre or less and for patch spraying. Tractor-mounted sprayers driven from the power takeoff are very satisfactory for larger areas.

A good weed sprayer should:

1. Have a pump which is inexpensive, easily replaced, resistant to wear and chemicals and has a minimum capacity of 4 gal. per minute.
2. Provide some means of keeping the solution well mixed. This can be by mechanical or jet agitation, using a bypass from the pump. Be sure the agitation mixes the entire tank. An agitator mounted too far from the tank bottom can leave an unmixed layer on the bottom.
3. Have 50-mesh screens for suction line and nozzles.

4. Have a gauge which measures pressure accurately in the range of 20 to 100 lb. per square inch.
5. Have flat fan nozzles with replaceable tips. Wide angle nozzles (73 to 80 degrees) will permit the boom to be carried closer to the ground and thus reduce spray drift.

Cleaning and Storage

Keep weed sprayers clean. Where soil applications only are practiced, thorough rinsing with water is sufficient. For other spraying purposes, wash out the sprayer (tank, hose, boom, nozzles) with one of the following in 100 gal. water:

1. 1 gal. household ammonia (allowed to stand in sprayer overnight).
2. 5 lb. of sal soda.
3. 8 lb. trisodium phosphate.

Corrosion and mechanical damage to pumps, tanks, nozzles, etc. may result from leaving water in spray equipment over winter. Thoroughly clean spray equipment after each spraying operation; however, even when properly cleaned, some water may remain in the sprayer. To prepare the spray equipment for storage, disconnect all hoses, and allow all water to drain. Coat all bare metal parts with oil or a rust inhibitor. Disassemble metal nozzles, and store them in oil. Prepare the sprayer pump for storage based on the manufacturer's recommendations.

Band Application

In cultivated crops, spraying narrow bands of herbicide over the rows will take less material per acre, cutting the cost per acre for the chemical. Where chemical costs are high, band spraying may be justified. However, with band spraying, timely cultivation of weeds in the unsprayed area between rows is necessary. In seasons when the soil is too wet to cultivate, overall spraying has the advantage of controlling weeds between the rows.

When band spraying, be very careful to maintain the proper rate of application on the area sprayed. (If you lower the spray boom to narrow the area covered by a given nozzle, remember that each nozzle is still delivering the same amount of spray mixture as it did on the wider area.)

Accurate Calibration

Accurate sprayer calibration is essential for effective chemical weed control without crop injury. Calibrate a new sprayer before use and recalibrate a sprayer each year before using.

MATERIALS REQUIRED

A quart container graduated in ounces.

Sufficient string to tie container to nozzle tip.

PRELIMINARY STEPS

1. Make certain that nozzle tips are of proper type for the spray job and of proper size for gal./acre.

2. Be sure all nozzle tips are of the same size and type and that screens are of proper mesh. (For most wettable powders, 50-mesh or coarser screens are recommended.) Check nozzle delivery. All nozzles should deliver within 10% of each other.

3. For spraying wettable powders, be sure the sprayer is equipped with some type of jet or mechanical agitation.

PROCEDURE

1. In a band application, accurately determine the width, in inches, of the band sprayed. In a broadcast application, measure the distance, in inches, between two adjacent nozzles.

2. Locate this width in the table below and read off the corresponding course distance.

WIDTH (inches)	COURSE DISTANCE (feet)
8	510
10	408
12	340
14	291
16	255
18	227
20	204
22	185
24	170
26	157

3. In the field to be sprayed, mark off course of the proper distance.

4. Tie quart container to one nozzle on the sprayer so as to catch all of that nozzle's spray when sprayer is turned on.

5. Start a distance back from the beginning of the course to get up to operating speed, and turn sprayer ON at beginning of course and OFF at end of course.

6. Remove quart container, and read volume collected IN OUNCES.

7. Ounces collected = gal./acre.

This procedure can be used to calibrate sprayers for both banded and broadcast type applications. For a given recommendation, the actual amount of material to be applied per square foot of soil treated should be the same for both types of application. Banding reduces the amount of chemical used by reducing the number of square feet treated per acre.

After using the above procedure for calibration of sprayer, remember that the gal./acre figure determined is for each acre (43,560 sq. ft.) treated, NOT necessarily each acre driven over. In a broadcast application, the acres treated will be equal to the acres driven over.

Granular Formulations

Herbicides are available in granular form for dry application. Granules are usually applied in a band over the row at planting time, but they may also be

broadcast. Usually, equal weed control can be expected from granular and spray formulations, but in some cases granules have not given as good weed control as the sprays. This generally has been due to either the use of equipment giving nonuniform distribution of the granules or to formulations with too high a concentration, resulting in inadequate volume for uniform distribution.

Granular herbicides eliminate the need for a water supply and they reduce the drift hazard. But there still is a volatility hazard from granular formulations of 2,4-D ester or dicamba applied near sensitive crops—especially grapes and tomatoes. Granules give best results on fine, firm seedbeds. A wide, flat press wheel on the planter is desirable for band application at planting. Weed control may be hampered when granules are applied on a rough seedbed, because of uneven application, such as that often obtained with minimum tillage.

The use of granular formulations does not eliminate the need for calibration. Various materials will "feed" differently because of variations in carrier and in particle size. Therefore, granular applicators, like sprayers, should be accurately calibrated.

Herbicide Rates and Spray Volume

Table 1 lists chemicals which will give satisfactory weed control without injury to crops, except as noted under "Remarks." The volume of water to use will vary with the herbicide, although generally 10 to 40 gal. per acre and a spraying pressure of 30 to 40 lb. is recommended for ground equipment. A minimum of 10 gal. of water per acre is recommended for the phenoxy herbicides [2,4-D, MCPA, 4-(2,4-DB)]. With wettable powders such as atrazine and linuron, use nozzles that deliver at least 15 gal. per acre. Use 30 to 40 gal. of spray per acre when spraying quackgrass with atrazine or dalapon. Some contact type postemergence herbicides (Basagran, Blazer) require a minimum of 20 gallons per acre spray volume and 40 psi spray pressure to insure adequate coverage. Flat fan nozzles are effective for herbicide applications. Hollow cone nozzles can also give good results, especially for postemergence applications made at higher pressures. If higher pressures are used, be sure the nozzles are designed to be operated at the increased pressure. Operating nozzles beyond the specified pressure range will result in a poor spray pattern, insufficient coverage, and a lack of weed control.

Some herbicides are available in a number of different formulations and concentrations. For this reason the recommended rates in Table 1 (col. 3) are given as pounds of active ingredients per acre. Thus when a liquid formulation contains 4 lb. of active ingredient (or acid equivalent) per gallon, 1 pt. will provide ½ lb. of active ingredient, or 1 qt. will provide 1 lb. of active ingredient.

TABLE 1 — CHEMICALS FOR WEED CONTROL IN FIELD CROPS

IMPORTANT: READ THE FOLLOWING BEFORE USING

Rates are expressed in pounds of active ingredient (a.i.) per acre for the area actually sprayed; rates in formulation column are given as pounds or liquid measure of product unless otherwise noted.

(NOTE: Commercial rates are expressed in pt or qt or gal or lb).
Apply all agricultural chemicals in accordance with regulations and labels as to rates, timing and crops for which they may be used.

Rates recommended in this bulletin are for medium textured soils with 3% or greater organic matter.

Commercial atrazine is available under several trademarks. Atrazine is formulated as 80 W (80% wettable powder)—1¼ lb of product equals 1 lb of active ingredient—4L (flowable)—1 qt of product equals 1 lb of active ingredient—and Nine-O (90% water dispersible granule)—1.1 lb of product equals 1 lb of active ingredient. Princep is also available as 80W, 4L and as a 90% water dispersible granule (Caliber 90). Bladex is available as 80W or 4L.

Lexone and Sencor are available as 50 W (50% wettable powder)—2 lb of product equals 1 lb of active ingredient—4 lb/gal flowable formulations (Lexone 4L, Sencor 4)—1 qt of product equals 1 lb of active ingredient and as 75% dry flowable formulations (Lexone DF, Sencor DF)—1½ lb of product equals 1 lb of active ingredient.

Lorox is available as a 50% wettable powder or 4L.

Dual was previously formulated as a 6 lb/gal liquid (Dual 6E)—1 pt of product equals ¾ lb active ingredient—and is now available as a 8 lb/gal liquid (Dual 8E)—1 pt of product equals 1 lb of active ingredient. Dual rates in this booklet are based on the 8 lb/gal formulation.

Volumes of 2,4-D and MCPA are based on 4 lb/gal formulations.

Nortron is available as a 1.5 lb/gal liquid (Nortron E.C.)—1 qt of product equals 0.375 lb of active ingredient—and as a 4 lb/gal flowable (Nortron Flowable)—1 qt of product equals 1 lb of active ingredient.

WEED CONTROL GUIDE FOR CORN

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Preplant — Mineral Soil				
Annual broadleaves	atrazine	2	2½ lb 80W	— Usually obtain season-long control.
Annual grasses	(commercial product)		or 2 qt 4L	— Do not plant small grain, small seed forages, sugar beets, field beans or vegetable crops the year following corn.
(except green foxtail, giant foxtail, fall panicum, witchgrass and crabgrass)			or 2½ lb 90% WDG	— Rates of 2½ to 3 lb per acre may be necessary on soil high in organic matter (5 to 8%).
				— Residues more likely to persist if soil conditions are cool and dry.
				— Incorporation is not necessary.
Annual broadleaves	butylate	3½	2 qt	— Increase to 2½ qt per acre for longer control especially in reduced tillage (high trash levels).
Annual grasses	(Sutan Plus)		+	— DO NOT USE ON CORN SEED STOCKS (Breeders, Foundation, or Increase).
(including green foxtail, giant foxtail, fall panicum, witchgrass, crabgrass and sandbur)	+ atrazine		1¼ lb 80W	— Must be incorporated or mixed into top 2 to 3 in. of soil immediately after application; work in 2 directions.
	(commercial product)	1	or 1 qt 4L	— Usually obtain season-long control.
Nutsedge			1.1 lb 90% WDG	— For good control of nutsedge, increase rate of Sutan Plus to 2½ qt per acre.
				— Use 2½ qt per acre for sandbur.

butylate
(*Sutan Plus*)
+
cyanazine
(*Bladex*)

3½
+
2

2 qt
+
2½ lb 80W
or
2 qt 4L

— Increase to 2½ qt per acre for longer control especially in reduced tillage (high trash levels).
— DO NOT USE ON CORN SEED STOCKS (Breeders Foundation, or Increase).
— Must be incorporated or mixed into top 2 to 3 in. of soil immediately after application.
— For good control of nutsedge, increase rate of *Sutan Plus* to 2½ qt per acre.
— Use 2½ qt per acre for sandbur.

atrazine
(commercial product)
+
EPTC with protectant
(*Eradicane*)

1
or
1 qt 4L
or
1.1 lb 90% WDG
+
3½ qt

1
or
1 qt 4L
or
1.1 lb 90% WDG

— Incorporate to a depth of 4 to 5 in. immediately after application with a disk in both directions.
— Quackgrass control with no soil residue or carry-over.
— Rate may be reduced to 2½ qt per acre if quackgrass or nutsedge are not a problem.

atrazine
(commercial product)
+
metolachlor (*Dual*)

1
or
1 qt 4L
or
1.1 lb 90% WDG
+
1¼ qt

1
or
1 qt 4L
or
1.1 lb 90% WDG

— Gives better nutsedge control if incorporated 2 to 3 in.
— Will be more effective preplant, especially on nutsedge, in areas where soils tend to be dry.
— Note *Dual* rate applies to 8E formulation (8 lb/gal L).

atrazine
(commercial product)
+
alachlor (*Lasso*)

1
or
1 qt 4L
or
1.1 lb 90% WDG
+
2½ qt

1
or
1 qt 4L
or
1.1 lb 90% WDG

— For fair to good control of nutsedge, increase rate of *Lasso* to 3 qt per acre.
— Will be more effective preplant, especially on nutsedge, in areas where soils tend to be dry.
— 2½ qt per acre of *Lasso* should be used for effective fall panicum control.

atrazine
(commercial product)
+
cyanazine
(*Bladex*)
+
Sutan Plus
or
Eradicane
or
Dual
or
Lasso

½
+
1
+
4½
or
4½
or
2½
or
2½

½ lb 80W
or
½ qt 4L
or
% lb 90% WDG
+
1¼ lb 80W
or
1 qt 4L
+
2½ qt
or
2½ qt
or
1¼ qt
or
2½ qt

— NOTE SPECIFIC REMARKS ABOVE FOR *SUTAN PLUS*, *ERADICANE*, *DUAL* AND *LASSO*.
— Can be used to reduce possibility of atrazine carry-over.

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Nutsedge	butylate (<i>Sutan Plus</i>)	4	2½ qt	— Incorporate to depth of 2 to 3 in. — Control of late-season grasses.
	alachlor (<i>Lasso</i>)	3	3 qt	— Under conditions of limited rainfall, shallow incorporation (2 to 3 in.) will improve control of nutsedge and late-season grasses.
	metolachlor (<i>Dual</i>)	2½	1½ qt	— Under conditions of limited rainfall, shallow incorporation (2 to 3 in.) will improve control of nutsedge and late-season grasses. — Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).

Preemergence — Mineral Soil

Annual broadleaves Annual grasses (including fall panicum, green foxtail, giant fox- tail, witchgrass and crab- grass)	atrazine (commercial product) + alachlor (<i>Lasso</i>)	1 + 2	1½ lb 80W or 1 qt 4L or 1.1 lb 90% WDG + 2 qt	— 2½ qt acre of <i>Lasso</i> should be used for more effective fall panicum control. — May substitute <i>Princep</i> for atrazine if fall panicum is a severe problem.
	atrazine (commercial product) + metolachlor (<i>Dual</i>)	1 + 2	1½ lb 80W or 1 qt 4L or 1.1 lb 90% WDG + 1 qt	— May substitute <i>Princep</i> for atrazine if fall panicum is a severe problem. — Increase rate to 1½ qt for more effective control of fall panicum. — Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).
	atrazine (commercial product) + pendimethalin (<i>Prowl</i>)	1 + 1½	1½ lb 80W or 1 qt 4L or 1.1 lb 90% WDG + 1½ qt	— DO NOT INCORPORATE. — Do not use on sandy soils with less than 1.5% organic matter. — May substitute <i>Princep</i> for atrazine if fall panicum is a severe problem. — Do not use for no-till corn.
	cyanazine (<i>Bladex</i>) + alachlor (<i>Lasso</i>)	1½ + 2	1.9 lb 80W or 1½ qt 4L + 2 qt	— No residue carry-over. — Can be used where residue problems have existed with atrazine.

cyazifluoproc (<i>Bladex</i>)	1½	1.9 lb 80W or 1½ qt 4L	— No residue carry-over. — Can be used where residue problems have existed with atrazine. — Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).
+ metolachlor (<i>Dual</i>)	+	+	
dicamba (<i>Banvel</i>)	2	1 qt	— HAZARD OF INJURY FROM BANVEL ON NEARBY SENSITIVE CROPS.
+ alachlor (<i>Lasso</i>)	+	+	— Injury may occur on sandy and loamy sand soils.
	2	2 qt	— Longevity of broadleaved weed control is limited.
atrazine (commercial product)	½	½ lb 80W or ½ qt 4L	— Can be used to reduce possibility of atrazine carry-over.
		or % lb 90% WDC	— See specific remarks below for <i>Lasso</i> , <i>Dual</i> and <i>Prowl</i> .
+ cyazifluoproc (<i>Bladex</i>)	+	+	
	1	1½ lb 80W or 1 qt 4L	
+ <i>Lasso</i> or <i>Prowl</i> or <i>Dual</i>	+	+	
	2	2 qt	
	or	or	
	1½	1½ qt	
	or	or	
	2	1 qt	
Annual broadleaves Annual grasses (except green foxtail, giant foxtail, fall pani- cum, witchgrass and crab- grass)	2	2½ lb 80W or 2 qt 4L or 2½ lb 90% WDC	— Usually obtain season-long control. — Do not plant small grain, small seeded forages, sugar beets, field beans or vegetable crops the year following this treatment. — Rates of 2½ to 3 lb per acre may be necessary on soils high in organic matter (5 to 8%). — Residues more likely to persist if soil conditions are cool and dry.
atrazine (commercial product)	2	2 qt	— Follow with 2,4-D amine postemergence for control of annual broadleaved weeds if needed. — Application may be made preplant. — (See remarks under "Nutsedge control.")
alachlor (<i>Lasso</i>)	2	2 qt	
Annual grasses (including fall panicum, green foxtail, giant fox- tail, witchgrass and crab- grass) Pigweed	2	1 qt	— Follow with 2,4-D amine postemergence for control of annual broadleaved weeds if needed. — Application may be made preplant. — (See remarks under "Nutsedge control.") — Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).
metolachlor (<i>Dual</i>)	2	1 qt	

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual broadleaves (except pigweed)	pendimethalin (Prowl)	1½	1½ qt	— Do not use on sandy soils with less than 1.5% organic matter.
Annual grasses (including fall panicum, green foxtail, giant foxtail, witchgrass and crabgrass)	+ cyanazine (Bladex)	+ 1½	+ 1.9 lb 80W or 1½ qt 4L	— Both materials weak on pigweed. — Do not use for no-till corn.
Annual broadleaves only	2,4-D amine	¾	1 pt	— For corn over 6 to 8 in. use drop nozzles. — Ester formulations will cause more crop injury and are not recommended. — Not effective on smartweed. — Hybrids vary in tolerance. — Most effective when weeds are small (2-4 in.).
Annual broadleaves	cyanazine (Bladex)	2	2½ lb 80W	— USE WETTABLE POWDER ONLY. — Apply before weeds are 1½ in. tall. — Apply before corn is 4 in. tall. — Some temporary setback or stunting of corn may occur, especially in sandy soil.
Annual broadleaves	ametryne (Evik)	1%	2 lb	— Do not use with crop oils, additives, or liquid herbicides as severe crop injury may occur. — CAUTION—KEEP OFF CORN FOLIAGE. — Do not use before corn is 12 inches tall.
Annual broadleaves	+ surfactant	+ 1 pt	+ 1 pt	— Emergency use. — Use drop nozzles or directed spray.
Annual broadleaves (except green foxtail, giant foxtail, fall panicum, witchgrass and crabgrass)	atrazine (commercial product)	2	2½ lb 80W or 2 qt 4L or 2½ lb 90% WDG	— Emergency use. — Grasses must be less than 1½ in. tall. — Timing of application is critical to get best results. — Surfactants at 1 pt per A may be used in place of crop oil concentrate but are somewhat less effective. — Greater chance for residue since treatment is later in season.
	+ crop oil emulsifier concentrate	+ 1 qt	+ 1 qt	— Do not add Banvel or 2,4-D as injury may occur. — Corn injury is possible during stress conditions (cold, wet, cloudy weather) or if the corn is succulent from recent rainfall.
Nutsedge	atrazine (commercial product)	2 + 2	2½ lb 80W or 2 qt 4L or 2½ lb 90% WDG	— Apply 2 lb of atrazine per acre when nutsedge is 2 in. tall, and apply 2 lb atrazine per acre 2 weeks later. On muck soils, two repeat applications should be applied at 1 lb per acre plus 1 qt of concentrate at 1-week intervals after the initial treatment.
	+ crop oil emulsifier concentrate	+ 1 qt	+ 1 qt	— Surfactants at 1 pt per A may be used in place of crop oil concentrate but are somewhat less effective. — Corn injury is possible during stress conditions (cold, wet, cloudy weather) or if the corn is succulent from recent rainfall.

Postemergence — Mineral Soils

Nutsedge Canada thistle	bentazon (<i>Basagran</i>) + crop oil concentrate	$\frac{3}{4}$ + $\frac{3}{4}$ See Remarks + 1 qt + 1 qt	1 $\frac{1}{2}$ pt + 1 $\frac{1}{2}$ pt + 1 qt + 1 qt	— TWO APPLICATIONS REQUIRED FOR BEST NUTS- EDGE AND CANADA THISTLE CONTROL. — Increase rate to 1 qt per acre for each application for more effective Canada thistle control. — Controls only specific broadleaves. — Check label for specific rate at proper weed growth stage. — Treat when nutsedge is 4 to 6 in. and again 10 days later. — Use a minimum of 40 psi and 20 gal/A of water. Do not use flood nozzles.
Velvetleaf, jimsonweed, smartweed, wild buck- wheat, Canada thistle	dicamba (<i>Banvel</i>)	$\frac{1}{2}$	1 pt	— Use for corn 5 in. or less tall. FOR CORN OVER 5 IN., REDUCE RATE TO $\frac{1}{2}$ PT PER ACRE. — USE EXTREME CAUTION. — DRIFT TO NEARBY SENSITIVE CROPS IS A HAZARD. — A nonvolatile form of <i>Banvel</i> (<i>Banvel II</i>) is available and should be used if drift to sensitive crops is possible. <i>Banvel II</i> is one-half the concentration of <i>Banvel</i> . Use twice the amount of <i>Banvel II</i> as <i>Banvel</i> for equivalent rates. — For corn over 6 to 8 in. use drop nozzles. — Use pressure less than 20 psi. — Do not apply if soybeans in the vicinity are over 10 in. tall or have begun to bloom.

Preemergence — Organic Soils

Annual grasses	propachlor (<i>Bexton</i> or <i>Ramrod</i>)	5	8 lb (65% WP)	— Must follow with a postemergence treatment for con- trol of broadleaved weeds.
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Postemergence — Organic Soils

Annual broadleaves	atrazine (commercial product)	3	3 $\frac{3}{4}$ lb 80W or 3 qt 4L	— Emergency use. — Grasses should be less than 1 $\frac{1}{2}$ in. tall. — Timing of application is critical to get best results.
Annual grasses (except fall panicum, green foxtail, giant fox- tail, witchgrass and crab- grass)	+ crop oil emulsifier concentrate	+ 1 qt	+ 3 $\frac{1}{2}$ lb 90% WDC + 1 qt	— Surfactants at 1 pt per A may be used in place of crop oil concentrate but are somewhat less effective. — Greater chance for residue since treatment is later in season. — Corn injury is possible during stress conditions (cold, wet, cloudy weather) or if the corn is succulent from recent rainfall.
Annual broadleaves	2,4-D amine	$\frac{1}{2}$	1 pt	— For corn over 6 to 8 in., use drop nozzles. — Ester formulations will cause more corn injury and are not recommended. — Not effective on smartweed. — Hybrids vary in tolerance.

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Velvetleaf, jimsonweed, smartweed, wild buckwheat, Canada thistle	dicamba (<i>Banvel</i>)	½ lb	1 pt	<ul style="list-style-type: none"> — Use for corn 5 in. or less tall. FOR CORN OVER 5 IN., REDUCE RATE TO ½ PT PER ACRE. — USE EXTREME CAUTION. — DRIFT TO NEARBY SENSITIVE CROPS IS A HAZARD. — A nonvolatile form of <i>Banvel</i> (<i>Banvel II</i>) is available and should be used if drift to sensitive crops is possible. <i>Banvel II</i> is one-half the concentration of <i>Banvel</i>. Use twice the amount of <i>Banvel II</i> as <i>Banvel</i> for equivalent rates. — For corn over 6 to 8 in., use drop nozzles. — Use pressure less than 20 psi. — Do not apply if soybeans in the vicinity are over 10 in. tall or have begun to bloom.
Nutsedge Canada thistle	bentazon (<i>Basagran</i>) + crop oil concentrate	¾ + ¾ See Remarks + 1 qt + 1 qt	1 ½ pt + 1 ½ pt + 1 qt + 1 qt	<ul style="list-style-type: none"> — TWO APPLICATIONS REQUIRED FOR BEST NUTSEDGE AND CANADA THISTLE CONTROL. — Increase rate to 1 qt per acre for each application for more effective Canada thistle control. — Controls only specific broadleaves. — Check label for specific rate at proper weed growth stage. — Treat when nutsedge is 4 to 6 in. and again 10 days later. — Use a minimum of 40 psi and 20 gal/A of water. Do not use flood nozzles.
Nutsedge	atrazine (commercial product) + crop oil emulsifier concentrate	2 + 1 + 1 See Remarks + 1 qt	2 ½ lb 80W or 2 qt 4L or 2 ½ lb 90% WDG + 1 qt	<ul style="list-style-type: none"> — Apply 2 lb atrazine per acre when nutsedge is 2 in. tall, and apply two repeat applications at 1 lb per acre plus 1 qt concentrate at 1-week intervals after the initial treatment. — Surfactants at 1 pt per A may be used in place of crop oil concentrate but are somewhat less effective.
Quackgrass	atrazine (commercial product)	4	5 lb 80W or 4 qt 4L or 4 ¾ lb 90% WDG	<p style="text-align: center;">Quackgrass</p> <ul style="list-style-type: none"> — When stand of quackgrass is heavy, apply in fall. Otherwise apply in spring before plowing when quackgrass is 4 to 8 in. tall. — Wait at least 10 days to plow. — Split application; apply 2 lb per acre preplow and 2 lb per acre preemergence to give control of annual weeds also. — When a total of 4 lb of atrazine is used, carryover may persist 2 to 3 years.

atrazine (commercial product)	1	1 1/4 lb 80W or 1 qt 4L or 1.1 lb 90% WDG +	— Incorporate to a depth of 4 to 5 in. immediately after application with a disk, 2 times in opposite directions. — Quackgrass control with minimum soil residue or carryover.
+ EPTC with protectant (<i>Eradicane</i>)	6	+	
atrazine (commercial product)	2	2 1/2 lb 80W or 2 qt 4L or 2 1/2 lb 90% WDG +	— Postemergence. Apply when quackgrass is 1 to 3 in. tall. — Increase rate to 3 lb per acre active ingredient for heavy infestations. — When a total of 4 lb of atrazine is used, carryover may persist 2 to 3 years.
+ crop oil emulsifier concentrate	1 qt	+	— Corn injury is possible during stress conditions (cold, wet, cloudy weather) or if the corn is succulent from recent rainfall.
glyphosate (<i>Roundup</i>)	1 1/2	2 qt	— Before planting in the spring or as a fall treatment. — Apply to actively growing quackgrass at least 8 in. tall. — Use 15 to 20 gal water per acre. — No soil residue. — Can plow or till 3 days after application and plant crop. — Do not plow or till prior to treatment.

No-Till

See Extension Bulletin E-907, *No-Till Corn*: 4, WEED CONTROL. Many of the above preemergence herbicides are labeled for no-till application in combination with paraquat or *Roundup*. Check specific label recommendation for herbicide rates.

WEED CONTROL GUIDE FOR SOYBEANS Preplant

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual grasses	metribuzin	%	3/4 lb 50W	— Some control of jimsonweed, velvetleaf and cocklebur.
Annual broadleaves	(<i>Lexone</i> or <i>Sencor</i>)		or 3/4 pt 4L	— Reduce metribuzin rate if soil pH is above 7.0.
Nutsedge			or 1/2 lb 75% DF	— Note label for rotational crop restrictions. — <i>Lasso</i> rate should be increased to 3 qt per acre and <i>Dual</i> to 2 1/2 pt per acre for effective nutsedge control.
	+ alachlor (<i>Lasso</i>)	+	+	— Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).
	or metolachlor (<i>Dual</i>)	2	2 qt	
		or	or	
		2	2 pt	

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual grasses Annual broadleaves (including nightshade) Nutsedge	chloramben (<i>Amiben</i>) + alachlor (<i>Lasso</i>) or metolachlor (<i>Dual</i>)	2 + 2 or 2	1 gal + 2 qt or 2 pt	— Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L). — <i>Lasso</i> rate should be increased to 3 qt per acre and <i>Dual</i> to 2½ pt per acre for effective nutsedge control.
Annual grasses	trifluralin (<i>Treflan</i>)	¾	1½ pt	— Incorporate or mix thoroughly into top 2 or 3 in. of soil within 24 hr after application. — On sandy and sandy loam soils low in organic matter, use ½ lb (1 pt) per acre. — Most effective control if application is made 10 days to 2 weeks ahead of planting and field reworked just prior to planting.
	profuralin (<i>Tolban</i>)	1	2 pt	— Incorporate thoroughly in top 2 to 3 in. of soil within 4 hr of application. — Use ¾ lb per acre (1½ pt) on coarse-textured soils low in organic matter.
	fuchloralin (<i>Basalin</i>)	1	2 pt	— Incorporate within 8 hr of application in top 1 to 2 in. — May apply 6 to 8 weeks before planting.
	pendimethalin (<i>Prowl</i>)	1	2 pt	— Incorporate in top 2 to 3 in. — Incorporate within 168 hr (7 days) unless rainfall occurs (¼ to ½ in.).
Annual grasses Annual broadleaves (except nightshade)	Combine any of the above dinitroanilines with metribuzin (<i>Lexone</i> or <i>Sencor</i>)	¾	¾ lb 50W or ¾ pt 4L or ½ lb 75% DF	— Some control of jimsonweed, velvetleaf and cocklebur. — See specific remarks for each dinitroaniline herbicide. — Reduce rate if soil pH is above 7.0. — Note label for rotational crop restrictions.
Annual grasses Annual broadleaves (including nightshade)	Combine any of the above dinitroanilines with chloramben (<i>Amiben</i>)	2	1 gal	— See specific remarks for each dinitroaniline herbicide. — Increased mustard and ragweed control over dinitroaniline alone.

Preplant Followed by Preemergence

Dinitroanilines as listed above applied preplant incorporated

FOLLOWED BY:

chloramben (<i>Amiben</i>)	2	1 gal	— Applied preemergence.
dimoseb (<i>Premerge</i>)	4½	1½ gal	— Applied preemergence.

metribuzin (<i>Lexone</i> or <i>Sencor</i>)	%	$\frac{3}{4}$ lb 50W or $\frac{3}{4}$ pt 4L or $\frac{1}{2}$ lb 75% DF	— Applied preemergence. — Some control of jimsonweed and cocklebur. — Reduce rate if soil pH is above 7.0. — Note label for rotational crop restrictions.
linuron (<i>Lorox</i>)	%	$\frac{1}{2}$ lb 50W or $\frac{3}{4}$ qt 4L	— Applied preemergence. — If heavy rainfall occurs soon after application, injury to crop may result.

Preemergence

Annual broadleaves Annual grasses	3	$1\frac{1}{2}$ gal	— May be necessary to rotary hoe if rainfall does not occur within 4 to 5 days after application.
linuron (<i>Lorox</i>)	%	$1\frac{1}{2}$ lb or $\frac{3}{4}$ qt 4L	— If heavy rainfall occurs soon after application, injury to crop may result.
+ alachlor (<i>Lasso</i>) or metolachlor (<i>Dual</i>)	+ 2 or 2	+ 2 qt or 2 pt	— Do not use on coarse-textured sandy or loamy sand soils or on soils with less than 2.5% organic matter. — Plant soybeans at least $1\frac{1}{4}$ in. deep. — Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).

chloramben (<i>Amiben</i>) + alachlor (<i>Lasso</i>) or metolachlor (<i>Dual</i>)	2 + 2 or 2	1 gal + 2 qt or 2 pt	— Preferred on sandy soils low in organic matter where injury has been a problem. — Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).
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metribuzin (<i>Lexone</i> or <i>Sencor</i>) + alachlor (<i>Lasso</i>) or metolachlor (<i>Dual</i>)	% + 2 or 2	$\frac{3}{4}$ lb 50W or $\frac{3}{4}$ pt 4L or $\frac{1}{2}$ lb 75% DF + 2 qt or 2 pt	— Some control of cocklebur and jimsonweed. — Reduce <i>Sencor</i> or <i>Lexone</i> rate if soil pH is above 7.0. — Note label for rotational crop restrictions. — Note <i>Dual</i> rate applies to 8E formulation (8 lb/gal L).
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alachlor (<i>Lasso</i>) + naptalam + dimoseb (<i>Dyanap</i>)	2 + 6 qt	2 qt + 6 qt	— Apply 3 days after planting and before soybean leaves open.
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Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Postemergence				
Annual broadleaves (including nightshade, pigweed and jimson- weed)	acifluorfen (<i>Blazer</i>)	½	1 qt	— Use a minimum of 40 psi and 20 gal per acre of water. — Do not use flood nozzles. — Do not add surfactants or oil concentrate to spray mixture to avoid crop injury. — Weak on velvetleaf and cocklebur. — Delay 7 days between <i>Blazer</i> use and <i>Hoelon</i> treatment.
Annual broadleaves (including cocklebur, vel- vetleaf and jimsonweed)	bentazon (<i>Basagran</i>) + crop oil concentrate	1 + 1 qt	1 qt + 1 qt	— Use a minimum of 40 psi and 20 gal/A of water. Do not use flood nozzles. — No activity from <i>Basagran</i> preemergence. — Weak on pigweed, nightshade, and lambsquarters. — Delay 7 days between <i>Basagran</i> use and <i>Hoelon</i> treatment.
Annual grasses Volunteer corn	diclofop (<i>Hoelon</i>)	1	1 ½ qt	— Note <i>Hoelon</i> is a restricted use herbicide and requires a certified applicator for use. — Apply to grasses less than 4 in. tall. — Apply to volunteer corn less than 12 in. tall. — Do not tank mix with other chemicals. — Delay 7 days between <i>Hoelon</i> use and <i>Basagran</i> or <i>Blazer</i> treatment.
Nutsedge Canada thistle	bentazon (<i>Basagran</i>) + crop oil concentrate	¾ + ¾ + 1 qt + 1 qt	1 ½ pt + 1 ½ pt + 1 qt + 1 qt	— Increase rate to 1 qt per acre for each application for more effective Canada thistle control. — Treat when nutsedge is 4 to 6 in. and again 10 days later. — See nutsedge remarks under Special Weed Problems. — Use a minimum of 40 psi and 20 gal/A of water. Do not use flood nozzles. — Delay 7 days between <i>Basagran</i> use and <i>Hoelon</i> treatment.

Special Weed Problems

Velvetleaf	trifluralin (<i>Treflan</i>)	¾	1 ½ pt	— Preplant incorporated.
Cocklebur	or	or	or	— Only fair control.
Jimsonweed	profluralin (<i>Tolban</i>)	1	1 qt	— Some soybean injury may occur.
	or	or	or	— Also more effective control of other broadleaved weeds.
	fluchloralin (<i>Basalin</i>)	1	1 qt	— Reduce <i>Lexone</i> or <i>Sencor</i> rate if soil pH is above 7.0.
	or	or	or	— Follow with postemergence application of <i>Basagran</i> or <i>Blazer</i> (see sections above) if needed for complete control.
	pendimethalin (<i>Prowl</i>)	1	1 qt	

+ chloramben (Amiben)	+ 2	+ 4 qt
+ metribuzin (Lexone or Sencor)	+ %	+ % lb 50W or % pt 4L or % lb 75% DF

Preplant Incorporated

Velvetleaf	trifluralin (Treflan)	%	1 ½ pt	— Preplant incorporated tank mix of dinitroaniline plus metribuzin followed by second application of metribuzin preemergence.
Jimsonweed	profluralin (Tolban)	or 1	or 2 pt	— Both metribuzin treatments needed for effective control.
Cocklebur	fluchloralin (Basalin) or pendimethalin (Prowl)	or	or	— Some soybean injury may occur.
	metribuzin (Lexone or Sencor)	1	2 pt	— Reduce Lexone or Sencor rate if soil pH is above 7.0.
		or	or	— May require postemergent application of either Basa- gran or Blazer for complete control. See appropriate sections above for particular weed species and use direc- tions.
		1	2 pt	
		¼	½ lb 50W or ½ pt 4L or ½ lb 75% DF	

FOLLOWED BY:
Preemergence

metribuzin (Lexone or Sencor)	¼	½ lb 50W or ½ pt 4L or ½ lb 75% DF
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Jimsonweed	metribuzin (Lexone or Sencor)	½	1 lb 50W or 1 pt 4L or % lb 75% DF	— Preemergence.
Velvetleaf				— Fair to good control.
Cocklebur				— Some soybean injury may occur.
				— Reduce Lexone or Sencor rate if soil pH is above 7.0.
				— Follow with postemergence application of Basagran or Blazer (see sections above) if needed for complete control.

Nutsedge	alachlor (Lasso) or metolachlor (Dual)	3 or 2 ½	3 qt or 1 ¼ qt	— Preplant incorporation to a depth of 2-3 inches.
				— Some early distortion may be observed on soybean leaves.
				— Shallow incorporation will improve control under con- ditions of limited moisture.
				— Note Dual rate applies to 8E formulation (8 lb/gal L).

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Nutsedge	bentazon (<i>Basagran</i>) + crop oil concentrate	$\frac{3}{4}$ + $\frac{3}{4}$ See Remarks + 1 qt + 1 qt	1 $\frac{1}{2}$ pt + 1 $\frac{1}{2}$ pt + 1 qt + 1 qt	— TWO $\frac{3}{4}$ -lb APPLICATIONS REQUIRED FOR BEST NUTSEGE CONTROL. — Use a minimum of 40 psi and 20 gal/A of water. Do not use flood nozzles. — Postemergence. — Treat when nutsedge is 4 to 6 in. and again 10 days later.
Volunteer corn Weed escapes	glyphosate (<i>Roundup</i>)	Rate varies, see label and perennial weed control section (pg 28)		— Use with rope-wick applicator, wipe-on applicator, or recirculating sprayer.

Preemergence — Organic Soils

Annual grasses	chloramben (<i>Amiben</i>)	3	1 $\frac{1}{2}$ gal	— May require postemergence application of acifluorfen, bentazon and/or diclofop for complete control (see below).
Annual broadleaves	+ alachlor (<i>Lasso</i>)	+ 4	+ 1 gal	

Postemergence — Organic Soils

Annual broadleaves (including nightshade, pigweed, and jimsonweed)	acifluorfen (<i>Blazer</i>)	$\frac{1}{2}$	1 qt	— Use a minimum of 40 psi and 20 gal per acre of water. Do not use flood nozzles. — Do not add surfactants or oil concentrate to spray mixture to avoid crop injury. — Weak on velvetleaf and cocklebur. — Delay 7 days between <i>Blazer</i> use and <i>Hoelon</i> treatment.
Annual broadleaves (including cocklebur, velvetleaf and jimsonweed)	bentazon (<i>Basagran</i>) + crop oil concentrate	1 + 1 qt	1 qt + 1 qt	— Weak on pigweed, nightshade, and lambsquarters. — Use a minimum of 40 psi and 20 gal/A water. Do not use flood nozzles. — No activity from <i>Basagran</i> preemergence. — Delay 7 days between <i>Basagran</i> use and <i>Hoelon</i> treatment.
Annual grasses Volunteer corn	diclofop (<i>Hoelon</i>)	1	1 $\frac{1}{2}$ qt	— Note <i>Hoelon</i> is a restricted use herbicide and requires a certified applicator for use. — Apply to grasses less than 4 in. tall. — Apply to volunteer corn less than 12 in. tall. — Do not tank mix with other chemicals. — Delay 7 days between <i>Hoelon</i> use and <i>Basagran</i> or <i>Blazer</i> treatment.

WEED CONTROL GUIDE FOR SMALL GRAINS

Barley and Wheat (without legume seedings)

Annual broadleaves	2,4-D (amine)	½	1 pt	— Use when grain is fully tillered but before the boot stage (the grain is usually 6 to 8 in. tall at this stage, and the boot stage is reached when the upper sheath is beginning to swell with the enlarging head). — Do not apply in the fall.
Perennials (bindweed, thistles)	2,4-D (ester)	¾	1½ pt	— Use when grain is fully tillered but before the boot stage. — Control is limited. — Injury may occur. — Some control of wild onion and wild garlic.
	dicamba (<i>Barvel</i>)	¾	¼ pt	— Do not apply to spring-seeded barley. — Some control of wild onion and wild garlic. — Injury may occur on some varieties of wheat—Tecumseh, Abe, Arthur—do not use on these varieties.
Wild garlic Wild onion	dicamba (<i>Barvel</i>) + 2,4-D	¾ + ¾	¼ pt + 1 pt	— Do not apply to spring-seeded barley. — Injury may occur on some varieties of wheat—Tecumseh, Abe, Arthur—do not use on these varieties.

Oats without Legume Seedings

Annual broadleaves	2,4-D (amine)	%	¾ pt	— Use when grain is fully tillered but before boot stage. — Some yield reduction may occur but generally less than caused by weeds.
	MCPA	%	¾ pt	— Less injurious than 2,4-D. — Less effective than 2,4-D. — Use when grain is tillering but before the boot stage.

Small Grains Seeded to Legumes

Annual broadleaves	MCPA	%	¾ pt	— Use when grain is tillering but before the boot stage. — A canopy of grain and weeds over the seeding will reduce possibility of injury to alfalfa. — Sweet clover is very sensitive to MCPA.
	dinoseb (<i>Premerge</i>)	1.1	1½ qt	— Use when grain is 2 to 6 in. tall and weeds are small. — Use between 30 and 50 gal of water per acre. — Greater injury to crop if sprayed during cloudy weather.

WEED CONTROL GUIDE FOR FORAGES

Alfalfa, Trefoil and Clover Seedlings

(clear seedlings without small grain companion crops)

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual broadleaves Annual grasses	EPTC (<i>Eptam</i>)	3	3½ pt	— Work into soil immediately after application. — Seed may be planted immediately after this operation. — Do not use when grass is seeded with legumes.
	benefin (<i>Balan</i>)	1½	3 qt	— See remarks above for EPTC.
Annual broadleaves	4-(2,4-DB) (<i>Butoxone</i> or <i>Butyrac 200</i>)	1	2 qt	— Postemergence, alfalfa seedlings in 2-3 trifoliolate leaf stage. — Can use if annual broadleaf problem develops after using <i>Eptam</i> or <i>Balan</i> . — This treatment is not labeled for use with small grain companion crops.

Alfalfa

Annual broadleaves Annual grasses	profuralin (<i>Tolban</i>)	¾	1½ pt	— See remarks above for EPTC. — <i>Tolban</i> is only labeled for use with alfalfa seedlings.
Perennial weeds (quackgrass, Canada thistle, milkweed, etc.)	glyphosate (<i>Roundup</i>)	Rate varies, see label and perennial weed control section (pg 25)		— Apply to perennials at labeled rate and growth stage before alfalfa establishment.

Alfalfa (Established Stand)

Yellow rocket and broad- leaved winter annuals	simazine (<i>Princep</i>)	1	1¼ lb 80W	— For fall application on established (1 year) alfalfa or after the last cutting (before the ground freezes) of a spring seeded (by June 1) new alfalfa stand. — Will control winter annuals: yellow rocket, henbit, chickweed, peppergrass, shepherd's purse and downy brome. — Forage grasses will be injured or killed. — Some injury to alfalfa may occur on sands and loamy sands low in organic matter. — Use 2 lb <i>Princep</i> on fine textured soils with 4 to 6% organic matter (established stands only). — Some control of seedling white cockle.
	metribuzin (<i>Lexone</i> or <i>Sencor</i>)	¾	1 lb 50W or 1 pt 4L or ¾ lb 75% DF	— Apply to <i>dormant</i> alfalfa in late fall or early spring. — Non-dormant alfalfa may be severely injured.

terbacil (<i>Simbar</i>)	1	1 1/4	— Apply to <i>dormant</i> alfalfa in late fall or early spring. — Note label for rotational crop restrictions. — Early spring applications will control other broadleaf weeds and suppress quackgrass infestations.
Dandelions	1	2 lb 50W or 1 qt 4L or 1 1/2 lb 75% DF	— Apply in spring <i>before</i> alfalfa breaks dormancy. — Non-dormant alfalfa may be severely injured. — Perennial grasses may also be suppressed. — Early spring applications will control other broadleaf weeds and suppress quackgrass infestations.
Hoary alyssum Annual broadleaves	1	2 qt	— Early April. — Spray when hoary alyssum seedlings are in two to four leaf stage. — Do not graze or feed hay from forage for 60 days after spraying.
Quackgrass	1 1/2	3 lb	— Apply in late fall when soil temperatures are below 60° F. — For light to moderate quackgrass infestations, rate can be reduced to 1 lb a.i./acre (2 lb/acre of formulated product). — <i>Kerb</i> is a restricted use pesticide.

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Birdsfoot Trefoil (Established Stand)

Hoary alyssum Annual broadleaves	1	2 qt	— Early April. — Spray when hoary alyssum seedlings are two to four leaf stage. — Do not graze or feed hay from forage for 60 days after spraying.
Quackgrass	1 1/2	3 lb	— Apply in late fall when soil temperatures are below 60° F. — For light to moderate quackgrass infestations, rate can be reduced to 1 lb a.i./acre (2 lb/acre of formulated product). — <i>Kerb</i> is a restricted use pesticide.

Red Clover (current year seeding)

Yellow rocket and broad-leaved winter annuals	1/2	1 pt	— Spray after killing frost; legumes dormant.
Biennials and Perennials	1	1 qt	— Apply in fall or spring.

Grass Pasture

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Perennials	2,4-D (ester)	1	1 qt	— Legumes may be injured or killed. — Spot spray patches.

Legume Pasture

WEED CONTROL GUIDE FOR FIELD BEANS

Preplant

Annual broadleaves (including nightshade)	alachlor (<i>Lasso</i>)	2	2 qt	— <i>Amiben</i> may be applied with <i>Lasso</i> as a tank mix or as an overlay treatment preemergence.
Annual grasses	+ chloramben (<i>Amiben</i>)	+ 1½	+ 3 qt	— Check label for use on coarse-textured soils low in organic matter. — This treatment is used for black nightshade control.
Annual broadleaves (except nightshade)	EPTC (<i>Eptam</i>)	2¼	1¼ qt	— Incorporate immediately after application.
Annual grasses	+ trifluralin (<i>Treflan</i>) or profuralin (<i>Tolban</i>)	+ ½ or ¾	+ 1 pt or 1½ pt	

Annual broadleaves (including nightshade)	EPTC (<i>Eptam</i>)	2¼	1¼ qt	— Incorporate immediately after application.
Annual grasses	+ chloramben (<i>Amiben</i>) + trifluralin (<i>Treflan</i>) or profuralin (<i>Tolban</i>)	+ 2 + ½ or ¾	+ 4 qt + 1 pt or 1½ pt	— Rainfall isn't as critical for activation of <i>Amiben</i> as when it is surface applied. — Rate of <i>Amiben</i> may be reduced to 3 qt if nightshade is not present.

Preplant Followed by Preemergence

Annual broadleaves (including nightshade)	EPTC (<i>Eptam</i>)	2¼	1¼ qt	— PREPLANT.
Annual grasses	+ trifluralin (<i>Treflan</i>) or profuralin (<i>Tolban</i>)	+ ½ or ¾	+ 1 pt or 1½ pt	— Incorporate immediately after application.

FOLLOWED BY:

chloramben (<i>Amben</i>)	2	4 qt	— Effectiveness depends on adequate rainfall after treatment.
or			
dinoseb (<i>Premege</i>)	4½	6 qt	— Preemergence.
or			
chloramben (<i>Amben</i>)	1	2 qt	
+			
dinoseb (<i>Premege</i>)	3	4 qt	

Postemergence

Annual broadleaves	bentazon (<i>Basagran</i>) + crop oil concentrate	¾ + 1 qt	1½ pt + 1 qt	— Controls only certain broadleaves. See label and post-emergence soybean section. — Check label for specific rate and proper weed growth stage. — Beans must have 1 to 2 trifoliolate leaves before application.
Nutsedge Canada thistle	bentazon (<i>Basagran</i>) + crop oil concentrate	¾ + ¾ + 1 qt + 1 qt	1½ pt + 1½ pt + 1 qt + 1 qt	— See remarks for nutsedge control under soybeans. — Beans must have 1 to 2 trifoliolate leaves before application.

WEED CONTROL GUIDE FOR SUNFLOWERS

Preplant

Annual grasses Annual broadleaves (except ragweed, smartweed, mustard and nightshade)	trifluralin (<i>Treflan</i>) or profluralin (<i>Tolban</i>) or pendimethalin (<i>Prowl</i>)	¾ or 1 or 1	1½ pt or 2 pt or 2 pt	— Incorporate within 24 hr. after application with disk, springtooth harrow or other tool to thoroughly mix in the top 2 to 3 in. by incorporating twice in different directions. — On light soils (sandy and sandy loam) low in organic matter use ½ lb <i>Treflan</i> , ¾ lb <i>Tolban</i> , or ¼ lb <i>Prowl</i> .
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Preemergence

Annual grasses Annual broadleaves	chloramben (<i>Amben</i>)	2	1 gal	— Do not graze or feed sunflower forage from <i>Amben</i> -treated areas. — <i>Amben</i> may follow preplant treatments.
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WEED CONTROL GUIDE FOR POTATOES

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Quackgrass	dalapon (<i>Dowpon M</i>)	10	13½ lb	— Spray in spring when quackgrass is 4 to 6 in. tall. Wait one week before plowing. — Use in 30 to 40 gal water per acre. — Control of quackgrass will be reduced when heavy stand of rye cover is present.

Preplant Followed by Delayed Preemergence

Annual grasses Annual broadleaves	EPTC (<i>Eptam</i>)	4	4½ pt	— Work into soil immediately after application. — Six lb per acre may be used if nutsedge is a problem. — Preplant incorporated.
FOLLOWED BY:				
	linuron (<i>Lorox</i>)	1	2 lb	— Treatment should be made prior to potato emergence and after weed emergence.
	or			
	metribuzin (<i>Lexone</i> or <i>Sencor</i>)	or ½	1 lb 50W or 1 pt 4L	
			or ¾ lb 75% DF	

Early Preemergence Followed by Delayed Preemergence

Annual grasses (especially barnyard-grass)	alachlor (<i>Lasso</i>) or pendimethalin (<i>Prowl</i>)	2 or ¾	2 qt or 1½ pt	— If field leveling is necessary it should be done soon after planting. — Apply <i>early preemergence</i> —make application soon after planting. — Most effective on germinating grasses that have not emerged. — Do not use <i>Prowl</i> on muck soils or loamy sands with less than 1.5% organic matter.
FOLLOWED BY:				
	metribuzin (<i>Lexone</i> or <i>Sencor</i>)	½	1 lb 50W or 1 pt 4L	— Most effective on small <i>emerged</i> weeds. — Delayed preemergence.
	or			
	linuron (<i>Lorox</i>)	or 1	¾ lb 75% DF or 2 lb	
	or dimoseb (<i>Premerge</i>)	or 3	or 4 qt	

Delayed Preemergence

Annual broadleaves	linuron (<i>Lorox</i>)	1 1/2	3 lb	— Apply delayed preemergence; after weeds emerge but before potatoes emerge. — If field leveling is necessary, it should be done soon after planting to allow weed emergence before spraying.
	metribuzin (<i>Lexone</i> or <i>Sencor</i>)	1/2	1 lb 50W or 1 pt 4L or 3/4 lb 75% DF	— Refer to remarks under <i>Lorox</i> . — Use up to 1 lb active ingredient metribuzin on high organic muck soil.

Postemergence

Annual broadleaves Annual grasses	metribuzin (<i>Lexone</i> or <i>Sencor</i>)	1/4	1/2 lb 50W or 1/2 pt 4L or 1/2 lb 75% DF	— Do not make overall postemergence applications following 3 days of cool, wet or cloudy weather as crop injury may occur. — Do not use on early maturing varieties. — Do not use on red skin varieties. — Do not apply postemergence within 60 days of harvest. — Greater possibility of injury to potatoes when sprayed overall at 12- to 15-in. stages.
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WEED CONTROL GUIDE FOR MINT Row Mint and Meadow Mint

Annual broadleaves Annual grasses	terbacil (<i>Simbar</i>)	1/2	2 lb	— Apply preemergence only. — Rates may be reduced to 1 lb per acre if terbacil was used the previous year. — Do not plant any other crop except potatoes for two years following application.
Annual broadleaves (See label for specific species)	bentazon (<i>Basagran</i>) + crop oil concentration	1 + 1 qt	1 qt + 1 qt	— Postemergence application. — Controls only certain broadleaves. — Use a minimum of 40 psi and 20 gal/A of water. — Do not use flood nozzles. — Check label for proper weed stage for applications. — Weak on pigweed, nightshade and lambsquarters.
Nutsedge	bentazon + crop oil concentration	3/4 + 3/4 + + 1 qt + 1 qt	3/4 qt + 3/4 qt + + 1 qt + 1 qt	— Postemergence application. — See "Remarks" under nutsedge control in soybean section (Page 17).
Canada thistle	bentazon + crop oil concentration	2 + 2 + + 1 qt + 1 qt	2 qt + 2 qt + + 1 qt + 1 qt	— Postemergence application. — Two applications required for best thistle control. — Make first application when thistle is 8 inches tall and second application 7 to 10 days later. — Use a minimum of 40 psi and 20 gal/A of water. Do not use flood nozzles.

WEED CONTROL GUIDE FOR SUGAR BEETS

Preplant

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual grasses	cycloate (<i>Ro-Neet</i>)	3 lb	2 qt	— Incorporate immediately to 2 to 3 in. — Must be followed preemergence by <i>Pyramin</i> . — Injury may occur when <i>Betanal</i> and <i>Betanex</i> are applied postemergence.
Preemergence				
Annual broadleaves	ethofumesate (<i>Nortron</i>)	2	5½ qt 1.5 lb/gal E.C.	— Soybeans or alfalfa may be injured following <i>Nortron</i> . — On sandy soil with less than 1½% organic matter reduce <i>Nortron</i> rate to 1½ lb/A ai.
Annual grasses	+ pyrazon (<i>Pyramin</i>) + TCA (<i>TCA</i>)	+ 3 + 6	2 qt 4 lb/gal L + 4 lb + 5 qt	— In order to get near 100% weed control it will, in most cases, be necessary to follow up with a postemergence application.
	pyrazon (<i>Pyramin</i>) + TCA (<i>TCA</i>)	3 + 6	4 lb + 5 qt	— TCA should be included even if grasses aren't a problem, as better control of annual broadleaves will result. — In order to get near 100% weed control it will, in most cases, be necessary to follow up with a postemergence application. — For soils high in clay content or organic matter, the rate should be 4 lb <i>Pyramin</i> + 8 lb <i>TCA</i> .
Postemergence				
Annual broadleaves (including smartweed)	desmedipham (<i>Betanex</i>) + phenmedipham (<i>Betanal</i>) + endothall (<i>H273</i>)	½ + ½ + ½	3 pt + 3 pt + 1½ pt	— Apply when the beets are in the 2-4 true leaf stage. — When cultivating the unsprayed area, care should be taken so as to cut away a portion of the sprayed area on the first cultivation and don't roll fresh unsprayed soil back beyond the cut away point. — When temperature is 75° F or greater, apply in late afternoon or early evening. — Do not apply when plants are under stress such as temperatures above 85° F as injury may occur. — Add one qt. oil conc. per acre for hard to control large weeds or if plants are not vigorously growing.
	desmedipham (<i>Betanex</i>) + endothall (<i>H273</i>)	¾ + ½	4½ pt + 1½ pt	— Refer to remarks under <i>Betanex</i> + <i>Betanal</i> + <i>H273</i> . — More effective pigweed control.

ethofumesate (<i>Nortron</i>)	1	5 pt 1.5 lb/gal E.C. or 2 pt 4 lb/gal L	— Provides full season weed control. — Refer to remarks under <i>Betanex</i> + <i>Betanal</i> + <i>H273</i> .
+ desmedipham (<i>Betanex</i>)	+ ½	+ 3 pt	
+ phenmedipham (<i>Betanal</i>)	+ ½	+ 3 pt	
+ endothall (<i>H273</i>)	+ ½	+ 1 ½ pt	
ethofumesate (<i>Nortron</i>)	1	5 pt 1.5 lb/gal E.C. or 2 pt 4 lb/gal L	— Provides full season weed control. — Refer to remarks under <i>Betanex</i> + <i>H273</i> .
+ desmedipham (<i>Betanex</i>)	+ ¾	+ 4 ½ pt	
+ endothall (<i>H273</i>)	+ ½	+ 1 ½ pt	
Annual broadleaves (except smartweed)	2	2 ½ lb	— Apply when the beets are in the 2-4 true leaf stage.
pyrazon (<i>Pyramin</i>)	+ 1	+ 6 pt	— When cultivating the unsprayed area, care should be taken so as to cut away a portion of the sprayed area on the first cultivation and don't roll fresh unsprayed soil back beyond the cut away point.
+ phenmedipham (<i>Betanal</i>)			— Maximum total amount of pyrazon that can be used for beets grown and processed in Michigan is 8 lb per acre (2 lb on a 7-in. band).
			— When temperature is 75° F or greater, apply in late afternoon or early evening.
			— Do not apply when plants are under stress such as temperatures above 85° F as injury may occur.
			— Add one qt. oil concentrate per acre for hard to control large weeds or if plants are not vigorously growing.
pyrazon (<i>Pyramin</i>)	2	2 ½ lb	— Much better pigweed control than <i>Betanal</i> .
+ desmedipham (<i>Betanex</i>)	+ ¾	+ 4 ½ pt	— Refer to remarks under <i>Pyramin</i> + <i>Betanal</i> .
pyrazon (<i>Pyramin</i>)	2	2 ½ lb	— Refer to remarks under <i>Pyramin</i> + <i>Betanal</i> .
+ dalapon (<i>Dowpon M</i>)	+ 1	+ 1 ½ lb	
+ crop oil emulsifiable concentrate	+ 1 qt	+ 1 qt	

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Smartweed and buckwheat	endothall (H273)	½	1½ pt	— This herbicide can be added to any of the above post-emergence treatments to improve control of these species. — Volume based on 3 lb per gal formulation.

WEED CONTROL GUIDE FOR GRAIN SORGHUM

Preemergence

Annual broadleaves Annual grasses	propazine (Milogard)	2	2½ lb 80W or 2 qt 4L or 2.2 lb 90% WDC	— Do not use on sandy soils. — Do not plant small grains, small seeded forages, sugar beets, field beans or vegetable crops the following year.
Annual broadleaves Annual grasses	atrazine (commercial product) + propachlor (Berton or Ramrod)	1 + 3	1½ lb 80W or 1 qt 4L or 1.1 lb 90% WDC + 4½ lb (65% WP)	— Do not feed silage made from treated sorghum to producing dairy animals. — A commercial mix of <i>Ramrod</i> plus atrazine is available. — Not labeled for forage sorghum.

Postemergence

Annual broadleaves	2,4-D	¼	¼ qt	— Apply when sorghum is 6 to 12 in. high. — Do not use unless weeds are a serious problem because injury may occur. — Not labeled for forage sorghum. — Hybrids vary in tolerance.
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TABLE 2—PERENNIAL WEEDS NON-SELECTIVE CONTROL

Quackgrass (for spring seeded crops)	dalapon (Dowpon M)	15	20 lb	— Apply in fall. — Fall plow 7 to 10 days after spraying if possible. — Land can be planted to spring sown crops. — Use 30 to 40 gal water per acre. — For quackgrass control in corn, potatoes and sugar beets, see specific crop.
Quackgrass (for fall seeded crops)	dalapon (Dowpon M)	10	13½ lb	— Apply in spring or early summer (prior to July). — Plow 7 to 10 days after spraying. — Land can be planted to alfalfa, wheat or winter barley. — Use 30 to 40 gal water per acre.

Quackgrass (prior to corn, soybeans, wheat, barley, oats, sor- ghum, field beans, alfalfa, or following small grains in the fall)	glyphosate (Roundup)	1½	2 qt	— Apply to actively growing quackgrass at least 8 in. tall. — Use 15 to 20 gal water per acre. — No soil residue. — Can plow or till 3 days after application and plant crop. — Do not plow or till prior to treatment.
Canada thistle (prior to corn, soybeans, wheat, barley, oats, sor- ghum, field beans, alfalfa, or following small grains in the fall)	glyphosate (Roundup)	2¼	3 qt	— Apply when thistle is at bud stage or beyond. — Do not plow or till prior to treatment. — Poor control will result if application is made during times of poor growing conditions. — Can plow or till 3 days after application and plant crop.
Field bindweed (prior to corn, soybeans, wheat, barley, oats, sor- ghum, field beans, alfalfa, or following small grains in the fall)	glyphosate (Roundup)	2¼	3 qt	— Apply at or beyond full bloom. — Do not plow or till prior to treatment. — Poor control will result if application is made during times of poor growing conditions. — Can plow or till 7 days after application and plant crop.
Common milkweed (prior to corn, soybeans, wheat, barley, oats, sor- ghum, field beans, alfalfa, or following small grains in the fall)	glyphosate (Roundup)	2¼	3 qt	— Apply when actively growing and most plants have reached late bud to flower stage. — Spot treatment in labeled crops. — Rope-wick, wipe-on, or recirculating sprayer may be used in soybeans.
Hempdogbane (prior to corn, soybeans, wheat, barley, oats, sor- ghum, field beans, alfalfa, or following small grains in the fall)	glyphosate (Roundup)	3	4 qt	— Apply when actively growing and most plants have reached late bud to flower stage.
Johnsongrass (prior to corn, soybeans, wheat, barley, oats, sor- ghum, field beans, alfalfa)	glyphosate (Roundup)	2¼	3 qt	— Apply when actively growing when most plants are in the boot to head stage, at least 18 in. tall. — Rope-wick, wipe-on, or recirculating sprayer may be used in soybeans.
Cattail	dalapon (Downpon M)	15	20 lb	— Apply in June or July. — Use 80 to 100 gal water. — Keep livestock out.
Cattail	glyphosate (Roundup)	3	4 qt	— Applying when actively growing and most plants have reached early head stage.
Reed canarygrass (prior to corn, soybeans, wheat, barley, oats, sor- ghum, field beans, alfalfa)	glyphosate (Roundup)	2¼	3 qt	— Apply when actively growing and most plants have reached the boot to head stage.
Poison ivy	amitrole†	2	1 gal	— Apply in June or July. — Spray when in full leaf.
Canada thistle Horse nettle	amitrole†	4	2 gal	— Apply in June or July. — Do not pasture.

†Amitrole may not be used on cropland areas.

TABLE 3—GLOSSARY OF CHEMICAL NAMES

COMMON NAME	TRADE NAME* AND MANUFACTURER	CONCENTRATION AND COMMERCIAL FORMULATIONS†
ACIFLUORFEN	Blazer (Rohm and Haas)	2 lb/gal L
ALACHLOR	Lasso (Monsanto)	4 lb/gal L; 15% G
AMETRYN	Evik (Ciba-Geigy)	80% WP
ATRAZINE	Several (various)	80% WP; 4 lb/gal L, 90% WDG
ATRAZINE + METOLACHLOR	Bicep (Ciba-Geigy)	4.5 lb/gal L (2 + 2.5)
BENEFIN	Balan (Elanco)	1½ lb/gal L
BENTAZON	Basagran (BASF)	4 lb/gal L
BUTYLATE + R-25788	Sutan Plus (Stauffer)	6.7 lb/gal L; 10% G
CHLORAMBEN	Amiben (Amchem)	10% G; 2 lb/gal L
CYANAZINE	Bladex (Shell)	80% WP, 4 L; 15% G
CYCLOATE	Ro-Neet (Stauffer)	6 lb/gal L; 10% G
DALAPON	Dowpon M (Dow)	74% WSP
DESMEDIPHAM	Betanex (Nor-Am)	1.3 lb/gal L
DICAMBA	Banvel or Banvel II (Velsicol)	4 lb/gal or 2 lb/gal L
DICLOFOP	Hoelon (Am. Hoechst)	3 lb/gal L
DINOSEB	amine salt Premerge (Dow)	3 lb/gal L
(DNBP)	oil soluble Dow General (Dow)	5 lb/gal L
ENDOTHALL	Endothal, Herbicide 273 (Pennwalt)	1.46 lb/gal L 3 lb/gal L; 5% G
ENDOTHALL (as a desiccant)	Des-i-Cate (Pennwalt)	0.52 lb/gal L
EPTC	Eptam (Stauffer)	7 lb/gal L; 10% G
EPTC plus R-25788	Eradicane (Stauffer)	6.7 lb/gal L
ETHOFUMESATE	Nortron (Fisons)	1½ lb/gal L, 4 lb/gal L
FLUCHLORALIN	Basalin (BASF)	4 lb/gal L
GLYPHOSATE	Roundup (Monsanto)	3 lb/gal L
LINURON	Lorox (DuPont)	50% WP, 4 lb/gal L
MCPA	Several (various)	Various L
METOLACHLOR	Dual (Ciba-Geigy)	8 lb/gal L
METRIBUZIN	Lexone, Lexone DF, Lexone 4L (DuPont) Sencor, Sencor DF, Sencor 4 (Mobay)	50% WP; 75% DF, 4 lb/gal L
NAPTALAM + DINOSEB	Various	3 lb/gal L (2 + 1)
PARAQUAT	Ortho Paraquat (Chevron)	2 lb/gal L
PENDIMETHALIN	Prowl (American Cyanamid)	4 lb/gal L
PHENMEDIPHAM	Betanal (Nor-Am)	1.3 lb/gal L
PRONAMIDE	Kerb (Rohm + Hass)	50% WP
PROFLURALIN	Tolban (Ciba-Geigy)	4 lb/gal L
PROPACHLOR	Ramrod (Monsanto) Bexton (Dow)	65% WP; 20% G
PROPAZINE	Milogard	4 lb/gal L; 80% WP; 90% WDG
PYRAZON	Pyramin (BASF)	80% WP
SIMAZINE	Princep (Ciba-Geigy)	80% WP; 4% G, 4 lb/gal L; 90% WDG
TCA	TCA (various)	4.76 lb/gal L; 79.3% WSP
TERBACIL	Sinbar (DuPont)	4 lb/gal L; 80% WP
TRIFLURALIN	Treflan (Elanco)	4 lb/gal L; 5% G
2,4-D	Several (various)	L, G, various
2,4-DB	Butyrac (Amchem) Butoxone (Chipman)	2 lb/gal L

*"Several" means there are numerous trade names for the chemical. The mention of trade names does not imply that they are endorsed or recommended over those of similar nature not listed.

†DF—dry flowable, G—granular, L—liquid, WDG—water dispersible granule, WP—wetttable powder, WSP—water soluble powder.

TABLE 4—WEED RESPONSE TO HERBICIDES*

Herbicide	ANNUAL BROADLEAVES								ANNUAL GRASSES							PERENNIALS				
	Cocklebur	Jimsonweed	Lambsquarter	Nightshade (Black)	Pigweed (Redroot)	Ragweed	Smartweed	Velvetleaf	Wild mustard	Barnyardgrass	Crabgrass	Giant foxtail	Green foxtail	Yellow foxtail	Fall panicum	Witchgrass	Bindweed (field)	Canada thistle	Quackgrass	Yellow nutsedge
AMIBEN	P	P	G	G	E	E	G	F	F	F	F	F	F	F	F	F	N	N	N	N
AMITROLE	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	G	G	P
ATRAZINE	F	F	E	E	G	E	G	F	E	G	P	F	F	G	P	P	P	P	G	F
ATRAZINE + OIL CONC.	G	G	E	G	E	E	G	G	E	F	P	F	G	G	P	P	P	G	G	G
BALAN	N	N	G	N	G	N	P	N	P	E	E	E	E	E	E	G	N	N	N	P
BANVEL	G	G	G	G	G	G	E	G	F	N	N	N	N	N	N	N	F	F	N	N
BASAGRAN	E	G	G	P	P	E	E	G	F	N	N	N	N	N	N	N	N	G	N	G
BASALIN	N	N	G	P	G	P	P	N	P	E	E	E	E	E	E	E	N	N	N	N
BETANAL	F	F	E	F	P	G	G	P	G	P	P	P	P	P	P	P	P	N	N	N
BETANEX	F	F	G	F	G	G	G	P	G	P	P	P	P	P	P	P	P	N	N	N
BLADEX	F	P	E	G	F	E	G	P	G	G	F	F	G	G	F	F	N	N	N	N
BLAZER	F	G	G	E	E	E	E	F	E	N	N	F	N	N	F	N	P	P	N	N
DOWPON M	N	N	N	N	N	N	N	N	N	G	F	G	G	G	G	G	N	N	G	P
DUAL	N	N	P	F	G	P	P	N	P	E	E	E	E	E	E	E	N	N	N	G
DYANAP	F	F	G	F	G	G	G	P	G	F	F	F	F	F	F	F	N	N	N	N
EPTAM	P	P	G	P	F	F	F	F	F	E	E	E	E	E	E	E	N	N	G	G
ERADICANE	P	P	G	P	F	F	F	F	F	E	E	E	E	E	E	E	N	N	G	G
EVIK	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	F	F	P	F
H-273	P	P	P	P	P	P	E	P	P	N	N	N	N	N	N	N	N	P	N	N
HOELON	N	N	N	N	N	N	N	N	N	G	G	G	G	G	G	G	N	N	N	N
KERB	P	P	P	P	P	P	P	P	P	F	F	P	F	F	P	P	N	N	G	N
LISSO	N	N	P	G	G	P	P	N	P	E	E	E	E	E	E	G	N	N	N	G
LEXONE	G	F	E	N	E	E	E	G	E	F	F	F	G	G	F	F	N	N	N	N
LOROX	P	P	G	G	G	G	G	F	G	F	F	F	F	F	F	F	N	N	N	N
MCPA	F	F	G	G	G	G	G	F	G	N	N	N	N	N	N	N	P	F	N	N
MILOGARD	G	F	G	E	E	E	E	P	E	G	P	F	P	G	P	P	P	P	F	F
NORTRON	F	F	G	G	G	P	G	P	G	P	G	P	F	F	P	P	N	N	N	P
PREMERGE	P	P	G	G	G	E	G	P	G	P	P	P	P	P	P	P	N	N	N	N
PRINCEP	G	F	E	E	E	E	G	F	E	G	F	F	F	G	P	P	P	P	F	F
PROWL	N	N	G	P	F	P	P	P	P	E	E	E	E	E	E	E	N	N	N	N
PYRAMIN	P	P	E	G	G	G	G	P	G	F	F	F	F	F	F	F	N	N	N	N
RAMROD, BEXTON	N	P	P	N	F	P	P	P	P	G	E	E	E	E	G	G	N	N	N	N
RO-NEET	P	P	P	P	P	P	P	P	P	G	G	G	G	G	G	G	N	N	N	F
ROUNDUP	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G	E	F
SENCOR	G	F	E	N	E	E	E	G	E	F	F	F	G	G	F	F	N	N	N	N
SINBAR	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	P	F	F	P
SUTAN PLUS	P	P	P	N	P	P	P	P	P	E	E	E	E	E	E	E	N	N	P	G
TCA	N	N	F	P	F	F	F	N	P	G	G	G	G	G	G	G	N	N	G	P
TOLBAN	N	N	F	P	G	N	P	N	P	E	E	E	E	E	E	E	N	N	N	N
TREFLAN	N	N	G	N	G	N	P	N	P	E	E	E	E	E	E	E	N	N	N	N
2,4-D AMINE	F	F	G	G	G	G	P	F	G	N	N	N	N	N	N	N	P	F	N	N
2,4-D ESTER	F	F	G	G	G	G	P	F	G	N	N	N	N	N	N	N	F	G	N	N
4-(2,4-DB)	P	P	G	F	G	F	P	F	F	N	N	N	N	N	N	N	P	P	N	N

P = Poor; F = Fair; G = Good; E = Excellent; N = None

*The above ratings are a relative comparison of herbicide effectiveness. Weather conditions greatly influence the herbicide's effectiveness and weed control may be better under favorable conditions or poorer under unfavorable conditions.

