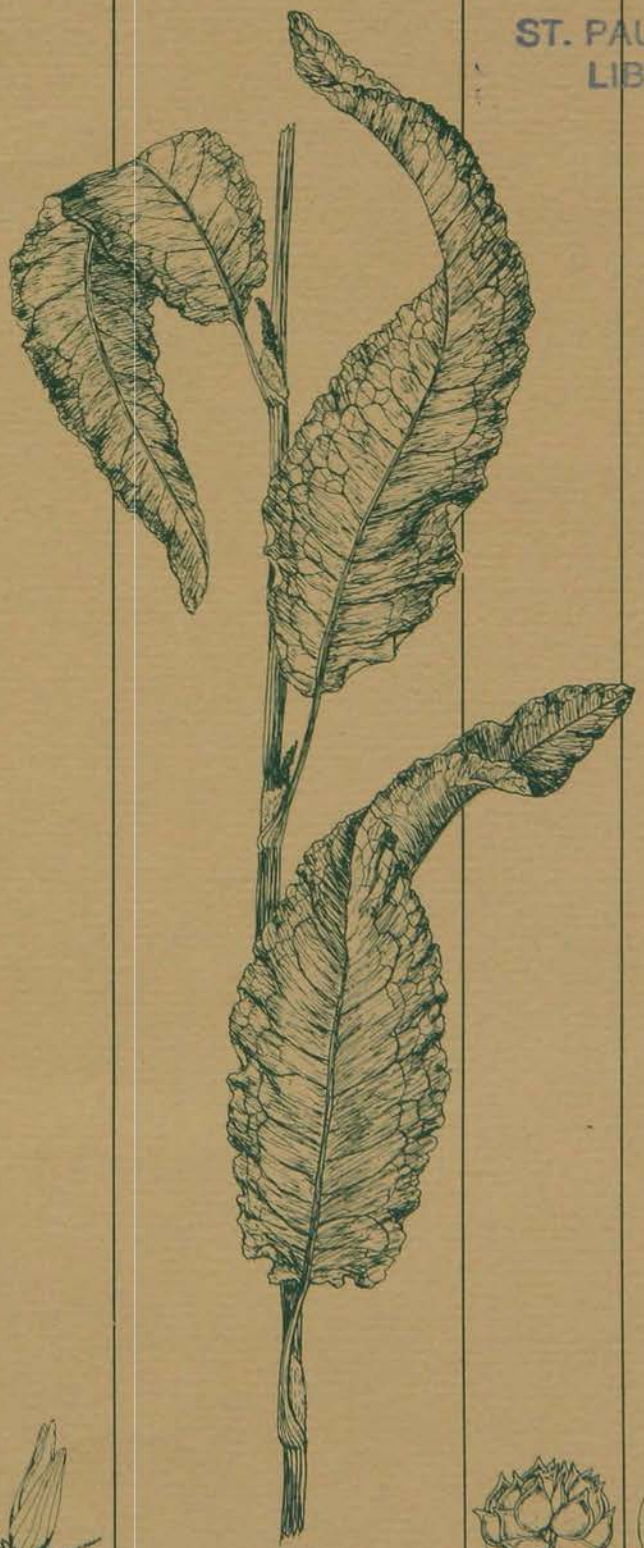
Weed Control for Reduced Tillage Systems







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Weed Control for Reduced Tillage Systems

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An important trend in American agriculture during the past few years has been the move toward adoption of reduced tillage systems. Reductions in the amount of tillage used to produce crops decrease both energy and labor inputs and provide other benefits as well. Numerous names are used to designate reduced tillage systems, including minimum tillage, conservation tillage, no-tillage, zero-tillage, till plant, and slot plant. Other names used include: chemical fallow, ecofallow, ecofarming, stubble plant, mulch tillage, lo-till, no-till, and stubble mulch farming. Since the names used to describe the systems vary, a description of the most common tillage systems, including the field operations for each, appears in table 1.

Reduced tillage is being used for the production of corn, soybeans, wheat, sorghum, cotton, and forages. Reduced tillage systems eliminate the conventional use of a moldboard plow and consequently leave varying amounts of crop residue on the soil surface. This practice requires the use of herbicides as the primary means of weed control.

Numerous combinations of seedbed preparation and herbicides can be considered as reduced tillage systems. Chisel or sweep plowing or field cultivation followed by planting is a common reduced tillage method in the Corn Belt. These systems loosen the soil but do not bury crop residue and unfortunately do not always destroy emerged weed seedlings. Contact herbicides may be required to kill these weeds. In the till-plant system, cultivation is used to build ridges and control weeds between the rows during the crop season. Systems that employ both tillage and herbicides afford growers more options for weed control and crop diversity. Tillage systems for several crops are listed in table 2.

Some other reduced tillage systems such as plow plant involve the moldboard plow but eliminate some of the seedbed preparation and weed control operations used in conventional systems. These systems also depend primarily on herbicides for weed control. The major focus of this bulletin, however, will be on tillage practices that do not utilize the moldboard plow.

In January, standing corn stalks catch and hold snow on a Nebraska farm. Conservation tillage systems reduce soil and moisture loss.

Table 1. Tillage and weed control operations for different tillage systems

Name of system	Region	Crops	Sequence of operations*
No-tillage	E, NC, SE, WC, SW	Corn, soybeans, wheat	Spray, plant, (spray) Plant, spray, (spray)
Minimum tillage	E, NC, SE	Corn, sorghum Soybeans, wheat	Disk 1 or 2 times, spray, plant, (spray) (or cultivate) Spray, disk 1 or 2 times, plant, (spray) (or cultivate) Chisel plow, spray, disk, plant, (spray) Chisel plow, disk, spray, plant, (spray) (or cultivate) Chisel plow, disk, plant, spray, (spray) (or cultivate)
	SW	Sorghum	Sweep plow, sweep plow, plant, spray
	SW	Cotton	Spray and incorporate, bed, plant, (cultivate)
Till plant	NC, SE, WC	Corn, sorghum	Till plant, spray, (cultivate) (spray)
	SW	Soybeans	
Stale seedbed	NC, SE	Soybeans	Fall or early spring disk, spray (spring), disk, plant, spray Fall or early spring disk or chisel, plant, spray
Ecofallow	WC	Wheat, sorghum	Spray stubble after crop harvest, plant, spray
Chisel	W	Wheat, barley	Spray, air seed, (spray)
Conventional	All	All	Plow, disk 1 or 2 times, plant, (spray) (cultivate) Spray, plow, disk 1 or 2 times, plant, spray, (cultivate) (spray)

*Operations in parentheses are postemergence to the crop.

Condition of soil surface and stubble mulch after a seeding with a no-till drill.

Table 2. Tillage and weed control for different management systems*

Situation/crop	Weed control	Application time	Remarks
No-tillage in sod Corn	Contact or translocated herbicides plus residual herbicides to control existing vegetation. Residual herbicide to control annual weeds. Select herbicides for control of species present.	Preemergence or preplant. Apply contact or tranlocated herbicides before corn emerges. Apply postemergence herbicides as needed to control weeds that escape. Split herbicide applications may be required.	Use only in areas with 24 inches or more precipitation or under irrigation. If alfalfa is present in sod in low rainfall areas, apply contact or translocated herbicides in fall or spring before planting to control alfalfa.
No-tillage in rye or winter wheat cover crop Corn Soybeans	Apply a grass herbicide to kill rye or wheat plus a preemergence herbicide for annual weed control. Rye or wheat should be at least 4 inches tall and in good growing condition.	Preemergence or preplant for no-till planter. Preemergence for planters with sweep or furrow openers. Apply herbicide before small grains reach 24 inches.	Grass herbicides should be applied before the planted crop emerges.
No-tillage following annual crops Corn Soybeans Sorghum	Use appropriate herbicide to control existing vegetation and annual weeds that are likely to emerge. Both contact and residual herbicides required.	Preemergence or preplant for no-till planters. Preemergence for sweep or furrow openers. Apply before crop emerges. Use postemergence herbicides for weeds that escape.	Control vegetation prior to crop emergence with appropriate herbicides. If postemergence herbicides are required, apply when weeds are small.
Wheat following wheat or barley	Apply a contact herbicide to control existing volunteer wheat and annual weeds, especially if chisel points are to be used for seeding. If sweeps are used for planting, contact herbicides sometimes are not necessary. Residual herbicides are required in both, however.	Preplant incorporated herbicides for annual grassy weeds with both chisel and sweep seed openers. Use postemergence herbicides for broadleaf weeds as needed. Use rope wicks for escaped grassy weed control as intensity warrants.	Chisel point planting requires a greater use and more precise application timing of herbicides than do sweeps. Postemergence herbicides are required for both, however. Apply when weeds are small.
Minimum tillage following annual crops Corn Soybeans Sorghum Wheat Cotton	Use appropriate herbicides to control annual weeds that are likely to emerge. Contact herbicides required if tillage does not control existing vegetation.	Preplant for soil incorporated herbicides. Preemergence for other residual herbicides. Postemergence as required.	If incorporated herbicides are used, select a sequence of tillage operations to ensure proper mixing with the soil.
Till plant Corn Sorghum Soybeans	Both herbicides and cultivation.	Residual herbicides after planting but before crop emergence. Cultivate to reestablish ridges.	Preemergence herbicide may be applied in a band.
No-tillage fallow systems (ecofallow) Corn Sorghum	Contact plus residual herbicides to control existing vegetation and eliminate weeds during the summer. Apply residual herbicides for the crop prior to planting in the spring.	Apply immediately after harvest and the next spring.	Herbicides must control weeds in wheat stubble or another contact herbicide application must be made. The fallow period provides an excellent opportunity to control perennial weeds.

*Check into local or state suggestions for minimum and no-tillage to determine cropping sequences and herbicides that are effective in your area.

Reasons for Reducing Tillage

Growers who practice reduced tillage crop production can benefit from several important advantages:

- **Reduced Wind and Water Erosion**. Soil loss with row crop production can be cut to less than 10 percent of the amount normally occurring with conventional tillage systems, provided vegetative residues are maintained on the soil surface. As a result, valuable top soil is saved and more intensive land use is permitted.
- **Decreased Equipment Costs**. Cutting down or eliminating field operations reduces wear on equipment.
- **Increased Energy Efficiency.** Eliminating trips over fields reduces the amount of fuel required to produce crops.
- **Conservation of Soil Moisture**. Tillage dries the soil. Leaving the surface untilled and mulch covered saves considerable soil water. This saving can translate into less frequent irrigation intervals or allow for a crop to be produced every year instead of every other year in dry regions. In humid areas, crop yields often are increased during dry seasons because of the availability of additional soil water.
- **More Efficient Use of Labor.** Time formerly used to prepare seedbeds can now be used to plant more crop acres. Crop establishment can be more timely and workers can manage greater acreages. Less labor is needed for existing acreage.
- **Improved Opportunity for Multiple Cropping**. Succeeding crops can be established rapidly because soil water is conserved through not tilling the soil.
- **Fewer Problems With Stones and Other Underground Obstructions.**

Problems With Reduced Tillage

Under some conditions, there may be certain disadvantages or problems that limit adoption of reduced tillage systems. These include:

- **Poorly Drained Soils.** Crops do not respond well to reduced tillage practices on certain soils, including those that are poorly drained. A degree of tillage may be required to maintain satisfactory yield levels on some soils.
- **Presence of Perennial Weeds, Diseases, and Insect Pests**. Incidence and severity of various pests can be increased with residue cover on the soil surface. This potential problem requires more careful monitoring of fields planted with reduced tillage practices.
- **Management Problems.** A major requirement in adopting reduced tillage systems is the need to put time and energy into learning the new production system. Crop productivity can suffer if any part of the new system is handled improperly.
- **Herbicide Failure.** Performance of some herbicides is changed when they are applied to mulch covered, untilled soil. Higher rates of herbicides than normal for tilled soil may be required for satisfactory weed control.

Making Reduced Tillage Work

Certain basic management requirements must be met for satisfactory crop production, regardless of the tillage practices used.

Lo-till planter demonstration near Enid, Oklahoma. The demonstration was held early in the planting season for winter wheat.

An acceptable population of the crop must be planted at the proper time. Plant nutrients must be supplied and positioned so they are available to the crop. Weed, disease, and insect pests must be controlled either by cultural practices or chemicals or a combination of both. The crop must be supplied with adequate water to meet the needs of growing plants. Thus, a suitable environment for crop growth must be created. As tillage is reduced, management practices must be altered to fit these new conditions. Reduced tillage systems require implement modifications for crop production. For example, planting equipment developed for tilled seedbeds often functions poorly in untilled or mulch covered soil. Planting equipment specifically developed for use in minimum tillage planting is available commercially for several crops.

Weed Control

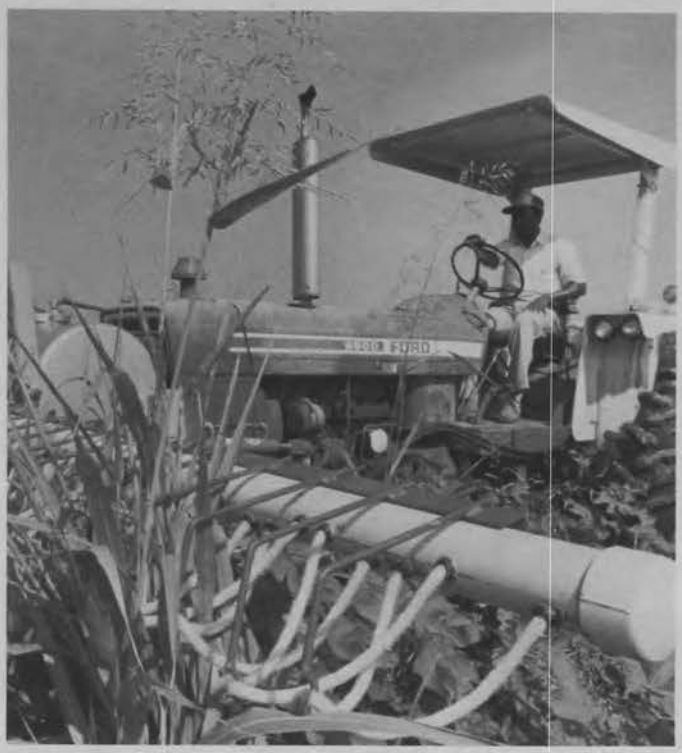
Weed control is a major factor in making reduced tillage systems work successfully. Reduced tillage, as it is practiced today, was not possible before the development of modern herbicides. In reduced tillage systems, herbicides are substituted for tillage to control weeds; in conventional systems herbicides supplement tillage. Thus, in reduced tillage systems, the dependency on herbicides is greater and their excellent performance is more critical. Reduced tillage systems may restrict the use of some herbicides and eliminate the use of others that are widely used for weed control under conventional tillage practices. For example, herbicides that must be soil incorporated cannot be used effectively in many reduced tillage systems.

Characteristically, herbicides and combinations of herbicides that perform satisfactorily for reduced tillage systems must meet several requirements. They must:

- Control vegetation present on the site.
- Prevent growth of weeds from seed that germinate after herbicide application.
- Not injure the crop.
- Not injure subsequent crops due to soil residues.

The importance of these requirements will vary depending on the geographical location, soils, crops grown, and reduced tillage systems used.

Winged shovel chisel plow hooked in tandem with a stalk chopper.



A rope wick applicator.

Combinations of herbicides usually are necessary to meet these requirements. Herbicides chosen must provide a broad spectrum of weed control and persist until the crop is well established since cultivation to control escaped weeds may not be practical. Therefore, the herbicides must persist in the soil and have residual activity until the crop canopy develops. Although several residual herbicides that are usually applied to the soil effectively control some emerged vegetation, contact or translocated herbicides often are required in the mixture. Depending on the crop and weeds present, a combination of two, three, or four herbicides may be required for satisfactory seasonal weed control. Applications of both preemergence and postemergence herbicides can be utilized to achieve weed control in reduced tillage systems.

The scope of this publication does not include specific herbicide recommendations. Consult current Cooperative Extension Service publications for herbicide selection and rates for different tillage and crop combinations.

Tillage practices generally have little or no influence on the effectiveness of contact or translocated herbicides applied to weed foliage. The activity of residual herbicides applied to the soil can be affected, however. Mulch cover on the soil surface may intercept 30 percent or more of the residual herbicide and can shelter small weed seedlings from contact herbicides. Some herbicides such as atrazine require more precipitation for activation if the soil has been tilled. Repeated applications of nitrogen fertilizers to untilled soil lower the pH of the surface layer, which in turn reduces the effectiveness and persistence of triazine herbicides. The organic matter content of the soil surface increases with many reduced tillage systems, creating a need for increased rates of residual herbicides. These effects are most pronounced with continued use of the no-tillage system on acidic soils in the humid eastern regions of the nation.

Weed problems often change with changes in weed control and cropping practices. Certain weed species may increase with continual use of reduced tillage, especially in a crop monoculture. This increase will include any species not controlled by the herbicide program. To counter annual weeds that escape control, the combination of residual herbicides must be changed. Postemergence herbicides may be necessary for control in some instances. Rotation of crops and herbicides can be an effective means of controlling specific weed species.

Perennial weeds often increase as the amount of tillage is decreased. Perennial weeds may escape control because the herbicides used are not effective or because the weed is not in a susceptible stage of growth for effective control when herbicides are applied. Tilling the soil to bring rhizomes to the soil surface increases control of some perennial plants. Certain difficult to control perennial weed species should be eliminated before minimum tillage systems are adopted. Crop rotation that permits the use of effective herbicides at the proper time for specific weeds and the use of wicks, roller applicators, or directed postemergence spray applications can enhance the control of perennial weeds.

Applying Herbicides Correctly

Proper herbicide application is essential for effective performance in reduced tillage systems. The need for uniform herbicide coverage in minimum tillage systems is just as important as with conventional tillage systems. Since fields normally have varying amounts of crop residue cover and weed growth, more care must be given to application equipment and its use. In some cases cover crops have been established and must be killed in preparation for the next crop. Since the herbicide is no more effective than its application, proper spraying becomes a key factor in weed control. Some of the factors to consider in spraying are:

Nozzle Selection

Uniform distribution of herbicides on the target area and proper concentration of herbicides in the spray solution are important factors in spray applications. For areas having dense cover crops or weed growth, spray particles must contact the foliage of all plants. Widely spaced flood nozzles (for example, 10 feet) may not provide adequate distribution and herbicide performance in dense vegetation or residue cover. Increasing the pressure for some nozzle types aids in spray penetration of the canopy, but drop size is decreased, which increases the number of particles and the potential for drift. Best results can be obtained by following the manufacturer's specifications for nozzles.

Carrier and Carrier Volume

Both water and liquid fertilizer provide convenient carriers for herbicides applied to minimum tilled fields. Optimum rates of carrier suggested on herbicide labels vary widely, ranging from less than 5 gallons per acre for some herbicides to 40 or more for others. Before liquid fertilizer is used as a carrier, checks should be made for compatibility of the materials and to be sure application is proper with the equipment being used. In some

Corn planted with a no-till planter without prior land preparation on stubble of rye used for temporary winter grazing. Corn was planted in 20-inch rows and was fertilized according to soil analysis.

cases, incompatibility may reduce weed control. Fertilizer solutions containing clay should not be used with paraquat or glyphosate since the clay inactivates these herbicides. There should be little effect on most other herbicides.

Spray Nozzle Height

Nozzle height should be set to permit the spray pattern to overlap for even coverage at the top interface of vegetation present. Booms should be maintained a uniform height above the soil or target vegetation being sprayed.

Time of Herbicide Application

The optimum timing may vary for different regions and the crop being planted. In some regions and for several tillage systems the best time is after planting but before crop emergence. Residual herbicides that are applied before planting can be moved out of the immediate zone of planted seeds by the action of the planter. This allows weeds to become established in the crop row. To obtain best weed control results under these conditions, herbicides should be applied following planting. For one trip operations, the herbicide sprayer can be mounted behind the planter units. After crop emergence, the number of effective herbicides available is limited and controlling weeds that escape becomes more difficult.

Spray Pattern

Uniform coverage is essential for spray application with minimum tillage systems. Double coverage with some herbicides can cause crop injury and carryover of residue to succeeding crops. Skips often cannot be effectively treated after crop emergence. There are several systems that mark the edge of the spray swath to avoid skips without excessive overlap. These systems include foam spots; dyes in the spray solution; mechanical systems, such as a disk or chisel; automatic flagmen; flags; and electronic marking systems.

Special Weed Problems

Certain weeds cannot be controlled satisfactorily with the means that are presently available in reduced and no-tillage crop production systems. These weeds represent a barrier to the adoption of reduced and no-tillage practices and must be eradicated or reduced before minimum tillage practices are adopted. Most problem weeds are perennials, although some

Table 3. Problem weeds for no-tillage and reduced tillage production of different crops

No-tillage should not be attempted in fields that are severely infested with these or similar weeds:

Corn	Soybeans	Sorghum	Wheat	Cotton
johnsongrass	johnsongrass*	johnsongrass	quackgrass	silverleaf nightshade
bermudagrass	bermudagrass*	bermudagrass	jointed goatgrass	johnsongrass*
wild proso millet	hemp dogbane	hemp dogbane	Russian knapweed	bermudagrass*
shattercane	redvine	Russian knapweed		redvine
bluestem	briars	wild proso millet		hog potato
switchgrass	wild proso millet*	shattercane		spurred anoda
trumpetcreeper	climbing milkweed	switchgrass		spurges
broomsedge	leafy spurge	bluestem		nutsedge
dallisgrass	sicklepod	broadleaf signalgrass		woolyleaf bursage
	purple nutsedge	Texas panicum		Texas blueweed
	trumpetcreeper			groundcherry
	forage grasses*			field bindweed
	quackgrass*			

In addition to the weeds listed above, these weeds are also difficult to control in reduced tillage systems:

Corn	Soybeans	Sorghum	Wheat	Cotton
briars	milkweed	jointed goatgrass	wild oats	velvetleaf
hemp dogbane	alfalfa	fall panicum	cheat	devilsclaw
climbing milkweed	horsenettle	horsenettle	Canada thistle	cocklebur
fall panicum	sunflower	sandbur	bindweed	lanceleaf sage
horsenettle	burcucumber		annual bromes	Venice mallow
burcucumber	broadleaf signalgrass*			
broadleaf signalgrass	switchgrass*			

*Early evaluations of recently developed postemergence grass herbicides indicate that these herbicides do control these weeds in broadleaf crops.

annual species also are difficult to control. A listing of problem weeds appears in table 3.

Several factors contribute to the degree of control that can be expected for certain weeds. In some cases, suitable herbicides that will eliminate the weed with one application are not available. Since some of the more effective herbicides cannot be applied after the crop has emerged, the time of herbicide application may not be at a stage during which weeds can best be controlled. Translocation of the herbicide is necessary to destroy the underground parts of many perennial weeds, and the most efficient translocation varies with the stage of growth. Other weeds may emerge over an extended period of time—after soil applied herbicides are no longer effective and before the crop canopy is established enough to suppress further weed emergence and growth. In general, any weed not controlled in a specific management system will increase and become a problem. Some weed infestations increase very slowly, whereas others may cover the field in only a few crop seasons.

Several strategies can be used to reduce infestations of problem weeds. These include:

- **Rotation of Crops, Herbicides, and Tillage.** In areas where several crops are produced, rotation permits selection of a greater variety of herbicides. If crops are planted at different times (for example, fall vs. spring seeding), herbicide applications can be timed to coincide with the most susceptible growth stages of weeds. Because winter annual weeds infest fall planted crops and summer annual weeds infest spring crops, crop rotation helps eliminate these weeds.
- **Adoption of Minimum Tillage Rather Than No-Tillage Systems.** Tillage helps disrupt the underground parts of some perennial weeds and destroy existing vegetation. Certain effective, soil incorporated herbicides can be used in systems in which some tillage is used.
- **Use of Crop-Fallow Systems in Areas With Low Rainfall.** These systems offer opportunities to control problem weeds when the crop is not present. Certain problem weeds can be controlled following small grain harvest in high rainfall areas. Both herbicides and tillage can be used in crop-fallow systems.

There are four steps to follow in controlling weeds for reduced tillage systems:

1. Determine which weeds are present or anticipated. Consult field histories and scout fields to observe weeds currently growing or present during the past season. Sites with problem weeds usually can be identified.
2. Select herbicides and rates for the weed control program. A combination of herbicides is required for most crops and sites. Such combinations should be based on crops grown, weeds present, soil characteristics, crops that follow, and tillage system selected. Consult the Cooperative Extension Service in your area for specific recommendations.
3. Apply the herbicides uniformly and at the proper time.
4. Monitor fields carefully during the early stages of crop growth. Spraying mistakes or weed escapes often can be corrected with timely applications of postemergence herbicides or with cultivation.