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G90-983 Equipment Adjustments for Herbicide Incorporation

Robert Grisso
University of Nebraska - Lincoln

Elbert C. Dickey
University of Nebraska - Lincoln, edickey1@unl.edu

Alex Martin
University of Nebraska - Lincoln, amartin2@unl.edu

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Equipment Adjustments for Herbicide Incorporation

This NebGuide discusses how to operate liquid herbicide application equipment on tillage implements.

Robert Grisso, Extension Agricultural Engineer
Elbert Dickey, Extension Agricultural Engineer--Conservation
Alex Martin, Extension Weeds Specialist

Heightened concerns for energy and soil conservation have caused producers to reduce the number of secondary tillage operations while trying to maintain satisfactory incorporation of herbicides. Many herbicides are carried into the soil by rainfall or sprinkler irrigation and do not require mechanical incorporation. However, some soil-applied herbicides require mechanical incorporation to reduce volatility and photodecomposition losses. These are Eradicane, Sutan+ and Treflan[1]. For more information use *NebGuide G92-1081, Factors That Affect Soil Applied Herbicides*.

Soil Mixing -- The Key To Incorporation

Many herbicides are labeled for single-pass incorporation when soil and residue conditions are ideal, thus reducing the number of tillage passes required and minimizing the amount of residue that will be destroyed. The success of single-pass herbicide incorporation has been debated and researched by university and commercial weed-control experts who viewed various surface conditions, application techniques, and tillage implements. Success depends on the extent of soil and herbicide mixing. The two most common errors with incorporation are operating equipment too slow, too shallow or on soil that is too wet. These errors result in streaks of weeds. Producers should modify commonly accepted incorporation practices to reduce tillage trips and conserve soil by maintaining surface residue.

Soybean stubble usually creates no problem for single-pass incorporation, especially when the soil is dry. On cornstalks and grain sorghum stubble, some farmers may use a chisel plow or disk operation in the fall. The stalks will further decompose over the winter and single-pass incorporation can be used in

the spring if the ground surface is level, dry and not ridged. However, the tradeoff for multi-pass incorporation is loss of erosion control and the extra expense of machine operation and labor.

Most experience points to the importance of relatively dry soil for single-pass incorporation. Tillage implements should be equipped with a leveling device (harrow) to help reduce herbicide streaking and should be operated between 6 and 7 mph for thorough incorporation.

Volatile herbicides like Eradicane, Sutan+ and Treflan should be incorporated 2 to 3 inches deep; while herbicides like Lasso or Dual should be placed 1 to 2 inches deep. Root uptake herbicides like Bladex and Atrazine can be incorporated at either depth. The mixing depth is not the same as the operating depth. Mixing depth will vary with the implement and soil conditions. Sutan+ tank-mixed with atrazine and/or Bladex requires one incorporation pass on soybean stubble and two incorporations in corn residue. In unfavorable conditions such as wet soil and/or residue, another incorporation pass may be desirable. Treflan requires two incorporation passes. In heavy residue one tillage pass is required before application.

Equipment Adjustment For Incorporation

Two approaches are commonly used for herbicide incorporation: complete incorporation and shallow incorporation, commonly called surface mixing. Complete incorporation calls for all the herbicide to be thoroughly mixed to a depth of 2 to 3 inches in the soil. Shallow incorporation involves shallower and less complete mixing. Shallow placement improves horizontal distribution compared to deeper mixing.

Equipment selection, assembly, and operation are the most important factors in obtaining uniform herbicide incorporation. Equipment must be adjusted in the field to the specific conditions under which it will operate. Previous crop, amount of crop residue, soil type,drainage, previous tillage operations, and weather all require adjustments in incorporation equipment.

Figure 1. Tillage implements spraying during a field operation.

The following adjustments should be made on any incorporation equipment:

- Adjust the implement so it is level, both front to back and side to side (*Figure 1*). Adjust to desired operating depth (a depth of 1 to 6 inches, depending on the tillage implement and herbicide). If wheel hydraulic cylinders do not have stop adjustments, install them for precise resetting of depth. As soil and residue moisture conditions change during the day, operating depth may need to be increased.

- Adjust adjoining implement wings so they operate at the same depth as the center tillage unit. Implement wings are lighter and tend to ride up and operate shallower than the center unit. Eye-bolt adjustment on wing cylinders, wing-tire deflation, changing wing-tire size, or adding weight to the wing can bring wings in line with the center unit. Unequal tire sizes across the tool may make adjustment impossible without tire replacement.
- Adjust implements so that all soil is being worked across the entire width of the tool. A misplaced shank, broken tines or worn tillage components can result in nonuniform incorporation. In addition, tractor and tillage equipment tracks need to be tilled for uniform incorporation. It may be necessary to move a field-cultivator shank over slightly or add a shank behind equipment tires to till the tire tracks.
- Ground speed and operating depth determine the completeness of soil mixing and herbicide distribution accomplished by a particular tillage implement. In general, a speed of greater than 5 mph is recommended for proper incorporation. As the optimum speed of operation is approached, mixing and horizontal distribution increase. Above the optimum speed, horizontal distribution decreases because depth is difficult to maintain at higher speeds.

Often, tillage equipment is larger than the tractor can pull at the speeds necessary for proper incorporation. On hilly ground or when soil conditions are less than optimum, incorporation speeds are reduced and incorporation uniformity suffers. As a general rule, disk-field cultivator combination tools require about six to eight horsepower per foot of implement width and finishing-disk and field cultivator combination implements require about eight to 12 horsepower per foot. During implement selection, choose a tillage device smaller than typically matched with your tractor. This will allow for additional power required to transport the spray tank, spray solution and operate the sprayer accessories.

Harrow Devices

The purpose of a harrow is to eliminate ridges and to help distribute herbicide in the top 1/2 to 2 inches of soil. Rolling basket, coil-tine, and flexible-spike harrows are used for leveling and incorporating herbicides. The coil-tine and flexible-spike harrow are the most common.

Harrows improve horizontal distribution with single-pass complete incorporation because much of the herbicide is below the operating depth of the harrow. Harrows add considerably, however, to the horizontal distribution of surface mixing. In fact, without a good harrow, single-pass surface mixing would seldom be satisfactory.

Coil-tine harrows are used behind disks, C-shank field cultivators, and combination implements where residue-shedding ability is needed and soil leveling is important. A minimum of a three-bar harrow is recommended. A three-bar coil-tine harrow has about a 3-inch effective tine spacing (the narrowest distance between tines on different bars measured perpendicular to the direction of travel), which causes considerable lateral soil movement. The method of attachment to an implement is very important in maintaining uniform incorporation. It should be attached as close as possible (about 6-7 inches) behind the last row of tillage gangs. There should be at least two carrier arms per harrow section to maintain stability.

Coil-tine harrows generally have two adjustments: down pressure and tine angle. The most aggressive mixing and tillage action is obtained with the tines perpendicular to the soil surface. Aggressiveness decreases as the tines are angled toward the rear. As tillage aggressiveness decreases, residue-shedding ability increases. In situations where crop residues do not present a plugging problem, adjust tines to the most aggressive (perpendicular) position and apply as much down pressure as possible without inhibiting tine lateral movement and vibration.

Flexible-spike harrows also are used behind tillage implements. These harrows are usually suspended from the rear of the implement and penetrate soil under their own weight. A flexible-spike harrow typically consists of five bars of spike harrow teeth with about 1.5 inches of effective spike spacing. The narrow effective spacing results in considerable lateral soil movement.

The Fuerst harrow is a version of the flexible-spike harrow. Its flexible design, many harrow spikes, and weight make it an excellent harrow to pull behind incorporation implements to level small ridges and distribute herbicide. Its ability to shed residue is good.

Tandem Disk

Width of tandem disks, blade diameter and the distance between blades have tended to increase in recent years. Increases in blade diameter and spacing have led to herbicide performance problems due to excessive operating depths. Realizing this, equipment manufacturers are producing wide "lighter" disks that have smaller blades and are closer together for more uniform herbicide incorporation.

Two types of disk blades are available: conical (flat angled) and spherical (curve-angled). Conical blades are not suitable for herbicide incorporation because they cut and invert soil rather than mix it. This results in burial of herbicide rather than a uniform mixing. Spherical blades cut, invert, and mix the soil and herbicide. Incorporation is about one-half the depth of operation.

The angle of tandem-disk gangs (*Figure 2*) determines the distance soil is moved. Poor incorporation often results because more soil is thrown out by the front gang than returned by the rear gang. More uniform incorporation can be achieved by adjusting the angle of the disk gangs so that soil thrown by the front and rear gangs are equal. Often, the front gangs run deeper than the rear gangs which results in burial of the herbicide. Thus a disk must be leveled front-to-rear during field operation for uniform incorporation.

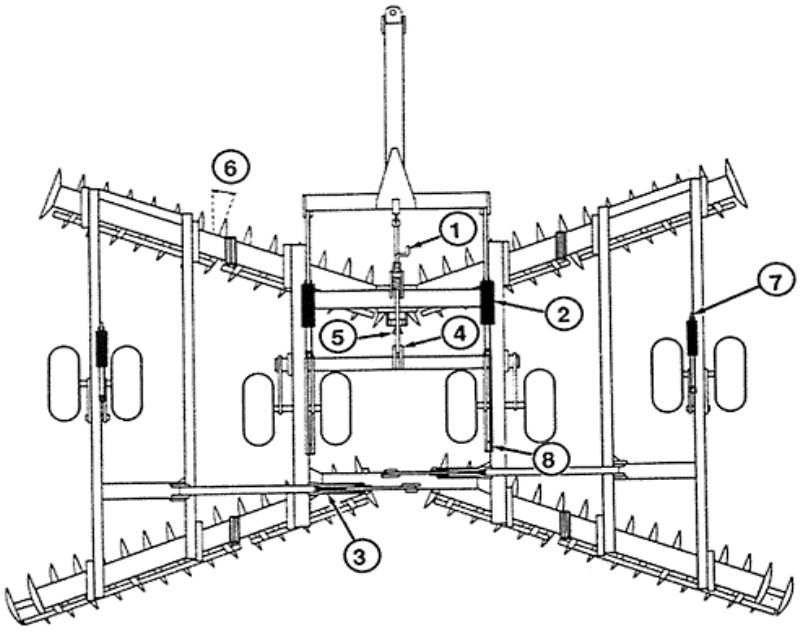


Figure 2. Adjustment made on a tandem disk. (1) Leveling crank, (2) Depth control cylinders, (3) Wing lift cylinders, (4) Frame level adjustments, (5) Center shank, (6) Disk angle, (7) Wing depth adjustment, (8) Transport bars.

Disks will handle rough, residue-covered fields and are an excellent tool for the first pass of a double-incorporation program or for single-pass incorporation. When using a disk for the second pass on a double-incorporation program, operating depth should be reset. Incorporation depth is about half the operating depth during the first pass and about three-quarters of the operating depth during the second pass. Additionally, at the same depth setting, disks will operate deeper during the second pass. If a disk is used for the second pass, reduce the operating depth by 33 percent. For example, suppose the first pass had a depth of 6 inches then the second pass should be decreased to 4 inches. A field cultivator may provide a better alternative for the second pass.

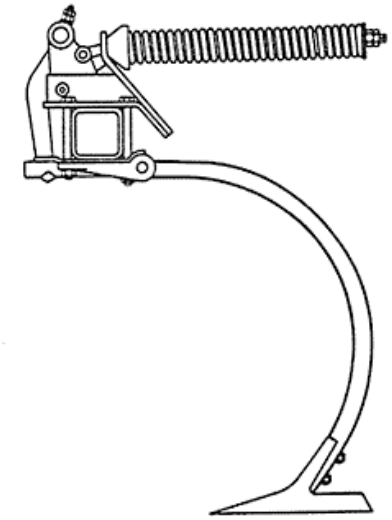
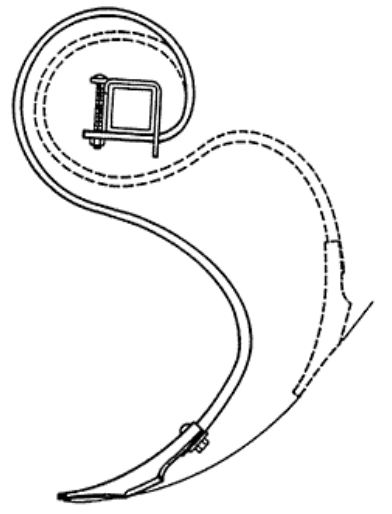


Figure 3. C-shank for a field cultivator.

C-Shank Field Cultivator (CFC)

C-shank field cultivators incorporate herbicides by means of soil inversion and mixing. The tillage action is somewhat similar to that of a disk. Incorporation depth is approximately half the operating depth of the tool. It is important that all soil is evenly tilled across the entire width of the implement. This can be accomplished by equipping each shank with a sweep (*Figure 3*) at least as wide as the effective shank spacing. Sweeps that are too small can result in incomplete mixing when operated at normal field speeds. Sweeps that are too large can cause excessive soil movement and concentrate or "windrow" the herbicide. Sweeps too worn for thorough mixing of the soil and herbicide may need to be replaced. These problems, as well as slow or excessive operating speeds, can cause streaks of weeds for each shank. If a C-shank field cultivator is not level when operated, one row of shanks will penetrate too deeply and dig up untreated soil. This problem can also result in weed streaks for each shank of the deep-penetrating gang.

C-shank field cultivators can handle rough, residue-covered fields and are excellent for both passes of double-incorporation and surface mixing. Less surface residue is covered with C-shank field cultivators than with a disk. However, herbicide and soil mixing is less complete than with a disk or S-tine field cultivator operated at the same depth and speed. A properly adjusted harrow used with a C-shank field cultivator can improve herbicide and soil mixing.



S-Tine Field Cultivator

The S-tine field cultivator has become a popular implement for surface mixing or for the final pass of a double-incorporation. The S-tine field cultivator incorporates herbicides by shattering soil with the vibrating motion of the flexible S-tines (*Figure 4*). This shattering action produces an incorporation depth that is from two-thirds to three-quarters of the operating depth.

Incorporation is greatly reduced when S-tine vibration is restricted. For this reason, S-tine field cultivators incorporate most effectively in ground that has been previously tilled. Deep operation is not recommended because the tines can dig up untreated soil. The maximum recommended operation depth is 3.5 to 4 inches.

Figure 4. S-shank for a field cultivator.

Typical equipment specifications are for 2.5 inch sweeps on a 4-inch effective spacing or 4-inch sweeps on a 6-inch effective spacing. Sweeps need not overlap because of the vibrating action of the tines. Generally, S-tines cannot accommodate larger sweeps.

The horizontal distribution that results is about one and one-half times better than that obtained from surface mixing with a disk or C-shank field cultivator. Tines with narrow points will not provide consistent results. Herbicide and soil mixing with S-tine field cultivators is about the same as a disk operated at the same depth. S-tine field cultivators are not recommended for single-pass incorporation because they cannot be operated deep enough. Excellent depth control is possible with most S-tine field cultivators.

Summary

Maintaining satisfactory incorporation of herbicides during tillage requires that tillage implements be properly adjusted and operated. Equipment must be adjusted in the field to the specific conditions under which it is expected to operate. Follow recommended adjustments on the incorporation equipment for best performance.

Additional Reading

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Martin, A.R., R.N. Stougaard, F.W. Roeth, R.S. Moomaw, R.G. Wilson, G.A. Wicks, and R.N. Klein. 1990. A 1990 Guide for Herbicide Use in Nebraska. NE Coop. Ext. EC-90-130.

[1]Trade and company names are included for the benefit of the reader and do not infer endorsement or preferential treatment of the product by the University of Nebraska-Lincoln.

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