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SEARCH

# Mechanical Weed Control with a Harrow or Rotary Hoe

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Mechanical weed control is one tool in an integrated weed management system. Tillage can be the sole weed management tool or, more likely, complement other means such as cultural methods (e.g. crop rotation, narrow rows, and proper crop seeding dates and rates) and herbicides. Equipment for mechanical weed control includes harrows, rotary hoes, betweenrow tillage equipment, undercutters, rod weeders, mowers, combine weed seed savers, etc. Discussion in this publication will be limited to light springtooth harrow or rotary hoe use during preemergence to early postemergence crop stages for weed seedling management and control.

A harrow or rotary hoe can rapidly, economically, and effectively control certain weeds. The weeds, crop, environment, equipment, and management techniques (e.g. tillage timing) of the producer are important factors in determining the effectiveness of mechanical weed control.

Research in North Dakota indicates that the level of weed control and crop seed yield is generally less with use of only a harrow or rotary hoe, but the cost of weed control is generally less compared to herbicides. Table 1 shows annual weed control and crop response with a harrow or rotary hoe. Annual weed control in the trials varies from good to none. A major reason for unsatisfactory weed control is unfavorable environmental conditions (e.g. extended wet soil surface) that did not allow the proper timing of tillage operations.

| Crop and   | Year    | Tillage    | - Annual Weed | Control - |
|------------|---------|------------|---------------|-----------|
| Location   |         | Implement* | Broadleaf     | Grass     |
| Field pea: | 1996-97 | Harrow     | 18-87         | 58-74     |
| Carrington |         | Rotary hoe | 25-89         | 54-81     |
| Flax:      | 1993-95 | Harrow     | 28            | 11        |
| Dickinson  |         | Rotary hoe | 28            | 22        |

### Table 1. Weed and crop response with the use of a harrow or rotary hoe in North Dakota.

Lentil:

#### Mechanical Weed Control with a Harrow or Rotary Hoe

| Dickinson   | 1994  | Harrow<br>Rotary hoe  | 51<br>7   | -  | 0<br>24  |           |
|---|---|---|---|--|--|-----------|
| Pinto bean:<br>Carrington   | 1991-92   | Rotary hoe<br>(plus two   | 77<br>cultivatic  | ,<br>)<br>)  | 75   |           |
| Sugarbeet:  | 1984-85   | Harrow<br>Rotary hoe  | 30<br>20  | )  | 20<br>10   |           |
| Sunflower:<br>Carrington  | 1997-98   | Harrow<br>Rotary hoe  | 73-<br>21-  | -80 70<br>-78 23   | 6-85<br>3-79   |           |
| Wheat:  |   |   |   |  |  |           |
| Langdon   | 1988  | Harrow  |   | !  | 51   |           |
| Dickinson   | 1994  | Harrow  | 54  | Ł  | 8  |           |
| Carrington  | 1995  | Rotary hoe<br>Harrow<br>Rotary hoe  | 54<br>33<br>35  | -<br>  | 36<br><br>   |           |
|   | <br>Та  | able one Con  |   |  |  |           |
|   |   |   |   |  |  |           |
| Crop and  |   | Tillage   | Visual  | (  | Crop   |           |
| Location  | Year  | Implement*  | Injury  | Density  | Seed Yiel  | d         |
|   |   |   | <br>%   | % of check   | * of herb. o   | <br>check |
| Field pea:  |   |   |   |  |  |           |
|   |   |   |   |  |  |           |
| Carrington  | 1996-97   | Harrow  | 15  |  | 71   |           |
| Carrington  | 1996-97   | Harrow<br>Rotary hoe  | 15<br>11  | <br>   | 71<br>71   |           |
| Carrington<br><br>Flax:   | 1996-97<br>   | Harrow<br>Rotary hoe  | 15<br>11  | <br>   | 71<br>71   |           |
| Carrington<br><br>Flax:<br>Dickinson  | 1996-97<br><br>1993-95  | Harrow<br>Rotary hoe<br>Harrow  | 15<br>11<br>  | <br><br>70   | 71<br>71<br>   |           |
| Carrington<br><br>Flax:<br>Dickinson  | 1996-97<br><br>1993-95  | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe  | 15<br>11<br><br>  | <br><br>70<br>61   | 71<br>71<br>88<br>28   |           |
| Carrington<br><br>Flax:<br>Dickinson<br>  | 1996-97<br><br>1993-95  | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe  | 15<br>11<br><br>  | <br><br>70<br>61   | 71<br>71<br>88<br>28   |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson  | 1996-97<br>1993-95<br><br>1994  | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow  | 15<br>11<br><br>  | <br><br>70<br>61<br>   | 71<br>71<br>88<br>28<br>29   |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson  | 1996-97<br><br>1993-95<br><br>1994  | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe  | 15<br>11<br><br>  | <br>70<br>61<br>77<br>61   | 71<br>71<br>88<br>28<br>29<br>28   |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:   | 1996-97<br>1993-95<br>1994  | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe  | 15<br>11<br><br>  | 70<br>61<br>77<br>61   | 71<br>71<br>88<br>28<br>29<br>28   |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington   | 1996-97<br>1993-95<br>1994<br>1991-92   | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Rotary hoe  | 15<br>11<br><br><br><br>0                               | <br>70<br>61<br>77<br>61   | 71<br>71<br>88<br>28<br>29<br>29<br>28<br>86                               |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington   | 1996-97<br>1993-95<br>1994<br>1994<br>1991-92                                       | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Rotary hoe<br>(plus two   | 15<br>11<br><br><br><br>0<br>cultivatic                 | <br>70<br>61<br>77<br>61<br>   | 71<br>71<br>88<br>28<br>29<br>29<br>28<br>86                               |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington   | 1996-97<br>1993-95<br>1994<br>1991-92   | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Rotary hoe<br>(plus two   | 15<br>11<br><br><br>0<br>cultivatic                     | 70<br>61<br>77<br>61<br>   | 71<br>71<br>88<br>28<br>29<br>28<br>86                                     |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:   | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85                                    | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe   | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13         | 70<br>61<br>77<br>61<br>   | 71<br>71<br>88<br>28<br>29<br>29<br>28<br>86<br>                           |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:   | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85                                    | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe   | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13         | <br>70<br>61<br>77<br>61<br>   | 71<br>71<br>88<br>28<br>29<br>28<br>86<br>                                 |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington   | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1907-08                         | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe   | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13         | 70<br>61<br>77<br>61<br>0n)<br>17<br>20  | 71<br>71<br>28<br>29<br>28<br>86<br>                                       |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington   | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1997-98                         | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe<br>Harrow   | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13<br>     | <br>70<br>61<br>77<br>61<br><br>0n)<br>17<br>20<br><br>75<br>91                  | 71<br>71<br>28<br>29<br>28<br>86<br>                                       |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington   | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1997-98                         | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe   | 15<br>11<br><br><br>cultivatic<br>16<br>13              | <br>70<br>61<br>77<br>61<br><br>on)<br>17<br>20<br>75<br>91                      | 71<br>71<br>28<br>29<br>28<br>86<br><br><br>89<br>82                       |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington<br>Wheat:                                       | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1997-98                         | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe   | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13<br>     | <br>70<br>61<br>77<br>61<br>   | 71<br>71<br>88<br>28<br>29<br>28<br>86<br><br><br>86<br>88<br>88           |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington<br>Wheat:<br>Langdon                            | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1997-98<br>1988                 | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow   | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13<br>     | 70<br>61<br>77<br>61<br>00)<br>17<br>20<br>75<br>91                              | 71<br>71<br>71<br>29<br>28<br>86<br><br><br>89<br>82<br>64                 |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington<br>Wheat:<br>Langdon<br>Dickinson               | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1997-98<br>1988<br>1994         | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Contemposed<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow                    | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13<br>     | <br>70<br>61<br>77<br>61<br><br>m)<br>17<br>20<br><br>75<br>91<br><br>88         | 71<br>71<br>71<br>29<br>28<br>86<br>                                       |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington<br>Wheat:<br>Langdon<br>Dickinson<br>Carrington | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1997-98<br>1988<br>1994<br>1995 | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Contary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Harrow<br>Rotary hoe<br>Harrow             | 15<br>11<br><br><br>cultivatic<br>16<br>13<br><br>      | <br>70<br>61<br>77<br>61<br><br>m)<br>17<br>20<br>75<br>91<br><br>88<br>77<br>76 | 71<br>71<br>71<br>29<br>28<br>86<br><br><br>89<br>82<br>64<br>1.12<br>1.30 |           |
| Carrington<br>Flax:<br>Dickinson<br>Lentil:<br>Dickinson<br>Pinto bean:<br>Carrington<br>Sugarbeet:<br>Sunflower:<br>Carrington<br>Wheat:<br>Langdon<br>Dickinson<br>Carrington | 1996-97<br>1993-95<br>1994<br>1991-92<br>1984-85<br>1997-98<br>1988<br>1994<br>1995 | Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Rotary hoe<br>(plus two<br>Harrow<br>Rotary hoe<br>Harrow<br>Rotary hoe<br>Harrow<br>Harrow<br>Rotary hoe<br>Harrow | 15<br>11<br><br><br>0<br>cultivatic<br>16<br>13<br><br> | <br>70<br>61<br>   | 71<br>71<br>71<br>29<br>28<br>86<br><br><br>89<br>82<br>64<br>1.12<br>1.30 |           |

\*Two passes with tillage implements.

A combination of mechanical weed control and herbicides at reduced rates (if appropriate) may be a viable compromise versus choosing one single method. Also, a harrow or rotary hoe may be needed to

incorporate a preemergenceapplied herbicide if rainfall adequate to move the herbicide into the soil does not occur.

Annual weeds that emerge from shallow soil depths (less than 1 inch) can be controlled by a harrow or rotary hoe. Examples would include common lambs-quarters, kochia, nightshade spp., pigweed spp., wild mustard, green and yellow foxtail, and barnyard-grass. Weeds that typically emerge from soil depths of greater than 1 inch such as common cocklebur, volunteer grain, volunteer sunflower, and wild oat are difficult to control with shallow tillage. Also, established biennial or perennial weeds are not controlled by shallow tillage due to extensive crown and/or root systems.

Shallowemerging weeds need to be controlled soon after germination and before the root system is well established. The optimum time to control weeds is the "white sprout" stage. At this stage, weeds have not emerged but are just below the soil surface. The young plants are white (have not been exposed to sunlight and turned green), tender, and very susceptible to injury by tillage. Check fields for this stage by lightly wiping your hand or a spade across the soil surface. Weeds also are easy to control a few days after emergence. Generally, grassy weeds should not exceed the oneleaf stage and broadleaf weeds the cotyledonleaf stage of growth to expect adequate control with a harrow or rotary hoe.

A general recommendation with mechanical weed control is to till with a harrow or rotary hoe one to five days after crop planting ("blind tillage") followed by a second tillage pass seven to 10 days later. A third tillage pass seven to 10 days later is optional. A compromise may have to be made between optimizing weed control and minimizing crop injury when using a harrow or rotary hoe after crop emergence. Also, a short window of opportunity normally exists for timely use of tillage due to unfavorable weather conditions.

Crop species and stage is an important consideration when timing mechanical weed control operations. The ideal situation is when the crop is at a stage of high tolerance to the harrow or rotary hoe and the weeds are in a highly susceptible stage. In some crops, this situation will rarely occur unless a herbicide is used to control earlygerminating weeds. Crops generally will tolerate preemergence use of a harrow or rotary hoe until the seedling emergence structure (coleoptile of grasses and epicotyl or hypocotyl of broadleaves) is near the soil surface. Pre or postemergence use of the harrow or rotary hoe is risky with most shallowseeded crops. However, use of light tillage may be the only option to control weeds or break soil crusts while attempting to establish the crop. Table 2 shows various crops and the recommended stages of growth to minimize injury or stand loss while using a harrow or rotary hoe for weed control.

|                                  | Timing   |                               |  |  |
|----------------------------------|--|-------------------------------|--|--|
| Crop Species                     | Preemergence   | Postemergence                 |  |  |
| Barley**                         | Coleoptile 0.5 inch or<br>greater below soil surface.            | 1-3 leaf stage (1 time only). |  |  |
| Buckwheat                        | Before crook stage.  | Stand reduction will occur.   |  |  |
| Canola                           | Before seed germination.<br>Less than 0.5 inch tillage<br>depth. | Not recommended.              |  |  |
| Chickpea<br>(Garbanzo<br>bean)** | Epicotyl 0.5 inch or<br>greater below soil<br>surface.           | Up to 2-4 inches tall.        |  |  |

## Table 2. General recommendations for timing of harrow or rotary hoe use\*.

| Corn**          | Up to and including emergence.                                   | Emergence to 6 inches tall.                     |  |
|-----------------|--|---|--|
| Crambe          | Before seed germination.<br>Less than 0.5 inch tillage<br>depth. | Not recommended.                                |  |
| Dry bean        | Before crook stage.  | 1-2 trifoliolate stage.                         |  |
| Field pea**     | Epicotyl 0.5 inch or<br>greater below soil surface.              | Emergence to 2-4 inches tall.                   |  |
| Flax            | Before seed germination.<br>Less than 0.5 inch tillage<br>depth. | Stand reduction will occur.                     |  |
| Lentil**        | Epicotyl 0.5 inch or<br>greater below soil surface.              | 1-4 inches tall.<br>Stand reduction will occur. |  |
| Lupin           | Before crook stage.  | Emergence to 2 inches tall.                     |  |
| Mustard         | Before seed germination.<br>Less than 0.5 inch tillage<br>depth. | Not recommended.                                |  |
| Oat**           | Coleoptile 0.5 inch or<br>greater below soil surface.            | Not recommended.                                |  |
| Proso millet**  | Before seed germination.<br>Less than 0.5 inch tillage<br>depth. | Not recommended.                                |  |
| Safflower       | Before crook stage.  | Possible stand reduction.                       |  |
| Grain sorghum** | Coleoptile 0.5 inch or<br>greater below soil surface.            | Emergence to 6 inches tall.                     |  |
| Soybean         | Before crook stage.  | 1-2 trifoliolate stage.                         |  |
| Sugarbeet       | Before germination. Less<br>than 0.5 inch tillage depth.         | 4-6 leaf stage.                                 |  |
| Sunflower       | Before crook stage.  | 2-6 leaf stage.                                 |  |
| Wheat**         | Coleoptile 0.5 inch or<br>greater below soil surface.            | 1-3 leaf stage.                                 |  |

\* Timing of tillage may vary depending on environment and equipment. Chickpea, dry bean, field pea, lentil, lupin, soybean, and sunflower foliage should be dry before tillage to reduce risk of disease spread.

\*\* Regrowth should occur if aboveground stem damaged or removed.

Crops can easily be injured. Minimize injury during mechanical weed control operations to maintain uniform crop development, competitiveness with weed escapes or late emerging weeds, and seed yield and quality potential. Loss in crop density is normal and may range from 1 to 25 percent or more depending on the crop, crop stage, environmental conditions, tillage equipment, etc. Taking a crop stand count before and after tillage is a good method of evaluating injury. Earlyseason leaf removal without significant stand loss usually will not reduce crop yield. <u>Table 1</u> lists crop stand reduction with a harrow or rotary hoe in selected research trials conducted in North Dakota. To compensate for potential stand

loss, planting rate should be increased 10 percent or more above normal.

Environmental conditions should be closely monitored to help maximize weed control with a harrow or rotary hoe. Optimum conditions for timing mechanical weed control include a dry and level soil surface, warm air temperatures (75 F or greater), wind and sunshine.

A dry and level soil surface is necessary to allow effective operation of equipment and to minimize reestablishment of displaced weeds from tillage.

Warm, windy, and bright sun conditions, as well as dry weather during and following tillage, will reduce reestablishment of tilled weeds, as the weeds will dry out before they can reroot. Timing the tillage during midday with optimum conditions will allow more time for weed desiccation.

Also, these conditions will cause the crop to be less turgid. The crop will be more flexible as tillage implement points or shovels move through the canopy, so less crop injury would be expected. Crops well rooted and anchored will have less injury resulting from mechanical weed control.

Tillage equipment selection, adjustment, and timely use are important for acceptable mechanical weed control. Numerous types of harrows and rotary hoes are commercially available. Make sure that the implement of choice is suitable for preemergence and postemergence weed control.

For example, light harrows must be used instead of heavy and/or rigidtooth types. Harrow teeth should be set back at an angle. If a considerable amount of crop residue is present in the field, make sure the harrow or rotary hoe has adequate clearance to avoid collection of large amounts of residue. Residue bound in an implement will cause excessive crop damage if the operation is continued.

Implement tillage depth (normally 0.5 to 0.75 inches) and speed should be set to dislodge weeds but to minimize crop injury. Recommended harrow speed is 4 to 6 miles per hour. Rotary hoe effectiveness increases with increasing speeds, but so does crop injury potential. Rotary hoes typically are operated at 7 to 14 miles per hour. Closely monitor equipment after the tillage operation is initiated as environmental and plant (crop and weed) changes that can adversely change the expected outcome may occur from one part of the field to another.

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