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Effective high-speed, high-residue rowcrop cultivation

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Effective high-speed, high-residue rowcrop cultivation

Abstract

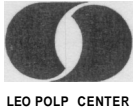
Banding of herbicides linked with mechanical cultivation has been touted as a way to decrease dependence on chemical inputs in farming. Tests on a farm near Boone, Iowa, were used to determine the effects of cultivator design and speed when combined with the banding of chemicals to control weeds. Three cultivator styles, two speeds, and two herbicide bands (19 cm. and 38 cm.) were tested. Results showed that faster cultivation speeds did not harm weed control or crop yields. There was no difference between yield in a broadcast treatment and that of a cultivator treatment in conjunction with a wide band of herbicide when disc hillers were also used.

Keywords

Agricultural and Biosystems Engineering, Agronomy, Weed control alternatives (not GMOs)

Disciplines

Agricultural Science | Agriculture | Agronomy and Crop Sciences | Bioresource and Agricultural Engineering | Weed Science



Effective high-speed, high-residue row crop cultivation

Abstract: *Banding of herbicides linked with mechanical cultivation has been touted as a way to decrease dependence on chemical inputs in farming. Tests on a farm near Boone, Iowa, were used to determine the effects of cultivator design and speed when combined with the banding of chemicals to control weeds. Three cultivator styles, two speeds, and two herbicide bands (19 cm. and 38 cm.) were tested. Results showed that faster cultivation speeds did not harm weed control or crop yields. There was no difference between yield in a broadcast treatment and that of a cultivator treatment in conjunction with a wide band of herbicide when disc hillers were also used.*

Background

Nearly 95 percent of Iowa's row crop acres are treated with herbicides, a cause for environmental concern. One alternative method to reduce use of chemical herbicides is mechanical row-crop cultivation coupled with banding rather than broadcasting herbicides. Several studies have suggested that combining these two practices can adequately control weeds and maintain yields when compared to broadcasting of herbicide with no cultivation.

However, there are other concerns. Wet weather can make cultivation difficult to perform. According to surveys, farmers are hesitant to rely on cultivation for weed control, preferring to cultivate to aerate soil or curb weed escapes. Farmers would also like to be able to cover more acres in the same period of time. One way to accomplish this would be to increase speed, but no studies have been done to compare speeds of cultivator operation.

Conservation tillage conserves soil, but surface plant residue may interfere with effective cultivator operation. Rapid crop growth and significant residue produced by continuous corn offer an especially difficult challenge to successful cultivation. Objectives of this experiment in no-till continuous corn production were to:

- 1) Determine the effects of the tool design, speed, and herbicide bandwidth on effec-

tiveness of cultivation for weed control in high-residue production systems.

- 2) Determine areas where present cultivation tools are inadequate and test an alternative design to remedy the inadequacy.

Approach and methods

Several weed control regimens were investigated, using combinations of three cultivator styles, two operational speeds, and two herbicide bandwidths. Broadcast herbicide and no herbicide (control) treatments were also included. Neither of these two treatments were cultivated. The same treatments were applied to the same plots each year to simulate a fixed weed strategy.

Among the three cultivator shovels tested were a 56-cm wide conventional low crown sweep and a 53-cm wide sweep with a protruding point to avoid slabbing by prefracturing soil before it is lifted by the sweep, often referred to a point-and-share type of sweep. In 1993, disc hillers were added to a conventional sweep configuration. For the next three seasons, a 46-cm vee-shaped flat sweep called a smith fin was used and disc hillers were added to all cultivation methods. The smith fin is not currently used in Midwest corn production, but is used extensively in peanut farming. Open top shields were added to the cultivator in 1994 and continued to be used in subsequent years.

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Budget

\$22,000 for year one
\$27,519 for year two
\$28,050 for year three

Two cultivation speeds were employed, conventional and faster. In 1993, wet soil limited speeds to 5.6 and 8.0 km/hr. From 1994 to 1996, the test speeds were 6.4 and 11.2 km/hr.

Each year's trials included two different bandwidths of herbicide applications: 19 cm and 38 cm. In 1993, herbicides (alachlor and cyanazine) were applied at planting. Due to the presence of dandelions at planting in 1994, glyphosate, 2,4-D ester, and crop oil were broadcast applied for burndown. Otherwise, the same herbicides and seed varieties were used from 1994 to 1996. (Broadcast herbicide for burndown of vegetation was also used at planting in 1995 and 1996 to stem early weed growth.)

Effects of cultivation were evaluated by measuring weed control and counting weed populations. Weed cover ratings were made in 1994 through 1996. Ground cover was measured, and the prior year's plant residue and weeds were counted as cover because they protect soil from detachment and erosion. Crop vigor was evaluated by measuring extended leaf height and crop plant populations. Moisture content of the soil (surface 5 cm- layer) was taken three times during the season in 1993 to 1995, and once at cultivation in 1996. Grain yield and moisture content were measured at harvest.

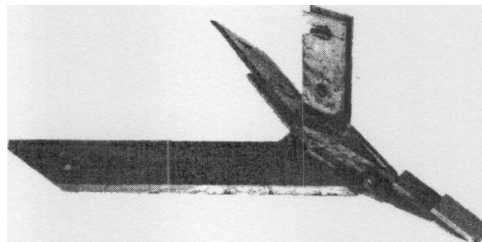
Results and discussion

Weed population. For the four-year period, weed populations were generally less in the wide-band herbicide treatment than in the narrow-band treatment. Few differences were observed due to cultivation style or speed. Weed population in the wide-band treatment was statistically different than the broadcast herbicide treatment only in the last year and only before cultivation and late in the season.

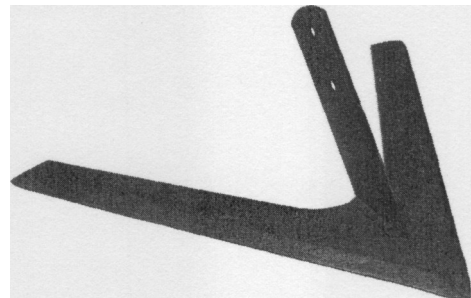
Visual weed ratings: Results varied from year to year, but findings support using a wide-band treatment rather than a narrow-band treatment, as well as using a low-profile sweep to reduce weed cover. In two of the four years, a faster cultivator speed also helped curb weed cover.

Ground cover: The percentage of ground cover was measured before and after cultivation. Overall, the ground cover did not often seem to be different when comparing cultivated with broadcast treatments. Cultivation generally reduced ground cover except in weedier plots. The wide-band treatment had less cover than the narrow-band treatment because there were fewer weeds. Cultivator treatments with good weed management had a range of 4 to 9 percent less ground cover after cultivation than the broadcast treatment after cultivation.

Disc hi Hers were added to a conventional sweep blade configuration in 1993.



The Smith fin is not currently used in Midwest corn production, but is used extensively in peanut farming.



Soil movement: The more soil that is thrown, the more likely that weeds in the crop row will be buried, but it also increases the likelihood that the crop will be covered by the soil. The data showed no significant effect of herbicide bandwidth on soil movement.

However, there were treatment differences for two years with cultivator speed and three years with cultivator style. In 1993 and 1996, the slow speed moved less soil than the fast speed. However, increasing speed had little effect as the fast treatment moved no more than 1.4 cm of soil into the row in any year compared with the slow treatment. The smith fin moved less soil than the other treatments in two of the four years. The general effects of cultivator style were not clear-cut, possibly because the shields played a major role in preventing soil from being thrown on top of the plants.

Grain yield and moisture: In 1993, the only comparable differences among cultivated treatments in grain moisture and yield were among cultivator styles. All cultivated treatments showed significantly less yield than the broadcast treatment yields, with the exception of the sweep cultivator with disc hillers. This led to using the disc hillers on all cultivators in the 1994 experiment. The faster speed treatment and the wide band treatment had significantly greater yields than their counterparts (slow speed and narrow banding) in 1994 and 1996, perhaps because of more effective weed control. The no-herbicide control plots yielded far less than all other treatments in 1994 through 1996.

Corn population: Narrow-band treatments generally had lower populations than wide-band treatments because the weeds inhibited corn germination. Control plots had a lower population the last three years. The wide-band treatment had a greater population than the narrow-band treatment before cultivation in three of the four years covered.

Extended leaf height: In 1993, the broadcast treatment grew much faster than several of the other treatments, probably due to less shading. In 1994, 1995, and 1996, plants in the wide-band treatments were taller than those; in nar-

row-band plots where weeds stunted plant growth. The trend in these data is that the difference in crop growth between the broadcast treatments and the other treatments seems to increase as the season progresses.

Soil moisture: There was no difference in soil moisture content among the three cultivator styles in 1993 and 1995. In 1994, before cultivation, a difference was noted between broadcast and point-and-share treatments. After cultivation, this difference was seen along with a difference in moisture between the broadcast and control treatments. With the exception of the late season measurement, the broadcast treatments were the wettest and the soil moisture generally declined throughout the season.

Conclusions

Overall, the study indicated that in 76-cm crop rows, wide-band herbicides (38-cm) combined with cultivators and disc hillers produce yields statistically equivalent to broadcasting of herbicides. A greater cultivation speed and use of either a sweep or smith fin with disc hillers and shields, along with application of a wide bandwidth of herbicide, should further minimize any yield penalty. Even with a slight yield reduction, profitability could be maintained due to lowered input costs. Other points brought out by the experiments include:

- 1) A faster cultivation speed does not seem to have a detrimental effect and would help farmers complete cultivation more quickly. The faster speed plots showed significantly greater yields than the slow speed treatments in the two years tested. Crop damage from the greater amount of soil thrown into the row can be decreased by use of shields on the cultivator.
- 2) For a single cultivation system, a 38-cm band had significantly greater yield than a 19-cm band. The narrow bandwidth resulted in lower yield in three of four years studied. In all four years, a significant difference was seen in the weed population after cultivation or late in the season.

- 3) In 1993, the sweep cultivation with disc hillers had greater yields. In 1994, all combinations used the disc hillers and yield data showed that the smith fin and sweep treatments had significantly higher yields than the point-and-share treatments.
- 4) A significant difference was seen between broadcasting and most of the cultivator styles in much of the data taken. This may be because the main effects of cultivator styles included both narrow- and wide-bandwidths. When disc hillers were used, a significant difference was seen between the broadcast and narrow bands, but not in most instances between the broadcast and wide bands. Ground cover was generally reduced 4 to 9 percent by cultivation as compared with broadcast herbicides, except for weedier treatments.

Implications

Data from this research in a high-residue system demonstrate that using a single cultivation and a 38-cm wide band of residual herbicide applied at planting is a successful management strategy that can foster a 50 percent reduction in herbicide use on 76-cm corn rows.

If a large acreage must be cultivated within a narrow time frame due to weather concerns or shortage of labor, a faster than normal operating speed (11.2 km/hr) can be used. Weed

management and grain yield are not harmed at this higher speed. More research is needed to see if even greater speeds can be used without detrimental effects.

Research on whether multiple cultivation schemes will work for soybean production is a good possibility. The slower-growing soybean plant in wide rows takes longer to shade potential interrow weed growth.

Education and outreach

Information from this project was initially presented at a 1995 grower field day on Ron Rosmann's farm near Harlan, Iowa. During the winter meeting season of 1995-96, project results were shown at ag expositions in Cedar Rapids, Omaha, and Mason City. High-speed, high-residue cultivation information was given to agribusiness professionals at the 1995 Integrated Crop Management Conference in Ames. Results were discussed at three in-service training sessions with 80 agricultural professionals from Extension, NRCS, and the farm press. In 1996, information was presented and cultivator sweeps demonstrated to 120 growers at the Southeast ISU Research Farm near Crawfordsville.

Fleischer Manufacturing, which provided a cultivator for use in the project, has asked permission to reprint 5000 copies of the ISU Extension bulletin detailing project findings.

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