

Effect of Tillage Timing on Herbicide Toxicity to Field Bindweed

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When can tillage be resumed after herbicide treatment of field bindweed (*Convolvulus arvensis* L.) without reducing control? This question was answered with experiments on a clay loam soil in the semi-arid southern Great Plains in mid-summertime of 1979, 1985, and 1986 when field bindweed vigor was visually rated as good, fair, or poor, respectively. Plant vigor was controlled by availability of soil water. Highest control, about 95%, of field bindweed 9 mo after application of 2,4-D, glyphosate, and dicamba was achieved when vigor was good. Control with picloram + 2,4-D was not affected by plant vigor. When field bindweed growth was rated as good, control with dicamba, glyphosate, and a mixture of 2,4-D and picloram was not reduced when sweep tillage was delayed for 1 day after treatment (DAT). To achieve maximum control with 2,4-D, tillage had to be delayed 7 DAT. When plant vigor was fair, control was not reduced with picloram + 2,4-D when tillage was delayed 2 DAT. Glyphosate and dicamba gave maximum control after 3 DAT delay, and 2,4-D required a 7 DAT delay for maximum effectiveness. With poor plant vigor, picloram + 2,4-D, a herbicide combination that persisted in the soil, gave best control when tillage was delayed 2 DAT. Dicamba, a less persistent herbicide, required a 7 DAT delay for maximum control. Control was not better than zero 9 mo after treatment with glyphosate or 2,4-D when plants had poor vigor.

FIELD BINDWEED is a creeping herbaceous perennial weed native to Europe and western Asia that was introduced to North America along the Atlantic seaboard about 1790 (Phillips, 1978). The weed has spread coast to coast and now primarily is a problem in wheat (*Triticum aestivum* L.) growing areas in the western USA and Canada.

Research in the 1940s and 1950s showed that sweep plowing at 2 to 3 wk intervals for 3 to 5 yr controlled large infestations of the weed by gradually reducing root reserves (Phillips and Timmons, 1954; Wiese and Rea, 1959). In the late 1940s it was demonstrated that 2,4-D was toxic to field bindweed (Phillips, 1950). In humid areas, the best time to apply 2,4-D was at plant budding. However, in arid regions like the southern Great Plains, where drought often limits plant growth, most consistent herbicidal control was obtained when field bindweed plants were 5 to 6 wk old, runners were 6 to 10 in., and plants were not stressed because of limited soil water (Wiese and Rea, 1962). Although 2,4-D killed field bindweed tops and some of the roots, repeated applications did not eliminate the weed (Phillips, 1961; Swan, 1982; Wiese and Lavake, 1986). This herbicide proved most effective when used in combination with tillage at 2 to 3 wk intervals during fallow periods

between crops that were competitive to field bindweed (Derscheid et al., 1970; Russ and Anderson, 1960; Stahlman, 1978; Schweizer et al., 1978; Wiese and Rea, 1959). Using 2,4-D along with tillage reduced management costs by decreasing number of tillages per year and number of years needed for control. Also, if rain delayed tillage, 2,4-D treatment of large field bindweed kept root reserves in check (Wiese and Rea, 1962). Recently dicamba, glyphosate, picloram, imazapyr, fluroxypyr, and mixtures of some of these herbicides have proven effective against 4 to 6 wk old field bindweed plants that had runners 6 to 10 in. long (Heering and Pepper, 1988; MacDonald et al., 1993; Schoenhals et al., 1990; Westra et al., 1992; Wiese et al., 1967).

Although the best stage to treat field bindweed with postemergence herbicides has been established, information on resuming tillage after herbicide treatment varies from no advice in most publications, to a 2 wk delay in another (Wiese et al., 1955), and until weeds reemerge in another (Wiese and Rea, 1962). In order to use postemergence herbicides effectively in a control program with 2 to 3 wk sweep plowings, a plowing must be skipped to let field bindweed grow enough to assure maximum herbicidal effectiveness. During this time, field bindweed and other weeds grow and use soil water needed for subsequent crops. Therefore, this research was conducted to determine how soon after herbicide treatment that sweep plowing could be resumed without reducing effectiveness of several herbicides that are used to control field bindweed.

MATERIALS AND METHODS

This study was conducted on Pullman clay loam (fine, mixed, mesic, Torric Paleustolls) having 1.7% organic matter and pH 7.7 near Amarillo, TX, in the southern Great Plains. The study area had not been cropped for several years, but had been sweep plowed three or four times annually to control annual weeds and encourage growth of field bindweed. Herbicides were applied, on 20 Aug. 1979, 30 July 1985, and 29 July 1986 to solid stands of field bindweed. Herbicide plots were sweep plowed at 0.17 (4 h), 1, 2, 3, or 7 DAT. Sweep plowing to sever all roots was 4 to 6 in. deep with an implement having three V shaped blades that were each 30 in. wide. The experimental area had been sweep plowed about 6 wk before herbicide application. All plots including the check were sweep plowed in the fall, about 6 wk after treatment, to kill all annual weeds and again the next April to control winter annual weeds.

Herbicide treatments were: butoxyethyl ester formulation of 2,4-D, (1.0 lb ai/acre); isopropyl amine salt of glyphosate, (3.0 lb ai/acre); dimethylamine salt of dicamba, (1.0 lb ai/acre); and potassium salt of picloram mixed with 2,4-D,

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(0.25 + 0.5 lb ai/acre). There also was an untreated and unplowed check. A tractor-mounted, compressed air plot sprayer was used to apply 30 gpa of spray mixture at 30 psi using fan tips.

Design for each of the experiments was a split plot with time of sweep plowing being main plots and herbicide treatments sub-plots. Individual herbicide plots were 10 by 10 ft and treatments were replicated three times.

Visual estimates of weed control (where 0 = no control—like the untreated check—and 100% = absence of weeds), were made the following May or June about 9 to 10 mo after treatment. This was before summer annual weeds competed with field bindweed. Percentage control data from all experiments were analyzed with ANOVA and mean differences were separated with LSD 0.05.

RESULTS AND DISCUSSION

The 3 yr of the experiment were typical of plant vigor conditions growers would face in attempting an integrated field bindweed control program using sweep plowing and herbicides. In this arid part of the southern Great Plains, plant vigor is controlled by availability of soil water. At the time herbicides were applied, plant vigor was rated visually according to overall appearance of foliage on a scale of excellent, good, fair, or poor. Excellent indicated lush growth; good, some growth; fair, a little growth but leaves not wilted; and poor, leaves wilted or drying up with no growth. Field bindweed plant vigor ratings and length of runners in 1979, 1985, and 1986 were: good/8 in.; fair/6 in.; and poor/7 in., respectively.

Glyphosate

Control of field bindweed 10 mo after treatment with glyphosate at 3 lb/acre was very much dependent upon both plant vigor at time of treatment and time of sweep tillage following treatment (Fig. 1). When field bindweed plant

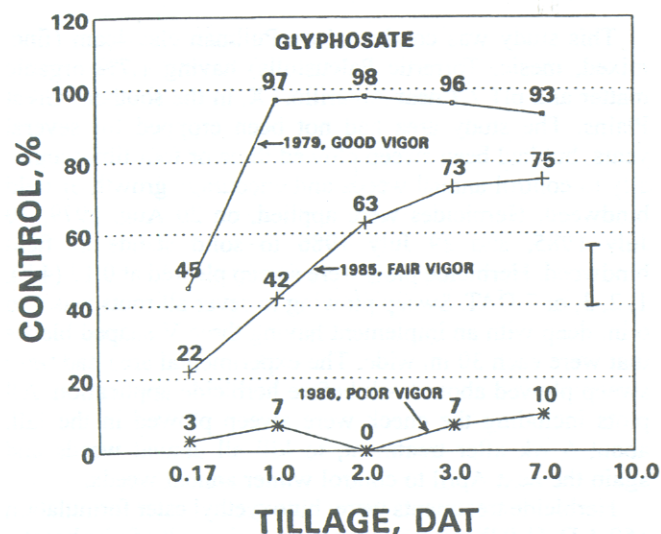


Fig. 1. Field bindweed control with glyphosate at 3 lb/acre when followed by sweep tillage at various times after treatment in 1979, 1985, and 1986 when plants had good, fair, or poor vigor, respectively. Bar indicates LSD 0.05, of 18%.

vigor was good in 1979, control was 93 to 97% if tillage was delayed to 1 DAT but only 43% if tillage was performed 4 h after treatment. With fair vigor in 1985, maximum control was about 75% and sweep tillage had to be delayed for at least 3 DAT or control was reduced. When vigor was poor and plants were not growing in 1986, control was not significantly greater than 0 regardless time of tillage after treatment.

2,4-D

Plant vigor also affected field bindweed control with 2,4-D at 1 lb/acre (Fig. 2). Maximum control was 96% when plants had good vigor in 1979, but tillage had to be delayed until 7 DAT. If tillage was performed 3 DAT, control was only 67%. When field bindweed plants had fair vigor in 1985, maximum control was 62% when tillage was delayed until 7 DAT. This was a reduction of over 30% compared with plants with good vigor. With poor vigor in 1986 there was no control unless tillage was delayed up to 7 DAT. Then control was only 17% almost to the 5% level of significance of 18%.

Dicamba

Field bindweed control with dicamba at 1 lb/acre was similar to that achieved with glyphosate and 2,4-D when plants had good or fair vigor (Fig. 3). With good vigor, maximum control was achieved if tillage occurred 1 DAT. When plants had fair vigor in 1985, highest control resulted when tillage was delayed to 3 DAT. Control was 17 to 30% when plants had poor vigor and tillage was delayed only to 3 DAT. Control increased to 53% when plowing was conducted 7 DAT.

Picloram + 2,4-D

Field bindweed vigor at spraying had very little effect on control with picloram + 2,4-D at 0.25+0.5 lb/acre (Fig. 4).

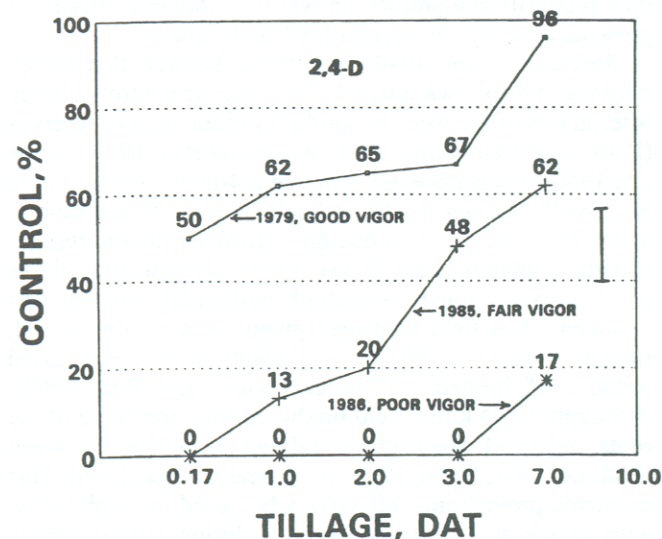


Fig. 2. Field bindweed control with 2,4-D at 1 lb/acre when followed by sweep tillage at various times after treatment in 1979, 1985, and 1986 when plants had good, fair, or poor vigor, respectively. Bar indicates LSD 0.05 of 18%.

Tillage did not affect control if delayed for at least 2 DAT. When tillage was delayed for 2 DAT, control varied from 80 to 97% regardless of year or plant vigor. When vigor was rated poor, tillage did not affect control.

DISCUSSION

These experiments reiterate that a high level of control with 2,4-D, glyphosate, and dicamba will be achieved only when field bindweed growth is vigorous (Schoenhals et al., 1990; Wiese and Lavake, 1986). Spraying these herbicides when field bindweed growth is slow or stopped from lack of soil water only will result in top kill of foliage. On the other hand, spraying the three herbicides to vigorously growing

field bindweed killed all roots in the top 17 in. of soil (Wiese and Rea, 1962). Field excavations indicated that the top 17 in. of soil contains 50% or more of field bindweed's total root weight (data not shown). Consequently, in an integrated control program, sweep plowing is the best alternative when soil is dry and plant vigor is poor during spring and summer. This generalization does not hold in late fall because treatment with dicamba has given excellent control regardless of plant vigor when applied in late fall (Wiese and Lavake, 1986). Picloram, also has given excellent control in the fall regardless of plant vigor because at least part of the control was the result of persistence in the soil (Schoenhals et al., 1990).

Results of this study indicate that maximum control, which is determined by field bindweed vigor, will be achieved if sweep tillage is delayed until 7 DAT with herbicides. When field bindweed has adequate soil water to promote good or fair vigor, control will not be decreased when sweep plowing is delayed for 3 DAT with all herbicides except 2,4-D. Delaying plowing for 3 to 7 DAT, rather than for 2 wk or longer, will conserve soil water by reducing residence time for field bindweed and other weeds. The extra soil water may increase subsequent crop yields and, as a result, would decrease cost of control.

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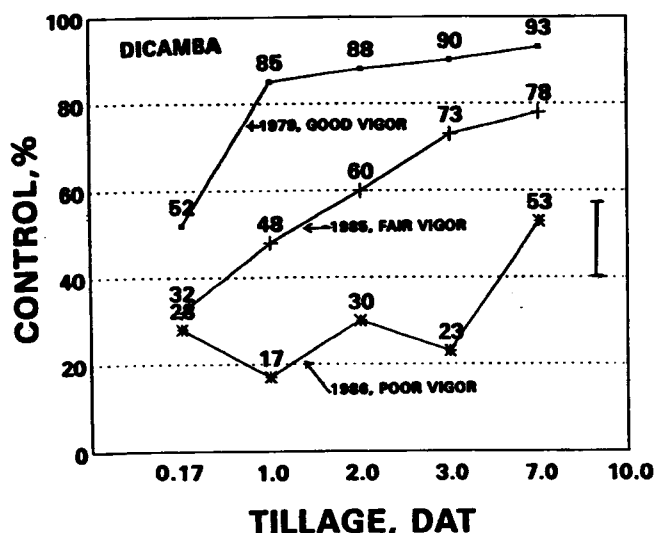


Fig. 3. Field bindweed control with dicamba at 1 lb/acre when followed by sweep tillage at various times after treatment in 1979, 1985, and 1986 when plants had good, fair, and poor vigor, respectively. Bar indicates LSD 0.05 of 18%.

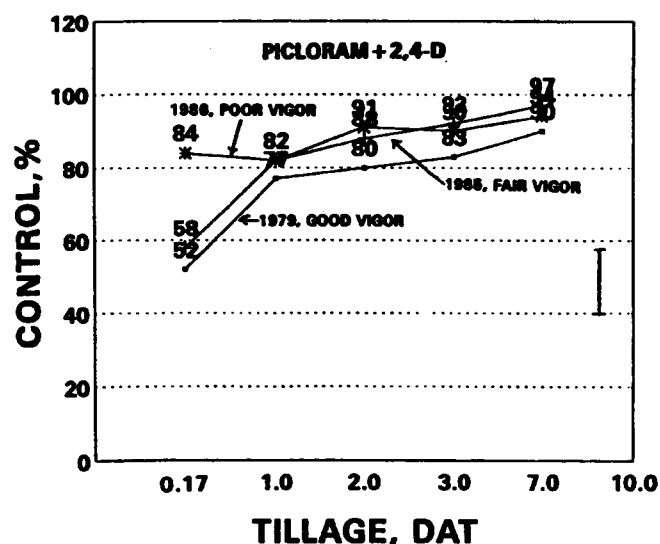


Fig. 4. Field bindweed control following picloram+2,4-D at 0.25+0.5 lb/acre when followed by sweep tillage at various times after treatment in 1979, 1985, and 1986 when plants had good, fair, or poor vigor, respectively. Bar indicates LSD 0.05 of 18%.