Downy Brome (*Bromus tectorum*) Emergence Variability in a Semiarid Region[1]

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Abstract. This study characterized seedling emergence of downy brome from August to early December over a 6-yr period. Seedlings were counted weekly in quadrats established in winter wheat stubble at Akron, CO. Seedling emergence varied among years, which was caused by erratic seasonal precipitation. Producers delay planting of winter wheat to reduce downy brome density in the crop, but in only 1 yr out of 6 would producers have benefited from this control strategy. Furthermore, delayed planting has negative crop consequences: less grain yield and more susceptibility to plant diseases and wind erosion because of less fall plant growth. Because fall precipitation is erratic in the semiarid Great Plains, other control strategies, such as nitrogen placement and increased seeding rates of winter wheat, would be more effective for downy brome management, yet not detrimental to winter wheat production. **Nomenclature:** Downy brome, *Bromus tectorum* L., #[3] BROTE; winter wheat, *Triticum aestivum* L.
Additional index words: Cultural practices, decision risk, outcome prediction, BROTE.

INTRODUCTION

In the western United States, downy brome remains a difficult-to-control weed, especially in winter wheat-fallow rotations (13, 22). Presently, no herbicides are registered that control downy brome economically or consistently in winter wheat (17, 24). Thus, producers rely on cultural practices to minimize downy brome interference and grain yield losses (3, 22).

One cultural practice is nitrogen (N)[4] fertilizer management. For example, banding N fertilizer with winter wheat seed reduced downy brome density 29% and biomass 50% while increasing winter wheat grain yield 32% compared with broadcasting N at planting (15). Also, applying N fertilizer 4 mo before planting reduced downy brome biomass in winter wheat 45% compared to broadcasting N during the crop season (2).

Enhancing the rate of winter wheat canopy development by increasing seeding rates and using narrow row spacing increases wheat yields in brome-infested fields (11, 12, 19). Winter wheat cultivars also differ in their competitiveness with downy brome. Taller wheat cultivars tolerate downy brome interference with less yield loss (5), and reduce downy brome seed production (3), thus reducing weed densities in future wheat crops.

Delayed planting of winter wheat is also used for downy brome management. This practice allows more downy brome to germinate before planting winter wheat, if precipitation occurs within this period. Seedlings that emerge are then controlled by tillage or non-selective herbicides (14, 22). This practice, when successful, increases grain yields (22). However, planting winter wheat outside of its optimum period has detrimental aspects. In the semiarid regions of the U.S., grain yield is reduced 4 to 8% for each week delay after the optimum period (16). In Oklahoma, delaying wheat planting by 4 wk to control brome species resulted in severe economic penalties (10).

Success of the delay-of-planting strategy is related to the critical period of downy brome interference in winter wheat, which is only 3 wk (4, 20). Downy brome that emerges more than 3 wk after winter wheat emergence usually does not affect grain yield. Downy brome emergence is correlated with precipitation (1), and because rainfall in the semiarid Great Plains is extremely erratic (8), it is possible that downy brome may not emerge within this 3-wk interference window. If emergence does not occur, producers would incur an economic cost (reduced grain yield) without accruing a weed control benefit.

Decision aid models have been developed to guide management decisions in weed control systems (21, 25). If downy brome emergence data were available, these models could be parametized to predict what effect cultural

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[3]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Revised 1989. Available from WSSA, 1508 West University Ave., Champaign, IL 61281-3133.

[4]Abbreviations: N, nitrogen.

practices, such as delay of planting, would have on grain yield.

Therefore, this study characterized the variability of downy brome emergence between August 1 and December 5 over a 6-yr period in the semiarid Great Plains.

MATERIALS AND METHODS

Site description. The study was conducted at Akron, CO, on a Weld silt loam (fine, montmorillonitic, mesic Aridic Paleustoll) with 1.2% organic matter and a pH of 6.9. The long-term (88-yr) average weekly precipitation from August 1 to December 5 ranges from 3 to 16 mm, with the first 3 wk in August receiving the highest precipitation. Average precipitation for the measurement period is 126 mm. Average daily air temperature decreases from 23 C in early August to 0 C in early December, at a rate of approximately 1.5 C per week.

Study procedures. In 1988 and 1990 to 1994, six 1-m^2 quadrats were established in winter wheat stubble of a reduced-till winter wheat-fallow production system. Weeds were controlled during the fall after wheat harvest with atrazine [6-chloro-*N*-ethyl-*N'*-(1-methylethyl)-1,3,5-triazine-2,4-diamine], and controlled during the following summer as needed by sweep plowing[5] three or four times. The last tillage was in late July. Winter wheat was planted adjacent to the study sites, but not in the quadrats nor did the drill pass through the study area.

Seedling emergence was recorded weekly, starting on August 1 and continued until December 5. After counting, all downy brome seedlings were pulled and removed. Total seedlings per year ranged from 43 to 582/m^2, averaging approximately 170 seedlings/m^2 per year. The source of weed seeds was the indigenous soil seedbank plus downy brome seeds (200 viable seeds/m^2) applied to the soil surface by hand and incorporated by sweep plow tillage in late July. The lack of winter wheat seedlings within the quadrats would not affect downy brome emergence, especially during the 3-wk interference window, as canopy development during this period would be less than 2% ground cover.

An emergence pattern was developed for each year by converting seedling emergence per week into a percentage of total emergence between August 1 and December 5 for all replications. Data from the 6 yr were then averaged by weekly intervals, with one standard deviation derived from yearly averages for each week.

[5]The sweep plow consists of V-shaped blades that sever weed roots with minimum soil disturbance.

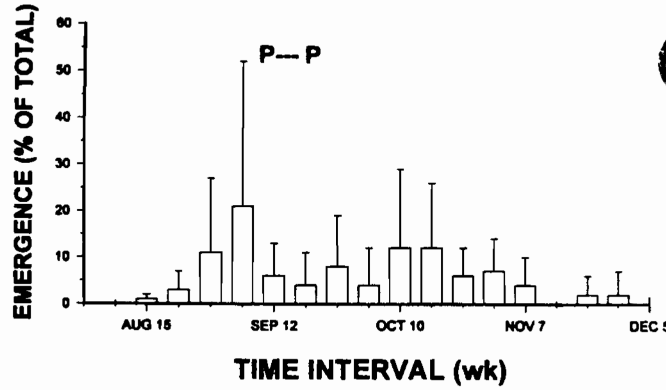

Figure 1. Downy brome emergence, averaged over six years. The symbol, P—P, indicates the optimum planting dates, September 10 to 25, for winter wheat in northeastern Colorado. Vertical lines represent one standard deviation of weekly means.

RESULTS AND DISCUSSION

Downy brome emergence characteristics. When evaluating downy brome emergence over the duration of the study, seedlings emerged in every week between August 15 and December 5 (Figure 1). The greatest emergence occurred between late August and late October. However, emergence within individual years was erratic (Figure 2, 3, and 4). For example, in 1988, downy brome emerged between August 15 and October 17, whereas in 1990, downy brome emerged between October 10 and December

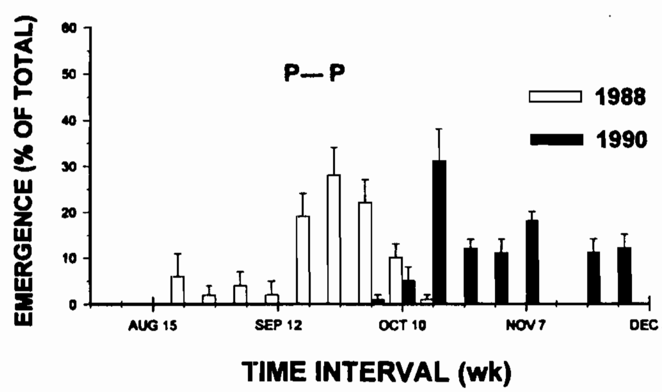

Figure 2. Downy brome emergence during 1988 and 1990. The symbol, P—P, indicates the optimum planting dates, September 10 to 25, for winter wheat in northeastern Colorado. Vertical lines represent one standard deviation of weekly means.

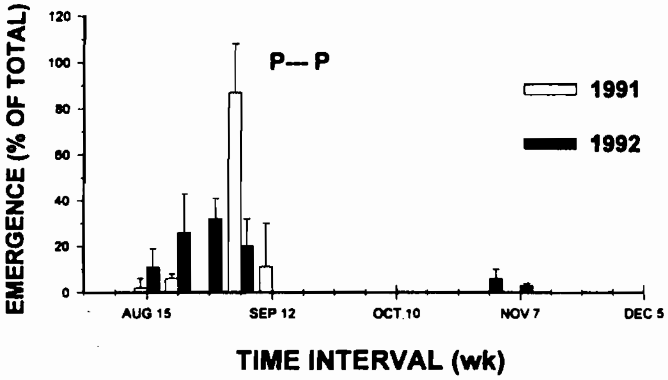

Figure 3. Downy brome emergence during 1991 and 1992. The symbol, P—P, indicates the optimum planting dates, September 10 to 25, for winter wheat in northeastern Colorado. Vertical lines represent one standard deviation of weekly means.

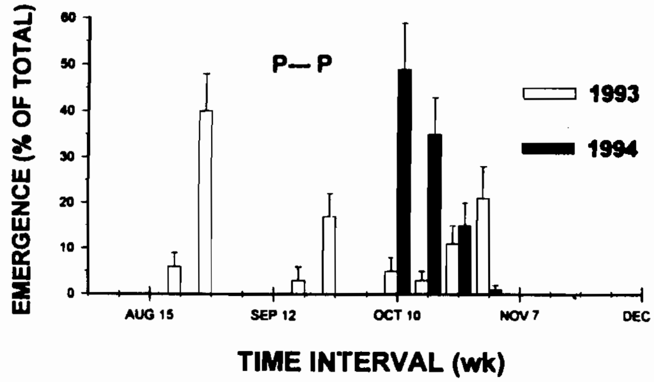

Figure 4. Downy brome emergence during 1993 and 1994. The symbol, P—P, indicates the optimum planting dates, September 10 to 25, for winter wheat in northeastern Colorado. Vertical lines represent one standard deviation of weekly means.

5 (Figure 2). In 1991, 1992, and 1994, downy brome emerged mainly within a 3- to 4-wk period, but in 1993, emergence occurred over 15 wk (Figures 3 and 4).

The drastic difference in emergence among years was caused by erratic precipitation. Average precipitation over the 6 yr was similar to the long-term average for this location (data not shown), but extreme variation occurred among years (note the standard deviations in Figure 5). As an example, for the 7 d before August 29, precipitation ranged from 0 to 70 mm and averaged 15 mm. In 3 yr, no precipitation occurred during this 7-d period, whereas in the other 3 yr, the amount of precipitation recorded was 5, 15, and 70 mm. This inconsistency in precipitation among years also occurred with other weekly intervals, which is characteristic of precipitation in semiarid regions (8).

The optimum planting date for winter wheat is between September 10 to 25 for northeastern Colorado[6]. Effectiveness of delayed planting as a control strategy is related to downy brome emergence within the 3-wk interference period (4, 20). Therefore, as an example, if a producer delayed planting 3 wk after a target date of September 19, downy brome emergence would have occurred during this 3-wk interference window only in 1988 and 1993. In 1988, 60% of downy brome seedlings emerged between September 19 and October 10, with no seedlings emerging after this date (Figure 2). Thus, producers would have eliminated downy brome in their crop.

In 1993, however, only 20% of the season's emergence occurred within this time period, followed by 40% of seasonal seedling emergence between Oct 10 and Oct 31 (Figure 4). Because a significant number of downy brome seedlings would have emerged within 3 wk after the delayed planting date in 1993, no weed control benefit would have resulted. Our data indicate that producers would have benefited from this control strategy only 1 yr out of 6.

Management implications. Producers select weed management strategies based not only on effectiveness of control (26), but also on the potential risk of choosing the wrong strategy (9). Thus, producers need knowledge that enables them to predict possible outcomes among several alternatives (18). If the delay-of-planting strategy is considered as a management option, producers need to compare economic cost of late planting versus effectiveness in controlling downy brome.

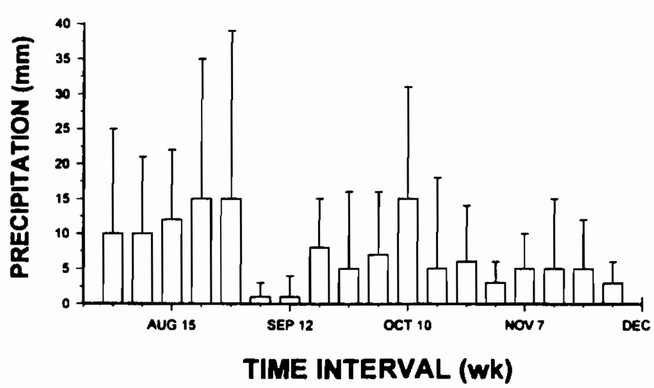

Figure 5. Average weekly precipitation (bars) and one standard deviation (vertical lines) during the 6-yr study at Akron, CO.

[6]Quick, J. S. 1994. Personal Communications. Winter Wheat Breeder, Colorado State Univ. Fort Collins, CO, 80523.

Based on our results, delayed planting is only partially effective, being successful 17% of the time. Other control tactics are not only more effective, but also are more consistent. With N fertilizer placement, producers will consistently favor wheat over downy brome (2, 3, 15). Increasing seeding rate of wheat will favor wheat over downy brome > 75% of the time (7, 11, 12). Another strategy, planting winter wheat in narrow row spacing (15 cm versus 30 cm), has been effective approximately 60% of the time (11, 12, 19). Furthermore, combining N placement (fallow application) and increased seeding rate with tall wheat cultivars has consistently reduced downy brome growth in wheat over several years (3).

Compared with other cultural strategies, delaying winter wheat planting is the least favorable strategy to consistently control downy brome. In addition, delayed planting has several detrimental consequences for producers. First, grain yields are reduced, thus leading to economic loss (7, 16). Secondly, late-planted winter wheat develops a less dense canopy, leading to increased weeds in winter wheat and in future summer annual crops, if producers are cropping more intensively than wheat-fallow (23). Thirdly, by planting winter wheat outside of its optimum planting range, it is more susceptible to other pests such as plant diseases (6).

The impact of delayed winter wheat planting on downy brome management is minor when compared to the economic and weed population dynamics penalties. If precipitation occurs within the target planting period, delaying planting will be effective. Because producers plant over several days, they could plant their infested fields later, thus increasing the opportunity for precipitation to occur. However, as a planned strategy, producers will accrue more consistent weed control benefit with other cultural strategies (3, 11, 15, 22).

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