Reprinted from AGRONOMY JOURNAL
Vol. 68, Nov.-Dec. 1976, p. 952-955

Downy Brome Control in Dryland Winter Wheat with Stubble-mulch Fallow and Seeding Management[1]

T. W. Massee[2]

ABSTRACT

Differences in downy brome (*Bromus tectorum* L.) control had been observed under field conditions of eastern Idaho when dates of stubble-mulch tillage, final rod weeding, and winter wheat (*Triticum aestivum* L.) planting were varied. This field-plot experiment on Tetonia silt loam (Pachic Cryoboroll-coarse, silty, mixed) tested the degree of downy brome control obtained with three initial stubble-mulch tillage dates, two final rod weeding dates, and three winter wheat planting dates.

Downy brome was best controlled with a combination of initial tilling early in the spring and a final rod weeding just before the late (15 September) wheat planting date. The early tillage killed downy brome before they produced seed. This also resulted in sufficient soil moisture retention in the seed zone for fall germination of other downy brome seeds, which were then killed by the final rod weeding just before the late wheat planting.

A reduction in natural downy brome emergence was observed at later fall dates. This was confirmed in a separate field-plot experiment (Portneuf silt loam, Xerollic Calciorthid, coarse, silty, mixed) where downy brome seed was planted at several dates, and helped explain some of the benefits of the mentioned late rod weeding and planting treatment.

These procedures incorporating stubble-mulch fallow are recommended, as normally practiced moldboard plowing creates an erosion hazard.

Additional index words: **Cheatgrass, *Bromus tectorum* L., Stubble-mulch fallow, Summerfallow, Soil moisture.**

THE use of stubble-mulch fallow for erosion control, the increased use of nitrogen fertilizers, and the use of herbicides that control broadleaf weeds, have intensified the downy brome (*Bromus tectorum* L.) weed problem (4, 5). In a winter wheat (*Triticum aestivum* L.) and fallow rotation, downy brome may be controlled by plowing (1, 4, 5). Plowing buries the seed of this winter annual well below its normal emergence limit of about 6 cm (2), where it may be expected to germinate and die within a year (2, 3). Chemical control of downy brome in wheat is still in the developmental stage (5).

This study with the stubble-mulch fallow system was made: 1) to determine the degree of control that could be achieved with various dates of initial tillage, subsequent rod weeding, and seeding of winter wheat, and 2) to determine the effects of tillage and seeding date on growth and production of wheat.

METHODS AND MATERIALS

Experiment 1 was conducted on field plots at the Univ. of Idaho Tetonia Research and Extension Center in the southeastern Idaho dryland area. The site was on relatively productive Tetonia silt loam (Pachic Cryoboroll, coarse, silty, mixed) where downy brome infestations had been slight to moderate—depending on the year. A factorial design was used with treatments of three dates for initial sweep tillage times two dates for final rod weeding for main plots (10.1 m wide and 37.5 m long) which were split for three seeding dates. Treatments were completely randomized and replicated three times. The three dates for the initial sweep-type stubble-mulch tillage treatment (at a 12-cm depth) were based on soil moisture content: a) early—when the moisture percent by weight (P_w) at the 7.5 to 15-cm

[1] Contribution from the Western Region, ARS, USDA; Univ. of Idaho College of Agric. Res. and Ext. Cent. cooperating. Received 2 January 1976.

[2] Soil scientist, Snake River Conservation Res. Cent. Kimberly, ID 83341.

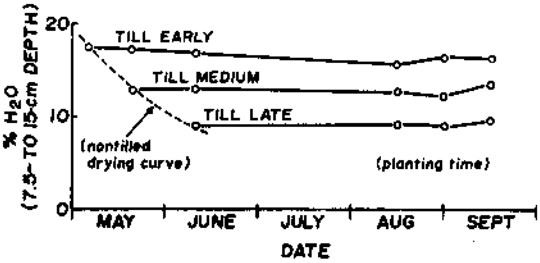

Fig. 1. Effect of initial spring stubble-mulch fallow tillage on subsequent soil moisture content through planting time.

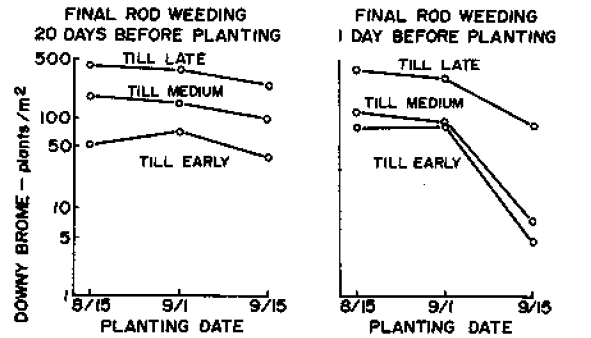

Fig. 2. Average (2-year) downy brome populations in wheat from initial stubble-mulch tillage date, rod weeding date, and planting date.

soil depth had decreased from winter conditions to 17.4%, or just sufficiently to allow suitable tillage; b) medium—when P_w had decreased to 12.9% (near −3 bars), about 2 weeks after the early treatment; and c) late—when P_w was 9.0% (near −15 bars) about 5 weeks after the early treatment. The dates for final rod weeding were either 1 or 20 days before seeding on 15 August, 1 September, or 15 September. 'Itana' wheat was used. Two sets of plots were maintained so that each year one set was in crop while the other was in fallow. Experimental data were gathered from 2 crop and 2 fallow years.

For Field Experiment 2, 100 seeds of either downy brome, or wheat, or a mixture of 100 of each, were handplanted 3 cm deep on Portneuf silt loam (Xerollic Calciorthid, coarse, silty, mixed) fallow land near Twin Falls, Idaho, to determine the effect of three planting dates (20 September, 3 October, and 19 October) on emergence. The plot size was 0.31 m². This gave each seed (and mixture of the two seeds) 31 cm² of space. Downy brome seed 3 months old, was considered to be past the dormancy period (2, 7), and had a germination of 68%. Nearly 100% of the wheat germinated. To ensure good seedbed moisture conditions, the plots were covered with burlap bags and sprinkle irrigated. Treatments were replicated three times in a randomized block design.

Experiment 3 was a growth-chamber test to determine at which temperatures downy brome and wheat emerged. Soil, seed source, handplanting, and the planting densities were the same as in Exp. 2, but in 3-liter pots. A 1.2-cm layer of vermiculite was applied to the soil surface to suppress evaporation. A small straight tube was installed vertically in the center of each pot for daily watering. It extended from the pot bottom to just above the vermiculite surface. Distilled irrigation water that was added to the exposed tube opening ran directly into the soil through the bottom of the tube and through perforations drilled in the lower side of the tube. Enough water was added to replace the daily weight loss, which brought the soil moisture content to the original one-third bar suction. Visual inspections showed that the soil was kept moist on its surface. Sixteen hours of artificial light with intensity of 500 to 600-μeinsteins/m² sec within the 400 to 700-nm range and with 8 hours of dark were used in all cases. Chamber light:dark temperature ratios (shown in Fig. 6) were representative of maximum: minimum fall temperatures recorded at the Tetonia Station during the period of Exp. 1. The pots were maintained for several weeks after any recorded emergence, and then discarded. Three replications were used.

RESULTS AND DISCUSSION

Experiment 1. Field Plots

Early and medium initial sweep tillage operations removed any young downy brome plants growing in the stubble. The late sweep tillage (on 18 June the 1st experimental year and on 12 June the 2nd) was so late that the downy brome plants had already reached anthesis to soft-dough stage and had a well-developed and dense upper root system that was similar to but not quite as intensive as an established lawn sod. The root mass was not broken up enough by the tillage to cause immediate desiccation, and plants were able to produce mature seed. This occurs commonly on farm fields with downy brome in this area, and is indicative of the weed's drought tolerance. Seed production on these late-tilled plots occurred each year, in comparison to only during the crop year on plots tilled earlier.

Soil moisture at the 7.5 to 15.0-cm depth remained nearly the same after tillage for the remainder of the summerfallow season (Fig. 1). The moisture differences associated with time of tillage plus the downy brome seed produced on fallow with the late-sweep treatment both became important secondary variables in the summerfallow year, and their effects persisted after planting wheat. There were large differences in number of downy brome plants found in the growing wheat crop (Fig. 2). Generally, early initial stubble-mulch tilling, seeding wheat late, and performing a final rod weeding immediately before planting, all helped to control downy brome. Using a combination of all these treatments resulted in only four downy brome plants/m². In comparison, late initial sweep tillage and early seeding without the final (1-day) rod weeding was the least effective combination, with an average of 389 downy brome plants/m².

Rod weeding 1 day before planting, as compared to 20 days, gave no benefit for either the early or medium (15 August and 1 September) plantings. And for a different reason, none of the late-tilled (drier) plots were benefitted by the 1-day rod weeding (Fig. 2). These results suggested that two respective circumstances were being expressed: a) the downy brome had not germinated by the earlier wheat planting dates and so it was not possible to obtain control by rod weeding then, and b) inadequate soil moisture delayed downy brome germination on the late-till plots until after even the latest (15 September) planting date and so the downy brome there escaped being killed by rod weeding. Field observations on time of downy brome emergence helped to confirm this. The earliest downy brome emergence was during the 2nd and 3rd weeks in September on plots with high seedbed moisture. However, emergence was delayed until October on the drier late-tilled plots, which coincided with when fall rains wetted the seed zone.

Wheat yields and downy brome populations were related (r = −0.85) as shown in Fig. 3. The linear regression line indicated about a 1% yield reduction for each 4.25 downy brome plants/m². The data

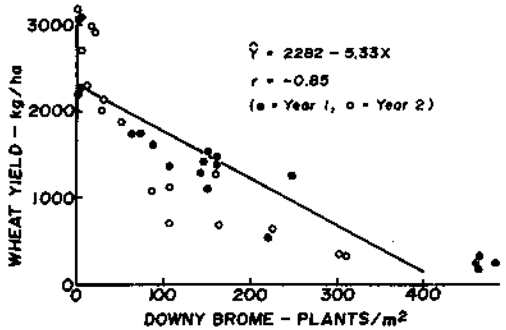

Fig. 3. Relationship between downy brome plants in growing wheat and wheat yield.

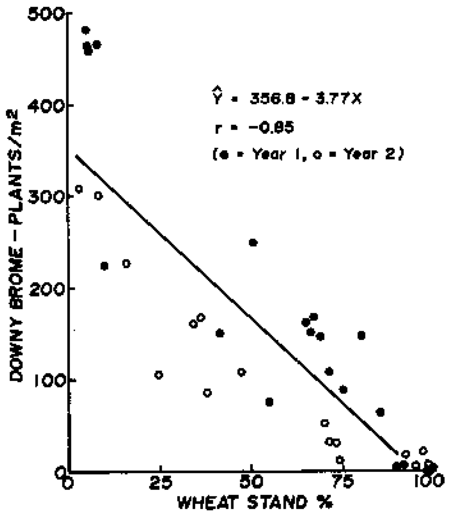

Fig. 4. Relationship between wheat stand and intensity of downy brome plants in the growing wheat. This relationship resulted primarily from differences in tillage treatments and planting dates, rather than from fall seedling competition between winter wheat and downy brome.

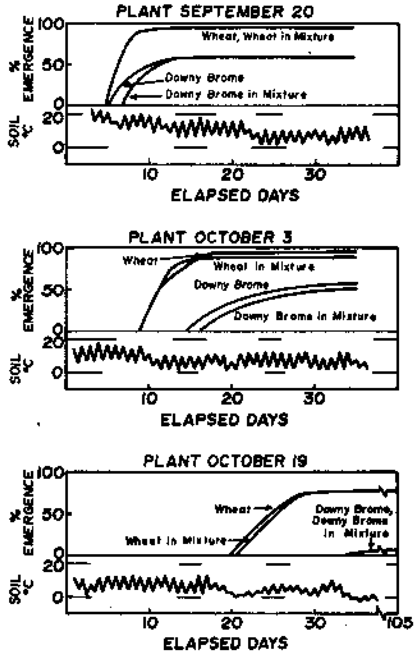

Fig. 5. Accumulative emergence of wheat and downy brome when planted separately or together. Soil temperatures are for the 10-cm depth.

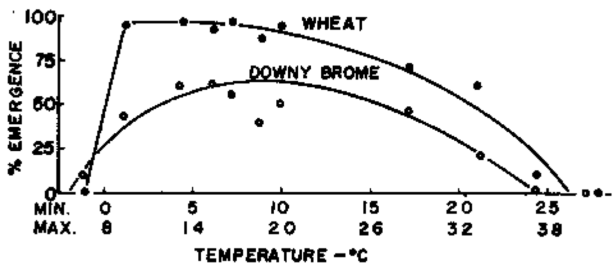

Fig. 6. Growth-chamber emergence of wheat and downy brome, indicating similar comparative responses to temperature.

points in this figure tend to form some curvature (concave upward). This may have resulted from downy brome plants, in dense populations, becoming restricted by competition with each other, causing the effect per downy brome plant on the wheat yield to be less. Wheat yields were also likely to be influenced by wheat stand, soil moisture available to wheat seedlings, and other factors. This yield reduction was silimar to that observed on Washington dryland where wheat yield was reduced about 1% for each 5.3 downy brome plants/m² (6). A 35% yield reduction was common in both studies where downy brome control was poor. The wheat yield-downy brome population relationship in this study is not a direct cause-and-effect type of relationship. That is, dry field conditions contributed to large downy brome populations because weed control was lost and stands of winter wheat were poor. Thus, downy brome population and wheat stand were indirectly related (Fig. 4). Probably downy brome and wheat became competitive only after emergence and initial growth, as is typical of plant competition.

Experiment 2. Small Plot Test with Planted Downy Brome and Wheat

Field observations, together with the data in Fig. 2, suggested the possibility of a natural decline in germination of viable downy brome seed by 15 September, even with adequate soil moisture. Plantings in Exp. 2 showed clearly that there was reduced germination at later dates of October, while wheat emergence remained good (Fig. 5). Sometimes downy brome emergence was slightly delayed when planted with wheat, but wheat emergence was not delayed when planted with downy brome (Fig. 5). Combined results from Exp. 1 and 2 show that early stubble-mulch tillage to retain seedbed moisture plus planting late with rod weeding done just before seeding effectively controlled downy brome for three reasons: a) downy brome growing in stubble was not allowed to reseed; b) fallow seedbed conditions were favorable for early downy brome seed germination and so it was killed by fallow tillage; and c) there was a decline in downy brome germination at later dates.

Experiment 3. Growth Chamber Plantings of Downy Brome and Wheat

Emergence of both wheat and downy brome was poor at day and night (light and dark) temperatures that were above 32 C and 20 C, respectively (Fig. 6). No attempt was made to identify whether the day, night, or combination of temperatures limited emergence. The temperature regimes that were used were representative of field conditions. A day temperature of about 32 C was a limiting factor with mature seed in Montana where varying night temperatures were used (2). In Exp. 3, emergence for both wheat and downy brome was near maximum below this limiting temperature regime until below-freezing nighttime temperatures (—1 C) were reached. At this —1 C nighttime temperature, no wheat but 10% of the downy brome emerged. This ability of downy brome to emerge at lower temperatures than wheat was not expected, i.e., after observing the reverse situation for late fall (with lower temperatures) in Exp. 2. It can be concluded that, in Exp. 2, the decrease in downy brome emergence while there was good wheat emergence was regulated in the field by additional environmental mechanisms and interactions. Thus, while quite exceptional downy brome control may be achieved in the intermountain area with simple management practices, as summarized above for Exp. 2, using these practices in other areas undoubtedly will require adjustments for local climatic regimes.

LITERATURE CITED

1. Fenster, C. R., and T. M. McCalla. 1970. Tillage practices in western Nebraska with a wheat fallow rotation. Nebr. Agric. Exp. Stn. Bull. 507. 20 p.
2. Hulbert, L. C. 1955. Ecological studies of *Bromus tectorum* and other annual bromegrasses. Ecol. Monogr. 25:181-183.
3. Klemmedson, James O., and Justin G. Smith. 1964. Cheatgrass (*Bromus tectorum* L.). Bot. Rev. April-June. p. 226-262.
4. Rydrych, D. J. 1970. Chemical controls for cheatgrass in wheat. Oreg. Agric. Exp. Stn., Oregon's Agric. Prog. 17:3, 16.
5. ———. 1974. Winter wheat as influenced by minimum tillage, chemical fallow, and weed competition. Annu. Oreg. Weed Conf. 23:18-20.
6. ———, and T. J. Muzik. 1968. Downy brome competition and control in dryland wheat. Agron. J. 60:279-280.
7. Steinbauer, G. P., and Buford H. Grigsby. 1957. Field and laboratory studies on the dormancy and germination of the seeds of chess (*Bromus secalinus* L.) and downy bromegrass (*Bromus tectorum* L.). Weeds 5:1-4.