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Seedbed and seeder options for old world bluestem establishment

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Abstract

Seedbeds of graze-out wheatland and herbicide-killed wheat (*Triticum aestivum* L.) were evaluated as were use of a grass drill and the Woodward chaffy grass seeder for Old World bluestem (*Bothriochloa ischaemum* (L.) Keng) establishment. Seedings were made in 3 consecutive years in western Oklahoma. Steer grazing days on the seedbed treatments, seedling establishment, and second year grass herbage production were measured. Adequate stands were established in either seedbed. Economics favor the graze-out wheat seedbed treatment which produced an average of 189 steer grazing days ha^{-1} $year^{-1}$. Adequate stands were established with either the grass drill or the Woodward seeder. Denser stands were usually established with the Woodward seeder—this was unexpected since it is a broadcast seeder. Results with the Woodward seeder are attributed to a requirement for very shallow planting of Old World bluestem and the protected environment of wheat drill furrows and wheat residue. Seedbeds of graze-out wheatland are recommended for Old World bluestem establishment in the Southern Plains.

Key Words: grass planting, chaffy-seeded grasses, warm-season grasses, graze-out wheat, *Bothriochloa ischaemum*.

Warm-season grasses have traditionally been established in the Southern Plains by drilling into sorghum (*Sorghum bicolor* (L.)Moench) stubble(Savage 1939). Disadvantages of this methodology are that no return is realized from the land the year of grass establishment, and that many farms are now equipped for wheat (*Triticum aestivum* L.) rather than sorghum production.

A new seeding technique used by some farmers to establish Old World bluestems (*Bothriochloa ischaemum* (L.) Keng) is drilling in the spring directly into wheat being used for spring pasture (graze-out wheat). The grazed wheatland offers a firm seedbed, while the graze-out wheat provides income and some site protection the year grass is seeded. Although usually successful, this technique has been faulted for depleting soil water at the time water is needed for grass seed germination and growth (Rollins and Ahring 1987). Also, stand establishment has not been sufficiently documented for this technique to be appraised as an acceptable practice by conservation agencies. A seeding alternative used by some producers is to plant grass into wheat residue after wheat has been grazed until early spring and then wheat regrowth killed with a herbicide.

Old World bluestem is the major grass established for introduced pastures in western Oklahoma and adjacent areas in Texas. It is a warm-season grass with chaffy seed. Such seed requires special grass drills to meter and place the seed at shallow depths (Wiedemann et al. 1979). A lower-cost simplified grass seeder, the Woodward chaffy grass seeder, has been recently developed. It is a broadcast seeder that feeds chaffy seed through holes in a rotating drum (Berg et al. 1992).

The objectives of this study were to evaluate 2 seedbed treatments; 1) graze-out wheat, 2) herbicide-killed wheat, and 2 seeders; 1) grass drill, 2) Woodward chaffy grass seeder for Old World bluestem establishment.

Methods

This field study was conducted over 4 growing seasons at the USDA-ARS Southern Plains Range Research Station near Woodward in northwestern Oklahoma. To include year-to-year weather variability in seedling establishment, separate sets of plots were established in 1991, 1992, and 1993 on Hardeman sandy loam (coarse loamy, mixed, thermic Typic Ustochrepts) that had been cultivated about 90 years since the native mixed grass prairie was plowed. The land was cropped annually to sorghum or wheat and was in wheat 3 years prior to study establishment. The soil tested adequate in P (29 to 44 mg P kg^{-1}, Mehlich 3 extraction) and K (185 to 215 mg K kg^{-1}, Mehlich 3 extraction). Nitrate N tested low (9 to 12 mg N kg^{-1}, calcium sulfate extraction, Hanlon and Johnson 1983).

Wheat was drilled in October in 3 to 7 ha fields. No fertilizer N was applied to the wheat prior to grass seeding in 1991 because of drought conditions. In 1992 and 1993, 70 kg N ha^{-1} as ammonium nitrate was broadcast on the wheat in February.

Wheat herbage on the whole field including study areas was heavily grazed to a 2- to 4-cm stubble by 300-kg steers in late winter or early spring (Table 1). The following treatments were then established on each of 5 replications in a randomized-complete-block design:

1. graze-out wheat–grass drill
2. graze-out wheat–Woodward chaffy grass seeder

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3. herbicide-killed wheat–grass drill
4. herbicide-killed wheat–Woodward chaffy grass seeder

About 1 week after termination of the early grazing, glyphosate [N-(phosophonomethyl)glycine] was sprayed at the rate of 0.5 kg a.i. ha^{-1} to kill wheat on the herbicide treatment. 'WW-Ironmaster' Old World bluestem was then seeded at 1.7 kg pure live seed ha^{-1} with a grass drill (Tye Company, Lockney, Tex.) or with a Woodward chaffy grass seeder (Ag Renewal Inc., Weatherford, Okla.). Seeding into the firm seedbed was in rows at a right angle to the wheat rows. The grass drill had a row spacing of 25 cm and was equipped with double disc openers, 1.6-cm depth bands and press wheels. The Woodward seeder had a row spacing of 25 cm between rows of holes encircling the drum. A 2-kg drag chain was pulled behind the drum in line with each row of holes. Plot width was 10 m for the grass drill and 11 m for the Woodward seeder. Plot length was 60 m.

After seeding grass in March or April (Table 1), steers were excluded from the herbicide treated plots and were allowed to heavily graze the graze-out treatment in common with the remainder of the field. Wheat was grazed out by mid-to-late April and steers removed. No attempt was made to measure steer weight gain because of the short grazing periods. Steer gain of about 1 kg day^{-1} is normally expected on graze-out wheat in this area.

Table 1. Wheat grazing periods, stocking, and grass seeding dates over 3 years.

Parameter	1991	1992	1993
Early grazing period	22 Feb.–4 Mar.	26 Feb.–9 Mar.	2–9 Apr.
Steer days ha^{-1}	56	74	99
Grass seeding date	14 Mar.	24 Mar.	19 Apr.
Graze-out period	1–18 Apr.	6-27 Apr.	26-30 Apr.
Steer days ha^{-1}	118	142	79
Total Steer days ha^{-1} on graze-out	174	216	178

All plots were sprayed with metsulfuron (2[[[[(4methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]benzoic acid) at the rate of 4 g a.i. ha^{-1} in late May of all grass seeding years to control broadleaf annual weeds.

Density of Old World bluestem seedlings was determined in early July after spring seeding and again the following May by counting plants rooted within one hundred 0.1-m^2 quadrats in each plot. Quadrat location was determined by randomly stretching a tape diagonally across the seeding rows and then placing the quadrat at 0.5-m intervals along the tape.

In April of the second growing season, the standing residue was mowed and 70 kg N ha^{-1} applied to the plots. In early July, a sickle bar harvester was used to cut a 20-m^2 area within each plot, the herbage was weighed, subsampled, subsamples were dried at 57° C to a constant weight, and oven-dry herbage production calculated.

May and June precipitation was favorable for warm-season grass establishment during the 3 years grass was seeded (Table 2). Precipitation was less than normal in April and July of all seeding years.

Data were first statistically analyzed using the combined data set over 3 years. The year effect was highly significant for seedling density and forage yield. Subsequently, the data from each year were analyzed separately.

Table 2. Spring, early summer, and total precipitation at Woodward, Okla. over the 4-year study period.

Year	Month Mar.	Apr.	May	Jun.	Jul.	Total for year
	(mm)					
1991	28	11	98	52	25	367
1992	38	20	135	104	33	590
1993	47	10	161	71	21	550
1994	15	110	65	33	63	565
80 year ave.	40	54	98	77	57	593

Results and Discussion

Old World bluestem seedling densities in July after spring seeding ranged from 12 to 46 plants m^{-2} (Table 3), and from 17 to 50 plants m^{-2} the following May (Table 4). An acceptable stand is 5.4 plants m^{-2} at the end of the first growing season (USDA-NRCS, Stillwater, Okla). Weeds were not a problem other than in 1993 when crabgrass (*Digitaria* spp.) was thick in localized patches covering about one third of the study area.

Stand density decreased in the 1991 planting from the seedling year to the second year; this was apparently because of low precipitation in summer and fall of 1991. Stand density remained nearly constant in the 1992 planting from the seedling count to the second year count. Stand density increased in the 1993 planting from the seedling year to the second year, apparently a reflection of seedlings initially overlooked within crabgrass patches, or possibly, late germinating seeds.

The year effect was highly significant ($P<0.001$) for stand density (Tables 3, 4). This was because competition from crabgrass resulted in fewer Old World bluestem plants established in the 1993 seeding, and probably because of expected year-to-year variability in the amount and timeliness of precipitation. The year effect was also highly significant ($P<0.001$) for herbage production (Table 5) reflecting low yields from the 1991 planting and high yields from the 1992 planting. These differences are again believed to be primarily caused by year-to-year variability in precipitation.

Seedbeds

Seedbeds of graze-out wheat or herbicide-killed wheat resulted in similar ($P>0.05$) seedling densities (Tables 3, 4). Herbage production from the 1991 and 1993 seedings was not affected ($P>0.05$) by seedbed treatment (Table 5). Herbage production was less ($P<0.01$) on the 1992 graze-out than the herbicide-killed wheat seedbed. This may be a reflection of greater soil water depletion by the preceding crop of graze-out wheat. The year ×

Table 3. Seedling density in July of spring seeded Old World bluestem as affected by seedbed and seeder treatments.

Treatment	Year planted 1991	1992	1993
	(seedlings m^{-2})		
Seedbeds			
Graze-out wheat	32a[1]	36a	15a
Herbicide-killed wheat	34a	40a	15a
Seeders			
Grass drill	29a	31b	12b
Woodward chaffy grass seeder	37a	46a	17a

[1]Means within years,seedbeds or seeders followed by different letters are significantly different at the 0.01 level.

Table 4. Density of Old World bluestem in May of the second growing season as affected by seedbed and seeder treatments.

Treatment	Year planted 1991	1992	1993
	----- (seedlings m^{-2})-----		
Seedbeds			
Graze-out wheat	21a[1]	39a	20a
Herbicide-killed wheat	21a	44a	21a
Seeders			
Grass drill	19b	32b	17b
Woodward chaffy grass seeder	22a	50a	24a

[1]Means within years, seedbeds or seeders followed by different letters are significantly different at the 0.01 level.

seedbed treatment interaction was significant ($P<0.05$) reflecting the greater yield on the herbicide treatment than the graze-out treatment from the 1992 planting; whereas, yields were similar on both seedbed treatments for the 1991 and 1993 plantings. Seedbed × seeder interaction was not significant ($P>0.05$) in any seeding year for number of seedlings established or herbage production.

Total steer days on graze-out wheat averaged 189 days $year^{-1}$. This is less than usually expected in the area and is attributed to a deficiency in seasonal precipitation. September through April precipitation was 160, 210, and 270 mm preceding and during the 1991, 1992, and 1993 graze-out periods, respectively; the 80-year average is 295 mm. September and October 1992 were dry (6 mm precipitation), delaying wheat emergence and early 1993 grazing. In all seeding years, graze-out was completed by mid to late April and wheat regrowth was nearly nil with dry conditions. With more favorable moisture conditions, wheat grazing can continue into May. Our observations on other plantings is that wheat should be grazed to a 2- to 4-cm stubble by mid May on graze-out seedbeds. In this area, wheat usually heads in mid April and grain is ripe in early June. Old World bluestem seedlings usually emerge in late May.

A return averaging \$25 ha^{-1} $year^{-1}$ is estimated from the graze-out seedbed treatment over this 3-year study. This is based on the following assumptions: income = 1 kg steer gain day^{-1} × 189 steer days ha^{-1} × \$0.77 kg^{-1} steer gain (custom wheat graze-out rate, Doye and Kletke 1994) = \$145 ha^{-1}; minus wheat pasture production costs of \$120 ha^{-1} (Jobes and Kletke 1994), this does not include land or cattle handling costs. The low return is partially a reflection of wheat forage production limited by drought in March and April 1991, and by late fall wheat emergence in 1992. A loss of \$81 ha^{-1} is estimated for the herbicide treatment: income = 1 kg steer gain day^{-1} × 76 steer days ha^{-1} × \$0.77 kg^{-1} gain = \$59 ha^{-1}; minus wheat pasture production costs of \$120 ha^{-1} and \$20 ha^{-1} herbicide treatment.

Table 5. Herbage production by Old World bluestem in July of the second growing season as affected by seedbed and seeder treatments.

Treatment	Year planted 1991	1992	1993
	----- (kg ha^{-1})-----		
Seedbeds			
Graze-out wheat	2,200a[1]	3,930b	2,860a
Herbicide-killed wheat	2,120a	4,810a	3,060a
Seeders			
Grass drill	2,120a	4,370a	2,900a
Woodward chaffy grass seeder	2,200a	4,370a	3,030a

[1]Means within years, seedbeds or seeders followed by different letters are significantly different at the 0.01 level.

Seeders

Adequate stands were established using either the grass drill or the Woodward seeder (Tables 3,4). However, more plants per $meter^2$ were usually established with the Woodward seeder which is a broadcast seeder. This was unexpected since shallow drilling is usually the preferred grass planting method because it enhances soil-seed contact and gives some protection against water loss to the atmosphere (Young et al. 1987).

We observed that grass plants were aligned with the shallow furrows made with the grass drill. Whereas, grass seeded with the Woodward seeder was aligned with the rows of wheat stubble which were at a right angle to the direction the seeder was pulled. A combination of some soil movement by the drag chains and spring rain plus a protected environment (Evans and Young 1987) in wheat planting furrows and graze-off wheat stubble probably resulted in adequate stand establishment using the Woodward seeder. The grass drill with 1.6 cm depth bands may have placed seed deeper than optimum. Hoof action may also cover seed with soil. However, note that stand density was similar (Tables 3, 4) on the graze-out treatment (heavily grazed after grass seeding) as compared to the herbicide-killed wheat treatment (not grazed after grass seeding).

Overall, it appears that Old World bluestem should be planted very shallow. Also, the relatively high seedling densities established in this study indicate that a lower seeding rate than the recommended 2.2 kg pls ha^{-1} (Rollins and Ahring 1987) may be considered where a firm seedbed and an appropriate seeder are used. Seedbeds of graze-out wheatland are recommended for Old World bluestem establishment in the Southern Plains.

Literature Cited

Berg, W.A., C.L. Dewald, and P.L. Sims. 1992. Grass and forb establishment on highly erodible marginal farmland in the Southern Plains of the USA, p. 423–430. *In*: H. Hurni and K. Tato (eds.) Erosion, conservation and small scale farming. Walsworth Pub. Marceline, Mo.

Doye, D.G., and D. Kletke. 1994. Oklahoma pasture and cropland rental rates: 1993. OSU Current Rep. 216. Okla. State Univ. Coop. Ext. Service. Stillwater, Okla.

Evans, R.A., and J.A. Young. 1987. Seedbed microenvironment, seedling recruitment,and plant establishment on rangelands. p. 212–220. *In*: G.W. Frasier and R.A. Evans (eds.) Proc. Symp. seed and seedbed ecology of rangeland plants. USDA-ARS. N.T.I.S., Springfield, Virg.

Hanlon, E., and G. Johnson. 1983. OSU agronomic services procedure for soil, forage and water testing. OSU Extension Facts 2901. Okla. State Univ. Coop Ext. Ser. Stillwater, Okla.

Jobes, R., and D. Kletke. 1994. Oklahoma farm and ranch custom rates, 1993-94. OSU Current Rep. 205. Okla. State Univ. Coop. Ext. Ser. Stillwater, Okla.

Rollins, D., and R.M. Ahring. 1987. Reseeding marginal cropland to perennial grasses. OSU Extension Facts 2581. Oklahoma State Univer. Coop. Ext. Service. Stillwater, Okla.

Savage, D.A. 1939. Grass culture and range improvement in the Central and Southern Great Plains. Circ. 491. USDA. Washington, DC.

Wiedemann, H.T., J.H. Brock, C.E. Fisher, and B.T. Cross. 1979. Seed metering and placement devices for rangeland seeder. Trans. ASAE 22:972–977.

Young, J.A., R.A. Evans, and G.J. Cluff. 1987. Seeding on or near surfaces of seedbeds in semiarid environments, p. 57–61. *In*: G.W. Frasier and R.A. Evans (eds.) Proc. Symp. seed and seedbed ecology of rangeland plants. USDA-ARS. N.T.I.S., Springfield, Virg.