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Yield and quality of WW-Iron Master and caucasian bluestem regrowth

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Abstract

Old World bluestems (*Bothriochloa* spp.) have been seeded on over a million hectares of marginal farmland in Oklahoma and Texas, yet we know little about their regrowth yield and quality. The objective was to determine seasonal pattern of forage regrowth yield and quality of leaves and stems of WW-Iron Master (*B. ischaemum* [L.] Keng) and Caucasian (*B. caucasica* [Trin.] C.E. Hubb.) bluestem when 4-week regrowth was harvested at weekly intervals from early May through mid-September. Four plots of each bluestem were established in each of the 4 blocks (32 plots total). Harvesting was rotated so that 4-week regrowth of each bluestem was harvested weekly from 1 of the 4 plots in each block during 1988 and 1989 to determine regrowth yield, in vitro dry matter digestibility (IVDMD), and crude protein (CP) of leaves and stems. Forage regrowth of both species peaked in June both years. Regrowth during August averaged 10 and 35% of June regrowth in 1988 and 1989. WW-Iron Master produced 80 and 45% greater 4-week regrowth than Caucasian in 1988 and 1989. WW-Iron Master produced 75 and 28% greater leaf regrowth than Caucasian in 1988 and 1989 and twice as many stems both years. Leaf and stem IVDMD of WW-Iron Master averaged 2 to 6 percentage units higher than Caucasian. Leaf CP of WW-Iron Master averaged 2 percentage units higher than Caucasian during May and June. However, stem CP of WW-Iron Master averaged 1 percentage unit lower than Caucasian. Grazing management plans need to consider that the majority of bluestem forage production was restricted to a 1 month period in June. This technique of sampling 4-week regrowth every week during the growing season was an effective method for determining the seasonal regrowth pattern.

Key Words: *Bothriochloa caucasica, Bothriochloa ischaemum,* crude protein, in vitro digestibility, leaves, stems

Old World bluestems (*Bothriochloa* spp.) have been seeded on over a million hectares of marginal farmland in Oklahoma and Texas in the last 10 years, yet we know little about the yield and quality of regrowth. Additional knowledge is needed about seasonal pattern of forage regrowth yield and quality available to grazing animals in order to model available forage and livestock weight gain.

Taliaferro et al. (1984) clipped regrowth of 'Plains' (*B. ischaemum* [L.] Keng) and 'Caucasian' (*B. caucasica* [Trin.] C.E. Hubb.) bluestem at 3, 5, 7, 9, and 11 week intervals. Regrowth from each clipping interval was harvested 3 times during the year but clipping intervals were not close enough to identify the major period of regrowth yield and quality. They found that forage regrowth of Plains and Caucasian bluestem was nearly equal but in vitro dry matter digestibility (IVDMD) of Plains averaged 1.5 to 4.1 percentage units higher than Caucasian.

Little information is available on the regrowth yield and quality of 'WW-Iron Master' bluestem (*B. ischaemum* [L.] Keng). Berg et al. (1986) reported that WW-Iron Master (PI301535) produced more forage with less Fe chlorosis than 11 other accessions/cultivars of Old World bluestem on soils deficient in plant available Fe. Dewald et al. (1988) found that initial growth of WW-Iron Master harvested between first heading and seed ripe had higher crude protein (CP) and IVDMD than 'WW-Spar' (*B. ischaemum* [L.] Keng), Plains, or Caucasian bluestem during a 3-year period.

The objective of this research was to determine the seasonal pattern of regrowth yield and quality of leaves and stems of WW-Iron Master and Caucasian bluestem when 4-week regrowth was harvested at weekly intervals from early May through mid-September.

Materials and Methods

The study was conducted during 1988 and 1989 at Woodward, Okla. on WW-Iron Master and Caucasian Old World bluestems. WW-Iron Master is simular to WW-Spar but has darker green leaves. WW-Iron Master was released in 1988 (Dewald et al. 1988). It is less subject to Fe deficiency and produces more forage with less chlorosis than presently released cultivars of Old World bluestem.

The soil at the site is Woodward loam (coarse silty, mixed, thermic Typic Ustochrepts) that was previously cropped with grain sorghum (*Sorghum bicolor* [L.] Moench) for many years. Bluestem plants were established in the greenhouse then transplanted into field plots (1.5 by 6.1 m) on 1 May 1985. Each plot consisted of 5 rows of 20 plants each centered on 30-cm spacing in both directions. The uniform 30-cm plant spacing greatly

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decreases the experimental error of yield and quality and yet forage growth is simular to that in a normal seeding. Four plots of each bluestem were randomly arranged in each block of 4 blocks (32 plots total). Plots were burned each spring to remove old residue when green growth started and were fertilized each year during March or early April with ammonium nitrate at 45 kg of N ha^{-1}. It is a common practice to burn residue to increase animal weight gain. During the 2 years before the study, forage was harvested once after first heading and regrowth 4 weeks later.

Precipitation was measured in a standard rain gauge located 1.4 km southeast of the site. Long-term precipitation was 598 mm with 104 mm received from October through December, 80 mm from January through March, 232 mm from April through June, and 182 mm from July through September.

Four-week regrowth was harvested from the center 3 rows of each plot with a sickle mower leaving a 3-cm stubble height. Harvesting was rotated so that 4-week regrowth was harvested from 1 of the 4 plots every week. Regrowth was harvested weekly from early May through mid-September as shown in Table 1. Initial harvest each year was done in early April just after the bluestems had started growth. Each plot was harvested 4 times in 1988 and 5 times in 1989. Forage from the border rows was removed the same day. A 300 to 400-g subsample (wet) of plant material was oven dried at 60° C to constant weight. Leaf percentage was determined by chopping the subsample into 2 to 4 cm lengths and then separating it with an aspirator into leaf and stem fractions (White 1990). Leaf fraction included all leaf blades and sheaths while stem fraction included only stems. Sometimes there were insufficient stems for chemical analysis. Leaf and stem fractions were ground in a shear-mill to pass a 1-mm screen and analyzed for in vitro dry matter digestibility (IVDMD) by the Tilley and Terry two-stage method (Tilley and Terry 1963) as modified by (White et al. 1981). The nutrient-buffer was supplemented with urea. Nitrogen content of leaf and stem fractions was determined with a semimicro-Kjeldahl method (Bremner and Breitenbeck 1983) and multiplied by 6.25 to estimate crude protein (CP).

Table 1. Harvest dates or 4-week regrowth of WW-Iron Master and Caucasian Old World bluestem forage at Woodward, Okla. during 1988 and 1989.

1988	1989
-------- month/day --------	
5/4	
5/12	5/10
5/18	5/19
5/25	5/24
6/1	5/31
6/8	6/6
6/15	6/14
6/22	6/21
6/29	6/28
7/7	7/5
7/13	7/12
7/20	7/19
7/27	7/26
8/3	8/2
8/10	8/9
8/17	8/16
8/24	8/23
8/31	
9/6	
9/14	

Results from each series (a series = 4 cuttings) of 4-week regrowth were analyzed with 2 species by 4 harvest date factorial analysis of variance for a randomized complete block. The 4 series in 1988 and 5 in 1989 could not be combined because the Bartlett chi-square test indicated that experimental errors were not homogeneous. Because of significant date by species interactions, analysis of variance was calculated for each date.

Daily forage yield was estimated by first dividing 4-week regrowth by actual days of regrowth. The experimental design was such that each week's regrowth was measured by 4 cutting dates. The average daily yield was estimated by averaging the current harvest date with that of the next 3 harvests. Averaging the 4 harvest dates moves the forage yield curve slightly ahead and some what smooths the curve. This is more realistic than not averaging them.

Results

Forage Regrowth

Precipitation differed greatly between the 2 years and affected regrowth. April through June precipitation was only 69% of normal in 1988 and 109% of normal in 1989. January through March precpitation was 122% above normal in 1988 and 10% below normal in 1989.

Daily regrowth peaked during June both years (Fig. 1a and 1b). During 1988, regrowth of WW-Iron Master continued to increase until late June while moisture stress caused regrowth of Caucasian to decline after early June. Caucasian regrowth stopped declining in July following a 70-mm rain. Peak regrowth of WW-Iron Master was 80% greater than Caucasian in 1988 because its regrowth continued 3 more weeks. With above April through June precipitation in 1989, WW-Iron Master's peak regrowth was 45% greater than Caucasian. Regrowth during August 1988 and 1989 was only 10 and 35% of peak regrowth. The shape of regrowth curve was poorly related with previous 7-day precipitation either year (Fig. 1c and 1d).

Seasonal pattern of leaf regrowth (Fig. 1e and 1f) was similar to total forage regrowth. WW-Iron Master produced 75 and 28% more peak leaf regrowth than Caucasian during 1988 and 1989, respectively, and twice as much peak stem regrowth (Fig. 1g and 1h) both years.

IVDMD

Leaf in vitro dry matter digestibility (IVDMD) of WW-Iron Master regrowth averaged 2 to 4 percentage units higher than Caucasian (Fig. 2a and 2b). During May and June both years, leaf IVDMD of WW-Iron Master decreased an average of 0.5 percentage units per 100 kg ha^{-1} increase in leaf yield. The IVDMD of Caucasian leaves per increase in yield decreased twice as fast as WW-Iron Master. Stem IVDMD of WW-Iron Master was 2 to 6 percentage units higher than Caucasian during June and August in 1988 (Fig. 2c), but averaged higher than Caucasian only during early June and September in 1989 (Fig. 2d).

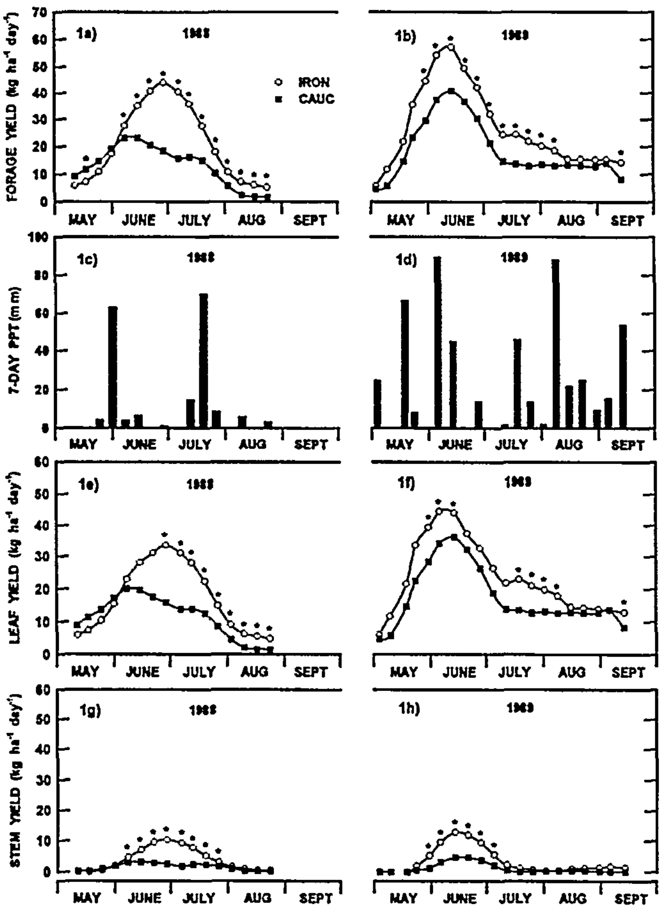

Fig. 1. Average daily whole plant forage (1a and 1b), previous 7-day precipitation (1c and 1d), leaf (1e and 1f), and stem (1g and 1h) regrowth yield of WW-Iron Master (Iron) and Caucasian (Cauc) Old World bluestems when 4-week old regrowth was harvested weekly near Woodward, Okla. during 1988 and 1989. Significant species differences at P≤0.05 probability level are noted with an asterisk.

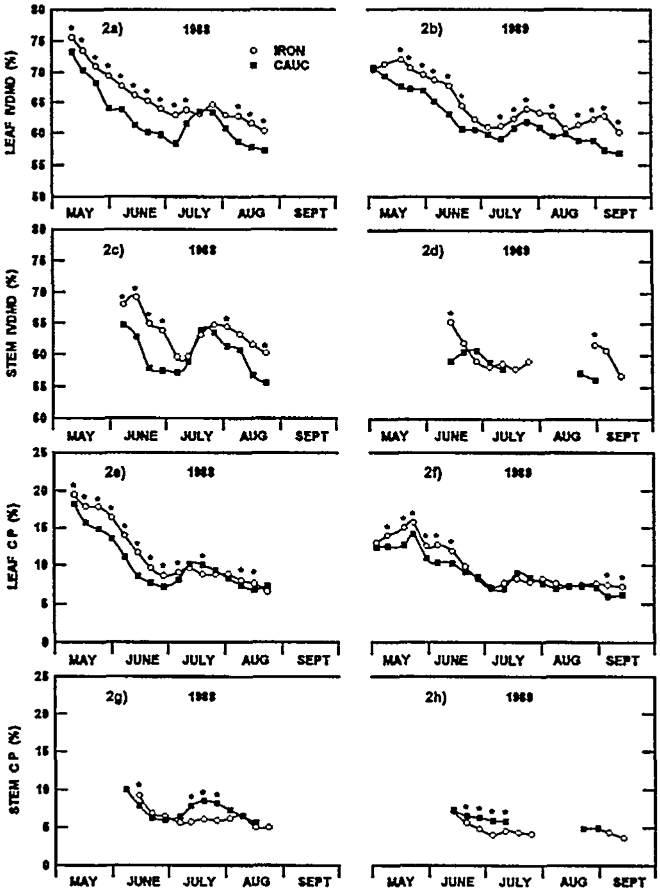

Fig. 2. The in vitro dry matter digestibility (IVDMD) of leaf (2a and 2b) and stem (2c and 2d) and crude protein (CP) of leaf (2e and 2f) and stem (2g and 2h) regrowth of WW-Iron Master (Iron) and Caucasian (Cauc) Old World Bluestems when 4-week old regrowth was harvested weekly near Woodward, Okla. during 1988 and 1989. Significant species differences at P≤0.05 probability level are noted with an asterisk.

Crude Protein

Leaf crude protein (CP) of WW-Iron Master averaged 2 percentage units higher than Caucasian during May and June both years (Fig. 2e and 2f). There was no consistent difference in leaf CP between bluestems during July and August both years. During May and June leaf CP of WW-Iron Master decreased an average of 0.35 and Caucasian 0.41 percentage units per every 100 kg ha^{-1} increase in leaf yield. During 1989, leaf CP peaked during late May (3 weeks after a 3 May rain) then decreased until early July (Fig. 2f). The leaf CP of Caucasian increase during July 1989 was much less than occurred during 1988. Never the less, both species exhibited increased leaf CP during July. When CP was analyzed across all dates, dates were significant. The LSD test showed that any CP change over 0.3 percentage units was significant.

Stem crude protein (CP) of WW-Iron Master averaged 1 percentage unit lower than Caucasian both years (Fig. 2g and 2h). During 1988 stem CP varied from 5 to 10% and during 1989 varied from 4 to 7%. Leaf CP never fell below 7% either year.

Discussion

More than 70% of the total WW-Iron Master and Caucasian regrowth occurred during June. Forage quality of these grasses declined as regrowth increased during May and June. WW-Iron Master produced greater regrowth and had higher leaf in vitro dry matter digestibility (IVDMD) and crude protein (CP) than Caucasian. Dewald et al. (1988) also found that IVDMD and CP of WW-Iron Master (PI301535) was higher than Caucasian. Faix et al. (1980) also found that IVDMD of Caucasian was less than Plains and 4 experimental strains of *Bothriochloa ischaemum* (B, L, LL, and T) bluestem. Caucasian produced the highest forage yield of all bluestems with above normal precipitation (Coyne et al. 1982, Dalrymple et al. 1984, Dewald et al. 1985). WW-Iron Master produced higher forage yields than other bluestems when grown on eroded calcareous soils where Fe deficiency was a problem (Berg et al. 1986).

Management of any forage depends upon balancing forage yield and quality with livestock requirements. Forage regrowth after mid-July was only 10 to 35% of that during June. Regrowth during June was 3 to 4 times more than livestock in a set stocking rate based on July and August regrowth could utilize. Leaf crude protein (CP) after mid June was only sufficient for maintenance of a dry pregnant mature cow (NRC 1976) but not weight gain. This data indicates that CP of 4-week regrowth of bluestems after mid June may be deficient for weight gain of cattle. Most of the forage should be utilized during June to obtain maximum animal weight gains. This can be accomplished by harvesting half the forage for hay during June when forage quality is high, or by doubling the stocking rate during June to ensure maximum livestock utilization. An alternative to these suggested management plans is to identify a forage with a regrowth pattern that is either earlier or later than Old World bluestems. Grazing animals could then be rotated between 2 or more species to maximize livestock weight gains.

The technique of sampling 4-week regrowth every week through the growing season is an effective method for determining the seasonal regrowth pattern. Such information could be used to develop simulation models for grazing management to enhance livestock weight gains. This technique showed the seasonal distribution of forage quantity and quality available to grazing animals. Studies to determine the relative intake of stems and leaves by grazing animals are needed to accurately estimate livestock weight gains.

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