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Yield by Morphological Component of Sideoats Grama (*Bouteloua curtipendula* (Michx.) Torr.) From Sowing to the Establishment

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Abstract: The aim of this study is to analyze the dry matter yield of morphological components of sideoats grama (*Bouteloua curtipendula* (Michx.) Torr). The 7 genotypes of sideoats grama identified with numbers 5, 62, 125, 181, 303, 357, 417 and the commercial variety El Reno were used. The 6 destructive samplings were made at 50, 65, 80, 95, 110 and 125 days after sowing (das) to 5 plants (replicates) per genotype. Statistic differences were observed in all of the variables for leaf dry matter (mg/DM/plant) between genotypes differences ($p<0.01$) were observed. For 125 das, genotypes 303, 357 and 5 exceeded the variety El Reno in 3.9, 3.8 and 3.5 magnitudes, respectively. Genotypes 62 and 181-125 das showed greater amount of stem respect to other morphological components and genotypes ($p<0.01$). Genotype of 125-125 das produced higher proportion of leaf compared to previous dates ($p<0.01$). It is concluded that by the differences between genotypes, being young plants, the outstanding plants will have greater ability to photosynthesize more nutrients which will be reflected in a better adaptation to the establishment.

Key words: Nutrients, photosynthesize, genotype, sow, sideoats grama

INTRODUCTION

Excessive stocking and continuous grazing are the factors that most have affected the deterioration of grassland. The damage is manifested in loss of vegetation cover, habitat fragmentation, altered species composition and increased soil erosion (Dinerstein *et al*., 2000). In this regard, it is considered that due to the complexity of the problem, the solution also implies several complementary activities. One is reseeding grassland, important option that can be performed using native seed species.

The genetic breeding programs in forage grasses have been made with little genetic variability (Roundy, 1999; Larson *et al*., 2000). Thus, the released varieties are adapted to reduced environments without knowing the productive potential of the natural diversity of the species of interest (Huff, 1997; Fu *et al*., 2004). This is due to the lack of specific studies about the effectiveness of the collect and diversity in the development of the material (Phan *et al*., 2003).

In this study, researchers definethe morphological characterization to the description of variation that exists in a germplasm collection in terms of morphological and phenological characteristics of high heritability that is features whose expression is little influenced by the environment (Van Hintum, 1995).

According to the earlier to know the component yields of plants, at different stages of development among individuals from different populations is essential in breeding programs, since it helps identify superior genotypes tobe adapted to the dry conditions prevailing in Northern Mexico.

Mexico is a center of genetic diversity of many forage species. In the genus *Bouteloua* 57 species have been integrated which are located from Canada to Argentina, many of great importance to the rangelands of North America (Columbus, 1998; Siqueiros, 2001). Moreover, in this country collecting and evaluating forage germplasm has not been done systematically (Morales-Nieto *et al*., 2009a).

Sideoats grama retains its forage value longer, during Autumn, compared to other grasses, this species has great productive potential in arid conditions also during the Winter maintains high digestibility values (Anderson,

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2003; Morales-Nieto *et al*., 2008). Sideoats is a perennial, tillered C_4 plant that reproduce sapomictically where the embryo originates fromapomixis, its center of origin is located in Mexico (Carrillo *et al*., 2010).

The objective of this study is to evaluate the yield of the morphological components of 7 native genotypes of Mexico and the variety El Reno, this is because for the purposes of variety releaseit is necessary to know in detail the behavior of the species.

MATERIALS AND METHODS

The experiment was conducted from July 16 to September 30, 2011, at the faculty of veterinary medicine of the universidad Juarez of the state of Durango, located at km 11.5 of the Durango-El Mezquital road, it is located at 24° 28' N and 104° 40' W and locatedat 1890 m.a.s.l. In the area, climate is classified as BsKw considered dry semiarid with mean annual temperature of 17.5°C and annual average rainfall of 450 mm year^{-1}.

The 7 outstanding genotypes of sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.) were used which were product of a collection and morphological selection from 577 materials collected in 13 states (Morales-Nieto *et al*., 2009b).

Sowing was done on May 26, 2010 in seedling type trays (55×33 cm with 128 cavities whose depth was 4.4 cm). The substrate used was peatmoos at field capacity, sowing caryopses at 0.5-1 cm deep covered with fine vermiculite.

The 20 days after sowing (das), seedlings were transplanted topots of 2 L with red chestnut soil of volcanic origin and sandy loam texture with good drainage, establishing only one plant per pot. Plants were watered every 48 h with 0.5 L of tap water and fertilized every 14 days with triple 17 (NPK) at 3 g L^{-1} of irrigation water. The plants were protected with mesh shade throughout the investigation. At each sampling, plants were removed from the pot and washed with tap water and already cleaned, they were dried in the shade and its morphological components were separated: Leaf, stem, root, dead material and spike.

The 7 genotypes were evaluated identified by random numbers: 5, 62, 125, 181, 303, 357 and 417 and the commercial variety El Reno (control). Destructive samplings were made: At 50, 65, 80, 95, 110 and 125 days after sowing (das) taking reading of 5 plants (replicates) per genotype.

To estimate the leafbiomass a leaf was taken from the ligule (leaf blade). To estimate root biomass the weight of roots and crown was considered. For stem biomass, stems were cut to 0.5 cm of the crown and 1 cm below the onset of the inflorescence. In the case of inflorescence biomass, the rachis was considered as part of this tissue. Components were dried in a forced air oven at 55°C for 48 h and then weighed on an analytical balance. Variables were analyzed using a completely randomized design with mean separation using Tukey's test ($p<0.05$) with the statistical package SAS (1990).

RESULTS

Leaf dry matter: For leaf dry matter (mg/DM/plant) between genotypes within sampling dates, differences ($p<0.01$) were observed except for 80 and 95 das (Table 1). Most leaf production in all genotypes occurred starting from 95 das, there wasno predominance of any genotype on 1st dates. At 125 das, genotypes 303, 357 and 5 exceeded the variety El Reno in 3.9, 3.8 and 3.5 magnitudes, respectively. This is informative about the variation among genotypes and similarly a differential behavior under field conditions.

Root dry matter: In all sampling dates significant differences between genotypes ($p<0.01$, Table 2) were observed. At 50, 80 and 95 das, geno type 357 had

Table 1: Leaf dry matter (mg/DM/plant) in seven genotypes and a commercial variety of sideoats grama, at different date from post-sowing destructive sampling

	Days after sowing (destructive sampling)					
Genotypes	50	65	80	95	110	125
El Reno	46^{b}	53.0^{a}	30.0^{a}	98^{a}	212^{cd}	191^{b}
303	97^{ab}	49.0^{a}	29.0^{a}	238^{a}	356^{bcd}	750^{a}
417	41^{b}	49.0^{ab}	28.0^{a}	104^{a}	136^{d}	305^{ab}
125	77^{ab}	53.0^{a}	24.0^{a}	187^{a}	280^{a}	611^{ab}
357	131^{a}	33.0^{bc}	43.0^{a}	252^{a}	379^{bc}	740^{a}
5	87^{ab}	32.0^{c}	46.0^{a}	241^{a}	476^{ab}	679^{ab}
62	97^{ab}	44.0^{abc}	46.0^{a}	192^{a}	267^{bcd}	594^{ab}
181	91^{ab}	29.0^{c}	28.0^{a}	126^{a}	195^{cd}	306^{ab}
LSD	56	15.6	25.2	46	232	536

Table 2: Root dry matter (mg/DM/plant) in 7 genotypes and a commercial variety of sideoats grama, at different date of post-sowing destructive sampling

	Days after sowing (destructive sampling)					
Genotypes	50	65	80	95	110	125
El Reno	35^{bc}	52.0^{ab}	31.0^{b}	51^{c}	304^{b}	311^{d}
303	78^{bc}	27.0^{c}	32.0^{b}	168^{a}	502^{b}	551^{bc}
417	34^{c}	41.0^{bc}	18.0^{b}	51^{c}	282^{b}	320^{d}
125	76^{bc}	66.0^{a}	24.0^{b}	83^{bc}	1367^{a}	293^{d}
357	138^{a}	35.0^{bc}	94.0^{a}	177^{a}	677^{b}	946^{a}
5	60^{bc}	38.0^{bc}	64.0^{ab}	101^{bc}	457^{b}	686^{b}
62	84^{b}	56.0^{ab}	64.0^{ab}	110^{b}	492^{b}	593^{b}
181	53^{bc}	24.0^{c}	55.0^{ab}	81^{bc}	371^{b}	386^{cd}
DMS	50	20.8	45.8	55	411	177

$^{a-d}$Equal letters do not present significant differences; DMS = Least significant difference

Table 3: Dry matter of the aerial part (mg/DM/plant) in 7 genotypes and a commercial variety of sideoats grama, at different date of post-planting destructive sampling

	Days after sowing (destructive sampling)					
Genotypes	50	65	80	95	110	125
El Reno	63.0^{b}	83.0^{a}	4.0^{a}	75.0^{d}	304^{cd}	276^{d}
303	137.0^{ab}	77.0^{a}	4.0^{a}	20.0^{b}	807^{b}	1471^{ab}
417	62.0^{b}	77.0^{a}	4.0^{a}	9.0^{cd}	193^{d}	563^{bcd}
125	99.0^{ab}	84.0^{a}	3.0^{a}	104.0^{cd}	1402^{a}	453^{cd}
357	175.0^{a}	48.0^{b}	6.0^{a}	272.0^{a}	724^{bc}	1700^{a}
5	123.0^{ab}	47.0^{b}	7.0^{a}	174.0^{b}	843^{b}	1269^{abc}
62	125.0^{ab}	65.0^{ab}	7.0^{a}	173.0^{b}	450^{bcd}	1411^{ab}
181	150.0^{a}	45.0^{b}	4.0^{a}	151.0^{bc}	435^{bcd}	1040^{bcda}
DMS	76.2	22.3	35.9	64.2	477	949

^{abc}Equal letters do not present significant differences; DMS = Least significant difference

the highest values producing 138, 94 and 177 mg/plant, respectively (p<0.01). All treatments markedly increased root production at 110 das and genotypes 125 and 357 were the most outstanding. However, at 125 das genotype 357 showed the highest value with 946 mg/DM/plant, this represents 3 more times of root yield over the commercial control El Reno. Genetic variability is detected again, although under controlled conditions, it can give differential advantages among genotypes, promoting the most efficient genotype in root dry weight during seedling establishment in normal and adverse field environments.

Dry matter of aerial parts: On the dates, except for the 80 das, significant differences between genotypes (p<0.01) were observed, it is at 110 das when significant increases are observed in all materials (Table 3). Genotypes 125, 303, 5 and 357 are outstanding with 1402, 807, 843 and 724 mg/DM/plant, respectively. It is for the 125 das when consolidation of genotypes 303, 357, 62 and 5 with 1471, 1700, 1411 and 1269 mg/DM/plant, respectively were observed, these represent 5.3, 6.2, 5.1 and 4.6 magnitudes compared to the genotype El Reno. However, it is noteworthy that the critical days of development to achieve seedling establishment in the field are the first 40 days of post-sowing, therefore when observing variability in the development of leaf, root and root: Shoot ratio for all sampling, this should be assessed in terms that reflect environmental conditions, mainly of a moderate to severe winter drought in intensity and duration, the aforementioned in order to detect the genotypes with higher aptitude to be established.

Spike dry matter: In the first 4 sampling dates, values are zero for all genotypes (Table 4). Only at 110 and 125 das values showing statistical differences (p<0.01) were observed. The genotype 303 in 110 das had the highest value with 115 mg/DM/plant and was statistically equal to

Table 4: Spike dry matter (mg/DM/plant) in 7 genotypes and a commercial variety of sideoats grama, at different date of post-sowing destructive sampling

	Days after sowing (destructive sampling)					
Genotypes	50	65	80	95	110	125
El Reno	0	0	0	0	0^{b}	0^{c}
303	0	0	0	0	115^{a}	27^{ab}
417	0	0	0	0	0^{b}	10^{bc}
125	0	0	0	0	93^{ab}	0^{c}
357	0	0	0	0	16^{b}	37^{ab}
5	0	0	0	0	0^{b}	40^{a}
62	0	0	0	0	14^{b}	38^{a}
181	0	0	0	0	29^{ab}	50^{a}
DMS					95	27

Table 5: Dry matter of dead material (mg/DM/plant) in 7 genotypes and a commercial variety of sideoats grama, at different date of destructive sampling

	Days after sowing (destructive sampling)					
Genotypes	50	65	80	95	110	125
El Reno	0	0	0.0^{b}	6.0^{b}	24^{d}	25.0^{c}
303	0	0	0.0^{b}	15.0^{ab}	47^{bcd}	82.0^{ab}
417	0	0	2.2^{a}	6.0^{b}	19^{d}	33.0^{bc}
125	0	0	0.0^{b}	6.0^{b}	85^{a}	26.0^{c}
357	0	0	0.6^{ab}	16.0^{ab}	54^{bc}	92.0^{a}
5	0	0	0.0^{b}	14.0^{ab}	60^{ab}	78.0^{ab}
62	0	0	0.0^{b}	21.0^{a}	33^{bcd}	88.0^{a}
181	0	0	0.0^{b}	24.0^{a}	28^{cd}	66.0^{abc}
DMS				13.6	27	27.7

^{abc}Equal letters do not present significant differences; DMS = Least significant difference

genotypes 125 and 181. At the 125 das, genotype 181 had the highest value and was statistically equal (p>0.01) to genotypes 5, 62, 357 and 303.

Dry matter of dead material: In the first 2 dates (50 and 65 das) there is no presence of this material (Table 5). For 80 das, only genotypes 357 and 417 have values of 0.6 and 2.2 mg/DM/plant, respectively. From this date until 125 das, statistical differences (p<0.01) were observed between treatments. For dates 95, 110 and 125 das, genotypes 181, 125 and 357 have the highest values: 24, 85 and 92 mg/DM/plant, respectively. For the 125 das, genotypes that have the highest values and are statistically equal (p<0.01): 357, 62, 303, 5 and 181. The commercial variety El Reno showed the lowest values and was up to the 95, 110 and 125 das that presented 6, 24 and 25 mg/DM/plant, respectively. Statistically similar genotypes (p>0.01) for 125 das were El Reno 417, 125 and 181 with values of 25, 33, 26 and 66 mg/DM/plant, respectively.

Root, shoot ratio: On average, genotype 303 (1.93, p<0.01) had the highest amount of bio mass. Genotypes 357, 125, 62 and El Reno were the closest to the unit values (1.29, 1.37, 1.47 and 1.43), respectively (Table 6). Between dates, genotypes 303 and 5 did not show

Table 6: Root:shoot ratio observed in 7 genotypes and a commercial variety of sideoats grama, at different date of a destructive post-sowing sampling

	Days after sowing (destructive sampling)							
Genotypes	50	65	80	95	110	125	Average	DMS
El Reno	1.78^{aA}	1.60^{bAB}	1.560^{abAB}	1.470^{abA}	1.00^{bcB}	0.89^{cB}	1.38^{b}	0.80
303	1.75^{a}	2.80^{a}	1.540^{b}	1.230^{a}	1.61^{ab}	2.67^{a}	1.93^{a}	3.75
417	1.85^{aA}	1.88^{abAB}	2.340^{aA}	1.770^{aAB}	0.68^{cB}	1.76^{abcAB}	1.71^{ab}	1.47
125	1.31^{abA}	1.28^{bAB}	1.630^{abAB}	1.240^{aAB}	1.03^{bcB}	1.55^{bcA}	1.34^{b}	0.46
357	1.27^{aAB}	1.36^{bAB}	0.720^{bB}	1.540^{aA}	1.07^{bcAB}	1.80^{abcA}	1.29^{b}	0.72
5	2.04^{a}	1.26^{b}	1.160^{b}	1.720^{a}	1.84^{a}	1.85^{abc}	1.64^{ab}	1.06
62	1.49^{aB}	1.17^{bB}	1.110^{bB}	1.580^{aB}	0.91^{cB}	2.38^{abA}	1.44^{b}	0.78
181	2.84^{aA}	1.85^{abAB}	0.830^{bC}	1.870^{aAB}	1.17^{bcBC}	2.70^{aA}	1.88^{ab}	1.02
DMS	3.50	1.42	0.873	0.678	0.66	1.04	0.73	

[abc]Equal letters do not present significant differences within the column; [ABC]Equal letters do not present significant differences within the row; DMS = Least significant difference

differences ($p>0.01$) with a similar proportion from 50-125 das ($p>0.05$). Genotypes 357 and 181-80 das showed greater root weight compared to the aerial part, followed by genotypes 5 and 62.

Samplings in El Reno at 110 and 125 das did not show differences between them ($p>0.05$), however it was different at 50 das ($p<0.01$), at 110 das showed the same weight in aerial part respect to the root and at 125 das the root weight was higher than the aerial part ($p<0.05$). Genotype 357 at 80 das showed the highest amount of biomass compared to other genotypes ($p<0.01$). Meanwhile, the genotype 417 at 110 das showed the greatest amount of root at 125 das ($p<0.05$), however was similar to the first samplings ($p>0.05$). Genotype 181 at 80 das had the best proportion of root regarding the aerial parts and was different from the other samplings ($p<0.01$).

DISCUSSION

Although variables behave in a normal manner, abnormal data in study is observed which are probably due to the irregularity in the recovery of genotypes after transplantation to pots.

In this evaluation, the fact that statistically there are differences in leaf production in most of the period in the case of genotype 303 having a value 3.9 times higher than the control at 125 das, this translated to field conditions is reflected in a significant difference in terms of total dry matter production from the leaf which is reflected in a better performance of live stock on rangeland preferring consumption of leaf area of plants. However in the period of young plant when there are genotypes, as 303 having a value much higher than El Reno, it means young plants have better ability to photosynthesize more nutrients which is reflected in better adaptation to the establishment.

In this regard, cattle raisers can make decisions on the stocking rate in grassland and cattle grazing time considering the amount of forage determined by the combination of the various components in this case when the greater amount is leaf. This also applies to the genotypes 357, 5 and 62 that had a performance superior to the control.

The performance of these genotypes for this date is also important because in a commercial sowing under field conditions, after >4 months das, plants have already been established.

With regard to the evaluation of the leaf-stem ratio this is important, as a forage attribute of the species, as it allows us to determine that most of the above ground biomass is leaf, situation that benefits extensive cattle raising. In this sense, although in leaf production and leaf: Stem ratio there were no statistical differences in other evaluations, it is observed that genotype 125 has been outstanding because has a leaf production of 3.41 g/plant and leaf: Stem ratio of 2.32. However when assessing the leaf, stem ratio variable of Morales *et al*. (2009a), genotype 125 is not seen, as outstanding whereas genotype 5 is reported as one of a good forage value. This may be due to the fact that Morales *et al*. (2009b) did not evaluate seedlings from seed by contrast, they evaluated transplanted tillers. Also in relation to this variable, the same researchers mentioned genotype 303 with a regular performance. Values found in leaf-stem ratio in different sideoats grama genotypes were similar to those generated by Vallejos *et al.* (1989) who observed leaf-stem ratios in Brachiariaspp genotypes of 1.3 ± 0.3 and in *Megathhyrsus maximus* of 2.63 ± 0.69.

CONCLUSION

There is genetic diversity in genotypes of sideoats grama for attributes evaluated. According to this study, genotypes that have better performance are 303, 357, 62 and 5. This allows us to preselect the best materials with desirable forage characteristics for possible release, as varieties once that have been selected in challenging environments. El Reno is among the materials with lower performance in this evaluation, so it is concluded that there are best genotypes in terms offorage. Results of this evaluation require searching among native materials to find genotypes with desirable forage characteristics.

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