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INITIAL EVALUATION OF NINE ECOTYPES OF *SETARIA MACHROSTACHYA* GRASS AT A COMMON SITE

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Abstract: Overgrazing caused by extensive livestock farming on pastureland has led to a 58% loss in forage species diversity. Revegetation with native species has therefore been proposed to increase forage availability. However, the first step is to identify the ideal genotypes for this purpose. Therefore, the objective of this study was to evaluate, under the same conditions, the expression of various ecotypes of *Setaria machrostachya* grass in the early stages of establishment in terms of plant height and number of spikes. A completely randomized block design with three replicates was used, and the treatment means were compared using Tukey's test ($\alpha \leq 0.05$). Three outstanding ecotypes were found in terms of plant height, averaging up to 19 cm, which allows us to distinguish the genetic diversity of *Setaria machrostachya* ecotypes. No difference was found in the number of spikes per plant ($P \geq 0.05$), with the highest average being up to 3.3 spikes per plant. However, it is recommended that this variable in grasses continue to be measured until the second and third years of establishment.
Keywords: Native grass, genetic diversity, spikes.

INTRODUCTION

Overgrazing in areas of low rainfall in Mexico has caused a decline in forage production since the 1950s (Jurado *et al.,* 2021). Similarly, Quero-Carrillo *et al.* (2014) mention that 83% of Mexico's land area is located in semi-arid zones, yet forage production depends on summer rains and forage resources are not used in a systematic and orderly manner. Knowledge of native Mexican forage grass species is important for studying seasonal forage production and its quality in the face of low rainfall, and thus for organizing grazing and recovering pasture land (Gómez-Guzmán *et al.,* 2023). Overgrazing or continuous grazing has led to a 58% loss of plant species diversity in the area, and although grasses are the most abundant group, they account for only 20.6% of the frequency of occurrence in the area. However, regardless of the species present in the grazing area, ruminants consume the same protein content, which leads to a greater loss of food sources (Echavarría *et al.*, 2006). One of the strategies for the recovery of areas degraded by grazing is reseeding with grass seeds with high forage value. However, the availability of seed for reseeding pastures and grazing lands in arid and semi-arid areas is limited, so strategies are needed to identify adapted species as a first step (Martín *et al.*, 2024). *Setaria machrostachya* Kunt. HBK, known as early grass, is a native plant of great forage importance with wide distribution in the state of Chihuahua (Melgoza *et al.*, 2008). It has been reported to contain up to 13% crude protein and 69% digestibility. However, among other factors, overgrazing has led to the reduction and disappearance of populations of this species. The wide genetic variability and morphological characteristics of the different populations will serve as the basis for their selection for various purposes in ecosystem rehabilitation (Morales-Nieto *et al.,* 2015). The objective of this study was to evaluate the foliage height and number of spikes of nine ecotypes of *Setaria machrostachya* under the same environment.

MATERIALS AND METHODS

Experimental site. The study was conducted at INIFAP's San Luis Experimental Field, located in the Palma de la Cruz ejido, Soledad de Graciano Sánchez, S.L.P. The site is located 1,850 meters above sea level, at geographical coordinates Latitude (dec): 22.228928 and Longitude (dec): -100.850599. An *ex situ* experimental plot was established on July 18, 2024. Specimens of *Setaria machrostachya* were collected in 2023 and 2024 in the states

of Tamaulipas, Coahuila, Durango, and San Luis Potosí. Three complete specimens were collected in nursery bags measuring 20 cm wide by 30 cm long; the aerial part was pruned to a height of approximately 15 cm, and each plant was identified with a collection number. Each of the ecotypes represented a population according to its place of origin. Each population was separated by a distance of approximately 100 km or 50 km if the altitude above sea level increased or decreased by 500 m.

Population origin	Altitude above sea level	Ecotype
Saltillo, Coahuila.	1815	Se.ma.1 Sl.Coah.
Villa de Guadalupe, San Luis Potosí.	1715	Se.ma.2 V.Gpe.SLP
Guadalcázar, San Luis Potosí.	1217	Se.ma.3 G.zar.SLP
Tula, Tamaulipas.	1172	Se.ma.4 Tula. Tamps.
Soledad de Graciano Sánchez, San Luis Potosí.	1838	Se.ma.5 SGS.SLP
Hidalgo, Durango.	1787	Se.ma.6. Hgo.Dgo.
Cedral, San Luis Potosí.	1649	Se.ma.7 Cdr.SLP
Salinas de Hidalgo, San Luis Potosí.	2076	Se.ma.8 SH.SLP
Ríoverde, San Luis Potosí.	997	Se.ma.9 RVR.SLP

m.a.s.l. = meters above sea level.

Table 1. Origin of ecotypes in Mexico used in the experiment.

Experimental management. Land preparation was carried out on April 29, 2024, and consisted of fallowing with a moldboard plow, two passes with a harrow, and an agricultural leveler. Transplanting was done manually, in rows of 1.5 m with a plant spacing of 1 m in a staggered arrangement. Six grass seedlings were planted of each genotype (three per row, with each row serving as a block), and *Setaria machrostachya* plants were placed as a border crop. For planting, holes 30 cm deep and 15 cm in diameter were made, one liter of water was added to each hole, and then filled with the same soil until it was 15 cm deep, where part of a clump was planted. One liter of water was added again, and for the first three days, one liter of water per plant was watered daily, and then three times a week with one liter of water. The transplant was carried out on July 18, 2024. The height and number of spikes were measured on September 13, 2024, i.e., 58 days after transplanting (ddt). Before transplanting, the plants were cut to a uniform height of approximately 10 cm. Temperatures were recorded during the evaluation period (Figure 1).

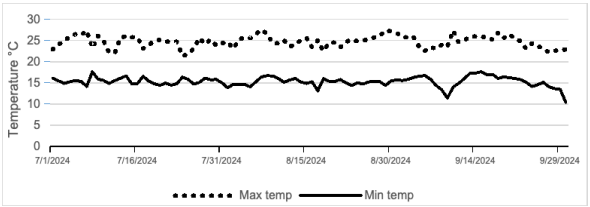

Figure 1. Average minimum and maximum temperatures during the experiment in Soledad de Graciano Sánchez, S.L.P.

Variables studied. The variables were foliage height and number of spikes per plant. The height of the plant was considered in general terms, when the set of leaves tended to incline horizontally or downward; spikes were considered to be fully open and spikes that were beginning to appear through the flag leaf sheath (spike emergence).

Data analysis. The data were subjected to analysis of variance using the SAS/STAT statistical program (2010), and the means were compared using Tukey's test ($\alpha \leq 0.05$), prior to Bartlett's homogeneity of variance. The model for foliage height variables was: $Y_{ij} = \mu + Trat_i + Bloq_j + e_{ij}$

Where Y_{ij} = is the response variable in treatment *i, repetition j*; = overall mean; effect of treatment *i*, where *i* = 1, 2, 3, …, 9; $Bloq_j$ = effect of block *j*; e_{ij} =random error.

RESULTS AND DISCUSSION

A difference was observed in foliage height ($P < 0.001$), with the Guadalcázar and Villa de Guadalupe ecotypes presenting the greatest height at 19 and 18.5 cm, respectively; while the populations from Hidalgo Durango and Ríoverde San Luis Potosí had lower heights than the first two ($P < 0.05$; Figure 2). The height of grass regrowth is an indirect way of measuring the vigor and potential of that population in the production of forage biomass. Therefore, the difference in height between ecotypes can be explained by genetic variability derived from the environmental conditions of the collection site, such as altitude, soil type, and water availability.

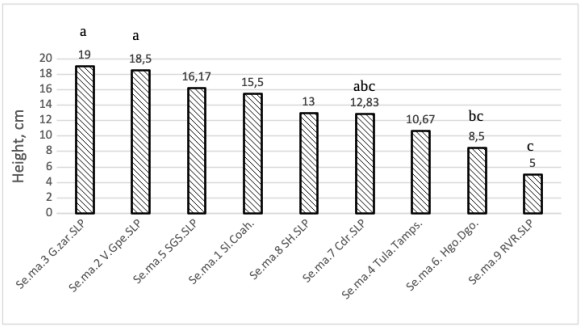

Figure 2. Foliage height of nine ecotypes of *Setaria machrostachya*, established *ex situ* under irrigation conditions, 58 days after transplanting in Soledad de Graciano Sánchez, S.L.P. a,b,c means with the same letters in bars do not differ statistically ($P>0.05$).

No difference was observed in the number of spikes per plant by origin of the early grass population ($P=0.6869$) and no block effect was detected ($P=0.7966$), with an overall average of 2.04 spikes; the results are shown in Table 2. Although no difference was found in the number of spikes per ecotype, Quero-Carrillo and Miranda-Jiménez (2023) mention that it is important to continue evaluating *Setaria machrostachya* because there is no commercial seed produced in Mexico, so this study should continue evaluating the ecotypes when they have been established for at least two years.

Ecotype	Average number of spikes per plant
Se.ma.5 SGS.SLP	3.33
Se.ma.3 G.zar.SLP	3.16
Week 2 V.Gpe.SLP	2.66
Week 7 Cdr.SLP	1.83
Week 8 SH.SLP	1.83
Week 1 Sl.Coah	1.5
Week 9 RVR.SLP	1.33
Week 4 Tula.Tamps.	0.66
Se.ma.6. Hgo.Dgo.	0

Table 2. Average number of spikes per plant of nine ecotypes of *Setaria machrostachya*, established *ex situ* under irrigation conditions, 58 days after transplanting in Soledad de Graciano Sánchez, S.L.P.

The *ex situ* collection of nine ecotypes of *Setaria machrostachya* showed wide variation in foliage height, as reported by Morales *et al.* (2015) in an evaluation of 44 populations of early grass in the state of Chihuahua, probably due to the environmental conditions of the sites of origin. In addition, Morales *et al.* (2015) found a significant correlation between dry matter production and foliage height ($r= 0.48$; $p\leq0.0009$), so in this study, the ecotypes *Se.ma.3 G.zar.SLP*, *Se.ma.2 V.Gpe.SLP*, and *Se.ma.5 SGS.SLP ecotypes* can be considered for further evaluation for forage purposes.

CONCLUSIONS

Under the same environment, the wide genetic variability of the populations was expressed in foliage height. The ecotypes *Se.ma.3 G.zar.SLP*, *Se.ma.2 V.Gpe.SLP*, and *Se.ma.5 SGS.SLP* of *Setaria machrostachya* presented the best height and can be considered for future evaluations for forage

purposes. The number of spikes per plant in the different populations did not differ under the same environment; however, it is recommended that this variable in grasses continue to be measured until the second and third years of establishment. The study is limited in the first year to establishing the plants from the different populations *ex situ*, monitoring them for one to three years, and measuring other variables such as forage quality and production, seed quantity and quality, and morphological characterization, among others.

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