BDEE 2021

sciforum

Proceedings

Forage Morphology and Productivity of Different Species of *Tripsacum* under Sub-Humid Tropical Conditions Aw$_2$.

José Francisco Villanueva-Avalos[1], Abieser Vázquez-González[1]* and Adrián-Raymundo Quero-Carrillo[2]

[1]INIFAP - Campo Experimental Santiago Ixcuintla. Km. 6 Entronque Carr. Internacional México-Nogales. Santiago Ixcuintla, Nayarit C.P. 63300. México; villanueva.francisco@inifap.gob.mx

[2]Colegio de Postgraduados en Ciencias Agrícolas-*Campus* Montecillo, Ganadería. Carretera México – Texcoco km 36.5, Montecillo, Texcoco, Estado de México. C. P. 56230. México ; queroadrian@colpos.mx

*Correspondence: vazquez.abieser@inifap.gob.mx; Tel.: +52 55 3871 8700 Ext. 84418

Abstract: Morphology and forage productivity of 25 *Tripsacum* spp. materials were characterized under tropical conditions (Aw$_2$) in Nayarit, Mexico. Treatments included: *Tripsacum latifolium, T. australe* var. Australe, *Tripsacum* spp., *T. dactyloides* (cv. Meridionale and Hispidum), *T. bravum*, *T. manisuroides*, *T. zopilotense, T. andersonii, T. lanceolatum, T. floridanum, T. laxum, T. cundinamarceae, T. intermedium*, *T. maizar*, and *T. peruvianum*. Five in row equidistant plants (1.5 m) and three rows (replicates) per species, were evaluated and fertilized using 100-60-00 per year. Variables included: plant mean height, leading flowered stem's height, plant crown circumference, basal cover, tillers per crown, forage yield and growth rates. Data was analyzed through a completely randomized design including 25 treatments (species, varieties, and/or ecotypes) and LSD tests for mean separation. Differences (P<0.01) were observed among morphological, productive variables, and species. Oustanding material included *T. latifolium* and *T. australe* (8.3 and 5.6 kg DM per plant). Forage production ranged (P<0.01) from 22% to 1405%, in comparison with the local ecotype *T. dactyloides*. Morphology and forage productivity within *Tripsacum* is highly variable, according to the genetic diversity available within this native to México genus, suggesting that *Tripsacum* agamic complex presents enormus forage production potential for its promotion under grazing for rain-fed systems.

Keywords: Tropic; *Tripsacum*; Morphology; Forage production; Growth rates

---

1. Introduction

Tripsacum spp. is a monoic, mainly diplosporic apomictic genus exclusive to the new world [1,2]; because of its resemblance to corn "maiz" it is also known as "Maicillo" or "Guatemala grass", it is considered close related to *Zea* and together with Teosintle *Zea mays* ssp. Parviglumis, historically vinculed to corn [3]. *Tripsacum* includes nearly 20 taxas distributed from USA to Paraguay [4], 12 of those concentrated in Guatemala and México, considered as centers of origin of the genus [5], showing practically all the genus' variability as well as several endemic species [6-9]. *Tripsacum* spp. agamic complex represents a source of important traits (genes) to generate, through selection or breeding, new plant materials showing outstanding traits for plant fitness and productivity: adaptation to harsh environments, higher production levels, better forage quality, better growing rates, among the main, both for wild life and domestic herds [10]. For tropical Mexico and because of *Tripsacum* spp. native condition (adaptation), it conforms a low-cost viable alternative to increase animal production [11]. Until today *Tripsacum* spp. genus forage attributes has not been well established for productivity; however it has been used as forage source, under empirical strateties, for cattle production, during many years. Experimental results on *Tripsacum* spp. forage potential are scarce and restricted to *T. dactyloides*, mainly in the United States [12-15]. Studies in Mexico have shown it is posible to obtain from 8.9 to 16.4 tons DM ha^{-1} in *T. dactyloides* and *T. andersonii* populations, respectivellym [16]. These productivity levels may be incresed up to 40 tons DM ha^{-1} in dense-well established prairies and fertilised under optimal management conditions [17].

Under tropical conditions the observed growth rates for five *Tripsacum* species fluctuated from 1g in *T. dactyloides* (dry season) to 136 g DM plant per day for *T. maizar* (rainy season), respectively. Forage production fluctuated from 1.2 to 14.8 tons DM ha^{-1} during the dry season and from 11.0 to 55.3 tons DM ha^{-1} during the rainy season, during the summer [11].

On these basis, the present study was developed in order to characterize forage morphology and productivity for 25 plant materials of *Tripsacum* spp. under tropical sub-humid (Aw_2) conditions in Nayarit, México.

2. Experiments

Experimental evaluation was developed at the National to Mexico Institute for Agriculture, Forestry, and Animal Research's (INIFAP) "El Verdineño" research station at central Nayarit at 40 meters above sea level, tropical sub-humid climate conditions (Aw_2), with a mean annual rain level of 1200 mm per year and mean temperature of 24°C, and a dry season with seven to eight months of duration [18].

Treatments included 25 plant materials among ecotypes, varieties, and species of the *Tripsacum* genus: *T. latifolium, T. australe* cv. Australe, *Tripsacum* spp. (10A, 11A, and 19A), *T. dactyloides* [cv. Meridionale, Hispidum, JJ-CH, 3B (local placebo), and 98B], *T. bravum* (4A and 6A), *T. manisuroides* (14A and 16A), *T. zopilotense, T. andersonii, T. lanceolatum* (18A and 68B), *T. floridanum, T. laxum* 36B, *T. cundinamarca, T. intermedium* (2A and 21A), *T. maizar* 7B, and *T. peruvianum*, both from the International Center for Corn and Wheat Improvement (CIMMyT; A) and local collections (B). Individual five plants rows (1.5 × 1.5 m between plants and rows) with at least five years of established, were evaluated applying 100-60-00 (N-P-K) unique fertilization during the rainy season. Both forage morphology and production were evaluated at the end of the drought season (june, 2017) with plants showing vegetative stage (mature due to drought) under a cutting interval of 210 days (end of the resting period imposed by drought); forage samples were dried to 55°C up to constant weight. Morphology measured variables included: plant height and leader stem (cm), plant crown circumference (m^2), basal coberture (cm^2), Number tillers per plant, including forage production (DM $plant^{-1}$; DM ha^{-1}), and rates of growth (DM g $plant^{-1}$ day^{-1}), as production variables. Data was analyzed using a completely randomized design with 25 treatments (plant species, ecotype, and varieties) with three replicates (row) and minimum significance test for mean separation [19].

3. Results

Forage morphology showed differences (P<0.01) among treatments for all studied variables (Table 1). Higher plant height (P<0.01) was observed for *T. australe* and *T. latifolium* with 155 and 148 cm, respectively; leader stem height was observed for *T. australe* and *T. latifolium* with 188 and 200 cm, respectively, and similar among the rest of treatments with a height higher to 130 cm. Plant's crown circumference was superior (P<0.01) for *T. latifolium* (400 cm), similar between *T. dactyloides* 98B and Meridionale with 350 and 340 cm, respectively. Regarding CB *T. latifolium* and *T. dactyloides* 98B were superior with 1294 and 998 cm^2, respectively. For tiller number *Tripsacum* spp. 11A was different (P<0.01) with 551 stems per plant. Similarly variables associated to forage production showed statistical differences (P<0.01) among *Tripsacum* plant material and *T. latifolium* with 8.3 kg DM plant^{-1} and 55.2 tons DM ha^{-1} and growth rates of 39.43 DM g plant^{-1} day^{-1}.

TABLE 1. MORPHOLOGY AND PRODUCTIVE TRAITS OF DIFFERENT *Tripsacum* SPECIES, ECOTYPES AND VARIETIES, UNDER SUB-HUMID TROPICS IN NAYARIT.

Species Cultivar/Variety	Height (cm) Plant	Height (cm) Leading Stem	Plant crown Circumference (m^2)	Basal coverture (cm^2)	Tillers per plant (number)	Forage production DM (kg plant^{-1})	Forage production DM (tons ha^{-1})	Growth rate DM (g plant^{-1} day^{-1}
T. latifolium	148 a	200 a	4.02 a	1294 a	101 efgh	8.3 a	55.2 a	39.4 a
***Tr au* var. Australe**	155 a	188 a	3.1 bcd	789 bcd	79 fghi	5.6 b	35 b	25 b
***Tripsacum* spp. 11A**	59 ijk	86 def	1.4 m	164 k	551 a	1.0 fgh	6.7 fgh	4.8 fgh
Tr da cv. meriodinale	120 b	126 bcd	3.37 abc	906 bc	74 ghi	2.3 cdefg	15.5 cdef	11.1 cdef
***T. bravum* #6A**	119 b	165 ab	1.81 jklm	264 ijk	136 def	3.0 cde	20.2 cde	14.5 cde
***Tr da* cv. JJ-Ch**	116 bc	166 ab	2.71 cdefg	592 defg	42 i	3.1 cd	20.6 cd	14.7 cd
***T. manisuroides* 14A**	110 bcd	168 ab	2.43 defgh	475 efghij	56 hi	1.7 defg	11.1 defg	7.9 def
***T. bravum* 4A**	103 bcd	161 ab	2.69 cdefg	576 defg	86 fghi	2.8 cdef	18.7 cdef	13.4 cde
T. zopilotense	99 bcde	136 abcd	2.18 ghijkl	380 fghij	202 c	1.9 cdefg	12.7 cdef	9.1 cde
T. andersonii	95 bcde	139 abcd	2.55 defgh	521 defg	29 i	1.2 defg	8.1 defg	5.8 def
***T. dactyloides* 98B**	93 cdef	144 abcd	3.53 ab	998 ab	125 defg	2.9 cde	19.6 cde	14.0 cde
***T. lanceolatum* 68B**	85 defg	133 abcd	2.11 hijklm	356 ghijk	65 hi	0.9 gh	5.8 gh	4.1 gh
T. floridanum	83 efghi	133 abcd	2.11 hijklm	356 ghijk	167 cd	1.3 defg	8.5 defg	6.1 def
***T. laxum* 36B**	81 efghi	128 bcde	2.97 bcde	704 bcde	42 i	0.7 gh	4.6 gh	3.3 gh
T. cundinamarca	79 efghi	130 abcd	2.86 bcdef	669 cdefg	132 defg	2.4 cdefg	15.8 cdef	11.3 cde
***T. lanceolatum* 18A**	79 efghi	128 bcde	2.23 fghijkl	406 efghij	152 cde	2.9 cde	19.8 cde	14.1 cde
***T. manisuroides* 16A**	79 efghi	115 bcde	2.65 defgh	560 defg	159 cde	3.6 bc	24.2 bc	17.2 bc
***Tripsacum* spp. 10A**	79 efghi	134 abcd	1.69 klm	232 jk	428 b	0.8 gh	5.1 gh	3.6 gh
***T. intermedium* #2A**	71 fghij	95 cdef	1.55 lm	195 k	182 cd	0.4 h	2.9 h	2.0 h
***T. maizar* #7B**	67 ghijk	116 bcde	2.59 defgh	536 defg	65 hi	0.7 gh	4.5 gh	3.2 gh
T. peruvianum	61 hijk	154 abc	1.71 klm	233 jk	83 fghi	1.2 efgh	7.9 efgh	5.6 efg
***T. dactyloides* #3B**	60 hijk	114 bcde	2.92 bcdef	679 cdef	31 i	0.6 gh	3.6 gh	2.62 gh
***Tr da* var. hispidum**	49 jkl	93 def	1.46 m	169 2k	75 ghi	0.7 gh	4.8 gh	3.4 gh
***T. intermedium* #21A**	44 kl	71 ef	2.34 efghij	438 efghij	149 cde	1.5 defg	10.3 defg	7.3 def

***Tripsacum* spp. 19A**	31	l	61	f	1.96	ijklm	313	hijk	37	i	0.3	h	1.9	h	1.4	h

a, b, c: Different letters within columns indicate differences (P<0.01) among species, ecotypes, and varieties.

4. Discussion

Independently of forage morphological traits and *T. latifolium*'s manifested superiority (P<0.01) for productive variables, forage production was different (P<0.01) ranged from 22 up to 1405% higher when compared to the local *T. dactyloides* 3B ecotype. The same placebo ecotype was superior in 22 y 47% in comparison to the less productive plant materials *T. intermedium* #2A and *Tripsacum* spp. 19A, respectively. Forage production obtained within the present study were similar or even higher to those reported [11,16,17], for native *Tripsacum* spp. populations. In the other hand the observed growth rate are similar to those reported for five native to western México ecotypes [11]. Under grazing, forage production should be measured on plant competition and the lowest soil exposition (highest plant cover) conditions, applying technology for an efficient harvesting moment of the produced forage, avoiding self shadowing (senescence) and harvesting too young plant regrowth, that may endanger the plant species because of mismanagement [20]; hence, the next step is to validate the valuable detected plant material under those conditions in order to define the promising plant materials for its solid promotion among cattlemen.

5. Conclusions

Both morphology and productive traits are highly variable in concordance with the wide diversity of Tripsacum genus in México. Highest forage production levels as well as growing rates were observed for T. latifolium. Twenty two of the evaluated plant material showed superior forage production performance (from 22 up to 1 405%) in comparison to the local ecotype. Tripsacum agamic complex is an important forage resource and it must be promoted as important for prairies establishment to achieve his productive potentian under grazing conditions.

Acknowledgments: To the National to Mexico Institute for Agriculture, Forestry and Animal Production Research (INIFAP) from the Ministery of Agriculture (SADER), México. For the support for the research work.
Author Contributions: José Francisco Villanueva-Avalos: field work and data analysis. Abieser Vázquez-González: field work, manuscript edition, and Adrián-Raymundo Quero-Carrillo: field work, data analysis and manuscript edition.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

LSD: Least significant difference
DM: Dry Matter
DM kg plant^{-1}: Dry matter kilogram per plant
DM plant^{-1}: Dry Matter per plant
DM ha^{-1}: Dry Matter per hectare
DM g plant^{-1} day^{-1}: Dry matter grams per plant per day

References

1. Quero, C. A.Apomixis importance for tropical forage grass selection and breeding. Review. Rev. Mex. Cienc. Pecu. 2010. 1(1): 25-42. http://www.scielo.org.mx/pdf/rmcp/v1n1/v1n1a3.pdf.

2. González, L. M.; Vera, C. P. Diversidad y distribución del género *Tripsacum* (Poaceae: Tripsacinae) en México. Univ. Autónoma Chapingo. División de Ciencias Forestales. Informe final SNIB-CONABIO, Proyecto No. FZ011. México, D.F. 2012. http://www.conabio.gob.mx/institucion/cgi-bin/datos2.cgi?Letras=FZ&Numero=11

3. Vidal, M. V.; F. Herrera C.; B. Coutiño E.; J. Sánchez G.; J. Ron P.; A. Ortega C.; J. Guerrero H. Identificación y localización de una nueva especie de *Tripsacum* spp. en Nayarit, México. Rev. Fitotecnia. 2010. (Núm. Especial 4). pp: 27-30. http://www.scielo.org.mx/pdf/rfm/v33nspe4/v33nspe4a7.pdf

4. De Wet, J. M. J., D. E. Brink, and C. E. Cohen. "Systematics of Tripsacum Section Fasciculata (Gramineae)." *American Journal of Botany* 70, no. 8 (1983): 1139-146. https://doi.org/10.2307/2443284

5. Zuloaga, Fernando O., Morrone, Osvaldo, Davidse, Gerrit, Filgueiras, Tarciso S., Peterson, Paul M., Soreng, Robert J., and Judziewicz, Emmet J. "Catalogue of New World grasses (Poaceae): III. subfamilies Panicoideae, Aristidoideae, Arundinoideae, and Danthonioideae." *Contributions from the United States National Herbarium*. 2003. 46:1–662.

6. González, L. M. Diversidad y distribución del género *Tripsacum* (Poaceae: Tripsacinae) en México. Proyecto CONABIO. 2007. 16 p. https://www.gbif.org/es/dataset/3254bb7f-4b13-444c-846e-33e43276aea0

7. Villanueva – Avalos, J.F.; D. Costich; J. F. Enríquez – Quiroz; A. R. Quero – Carrillo. *Tripsacum* spp.: Diversidad genética en México y Latinoamérica. INIFAP – CIRPAC. Campo Experimental Santiago Ixcuintla. Libro Técnico Núm. 6. Santiago Ixcuintla, Nayarit, México. 2015. ISBN: 978-607-37-0480-9. 98 p. https://www.researchgate.net/publication/295906223_Tripsacum_spp_Diversidad_genetica_en_Mexico_y_Latinoamerica

8. Villanueva – Avalos, J. F.; A. R. Quero – Carrillo. *Tripsacum* spp.: Un recurso forrajero nativo relegado en México. INIFAP – CIRPAC. Campo Experimental Santiago Ixcuintla. Libro Técnico Núm. 4. Santiago Ixcuintla, Nayarit, México. 2015. ISBN: 978-607-37-0432-8. 78 p.

https://www.researchgate.net/publication/287646205_Tropsacum_spp_UN_RECURSO_FORRAJERO_NATIVO_RELGADO_EN_MEXICO

9. Villanueva, A. J. F.; A. R. Quero C.; A. Pérez H.; M. Hernández R. *Tripsacum* spp. In: A. R. Quero C. y E. Flores A. (eds.) Gramíneas Nativas. Importancia e Impacto en Ecosistemas Ganaderos. Libro Técnico Colegio de Postgraduados. Montecillo, Texcoco, Edo. de México. 2020. pp: 62-92.
10. Springer, T. L.; L. de Wald C. Eastern gamagrass and other *Tripsacum* species. In: LE Moser, BL Burson, and LE Sollenberger (Eds.). Warm-Season (C4) Grasses. Agronomy Monograph 45. American Society of America, Soil Science Society of America, Madison, WI. 2004. pp 955-973. https://doi.org/10.2134/agronmonogr45.c29

11. Villanueva, A. J. F.; F. Herrera C.; A. Cárdenas S.; J. V. Rubio C. Comportamiento agronómico y tasas de crecimiento en cinco especies de *Tripsacum.* Congreso Mundial de Ganadería Tropical. Tampico, Tamps. México. 2014.pp: 109 - 113.

12. Brakie, M. R.; M. Adams F.; L. Young J. Yield of Eastern Gamagrass Selections as Affected by Clipping Interval and N Rates. Natural Resources Conservation Service. Plant Materials Program Eastern Gamagrass Technology. USDA-NRCS. Coffeeville, Mississippi. 2000. pp: 57 -60.

13. Douglas, J. L.; J. Houck M.; R. Brakie M.; M. Tharel L.; M. Owsley C.; L. Pfaff S. 2000. Yield, Quality and Persistence of 13 Accessions of Eastern Gamagrass. Natural Resources Conservation Service. Plant Materials Program Eastern Gamagrass Technology. USDA-NRCS. Coffeeville, Mississippi. pp: 45 -55.

14. Edwards, S. D. 2000. Clipping Effect on Yield and Quality of Eastern gamagrass, Switchgrass, and Bermudagrass. Natural Resources Conservation Service. Plant Materials Program Eastern Gamagrass Technology. USDA-NRCS. Coffeeville, Mississippi. pp: 35-40.

15. Tharel, L. M. 2000. Nutrient Utilization and Dry Matter Production of Eastern Gamagrass, Switchgrass and Old World Bluestem. Natural Resources Conservation Service. Plant Materials Program Eastern Gamagrass Technology. USDA-NRCS. Coffeeville, Mississippi. pp: 29 -32.
16. Quero, C. A. 1993. Estudio de componentes reproductivos, nivel de ploidía y morfología forrajera en el género *Tripsacum*. Tesis MC. Colegio de Postgraduados. 133 p.

17. Rodríguez, M. L. 2012. Composición química y degradabilidad *in situ* de cinco especies de *Tripsacum* spp. Tesis de Licenciatura. Universidad Tecnológica de la Costa. Santiago Ixcuintla, Nayarit. 46 p.
18. SEMAN (Sistema Estatal de Monitoreo Agroclimático Nayarit). 2007. Estación Meteorológica: El Verdineño-INIFAP.
19. Steel, R. G. D; H. Torrie J. 1985. Principios y procedimientos de bioestadística. McGraw-Hill. Ed. Interamericana. México, D. F.
20. Quero-Carrillo A. R., J. F. Villanueva-Ávalos, J. F. Enríquez-Quiroz, C. R. Morales-Nieto, E. D. Bolaños-Aguilar, J. Castillo-Huchim. J. J. Maldonado-Méndez y F. Herrera-Cedano. Manual de Evaluación de Recursos Genéticos de Gramíneas y Leguminosas Forrajeras. INIFAP-CIRPAC. Campo Experimental Santiago Ixcuintla. 2012. Folleto Técnico Núm. 22. Santiago Ixcuintla, Nayarit. México 41p. DOI: 10.13140/2.1.4642.8481