Forage Paper

Forage Morphology and Productivity of Different Species of *Tripsacum* under Sub-Humid Tropical Conditions †

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Abstract: Morphology and forage productivity of 25 *Tripsacum* spp. materials were characterized under tropical conditions in Nayarit, Mexico. Treatments included: *Tripsacum latifolium*, *T. australe* var. Australe, *Tripsacum* spp., *T. dactyloides* (cv. Meridionale and Hispidum), *T. bracum*, *T. manisuroides*, *T. zopilote*, *T. andersonii*, *T. lanceolatum*, *T. floridanum*, *T. laxum*, *T. cundinamarcae*, *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 (N-P-K units) per hectare per year. Variables included: plant mean height, leading flowering 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. Outstanding 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 Mexico genus, suggesting that *Tripsacum* agamic complex presents enormous 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 American continent [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* sub-species Parviglumis, close related to corn [3]. *Tripsacum* includes nearly 20 taxa distributed from USA to Paraguay [4], 12 of those concentrated in Guatemala and Mexico, 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, 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 support animal production [11]. To date, *Tripsacum* spp. genus forage attributes have not been well established for productivity; however, it has been used as a forage source, under empirical strategies, for cattle production, for 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 possible to obtain from 8.9 to 16.4 tons DM ha\(^{-1}\) in *T. dactyloides* and *T. andersonii* populations, respectively [16]. These productivity levels may be increased up to 40 tons DM ha\(^{-1}\) in dense, well-established prairies and fertilized 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 summer rainy season [11].

On this basis, the present study was developed to characterize forage morphology and productivity for 25 plant materials of *Tripsacum* spp. under tropical sub-humid conditions in Nayarit, Mexico.

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 m 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. braeam* (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) that had been established for at least five years, 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 coverture (cm\(^2\)), number of 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 least significant difference 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. The 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 per crown *Tripsacum* spp. 11A was different \((p < 0.01)\) with 551 tillers per plant crown. Similarly, variables associated with 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.

<table>
<thead>
<tr>
<th>Species</th>
<th>Variety</th>
<th>Height (cm)</th>
<th>Plant crown</th>
<th>Basal coverture</th>
<th>Tillers per plant</th>
<th>DM (kg Plant⁻¹)</th>
<th>DM (Tons ha⁻¹)</th>
<th>DM (g Plant⁻¹ Day⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. latifolium</td>
<td>148</td>
<td>200</td>
<td>4.02</td>
<td>1294</td>
<td>10 efgh</td>
<td>8.3</td>
<td>55.2</td>
<td>39.4</td>
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<tr>
<td>T. australis</td>
<td>155</td>
<td>188</td>
<td>3.15</td>
<td>789</td>
<td>79 efgh</td>
<td>5.6</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td>Tripsacum spp. 11A</td>
<td>59</td>
<td>86</td>
<td>1.4</td>
<td>164</td>
<td>551 a</td>
<td>1.0</td>
<td>6.7</td>
<td>4.8</td>
</tr>
<tr>
<td>T. dactyloides, meridionale</td>
<td>120</td>
<td>126</td>
<td>3.37</td>
<td>906</td>
<td>74 efgh</td>
<td>2.3</td>
<td>15.5</td>
<td>11.1</td>
</tr>
<tr>
<td>T. bravum 6A</td>
<td>119</td>
<td>165</td>
<td>1.81</td>
<td>264</td>
<td>136 defg</td>
<td>3.0</td>
<td>20.2</td>
<td>14.5</td>
</tr>
<tr>
<td>T. dactyloides JJ-Ch</td>
<td>116</td>
<td>166</td>
<td>2.71</td>
<td>592</td>
<td>42 i</td>
<td>3.1</td>
<td>20.6</td>
<td>14.7</td>
</tr>
<tr>
<td>T. manisaroides 14A</td>
<td>110</td>
<td>168</td>
<td>2.43</td>
<td>475</td>
<td>56 hi</td>
<td>1.7</td>
<td>11.1</td>
<td>7.9</td>
</tr>
<tr>
<td>T. bravum 4A</td>
<td>103</td>
<td>161</td>
<td>2.69</td>
<td>576</td>
<td>86 efgh</td>
<td>2.8</td>
<td>18.7</td>
<td>13.4</td>
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<tr>
<td>T. zopilotense</td>
<td>99</td>
<td>126</td>
<td>2.18</td>
<td>380</td>
<td>202 b</td>
<td>1.9</td>
<td>12.7</td>
<td>9.1</td>
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<tr>
<td>T. andersonii</td>
<td>95</td>
<td>139</td>
<td>2.55</td>
<td>521</td>
<td>29 i</td>
<td>1.2</td>
<td>8.1</td>
<td>5.8</td>
</tr>
<tr>
<td>T. dactyloides 98B</td>
<td>93</td>
<td>144</td>
<td>3.53</td>
<td>998</td>
<td>125 defg</td>
<td>2.9</td>
<td>19.6</td>
<td>14.0</td>
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<tr>
<td>T. lanceolatum 68B</td>
<td>85</td>
<td>133</td>
<td>2.11</td>
<td>356</td>
<td>65 hi</td>
<td>0.9</td>
<td>5.8</td>
<td>4.1</td>
</tr>
<tr>
<td>T. floridanum</td>
<td>83</td>
<td>133</td>
<td>2.11</td>
<td>356</td>
<td>167 cd</td>
<td>1.3</td>
<td>8.5</td>
<td>6.1</td>
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<tr>
<td>T. laxum 36B</td>
<td>81</td>
<td>128</td>
<td>2.97</td>
<td>704</td>
<td>42 i</td>
<td>0.7</td>
<td>4.6</td>
<td>3.3</td>
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<tr>
<td>T. cundinamarcaee</td>
<td>79</td>
<td>130</td>
<td>2.86</td>
<td>669</td>
<td>132 defg</td>
<td>2.4</td>
<td>15.8</td>
<td>11.3</td>
</tr>
<tr>
<td>T. lanceolatum 18A</td>
<td>79</td>
<td>128</td>
<td>2.23</td>
<td>406</td>
<td>152 cd</td>
<td>2.9</td>
<td>19.8</td>
<td>14.1</td>
</tr>
<tr>
<td>T. manisaroides 16A</td>
<td>79</td>
<td>115</td>
<td>2.65</td>
<td>560</td>
<td>159 defg</td>
<td>3.6</td>
<td>24.2</td>
<td>17.2</td>
</tr>
<tr>
<td>Tripsacum spp. 10A</td>
<td>79</td>
<td>134</td>
<td>1.69</td>
<td>232</td>
<td>425 b</td>
<td>0.8</td>
<td>5.1</td>
<td>3.6</td>
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<tr>
<td>T. intermedium 2A</td>
<td>71</td>
<td>95</td>
<td>1.55</td>
<td>195</td>
<td>182 cd</td>
<td>0.4</td>
<td>2.9</td>
<td>2.0</td>
</tr>
<tr>
<td>T. nitiz 7B</td>
<td>67</td>
<td>116</td>
<td>2.59</td>
<td>536</td>
<td>65 hi</td>
<td>0.7</td>
<td>4.5</td>
<td>3.2</td>
</tr>
<tr>
<td>T. peruvianum</td>
<td>61</td>
<td>154</td>
<td>1.71</td>
<td>233</td>
<td>83 efgh</td>
<td>1.2</td>
<td>7.9</td>
<td>5.6</td>
</tr>
<tr>
<td>T. dactyloides 3B</td>
<td>60</td>
<td>114</td>
<td>2.92</td>
<td>679</td>
<td>31 i</td>
<td>0.6</td>
<td>3.6</td>
<td>2.6</td>
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<tr>
<td>T. dactyloides,Hispidium</td>
<td>49</td>
<td>93</td>
<td>1.46</td>
<td>169</td>
<td>75 hi</td>
<td>0.7</td>
<td>4.8</td>
<td>3.4</td>
</tr>
<tr>
<td>T. intermedium 21A</td>
<td>44</td>
<td>71</td>
<td>2.34</td>
<td>438</td>
<td>149 cde</td>
<td>1.5</td>
<td>10.3</td>
<td>7.3</td>
</tr>
<tr>
<td>Tripsacum spp. 19A</td>
<td>31</td>
<td>61</td>
<td>1.96</td>
<td>313</td>
<td>37 i</td>
<td>0.5</td>
<td>1.9</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Different letters within columns indicate differences (p < 0.01) among species, ecotypes, and varieties.

4. Discussion

Plant genetic resources have been important basis as source of genetic diversity for forage species. Plant collection within the center of species origin represents the first important step toward plant improvement [20] and its evaluation promises important technical advancements. Mexico represents an important center of diversity for several important crops such as corn, avocado, squash, cocoa, tomato, etc.; however, few grass (Poaceae) tropical forage species have evolved there [21]. Tropical genera such as *Hymenachne* spp., *Paspalum* spp., *Echinochloa* spp., and *Tripsacum* represent native to Mexico grass valuable genera to study [22]. Independently of forage morphological traits *T. latifolium* manifested superiority (p < 0.01) for productive variables. Forage production was different (p < 0.01) ranging from 22 to 1405% higher when compared to the local *T. dactyloides* 3B ecotype. The local ecotype was superior in 22 y 47% in comparison to the less productive material *T. intermedium* 2A and *Tripsacum spp.* 19A, respectively. These results are informative on the wide variability for forage production. Forage production obtained within the present study were similar or even higher to those reported [11,16,17], for native *Tripsacum* spp. populations. On the other hand, the observed growth rate is similar to those reported for five native to western Mexico ecotypes [11]. Under grazing, forage production should be measured on plant competition conditions, applying technology for efficient harvesting, avoiding both self-shadowing (senescence) and harvesting too young plant regrowth, that may endanger the crop because of mismanagement [20]. Evaluating commercial diploid varieties (Pete, Iuka) in the central plateau of Mexico (2240 masl) in comparison with native to Mexico ecotypes, the superiority of polyploid native ecotypes was confirmed for dry matter production [23]. Then, the next step is to validate the valuable detected
plant material under plant competition 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 Mexico. Highest forage production levels as well as growing rates were observed for *T. latifolium*. Twenty-two of the evaluated plant materials showed superior forage production performance (from 22 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 rain-fed prairies establishment to achieve its productive potential under grazing conditions.

Supplementary Materials: The video presentation is available online at https://sciforum.net/event/BDEE2021/keynote/fe87c2c6b9ae63e0fe3756d5c3b85e16/presentation_video/sciforum-043575.mp4 (Accessed on: 23 December 2021).

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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 ha\(^{-1}\) Dry matter per hectare

References


