# Heritability and genotypic correlation between plant height and number of branches during the initial growth of *Stylosanthes guianensis*[1]

## Herdabilidade e correlações genotípicas entre altura da planta e número de ramos durante o crescimento inicial de *Stylosanthes guianensis*[1]

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[1]This research was supported by FUNDUNESP.

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**Abstract**

This research determined the heritability and the genotypic correlation between plant height and number of branches of 16 *Stylosanthes guianensis* (Aubl.) Sw. accessions, whose seeds were obtained from the "Banco Ativo de Germoplasma Forrageiro, EMBRAPA Cerrados". The following genetic parameters were estimated: heritability ($h^2m$), coefficient of genetic variation (CVg), coefficient of environmental variation (CVe) and genotypic correlations between the two traits, during different stages of the initial growth of *S. guianensis*. The experiment was carried out in a randomized block design with four repetitions, consisting of five plants per repetition. The results showed that there is high genetic variability among the accessions under observation, indicating that a selection program with the most efficient materials would lead to genetic improvements. Plant height shows high genotypic correlation in the different growing stages. It is an indication that it is possible to have the same gene pool, which determines the manifestation of plant height over time, and that the selection should be carried out in the earlier growing stages. The genotypic correlation between plant height and number of branches is of low magnitude. This suggests that, at least, some of the genes involved in these traits are, probably, independent. In this case, the selection of one of these growth traits does not necessarily improve the other one.

**Additional keywords:** forage legume, genetics improvement, genetic parameters.

**Resumo**

O presente trabalho objetivou determinar a herdabilidade e correlações genotípicas entre altura de planta e número de ramos de *Stylosanthes guianensis* (Aubl.) Sw. Foram analisados 16 acessos de *S. guianensis*, cujas sementes foram obtidas do Banco Ativo de Germoplasma Forrageiro da EMBRAPA Cerrados. Foram estimados os parâmetros genéticos herdabilidade ($h^2m$), coeficiente de variação genética (CVg), coeficiente de variação ambiental (Cve), além das correlações genotípicas entre os dois caracteres, durante diferentes estádios de crescimento inicial de *S. guianensis*. O delineamento foi em blocos casualizados com quatro repetições de cinco plantas. Verificou-se que existe ampla variabilidade genética entre os acessos avaliados, possibilitando ganhos genéticos em programas de seleção. O caráter altura de planta apresentou elevados valores de correlação genotípica nos diferentes estádios de crescimento, indicando a possibilidade de ocorrência de um mesmo conjunto gênico na manifestação deste caráter ao longo do tempo, e a possibilidade de se realizar seleção nos primeiros estádios de crescimento da planta. As correlações genotípicas entre altura de planta e número de ramos foram, em geral, de baixa magnitude, indicando que, pelo menos, alguns dos genes envolvidos na expressão destes caracteres são, provavelmente, independentes.

**Palavras-chave adicionais:** estilosantes, leguminosa forrageira, melhoramento genético, parâmetros genéticos.

## Introduction

About 100 million hectares are used for pasture production in Brazil – almost twice the area used for grain production. Legume forages improve pasture nutritive properties, mainly in the dry season, and also contributes to fertilization through symbiotic Nitrogen (N) fixation (PEREIRA et al., 2001). Because of such characteristics, many species of legume forages have been used, not only in pastures, but also in other agricultural systems. According to KARIA et al. (2001), efforts are focusing on selection and improvement of new materials adapted to specific conditions.

The improvement of forage plants has some particularities because the aim is not only to enhance plant productivity, but also to increase animal production (FERREIRA & PEREIRA, 1999). In fact, the quality of the final animal product (meat, milk, wool) is assessed from plant characteristics such as height and dry matter production (KARIA et al., 2001). The primary traits selected in forage plants are high dry-matter yield, persistence, adaptation to stressful environmental conditions, seed quality and production (CAMERON et al., 1997). However, once a specific genetic trait is selected, other correlated traits may be modified, thus reinforcing the need for selecting a set of traits of interest (PAULA et al*.,* 2002).

Considering pasture legumes, evaluation of traits, such as competitive skills and persistence, is crucial because these plants are used in agricultural systems where plant diversification is high and reaching a dynamic equilibrium with other species is a great challenge. The competitive ability and the persistence of the plant may be assessed from plant growth dynamic (EDYE, 1997), *i.e.*, plant height, number of branches and leaves, and dry matter yield.

The Brazilian legume forage *Stylosanthes guianensis* (Aubl.) Sw. (Fabaceae) has high potential for genetic improvement (VALLS et al., 1994). Considering other legumes, *S. guianensis* exhibits high production of dry matter in either wet or dry seasons, high percentage of soil cover, and high adaptation level (DAHER et al., 2001; COSTA et al., 2001). This species results in high productivity in pastures mixed with *Brachiaria decumbens* (MESQUITA et al., 2001) and is highly tolerant to saline stress (LOVATO & MARTINS,1997; GONELA et al*.,* 2004).

Many studies have shown the wide variety of physiological properties in *S. guianensis*, which provide persistence and adaptation to different environmental conditions and also high productivity (PATERNIANI, et al.,1999[a,b]; 2001[a,b]). Because of such characteristics, this species has been indicated for planting in Cerrado's grass-legume mixed pastures or in association with annual and perennial crops; it has been also indicated as protein bank and green manure. Furthermore, techniques for genetic transformation have been fitted to the genetic improvement of *S. guianensis* due to the high utilization potential of this plant (VALARINI et al., 1997; QUECINI, et al., 2002).

The present study determined the heritability and genotypic correlation between two physiological traits associated with competitive ability, plant height and number of branches, during the early growth of 16 *S. guianensis* accessions. Although other studies showed that some traits of *S. guianensis* may be used in genetic improvement, the present work is the first to focus on characteristics related to competitive ability .

## Materials and Methods

*Stylosanthes guianensis* seeds were obtained from the Banco Ativo de Germoplasma Forrageiro, EMBRAPA Cerrados. Sixteen accessions were evaluated: CPAC 4144, 4227, 4234 (var. *canescens*), CPAC 1371, 4285 (var. *microcephala*), CPAC 1109, 1118, 1134, 2769, cv. Bandeirante (var. *pauciflora*), CPAC 1314, 4316, 4323, 4332, cv. Cook and cv. Mineirão (var. *vulgaris*).

The experiment was carried out in a randomized block design with four repetitions, five plants per repetition. The same plants were observed at 5 ages. Thus, 100 seeds of each variety were planted in individual pots filled with a 3:1 soil-to-sand mixture. The pots were kept in a non-covered area and were watered daily during the experiment. Plant height (cm) and number of branches were measured 60, 75, 90, 105 and 120 days after seedlings had emerged. On these days, the following genetic parameters were estimated: heritability ($h^2m$), coefficient of genetic variation (CVg), coefficient of environmental variation (CVe), and genotypic correlations between plant height and number of branches. Growth data were transformed as $\sqrt{x+0.5}$ and then means were analyzed by one-way ANOVA. The software GENES was used for analyzing the genetic variables (CRUZ, 1997).

## Results and Discussion

ANOVA results and the descriptive and genetic analyses are in Table 1. Height and number of branches were different among *S. guianensis* accessions (ANOVA, $P<0.01$), except for the number of branches on days 75 and 90.

These results indicate the growth variability of *S. guianensis* accessions, strongly suggesting that a selection program with the most efficient accessions would lead to genetic improvements.

**Table 1 -** ANOVA (mean square) and descriptive and genetic analyses of plant height and number of branches in 16 accessions of *Stylosanthes guianensis* from 5 observation ages (d).

| | Analyses | Df | Height | | | | | Number of branches | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 60 d | 75 d | 90 d | 105 d | 120 d | 60 d | 75 d | 90 d | 105 d | 120 d |
| ANOVA | Blocks | 3 | 25.12 | 31.38 | 37.99 | 104.72 | 105.73 | 0.15 | 0.14 | 0.21 | 0.23 | 0.16 |
| | Accessions | 15 | 51.80** | 105.28** | 178.64** | 258.5** | 360.15** | 0.24** | 0.15ns | 0.09ns | 0.11** | 0.11** |
| | Residual | 45 | 10.58 | 13.32 | 11.99 | 16.58 | 19.65 | 0.09 | 0.09 | 0.05 | 0.04 | 0.03 |
| Descrip. | CV exp | | 19.02 | 14.75 | 11.80 | 11.53 | 10.69 | 9.83 | 8.90 | 5.32 | 4.64 | 4.18 |
| | Mean | | 17.10 | 4.74 | 29.34 | 35.33 | 41.48 | 3.10 | 3.44 | 4.03 | 4.15 | 4.21 |
| Genetics | $h^2m$ | | 0.80 | 0.87 | 0.93 | 0.94 | 0.95 | 0.61 | 0.39 | 0.47 | 0.65 | 0.71 |
| | CVg | | 18.77 | 19.38 | 22.00 | 22.01 | 22.24 | 6.09 | 3.54 | 2.50 | 3.19 | 3.31 |
| | CVg/CVe | | 0.99 | 1.31 | 1.86 | 1.91 | 2.08 | 0.62 | 0.40 | 0.47 | 0.69 | 0.79 |

** = P< 0.01
ns = P > 0.05
CV exp = experimental coefficient of variation
$h^2m$ = heritability coefficient
CVg = genetic coefficient of variation
CVe = environmental coefficient of variation

*S. guianensis* height heritability ($h^2m$) was already high in the earlier observations and increased over time. A similar profile was found when height was analyzed by CVg and the ratio CVg/CVe. These results indicate that *S. guianensis*' height may be successfully selected among genetic traits and that environmental pressure is stronger only in the first stages of vegetal growth.

The genetic variability found for number of branches was lower than that of plant height. The CVg decreased over time, while the higher values for $h^2m$ and CVg/CVe occurred on day 120. This is a consequence of the environmental variation which decreased more than did the genetic one.

The estimates for genotypic correlation (rg) between the studied characters of the 16 accessions of *S. guianensis* from the five ages of observation are shown in Table 2. The genotypic correlations among plant heights were higher than 0.94, while the genotypic correlation among the number of branches was lower and varied within a broad range (0.55<rg < 0.99). High levels of genotypic correlation for a same characteristic in different evaluation periods suggest the occurrence of a same gene pool expressing this trait over time. In general, the genotypic correlation between plant height and number of branches was of low magnitude (rg < 0.60), indicating that at least some genes enrolled in the expression of these traits are independent.

**Table 2 -** Genotypic correlations (rg) between plant height and number of branches on the observation ages (days).

| | Days | Height | | | | | Number of branches | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 60 | 75 | 90 | 105 | 120 | 60 | 75 | 90 | 105 | 120 |
| Height | 60 | - | 0.97 | 0.94 | 0.94 | 0.95 | 0.60 | 0.60 | 0.77 | 0.68 | 0.54 |
| | 75 | | - | 0.99 | 0.99 | 0.97 | 0.49 | 0.37 | 0.67 | 0.62 | 0.45 |
| | 90 | | | - | 0.99 | 0.97 | 0.37 | 0.29 | 0.62 | 0.57 | 0.41 |
| | 105 | | | | - | 0.99 | 0.37 | 0.29 | 0.65 | 0.61 | 0.46 |
| | 120 | | | | | - | 0.43 | 0.45 | 0.78 | 0.74 | 0.61 |
| Number of branches | 60 | | | | | | - | 0.86 | 0.77 | 0.58 | 0.55 |
| | 75 | | | | | | | - | 0.88 | 0.77 | 0.83 |
| | 90 | | | | | | | | - | 0.99 | 0.99 |
| | 105 | | | | | | | | | - | 0.98 |
| | 120 | | | | | | | | | | - |

Many traits should be simultaneously analyzed for improving forage plants. In a field experiment, PONTES et al. (1983) evaluated 25 populations of *S. guianensis* and found positive genotypic and phenotypic correlation among six traits of agronomic importance. These authors concluded that some characteristics may be improved indirectly through selection of the correlated traits.

## Conclusion

The high genetic variability among the 16 *Stylosanthes guianensis* accessions tested indicates that a selection program with the most efficient materials would lead to genetic improvements.

A same gene pool is likely to be involved in the manifestation of plant height over time and selection should be carried out in the earlier developmental stages.

The genotypic correlation between plant height and number of branches is of low magnitude, thus suggesting that some genes involved are independent. In this case, selection of one of these growth traits does not necessarily improve the other trait.

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Recebido em 11-06-2005

Aprovado para publicação em 20-07-2006