Influence of propagule node number and planting frame on the growth of Trichanthera gigantea

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ABSTRACT

In order to evaluate the growth of *Trichanthera gigantea* plants two experiments were conducted, the first one under nursery conditions, in which propagules with different number of nodes were used; and a second trial was carried out under field conditions, with two planting frames. In the first one a completely randomized design was used and in the second the design consisted in randomized blocks. The *T. gigantea* propagules with three nodes provided a higher amount of shoots per stake (6), with a higher length (4,27 cm). In the field, after 11 months, plants taller than 160 cm and with many branches were obtained. The leaves reached 24 cm long and 12 cm wide, independently from the planting frame used. In the 0,75 m^2-frame, yields of 533 kg DM/ha for the leaves and of 373,0 kg DM/ha for the fresh stems were observed, which was highly significant in comparison with the 1,0 m^2-frame (213 and 135 kg DM/ha for the leaves and fresh stems, respectively). It is concluded that it is possible to use stakes of *T. gigantea* plants with different number of nodes for the establishment in nursery, although the propagules with three nodes provided a higher amount of shoots. Likewise, the use of a 0,75 m^2-plantation frame allowed to obtain higher yields in dry foliage as compared to the 1,0 m^2-frame; therefore, to use propagules with three nodes and a planting frame of 0,75 m^2 for the propagation of *T. gigantea* is recommended.

Key words: nodes, *Trichanthera gigantea*, nurseries

INTRODUCTION

The use of forage trees and shrubs constitutes an alternative for the agricultural sector, but the lack of knowledge about their characteristics of economic importance limits their use as forage species in protein banks or in silvopastoral systems, within the framework of sustainable agriculture (Posso *et al.,* 2011). The implementation of low-cost technologies, whose short-term benefit can be observed in a sustained increase of animal production, is possible through the use of forage trees (Suárez *et al.,* 2008).

Trichanthera gigantea is an *Acanthaceae* from the northern Andean region, to which applications in water conservation and as living fences and animal feed are ascribed, among others. In addition, it has the capacity of producing high levels of green forage during the year (Arosemena, 2009). This plant offers many advantages for its use as forage source, because it has high protein content, high digestibility and good acceptability by livestock (Savón *et al.,* 2006). Its use as animal feed has been studied in different animal species, fundamentally in pigs, rabbits, chicken and sheep (Acosta *et al.,* 2006).

Many studies have demonstrated that planting density is closely related to biomass production in plants used as forage. Funaro and Paccapelo (2005) obtained the highest dry matter values of leaves and whole plant in forage corn when using a planting density of five plants per square meter depending on the genotype used. Boschini *et al.* (1998), when studying the effect of planting distance in mulberry (*Morus alba*), determined that this had strong incidence on plant production, and a non-lineal trend to decrease yield as the distance increased was observed. In studies conducted by Vega and Lamela (2003) it was determined that the planting frame did not influence the establishment period, stem diameter, canopy width and height of *Leucaena leucocephala.*

In Cuba *T. gigantea* is little known and its distribution is very scarce, because it is principally limited to research centers and small areas of seed banks. In the eastern zone its presence is even scarcer and there is no evidence that its morphological and productive response has been evaluated under the conditions of this region.

The objective of this work was to determine the effect of propagule node number on the growth of *T. gigantea* plants, under nursery conditions; as well as the effect of the planting frame on the expression of some indicators of its growth under field conditions.

MATERIALS AND METHODS

Two experiments were conducted, at the Center of Plant Biotechnology Studies and at the experimental area of the School of Agricultural Sciences of the University of Granma (Granma province, Cuba), during the period between November, 2010 and October, 2011.

- Experiment 1. Effect of propagule node number on the growth of *T. gigantea* plants under nursery conditions

Treatments and design

The design was completely randomized and 20 propagules (stakes) were used for each treatment, with three repetitions, for a total of 60 per each. The treatments, in correspondence with the node number of the propagules, were: T1: stakes with a node, T2: stakes with two nodes, and T3: stakes with three nodes.

Experimental procedure

The propagules were obtained from the germplasm bank of the Center of Plant Biotechnology Studies. They were cut into different sizes with regards to the treatment, with a diagonal cut in the basal extreme (to facilitate rooting), and then all the leaves were eliminated

The stakes were planted in black polyethylene bags, on a substratum formed by a mixture of soil-totally decomposed cattle manure (1:1 ratio). The light was regulated with the use of a black mesh. During the first week after sowing, irrigation was carried out daily for 20 minutes with micro-sprinklers; afterwards, the frequency was diminished to three times per week.

At 15 and 30 days after sowing, the following variables were evaluated in all plants: number of stakes with shooting, number of shoots per stake and number of leaves per shoot.

- Experiment 2. Response of *T. gigantea* plants to the planting frame under field conditions.

Sprouted and rooted stakes from the nursery were used as planting material.

Treatments and design

The design was randomized blocks with three repetitions. Each block was formed by two rows of 10 plants, for a total of 20 per block and 60 for each treatment. The blocks were separated by a distance of one meter between them. Two planting frames were evaluated: T1: 0,75 m^2, and T2: 1 m^2

Experimental procedure

Sowing was performed in October, 2010, on a flat soil classified as Brown with Carbonates (Hernández *et al.,* 1999). The clearing and ploughing were done at 0,50 m deep, with a tractor; and the crossing and plowing were made with the use of animal traction. The plants were placed in a hole 10 cm deep and with a diameter of 8 cm, and the polyethylene bags were removed at the moment of sowing.

During the first four weeks after sowing manual irrigation was performed, always when it was necessary to maintain the soil humidity. Later, it was done only during high drought periods. Fertilization was applied every three months, adding one kilogram of totally decomposed cattle manure on each plant stem basis.

Measurements . Twenty days after sowing, the survival of the stakes was evaluated, through the count of living plants in relation to the total of planted stakes. After 3, 5, 7, 9 and 11 months 10 plants were randomly chosen per block and the following variables were evaluated: plant height (cm), number of branches per plant, leaf length (cm) and leaf width (cm).

The foliage was cut at11 months, at a height of 0,70 m above the soil, with pruning shears. This cut was used to evaluate dry mass (kilograms of dry matter per hectare) of the leaves and fresh stems. The plant material was dried in an oven at 85 °C during 72 h, until reaching a constant weight; then it was weighed with a digital scale (Sartorius®).

Statistical analysis

The experiment data under nursery conditions were subject to a simple variance analysis; Tukey's multiple range test was applied when there were significant differences among the means, for $p < 0,05$. For the data of the field experiment, an analysis of sample inference between two populations was used, for independent samples; the statistical pack STATISTICA version 8.0 for Windows was used.

RESULTS AND DISCUSSION

- Experiment 1

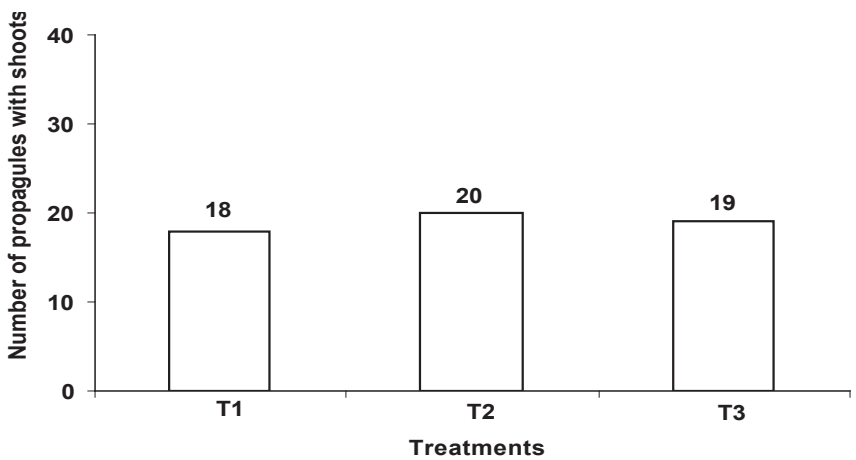
Figure 1 shows the number of propagules with shoots. There were no significant differences between the treatments and in all cases there were values over 90 %.

These results indicate that when the light and humidity conditions are maintained, and the cultural attentions are adequately performed, high shooting percentages of *T. gigantea* propagules can be obtained under nursery conditions, independently from the number of nodes they have.

The number of shoots per propagule (table 1) had significant differences between the treatments. The highest value (6) was obtained when propagules with three nodes were used, followed by the treatment where stakes with two nodes were used. At the cutting time the shooting of all the auxiliary buds that were in a dormant state in the stakes occurred.

After 30 days, the leaf number per shoot (table 1) did not show significant differences between the treatments and in all of them values higher than four leaves per shoot were achieved. It was evident that in this crop a fast growth of the shoots occurred, as well as the formation of new leaves during the nursery phase. Likewise, it is possible to use stakes of different sizes for the propagation of *T. gigantea*, with high shooting values; however, the ones with three nodes provided a higher number of shoots in comparison with the ones with one or two nodes. These results coincide with those reported by Milera *et al*. (1996), who obtained a higher shooting of *T. gigantea* stakes by using propagules with three and four nodes (100 % shooting), with regards to that obtained using stakes with one and two nodes.

The results reported by Vargas *et al*. (2000) are also similar to the ones obtained in this work. These authors obtained more than 87 % of survival by using stakes of *T. gigantea* with three nodes, and the initial regrowths appeared within the first 30 days after planting.



T1: propagules with one node, T2: propagules with two nodes, T3: propagules with three nodes, SE ± 0,25

Figure 1. Number of propagules with shoots in the different treatments.

Table 1. Effect of the number of nodes of the stakes on the shoot and leaf number 30 days after sowing.

Treatment	Shoots/stakes	Leaves/shoot
Propagules with one node	2,0^{c}	5,0
Propagules with two nodes	4,0^{b}	5,0
Propagules with three nodes	6,0^{a}	5,0
ES ±	0,14*	0,09

a, b, c: means with different letters for a same column differ statistically, according to Tukey (1952). * $p < 0,05$

• Experiment 2

Table 2 shows plant height at different evaluation moments. There were no significant differences between the treatments, which indicates that the planting frame did not influence such indicator.

In general, a continuous increase of height was observed, although less marked during the first seven months, which could be related to the slow rate that trees show in the first stages of growth and development. In the initial months the plants were in establishment; therefore, significant effects on the growth variables should not be expected, because they had not yet achieved maximum growth. Since the seven months and up to 11 months, a faster growth occurred, which indicates that they maintained a constant growth.

Jiménez (2006) reported height values of *T. gigantea* plants of 48,5 and 66,4 cm after three and six months, respectively, which were higher than the ones reached in this work; this can be associated to the edaphoclimatic conditions under which the essay was conducted. Vega and Lamela (2003), when studying the effect of planting frame on the agronomic performance of *L. leucocephala* (another forage shrubby plant) in association with pasture, found significant differences for the height of leucaena at two moments of the evaluation cycle; but those differences disappeared in all the treatments, when the plants reached 2 m, 12 months after planting.

Gómez *et al*. (2008), when studying the effect of planting frame on the production of living fences of *Gliricidia sepium*, observed significant differences in plant height among the distances between plants, during the first and second year, and the highest values were obtained in the shortest distance. However, during the third year the results were similar.

Table 3 shows the number of branches per plant. At 11 months the plants showed significant differences, which was favorable for the planting frame of 0,75 m^2.

This result could be caused by the fact that after 11 months the plants were taller, as compared to the previous months, and this caused an increase of the shade level and a higher competition among them in the frame of 0,75 m^2, with regards to the ones planted at one meter of distance. This could influence the development of a higher number of branches. Similar results were obtained by Gómez *et al.* (2008), when evaluating the effect of the planting distance in *G. sepium* in relation to the number of main shoots during the third year after planting; the best performance corresponded to the lower planting frame (50 x 60 cm), which was ascribed to the influence of shade in the treatments with higher density of plantlets.

The leaf length and width (table 4) increased progressively as the planting time passed by, without differences between the frames used for this objective. After 11 months leaves of a similar size to the one reported for this crop were obtained (Ceballos, 2009), which constitutes an important aspect if it is considered that leaves are the plant part most used as animal feed.

In this sense, Jiménez (2006) obtained values of 22,12 and 11,87 cm for leaf length and width of

Table 2. Effect of planting frame on plant height.

Planting frame (m^2)	Height (cm)				
	3 months	5 months	7 months	9 months	11 months
0,75	25,0	43,0	56,0	101,0	162,0
1,0	18,0	41,0	55,0	99,0	161,0
SE ±	0,58	0,29	0,23	0,29	0,18

Table 3. Effect of planting frame on the number of branches.

Planting frame (m^2)	Number of branches/plant				
	3 months	5 months	7 months	9 months	11 months
0,75	6,0	11,0	16,0	17,0	41,0
1,0	7,0	12,0	17,0	17,0	26,0
SE ±	0,13	0,14	0,15	0,13	1,24*

* $p < 0,05$ (Tukey, 1952).

Table 4. Effect of planting frame on leaf length and width.

Planting frame (m^2)	Leaf lenght (cm)			Leaf width (cm)		
	3 months	7 months	11 months	3 months	7 months	11 months
0,75	7,0	13,0	23,0	4,0	9,0	12,0
1,0	7,0	13,0	25,0	4,0	8,0	12,0
SE ±	0,09	0,12	0,11	0,14	0,09	0,12

T. gigantea plants cultivated under full sunlight, results that are very similar to the ones obtained in this work.

Table 5 shows the dry mass values of leaves and fresh stems, which were significantly higher when using the planting frame of 0,75 m^2.

These results were obtained because by using the planting frame of 0,75 m^2 a higher density of plants per area is achieved (13 333,3 plants/ha) and –thus– a higher dry foliage amount, as compared to a frame of 1 m^2 (10 000 plants/ha), in which a lower amount of foliage per planted area is obtained.

In the evaluation of the effect of planting distance on the biomass production of mulberry (*M. alba*), Boschini *et al*. (1998) obtained similar results, achieving a higher dry matter production when using a lower planting distance (60 cm), in comparison with distances of 80 and 120 cm.

CONCLUSIONS

- It is possible to use stakes with different number of nodes for the establishment of *T. gigantea* in nursery, because they provide high survival values; although the propagules with three nodes facilitated a higher number of shoots.
- At 11 months the *T. gigantea* plants were taller than 160 cm, with a high number of branches per plants and leaves, independently from the planting frame used.
- The use of a planting frame of 0,75 m^2 allowed to obtain significantly higher yields in fresh foliage as compared to the frame of 1 m^2.

To use propagules with three nodes and a planting frame of 0,75 m^2 for the propagation of *T. gigantea* is recommended.

Table 5. Effect of planting frame on the dry mass of leaves and fresh stems.

Planting frame (m^2)	Leaves	Fresh stems	SE ±
		kg DM/ha	
0,75	533,3	213,0	0,06*
1,00	373,0	135,0	0,01*

* $p < 0,05$ (Tukey, 1952).

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