Influence of sowing different varieties of improved grasses on the control of wiregrass (*Sporobolus indicus* L R.Br.)

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In a grassland of common guinea grass (*Panicum maximum*, Jacq), damaged and invaded by the wiregrass (*Sporobolus indicus*), the influence of sowing different varieties of improved grasses on the control of wiregrass was studied. The treatments were distributed in a random block design with four replicates: a) plantation of *Pennisetum purpureum* cv. Cuba CT-115, b) plantation of *Cynodon nlemfuensis* cv. Star grass, c) sowing of *Brachiaria decumbens* cv. Basilisk, d) sowing of *Panicum maximum* cv. Likoni and f) sowing of *Panicum maximum* cv. Mombaza. At the begining, there were no significant differences on the population and height of the wiregrass. Its population was reduced from 7 to less than 0.9 plant/ m^2 at the end of the experiment in all treatments. In the two samplings conducted with the variaties sown, the highest pasture height ($P < 0.001$) was found in Cuba CT-115 and the lowest values were presented in star grass and brachiaria. At the end of the experiment, the lowest ($P < 0.01$) population of wiregrass (0.26 plants/m^2) was presented where sowing guinea Likoni. The number of tillers/plant of wiregrass was lower when brachiaria was planted, without differing from the treatments where CT-115 or guinea Likoni were sown. Guinea Mombaza and Cuba CT-115 were the variaties less invaded by weeds in general and ended with more than 98 % of pureness. Star grass and brachiaria had less than 50 % of pureness. Guinea Likoni had an intermediate performance. The highest biomass production ($P < 0.001$) and the lowest ($P < 0.001$) cost/t/ha of GM and DM produced were reached when Cuba CT-115 was planted. An intermediate value for this measurement was achieved in Guinea Mombaza. The results of this study indicate that the use of improved pastures could be an option for the control of wiregrass by renewing or with new sowings. A good agrotechnical management is recommended as well as taking care of the soil fertility after controlling the wiregrass.

Key words: *Sporobolus indicus, weeds control, improved pastrues*.

Worldwide, the degradation of improved pastures is a problem that concerns to scientist and rulers due to its damages to economy and environment. It is known that, in these agroecosystems, the presence of weeds over 60 % indicates an advanced deterioration (Andrade *et al*. 2006). In Brazil, for example, half of the improved pastures in the Central Amozonia (50 millions of ha) are affected for this cause (Días Filho 2005). In the world, this phenomenon reaches 680 millions of ha (Brown 2003). Cuba is not exent of this reality, in the 80's, at about 50 % of the grasslands (1.2 millions of ha) had a degradation level (Padilla *et al*. 2001). At present, out of 2.6 millions of hectares dedicated to cattle rearing, only 19 % are covered by these species. They are infested with undesired wood weeds at 43.4 %.

Although the infestation magnitude with species like *Paspalum virgatum* (razorgrass) and *Sporobolus indicus* (L.) R. Br. (wiregrass) is unknown in Cuba; the negative effect of the last on the improved pastures is higher in our country and other tropical regions. This could be due to the physiological characteristics of wiregrass that are similar (photosynthetic path C_4) to the majority of the grasses cultivated. Besides, it has a permanent life cycle and poor nutritive quality (2.5-5.46 % CP), even in vegetative development. Therefore, this weed could provoke, in short time, high invasion and infestation degree in different agroecosystems, causing great amount of losses in biomass yield. On this respect, Jacobo and Rodríguez (2009) stated that, in the context of Argentina, in order to conduct a vigorous plan of recovering natural grasslands, the development and maintenance of improvement programs, inscription of cultivars and production of improved seeds of native species is still pending for the Pampa of that country.

A possible way to control wiregrass is the sowing of aggressive or of high plasticity species, propitiating an excluding competition where the weed is not favored and the improved species competes favorable for the ecological niche in the grassland.

The sowing or plantation of aggressive species could be an important via for reducing high populations of wiregrass, where the competition for water, light and nutrients favors the improved species. The objective of this study was to assess the effect of sowing different tropical grasses, creeping and of erect aspect in the control of wiregrass.

Materials and Methods

Treatment and experimental design. A random block design with four replicates was used. The treatments were: a) plantation of *Pennisetum purpureum* cv. Cuba CT-115, b) plantation of *Cynodon nlemfuensis* cv. star grass, c) sowing of *Brachiaria decumbens* cv. Basilisk, d) sowing of *Panicum maximum* cv. Likoni and f) sowing of *Panicum maximum* cv. Mombaza. The plots area was of 6 x 6 m.

Procedure. The experiment was conducted in a degraded grassland of *Panicum maximum* Jacq., with initial invasion of 6.5 - 7.25 plants/m^2 of wiregrass, covering at about 62 % of the area. Before the sowing, in June, the soil (type calcic ferralic) (Hernández *et al*. 2005) was prepared according to the conventional way, with ploughing, crossings and alternate mid harrowing. It was prepared in the dry season, from March to April. The last harrowing was in June, before planting the grasses varieties.

The pastures Cuba CT-115, star grass and brachiaria, were planted with the ploughing method, according to the dosage recommended for each variaty (Padilla 2008). For this type of plantation, a three-disc harrowing (ADIS-3) was used. The stems were covered at a depth of 10 cm. In the case of the stolons, the apical part was uncovered. The stems or stolons used had between 4 and 5 sprouts.

The vegetative seeds of CT-115, star grass and brachiaria, had 120 d of age and the plantation dosage was of 5 t/ha for the first and 3 t/ha for the other two.

The seeds of Guinea Mombaza and Likoni were sown broadcasting, with dosages of 10 kg/ha of total seed, with 12 % of germination.

In order to assess the effect of the species on the control of wiregrass, the population was measured before implanting the treatments and preparing the soil. An intermediate sampling was conducted after the species were established and at the end of the experiment. After the grassland was established, it was grazed by the cattle of the unit, with resting periods of 25-30 d in the rainy season and 60 d in the dry one.

The first sampling was conducted 120 d after sowing the varieties. The second was carried out 90 d after the first and the number of plants/m^2 of wiregrass was measured, as well as height and number of stems/m^2 of CT-115. The final sampling of number of plants/m^2 of wiregrass was conducted 10 months after plantation, once the third rotation with cattle in the area took place. The number of plants/m^2 of wiregrass, bunches/m^2 and tillers/plants was measured in five points/plot, with frames of 1 x 1 m, randomly taken in diagonal in each treatment. The height was measured in three points of each 1 x 1m frame. The yield of CT-115, guinea grass, star grass, brachiaria and wiregrass was determined in five frames of 1 x 1 m. The cut was made with a machete and the samples were manually separated to weight them individually per species.

The cost analysis was made considering the biomass production during the establishment and in both samplings conducted, as well as the sowing or plantation costs of these varieties.

The botanical composition was determined through the manual separation methods and species weighing. When necessary, the multiple range test of Duncan (1955) was used in the analysis of variance. The number of plants/m^2, tillers/plant and number of bunch/m^2, were transformed according to $\sqrt{x}$, while the percentage of improved species was transformed according to arc sin $\sqrt{\%}$.

Results

No significant differences were found in the height and population of wiregrass (tillers/plants) in the sampling conducted before applying the treatments (table1). However, at the end of the experiment (18 months after sowing the varieties), the number of tillers/plants of wiregrass was lower ($P < 0.01$) where brachiaria was sown, that did not differ from the treatments where sowing CT-115 or guinea Likoni. However, the highest height of wiregrass at the end of the experiment was reached when planting Cuba CT-115, without differing significantly from the treatment where Guinea Mombaza was planted.

There was significant interaction ($P < 0.05$) between the sampling times and the varieties used in the control of wiregrass (table 2). Likewise, significant differences were found in the number of plants/ m^2 of this weed before applying the treatments (6.50-7.25 plants/m^2). However, once they were implanted, in the second sampling, the species invaded by the weed the most ($P < 0.05$) was guinea Likoni, that did not differ from Guinea Mombaza. This did not occurred in the final sampling, where guinea Likoni control wiregrass the most (0.25 plants/m^2), without differing from the other varieties studied. It was significant that, at the end of the experiment, all the species used reduced the wiregrass population to values inferior to 1.0 plants/m^2.

Table 1. Performance of height and population of wiregrass at the beginning and end of the experiment

Treatments	Beginning 26-3-03		Final (3-12-04)	
	Height	tillers/plant	Height	tillers/plant
Cuba CT-115	35.00	5.50 (30.5)	63.25^{c}	5.36^{ab} (28.75)
Star grass	38.75	5.55(30.75)	52.38a	5.72^{bc} (32.75)
Brachiaria	31.25	4.91 (24.25)	57.25^{ab}	5.18^{a} (26.88)
Guinea Likoni	35.00	5.33 (28.5)	54.00^{ab}	5.39^{ab} (29.13)
Guinea Mombaza	35.00	5.12 (26.25)	58.50^{bc}	5.87^{c} (34.5)
SE±Sig	2.400	0.18	1.56**	0.11**

^{abcd}Values with different letters in the same row differ at $P < 0.05$ (Duncan1955)

**P < 0.01 ***P < 0.001

Table 2. Effect of grasses on the number of wiregrass plants/m^2 in time

Species	Sampling times			SE ± Sig
	Before treatment (26-3-03)	Second sampling (3-12-03)	Final sampling (3-12-04)	
Cuba CT-115	2.66^d (6.75)	0.75^{ab} (1.25)	1.00^{abc} (0.66)	
Star grass	2.74^d (7.25)	0.63^a (0.03)	1.12^{bc} (0.91)	0.13*
Brachiaria basilisk	2.61^d (6.50)	0.63^a (0.03)	1.00^{abc} (0.67)	
Guinea Likoni	2.70^d (7.00)	1.26^c (1.25)	0.75^{ab} (0.25)	
Guinea Mombaza	2.71^d (7.00)	0.98^{abc} (0.75)	1.01^{abc} (0.66)	

abcd Values with different letters in the same row differ at P < 0.05(Duncan1955)
( ) real values *P< 0.05

Table 3. Components of the improved pastures yield

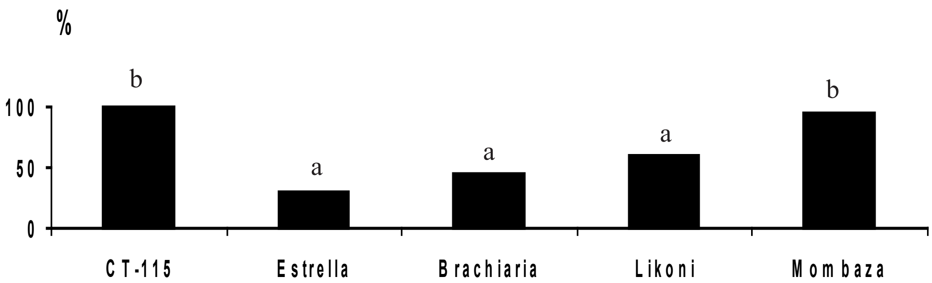
Treatments	First sampling 21-10-13		Second sampling 3-12-03	
	Height, cm	Bunches m^2	Height, cm	Bunches m^2
Cuba CT-115	285.63^d	2.75^c(7.5)	190.75^c	1.41(2.0)
Star grass	58.13^a	-	60.0^a	-
Brachiaria	55.83^a	2.9^c(8.5)	51.25^a	1.39(2.0)
Guinea Likoni	99.38^b	2.36^b(5.65)	101.5^b	1.1(1.25)
Guinea Mombaza	195.63^c	1.51^b(1.25)	125.25^b	1.1(1.25)
SE±	7.77***	0.10***	8.17***	0.11

abad Values with different letters in the same row differ at P < 0.05 (Duncan 1955)
*P < 0.05 ***P < 0.001
( ) Real values

Table 4. DM yield t/ha MS of the varieties of improved pastures

Treatment	Sampling times		
	21-10-03	3-12-03	3-12-04
Cuba CT-115	25.89^c	8.78^b	8.70^b
Star grass	0.90^a	0.82^a	2.84^a
Brachiaria	4.05^a	1.20^a	3.21^a
Guinea Likoni	6.41^a	1.63^a	3.40^a
Guinea Mombaza	13.39^b	3.16^a	3.30^a
SE sig ±	2.06***	0.82**	1.03**

abc Values with different letters in the same row differ at P < 0.05 (Duncan 1955)
**P < 0.01 ***P < 0.001
( ) values within parenthesis are the real ones



ab Values with different letters differ at P < 0.05 (Duncan 1955)

Figure 1. Percentage of the improved species of the grassland

Table 5. Cost analysis of the DM and GM ton according to treatment

Treatment Measurement	Cuba CT-115	Star grass	Brachiaria	Guinea Likoni	Guinea Mombaza	SE (±)*Sig
Costo t/ha MV	10.66[a]	32.70[b]	34.76[b]	28.41[b]	28.83[b]	1.70***
Costo t/ha MS	43.14[a]	100.29[b]	69.49[b]	82.04[b]	83.91[b]	3.82***

[abc] Values with different letters in the same row differ at $P < 0.05$ (Duncan 1955)
***$P < 0.001$

The performance of the planted varieties in the two samplings conducted is shown in table 3. In both cases, the highest pasture height ($P < 0.001$) was for CT-115, with lower values in star grass and brachiaria. Guinea Mombaza and Likoni had an intermediate value. In the first sampling, among the varieties forming bunches, the highest ($P < 0.001$) population was for CT-115 and brachiaria, in respect to the two varieties of guinea. In the second, the number of bunches/m^2 was similar in all treatments.

In the varieties of improved pastures, the DM yield was higher ($P < 0.001$) in Cuba CT-115 in the three samplings conducted (table 4). Guinea Mombaza had an intermidiate performance.

The percentage of improved species was higher ($P < 0.01$) in Cuba CT-115 (99 %) and Guinea Mombaza (96 %) (figure 1).

The lowest cost ($P < 0.001$) per t/ha of GM and DM produced was obtained when planting Cuba CT-115 (table 5)

Discussion

The highest population of wiregrass in the treatments with both varieties of guinea grass could be due to the straight growth habit and their lowest population. This, together with an intermediate height, favored the light penetration on the soil, favoring temporarily the wiregrass survival. It did not occur like that in the CT-115 due to the higher height and higher biomass production, apart from the straight growth of its stems.

In spite guinea Likoni did not control immediately wiregrass after the treatment, it was the only one that diminished the population of this weed in time. This could be due to its capacity of recycling the seed, for being a high seed producer variety and with high capacity to recover its population in short periods of time. It did not happen like that with the star grass, in spite of the aggressive growth of its stolons, the population of this weed increased in time after the treatments. However, the populations of the weed were below the critical level, as Padilla *et al*. (2012) found that, wiregrass populations of 5 plants/m^2 reduce the biomass production and increase the cost of the forage produced in guinea Likoni. However, in spite the treatments diminished the populations to values below 1 plant/m^2, the pastures could be invaded again by this weed if a proper agrotechnical management is not performed and soil fertility maintains. This alert was made by Padilla *et al* (2005) and confirmed by Sardiñas (2010). This, in our experience, is due to the well adaptation of wiregrass to the soil of low or null fertility, growing very well on the road border and even on roofs of houses on concrete.

The Guinea Mombaza also seems to be a promising species for controling weeds. Nevertheless, it did not occur like that in this experiment as it population was relatively low and could not express its maximum biological potential. This criterion could be supported by the fact that Mombaza and CT-115 were the species less invaded by other undesirable species.

Grasslands' recovery through rehabilitation had a special attention and countable results from the scientific and practical point of view in Cuba and other tropical regions. However, through the renewal way or through new sowings did not receive the same attention, mainly with the integral focus of using improved pastures capable of competing with the weeds predominating in the ecosystem for water, light and nutrients in a same ecological niche. Therefore, this study makes an important scientific contribution by showing that the use of pastures varieties such as Guinea Mombaza and Cuba CT-115, just introduced in Cuban cattle enterprises are a technical and economical option for recovering grasslands with high invasion of wiregrass. In this sense, Sardiñas *et al*. (2011) recommended new sowings of Guinea Mombaza and Likoni for controlling wiregrass in areas invaded by this weed.

This study also shows that Brachiaria Basilisk and improved star grass do not control wiregrass and that guinea Likoni controls this weed effectively on time when using the technique of renewal or new sowings.

Assessing the performance of yield and its components and comparing varieties of heterogenous growth habits were not an objective of this study. It was an objective the use of this information as an expression of the biological performance of these varieties considering their capacity of competing with wiregrass and removing it from the ecosystem.

The results of biomass production and low costs for obtaining one tone of Cuba CT-115 forage show the kindness of this new clone, that together with its capacity of removing the weed as proved in this study and others of Padilla *et al*. (2005), increase the popularity of this pasture in Cuban producers and other tropical Latin-American regions. On this respect, Mora *et al*. (2008), in Mendoza, Argentina, found that the sowing of *Eragrostis curvula* increased productivity, twice superior to the traditional control and, at the same time, controlled the *Eleonorus muticus*, a dominant spcies of low productivity in that region.

This study offers a sustainable solution to the control of wiregrass through the biological control. It shows the possibility of managing properly the excluding competetion between the improved pasture of aggressive growth such as CT-115, Mombaza and Likoni, with a weed (wiregrass), without using agro-toxics. This solution is important as wiregrass is today a true lash for improved pastures in Cuba and other tropical and sub-tropical regions of the world.

Other studies could be focused on a scientific response to the posible effects of some varieties of improved pastures on controlling the weed in grassland ecosystems. It is known that a plant may interphere direct or indirectly on the development of other plants through the release of chemical compounds called allelopathic substances. In the last three decades, a great number of studies have been published demonstrating the potential of several plant species, grasses and legumes inhibiting the germination and growth of different weeds (Souza and Alves 1995).

In studies conducted by Souza and Alves (1995) with *Brachiaria brizantha* cv. Marandú, they found several substances with allelopathic properties such as tannins and saponins, capable of inhibiting the development of diverse invasive plants.

The holistic approach of systems integrations, with the presence of grasses and legumes, considering the allelopathic effect of these species could contribute to the reduction of invasive plants in the ecosystems of improved pastures.

The results of this study indicate that sowing improved pastures of great aggressiveness in the grassland invaded is a possible option for controlling wiregrass.

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