Performance of Guinea grass (*Panicum maximum* Jacq cv. Likoni) forage area according to the population of wire grass (*Sporobolus indicus* L.)

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The influence of wire grass (*Sporobolus indicus*. L) (0, 2, 4 and 6 plants/m^2) on yield, cost and quality of Guinea grass (*Panicum maximum* Jacq cv. Likoni) biomass was studied in a calcic ferralic soil, through a completely random design and ten repetitions. The wire grass height did not vary with the increase of its population and the area of the soil covered was increased ($P < 0.001$). There was an inverse ratio ($r = -0.88$) ($P < 0.001$) between Guinea grass yield and wire grass population. The forage cost increased from 25.21 to 78.63 pesos, for 0 and 6 plants of wire grass/m^2, respectively. The chemical composition of the soil did not vary with the treatments. The highest wire grass population produced lower ($P < 0.05$) content of organic matter digestibility (OMD) and Ca ($P < 0.01$). There was no effect on the chemical composition of Guinea grass. In the wire grass, only CP and P were lower ($P < 0.01$) with the population increase. It is concluded that the increase of wire grass population diminished the Guinea grass yield, elevated the cost of biomass production and altered some indicators of forage quality. Further studies on the possible effects of wire grass population on biomass quality of improved pastures are recommended.

Key words: *Panicum maximum, Sporobolus indicus, weeds population, yield, cost*

Wire grass (*Sporobolus indicus* L.) is a weed invading Cuban grasslands and those of other tropical and subtropical regions (Sánchez *et al*. 1991). During many years, in the southern part of the United States, this weed has introduced in bermuda grass (*Cynodon dactylon*) grasslands (Mislevy and Martín 2002). In Argentina and other Latin American countries, wire grass is one of the most disseminated species and of difficult control. In Mexico, this plant is in the states of Campeche, Chiapas, Chihuahua, Colima, Distrito Federal, Durango, Guerrero, Hidalgo, Jalisco and Michoacán. In this last, wire grass grows naturally and reaches from 1000 to 2250 m a.s.l. This species is of great ecological and phenotypical plasticity, meaning that it could have a wide range of natural enemies. Due to its aggressiveness when invading, it damages seriously from the economical point of view.

At present, no efficient method is known for controlling wire grass. The traditional techniques do not eliminate it due to its similar physiological characteristics to those of grass improved pastures with photosynthetic pathway C_4 (Feldman and Refi 2006). Besides, wire grass may provoke, in a short period of time, high degree of invasion and infestation in different agroecosystems of cultivated pastures (Crespo and Fraga 2005). Under these conditions, searching techniques for its efficient control is a need for producers, technicians and scientists (Padilla 2002, Sardiñas *et al*. 2005 and Valenciaga and Mora 2007).

Adjei *et al*. (2003) stated that the burning and mechanical cutting stimulates the appearance of new tillers in wire grass, as the active buds in the basis of the air stems allow them to regrow easily after cutting.

Although they have not been counted so far, the Cuban grasslands show high infestation levels of wire grass. Due to its low palatability, this weed becomes a real threat for improved pastures, when using continuous grazing. How the yield of these pastures is affected when wire grass increases is not known either. The objective of this study was to assess the effect of the invasion of wire grass on yield, cost and quality of biomass in a forage area of Guinea grass.

Materials and Methods

A completely randomized design was used with ten repetitions. Frames of 2 x 2 m, being as experimental unit, were used for the samplings. The treatments consisted of populations of 0, 2, 4, and 6 wire grass plants/m^2.

The experiment was conducted in a forage area of Guinea grass in the Institute of Animal Science, in the Mayabeque province, Cuba. This facility is between 22º 53' NL and 82º 02' WL, at 92 m a.s.l. The area was not fertilized in the last five years. The soil corresponded to the calcic ferrallic type (Hernández *et al*. 2005), equivalent to the Inceptisol. The treatments were randomly distributed in a previously selected area, with wire grass population between 0 and 6 plants/m^2. Frames of 2 x 2 m were placed, according to the number of plants/m^2. Uniformity cut at 10 cm height was conducted, and at 120 d of regrowth, corresponding to the rainy season. Yield, height and area covered by forage were determined through the sample of ten frames (4 m^2 each). In order to measure the yield and botanical composition, the Guinea grass was manually harvested and separated from wire grass. Besides, three heights per frame were measured and the area covered by each of them was determined. Samples of 200 g of Guinea grass and wire grass were selected to determine ash, CP, Ca, P, CF, OMD (AOAC 1995), NDF and ADF (Goering y van Soest 1970). A sample, composed of three sub-samples in each frame, was determined to analyze N, P, K, Ca, Mg, OM and pH (Jackson 1970).

Cost sheets were elaborated for each treatment. The expenses of salary, oil, machinery, mechanical labors, seeds and other elements needed for forage production were calculated. After having this information, the costs for each treatment were calculated. The current prices were also considered, according to the methodology of Cino *et al*. (2007).

The data processing was conducted through the statistical software InfoStat, version 1.0 (Rienzo *et al*. 2001). When necessary, the mean values were compared through the multiple range test of Duncan (1955). The percentages of covered area and those of the decrease of guinea grass biomass production were transformed according to the arc sine $\sqrt{\%} + 0.375$

Results and Discussion

The lowest ($P < 0.01$) height and area covered by Guinea grass were presented with the invasion of plants/m^2 of wire grass (table 1). The raise of the weed population increased ($P < 0.001$) its area covered but did not affect the height.

The previous statement could be associated, among other causes, with the effect of the competition for vital space between wire grass and Guinea grass. According to Alemán (2004), the transformation of the botanical composition with the increase of the weed density is within the main elements that could determine this type of competition is. The similarity between wire grass height and the density increase indicates that there was no intra-specific competition. In observations conducted in agroecosystems of improved pastures invaded of wire grass, with populations superior to those of this study, reduction in the weed height is not indicated. This, apparently, does not influence the competition between plants of the same species.

The Guinea grass yield decreased and that of the wire grass increased ($P < 0.001$), as its population raised (table 2). This increase had a negative economic effect. The cost of t/ha of Guinea grass DM augmented from 25.2, with 6 plants/m^2, to 78.63 Cuban pesos, when frequency was cero. Ferrell *et al*. (2006) also found that middle and high populations of wire grass reduced the biomass yield of the *Paspalum notatum* (bahiagrass) natural pasture from 1.16 t of DM ha^{-1} to 0.59 and 0.15, respectively.

The knowledge on the economical threshold of weeds in tropical pastures is still limited. Dias-Filho (1990) refers that, apparently, this type of plants affects since the initial stage of establishment and during the useful life cycle of the grassland. The highest production cost of the dry matter ton of Guinea grass could be related to the diminishing of biomass availability, as the weed population increased, raising the production ha^{-1} price. These results indicate the necessity of applying methods for minimizing the damages these plants may cause, because the economical losses are considerable (Bray

Table 1. Effect of the weeds on the height and the area covered of guinea grass and wire grass

Wire grass plants m^{-2}	Height (cm)		Covered area, %	
	Guinea grass	Wire grass	Guinea grass	Wire grass
0	87.4^a	-	1.0	-
2	82.4^{ab}	41.9	77.0^a (92.1)	9.0^a (4.87)
4	75.3^b	54.7	68.0^a (86.4)	20.0^b (13.14)
6	64.6^c	49.4	55.0^b (67.1)	34.0^c (32.86)
SE (±)	3.5**	3.6	4.2**	3.5***

abc Means with different letters per column differ at $P < 0.05$ (Duncan 1955)
( ) Real values. [1]The area covered was of 100 % in all repetitions
**$P < 0.01$ ***$P < 0.001$

Table 2. Biomass yield according to the infestation degree of wire grass. Production cost of the dry matter ton.

Wire grass plants m^{-2}	Wire grass (t MS ha^{-1})	Guinea grass (t MS ha^{-1})	Guinea grass cpst($ t MS ha^{-1})
0	-	2.1^a	26.2^a
2	0.1^a	1.8^b	31.3^b
4	0.5^b	1.2^c	48.8^c
6	0.9^c	0.7^d	78.6^d
SE (±)	0.05***	0.09***	0.08***

abc Values with different letters per column differ at $P < 0.05$ (Duncan 1955)
***$P < 0.001$

et al. 2008).

The cost of the damages of this undesirable species in the grasslands is hard to determine. Apart from diminishing the dry matter yield of the pasture, quality is affected, reducing the animal intake. The additional expenses for keeping the grassland and the forage area free of weeds should be added.

As wire grass population increased, the percentage of Guinea grass biomass production decreased ($P < 0.001$). This was adjusted to the linear equation $Y = 2.20 – 0.25 x$, $SE = \pm 0.019$, $r = -0.88$. Likewise, the Guinea grass biomass production was reduced to 66 %, with wire grass population of 6 plants/m^2, in respect to the control (figure 1).

The lowest height, covered area and yield of Guinea grass obtained with the highest wire grass population indicate the competition that could be established between this weed and Guinea grass. This, together with the negative correlation between the increase of wire grass and Guinea grass biomass production, confirm the statement of Dias-Filho (2005). This author refers that per each kilogram of weight increase of the weeds, the equivalent diminish of the improved pastures yield is produced. The literature describes that weeds reduce the yield of the agricultural crops in 25 % (Labrada 1996). However, Alemán (2004) informed that the losses could reach 50 %. In this study, the results indicated damages of 68 % with the highest wire grass density, surpassing that reported for improved pasture which is of 30 % (Anon 2010).

The results of Ferrell *et al*. (2006) show that the accumulation of bahiagrass biomass was reduced from 1.164 kg ha^{-1}, with scarce wire grass population, to values of 590 and 154 kg ha^{-1} for middle and high populations, respectively. These results confirm the hypothesis that this weed can affect the biomass production of improved pastures in different tropical and sub-tropical regions. (Sardiñas 2009).

The Guinea grass yield with the highest wire grass invasion represented one third of the biomass production in this experiment. This indicates that the loss due to this weed in the basic grassland could be greater, compared with the criteria of other authors.

The pasture developed between invasive plants could have limited volume of roots, as the competition for the vital space takes place in the radical zone as the air part. This brings about a lower access to nutrients and water from the soil, together with the diminishing of the photosynthetic rate of the grassland, aspect that could justify, somehow, the reduction of Guinea grass yield in this experiment.

There was no significant effect of the number of wire grass plants on the content of N (0. 33 %), P (5.3 mg 100 g^{-1}), Ca (114.77 cmol kg-1), OM (3.19 %) and pH (5.30) of the soil, although the Mg content (3.1 cmol kg^{-1}) was lower when the wire grass density was higher. The content of K (3.42 mg 100 g^{-1}) was lower ($P < 0.05$), when the weed population was higher, in respect to the presence of two plants of wire grass m^{-2}.

The majority of the weeds have great competence capacity, as they need scarce resources to form a gram of dry matter or because they take these elements from the soil more easily than other plants under stress conditions. This is the case of wire grass and other grasses, as Catasús (1997) indicated.

These citeria, together with the fact that the nutrients content on the soil was not a limitation, could explain the lack of response when wire grass density increases, except for Mg and K. In this case, the information available did not allow relating the effect of wire grass density with the reduction of these macronutrients. However, Dias-Filho (2001) found that the increase of weeds reduced the P content.

When the nutrients content of Guinea grass was analyzed, there was a lower ($P < 0.05$) value of OM (49.42%) and Ca (0. 49 %) ($P < 0.01$) in highest wire grass density, while the ash content (10.27 %), CP (5.07 %), P (0.375 %), NDF (75.88 %), andADF (46.35 %) were not affected. The CF had an erratic behavior, its values ranged between 33.69 and 37.86 %.

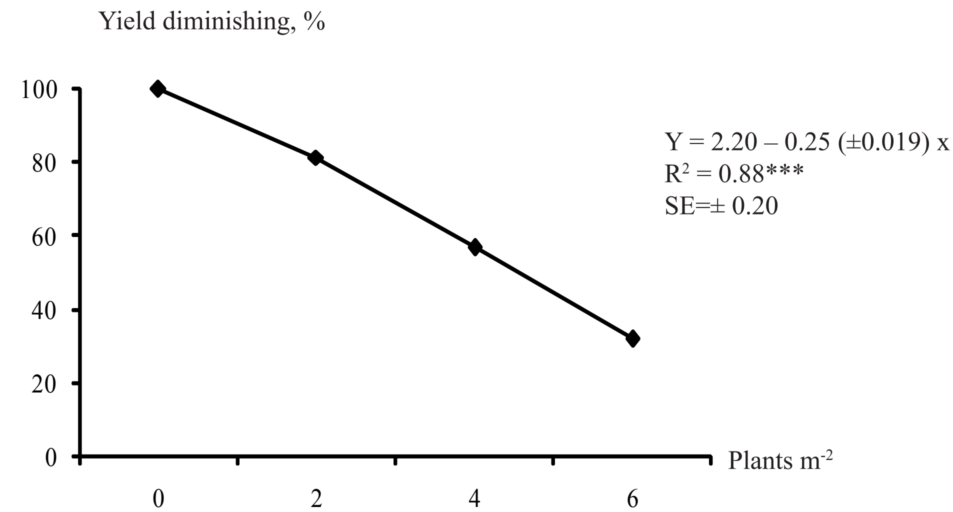

Figure 1. Diminishing of Guinea grass yield according to the wire grass invasion

The values of CP (2.96 %) and P (0.22 %) in wire grass were lower as their population increased (P < 0.01). However, ash (7.32 %), Ca (0.64 %), CF (37.41 %), OMD (51.71 %), CF (37.41 %), ADF (44.81 %) and NDF (80.37 %) were not affected.

Studies conducted on soils with very low fertility show that weeds, in respect to improved grasses, are capable of extracting nutrients from the soil more easily. This leads also to the superiority of their content. Dias-Filho (2005) reported higher contents of N and P in weeds predominating in a degraded grassland of *Hyparrhenia rufa* with ten years of age in the Brazilian Eastern in respect to the improved pasture.

The same did not occurred in this experiment, maybe because the nutrients range of the experimental area was acceptable for this type of soil (Crespo *et al*. 2006). This could influence on the fact that the majority of the nutrients studied were not affect by the effect of the treatments. The fact that in this study Guinea grass had the highest content of ash, CP and P compared with wire grass, confirm that the nutrients content of the soil favored improved pasture more than weeds.

The diminishing of some bromatological elements as weeds increase could be associated to the excluding competence among species for the ecological niche, water, light and nutrients, shown in yield and their components. In respect to the biomass quality, although it was not so evident, it was also affected by the infestation level. That was shown by the Guinea grass OMD and wire grass CP and P, which were inferior when the population of this weed was higher. Likewise, the values of Ca, CP, and P had similar performance when assessing integrally the improved pasture and the weed in the ecosystem. It seems that the diminishing of OMD could be associated with the increase of NDF rather than with the wire grass density. This is because the pasture was cut at 120 d of regrowth.

Similar results were found by Ramírez *et al*. (2010) in Guinea grass, when studying the effect of age on different indicators of the plant quality in cattle soils of Granma province, Cuba.

The CP contents of 5.07 % in Guinea grass and of 2.96 % in wire grass also indicate low biomass quality in a grassland agroecosystem invaded by this weed.

These results are an alert on the negative effect of wire grass on the biomass volume and quality of forage areas. New studies with this and other pastures on lower fertile soils are needed.

It is concluded that the largest wire grass populations diminished the forage yield and increased the production cost of each DM ton produced by Guinea grass. The increase of wire grass influenced on the deterioration of some bromatological indicators of Guinea grass and wire grass, mainly on CP, Ca, and OMD. The contents of N, P, K, Ca, Na, OM and pH of the soil were not affected.

Acknowledgment

Thanks are given to the Doctors Rafael S. Herrera, Gustavo J. Crespo and Nurys Valenciaga for revising the manuscripts and their recommendations.

References

Adjei, M.B., Mullahey, J., Mislevy, P. & Kalmbacher, R. S. 2003. Smutgrass control in perennial grass pastures. SS-AGR-18. University of Florida, IFAS Distribution, Gainesville. Available: http://edis.ifas.ufl.edu/AA261. Consultado: 11/11/2005

Alemán, F. 2004. Manual de investigación agronómica: con énfasis en Ciencias de las Malezas. Primera Edición. Imprimatur. Artes gráficas. Managua. La Habana, Cuba. 248 pp.

Anon 2010. Manejo y control de la proporción de arvenses en pasturas y cultivos forrajeros. Available: <http//kogi.udea.edu.co/manejodepraderasarvenses.doc.> [Consulted: July 4, 2010]

AOAC 1995. Official Methods of Analysis. Ass. Off. Agric. Chem. 16 th Ed. Maryland. USA

Bray, E., Holmes, B. & Officer, D. 2008. Economic analyses of options for weedy Sporobolus grass management. The Rangeland J. 30:375.

Catasús, L. 1997. Manual de Agrostología. Editorial Academia. La Habana, Cuba. pp.98

Cino, D. M., Padilla, C y Sardiñas, Y. 2007. Propuestas de fichas de costos de nuevos cultivos forrajeros. Revista ACPA 26:48

Crespo, G. & Fraga, S. 2005. Preliminary study of the effect of rehabilitation methods and the application of cattle manure on the control of wire grass (*Sporobolus indicus* L. R. Br.) in a rangeland of guinea grass (*Panicum maximum* cv Likoni). Cuban J. Agric. Sci. 39: 609

Crespo, G., Otero, B. & Fraga, S. 2006. Methodology for the integral assessment of the fertility state of the soils in a cattle región of Havana. Cuban J. Agric. Sci. 40:477

Dias-Filho, M. B. 1990. Plantas Invasoras Em Pastagens Cultivadas Da Amazônia: Estratégias De Manejo E Controle. Empresa Brasileira De Pesquisa Agropecuária-Embrapa. CPATU. Brasil

Dias-Filho, M. B. 2001. Processos E Causas De Degradacao E Estrategias De Recuperacao. En Pastagens Tropicais. I Foro Latinoamericano de Pastos. CD-ROM. La Habana, Cuba

Dias Filho, M. B. 2005. Degradacão de pastagens. Processos, causas e estratégias de recuperacão. Seunda Edição. Embrapa AMAZONIA Oriental, Brasil. 173 pp.

Duncan, D. B. 1955. Multiple range and multiple F test. Biometrics 11:1

Feldman, S. & Refi, R. 2006. Changes of the floristic composition in a pampean native grassland under different management practices. Facultad de Ciencias Agrarias. Universidad del Rosario. Rev. Cien. Inv. Agr. 33:89

Ferrell, J. A., Mullahey, J, J., Dusky, J, A. & Roka, F. M. 2006. Competition of giant Smutgras (*Sporobolus indicus*) in bahiagrass pasture. Weed Sci. 54:100

Goering, M. K. & van Soest, P. J. 1970. Forage fiber analysis (apparatus, reagents, procedures and some applications). Agricultural, USDA, Washington D. C. 379 pp.

Hernández, A.J., Morales, M.D., Ascanio, M.G. & Cabrera, A.R. 2005. Correlación de la nueva versión de clasificación genética de los suelos de Cuba con las clasificaciones internacionales y nacionales: una herramienta útil para la investigación, docencia y producción agropecuaria. Instituto Nacional de Ciencias Agrícolas. La Habana, Cuba. 243 pp.

Jackson, M L. 1970. Análisis químico de suelos. Ed. Univ. Wisconsin. USA. 662 pp.

Mislevy, P.Y. & Martin, F.D. 2002. West Indian dropseed Giant Smutgrass *Sporobolus indicus* var. Pyramidalis. Control in Bahiagrass (*Paspalum notatum*). Weed Technol. 16: 707

Labrada, R. 2009. Manejo mejorado de malezas para mitigar la crisis de alimentos. XII Congreso da SEMh/XIX Congreso da ALAM/ II Congreso de IBCM

Padilla, C. 2002. Soil tillage and chemical fertilization on the recovery of a guinea grass (*Panicum maximum* Jacq.) Cuban J. Agric. Sci. 36:173

Ramírez, J. L., Verdecia, D. & Álvarez, Y. 2010. Rendimiento de materia seca y calidad nutritiva del pasto *Panicum maximum* vc. Likoni en un suelo fluvisol de la región oriental de Cuba. Rev. Electrónica Vet. Available: <http://www.veterinaria.org/revistas/redvet/n070710/071018.pdf.> [Consulted: October 3, 2011]

Rienzo, J.A., Balzarín, M., Casanova, F., González, L., Tablada, M., Washington, G. & Robledo, C. W. 2001. InfoStat versión 1. Software Estadístico. Facultad de Ciencias Agropecuarias. Universidad Nacional de Córdova. Argentina

Sánchez, M.G., Gamboa, H. & Sisco, O. 1991. Chemical weeds control in a mango plants nursery (*Mangifera indica*) c.v. Jamaica. Ed. Estación Experimental Fabio Baudrit. Costa Rica. Boletín Técnico. 24:10

Sardiñas, Y. 2009. La biología y control de *Sporobolus indicus* (L.) R. Br. en agroecosistemas de pastizales de *Panicum maximum* vc. Likoni en avanzado estado de degradación. Master Thesis. Instituto de Ciencia Animal. La Habana, Cuba. 112 pp.

Sardiñas, Y., Padilla, C. & Curbelo, F. 2005. Preliminary note on the control of wire grass (*Sporobolus indicus* L.R. Br.) and the recovery of a rangeland of guinea grass (*Panicum maximum* cv Likoni) with the application of mechanical labors and fertilization. Cuban J. Agric. Sci. 39:79

Valenciaga, N. & Mora, C. 2007. A note on the phytophagous insects living in invaded areas of wire grass (*Sporobolus indicus*). Cuban J. Agric. Sci. 41:275

Received: June 6, 2012