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Generic composition of the soil seed bank in a multi-associated silvopastoral system (Technical note)

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ABSTRACT

A study was conducted at the Experimental Station of Pastures and Forages "Indio Hatuey" in order to determine the composition, by genera, of the seed bank of a Ferralitic Red soil under livestock production; which was inserted in a multi-associated silvopastoral system with more than 10 years of exploitation. A randomized block design with three repetitions was used, and the treatments were the sampling depths 0-5 and 5-10 cm. The work was done in a 4-ha lot on which three strips were drawn, divided into 8 x 10 m plots. The soil samples were extracted from a 1-m^2 area. Eight grass and legume genera were identified; the most frequent ones were: *Panicum* (78,7 %), *Leucaena* (9,27 %), *Neonotonia* (6,03 %) and *Teramnus* (2,35 %). There were significant differences ($p < 0,05$) in favor of the depth 0-5 cm, in which the highest seed proportion was found. *Neonotonia* and *Leucaena* showed the highest percentage of hard seeds, although all the legumes showed high viability. It is concluded that there was a high reserve of Guinea grass seed in the soil of the multi-associated system, as well as diversity of legume genera. In addition, a high percentage of seed was found in the higher stratum of the soil (0-5 cm), which can constitute an advantage in the processes of pastureland renewal with these plants.

Key words: seed bank, silvopastoral systems

INTRODUCTION

Pasture deterioration constitutes a topic of interest for researchers and farmers, because of its significance for pastureland productivity and its useful life (Mares, 1984; García, Ramírez and Sánchez, 2012). The main mechanism used by plants to achieve their persistence in time and maintain their population is seed production. Thus, the knowledge of the seed bank or reserve in the soil of a pastureland can be an important factor to predict population changes under different managements (Kitahara, Yoshimura and Suzuki, 1989; Marcante, Schwienbacher and Erschbamer, 2009). The strategic management of the seed bank in the soil can help farmers decrease the costs of pasture renewal, because the natural advantages of distribution and stability of the different involved species are used, which has a positive impact on the ecosystem of the place.

Considering the above-explained facts, the objective of the study was to determine the composition –per genus– of the soil seed bank, in a multi-associated silvopastoral system.

MATERIALS AND METHODS

The trial was conducted at the Experimental Station of Pastures and Forages (EEPF) "Indio Hatuey", which is located in the Perico municipality, Matanzas province, on the geographical spot determined by 22º 48' 7" North latitude and 81º1' West longitude, at 19,01 m.a.s.l.

The conditions of the experimental area correspond to a climate of tropical savanna, characteristic of Cuba (Academia de Ciencias de Cuba, 1989), with an annual rainfall mean higher than 1 320 mm. The soil has plain topography and is classified as lixiviated Ferralitic Red (Hernández *et al*., 1999).

The composition of the seed bank was studied on a soil covered by a multi-association of grasses and climbing and woody legumes, which was established and used for animal production during ten years.

A completely randomized design was used with three replications per treatment, constituted by two sampling depths (0-5 and 5-10 cm).

The samples were taken in a 4-ha lot, on which three strips were drawn divided into 8 x 10 m plots. The soil samples were extracted from a 1-m^2 area; nine samples were taken per replication (27 per treatment), using a core drill. The seed quantification was done by physical separation; initially, the soil fractions were dry sieved and then moist sieved, by washing it with water –using a battery of three sieves of 20 cm diameter and mesh of 2,0; 1,0 and 0,21 mm–; the moist samples were placed on absorbent paper during 24 hours to be dried.

The number of seeds per genus on a surface of 1,0 m^2 was measured by means of visual separation. The collected seeds were classified as healthy or filled, and barren or empty; the agamic seeds were excluded.

The identification up to the genus level was made using the systematic keys applied at the EEPF "Indio Hatuey". The frequency of the individuals found was calculated, according to the formula:

FI = No. of individuals x 100/Total of the No. of samples.

The germination and viability of the seeds collected in the soil were estimated under laboratory conditions, according to the methodology suggested by ISTA (1999).

The data were processed with the statistical pack SAS (1994) and the values obtained were transformed in sin-√%, for the respective analyses. The means were compared through Duncan's (1955) multiple range test and any value of $p \leq 0{,}05$ was considered significant.

RESULTS AND DISCUSSION

Table 1 shows the number of seeds, per genus, of the different species found in the multi-associated area. Eight genera were determined, five of legumes (including a woody one) and three of grasses; as well as a small pool of seeds from several legumes, which were grouped in one lot. The most outstanding genera were: *Panicum*, with 78,7 % of appearance; *Leucaena*, 9,27 %; *Neonotonia*, 6,03 %; and *Teramnus*, 2,35 %. The total number of individuals was 679; the resulting seed bank by extrapolation had as average 25,1 seeds/m^2, from which 19,7 seeds/m^2 belonged to *Panicum*.

The highest appearance frequency of seeds from the above-mentioned genera could have been

Table 1. Number of seeds per genus and appearance frequency of the individuals.

	Replication 1									Replication 2									Replication 3									No.	FI (%)
Genus/sample	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9		
Leucaena	5	4	5	2	5	3	6	3	1	2	3	2	1		1	2			1	5	3	2			3	3	1	63	9,27
Neonotonia	1	2	3	1	5	1	2	1			1		2	1	1			1	1	5		1	3		2	3	4	41	6,03
Teramnus		1	1		1	1		2	1				1					2	1	1				4				16	2,35
Centrosema	1					1			2	1							1			1								7	1,03
Panicum	36	33	20	26	10	18	3	17	11	31	27	12	23	19	25	19	19	6	44	24	14	23	22	14	10	16	12	534	78,7
Stylosanthes	1																											1	0,14
Brachiaria				2			1					1						1	1	1				1				8	1,17
Sorghum				1								1					1						1	1				5	0,73
Other legumes		1										1									2							4	0,58
Total	44	41	29	32	21	24	12	23	15	34	31	17	27	20	27	21	21	10	48	37	19	26	26	20	15	22	17	679	

related to the floristic composition of these genera during the time the silvopastoral system was under exploitation (Hernández, Carballo and Reyes, 1999), in addition to the fructification capacity they showed under the studied conditions. On the other hand, the climbing growth habit of those herbaceous legumes and the higher size of leucaena with regards to the grasses confer them the possibility to compete favorably for light (Hernández, Carballo and Reyes, 2000); as well as to keep out of the reach of animals in the critical periods of flowering and fructification. This allows them to produce and deposit seeds on the soil for their periodic re-plantings, and can increase their useful life.

In general, the seeds of natural and cultivated pastures are dispersed over the soil surface and are gradually incorporated to its different strata, with which the seed bank or reserve is created. Figure 1 shows the concentration of seeds in the soil –at different depths–, with significant differences ($p<0,05$) in favor of the depth 0-5 cm, in which the highest proportion was found.

The depth at which the seeds are found constitutes a key process in plant distribution and in the structure of the community, because it can favor –or not– the success of seedling emergence. The depth below which the seeds are not capable of germinating varies between the soil type and its degree of compaction (Owens, Wallace and Archer, 1995; Fenner and Thompson, 2005); thus the differences in the environmental and edaphic conditions can influence significantly their survival.

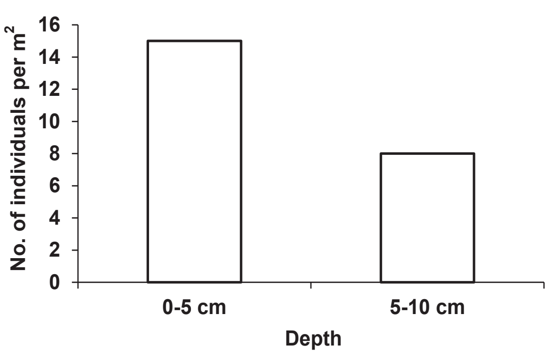

Fig. 1. Concentration of the seeds in the soil.

Studies have been conducted on the time the seeds of the different species can persist in the soil (Arroyo, Cavieres and Humaña, 2004). Based on the available data, some authors state that most of them can be considered transitory or persistent at short term (Cerabolini *et al*., 2003) and that smaller seeds tend to be more persistent and viable. However, it depends on the environmental factors and the characteristics of the species.

Table 2 shows some seed quality indicators of the legume genera in the seed bank of the multi-associated system. There was high viability in the different genera and very variable germination, as well as high percentage of hardness for glycine and leucaena (88,5 and 56,7 %, respectively).

Table 2. Quality of legume seeds in the soil.

Genus	Germination (%)	Viability (%)	Hardness (%)
Neonotonia	11,4	100	88,5
Teramnus	62,1	96,5	34,5
Leucaena	32,4	89,2	56,7
Centrosema	50,0	50,0	0

The germination percentages were low for *Neonotonia* and *Leucaena*, probably due to the high presence of seeds with hard coats. This dormancy or inactivity may be an advantage in the permanence of the seed bank of these genera, because such mechanism constitutes a protection to achieve survival under adverse meteorological conditions (Cooper *et al*., 2004; González, Reino, Sánchez and Machado, 2012). Under natural conditions, the seed coat becomes progressively permeable and a germination of 10-13 % of the seed per year is enough to achieve survival (Paíz, 1996). On the other hand, the species that have high reproductive potential, as well as the seeds with very little dormancy, undergo large oscillations in the size of their population in the soil.

It is concluded that there was a high reserve of *Panicum* genus seed in the soil of the multi-associated system, as well as diversity of some legume genera. In addition, a high percentage of seeds was found in the top stratum of the soil (0-5 cm), which may constitute an advantage in the renewal processes of pasturelands with these plants.

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