Effect of the plantation of *Pennisetum purpureum* cv. Cuba CT-115 on the variation of the physico-chemical properties of the soils in the Picadura farm, Cuba

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It was studied the effect of the plantation of the *P. purpureum* cv. CUBA CT-15 pasture by the plowing method and perpendicular to the slope, in the physico-chemical properties of the brown calcic carbonated lithic and brown calcic carbonated soils, in the unit 123 of the Picadura farm, in the Mayabeque province, Cuba. The properties analyzed were: texture (T), humidity (H), apparent density (AD), changeable cations (CC), and bases interchange capacity (BIC) at different depths. The results were determined the central trend statistics: mean, standard deviation, and coefficient of variation. Student's t-test was used for the comparison of the means. In the brown calcic carbonated lithic soil, after the pasture was planted, the AD decreased from 1.2 to 0.90 g/m3 at both depths, whereas the clay content was superior to 60 %. In this soil, the BIC and the Ca^{2+} increased, and the Mg^{2+} tended to decline. In the brown calcic carbonated soil, the predominant texture was also clayish (63 to 75 % of clay) and there was significant increase of the Ca^{2+} and of the BIC, without variation in the rest of the cations. It was concluded that the plantation of this pasture species perpendicular to the slope decreases the AD, and increases the movement of cations through the profile of both types of soils. This is a sign of improvement of the permeability, provoking higher resistance to erosion.

Key words: *P. purpureum cv. Cuba CT-115, plantation, soil properties, cattle area, Cuba*.

The effect of cattle rearing on some physical, chemical, and biological properties of the soils in the Mayabeque province has been studied by Rodríguez (2004), Crespo (2005), and Lok (2006). These authors concluded that the most impaired indicators are apparent density, structural stability, permeability, and content of organic matter. Also, it has been proved that the type of vegetation in the grassland affects notably these indicators (Ernst 2004 and Nunes *et al*. 2010).

In a period of rainfall of 64 mm, Crespo (2010) confirmed soil losses by water sliding of 1.16 t/ha in a natural grassland, and only 0.46 t/ha in one with mixtures of creeping legumes, in a terrain with approximately 12 % of slope and predominance of light texture. However, the effect of cattle rearing on the physical and chemical properties of the soil, in regions with certain level of slope, has not been sufficiently studied yet.

The object of this study was determining the effect of the *Pennisetum purpureum* cv. CUBA CT-115 pasture, planted by the plowing method, perpendicular to the slope, on the physico-chemical characteristics of two soils predominating in the cattle areas of the Mayabeque province, en Cuba.

Materials and Methods

Characteristics of the experimental site. The Picadura farm, from the Empresa Genética del Este de La Habana, Cuba, is located at coordinates 354 000 – 355 000 North and 414 000 – 418 000 East. The surface is slightly mountainous, with slopes between 5 and 10 %, which facilitate land sliding during the rainy season, with gradual loss of fertility (Crespo 2005).

The productive unit 123 has an agricultural area of 21.0 ha. It is specialized in the production of pregnant heifers, which remain in it up to pregnancy (average weight of 350-400 kg). The herd was composed of 75 heifers, with annual average stocking rate of 2.38 LAU/ha.

At first, the botanical composition in the grassland from this unit was unfavorable, with only 12 % of star grass (*C. nlemfuensis*) and predominance of other species of little forage value.

Experimental procedure. The B_2 and B_6 paddocks were selected. They were located in the squares one and four of the grassland. There was predominance of the brown calcic carbonated lithic soils in the B_2, and the brown calcic carbonated soils in the B_6 (Anon 1999). The B_2 paddock occupied a position higher than the B_6, and the average slope of the area fluctuated between 5 and 8 %.

The initial sampling of the brown calcic carbonated lithic soil (B_2 paddock) was performed on March 22, 2006, collecting three samples diagonally, at depths of 0-20 and 20-35 cm. The first sample collection in the brown calcic carbonated soil (B_6 paddock) was performed on June 6, 2006. Also, three samples were collected diagonally, but at depths of 0-20 and 20-40 cm. The textural composition, the changeable bases, and the bases interchange capacity were determined.

Also, samplings were conducted to determine the apparent density and the humidity at the time of the sample collection, at the depths of 1 to 6 and 15 to 20 cm in the area of the brown calcic carbonated lithic soil. In the brown calcic carbonated soil, it was performed from 2 to 12 and from 21 to 31 cm of depth, because in the latter the effective depth was higher. Later, the *P. purpureum* cv. Cuba CT-115 pasture was planted in these areas, species wider spread in the grasslands from this farm for the formation of biomass banks. The plantations were performed by the plowing method, perpendicular to the slope.

One year and a half after pasture plantation, in 2008, in the rainy season, a monitoring sampling was conducted in both areas, in three random points in the two diagonals. The physical properties analyzed and the analytical methods applied were: texture and microstructure (NC ISO 11277, 2002); gravimetric humidity (NC 110, 2001); apparent density (NR AG 371, 1980); changeable cations (Ca^{2+}, Mg^{2+}, Na^+ and K^+) per ammonium acetate 1 N at pH 7.

The results were analyzed statistically through the central trend statistics: mean, standard deviation (SD) and coefficient of variation (CV), for each depth in particular. The means were compared through Student's t-test.

The criteria of Kaurichev *et al*. (1984) and of the Ministry of Agriculture (1984 and 1985) were used for the interpretation of the results.

Results and Discussion

Table 1 shows the variation of the physical properties in the brown calcic carbonated lithic soil of the B_2 paddock. According to the criteria of Kaurichev *et al*. (1984), in the first sampling, the apparent density of the soil was low in the first depth, and middle, in the second. Nevertheless, in that of monitoring, this indicator showed very low values in the two depths. This could be due to the combined effect of the plowing method, applied to plant the pasture. Also, this could be due to the action of the root mass of this plant during its establishment. The studies of Lok *et al*. (2010) have proved that the Pennisetum genus showed the grasses with greatest root growth, compared with other species commonly used in Cuban cattle production.

As expected, the predominant texture of the soil remained clayish, before and after the pasture plantation, with more than 58 % of clays at the depths of 0-20 and 20-35 cm.

The humidity of this soil was significantly higher ($P < 0.05$) at the depth of 21-25 cm, after the pasture plantation. This seems to be favored by the decrease in the apparent density.

In respect to the variations of the changeable bases of this soil, before and after the pasture plantation (table 2), there was significant gain of Ca^{2+} at both depths. This does not discard the possibility of the roots from this plant contribute to the rise of this element at the two depths under study. Although the Ca increased, it did not bring about the fall of the Mg^{2+}. The bases interchange capacity (BIC) rise, which occurred at both depths, after planting the pasture, could be due to several causes: the increment in the OM, due to the pasture plantation, or due to the gain in changeable calcium or to the dissolution of the carbonates, produced by the extraction method used.

The increase of Ca^{2+} in this soil was verified at 20 to 40 cm of depth, but the decrease of Mg^{2+} was not

Table 1. Variation of the physical properties of the brown calcic carbonated lithic soil (B_2 paddock)

Depth, cm	Initial sampling $\bar{X}$			Monitoring sampling $\bar{X}$			SE±
	Evaluation	SD	CV, %	Evaluation	SD	CV, %	
	AD, g/m³			AD, g/m³			
1 – 6	1.08 Low	0.14	1.26	0.88 Very low	0.10	11.70	0.06*
21 - 25	1.21 Middle	0.13	1.11	0.90 Very low	0.07	87.40	0.07*
	Texture,% (0 – 20 cm)			Texture,% (0 – 20 cm)			
Loam	10.23	0.96	9.39	21.39	4.89	22.86	2.50
Lime	23.50	0.49	2.97	19.73	2.14	10.86	1.80
Clay	66.22	0.78	1.19	58.87	6.29	10.68	2.80
	Texture,% (20 – 35 cm)			Texture,% (20 – 35 cm)			
Loam	9.95	4.27	42.88	17.18	1.07	6.21	2.60
Lime	19.75	4.50	22.81	17.80	2.80	17.81	2.10
Clay	70.29	1.42	2.02	65.01	3.87	5.95	2.40
	Humidity,%			Humidity,%			
1 – 6	27.91	9.28	3.32	40.52	7.40	18.26	3.95
21 - 25	19.60	6.06	3.08	46.94	2.94	6.26	6.82*

*P < 0.05

Table 2. Variation of the changeable bases in the brown calcic carbonated lithic soil (B2 paddock) (Cmol(+).kg^{-1})

Bases	Initial sampling				Monitoring sampling				SE±
	Mean	SD	CV, %	n	Mean	SD	CV, %	n	
20 – 40 cm									
Ca^{2+}	41.87	1.99	4.75	3	52.39	2.37	4.52	3	2.80*
Mg^{2+}	6.40	4.11	64.25	3	3.54	2.08	58.92	3	1.10
Na^{+}	0.40	0.05	12.5	3	0.37	0.064	17.01	3	0.04
K^{+}	0.41	0.05	11.17	3	0.43	0.064	14.88	3	0.05
CIB	49.09	3.41	6.96	3	56.73	2.83	4.99	3	0.80*
20 – 40 cm									
Ca^{2+}	39.73	1.52	3.83	3	53.06	2.44	4.59	3	2.82*
Mg^{2+}	4.28	2.17	50.7	3	1.36	0.21	15.69	3	0.20
Na^{+}	0.35	0.05	14.29	3	0.39	0.065	16.83	3	0.05
K^{+}	0.37	0.07	19.15	3	0.37	0.023	6.30	3	0.01
CIB	44.73	3.79	8.47	3	55.18	2.25	4.08	3	2.90*

*$P < 0.05$

significant, although it did not differ by the variable influence of the soil and by the partial catch of this ion, from the wash of the superior layer. The BIC, at both depths, was increased significantly ($P < 0.05$) after the pasture plantation. This could be attributed to the causes indicated for the depths cited. It seems verifiable the possibility that the roots of this plant have contributed to the rise in Ca, found at both depths in the second sampling.

In the brown calcic carbonated soil of the B_6 paddock (table 3), the apparent density (AD) at the depths of 1-11 and 21-31 cm, was qualified at the start (first sampling) as low and very low, respectively. This was, apparently, due to the high soil humidity sampled at the rainy season; besides due to the good structural stability. The performance of this indicator could not be determined in the second sampling.

The composition of this soil texture evidences the predominance of clayish textures at both depths, although this fraction decreased. The loam fraction increased at both depths, after the pasture establishment. This seems to be due to the space variabilit of the samples.

In this soil, the content of Ca^{2+} and BIC was also increased, and the Mg^{2+} decreased at both depths, after pasture plantation (table 4). The rest of the cations did not show a clear performance.

The results in the two brown soils of this cattle unit suggest that the CT-115 pasture plantation by the plowing method increased the BIC, with possible supply of the Ca^{2+} ion. The movement of ions was proved in both soils using the profile, which constitutes an index of permeability improvement. Also, the apparent density was improved, immediately after pasture plantation. The results are beneficial for the erosion decrease in both soils in the production

Table 3. Variation of the physical properties in the brown calcic carbonated soil of the B_6 paddock

Depth, cm	Initial sampling, $\bar{X}$			Monitoring sampling, $\bar{X}$			SE±
	Evaluation	SD	CV, %	Evaluation	SD	CV, %	
	AD, g/m^3			DA, g/m^3			
1 – 11	1.05 low	0.06	5.89	nd	nd	nd	nd
21 - 31	0.97 very low			nd	nd	nd	nd
	Texture,% (0 – 20 cm)			Texture,% (0 – 20 cm)			
Loam	7.89	1.98	25.09	18.20	4.13	22.67	2.80*
Lime	20.68	0.22	1.06	18.80	4.76	25.35	0.08
Clay	71.43	2.19	3.09	63.00	8.83	14.01	2.20*
	Texture,% (20 – 40 cm)			Texture,% (20 – 40 cm)			
Loam	8.68	4.82	55.52	14.54	5.11	35.15	1.60*
Lime	18.26	1.84	11.32	14.31	4.49	31.39	4.20
Clay	75.06	6.66	8.87	71.15	9.41	13.22	1.14*

*$P < 0.05$ nd = non-determined

Table 4. Variation of the changeable bases in the brown calcic carbonated soil of the B_6 paddock (Cmol (+).kg^{-1})

Bases	Initial sampling				Monitoring sampling				SE ±
	Mean	SD	CV%	n	Mean	SD	CV%	n	
0 – 20 cm									
Ca^{2+}	41.87	1.99	4.75	3	52.39	2.37	4.52	3	2.9*
Mg^{2+}	6.40	4.11	64.25	3	3.54	2.08	58.92	3	0.80*
Na^{+}	0.40	0.05	12.5	3	0.37	0.064	17.01	3	0.20
K^{+}	0.41	0.05	11.17	3	0.43	0.064	14.88	3	0.05
CIB	49.09	3.41	6.96	3	56.73	2.83	4.99	3	2.10*
20 – 40 cm									
Ca^{2+}	39.73	1.52	3.83	3	53.06	2.44	4.59	3	2.80*
Mg^{2+}	4.28	2.17	50.7	3	1.36	0.21	15.69	3	0.62*
Na^{+}	0.35	0.05	14.29	3	0.39	0.065	16.83	3	0.21
K^{+}	0.37	0.07	19.15	3	0.37	0.023	6.30	3	0.01
CIB	44.73	3.79	8.47	3	55.18	2.25	4.08	3	2.75*

* $P < 0.05$

unit under study.

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