Overview on Se use in soils of São Paulo state and its application to signal-grass

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Abstract
Soil fertilization with Selenium (Se) can enhance forages. The objective of this research was to evaluate the influence of Se on soil-plant systems based on a different analysis. It was observed Se content in the soil and forages (*Brachiaria decumbens*) in São Paulo state. Different levels of sodium selenate were applied to *Brachiaria brizantha* cv. Mandaru soil observed with Se deficiency. The micronutrient influences plant nutrition and directly affects animal nutrition. The experimental design used was randomized blocks in a factorial 3x3x2 with four repetitions. The treatments comprised of three soils (NITOSSOLO VERMELHO eutroférrico, LATOSSOLO VERMELHO Distroférrico and ARGISSOLO AMARELO Distrófico Abrúptico), three levels of Se (0, 10 and 20 g/ha) and two cuts (30 and 80 days after plant uniformity). The statistical analyses were performed with SAS (2004) system. As a result, low levels of Se were verified. Small contents of the microelement were observed in the soils and consequently in the forage analysis. Se soil levels correlate negatively with sand content. Se levels did not change the dry matter production and it did not reach cattle nutritional requirements. However, did interfere in calcium levels. More studies are necessary to recommend the optimum Se requirement level.

Key Words
Brachiaria brizantha, Brazil, forage, sodium selenate.

Introduction
Se essentiality in higher plants has been reported (Malavolta 2006). This microelement is essential for animals and its deficiency can result in the development of diseases (Terry *et al.* 2000). The geographic origin of the animals is a more important determinant of the Se concentration in beef than the presence or absence of supplemental Se (Hintze *et al.* 2001). Se levels in forages can vary from soil to soil and within the same soil because there are factors that can influence its absorption by plants. The United Kingdom showed that increasing the Na and Se levels in grass is better than using mineral supplements to increase Se in animal blood. Deficiency correction in grass increased milk production 9%, of protein level 9.6% and of fat in milk 15.6% (Selênio 2006). Se levels in dry matter of forages in 12 areas of São Paulo were 0.076 and 0.052 ppm Se in the wet and dry seasons respectively, showing general deficiency (Lucci *et al.* 1984). However, this research did not correlate the forage Se with the soil Se. There is little information about Se in Brazilian soils. Several factors in the soil may affect absorption of Se by plants. These factors are reflected in the necessity to find information on Brazilian soils and pasture grass under levels of Se application.

Methods
The overview on Se use in soils of São Paulo state in Brazil and in the grass (*Brachiaria decumbens*) cultivated in these soils during summer. The second stage of research was carried out in a greenhouse. It aimed to evaluate the behavior of the *Brachiaria brizantha* (Hochst. ex A. Rich.) Stapf cv. Marandu under application of Se levels from Sodium selenate in soils with deficient levels of Se. The experimental design used was randomized blocks in a factorial 3x3x2 with four repetitions. The treatments were three soils (typic Hapludalf, Oxisol and Red Dusky Podzol), three levels of Se (0, 10 and 20 g/ha) and two cuts (30 and 80 days after plant uniformity). The data were statistically analyzed (SAS 2004). Averages were compared using orthogonal contrasts and significance level of 10%.

Results
Small contents of Se were observed in the soils and consequently in the forage (Figure 1). When there is less than 500 µg of Se/kg in the soil, it is characterized as Se deficiency in the soil (Millar 1983). Se deficiency occurs in pastures containing less than 30 µg of Se per kg of dry matter (Malavolta 2006 and Millar 1983).

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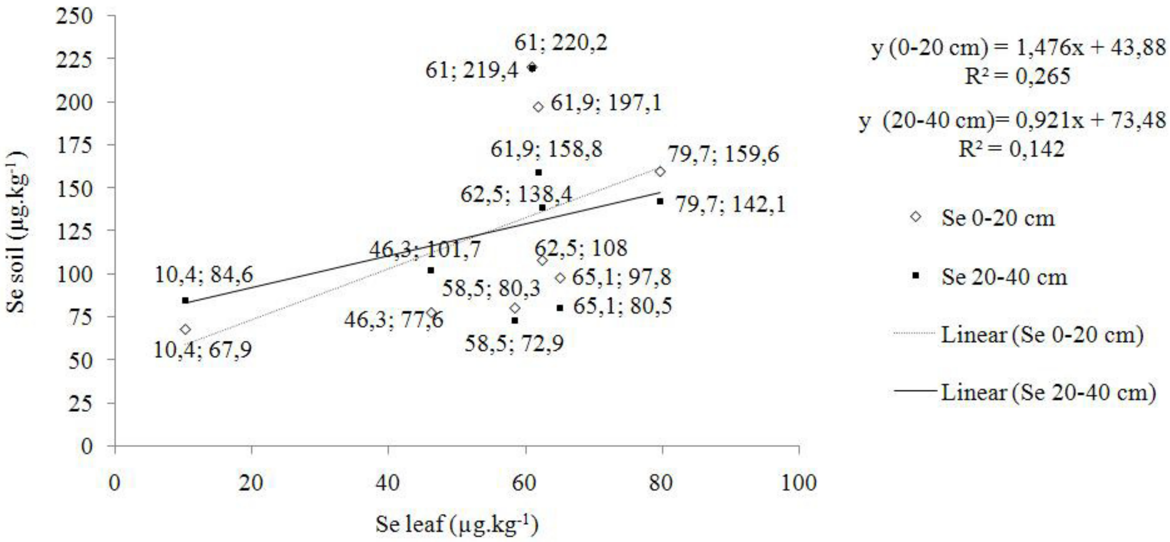

Figure 1. Correlation between Se levels in *Brachiaria decumbens* and soil (0-20 and 20-40 cm).

None of the soils evaluated showed Se levels high enough to supply desirable amounts for the grass, considering that the requirement for beef cattle is 100 µg/kg (NRC 2000). The levels in the plant were below the requirements for animals; however, the relations between Se in the plant and in the soils, both depths, were positive, in spite of the low correlation coefficients. The physico-chemical analysis on horizons in the soils presented the lowest Se levels for soils with the highest sand levels. The deficient areas correspond to soils with relatively high percentages of sand (Rosa 1991). The deficiency is usually found in sandy soils (Selênio 2006). The differences found between the horizons can be related to the occurrence of leaching with descending movement of the element, considering the fact that it is always in the form of anion selenite (SeO_3^{-2}). The Se distribution in the soil profile is a determinant of its concentration in the plant (Reid and Horvath 1980). Such fact would justify the behavior observed in the profiles analyzed in which the type of soil can greatly influence the magnitude of the leaching process (Sangoi 2003). In the plant, Se doses influenced the Ca level following a negative quadratic relationship ($y = -0.014x^2+0.25x+7.7$ ($R^2=1$)) with the highest point at 10 g/ha of Se and Se level of ($p=0.0012$), which presented a curve linear behavior (Table 1).

Table 1. Chemical analysis of *Brachiaria brizantha* submitted to Se treatment for versus periods (Averages followed by the same letter in the column did not statistically differ among one another by Tukey 10%)

		P	S	K	Ca	Mg	Cu	Fe	Mn	Zn	Se
		g.kg^{-1}					mg.kg^{-1}				µg.kg^{-1}
Levels of Se (g/ha)	0	0,8^a	0,9^a	32^a	8^{ab}	3,8^a	5^a	52^a	94,2^a	24^a	4,1^b
	10	0,9^a	1,1^a	31^a	9^a	3,7^a	5^a	44^a	94,6^a	24^a	27,4^{ab}
	20	0,8^a	1,0^a	32^a	7^b	3,9^a	5^a	47^a	93,5^a	24^a	49,0^a
Evaluation time (days)	30	0,8^b	1,0^a	39^a	6^b	3,1^b	6^a	53^a	56^b	24^a	41,1^a
	60	0,9^a	1,0^a	24^b	9^a	4,6^a	5^b	42^b	132^a	24^a	12,6^b

The Se level in the soil did not present a dose effect (Table 2) and were low considering the deficiency criterion (Millar 1983). Among the other chemical attributes concerning soil fertility, only P, Mn and H+Al showed effects. The doses presented positive effects with the reduction of H+Al levels, which followed a negative quadratic model, while the micronutrient Mn showed a positive quadratic relationship ($p=0.0003$).

There was difference for Se levels in the plant ($p=0.0370$) and in the soil ($p=0.0289$) for the soils evaluated (Figure 2). The inverse relationship between the Se level in the soil and in the plants for NITOSSOLO VERMELHO Eutroférrico can be justified by the possible unavailability of the form in which the Se is in the soil. The dry matter production (average 29g), the CP level (average 5.7%), the residual dry matter (average 42.3 g), the root length (average 36.8 cm) and the root weight (average 40 g) did not show a dose effect. The level of dry matter showed only time effect, increasing from 27 to 35%.

Table 2. Average levels of chemical attributes of soil fertility of applied to *Brachiaria brizantha* submitted to Se treatments (Averages followed by the same letter in the column did not statically differ among one another by Tukey 10%).

Doses of Se ($g.ha^{-1}$)	pH	M.O.	P	S	K	Ca	Mg	H + Al	Al	CTC	SB	V	m	B	Cu	Fe	Mn	Zn	Se
	$CaCl_2$	$g.dm^{-3}$	$mg.dm^{-3}$		$mmolc.dm^{-3}$							%		$mg.dm^{-3}$					$\mu g.kg^{-1}$
0	$5,3^{a}$	27^{a}	25^{a}	6^{a}	$0,6^{a}$	19^{a}	5^{a}	26^{a}	2^{a}	52^{a}	25^{a}	48^{a}	7^{a}	$0,23^{a}$	$4,9^{a}$	38^{a}	$10,2^{a}$	$6,2^{a}$	$25,1^{a}$
10	$5,4^{a}$	27^{a}	22^{b}	5^{a}	$0,6^{a}$	19^{a}	5^{a}	25^{a}	1^{a}	51^{a}	25^{a}	50^{a}	7^{a}	$0,20^{a}$	$4,9^{a}$	39^{a}	$8,1^{b}$	$6,2^{a}$	$26,1^{a}$
20	$5,4^{a}$	27^{a}	22^{b}	5^{a}	$0,6^{a}$	19^{a}	5^{a}	19^{b}	1^{a}	52^{a}	25^{a}	50^{a}	5^{a}	$0,22^{a}$	$5,3^{a}$	40^{a}	$10,0^{a}$	$6,1^{a}$	$18,5^{a}$

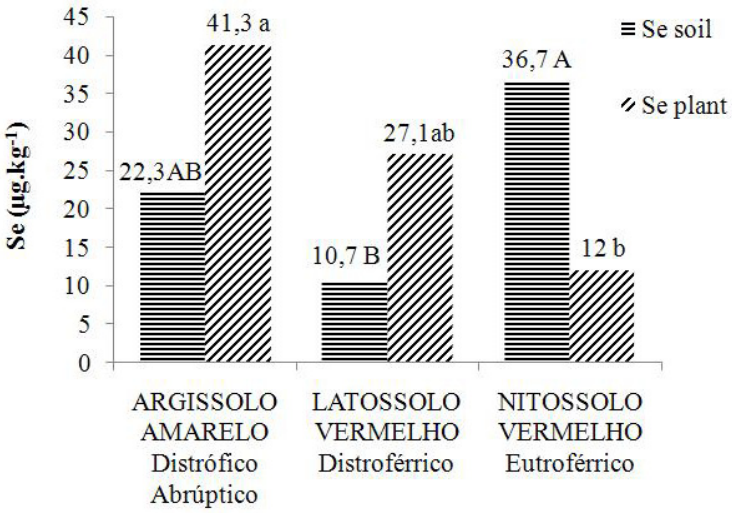

Figure 2. Average levels of Se in the soil and in the plant applied to *Brachiaria brizantha* submitted to Se treatments (Averages followed by the same letter in the column did not statically differ among one another for each parameter analyzed by Tukey 10%).

Conclusion

Some of the main soils in São Paulo state present low Se levels and therefore *Brachiaria decumbens* on them showed considerably deficient levels, the Se concentration in the soil and in the plant were related. The relation between Se levels in the soil and in the plant varies from soil to soil. The levels in the soil have a negative relationship with sand levels. The Se doses applied did alter the Se levels in the soil and were not enough for the grass to reach foliar levels necessary to supply the requirements for animals and did not modify the dry matter production; however, they changed the chemical composition of plants interfering with the Ca levels. Se fertilization for *Brachiaria brizantha* can be carried out through soil supply, but the doses were low, which requires more studies to ensure the efficient doses to be applied and preventing contamination for both animal and the plant.

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