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Factors Affecting Nitrate Levels in Pastures

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Abstract: Nitrate levels in oat at three different regions within the country were determined. In this case the factors that can affect the accumulation of nitrates in pastures are analized, as well as the correlations between nitrate levels in oats, nitrate levels in the soil, previous fertilization with nitrogen-containing compounds and pertinent meteorologic data. The nitrate levels in soil were studied using a potentiometric method with a specific electrode. Tau coefficient of correlation was used for studying the association between nitrates in soil and nitrates in oats. The significance level was established at 0 0,05. The statistical program SPSS was used for analizing the results obtained. In none of the places analized (San José, Paysandú and Canelones) the nitrate levels in soil correlated positively with the nitrate levels found in oat. The only oat sample that reached potentially toxic levels correlated with a high level of nitrate in soil. All of the samples analized had received nitrogenated fertilizations before sowing. There was no hydric deficit previous to any sampling which coincides with the low levels reached during the determinations.

Key words: Nitrate level, accumulation of Nitrates,

INTRODUCTION

Uruguay is a cattle breeding country, producing meat and milk. It has been estimated that from a total of 12.000.000 bovines, 100.000 die annually due to plant intoxications. Any work done focused on diminishing these loses will end up being a clear benefit for the industry. Part of this problem is attributed to nitrate and nitrite intoxication[1-3].

According to classical bibliographical data[4-6] the excessive accumulation of nitrates in oat occurs when the plant absorbs more nitrate from the soil than it is capable of synthesizing and convert into protein. Possible causes include the following: fertilizing either with nitrogenated products or with manure, prolonged draught, excess of humidity, cold, scarce light, being all these stress conditions which delay growth and favor nitrate accumulation. Grazing becomes risky after it rains following a period of draught, because under these circumstances large quantities of nitrate that were in the soil pass on to the plant, which in turn it absorbs them rapidly accumulating them in its tissues. Other factors such as soil pH, lack of certain minerals, acid soil, Phosphorous (P), Sulphur (S), or Molibdene (Mo) deficiencies predispose the soil to accumulate nitrates. Another source of intoxication that must be considered is water. Nitrates can reach toxic levels in almost any forrage, but frequently levels are higher in gramineous than legumes. In Uruguay there are very few intoxications due to nitrates in pastures published[1-3], though there have been numerous deaths occuring in different years which haven't been reported in the veterinary literature. Many of these cases have been registered by the Toxicology Department and Official Diagnostic Laboratories when consulted or communicated of toxic cases. During the autumn of 1992 a large number of cases occurred in the southwest part of the country and the same conditions were found in the autumn of 2000. During these years there were parts of the country suffering severe droughts, which could create a lattent risk of intoxication. The aim of this work is to evaluate the different factors involved in causing intoxication, which imply an increase in the concentration of nitrates in plants.The factors that can influence the accumulation of nitrates are analysed, as well as the correlations between nitrate levels in oats and soil, previous fertilization with nitrogenated compounds and corresponding meteorologic data.

MATERIALS AND METHODS

The regions selected to be studied were San José, Paysandú and Canelones. Trips to San José were made every three months in an effort to try to make a seasonal

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Table 1: Nitrate concentration in pastures and soil samples from San José, Paysandú and canelones

San josé		Paysandú		Canelones	
Nitrates		Nitrates		Nitrates	
Soil	Pastures	Soil	Pastures	Soil	Pastures
61	450	10	1105	12	1250
13	933	13	696	12	833
12	3000	35	1000	11	824
30	900	1136	6429	12	882
13	1625	14	439	10	700
12	800	30	864	23	714
72	1789	32	727	10	714
56	1200	11	850	10	1100

Table 2: Satistical correlations

Origin	Tau	p
San josé	-0.074	0.802
Paysandú	0.214	0.458
Canelones	0.205	0.509

evaluation. In each region eight oat plantations were monitored. At the time of the first visit to each selected farm two types of samples were taken: oat and soil. The soil samples were taken from the same site as the oat

Table 3: Nitrate concentrations in oat samples and meteorologic conditions during the sampling day and during the three previous days

SAMPLE	CONC(mg/kgdry matter)	San josé meteorologic station				
2 EP April	450	Latitude		Longitud		Elevation
3 EP April	933	---		---		---
4 EP April	3.000	34° 21,2'S		56°45,4'W		72mSNMM
6 EP April	9000					
7 EP April	1.625	4/15/02				
9 EP April	800	Day	Tx	Tn	RH	MCloud
11 EP April	1.789	12	18.5	13.5	82	7
13 EP April	1.200	13	17.8	12.5	66	8
		14	22.0	12.4	77	7
		15	23.6	12.8	86	5
SAMPLE	CONC.(mg/kgdry matter)	07/03/024				
2 EP July	2.500	Day	Tx	Tn	RH	MCloud
3 EP July	1.143	30	12.2	8	80	6
4EP July	1.067	01	12.8	4.5	76	6
6 EP July	1.250	02	14.2	9.5	95	6
7 EP July	824	03	12.2	10.4	97	8
9 EP July	1.133					
11 EP July	1.875					
13 EP July	1.733					
SAMPLE	CONC.(mg/kgdry matter)	10/22/02				
2 EP Oct	222	Day	Tx	Tn	RH	MCloud
3 EP Oct	1.056	19	20.0	5.6	79	7
4 EP Oct	917	20	22.0	7.4	73	6
6 EP Oct	893	21	16.8	9.2	97	6
7 EP Oct	529	22	13.4	10.5	72	7
9 EP Oct	190					
11 EP Oct	1.750					
13 EP Oct	708					
SAMPLE	CONC.(mg/kg dry matter	Paysandú meteorologic station				
1 PDU Aug	1.105	Latitude		Longitud		Elevation
2 PDU Aug	696	---		---		---
3 PDU Aug	1.000	32°20,9'S		58°02,2'W		61.12mSNMM
4 PDU Aug	6.429					
5 PDU Aug	439	08/23/02				
6 PDU Aug	864	Day	Tx	Tn	RH	MCloud
7 PDU Aug	727	20	18.0	8.8	64	5
8 PDU Aug	850	21	19.0	6.0	56	3
		22	20.4	6.0	60	1
		23	27.0	12.0	77	5

SAMPLE	CONC.(mg/kgdry matter)	11/22/02				
1 PDU Nov	800	Day	Tx	Tn	RH	MCloud
2 PDU Nov	500	19	29.0	18.0	67	6
3 PDU Nov	737	20	26.0	18.8	78	7
4 PDU Nov	2.811	21	26.0	14.2	55	5
5 PDU Nov	957	22	27.1	12.0	56	2
6 PDU Nov	556					
7 PDU Nov	230					
8 PDU Nov	455					
SAMPLE	CONC.(mg/kgdry matter)	Canelones meteorologic station				
1Sep SR	1.250	11/22/02				
2 Sep SR	833	Day	Tx	Tn	RH	Mcloud
3 Sep SR	824	15	17.0	3.6	78	5
4 Sep SR	882	16	20.0	8.2	80	7
5 Sep SR	700	17	23.5	14.5	90	7
6 Sep SR	714	18	23.5	15.4	91	5
7 Sep SR	714					
8 Sep SR	1.100					

References Tx: Absolute maximum temperature at instrument shelter in °C
Tn: Absolute minimum temperature at instrument shelter in °C
RH: Mean daily relative humidity in (%)
Mcloud: Mean cloudiness in octa

Daily pluvioetric information in mm

Paysandú					Canelones			San José						
DAY	JUL	AUG	OCT	NOV	DAY	AUG	SEP	DAY	MAR	APR	JUN	JUL	SEP	OCT
1	2.5				1		8.0	1						
2	10.1		8.6	0.3	2			2				12.0		3.0
3	35.1			16.2	3			3				27.0		
4	25.0	TRZ			4			4	53.0		27.0	18.0		9.0
5	5.7				5		3.0	5				9.0		
6	0.1		36.2		6			6		50.0				10.0
7			TRZ		7			7		6.0				
8	0.2	5.5	15.0	44.1	8	5.0		8						
9	0.4		TRZ	5.0	9			9	5.0	2.0				
10			0.2		10			10	25.0					
11					11		21.0	11		7.0			28.0	
12					1			12						
13					13			13	5.0					
14				14.3	14			14	6.5					8.0
15			34.0	0.2	15			15	16.0	13.0				31.0
16		1.7	0.3		16	12.0		16		34.0				
17		0.2		TRZ	17		25.0	17	1.0					
18		19.1			18	35.0	17.0	18	12.0				23.0	
19		0.5	7.0	23.6	19		17.0	19	10.0					6.0
20	2.5		9.0	5.4	20			20						20.0
21	0.3				21			21				1.0		
22					22			22		5.0				
23	0.2	TRZ			23	15.0		23						
24	TRZ			59.0	24			24				5.0		
25				42.2	25			25						
26	TRZ		7.6		26			26						
27			0.1		27			27						
28		25.4	TRZ		28	43.0		28	16.0	8.0	16.0		24.0	4.0
29	0.3	TRZ			29			29	55.0			6.0		
30	0.2			42.1	30			30	7.0			3.0		
31					31	8.0		31	12.0					
total	82.6	52.4	118.0	252.4	total	118.0	91.0	total	223.5	125.0	43.0	72.0	84.0	91.0

TRZ: unmeasurable precipitation

samples following the recomendations made by the technicians of Control de Suelos y Fertilizantes of the Ministry of Agriculture for determining nitrate levels of soil. Soil nitrates were studied using a potenciometric method with a specific electrode for nitrates. For studying the association between nitrates in soil-nitrates in oat Tau coefficient of correlation was used. The significance level was established at p equal or less than 0,05. For analysing the results obtained the statistical program SPSS was used.

RESULTS

Association between nitrates in soil and nitrates in oats: Tau coefficient of correlation was used.

DISCUSSION

In none of the three places where samples were taken (San José, Paysandú or Canelones) did the levels of nitrates in soil correlate with the ones in oats. In spite of this it is shown that the only oat sample that reaches potentially toxic levels correlates with a high level of nitrates in soil. All of the samples processed had received nitrogenated fertilizations prior to the sow. The incidence that these may have had in the final concentration found in the samples could not be studied because finding oat samples without fertilizer for doing a comparative study was not possible.

Draught is considered the most important predisposing cause of toxicity in Uruguay because it causes an increase in nitrate levels both in soil and in plants[1-3]. As the pluviometric data of the meteorologic stations show there was no hydric deficit before any sampling, which coincides with the low nitrate levels found during the analysis.

Samples 3 and 4 from Paysandú come from a plantation extending up to 80 ha. Sample 4 reached potentially toxic levels. Sample 3 was taken from a high part of the field while sample 4 was taken from the opposite end, which is a low zone. Both parts were separated by a small stream. Sample 3 reached normal concentrations while sample 4 showed to be potentially toxic. This difference seems to be caused by the downward slope and to the drainage, both of which determine that nitrates be dragged downhill to the site were sample 4 was obtained.

We consider that more studies of this type should be made in other regions of the country and with environmental conditions that favour nitrate accumulation, as more droughts and unstable weather conditions are predicted.

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