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Influences of the phosphoric fertilizers on the fertility of the soil in pasture areas of the dehesa of Extremadura

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Summary - The methods of improving the pastures (production and preservation) in the Extremadura "dehesa" are based on: legumes, phosphorus and grazing. Traditionally superphosphate of lime at 18% has been used annually to supply phosphorus to the pastures. In this paper the method (superficial or subsoil) and time of application as well as an ecological alternative to the superphosphate of lime such as phosphoric and peletizada rock are discussed. In the second year the results obtained in soils covered in winter and spring were limited for granite soils and not significant for slate soils. With the exception of Pradillo (Trasierra) where the levels of vegetal cover were close to critical for these areas (risk of erosion), the rest of the data were good or very good and without risk of erosion, specially in winter. The levels of fertility (Olsen phosphorus and organic matter) were higher in the second year in an important part of the treatments and tests in which phosphorus was applied, especially in granite soil. Therefore, we can state that during the second year no big differences have been found (fertility of the soil and vegetal cover) between superphosphate of lime and phosphoric rock, or in the time of application.

Key-words: natural phosphates, phosphoric rock, Mediterranean ecosystem

Résumé - *L'amélioration des pâturages dans les dehesas d'Extremadura est basée sur la trilogie légumineuses, phosphore et pâturage. Cet article compare plusieurs méthodes et périodes d'application et une alternative écologique au superphosphate sous la forme de roche phosphorique broyée. Au bout de 2 ans, les résultats en terme de couverture du sol étaient insuffisants sur sol granitique mais étaient satisfaisants pour tous les autres sites excepté Pradillo où des risques d'érosion restaient présents. La fertilité du sol exprimée par le taux de phosphore et de MO augmente la deuxième année dans tous les traitements où du phosphore a été appliqué, en particulier sur sol granitique. Aucune différence n'a été identifiée entre les deux types de fertilisation phosphatée.*

Mots-clés: *phosphate naturel, roche phosphorique, milieu méditerranéen*

Introduction

The most common method of pasture improvement in acid soils in semi-arid Mediterranean climate (rainfall: 450 to 850 mm/year; drought: 3 to 5 months/year) in the Extremadura 'dehesa' ecosystem is based on the supply of moderate quantities of phosphorus (Olea *et al.*, 1998; Olea y Viguera, 1998; Granda, 1992), which activate the legumes, especially the annual ones, provided they are correctly grazed.

The annual supply of 18 to 27 UF of $P_2 O_5$/ha doubles its production and improves its quality (Moreno, 1993; Granda *et al.*, 1992; Olea *et al.*, 1995). The product traditionally used has been superphosphate of lime at 18% which is not considered ecological. Alternative ecological products such as phosphoric rock could be used instead.

Superphosphate of lime is applied in Autumn although it has not been confirmed scientifically to be the best time. Not enough research has been done on the methods and ways of application of phosphorus to the soil in extensive systems. What is known is that superphosphate does not normally reach deep enough causing losses (Moreno *et al.*, 1993).

Materials and methods

The project was carried out in 3 'dehesas' in the province of Badajoz: Manpolin (Higuera de Vargas), Cotorio (Pantano de Cornalvo) and Pradillo (Trasierra).Two tests in granite soils (Mampolin and part of Cotorio) and two slate soils (Pradillo and part of Cotorio).

Edafologic characteristics: these soils belong to the Inceptisol group. They are acid soils, with a sandy-loam structure, little organic matter, deficiency of nitrogen and no phosphorus (Table 1: control treatment).

Table 1: Edafologic characteristic of the soil after treatment.

	1.A	1B	1C	1D	2 A	2 B	2C	2D	3 control
MAMPOLIN GRANITE/ WOODED LAND									
pH 1:2,5	4,8	4,8	4,8	4,9	4,6	5,1	5,1	4,8	5
O.M.	2,9	2,8	2,8	2,7	2,3	2,6	2,3	2,8	1,8
P Olsen	7,7	11,2	8,2	9,7	5,9	5,7	7,3	9,5	0,5
COTORIO GRANITE /PASTURE LAND									
pH 1:2,5	4,7	4,8	4,7	4,7	4,5	4,5	4,7	4,8	4,8
O.M.	1,7	1,9	1,4	1,4	1,6	1,3	1,6	1,5	1
P Olsen	2,6	2,5	4,2	4,2	4,9	7,5	5,4	3,2	0
PRADILLO SLATE/ PASTURE LAND									
pH 1:2,5	5,6	5,5	5,6	5,8	5,8	5,5	5,6	5,7	5,6
O.M.	1	1,1	1,1	1,1	1,6	1,1	1,4	1,2	0,7
P Olsen	8,4	5,3	6,8	5,4	6,9	7,5	6,4	6,7	0
COTORIO SLATE/ WOODED LAND									
pH 1:2,5	5,3	5	5,2	5,2	5,2	5,2	5	5,1	53
O.M.	4,4	3,2	2,5	3,6	3,5	3,1	3,0	2,4	1,4
P Olsen	5,6	3,6	2,5	3,6	4,2	4	4,2	4,5	0

Numbers shows the fertiliser applied: 1 superphosphate of lime, 2 phosphoric rock, 3 no fertiliser (treatment control). The letters show the time and method: A=October superficial, B=October subsoil, C=December superficial and D=March superficial.

Weather conditions: the four tests were carried out in a Mediterranean climate -cold winters, hot summers and variable rainfall in quantity and distribution (table 2). There were some rainfall differences among the places where the research took place. We can state that 1996/97 and 97/98 were, in general, average with the exception of the sudden heavy rainfall of 1997.

Product used: superphosphate of lime at 18% of P_2O_5 (traditionally used in the 'dehesa') and phosphoric rock (natural phosphates with 26-33% of P_2O_5).

Method: plots of 50 m^2 were chosen at random, each test was repeated four times. The variables studied were:

- Two phosphoric products: superphosphate of lime at 18% and phosphoric rock.
- Four methods of application: superficial in October, subsoil in October, superficial when the clover plant had 3 leaves and superficial in the first two weeks of March.
- One control plot (with no fertiliser)

The tests were carried out following the same grazing system as in the rest of the 'dehesa'.

Controls

Soil analysis: as recommended by the MAPA.

Vegetal cover: the proportion of soil covered with plants is checked twice a year (winter/spring).

Table 2: Weather conditions.

	T. average	m.[1]	Annual rainfall	Spring rainfall	Autumn rainfall
		Mampolin (Higuera de Vargas).			
96/97	18,06	5,0	759,3	155,4	173,7
97/98	18,02	6,1	811,8	148,1	503,3
30 year average	16,58	5,0	649,2	161,6	194,1
		Cotorio (Pantano de Cornalvo).			
96/97	18,18	5,2	610	68,9	189,6
97/98	17,94	5,7	849,8	181,3	404,5
30 year average	17,47	4,1	558,2	148,8	163,6
		Pradillo (Trasierra)			
96/97	14,69	3,2	499,3	67,9	109,9
97/98	15,95	4,7	535,2	139,7	165,3
30 year average	15,76	2,9	474,8	117,7	144,7

m= The average lower temperatures in the coldest month of the year

Results and discussion

Soil fertility. Table 1 shows the results of the soil analysis (Sample taken in spring 98). After two years the fertility of the soil was improved. We can appreciate an important increase in the available phosphorus and organic matter, reaching levels of 8 to 12 ppm in some treatments and tests (Olsen). Levels which are considered appropriate for these pastures (Olea *et al.*, 1989; Moreno *et al.*, 1993, Granda, 1992).

Herbaceous cover. The results are shown in table 3. In the slate soils there were no important differences ($p<0,05$) either in treatment or time of application in two tests (Trasierra y Cornalvo). However, due to the lack of rainfall in spring and the excess of animal grazing there were some differences in one of the tests (Pradillo) –81% winter, 53% spring). According to Stoking (1998) the levels in spring were almost critical.

Table 3: Vegetal cover in the second year of the project.

	GRANITE				SLATE			
	Mampolin		Cornalvo		Pradillo		Cornalvo	
Treatment	I/98	IV/98	I/98	IV/98	I/98	IV/98	I/98	IV/98
1 Super 18%	85 (*)	96	97	95	81	52	97	92
Appl. October	a	a	ab	ab				
2 Super 18%	61	83	90	92	72	57	96	90
Sulsoil October	c	c	abc	abc				
3 Super 18%	75	75	91	79	87	51	89	92
Appl. Dic-Jan	a	c	abc	d				
4 Super 18%	84	95	98	89	87	56	88	95
Appl. March	a	ab	ab	abc				
5 phosph. Rock	81	80	93	91	87	51	93	85
Appl. October	a	c	abc	abc				
6 phosph. Rock	61	84	93	91	82	48	93	94
Subsoil Oct.	c	c	ab	abc				
7 phosph. Rock	75	84	100	91	87	52	95	94
Appl. Dec-Jan.	a	c	a	abc				
8 phosph. Rock	76	84	90	97	74	59	87	87
Appl. March	a	c	ab	a				
9 Control	65	80	80	88	74	50	98	81
	bc	c	c	abcd				
C.V. %	10,14	9,0	9,5	7,5	14,5	21,6	11,1	15,2
LSD ($P<0,05$)	11,0	11,2	12,7	9,9	NS	NS	NS	NS

In the granite soils, in which the effect of phosphoric fertilisation is quicker (Olea *et al.* 98) levels are sufficient (Stoking, 98) in all treatments with fertilisers. The control treatment (with no fertilisers) obtained the lowest levels.

Conclusions

Data from a longer period would allow us to reach more interesting and reliable conclusions. However, based on our study the following features may be highlighted:

- The vegetal cover is increasing since the last Spring.
- In general fertilisation with superphosphate of lime at 18% and with phosphoric rock showed no differences.
- The method of application -subsoil - seems to have no advantages, on the contrary, it gave less vegetal cover in some areas causing a higher risk of erosion in Autumn and Winter mainly.
- The different times in which phosphorus was applied –Autumn, Winter and Spring- proved to be equally valid for the vegetal cover and the fertility of the soil.

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