European Society for Agronomy

VII ESA Congress
15-18 July, 2002
Cordoba, Spain

Book of Proceedings

Editors:

Francisco J. Villalobos

Luca Testi

VII CONGRESS OF THE EUROPEAN SOCIETY FOR AGRONOMY

© *Edita:* JUNTA DE ANDALUCÍA. ***Consejería de Agricultura y Pesca.***

Publica: VICECONSEJERÍA. Servicio de Publicaciones y Divulgación.

Colección: CONGRESOS Y JORNADAS

Coordinadores: Francisco J. Villalobos y Luca Testi

Fotografías e Ilustraciones: Autores

I.S.B.N.: 84-8474-059-5

Depósito Legal: SE.2.277 - 2002

Fotocomposición e impresión: J. de Haro Artes Gráficas, S.L. Parque Ind. P.I.S.A.
Mairena del Aljarafe • Sevilla

Ilustración de portada:

Cover paint: Wenceslaus, "August", from the "Cycle of the Months" frescoes, painted around 1400 in the Eagle Tower of the Castle of Buonconsiglio, Trento, Italy.

EVALUATING THE USE OF *LUPINUS ALBUS* FOR THE PHYTOREMEDIATION OF SOILS POLLUTED WITH Zn AND Pb

Pastor J.[1], Prieto N.[1] and Hernández A.J.[2]

1 Centro Ciencias Medioambientales, CSIC, Madrid. E-mail: j.pastor@ccma.es
2 Dto. Interuniversitario de Ecología, Universidad de Alcalá. E.mail: anaj.hernandez@uah.es

Introduction

The soil of several areas of central Spain is polluted with heavy metals (Zn, Cu, Pb and Cd among others) due to past industrial and mining activities, and the presence of abandoned landfills of rubble, industrial and urban waste. In an attempt to find suitable native plants for the recovery of these soils, an evaluation was performed on the forage leguminous species *Lupinus albus* Cv. Multolupa. The behaviour of this species towards heavy metals is currently being explored by several authors.

Material and methods

Five soils of acid pH were selected from the central Spanish zone. According to FAO classification, the first of these soils is a chromic luvisol; an abandoned agricultural soil previously subjected to cereal-legume rotation, with an extremely low Zn content and an absence of Pb (soil 1). Soils 2, 3 and 4 are pasture soils with total Zn and Pb contents in the range 90 to 550 ppm and 106 to 327 ppm respectively. Soil 2 shows similar Zn and Pb levels to those found in the covering soils of mixed waste landfills (Pastor and Hernández, 2002). Soil 5 is a distric leptosol with a high total and extractable Zn and Pb content. Soils 3, 4 and 5 were sampled in the immediate surroundings of past mines. With the exception of soil 1, these soils can be considered toxic (especially soils 4 and 5). Besides Zn and Pb the following elements were also determined in soil samples by atomic absorption spectroscopy: Cu, Al, Ba, Cd, Cr, Fe and Ni. Only high extractable Zn and Pb contents were recorded. Concentrations in the soil extracts were analysed according to the method of Lakanen (1967).

Once the total and extractable Zn and Pb soil contents had been established, 5 top soil samples were obtained. Three kilogram samples of each (in quadruplicate) were placed in 22 x 15 x 8 cm containers with a lower draining grid to collect excess water. The bioassay was performed under controlled green-house conditions seeding *Lupinus albus* cv Multolupa until the start of flowering (12 weeks). Three seeds of *Lupinus albus cv.* Multolupa were planted in each container. Each specimen was then subjected to determination of the following non-invasive quantitative agronomic variables: dry weight (grs), plant height (cm), leaf diameter (cm), length and width of the foliole (mm). Middle-aged leaves were used for this purpose. Other semiquantitative character was also taken into account: vigour (plants of scarce to highly vigorous growth graded according to a 7-point scale).

ANOVA was performed on log-transformed data to determine differences among treatments. We used the least-significant difference (LSD) option with the ANOVA as a post-hoc test of significance of differences among means for the different treatments. The software used was the SPSS version 10 package.

Results and discussion

This lupin was able to grow well and flower in even the most polluted soils. Analysis of variance revealed that the soil Zn content affected plant Zn levels. The table 1 show Zn and Pb levels as absolute means ± SE rather than log values to aid comprehension. The LSD of the groupings are also provided. Treatments sharing the same letter in a column did not differ significantly at a $p = 0.05$. The mean Lupinus content of this metal, in the most polluted soil, was 850 ppm, although levels up to 1300 ppm were recorded. These Zn concentrations are higher than those observed in other species spontaneously growing in these soils (Pastor and Hernández, unpublished data). The Zn contents shown by lupins growing in the 5 soils were significantly different. The Pb levels of the soils only affected lupin in the case of soil 5.

	SOIL					PLANT	
		Zn		Pb			
	pH	Extract.	Total	Extract.	Total	Zn	Pb
Soil 1	5.0	0.1	30	0.0	0	18.4±5.2 a	0
Soil 2	5.5	5	90	7.4	106	31.8±7.2 b	0
Soil 3	5.8	70	200	70.5	224	99.0±7.3 c	0
Soil 4	6.0	166	550	183.5	327	150.3±33.0 c	0
Soil 5	5.6	700	2600	1348.3	2388	850±376 d	25.5±49.8

Tabla 1: Soil and plant Zn and Pb contents

Tables 2 shows the results of the analysis of variance and provide mean values (± SE) for the 6 agronomic variables estimated for lupins growing in the five soils. Low or very low soil heavy metal levels showed scarce effects on plant variables. Significantly different plant variables were, however, noted when the lupins were grown in soils 1 and 2 compared to soils 3, 4 and 5. Plants growing in soils 1 and 2 only showed significantly different dry weights. Those growing in soils with total Zn and Pb contents above 200 ppm (extractable contents 70 ppm), showed practically no significant morphological differences but the variables height, dry weight and vigour barely reached 50% of those shown by controls growing in non-polluted soil (soil 1). Hernández *et al.*(1995) observed that the use of high Zn concentrations in the nutrient solution significantly impaired aerial growth, weight and number of nodules in only 18 days.

	Plant				Foliole	
Soil	Vigour	Height (cms)	Dry Weight (grs)	Leaf Diameter (cms)	Length (mm)	Width (mm)
Soil 1	6.6±0.5 a	39.3±5.6 a	2.3±0.3 a	6.0±0.7 a	30±4 a	134±23 a
Soil 2	6.0±0.9 a	32.0±5.2 a	1.6±1.2 b	5.3±0.6 a	26±4 a	112±21 a
Soil 3	3.1±1.5 b	23.2±6.7 b	0.8±0.2 c	3.7±0.6 b	17±3 b	73±13 b
Soil 4	3.4±2.6 b	22.8±11.2 b	0.7±0.4 c	4.1±1.6 b	21±7 c	83±26 b
Soil 5	2.8±1.5 b	19.1±9.1 b	0.9±0.2 c	4.0±0.8 b	20±2 c	82±18 b

Tabla 2: Mean values ±SE of different agronomic characteristics of *Lupinus albus* cv. Multolupa

We also noted that the leaf diameter, and the length and width of the foliole barely reached 75% of those recorded for plants grown in non-contaminated soil (soil).

Conclusions

L. albus Cv. Multolupa would appear to be appropriate for the phytoremediation of acid soils of intermediate Zn levels. In contrast, soil Pb was not taken up by the aerial parts of this species. In general, high soil levels of both these metals affect the growth and diminish the productive capacity of this lupin.

References

Hernández, M.J. *et al.* 1995. IV Congr. Luso-Espanhol Fisiol.Vegetal, Estoril (Portugal) pp.114.
Lakanen, E. 1967. Acta Agriculturae Scandinavica, 17: 131-139
Pastor and Hernández, 2002. Anales de Biología (in press)

This work was funded by the CICyT, Project AMB99-1218 and the CAM, Project 07M/0029/2001