OLIVE VEGETATION WATER RESIDUES COMPOSTED WITH OTHER AGRICULTURAL BY-PRODUCTS AS ORGANIC FERTILIZER

F. CABRERA, R. LOPEZ, J.M. MURILLO and M.A. BREÑAS

Instituto de Recursos Naturales y Agrobiología de Sevilla. C.S.I.C.
Apartado 1052, 41080 Sevilla, Spain.

ABSTRACT

The use of a commercial compost made up of olive vegetation water residues (more than 70 %) and other agricultural by-products as organic fertilizer has been study. "In vitro" germination of cress (Lepidium sativum L.) and ryegras (Lolium multiflorum Lam. cv. Barwoltra) was not damaged by compost, regardless of whether and aqueous extract of it or a sand-compost mixture were used. Germination in soil was also not impaired.

Results of dry matter production were compared with those obtained using inorganic fertilization. Successive cuttings of ryegrass showed that best results were obtained with inorganic fertilization, although differences between both treatments were progressively lower. Plant composition data is also discussed.

INTRODUCTION

The disposal of olive vegetation water ('alpechín') from olive processing industries is a problem in the Mediterranean countries, because of its high organic load (BOD 10-100 g/l; COD 40-200 g/l) and salt content (E.C. 8-22 mS/cm) (Ramos-Cormenzana, 1986). The discharge of 'alpechín' into water-courses produces a negative impact on water quality (Cabrera et al., 1984, 1986) and is therefore banned. Instead 'alpechín' is kept in evaporation ponds, which can produce pollution of the ground water, strong smell, appearence of insects and other nuisances.

The use of 'alpechín' as fertilizer, either directly or after biotechnological treatment, is a possible solution to the pollution problem originated by the olive oil industry. Agronomic value of 'alpechín' resides mainly in its high contents of organic matter and potassium, and moderate contents of phosphorus, magnesium and nitrogen. However its low pH, high salinity and abundance of polyphenols, make research necessary into the effect of its application on soil fertility and plant nutrition (Fiestas Ros de Ursinos, 1986; Pérez et al., 1986; Pérez and Gallardo-Lara, 1987, 1989; Cabrera et al., 1987).

The dried sludge resulting from the evaporation of 'alpechín' can also be used as fertilizer either directly or composted with other agricultural by-products (e.g.: grapeseed residues, cotton wastes, branches and twigs pruned from olive trees, and other olive residues). Data on this subject are scarce, and it is necessary to study the effect of the use of these by-products on soil and plants.

This study deals with the effect of an 'alpechín'-derived compost on 'in vitro' seed germination of cress (Lepidium sativum L.) and ryegrass (Lolium multiflorum Lam. cv. Barwoltra) (Zucconi et al., 1985; Barideau and Impens, 1985). Also, germination of the latter in two soils, sandy and calcic loam, and yield and plant composition were investigated.

MATERIALS AND METHODS

Table 1 shows some characteristics of the 'alpechín'-derived compost.

'In vitro' germination test using an aqueous extract of the 'alpechín' compost was performed following Zucconi et al., (1985). A compost sample with a moisture content of 60 % was incubated for 30 min. The extract obtained by pressure was filtered through a 0.45 µm Millipore filter. Volumes of 0.5 ml of solution containing 3, 10, 30 and 100 % of the extract were added to Petri dishes lined with filter paper and containing 8 seeds of cress. A control was prepared adding 0.5 ml of deionised water. A randomized complete block design with 10 replicates was used. Seeds were incubated at 25ºC in the dark. After 24 h 1 ml of ethanol (50 %) was added to stop the germination, and the number of germinated seeds and the root length were measured and expressed as percentage of control. A germination index was obtained multiplying the % germination by % root length divided by 100.

A similar procedure was followed to study the germination of ryegrass, adding 1 ml of solution with 10 and 30 % of the extract, using ten replicates with 5 seeds and a germination time of 72 h.

A germination test of ryegrass in a mixture (1:1) sand-compost was also carried out following Barideau and Impens (1985). Ten Petri dishes containing the mixture with ryegrass placed on the surface were moistened to maintain a suitable level of moisture and kept at 25ºC. The number of germinated seeds was recorded after 48 and 92 h and compared with those for the control, which were prepared in the same way as above but using only sand as substrate.

Latent toxicity (Zucconi et al., 1985) was also studied with ryegrass. A compost-water mixture (10 % w/w) was incubated at 27-30ºC under aerobic conditions, bubbling air. After 8 and 12 days a sample of supernatant was filtered through a 0.45 µm Millipore filter, and solutions at 10 and 30 % were prepared to carry out the germination test as described above for ryegrass.

Germination of ryegrass in the two types of soils, sandy and calcic loam (Table 2), was also tested in the glasshouse. Mixtures compost-soil at 5 % (w/w) were placed in pots of ca. 300 g in which 20 seeds were sown. A control was prepared without addition of compost. A randomized complete block design with five replicates was used. The number of emerged plant shoots was controlled until a constant value was obtained.

Dry matter production of ryegrass in two soils was studied in glasshouse containers of ca. 0.42 m^2, 50 cm depth (ca. 250 kg soil). Five treatments were tested in a completely randomized design with six replicates per treatment: treatment 0, control, without any addition of compost or mineral fertilizer; treatments 1 and 2, in which amounts of compost equivalent to 20000 and 50000 kg/ha were supplied; treatments 3 and 4 with doses of N and P as 15-15-15 complex NPK fertilizer, and urea, equivalent to those of treatment 1 and 2. A summary of fertilization is shown in Table 3. Compost and fertilizer were always incorporated into the upper 6-8 cm of soil 30 days before sowing. Periodical irrigation was used during plant cropping. Plant shoots were cut four times (46, 82, 109 and 145 days after sowing), weighed and analysed. Plant samples were washed with tap and deionised water, dried at 70ºC for 24 h and ground. Analysis of P, K, Na, Ca, Mg, Fe, Cu, Mn and Zn was made by treating the samples with conc. HCl after calcination at 500ºC. Total nitrogen was determined in samples by the Kjeldahl method.

Table 1: Some chemical properties of the alpechín compost.

pH (H_2O)	7.0	Total-Na (%)	0.26
E.C. (1:5) (mS/cm)	2.93	Total-Ca (%)	9.9
Moisture (%)	13.1	Total-Mg (%)	0.63
O.M. (%)	15.6	Total-S, SO_4-S (%)	0.44
$CaCO_3$ (%)	20.2	Total-Cl (%)	0.11
Kjeldahl-N, NH_4-N (%)	0.66	Total-B (mg/kg)	12
Total-P, PO_4-P (%)	0.18	Total-Fe (mg/kg)	9750
Total-K (%)	2.10	Total-Cu (mg/kg)	27
C/N	14.6	Total-Mn (mg/kg)	354
		Total-Zn (mg/kg)	47

Table 2: Soil description.

Soil	pH (H_2O)	$CaCO_3$ %	organic matter %	Mechanical Analysis coarse sand %	fine sand %	silt %	clay %
Sandy	8.45	8.6	0.14	87.4	2.5	2.5	7.6
Calcic-loam	7.90	27.0	0.53	44.8	12.8	21.1	21.3

Table 3: Fertilization of the containers.

Treatment	fertilizer (kg/ha)		equivalent fertilizer units (kg/ha) N	P_2O_5	K_2O
0	nill		nill	nill	nill
1	alpechín compost	20000*	120	73	440
2	alpechín compost	50000*	295	180	1100
3	15-15-15	487*	73	73	73
	urea	102*	47	-	-
4	15-15-15	1200*	180	180	180
	urea	130**	60	-	-
	urea	130***	60	-	-

* deep fertilization.

** top dressing fertilization after the 1st harvest.

*** top dressing fertilization after the 2nd harvest.

When data were subjected to an analysis of variance the mean separation was performed by the Tukey test. A significance level of $P < 0.05$ was considered throughout the study.

RESULTS AND DISCUSSION

Germination tests

Table 4 shows the results of the 'in vitro' germination test. The percentages of cress seeds germinated in presence of the extract of 'alpechín' compost, although lower than that for the control, do not differ significantly from that. However, mean root lengths for seeds treated with the aqueous extracts of compost are generally significantly shorter than for those of the control. Consequently germination index values for compost-treated seeds are lower than for the control, although in all cases but one these values are higher than 60, a value over which toxicity may be considered terminated (Zucconi et al., 1985).

For ryegrass also there are no significant differences for the percentage of germinated seeds between treatments. However mean root lengths are longer for seeds treated with aqueous extract of compost, although the differences are not always significant. Consequently germination index values are greater for compost-treated seeds, indicating that there is no inhibitory effect of the compost on germination of ryegrass. On the contrary compost seems to help root development.

It is important to note that the germination times for cress and ryegrass tests were different because the latter does not develop roots at 24 h, the time recommended by Zucconi et al. (1985). For ryegrass the percentage of germination and the root lengths were recorded at 72 h. This longer time seems to affect root elongation, which, as described above, is longer for compost treated seeds.

Results of latent toxicity experiments with ryegrass after digesting the compost extract for 8 and 12 days (Table 4), are very similar to those described above, and indicate again that 'alpechín' compost does not inhibit ryegrass germination and favours root development.

Germination of ryegrass seeds is also not inhibited when using a sand-compost mixture (1:1) (Table 5). On the contrary, germination percentages are higher when compost is present than in the control, the difference between these two treatments being higher in the first stages of growth (48 h). Therefore 'alpechín' compost again seems to have a beneficial effect on ryegrass seed germination.

Pot germination trials with ryegrass (Fig. 1) show that in both sandy and calcic soils, 'alpechín' compost does not damage seed germination. In fact, the percentages of emerged plant shoots throughout the experimental time are not statistically different for the control and the compost-treated pots. In both soils the percentage of emerged plants increases up to 8 days to stabilize at ca. 80 and 85 % in sandy and calcic loam soils respectively.

Yield and nutritional status of ryegrass

Figure 2 shows that cumulative dry matter production in the calcic loam soil is higher than in the sandy soil, probably due to the higher intrinsic fertility of the former.

Throughout the experiment cumulative dry matter production is high

Table 4: Germination and latent toxicity tests in alpechín compost aqueous extracts (Zucconi *et al.*, 1985).

	control	compost extracts			
		3 %	10 %	30 %	100 %
Germination test *Lepidium sativum* L.					
Germinated seeds (%)	91 a	80 a	77.5 a	79 a	85 a
Root length (mm)	2.23 c	1.66 a	1.48 a	1.83 b	1.93 cb
Germination Index	100	62.5	56.4	70.9	80.6
Germination test *Lolium multiflorum* Lam.					
Germinated seeds (%)	94 a	-	90 a	92 a	-
Root length (mm)	6.3 a	-	11.0 b	10.5 ab	-
Germination Index	100	-	169	163	-
Latent toxicity test *Lolium multiflorum* Lam. (8 days)					
Germinated seeds (%)	84 a	-	98 b	92 ab	-
Root length (mm)	12.8 a	-	16.1 b	14.5 ab	-
Germination Index	100	-	147	124	-
Latent toxicity test *Lolium multiflorum* Lam. (12 days)					
Germinated seed (%)	84 a	-	92 b	88 a	-
Root length (mm)	13.0 a	-	17.1 b	14.3 ab	-
Germination Index	100	-	144	114	-

Values followed by the same letter in the same row do not differ significantly ($P < 0.05$).

Table 5: Germination test of *Lolium multiflorum* Lam. in a mixture sand--alpechín compost.

time (h)	Germinated seeds (%)	
	control (sand 100 %)	sand-compost (50 %-50 %)
48	72	88
92	88	92

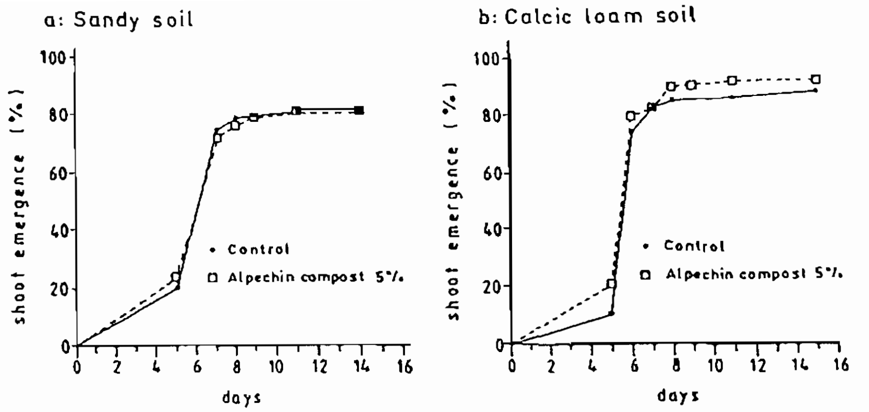

Figure 1: Germination of Lolium multiflorum Lam. in a sandy a calcic loam soil fertilized with alpechín compost.

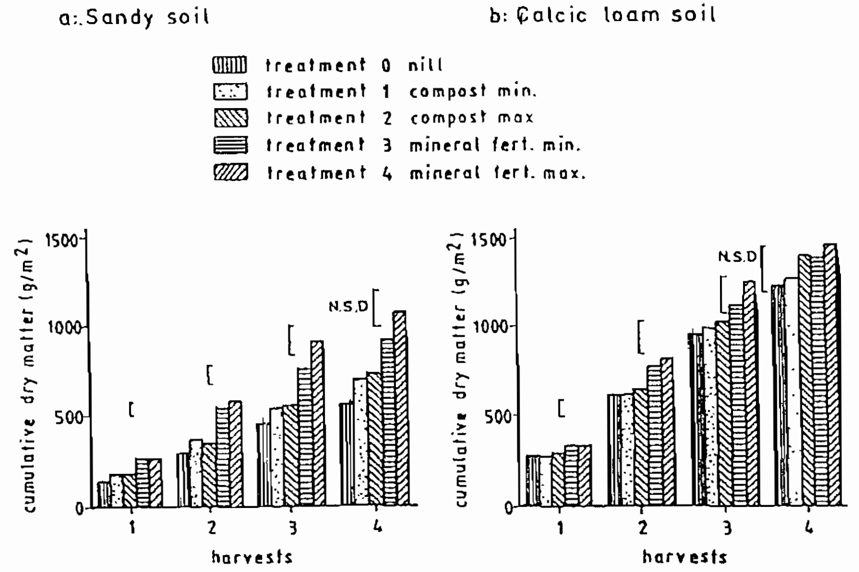

Figure 2: Crop yields of Lolium multiflorum Lam. with different fertilizations. (N.S.D. = non-significant difference).

in the containers treated with mineral fertilizer (treatments 3 and 4), low in the control (treatment 0), and has intermediate values in the containers treated with 'alpechín' compost (treatments 1 and 2), although differences are not always significant.

In the sandy soil, cumulative dry matter values of treatments 3 and 4 are always significantly higher than those of treatments 0, 1 and 2. However it was observed that after the second harvest, differences between non-cumulative yield values for compost and mineral fertilizer treatments were not significant (data not show here).

In the calcic loam soil significant differences between treatments are observed only in the second and third harvests, in which cumulative dry matter yield values for treatment 4 are significantly higher than for treatments 0, 1 and 2. It is interesting to note that significant differences between treatments were not found for non-cumulative dry matter yields (data not shown here).

These results indicate that the addition of the 'alpechín' compost to soils has no deleterious action on ryegrass crop yield. On the contrary, it seems to increase yield up to values close to those obtained with mineral fertilization.

For each soil the nutritional status of the ryegrass shoots was very similar in each harvest, although some variations throughout the harvests were found: generally the contents of N, P, K, Fe and Cu tend to decrease from the first to the fourth harvest while the contents of Na, Mg and Mn tend to increase. The contents of Ca and Zn showed minimum values in the second of third harvests (data not shown here).

Figure 3 shows the nutritional status of ryegrass shoots of the first and fourth harvests. Generally, for each soil the mean contents of each element studied, except Na and Mn, are very similar in each harvest independently of the treatments. However small significant differences between treatments were found for some elements in some harvests which could not be attributed to the treatments.

For Na it was found in both soils that mean values in treatments 3 and 4 in which mineral fertilizer was used, are generally significantly higher than in the other treatments.

Mean values of Mn of plants treated with 'alpechín' compost (treatments 1 and 2), are lower than those of the other treatments. This fact, also observed by other authors when applying farmyard manure and urban compost (Atkinson _et al._, 1958; Gallardo-Lara _et al._, 1986), could be attributed to the complexing agents present in the organic matter. In fact Wallace and Wallace (1983) stated that inhibition of the Mn uptake by plants when applying Zn chelates to soil could be caused by the presence of the chelating agent.

These early results suggest that, except for Mn, the application of the 'alpechín' compost to the soil as fertilizer does not unbalance the nutritional status of ryegrass.

These results are provisional, as the experiment will be continued for a longer period, in order to investigate the effects of the succesive application of the 'alpechín' compost on ryegrass.

ACKNOWLEDGMENTS

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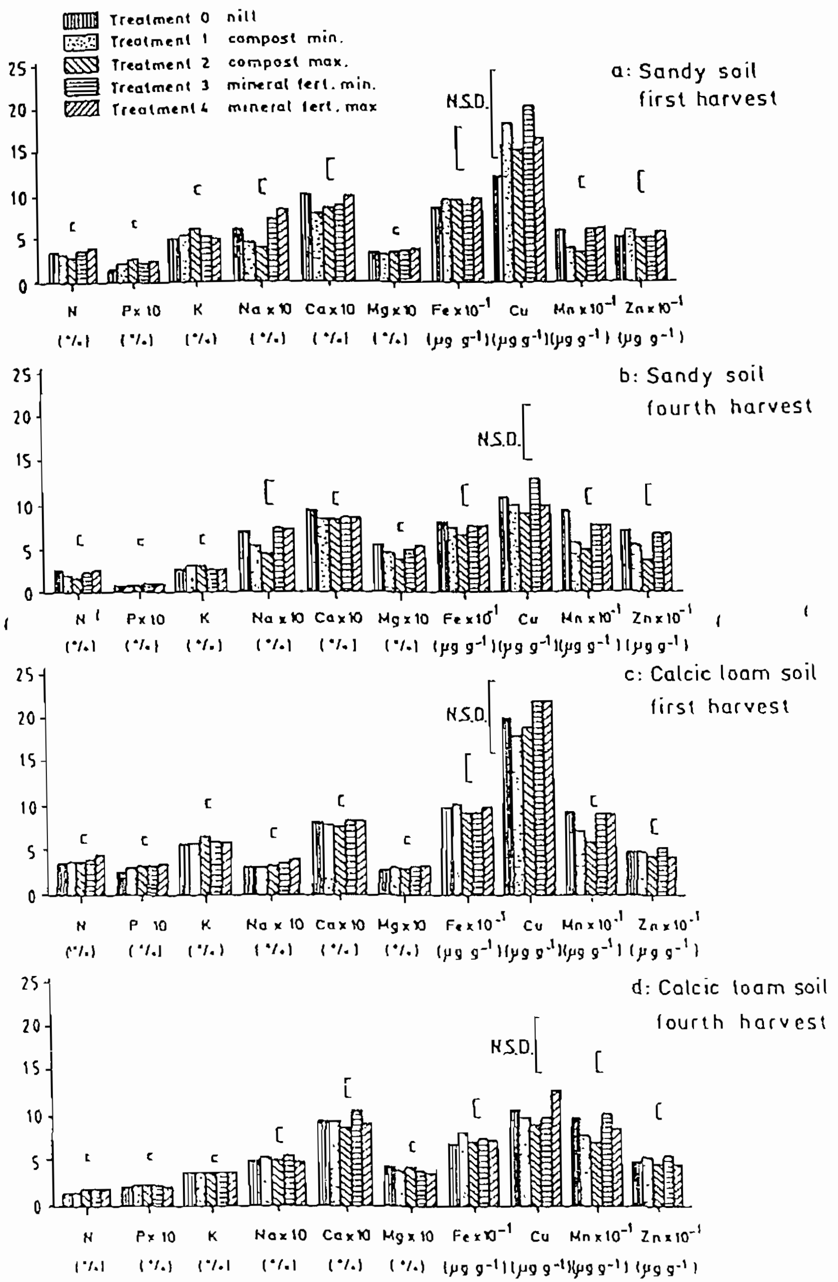

Figure 3: Nutritional status of Lolium multiflorum Lam. with different fertilizations. (N.S.D. = non-significant difference).

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