

**THE IMPACT OF ORGANIC AMENDMENTS ON FOREST SOIL PROPERTIES  
UNDER MEDITERRANEAN CLIMATIC CONDITIONS**

SHORT TITLE: THE IMPACT OF AMENDMENTS ON SOIL PROPERTIES

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## ABSTRACT

Restoring the native vegetation is one of the most effective ways to control soil degradation in Mediterranean areas, especially in very degraded areas. In the initial months after afforestation, vegetation cover establishment and soil quality could be better sustained if the soil was amended with an external extra source of organic matter. The goal of this study was to test the effect of various organic amendments on select soil properties (soil organic carbon (SOC), pH and EC) over a 24 month period. Four amendments were applied in an experimental set of plots: straw mulching (SM); mulch with chipped branches of Aleppo Pine (*Pinus halepensis* L.) (PM); sheep manure compost (SH); and sewage sludge (RU). Plots were afforested following the same spatial pattern and amendments were mixed with the soil at the rate 10 Mg ha<sup>-1</sup>. Organic amendments helped maintain SOC over the initial six months after the afforestation. However, only the SM and PM treatments had increased SOC values after 24 months. Decreases in EC were found after the addition of SM, PM and SH amendments. However, RU increased EC values 24 months after the afforestation. Variations in pH values were sufficient to establish differences among the various treatments. Furthermore, the results show that forest soils with or without organic amendments responded similarly to the seasonal changes in Mediterranean conditions.

## INTRODUCTION

Soil degradation affects more than 52 million ha of land in countries of the European Union (COM, 2002). This problem is particularly serious in Mediterranean areas, where the effects of anthropogenic activities (tillage on slopes, deforestation, pasture production) add to problems caused by prolonged periods of drought, and intense and irregular rainfall. Depending on the scale of study, soil organic carbon (SOC) dynamics in Mediterranean forests has been found to be particularly sensitive to factors related to seasonal changes in temperature and soil moisture (Casals et al., 2000; Eaton et al., 2008; Novara et al., 2011). During dry periods in the Mediterranean area, the lack of water entering the soil matrix reduces organic contributions to the soil (Van Wesemael and Veer, 1992; Fons and Vallejo, 1997). These processes lead to reduced soil fertility and soil loss (García Orenes et al., 2010; Tesfahunegn, 2013; Jiménez et al., 2013). Restoring the native vegetation is the most effective way to regenerate soil health (Alegre et al., 2004). The seeding and plant establishment stages are critical (Cerdá, 1998; Adekalu et al., 2007; Smets et al., 2008; Macci et al., 2012); but during these stages the beneficial effects of the vegetation may not be apparent, and the soil is highly susceptible to erosion and depletion of SOC (Steffen et al., 2011). Under these conditions, vegetation cover in areas having degraded soils may be better sustained if the soil is amended with an external source of organic matter (Srinivasarao et al., 2013; Shazana et al., 2013; Chaudhuri et al., 2013).

The effect of various organic amendments (including composted sewage sludge, manure, and crop residue mulch) on soil properties and carbon mineralization has been the focus of previous studies (Pérez-Lomas et al., 2010; Parras-Alcántara et al., 2013). Bulluck et al. (2002) showed that the application of organic residues to soil, including manure, composted cotton-gin trash, composted yard waste and cattle manure, is a management strategy that can

counteract the depletion of SOC in agricultural soils. However, the increase in SOC content following the addition of organic amendments is directly related to the soil management strategy applied (Lal, 1997; Brevik, 2009), as has been demonstrated under Mediterranean climatic conditions (García-Orenes et al., 2009). The application of organic amendments to calcareous soils causes a decrease in pH and a slight increase in electrical conductivity (EC) (Guang-Ming et al., 2006; Li et al., 2007). The addition of organic materials to soils also increases infiltration rates and reduces erosion rates (García-Orenes et al., 2012); these factors contribute to increased water available for plant growth and to successful and sustainable land management (Brevik, 2009).

The goal of this study was to analyze the effect of various organic amendments on the SOC content, pH and EC of soils in afforested plots, and to assess the effects of these parameters on seasonal variability under Mediterranean climate conditions.

## MATERIALS AND METHODS

### *Experimental site*

The El Pinarillo experimental site is located in the Sierra Tejada, Almirajara and Alhama Natural Park (southern Spain). The site is located at 470 m.a.s.l., in the upper part of an alluvial fan (calcareous conglomerates) surrounded by mountains with marble as the primary bedrock material (X: 424.240 m; Y: 4.073.098 m; UTM30N/ED50), and the climate is dry Mediterranean (mean annual temperature: 18 °C; mean annual rainfall = 589 mm y<sup>-1</sup>). The plots were located in an abandoned agriculture field recolonized by shrubs since the 1950s. The current vegetation consists of an open pine forest with typical degraded Mediterranean scrubs and tussocks; the area was affected by a fire that occurred in 1991. The vegetation cover is > 70% and includes *Chamaerops humilis* L., *Cistus albidus* D., *Rosmarinus*

*officinalis* L., *Thymus capitatus* L., *Rhamnus alaternus* L. and annual plants. The soils are classified as lithic and eutric leptosols according to FAO-WRB (2006). They are characterized by a high level of rock fragment cover on the surface (> 50%), a high gravel content in the profile (total gravel content = 56%; gravel content > 10 mm = 31%; gravel content 2f mm = 10%; gravel content 5f 1 mm = 15%), and a sandy-loam texture (sand = 60%, silt = 32%, clay = 8%). The general soil properties and characteristics of the study site are given in Table 1.

#### *Plots, amendments and afforestation*

An experimental paired-plot layout was established (homogeneous slope gradient: 7.5%; aspect: N170°) in October 2010. The vegetation cover present was removed from the experimental area to avoid variation in the cover. Various management treatments and addition of organic amendments were applied in May 2011, using two replicate plots per treatment (24 m<sup>2</sup>; 2 m wide × 12 m long). Four organic soil amendments were tested: i) straw mulching (SM); ii) mulch with chipped branches of Aleppo Pine (*Pinus halepensis* L.) (PM); iii) sheep manure compost (SH); and iv) sewage sludge (RU) from a wastewater treatment plant. The amendments were applied at a rate of 10 Mg ha<sup>-1</sup> and replicated twice in a completed randomized block design. Six months later (November 2011) the plots were afforested with the same number of plants and spatial pattern of Mediterranean shrubs used by land managers of the Natural Park of Sierra Tejada, Almirajara and Alhama. The plant species used were *C. humilis* L., *Lavandula stoechas* Lam., *L. dentatae* L., *L. multifida* L., *R. alaternus* L., *R. oleoides* L., *Pistacea lentiscus* L., *R. officinalis* L. and *T. capitatus* L. The vegetation was planted in a grid pattern with 0.5 m between plants in each plot. During the afforestation process the soil was tilled to 25 cm depth from the surface. Two control plots were included, comprising afforested soil having no addition of amendments (C).

### *Soil sampling, analysis of soil properties and measurements*

Soil from the afforested plots was sampled in: i) spring 2012 (6 months post afforestation); ii) fall 2012 (12 months post afforestation); iii) spring 2013 (18 months post afforestation); and iv) fall 2013 (24 months post afforestation). Soil from the surrounding area was also tested to provide data on natural conditions (NC) (Table 2).

The sampling strategy for each plot involved collection of 4 disturbed soil samples taken from the surface (0–10 cm depth). The soil properties analyzed were: i) soil salinity (EC), which was measured in a deionized water suspension of the soil (5:1) using a Crisol Micro CM 2200 conductivity meter (ISRIC, 2002); ii) soil acidity (pH), which was measured in a deionized water suspension of the soil (2.5:1) using a Crisol GLP 21 pH meter; and iii) SOC, which was determined using the Walkley-Black method of oxidation with dichromate and subsequent titration (FAO, 2006).

A meteorological station installed in the experimental area registered rainfall and air temperature. Rainfall was measured using a tipping-bucket rain gauge (0.2 mm accuracy), and the air temperature was recorded at 5-min intervals.

### *Statistical analysis*

Statistically significant differences were determined using analysis of variance (ANOVA). The assumption of homoscedasticity was tested using Levene's test. In cases of nonhomoscedasticity (Levene test;  $p < 0.05$ ), nonparametric tests were used. Mean differences between the various experimental soil treatments were determined using Tukey's test or the Games-Howell test. In all analyses the selected significance limit was  $p < 0.05$ . Analyses were performed using SPSS (version 21) for Windows.

## RESULTS AND DISCUSSION

### *Rainfall and temperature variability*

The daily rainfall and air temperatures are shown in Figure 1. The cumulative rainfall recorded from 56 rainfall events between April 2011 and September 2013 was 1261.1 mm. The rainfall distribution and temporal variability followed the pattern typical for a Mediterranean climate: a three-month drought period between June and September, and a rainy period from approximately October to April. During the study period the maximum dry spell length (summer drought) was 94 days between 22 May 2013 and 25 August 2013. In the rainy season the maximum dry spell length was 9 days, from 30 October 2012 to 7 November 2012. The Mediterranean climate is characterized by the occurrence of the highest annual temperatures in summer. The mean temperature during the study period was 17.0 °C. The maximum recorded temperature was 43.0 °C, on 11 August 2012, and the minimum temperature (3.0 °C) was recorded on both 3 and 4 February 2012.

### *Soil organic carbon*

Changes in SOC in cultivated soils following afforestation have previously been reported (Campbell et al., 1995; West and Wilfred, 2002; Green et al., 2007; Blanco-Canqui and Lal, 2008). In a study in Michigan (USA), a reduction in SOC in the top 5 cm of soil was reported for a no-till field periodically ploughed to a depth of 20 cm (Pierce et al., 1994). In November 2011, the first 25 cm of soil were turned to carry out the afforestation. Six months later, in spring 2012, a reduction in SOC was recorded in the 0–10 cm depth zone in the control plots. The mean values of SOC in the NC and C plots were 4.6% and 3.2%, respectively (Tables 2 and 3). Several previous studies have indicated that the addition of organic amendments to agricultural soils may be an effective management strategy to counteract the depletion of SOC following ploughing (Wright and Hons, 2005; Bulluck et al., 2002; Lee et al., 2004;

Heras et al., 2005; Adekalu et al., 2007; Mulumba and Lal, 2008). Similarly, our results suggested that the addition of organic residues (PM, SM, SH and RU) may initially slightly increase the levels of SOC in the top 10 cm of the soil following afforestation (Table 3). The results of the first sampling showed that the increase in the relative content of SOC in re-vegetated and amended plots with respect to the C plots was 1.2, 1.3 and 1.4 for the SH, RU and SM, and PM treatments, respectively. However, analysis (Games-Howell and Tukey tests) indicated that there were no significant differences in SOC relative to the control plots in the initial 18 months following afforestation (Table 3).

No significant differences were found among the various soil amendments in the first sampling period (spring 2012) (Table 4). One explanation is initial slow mineralization at the rates applied, as reported by Tejeda and González (2003). These results are consistent with those of Gonzalez-Ubierna et al. (2012), who assessed SOC in the months following addition of three test organic residues, but no differences in SOC relative to that in the initial soil sample were found. Jordán et al. (2010) investigated a cultivated area in southwest Spain, and showed that mineralization rates were higher when amendments were applied at low rates (3–5 Mg ha<sup>-1</sup>). They also reported an increase in the C:N ratio when wheat mulch was applied at high doses (10 Mg ha<sup>-1</sup>), and suggested that this was because of an increase in stable soil organic matter. Similar results have been reported for soils amended with sewage sludge (Albiach et al., 2001); the data suggested that the accumulation of organic matter in the soil following sludge addition decreased proportionally with an increase in the doses supplied. In the present study increases in SOC were found in fall 2012, and differences were found among the soils amended with SM, SH and RU (Table 4). Plots treated with RU had the highest SOC values in this second sampling period. RU also was the most significantly different among the amended soils in spring 2013 and fall 2013.

In general, the SOC values were similar among the various amended soils at the same sampling time. However, the SM, PM, SH and RU plots underwent a remarkable reduction in SOC over time (Table 3). The amendments were applied only once, and their effects diminished because of decomposition processes, especially during the wet season. The decrease in SOC was less marked for the SM and PM treatments, which were significantly different from the control and the RU and SH treatments in fall 2013, 24 months following afforestation. The SH and RU plots showed no changes in SOC relative to the control 24 months following afforestation. Similar results were found by Gonzalez-Ubierna et al. (2012), who undertook a comparative study of three types of organic amendments that were added as single applications in a farming area under semiarid climatic conditions, and demonstrated that SOC tended to decrease over time because of mineralization processes. Others studies related to farming systems have shown significant increases in SOC in the initial months following addition, but no significant differences 12 months following addition (Marinari et al., 2006).

Independent of soil management, there was intra-annual variability in SOC, coinciding with the Mediterranean wet and dry periods. Figure 2 shows that there was an increase in SOC at the end of the wet season (spring 2012 and spring 2013). A similar trend has been reported in studies of non-amended soils, abandoned fields, and rangelands under semiarid climatic conditions (Cerdá 1998; Verheijen and Cammeraat, 2007; Ruiz-Sinoga et al., 2010; Bodí et al., 2013, Gabarron-Galote et al., 2013). However, intra-annual variability in SOC in amended soils as a consequence of Mediterranean seasonality is not clearly described. According to Ruiz-Sinoga and Martínez-Murillo (2009), for cultivated abandoned un-amended land the lack of rainfall during summer triggers homogenization in the functioning and response of eco-geomorphological systems, and especially SOC, independent of the Mediterranean climatic regime. In relation to this, in our study the high temperatures in

summer (Figure 1; maximum 43 °C in August 2012) probably led to substantial mineralization of the labile organic matter fraction. This was evident in the significant decrease in SOC in the C, SM, PM, SH and RU plots during fall 2012 and fall 2013. The cumulative rainfall during the 2012 and 2013 dry periods was 1.6 and 0.8 mm, respectively; the lack of water entering the soil matrix resulted in decreased biomass and vegetation cover, which reduced organic contributions to the soil. This caused impoverishment of the soil, independent of the soil management applied, as has been reported for un-amended soils in Mediterranean areas (Barthès et al., 2000; Casals et al., 2000; Ruiz-Sinoga and Romero-Diaz, 2010; Ruiz-Sinoga et al., 2012). Our results of SOC variability over time have been interpreted similarly, regardless of the amendment applied. In this regard, SOC variations in time have been compared with results reported by other authors in similar climate conditions (Marinari et al., 2006; Garcia-Orenes et al., 2009; Ferreras et al., 2006; Madejón et al., 2007). During spring 2012 and spring 2013, it was found that the highest SOC values were quite similar to the maximum ones recorded by those authors. On the contrary, at the end of the dry Mediterranean season, the lowest SOC values were measured in this study. Unlike the already mentioned authors we have recognized the effect of Mediterranean climatic seasonality on SOC evolution. For instance, Marinari et al. (2006) found a significant increase in the microbiological biomass carbon content 9 months following the application of organic amendments to farming systems in Italy, but no significant differences after 14 months. The sampling dates coincided with the end of the wet and dry Mediterranean seasons, respectively. Garcia-Orenes et al. (2009) reported an increase in SOC in spring 2005, 16 months following the addition of an organic amendment, relative to the control. Ferreras et al. (2006) have reported that following sludge application to soil there was a reduction in the amount of CO<sub>2</sub> produced from August to November 2012. Thus, the local

climatic conditions at the time of soil sampling must be taken into account to interpret the long-term effects of soil amendments.

#### *EC and pH*

The salinity and acidity of afforested soils can affect plant growth (Allakhverdiev et al., 2000; Parida and Das, 2005). Allakhverdiev et al. (2000) reported that plants adversely affected by salinity grew more slowly and were stunted. Soil salinity and acidity might be affected by the application of organic amendments and could impact plant survival (Ferrerias et al., 2006, Guang-Ming et al., 2006; Li et al., 2007). Our results showed that 6 months following afforestation there was a decrease in EC in the C plots because of the ploughing to 25 cm depth. Similarly, Table 3 shows that during the study period the plots treated with PM, SM, SH and RU were not affected by salinity ( $< 2000 \mu\text{S cm}^{-1}$ ) when the afforestation was assisted. However, the SM, PM and RU plots showed a slight increase in EC in spring 2012 (at the end of the wet season), and the increased levels were significantly different from the control EC value. Bastidia et al. (2007) also observed an increase in EC values following the application of soil amendments; this was considered to be a result of the addition of soluble salts during incorporation of the amendment. Similar increases in EC have been reported by other researchers (Casado-Vela et al., 2007; Morugán-Coronado et al., 2011; Yilmaz and Alagoz, 2010), especially in the months following amendment additions at doses of 20 and 40  $\text{Mg ha}^{-1}$ .

In our study, significant differences relative to the control plots were only found for the PM and RU plots, 12 months following afforestation. In spring 2013 and fall 2013, only the RU treatment showed significant differences relative to the control (Table 3). In addition, the results showed that at the first sampling there was a marked reduction in EC in the SM, PM

and SH treatments relative to the control. Furthermore, the RU plots showed significant differences among sampling dates.

By fall 2013, 24 months following revegetation, the mean EC value in soils in the RU plots was approximately twice that in the C plots ( $1328.7 \pm 152.76 \mu\text{S cm}^{-1}$  and  $699.1 \pm 117.5 \mu\text{S cm}^{-1}$ , respectively). Méndez et al. (2012) reported a similar increase in EC values ( $1124 \mu\text{S cm}^{-1}$ ) when sewage sludge was applied to sandy loam soil in semiarid conditions. Figure 3 shows that there was intra-annual variability in EC similar to that observed in SOC, independent of the various experimental soil treatments. During the wet season, rainfall and lixiviation caused a slight decrease in the concentration of ions that contribute to soil salinity ( $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{HCO}_3^-$ ,  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ , and sometimes  $\text{NO}_3^-$  or  $\text{K}^+$ ) (Franco-Otero et al., 2011; González-Ubierna et al., 2012). Similarly, SOC mineralization following the dry season releases ions that contribute to increased EC values (Guang-Ming et al., 2006).

Méndez et al. (2012) showed significant differences in pH values in agricultural soil following the application of certain organic amendments, and Bernal et al. (1992) showed that the application of organic amendments to calcareous soils generated a decrease in pH. The mean pH values recorded in the present study are shown in Table 3. It is unlikely that the variation in pH values was sufficient to establish differences among the various soil treatments, or to affect plant growth. Although the differences were minor, slightly higher pH values were found in fall 2012 and 2013. Ruiz-Sinoga et al. (2012) found that along a Mediterranean climatic gradient the pH of soils having similar parent materials was highest at the most arid site, and lowest at the most humid site because of lixiviation of cations. Figure 4 shows that seasonal changes in pH were found between dry and wet Mediterranean periods in the control and amended plots.

In summary, the EC values followed a seasonal trend, independent of soil management; the pH values showed a similar but less clear tendency because of minor differences among

plots.

## CONCLUSIONS

High SOC values are commonly reported when organic amendments are added to cultivated soil. In this study, organic amendments were added to improve soil quality, and their potential impacts on afforested plant growth were assessed. An initial decline in SOC was found when revegetation occurred without soil amendment. Although the SM, PM, RU and SH treatments helped to maintain the SOC at high levels in the 6 months following application, the SOC in these amended plots underwent a marked reduction during the study period. Our results showed that only the SM and PM treatments had a slight increase in SOC 24 months following afforestation. Therefore, under the dry Mediterranean climatic conditions of the study, amending soil with straw mulch, mulch with chipped branches of Aleppo Pine (*Pinus halepensis L.*), sheep manure compost or sewage sludge caused no long- or short-term improvement in soil quality. Furthermore, the results show that forest soils with or without organic amendment, and soils under natural conditions, responded similarly to seasonal changes. Consequently, consideration of the influence of sampling date and annual climatic variability is necessary to improve interpretation of the results, and to enable assessment of the long-term effects of soil amendments.

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Table 1. Soil properties under natural conditions at the El Pinarillo experimental site. CEC: cationic exchangeable capacity; TC: total carbon; TN: total nitrogen; C/N: carbon/nitrogen ratio; EC: electrical conductivity; SOC: organic carbon content; SWC: soil water content.

Annual rainfall	(mm y <sup>-1</sup> )	589.0
Climatic regime		Dry
Main vegetal species		<i>Chamaerops humilis</i> , <i>Cistus albidus</i> , <i>Rosmarinus officinalis</i>
Soil properties		
Gravel	(%)	56.0
Sand	(%)	60.0
Silt	(%)	32.0
Clay	(%)	8.0
Field capacity SWC	(%)	25.2
Wilting point SWC	(%)	6.4
Available water	(%)	18.8
Aggregate stability	(%)	51.0
CEC	meq 100 g <sup>-1</sup>	120.4
TC	(%)	12.5
TN	(%)	0.2
C/N		74.0
SOC	(%)	1.9
pH		8.0
EC	( $\mu\text{S cm}^{-1}$ )	501.0

Table 2. Short-term variability in the analyzed soil properties under natural conditions at the El Pinarillo experimental site. Number of samples = 8. SD: standard deviation; EC: electrical conductivity; SOC: organic carbon content.

Natural condition			mean	± SD
Spring 2012	SOC (%)		4.6	1.0
	pH		7.7	0.1
	EC ( $\mu\text{S cm}^{-1}$ )		309.5	111.3
Fall 2012	SOC (%)		2.3	0.6
	pH		8.1	0.1
	EC ( $\mu\text{S cm}^{-1}$ )		515.2	60.4
Spring 2013	SOC (%)		2.9	0.3
	pH		7.8	0.0
	EC ( $\mu\text{S cm}^{-1}$ )		389.2	8.5
Fall 2013	SOC (%)		1.7	0.1
	pH		8.1	0.0
	EC ( $\mu\text{S cm}^{-1}$ )		600.3	66.9

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Table 3. Mean and standard deviation (SD) of soil organic carbon (SOC), soil acidity (pH) and soil salinity (EC) in the afforested and amended plots for each sampling date. Number of samples = 8. C: soil afforested, no amendment; SM: straw mulch; PM: mulch with chipped branches of Aleppo Pine (*Pinus halepensis* L.); RU: sewage sludge; SH: sheep manure compost. \* indicates a significant differences relative to the control (C) ( $p < 0.05$ ).

Management	Property	Spring 2012		Fall 2012		Spring 2013		Fall 2013	
		mean	SD ±	mean	SD ±	mean	SD ±	mean	SD ±
C	SOC	3.2	0.3	1.8	0.0	3.0	0.4	1.4	0.3
	pH	7.8	0.0	8.3	0.0	7.7	0.0	8.0	0.0
	EC	224.6	51.5	424.5	42.6	374.0	31.5	699.1	117.5
SM	SOC	4.1	0.4	1.5	0.1	2.9	0.2	2.0*	0.1
	pH	7.5*	0.0	8.2*	0.0	7.5	0.1	7.8*	0.0
	EC	348.7*	33.4	547.0	89.1	420.7	60.7	509.5	52.8
PM	SOC	4.6	0.7	1.7	0.4	2.5	0.2	2.1*	0.1
	pH	7.4*	0.1	8.2	0.0	7.6	0.0	7.8*	0.0
	EC	453.5*	76.0	673.7*	30.2	385.2	54.5	718.1	149.5
RU	SOC	4.1	0.4	2.2	0.0	3.3	0.2	1.6	0.1
	pH	7.5*	0.0	7.9*	0.0	7.4*	0.1	7.7*	0.0
	EC	420.2*	56.5	737.5*	58.1	507.2*	21.7	1358.7*	152.8
SH	SOC	4.0	0.4	1.8	0.1	3.7	0.4	1.6	0.1
	pH	7.8	0.0	8.2	0.1	7.7	0.0	7.9	0.1
	EC	212.3	33.3	489.0	49.6	389.2	111.8	593.3	95.0

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Table 4. Games-Howell and Tukey test results. \* indicates significant differences among the amendments ( $p < 0.05$ ). C: soil afforested, no amendment; SM: straw mulch; PM: mulch with chipped branches of Aleppo Pine (*Pinus halepensis L.*); RU: sewage sludge; SH: sheep manure compost; EC: electrical conductivity; SOC: organic carbon content.

		Spring 2012			Fall 2012			Spring 2013			Fall 2013		
Amendment		SOC	pH	EC	SOC	pH	EC	SOC	pH	EC	SOC	pH	EC
SM	PM	0.67	0.26	0.25	1.00	0.02*	0.22	0.73	0.63	0.96	0.96	0.02*	1.00
	SH	1.00	0.99	0.32	0.02*	0.00*	0.07	0.43	0.76	0.52	0.07*	0.02*	0.02*
	RU	0.51	0.00*	0.01*	1.00	0.74	0.71	0.06	0.12	0.97	0.06*	0.00*	0.65
PM	SM	0.67	0.26	0.25	1.00	0.02*	0.22	0.73	0.63	0.96	0.96	0.02*	0.23
	RU	0.72	0.15	0.95	0.35	0.00*	0.41	0.06	0.76	0.21	0.02*	0.00*	0.01*
	SH	0.07	0.00*	0.02*	1.00	1.00	0.01*	0.01*	0.09	1.00	0.02*	0.86	0.58
RU	SM	1.00	1.00	0.32	0.02*	0.00*	0.07	0.43	0.76	0.52	0.70*	0.02*	0.01*
	PM	0.72	0.15	0.95	0.35	0.00*	0.41	0.06	0.10	0.21	0.02*	0.00*	0.02*
	SH	0.46	0.00*	0.01*	0.01*	0.03*	0.00*	0.74	0.02*	0.24	1.00	0.00*	0.01*
SH	SM	0.51	0.00*	0.01*	1.00	0.74	0.71	0.06	0.12	0.97	0.06*	0.00*	0.58
	PM	0.07	0.00*	0.02*	1.00	1.00	0.01*	0.01*	0.09	1.00	0.02*	0.86	0.65
	RU	0.46	0.00*	0.01*	0.01*	0.03*	0.00*	0.74	0.02*	0.24	1.00	0.00*	0.01*

Accepted

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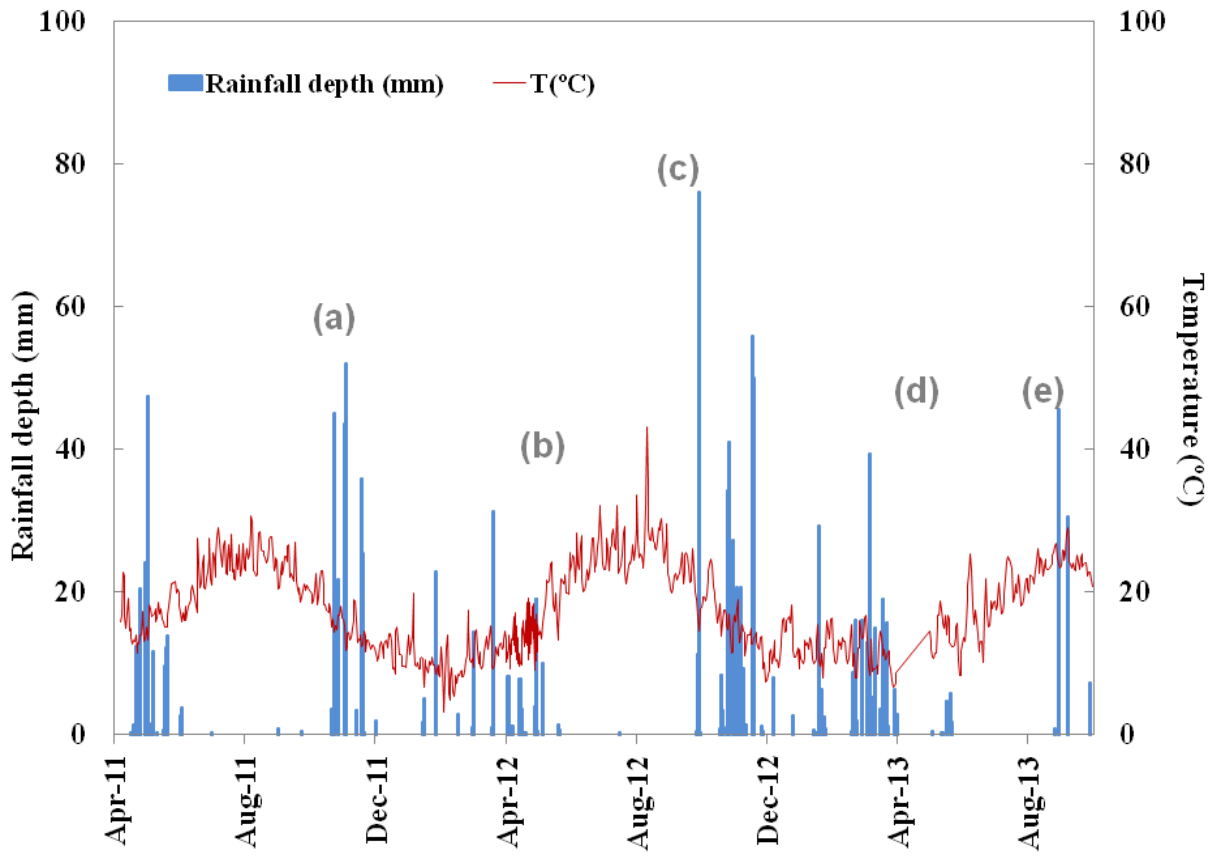


Figure 1

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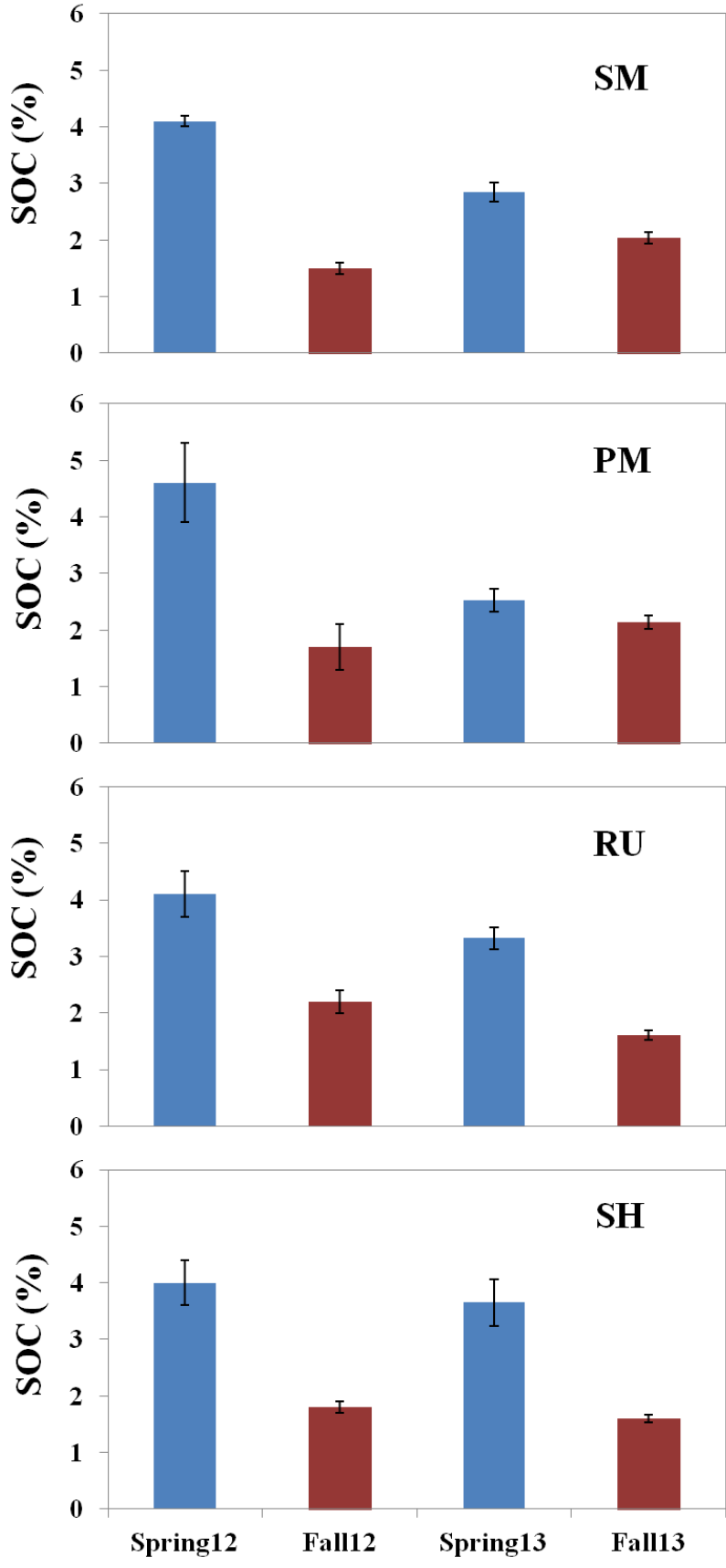


Figure 2

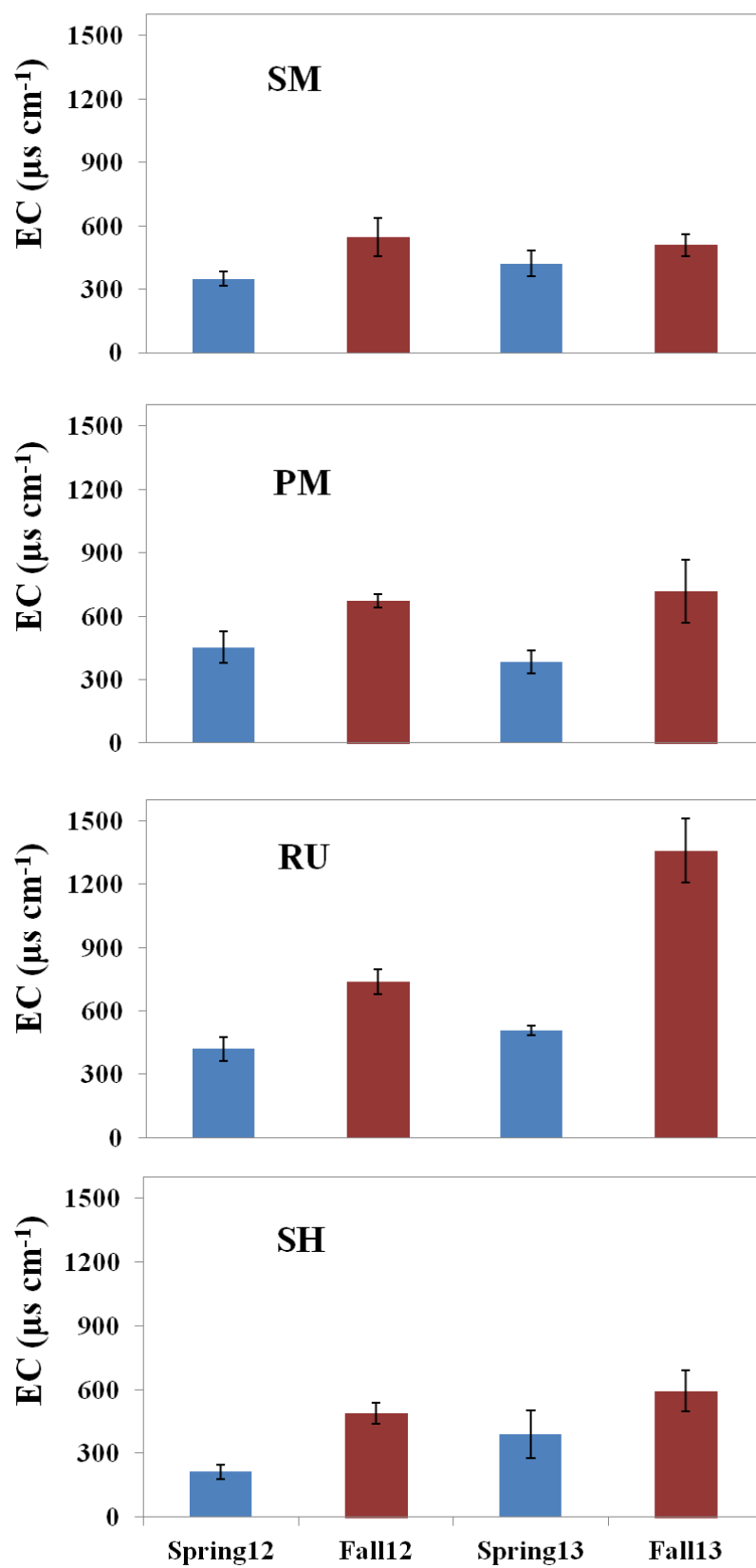


Figure 3

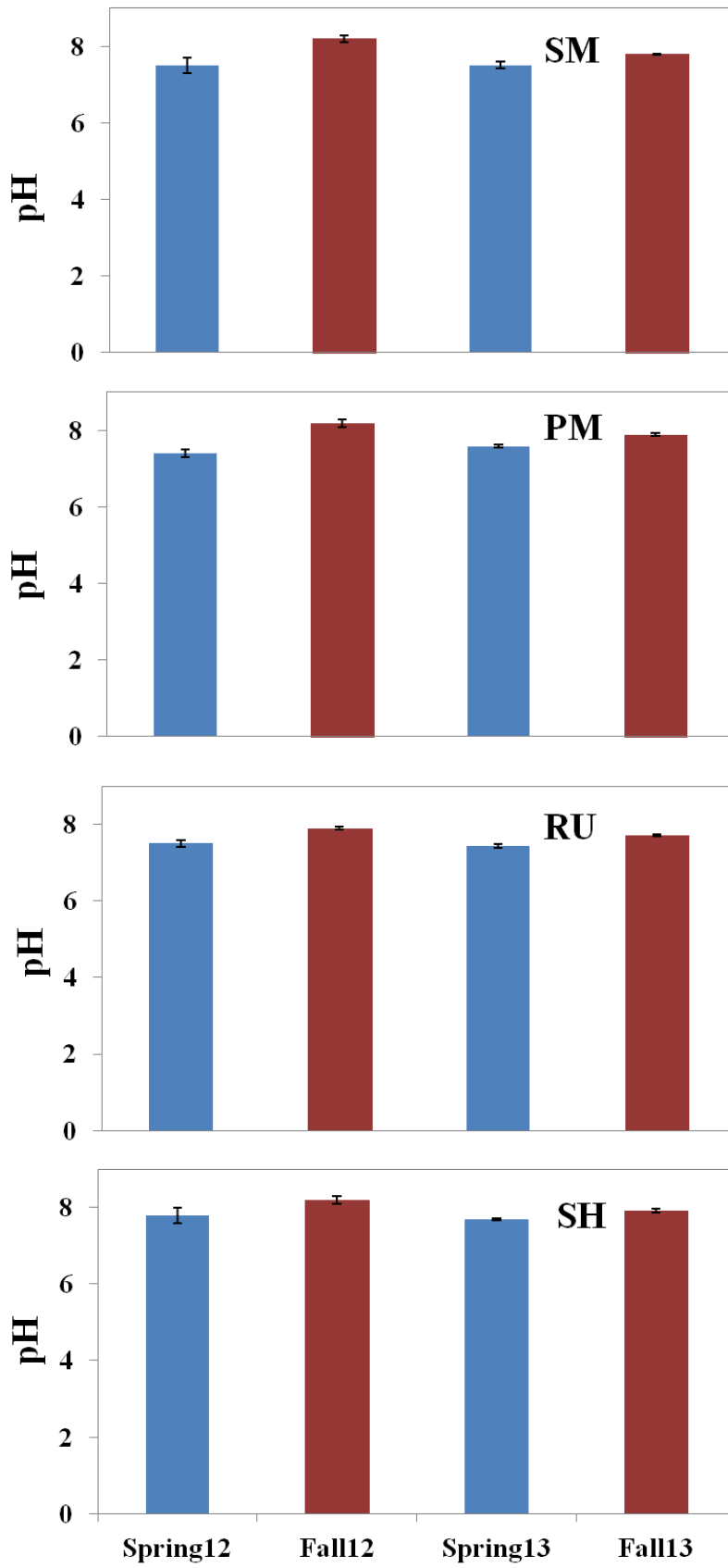


Figure 4