The role of ash on soil water repellency changes in a Mediterranean area affected by a forest fire: a field conditions study

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Introduction

Soil water repellency (WR) is one of the properties most affected by combustion during a forest fire (Doerr *et al*., 2000). The modifications of soil organic matter by the heating and the condesation of distilled organic compounds over mineral surfaces are the main factors responsible. After a fire, a layer of ash covers the soil surface affecting also its wettability; it has been demonstrated that ash can also be water repellent depending on the degree of combustion, and type of plant burned (Bodí *et al*., 2011). Ash plays an important role in terms of fertility but also in the hydrology of the affected area.

The results we show here are part of a bigger study where more parameters regarding soil properties and more factors have been studied and analyzed. One of those factors is ash, in order to assess how ash influences the behaviour of soil WR.

Study area and Methods

In July 2011, a forest fire affected an area of 50 has in Gorga, Alicante Province, SE Spain (Figure 1). The area has a Mediterranean climate with a mean annual precipitation of around 500 mm

Figure 1. Some general pictures of the study area in Gorga, Alicante Province, SE Spain. *By Jorge Mataix-Solera*

Immediately after fire, plots (1m^2) for monitoring were installed in burned (**B**) and adjacent control area (**C**). In the burned area, two treatments were established: burned ash (**Ba**): plots where ash was kept, and burned without ash (**Bwa**): plots where ash was removed simulating an ash exportation that sometimes occurs through wind erosion (Figure 2).

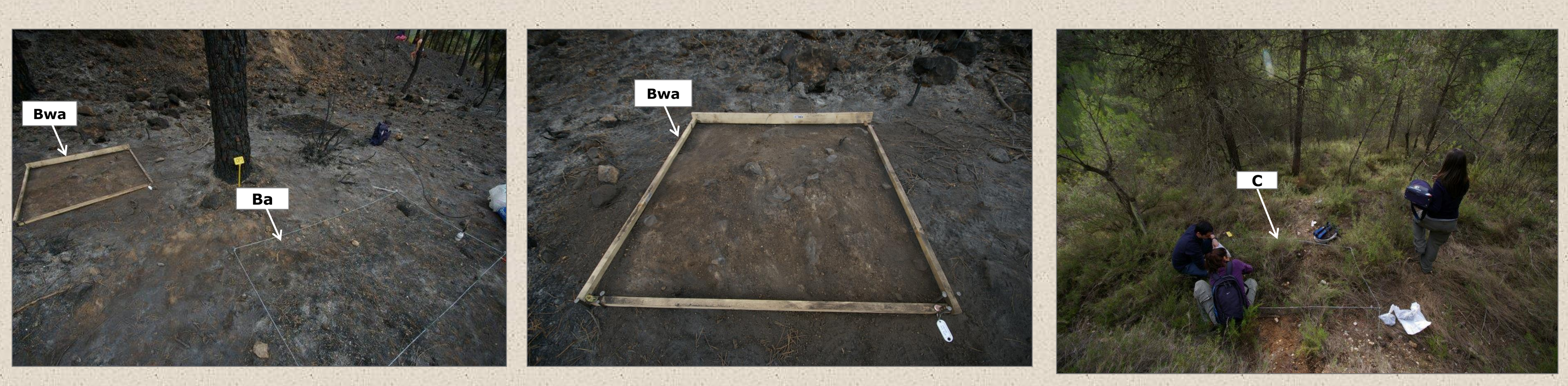

Figure 2. Some of the plots installed, where (Bwa): plot without ash, (Ba): plot with ash kept and (C): control plot. *By Jorge Mataix-Solera*

The *water drop penetration time test* (WDPT) was used to measure the persistence of WR over topsoil under field conditions. Mesurements were done over topsoil of mineral soil after removal of ash cover or litter debris in July (immediately after fire), October and December 2011, and in January and March 2012. Ash samples were also collected after fire and WR measured in laboratory.

Results and Discussion

In Figure 3 we show the results of WR as relative frequency of distribution in WDPT classes (s) (Bisdom *et al*., 1993). Figure 4 shows the mean values of WDPT for each time of field meaurements.

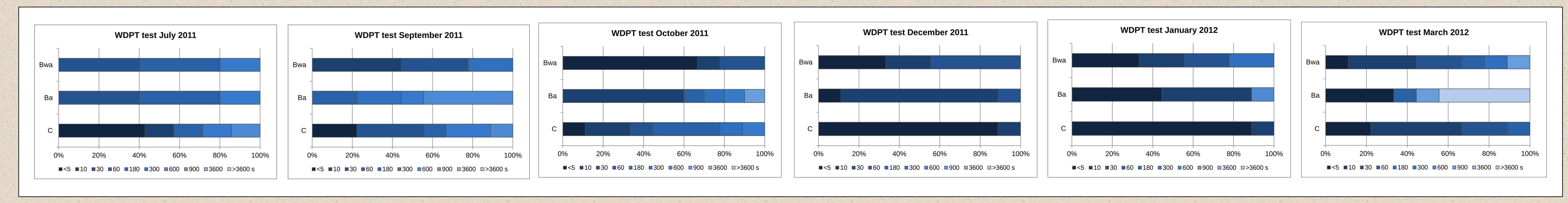

Figure 3. Relative frequency of WR distribution in WDPT Classes

As expected, WR immediately after fire (July 2011) was one of the highest measurements during the study period both in burned and control area, being higher (670±627s) in burned compared to control area (228±196s). The WR of ash measured in laboratory revealed that 50% of samples were water repellent (mainly in the WDPT classes of 10 and 30 s; Figure 6). During the rainy period (425 mm November-January), soil WR decreased being faster in Bwa plots. The decreasing tendency remain until December, when WR disappeared almost enterely in both, burned and control area, because of a rainy period. WR in March 2012 is recovered in burned area, being the highest increase in Ba (839±745s) and a lower increase happened in Bwa (103±151s) after a dry period. In control area WR is kept lower (13±5s).

Table 1. Mean values (s) and standar deviation of WDPT for each time of field meaurements.

	July11	September 2011	October 2011	December 2011	January 2012	March 2012
Bwa	670±627	36±48	7±7	9±5	26±29	103±151
Ba		217±85	127±129	7±2	40±59	839±745
C	228±196	108±112	94±126	4±1	3±1	13±5

The ash removal seems to facilitate a faster decrease in soil WR. A possible explanation is that the washing of water repellent compounds through soil profile with infiltration water was easier without ash cover, and the fact that the elimination of ash avoided the input of hydrophobic ash material from surface.

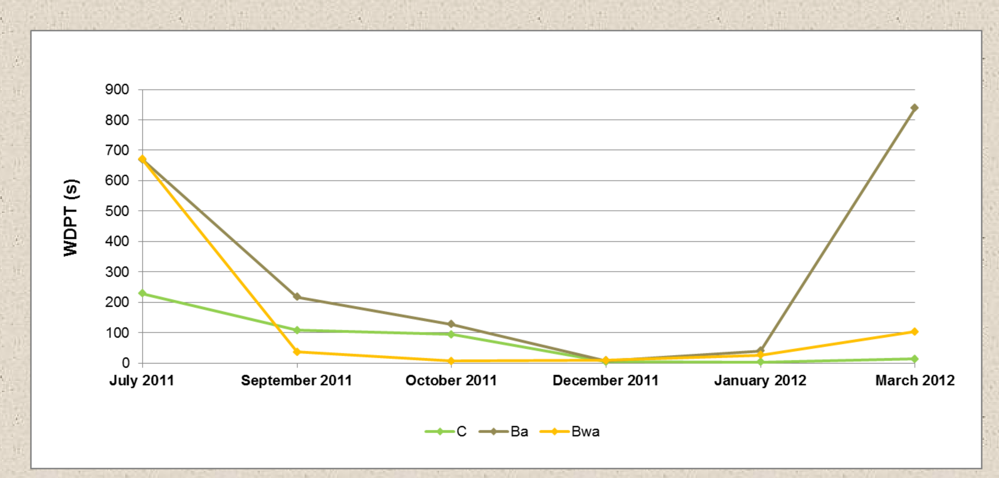

Figure 4. Mean values of WDPT (s) for each time of field meaurements.

Figure 5. Some general pictures of the field work in Gorga. *By Jorge Mataix-Solera.*

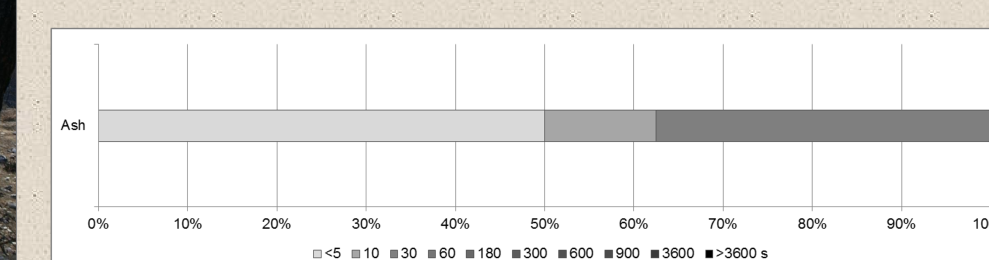

Figure 6. WR of Ash. Relative frequency in WDPT Classes

Conclusions

The presence of ash has an effect on soil WR in burned area. The ash removal allowed a faster decrease of soil WR. Washing of water repellent compounds through soil profile with infiltration water could be easier without ash cover. In addition, the elimination of ash avoided the input of hydrophobic ash material from surface. We continue monitoring the plots to check whether this "positive" effect of ash elimination on a faster decrease of soil WR is or not beneficial *versus* the expected "negative" effect of elimination of nutrients because of ash removal.

References

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Photo by Jorge Mataix-Solera

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