Emissions from prescribed fires of two shrub species: *Genista hispanica* subs *occidentalis* and *Calluna vulgaris*

Blanco-Alegre C.[1], Calvo A.I.[1], Castro A.[1], Oduber F.[1], Alves C.[2], Nunes T.[2], Valbuena L.[3], Cadenas R.M.[3], Castedo F.[3], Fraile R.[1]

[1]Department of Physics, IMARENAB University of León, 24071 León, Spain

[2]Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning, University of Aveiro, 3810-193Aveiro, Portugal

[3]Department of Biodiversity and Environmental Management, Area of Ecology, University of León, 24071 León, Spain

*roberto.fraile@unileon.es

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INTRODUCTION

- In the Mediterranean area, forest fires have increased in number over the last 50 years, including bush fires. These produce large amounts of atmospheric carbonaceous material, particularly elemental carbon (EC) and organic carbon (OC), which play an important role in global warming (Boreddy et al., 2017).
- Prescribed fires affect on the vegetation, soil, wildlife, water and air. They allow control and measurement their emissions.
- The main aims of this study were to study the impact of prescribed burnings on air quality and to search the relation between the smoke generated in bush fires and the seed germination processes after the fire (Bargmann et al., 2014).
- The importance of the present work lies in the fact that it is the result of a field campaign with real, not simulated, conditions.

STUDY AREA

- Scrub prescribed fires were carried out on October, 3rd and 4th, 2016 in La Cueta, León (NW Spain)
- The area is within a protected natural area ("Valle de San Emiliano")

Figure 1. La Cueta in the NW Iberian Peninsula and surroundings of the sampling site.

METHODOLOGY

The air sampling equipments were placed between 3 and 10 m downwind from the fire.

~1000 m^2 were burned in each plot (4)

Calluna vulgaris

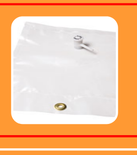
Genista hispanica subsp. *occidentalis*

SAMPLING INSTRUMENTS USED

A low volume ECHOPM TECORA to collect $PM_{2.5}$ onto quartz filter

A Gent stacked filter unit sampler to collect PM_{10} onto polycarbonate filters (0.2 µm pore size)

A thermocouple network to register the surface temperature evolution during fires



TEDLAR bags to sample smoke for further FTIR analysis

CO and CO_2 Combo IAQ Meter

RESULTS

Table 1. Summary of mean meteorological conditions in *Calluna* and *Genista* burning. Data provided by: Molina J.R, Rodríguez and Silva F., Laboratorio de Incendios Forestales. Univ. de Córdoba (Spain), LABIF-UCO.

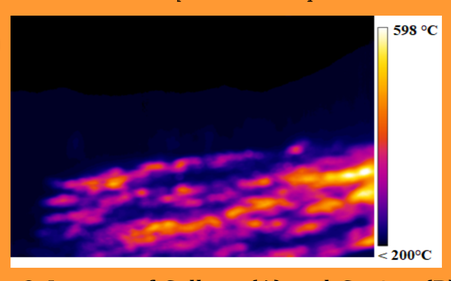
Calluna vulgaris				*Genista hispanica* subsp. *occidentalis*			
Altitude (m)	Wind Speed (m/s)	T (°C)	RH (%)	Altitude (m)	Wind Speed (m/s)	T (°C)	RH (%)
1395	4.3±1.7	17.7±0.6	40.1±1.1	1534	3.6±1.8	19.7±0.8	37.4±1.3

Modified combustion efficiency (**MCE**) is used to evaluate the completeness of combustion; it can be considered that >90% of the carbon combusted in a fire is emitted in the form of CO_2 and CO.

$$MCE = \frac{[CO_2]}{[CO_2] + [CO]}$$

- *Calluna vulgaris*: MCE>90 (91.4) **FLAMING PHASE**
- *Genista hispanica* subsp. *occidentalis:* MCE<90 (85.3) **SMOULDERING PHASE**

A)



B)

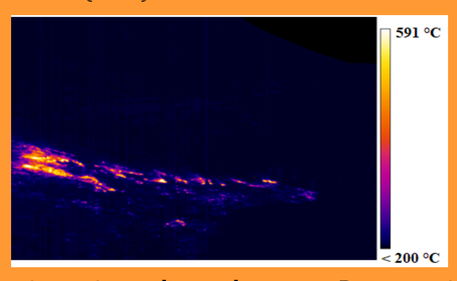


Figure 2. Images of *Calluna* (A) and *Genista* (B) burning using a thermal camera. Data provided by: Molina J.R, Rodríguez and Silva F., Laboratorio de Incendios Forestales. Universidad de Córdoba (LABIF-UCO).

Emission Factor (**EF**) is defined as the amount of a compound released per amount of dry fuel consumed, expressed in units of g kg^{-1}.

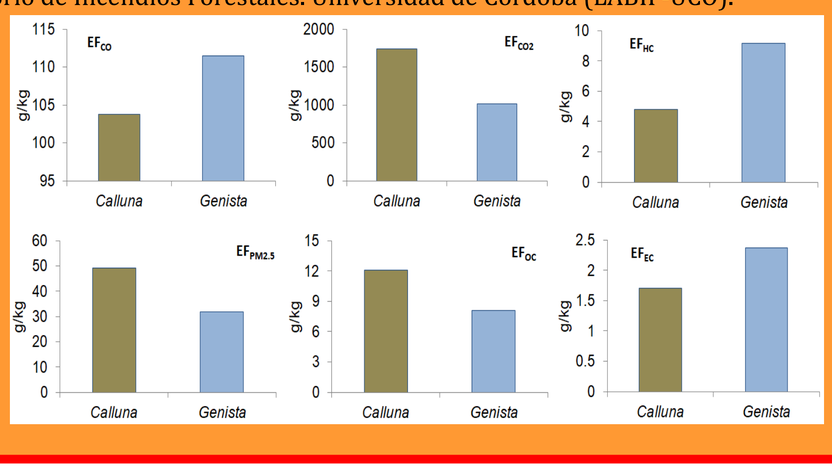


Figure 3. Emission Factor (EF) of CO, CO_2, HC, $PM_{2.5}$, organic carbon (OC) and elemental carbon (EC) during *Calluna* and *Genista* burnings.

Table 2 . Characteristics of the solid biomass fuels (*Calluna* and *Genista*).

SPECIES		Humidity (%)	Volatile	Ash (815ºC)	Ash (550°C)	C (%)	H (%)	N (%)	S (%)	HCV (kcal/kg)	LCV (kcal/kg)
Genista	s/dry	-	80.2	1.58	1.86	53.2	6.53	1.19	0.08	5238	4882
	s/r a.r*	10.1	72.1	1.42	1.67	47.8	6.99	1.07	0.07	4710	4330
Calluna	s/dry	-	77.5	1.74	1.98	53.3	6.34	0.9	0.09	5240	4895
	s/ a.r*	9.2	70.4	1.58	1.8	48.4	6.78	0.82	0.08	4759	4391

*Sample received without original humidity. **HCV (High Calorific Value); LCV (Low Calorific Value)

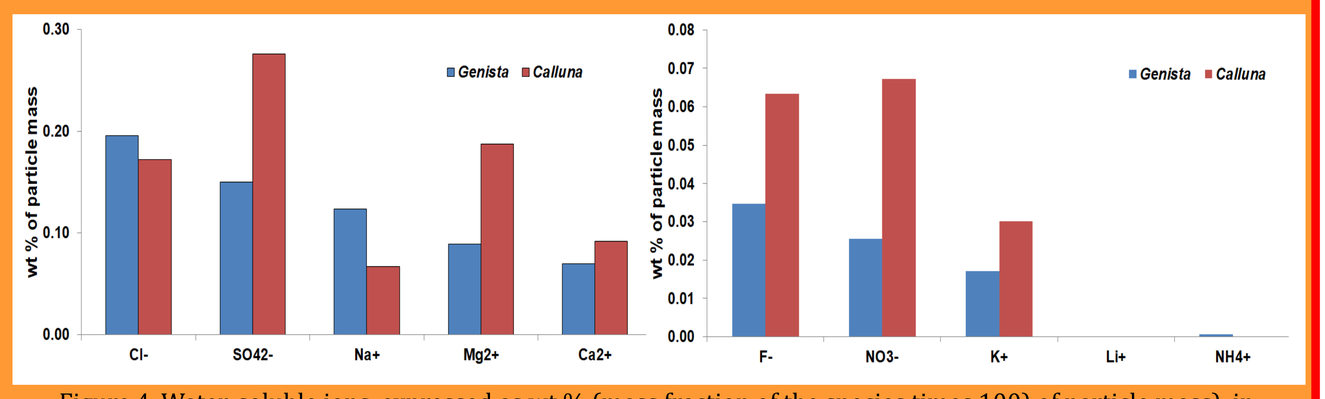


Figure 4. Water-soluble ions, expressed as wt % (mass fraction of the species times 100) of particle mass), in *Calluna* and *Genista* burnings.

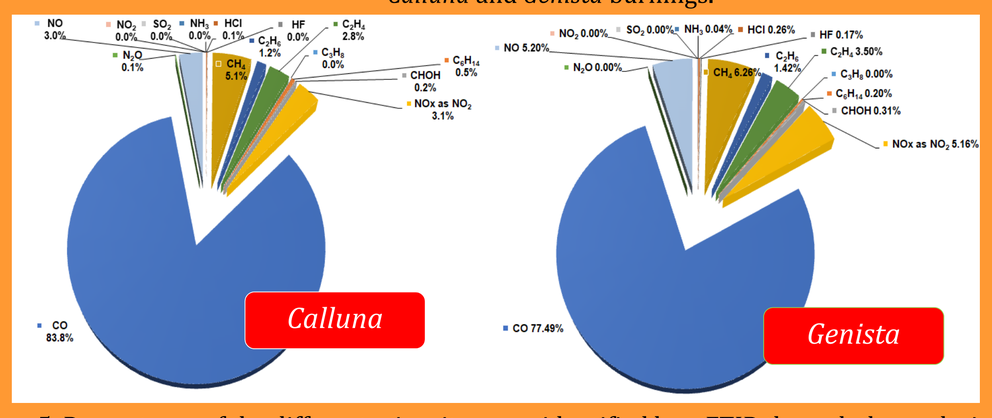


Figure 5. Percentages of the different minority gases identified by a FTIR through the analysis of the TEDLAR bags samples for *Calluna* and *Genista* burnings (CO_2 has been excepted).

CONCLUSIONS

- For *Calluna* EC+OC represents 28.1% of PM_{10}, while for *Genista* it represents 32.9%.
- $CO+CH_4+NO+C_2H_4$ represent more than 97.6 of gases emitted in *Calluna* and *Genista* burnings.
- Water soluble ions in *Calluna* present higher concentrations than emitted for *Genista* (except Cl^-).
- Cl^-, SO_4^{2-}, Na, Mg^{2+} and Ca^{2+} represent more than 80% of the total ion concentration emitted during the burnings of both species
- EF_{CO2} values for *Calluna* are similar are similar to those obtained for Amazonian forest clearing fire. (Soares Neto et al., 2009).

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