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Exploring the effects of carbon and ash derived from forest fires in relation to germination of two invasive alien species and one native species.

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Fire is an ecological factor that affects ecosystem structure and functioning and determines later recovery of the ecosystem through the modification of biological processes, such as seed germination and seedling establishment. Another factor that modifies ecosystems is the presence of invasive alien species, which easily colonize new habitats after disturbances such as forest fires. Within this research, we analyzed the germination response to fire through carbon and ash of three species that share habitat, one native species (*Daucus carota* L.) and two invasive alien species (*Helichrysum foetidum* (L.) Moench and *Oenothera glazioviana* Micheli) to identify and compare the effects of carbon and ash on the germination of these three species. For this purpose, germination tests were performed by using seeds treated with carbon and five concentrations of ash (from lower to higher -Ash1, Ash2, Ash3, Ash4, Ash5-), simulating remanent conditions after forest fires. Carbon and ash were obtained from the native species *Ulex europaeus* due to its abundancy in Atlantic shrubby ecosystems.

In control conditions, germination of the three species studied was: *D. carota* (34.4%), *H. foetidum* (77.6%) and *O. glazioviana* (12.0%). The three species showed slightly different responses to fire factors. Carbon slightly reduced germination of native *D. carota* and stimulated germination of *O. glazioviana*, but statistically differences were not found with control. Germination response to ash depended on the species and the ash concentration applied. Lower concentrations of ash did not affect germination, intermediate concentrations reduced it, and higher concentrations inhibited germination at all. Regarding the species, both *D. carota* and *O. glazioviana* maintained its germination similar to control with Ash1 and Ash2, reduced it with Ash3, and inhibited it with Ash4 and Ash5. Germination of *H. foetidum* was the most affected. It only remained unaltered with Ash1 and was reduced progressively with Ash2 and Ash3. Treatments Ash4 and Ash5 totally inhibited it, as the other two species studied.

At high concentrations, ash prevented the germination of the three species. In contrast, carbon did not modify it. After a forest fire, with soil covered by carbon and ash, germination of this species would be reduced or even removed if the concentration of ash is high. The difference success in this species after a forest fire could be explained by the amount of seeds produced or its response to other fire factors as heat or smoke.

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