Soil Respiration and Controls in Warmer Winter: A Snow Manipulation Study in Postfire and Undisturbed Black Pine Forests

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Abstract

Climate change impacts are driving forest fires worldwide and reducing snowfall in temperate countries. Whether these impacts result in a significant alteration of winter soil respiration (Rs) rates and temperature in the postfire and the undisturbed black pine (Pinus nigra) forests remain poorly understood. A field experiment was conducted in the postfire and the undisturbed black pine forests during a winter period in Türkiye to quantify Rs rates as affected by lack of snow and snow cover. Four treatments were applied: snow-exclusion postfire (SEPF), snow postfire (SPF), snow-exclusion undisturbed forest (SEUF), and snow-undisturbed forest (SUF). The SEPF exhibited the significantly lowest mean Rs rates (0.71 µmol m-2 s-1) compared to the SPF (1.02 µmol m-2 s-1), SEUF (1.44 µmol m-2 s-1, and SUF (1.48 µmol m-2 s-1). The Rs also showed significant variations with time ($p < .0001$). However, treatments and time exhibited no statistically significant interaction effects ($p = 0.6801$). Total amounts of winter Rs (January to March) ranged from 4.92 to 5.07 Mt CO2 ha-1 in the undisturbed forest and 2.53 to 3.51 Mt CO2 ha-2 in the postfire site. The Rs showed a significantly positive relationship ($p < .0001$) with the soil (0.59) and air (0.46) temperatures and a significantly negative relationship ($p = 0.0017$) with the soil moisture (-0.20) at the 5 cm depth. In contrast, the Rs showed a negative, but not statistically significant relationship ($p = 0.0932$) with the soil moisture (-0.16) at the 10 cm soil depth. The combined effects of lack of snow and forest fire resulted in a significant decrease of Rs. In contrast, a warmer winter significantly increased Rs rates in the undisturbed forest, suggesting that a warmer winter could potentially accelerate soil organic carbon losses in naturally growing undisturbed forest ecosystems, thus, providing positive feed backs to climate change.

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