Temporal Changes of Dissolved Carbon and Nitrogen Leaching from California Oak Woodland Litters

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Introduction

❖ Oak woodlands/annual grasslands are a significant physiographic component in California. These landscapes play a major role in the state's water supply system with two-thirds of all drinking water reservoirs located within oak woodland ecosystems. Of particular concern is the export of dissolved organic matter and nutrients from these watersheds into the surface water system. Dissolved organic matter (DOM) is of concern as it can form carcinogenic disinfection byproducts (DBPs), such as trihalomethane and chloroacetic acid, during drinking water chlorination. Dissolved nutrients are also of concern in some watersheds as they may contribute to downstream eutrophication and hypoxia. A common feature in the seasonal water quality dynamics of surface waters draining oak woodlands in California's Mediterranean climate is a pulse of dissolved organic matter and nutrients with the onset of the rainy season. We hypothesize that a large component of the DOM originates from the direct leaching of tree litterfall and annual grass detritus.

Objectives

❖ To determine the temporal changes in the quantity and quality of dissolved C and N in litter and duff leachates over the course of the winter rainfall season from the four dominant sources of litter in California oak woodlands, Blue oak, Live oak, Foothill pine and Annual grass.

❖ To establish the role of litter materials as a source of DOM and nutrients in order to better understand biogeochemical processes contributing to surface water quality.

❖ Assess the potential to implement management activities, such as late season grazing to remove grass litter prior to the onset of the rainy season, in order to reduce DOM and nutrient contributions.

Materials and Methods

❖ Experimental site : Sierra Foothill Research Extension Center (SFREC) of University of California, Yuba, CA

❖ Experimental period : 5 Dec. 2006 - 4 May 2007(150 days)

❖ Experimental materials : Triplicate samples of litter and duff from Live oak (*Quercus wislizenii* A. DC.), Blue oak (*Quercus douglassii* (H.&A.), Foothill pine (*Pinus sabiniana*) and Annual grasses were exposed to rain events during the 2006 water year to collect leachate.

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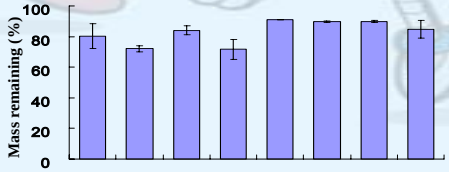
❖ Leachate samples were collected after each storm event and analyzed for the following constituents:
- Total nitrogen (TN) : Non-filtered - persulfate digestion
- Total dissolved nitrogen (TDN) : Filtered – persulfate digestion
- NH_4 and NO_3 (spectrophotometric analysis)
- Dissolved organic carbon (DOC) : TOC analyzer (Phoenix 8000)

❖ TC and TN analysis in leachates
- Total carbon (TC) and total nitrogen (TN) : Carlo Erba combustion

Results and Discussion

Photo: Litter and duff materials before and after 150 days of field leaching.



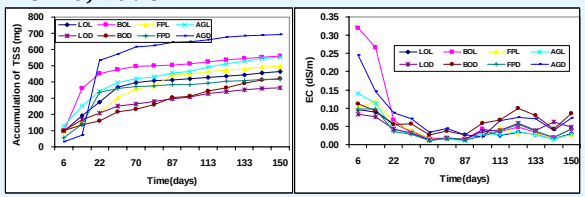
Percentage of original litter and duff remaining after 150 days of field leaching

Carbon and nitrogen concentration in litter and duff before and after 150 days of field leaching

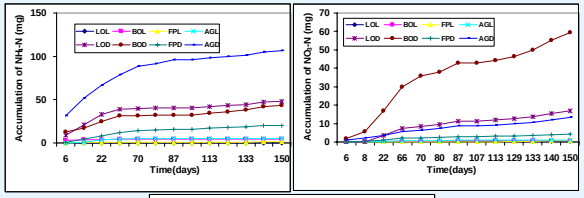
Species	Before experiment			After experiment		
	C (%)	N (%)	C/N	C (%)	N (%)	C/N
LOL	51.4(0.0)	0.87(0.01)	58.9	52.2(0.4)	1.15(0.05)	45.3
BOL	51.6(0.2)	1.49(0.03)	34.7	52.4(0.3)	1.92(0.03)	27.2
FPL	53.5(0.3)	0.79(0.02)	68.1	54.3(0.7)	0.98(0.07)	55.7
AGL	47.7(0.1)	0.61(0.01)	77.9	47.8(0.2)	0.64(0.10)	75.2
LOD	52.1(0.4)	1.47(0.02)	35.4	52.6(0.9)	1.88(0.09)	28.0
BOD	52.7(0.3)	2.49(0.04)	21.2	51.5(1.0)	2.59(0.05)	19.9
FPD	52.9(0.4)	1.20(0.05)	44.1	57.0(1.4)	1.20(0.02)	47.6
AGD	46.9(0.5)	4.18(0.09)	11.2	47.9(2.2)	3.81(0.12)	12.6

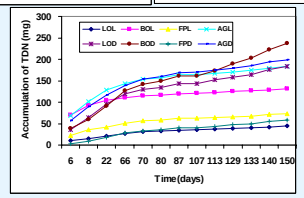
( ) : Standard deviation

➢ In litter samples, carbon concentration did not change, but nitrogen concentrations increased compared to the initial levels.
➢ In litter samples C:N ratios decreased after 150 days.
➢ These trends were not evident in duff.



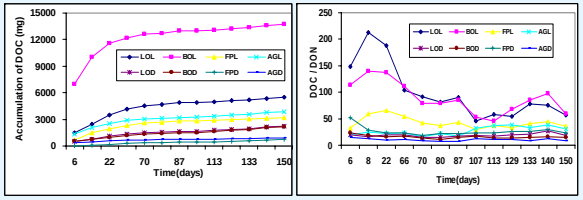
Cumulative mass of TSS (total suspended solids) and changes in EC (electric conductivity) in leachates over time.





Cumulative mass of NH_4-N, NO_3-N and TDN from each leachates over time

➢ While duff leachates had high concentrations of NH_4-N, NO_3–N, and TDN, litter leachates had minimal effluent of mineral nitrogen, except for blue oak.
➢ NH_4-N and NO_3 –N were present at the highest levels in the annual grasses and blue oak duff, respectively.
➢ These results were affected by the high initial nitrogen concentrations and the low C:N ratios in duffs and litters.



Cumulative accumulation of DOC and changes of the DOC:DON ratio for each leachates over time

➢ Cumulative leaching of DOC was highest in blue oak, live oak, and annual grass litter.
➢ The accumulation of DOC was lowest in duff samples, which are more highly decomposed materials.
➢ The DOC:DON ratios were relatively high during the initial decomposition of live oak and blue oak litters, the ratios decreased after 22 days.
➢ DOC:DON ratios in duffs were low with values less than 20 throughout the experiment.