EFFECTS OF CATTLE ON FINE ROOT DENSITY AND SOIL RESPIRATION

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Abstract: The effects of cattle on marsh plants at Palo Verde National Park have been well studied but the effects of cattle on soil biota are poorly understood. As we hypothesized, cattle reduced fine root density, but contrary to our expectation, they had no effect on soil respiration. The reduction of fine root density suggests that cattle reduce plant resource assimilation.

Keywords: Water retention, Palo Verde, Nutrients

INTRODUCTION

At Palo Verde National Park in Costa Rica, cattle are used to manage marsh vegetation. Although the effects of cattle on flora and fauna have been well studied (Burnidge 2000), effects on soil have been largely overlooked. Soil compaction by grazing cattle can negatively affect soil by damaging roots and reducing soil microbial respiration (Unger 1994). Alternatively, nutrient inputs from cattle defecations may increase soil respiration (Bilotta et al. 2007). To better understand the impacts of cattle on soil, we measured fine root density, soil compaction, and soil respiration in cattle grazed and ungrazed areas. We hypothesized that 1) fine root density is lower in cattle grazed areas and that 2) soil respiration rates differ between grazed and ungrazed areas.

METHODS

We took all field measurements on January 13, 2007 at 0700-1030 in a tropical dry secondary forest adjacent to the marsh ca. 0.4 km southeast of the OTS field station in Palo Verde National Park, Costa Rica. We randomly selected 10 *Pithecellobium dulce* trees within adjacent areas grazed or ungrazed by cattle. We took surface samples of mineral soil ranging from 30-200g, in a random direction 1m from the trunk. We assessed soil compaction immediately adjacent to where we took soil samples using an 11.3 kg drop cone penetrometer. For each soil sample, we measured the combined length of all roots > 0.5 mm diameter. To measure soil respiration, we constructed eight vial respirometers, four for each study area, each filled with 5g of soil and saturated with 2.1 ml of water (Braden et al. 2001). Respiration occurred overnight.

We calculated fine root density as total length per g of soil. We square-root transformed these data to satisfy assumptions of normality, and performed a one-tailed pooled variation t-test.

RESULTS

Fine root density was lower where cattle were present ($t = 1.82$, $df = 18$, $P = 0.04$). However, the presence of cattle did not significantly affect soil respiration ($t = 0.61$, $df = 6$, $P = 0.56$) or soil compaction ($t = 1.33$, $df = 17$, $P = 0.06$).

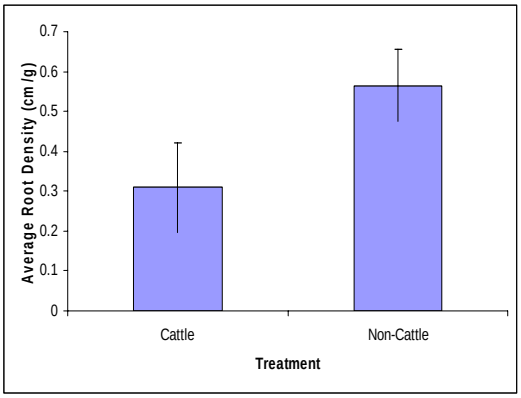

Figure 1. Mean densities of fine roots in soil (± 1 SE) in a cattle grazed area and a non-cattle grazed area in Palo Verde National Park, Costa Rica.

DISCUSSION

The lower fine root density in cattle-grazed areas may have been caused by the tearing action of cattle hooves, or by cattle grazing on the leaves of *P. dulce* and herbaceous vegetation in the cattle grazed site (Erickson et al. 2001). This lower root density may limit plants' ability to access water and nutrients in the soil (Unger 1994).

Cattle-grazed areas contained soil that appeared comparatively drier and more cracked. The area also had less vegetative cover, as observed by Stork et al. (2006). Cattle compact soil, increasing soil density and potentially inhibiting fine root growth (Montagu, 2001).

We found no effect of cattle on soil respiration, though we may have been limited by imprecise soil incubation methods. We recommend that later studies include samples that better represent grazed and ungrazed areas, rather than sampling close to trees, where cattle may trample and graze less.

Reduced fine root density suggests that cattle reduce plant resources assimilation.

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