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Ecosystem Carbon Responses to Nitrogen Additions in Subtropical Grasslands

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INTRODUCTION

Human activities have increased the availability of nutrients, particularly nitrogen (N), across many terrestrial ecosystems worldwide. Given the regulatory impacts of resources and consumers on net primary productivity and subsequent carbon (C) inputs to the soil, anthropogenic changes in nutrient inputs and disturbances caused by land use intensification have major impacts on how C is stored and protected in terrestrial ecosystems. The objective of this study was to investigate the impacts of continuous N additions on soil organic C (SOC) stocks and characteristics in subtropical grasslands.

MATERIAL AND METHODS

The study was conducted on an established bahiagrass (*Paspalum notatum*) field at the University of Florida/Range Cattle Research and Education Center (27°23'N, 81° 56'W) on a Ona fine sand (Sandy, siliceous, hyperthermic Typic Alaquods). Plots have been subjected to annual N application of 0, 60, or 120 kg N ha^{-1} during the past 6 years. Five composite soil core samples were taken from the 0 to 10 cm and 10 to 20 cm depths**.** Aggregate size/density separation was performed using the method described by Six et al. (1998). Hydrolyzable C separation was based on Silveira et al. (2008). Carbon and nitrogen concentrations were determined by dry combustion.

RESULTS

Total Soil C and N Stocks

Nitrogen additions increased soil C and N stocks at the 0 to 10 cm 1depth but no treatment effects were observed at the 10 to 20 cm depth (Table 1). On average, an annual increase of ~ 0.7 Mg C ha^{-1} in soil C was observed in response to N additions.

Table 1. Soil organic C (SOC) and N stocks as affected by N fertilization level.

Nitrogen Level	______ Soil C ______		______ Soil N ______	
kg ha^{-1}	g kg^{-1}	Mg ha^{-1}	g kg^{-1}	Mg ha^{-1}
0 to 10 cm depth				
0	21.9	19.9	1.2	1.1
60	31.9	25.2	1.8	1.4
100	27.9	22.6	1.6	1.3
Polynomial Contrast	L*	L*	L*	L*
0 to 10 cm depth				
0	14.4	16.8	1.1	1.3
60	12.4	15.0	0.8	1.0
100	12.7	15.7	0.8	1.0
Polynomial Contrast	NS	NS	NS	NS

†NS = not significant (P > 0.05); L = linear; * = P ≤ 0.05.

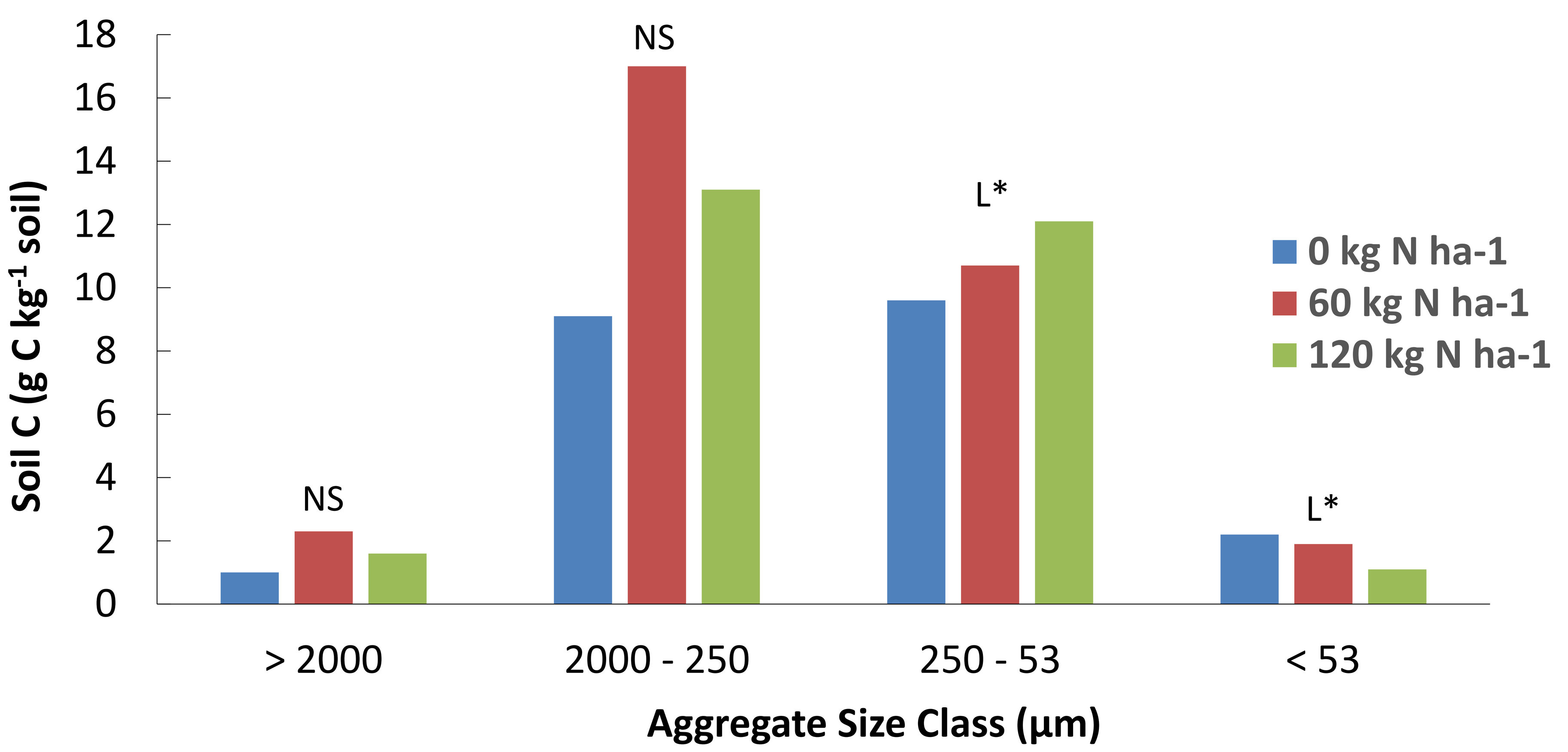

Fig. 1 Soil C distribution (0-10 cm) among the various aggregate size classes as affected by N fertilization levels.

RESULTS (Cont.)

Soil C associated with microaggregates (250 to 53 µm) increased linearly as N level increased (Fig. 1). Conversely, mineral-associated C (< 53 µm) decreased in response to greater N levels.

Microaggregates accounted for the greatest proportion of the C present in the bulk soil (40 to 52% of total C at the 0 to 10 and 10 to 20 cm depths, respectively).

At the 0 to 10 cm, N additions increased light-free C pool depth but no differences were observed in the light-occluded fraction (Fig. 2). No treatment effects were observed at the 10 to 20 cm depth.

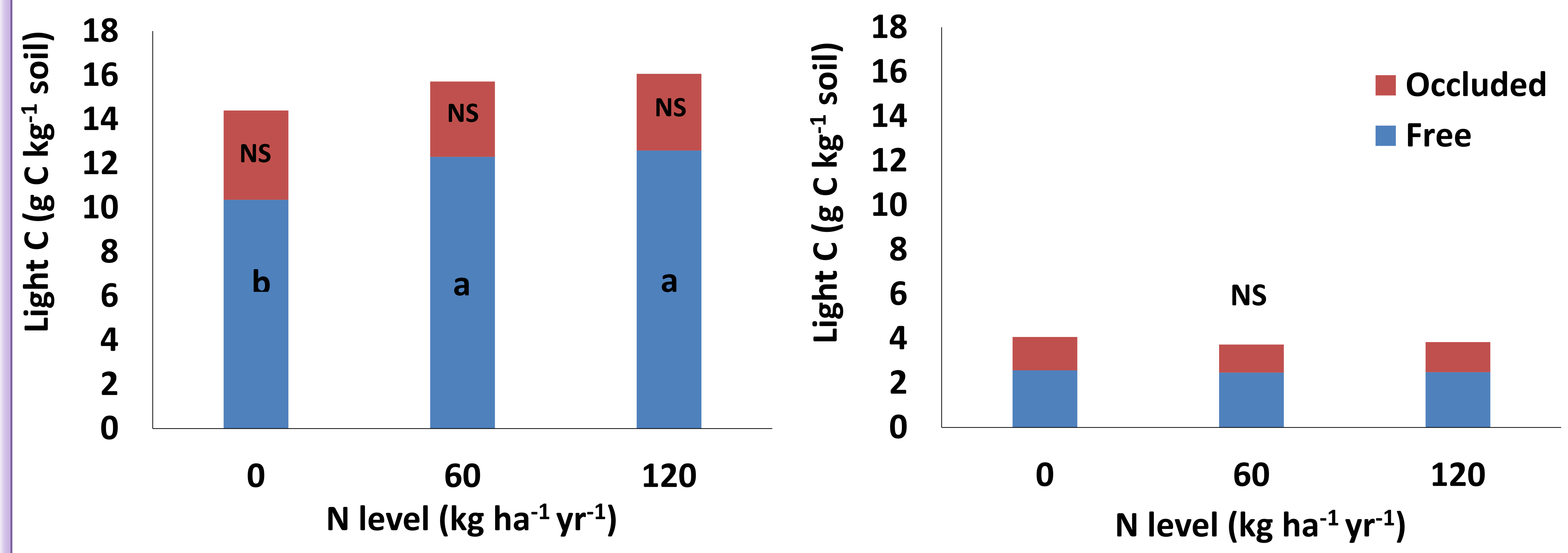

Fig. 2 Light-free and -occluded C fractions as affected by N fertilization levels.

Nitrogen fertilization increased hydrolyzable C at both soil depths (Fig. 3). Similarly, recalcitrant index (unhydrolyzable C: total C) decreased from 53 to 48% as N levels increased from 0 to 120 kg N ha^{-1}.

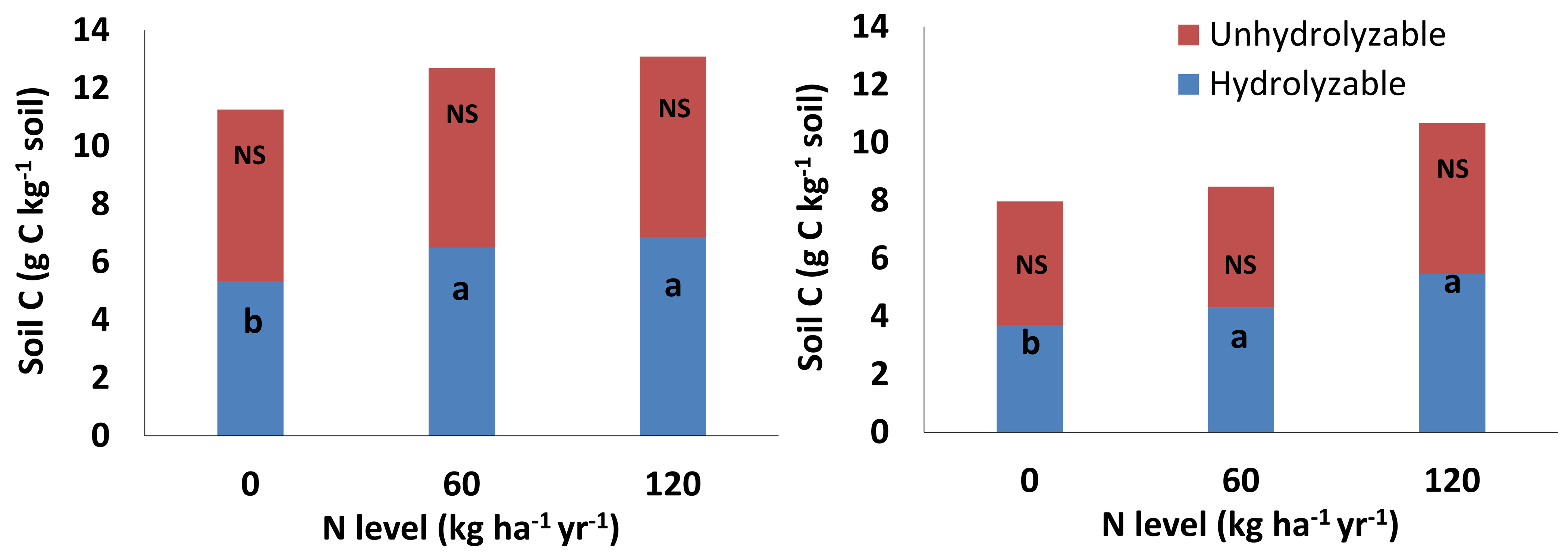

Fig. 3 Nitrogen fertilization impact on hydrolysable and unhydrolyzable C fractions.

CONCLUSIONS

Nitrogen management impacted the amounts and characteristics of C associated with subtropical grassland soils. Our data indicated that although soil C and N stocks increased in response to N fertilization, C accumulated in the treatments receiving N was present mainly in labile forms that can be more easily susceptible to decomposition.