N-fixation by kudzu (*Pueraria montana*): impacts on nitrogen cycling and soil microbial communities by an invasive vine

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Introduction:

When an invasive species possesses a functional property not found among common natives, the invader has the potential to change the ecology and biogeochemistry of the invaded system. Kudzu (*Pueraria montana*), an invasive leguminous vine capable of high rates of nitrogen (N) fixation[1], has the potential to alter ecosystem and biogeochemical properties far out of proportion to its biomass when it invades systems that lack dominant N-fixing taxa. Such a situation is currently occurring in the eastern United States, where kudzu is more common than other N-fixers (including soybean) throughout much of its range[2,3]. Here we present preliminary data from an ongoing study.

Methods: *Sites:* In September, 2005, we collected soil cores in Maryland from one site invaded by kudzu and one adjacent site where kudzu is absent. The paired sites were selected to have similar slopes, aspects, and land-use history, and were divided into field and forest strata for sampling. We also collected senesced leaves from kudzu and 7 co-occurring tree species.

Assays: We measured soil inorganic N by conducting KCl extractions and analyzing the filtrated extracts for NO_3^- and NH_4^+ using a Latchet auto analyzer (Wilsonville, OR, USA). Total C and N was measured using a CE Flash EA 1112 Elemental Analyzer). We conducted 10-day lab incubations of soil samples to measure net N mineralization (calculated as the difference in inorganic N content the soil extractions at the beginning and end of the incubation period) and net nitrification (calculated as the difference in the content of NO_3^- in the soil extractions at the beginning and end of the incubation period). We used the acetylene inhibition method to obtain an index of the denitrification activity of soils[4], employing gas chromatography to measure the N_2O evolved after 1 and 3 hours. The chloroform fumigation-incubation method was used to estimate microbial biomass[5].

Analyses: We used a 2-way ANOVA incorporating invasion status and stratum. We used a one-tailed test to determine whether N-cycling rates were higher in invaded plots. A one-way ANOVA followed by paired contrasts was used to evaluate leaf N.

Kudzu at Summit Hall Turf Farm, May 2005, before kudzu has fully leafed out

Same site, September, 2005, at peak foliar biomass

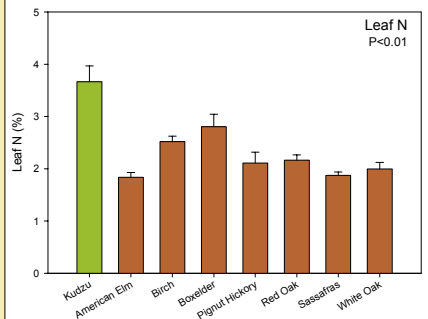

Figure 1: Leaf N in kudzu and 7 co-occuring tree species in Maryland

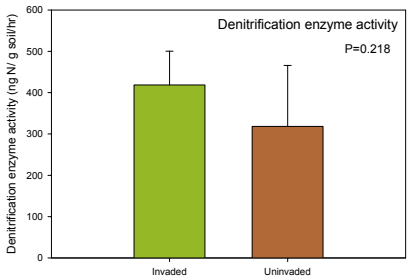

Figure 2: Denitrification enzyme activity, September, 2005

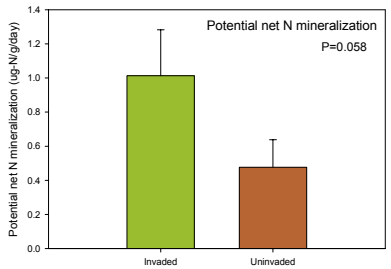

Figure 3: Potential net N mineralization, September, 2005

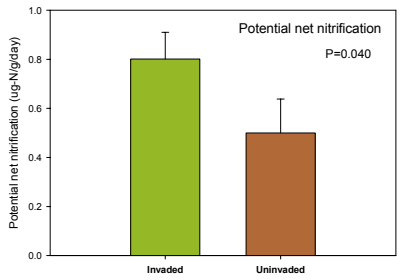

Figure 4: Potential net nitrification, September, 2005

Results:

Kudzu leaf N was 50% higher than the average for 7 native species ($P<0.01$, Figure 1). Kudzu is also altering soil nitrogen cycling: denitrification potential was slightly higher in the invaded site ($P=0.21$, Figure 2), while net mineralization doubled ($P=0.058$, Figure 3), and net nitrification was 1.6 times higher ($P=0.040$, Figure 4). Total C, total N, total inorganic N, and microbial biomass did not vary between sites.

Discussion:

Kudzu covers over 3 million ha in the eastern U.S., is spreading by over 50,000 ha yr^{-1}, and is expected to exhibit strong positive responses to warming and elevated CO_2[1]. As an N-fixing invader, kudzu represents a novel source of nitrogen to the N-limited systems of the eastern U.S., and has the potential to add over an order of magnitude more N than atmospheric N deposition[1,6]. Beyond the specific impacts on the nitrogen cycle, our results suggest that kudzu may cause a shift from N-limitation to N-saturation in invaded systems.

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