

# The Response of European Buckthorn, *Rhamnus cathartica*, to Soil Amendments in Restoration

Dayani Pieri<sup>1</sup>, Lauren Umek<sup>2</sup> (lumek@depaul.edu), Liam Heneghan<sup>3</sup>

<sup>1</sup> Oakton Community College

<sup>2,3</sup> Chicago Botanic Garden

<sup>2,3</sup> DePaul University



## Abstract

The restoration of natural areas after invasion of non-native species is a challenge for biodiversity conservation. Common buckthorn, *Rhamnus cathartica*, is one such non-native, woody, shrub invader in the Chicago region which has been shown to leave “legacy effects” in the soil even after removal. Previous studies show that buckthorn increases the gravimetric water and nitrogen contents in the invaded soils (Heneghan et al., 2004). Field studies also indicate that amending soil with mulch after invasion and removal, reduces the reinvasion of this species. This study investigated the impacts of soil amendments with mulch on non-native *Rhamnus cathartica* sapling growth and seed germination in a controlled environment compared to the field results. Our experiment utilized the soil amendments of standard mulch and *Rhamnus cathartica* mulch to simulate two of the treatments used in the field. It also examined the effects of these treatments on native *Rhamnus alnifolia* seed germination. In addition to buckthorn growth and seed germination rates, we examined the alterations of nitrogen and moisture levels that may occur in each treatment due to buckthorn growth. In the field, we observed that the mulch treatments reduced reinvasion. We also observed that mulch reduces buckthorn sapling growth and changes soil properties. We have no native seeds growing in the amended soil, but many buckthorn seedlings are growing in all treatments. Our results indicate that the addition of mulch reduces European Buckthorn growth and reinvasion in restoration.



R cathartica Saplings in Greenhouse

## Introduction

Restoration of native ecosystems after invasion by European buckthorn has become an important issue in the Chicago region. European buckthorn, *Rhamnus cathartica*, is a non-native, woody shrub invading North American woodlands. Over time, this species forms a dense thicket modifying a number of ecosystem properties in these woodlands including soils, moisture and available nitrogen (N) levels (Heneghan et al., 2005).

A field project which focuses on “soil amelioration” after removal of *Rhamnus cathartica* suggests that application of mulch to previously invaded soil, reduces re-invasion of that species (Heneghan, unpublished). The addition of high carbon (C) content of mulch may lead to microbial immobilization of plant available N, thereby potentially restoring the soil properties to their pre-invaded conditions. This experiment observes the impacts of soil amendments on *R. cathartica* growth both in the field and in a controlled environment, and compares the seed germination of *R. cathartica* to the native shrub in the same genus *R. alnifolia* in these soil treatments.

## Objectives

- To determine *R. cathartica*'s potential for re-invasion using restoration strategies
- To examine the growth rates of *Rhamnus cathartica* saplings planted in amended soils
- To examine changes in soils following the addition of mulch
- To examine the germination rates of non-native *Rhamnus cathartica* and native *Rhamnus alnifolia* seeds in amended soils

## Hypotheses

- R. cathartica*'s potential for reinvasion will be reduced by mulch amendments.
- Buckthorn mulch and standard mulch will decrease the growth of buckthorn saplings.
- Buckthorn mulch soil will have a higher content of moisture and a lower concentration of Nitrogen levels.
- Buckthorn mulch or Standard mulch will not inhibit the germination rates of *Rhamnus cathartica* or *Rhamnus alnifolia*.

## Methods

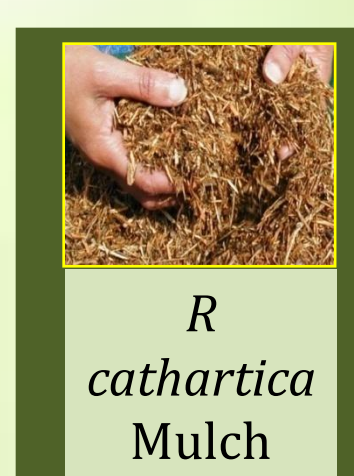
### FIELD EXPERIMENT

#### Reinvasion Density

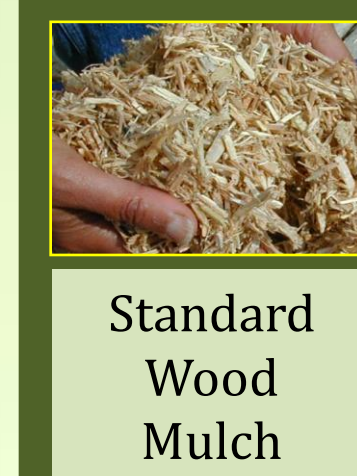
*R. cathartica* resprouts, saplings, and seedlings were counted in three 0.25m<sup>2</sup> quadrats in 5 replicate restoration plots that had *R. cathartica* mulch addition, standard mulch addition and no soil amendment, at Whippoorwill Farm in Mettawa, IL.

### GERMINATION EXPERIMENT

128 seeds each of the non-native *R. cathartica* collected from Lake County, IL and the native *R. alnifolia* collected from Chippewa National Forest, MN were planted in three soil treatments (Table 1) and left to germinate in flats in a greenhouse at CBG. Seedling emergence was observed and counted every three days.



R cathartica Mulch



Standard Wood Mulch

## Results

### FIELD RESULTS

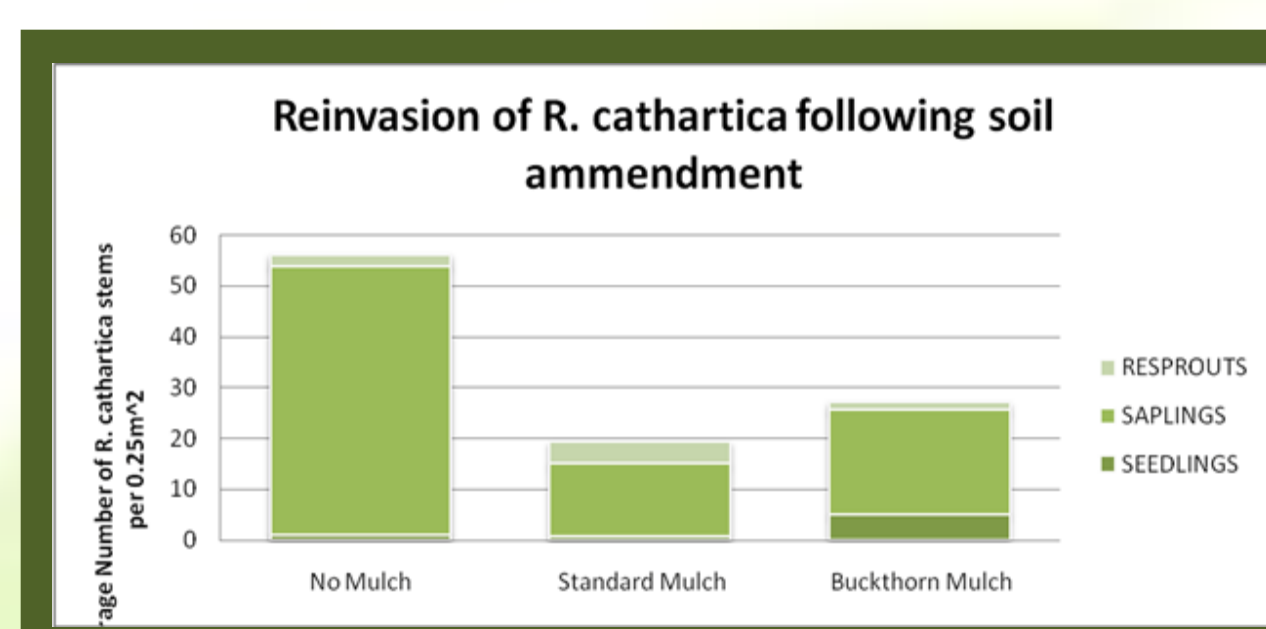


Figure 1: Reinvasion as Saplings, Seedlings & Resprouts

### GREENHOUSE RESULTS

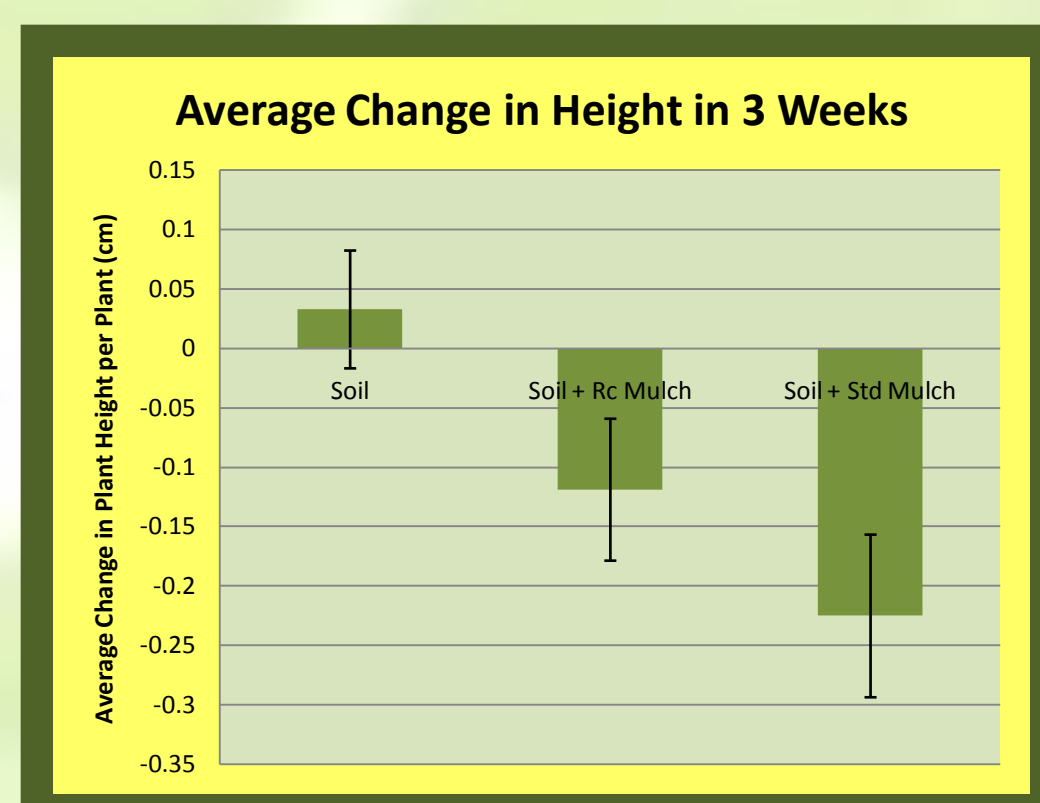


Figure 2: Saplings' Change in Height

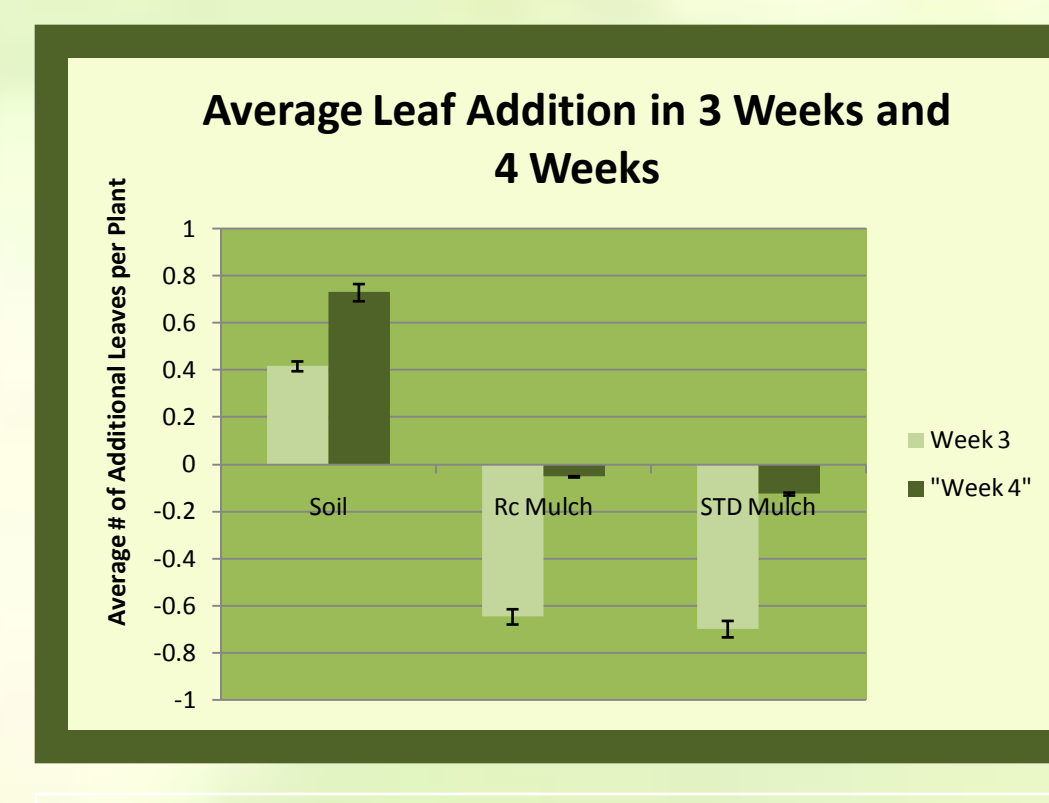


Figure 4: Change in Leaf Number

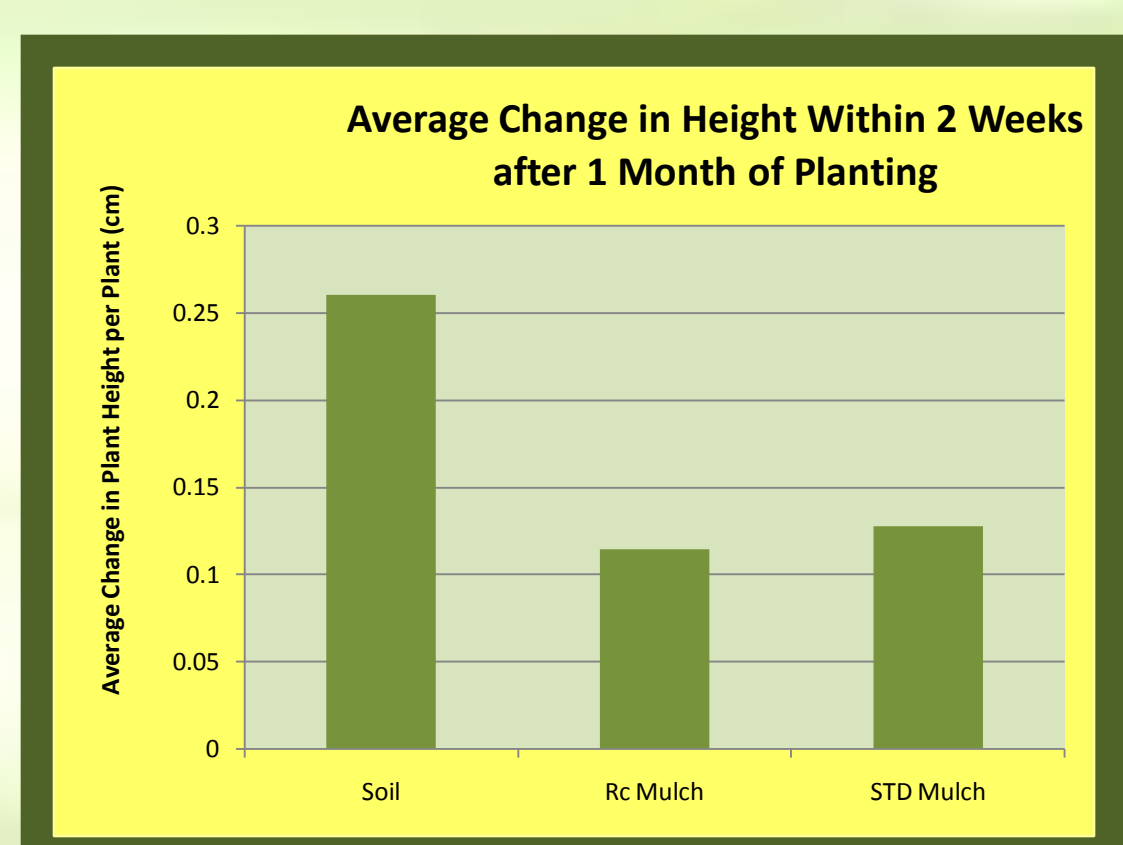


Figure 3: Saplings' Change in Height

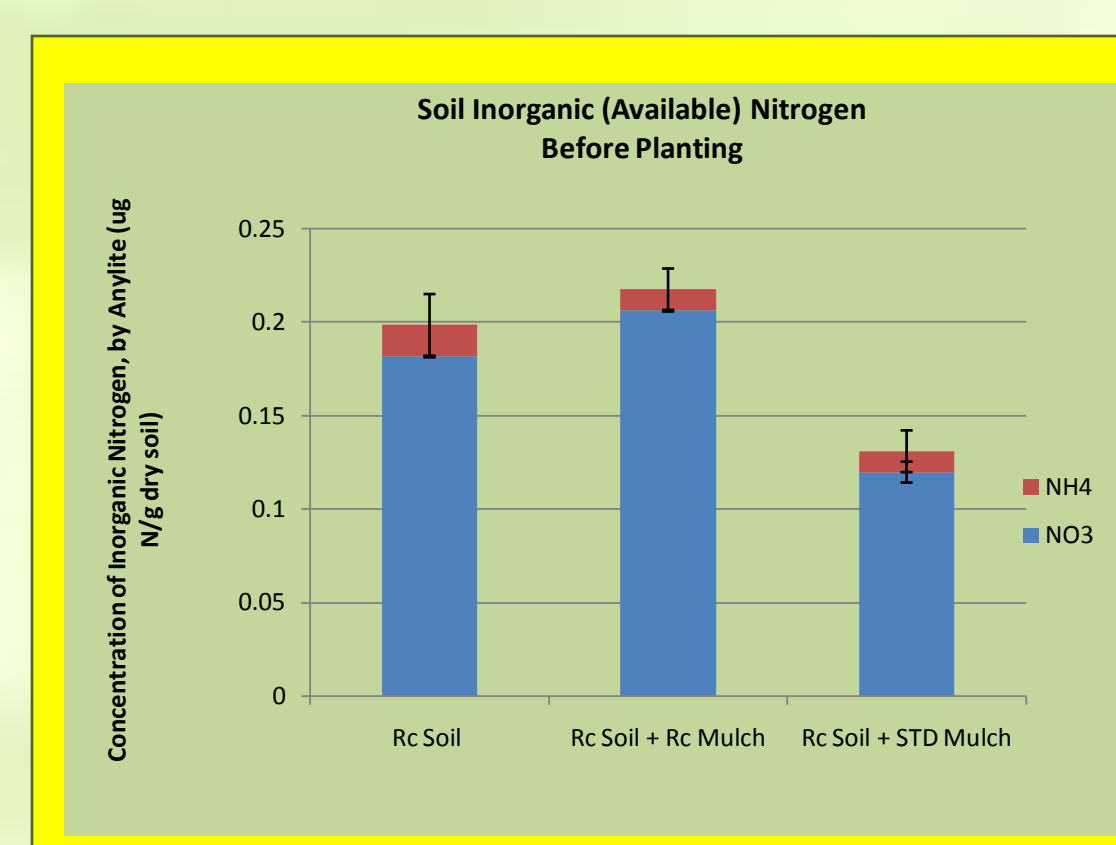


Figure 5: Soil N Levels

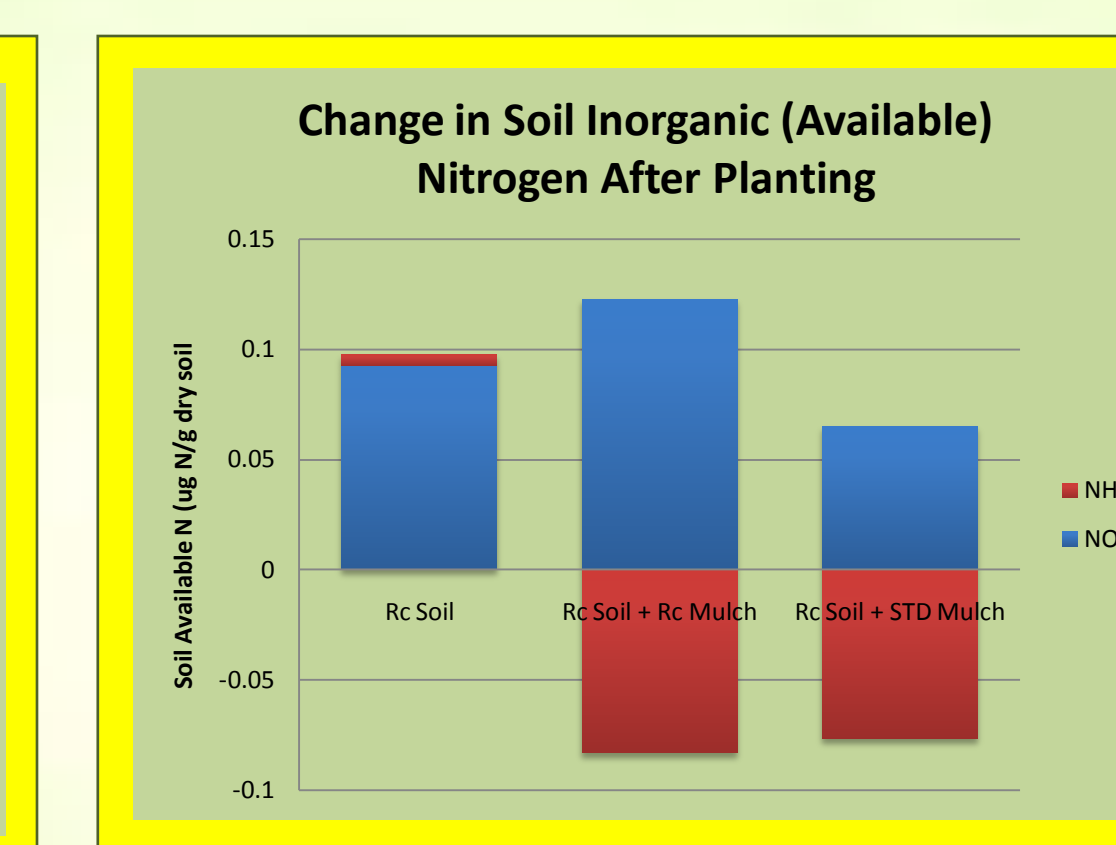


Figure 6: Change in Soil N Levels

### GREENHOUSE EXPERIMENT

288 buckthorn saplings were collected from Mary Mix Mc Donald woods in Glencoe, IL then rinsed, dried, weighed and planted randomly in each of three soil type (Table 1) and labeled. Saplings were watered twice daily in the greenhouse at Chicago Botanic Garden, Glencoe, IL (CBG).

Height and leaf number of each sapling were taken at weeks 0, 3 and 5.

	Soil Type	Additions	Amendments
Soil	Rc invaded soil from MOLA	Sandastic Playsand 3:2 Ratio	None
Rc	Rc invaded soil from MOLA	Sandastic Playsand 3:2 Ratio	50 ml Chipped Rc mulch from MOLA
STD	Rc invaded soil from MOLA	Sandastic Playsand 3:2 Ratio	50 ml Chipped Wood Ecology's wood mulch

Table 1: Soil Amendments

A sample of each type of soil was analyzed before and after planting for gravimetric moisture content and NO<sub>3</sub> and NH<sub>4</sub> concentrations using a 2M KCl extraction and colorimetric method with a HACH DR 5000 Spectrophotometer and reagents (Robertson et al., 1999)



Collecting R cathartica Re-invasion Density Data

## Discussion

Reinvasion of *R. cathartica* was highest in the no mulch plots and lowest in the STD plots. Re sprouts were lowest in the buckthorn mulch plots. Seedlings were mainly found in the buckthorn mulch plots (fig. 1).

An initial overall gain of height was observed in the soil pots but an overall loss of height was seen in pots with *Rhamnus cathartica* mulch and the standard mulch (fig. 2). A height gain later was observed in all amendments, however, the soil pots' height gain was more significant than the mulch treatments (fig. 3).

An initial overall gain in leaf number was observed in the soil pots but an overall loss of leaf gain was seen in pots with *Rhamnus cathartica* mulch and the standard mulch. Over time, the soil pots gained many leaves and the mulch pots showed less leaf loss (fig. 4).

The gravimetric water content was highest in the Rc soil and lowest in the soil and STD mulch mixtures before planting. The water content is reduced in the soil after mixing with sand, however, it is increased after mixing with Rc mulch before planting. After planting, the water content continued to be lower in the soil but higher in both mulch pots.

The NO<sub>3</sub> level was highest in the Rc mulch treatment and lowest in the STD mulch treatment before planting (fig. 5). After planting, the nitrate levels lowered in both treatments and the controls (fig.6).

The NH<sub>4</sub> level was highest in the soil and lowest in the std mulch treatment before planting. After planting, the NH<sub>4</sub> concentrations remained to be the highest in the soil pots and lowest in the Rc mulch pots (fig. 6).

The germination results are inconclusive at this point. Rc seeds have germinated in all three flats but only one Ra seedling has germinated in the soil flat and no Ra seeds have germinated in the amended soils.

Our results indicate the possibility of adding a mulch to soil may reduce the height and leaf number of the plant. Rc mulch may cause a reduction of soil Nitrogen levels in soil greater than the STD mulch. These factors may result in the reduction of the plants total growth rate. Therefore, we conclude that the soil amendment of the addition of mulch may reduce the reinvasion of *Rhamnus cathartica* in restoration.

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## References

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