Above- and Belowground Response to Tree Thinning Depends on Treatment of Tree Debris

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In review: *Ecological Applications*

Study Site: San Juan National Forest Near Dolores, CO

Site History:

Livestock grazing (before 1985), Fire suppression & Drought

Main Goal

Reduce wildfire risk around <u>homes</u> and Archaeological sites

Secondary Goals

Increase native understory and decrease soil erosion

Two Thinning Methods:

1) **Slash pile burning**

2) **Mechanical mastication**

Thin ~ 40-60% of overstory

Questions:

Will thinning treatments affect:

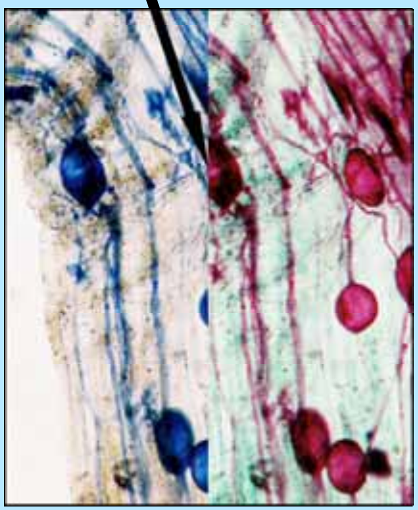
1) Soil Properties: physical or chemical?

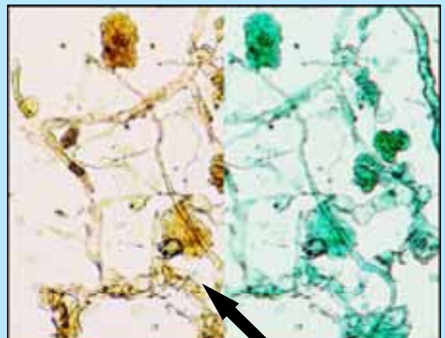
2) Arbuscular Mycorrhizal Fungi (AMF): propagule abundance, species richness or community?

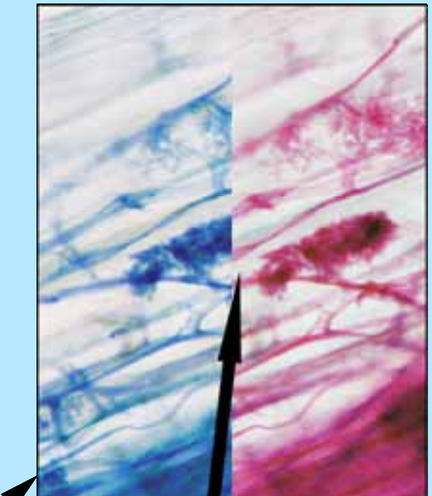
3) Plant Composition: Native or Exotic richness?

Arbuscular Mycorrhizal Fungi (AMF)

Vesicles



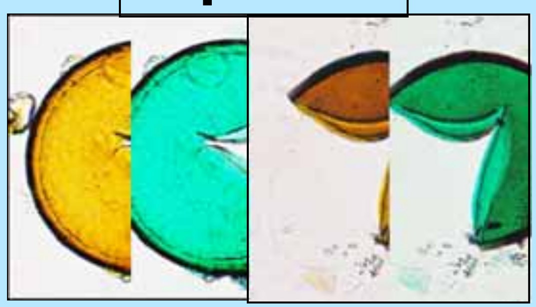




Hyphae

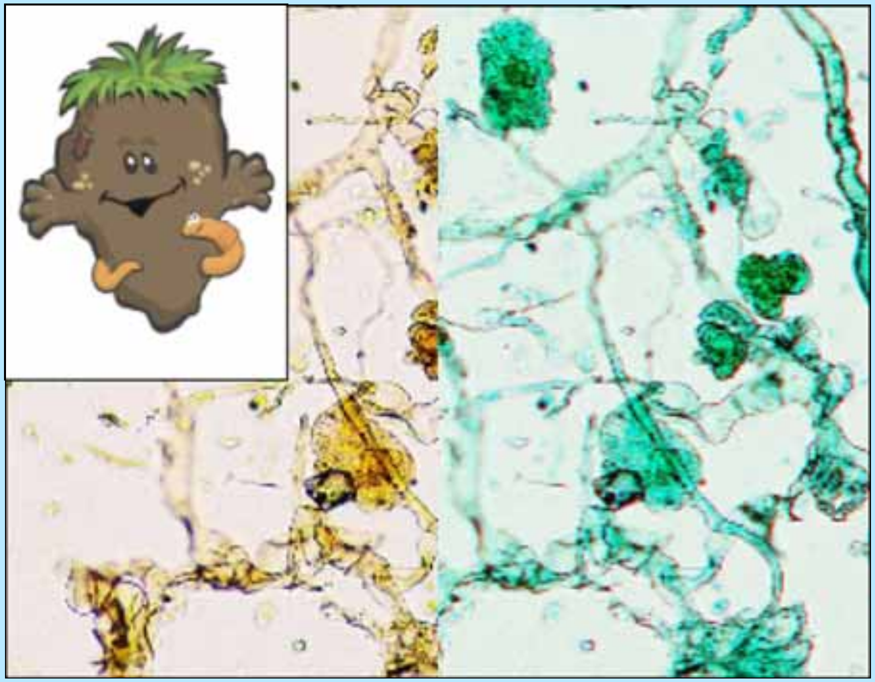
Arbuscules – nutrient exchange

Spores

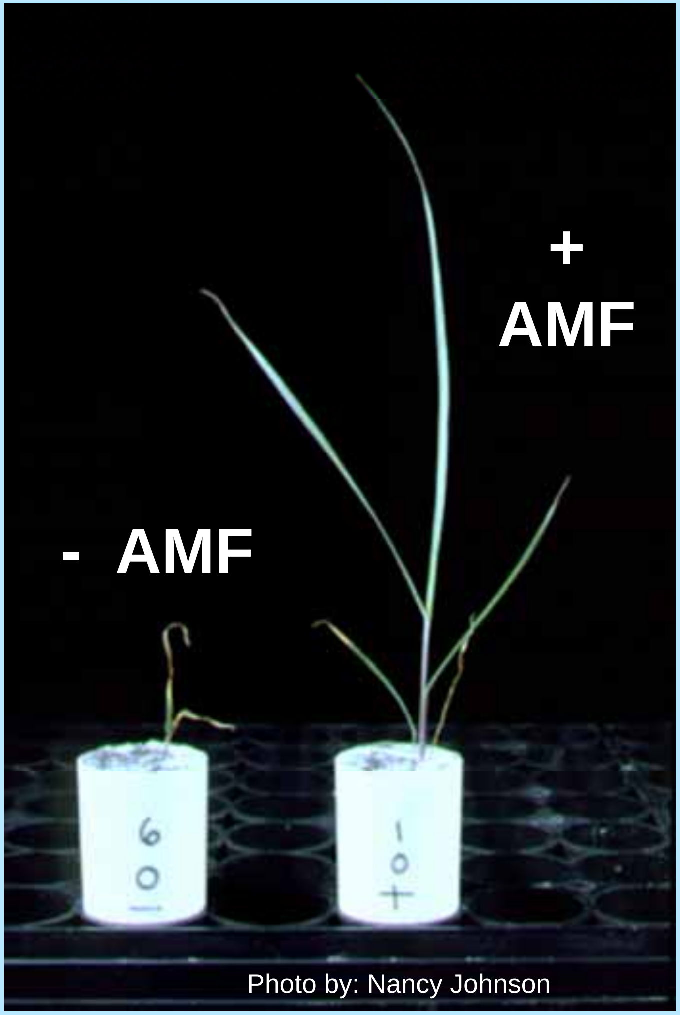


Over 90% of plants rely on AMF

AMF Promote Plant Growth and Increase Soil Stability



Soil hyphae and stability (Tisdall 1991)



Treatments

25 Mastication | 25 Untreated | 25 Pile Burns

Elevation: 7,136ft (2,175 m)

Soil: Alfisols **Texture: Sandy loam**

6-months and 2.5-years post treatment

Hypotheses

Pile Burn

↑ [Available Nutrients]
pH
Soil temp

↓ % Soil moisture
Soil stability
AMF & Plant
abundance &
richness

△ AMF & Plant
community

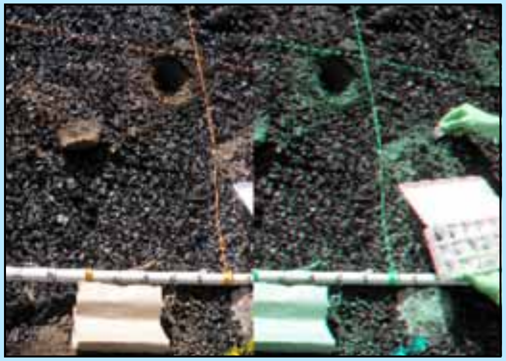
Mastication

↑ % Soil moisture
Soil compaction

↓ Soil temp
Available N

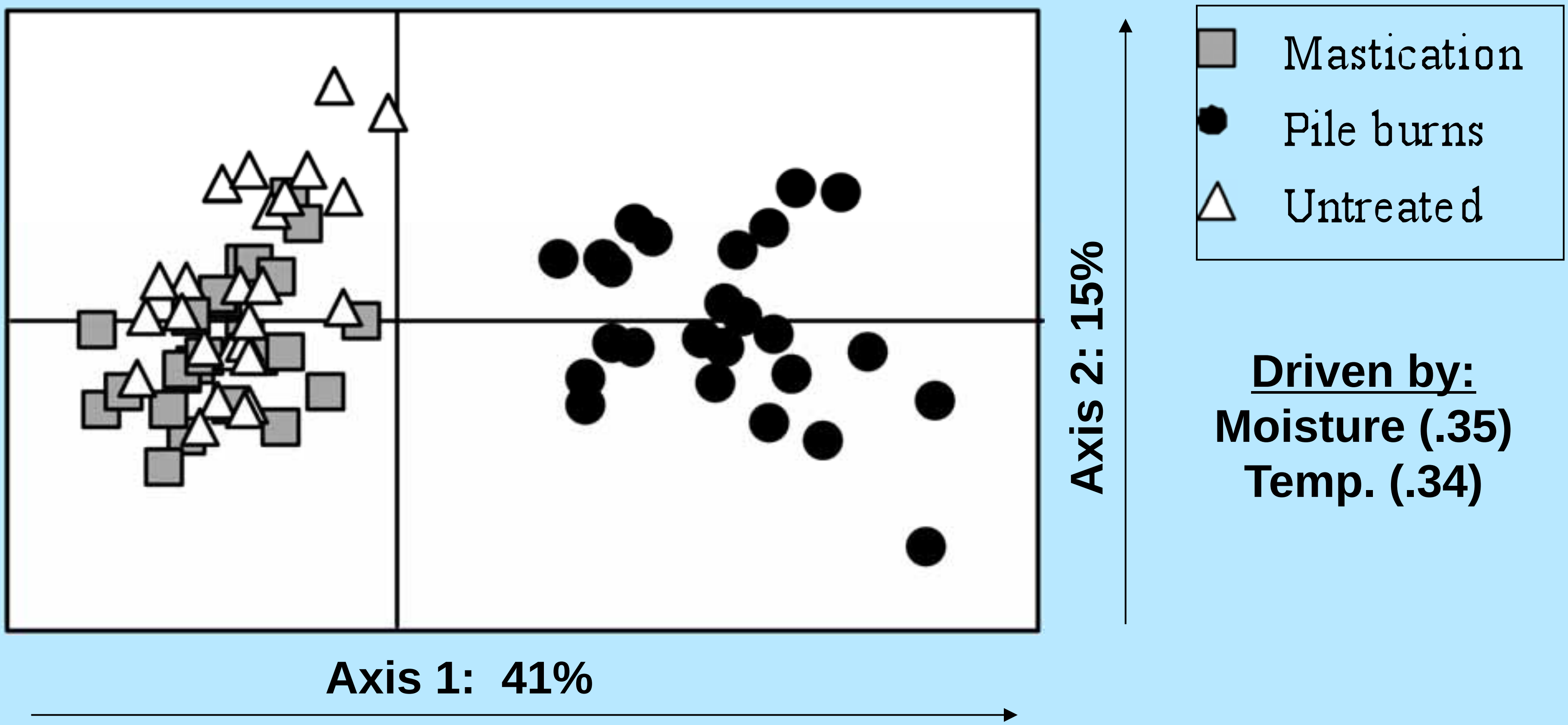
△ AMF & Plant
community

Methods



- Soil (0-15 cm)
  - Soil moisture, Temperature, pH, Total N and C, NO_3^-, NH_4^+ (KCL extraction), PO_4^{3-}, Bulk density, Soil stability (Slake test kit)
- AMF
  - Soil hyphae and spore abundance, richness
- Plants
  - Cover (Daubenmire), richness and native/exotic status

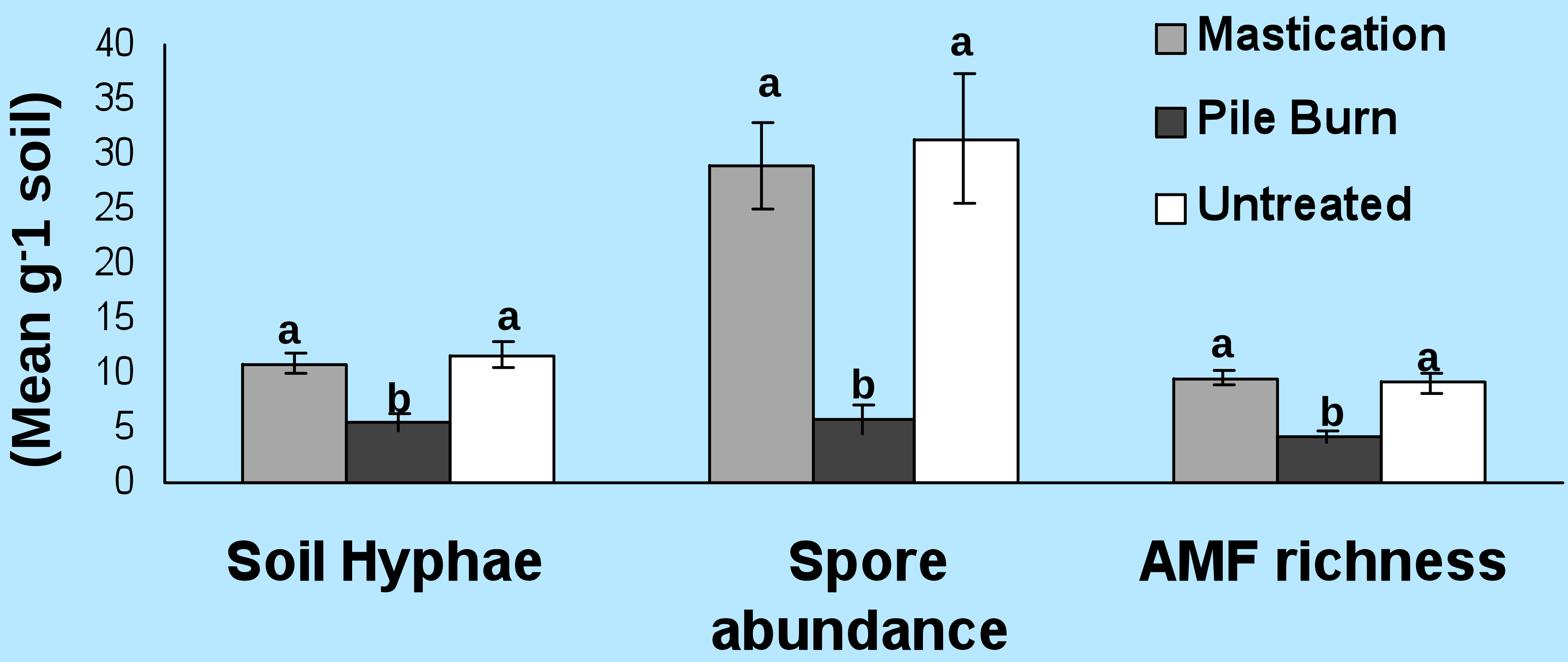
Results: PCA on Soil Properties



Driven by:
Moisture (.35)
Temp. (.34)

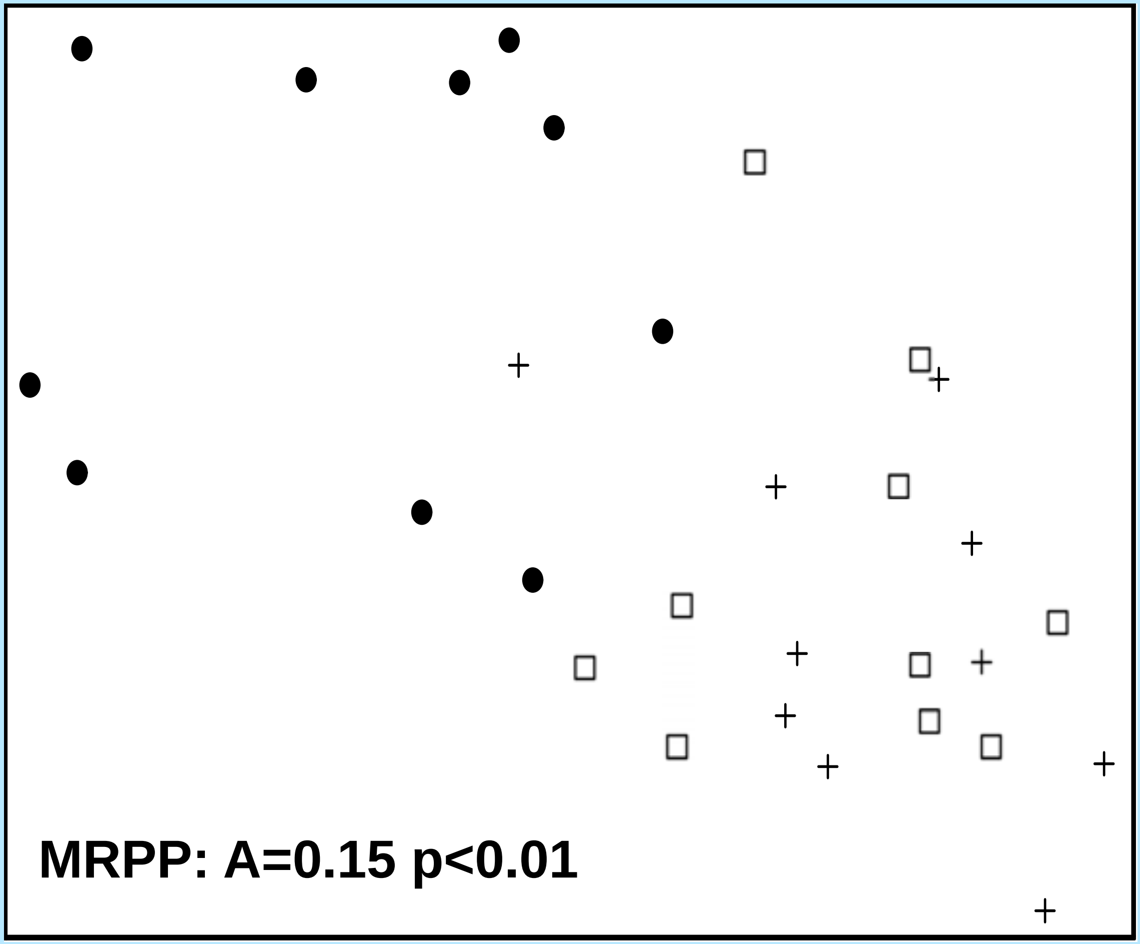
Driven by:
Temp. (.47)
NO_3^- (.37) and NH_4^+ (.36)
Soil stability

AMF Propagule Abundance and Richness Lower in Pile Burns



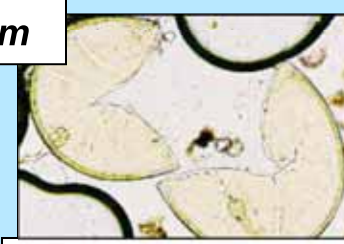
F= 13.3, p<0.01 F= 13.1, p<0.01 F= 15.3, p<0.01

AMF Spore Community Different in Pile Burns



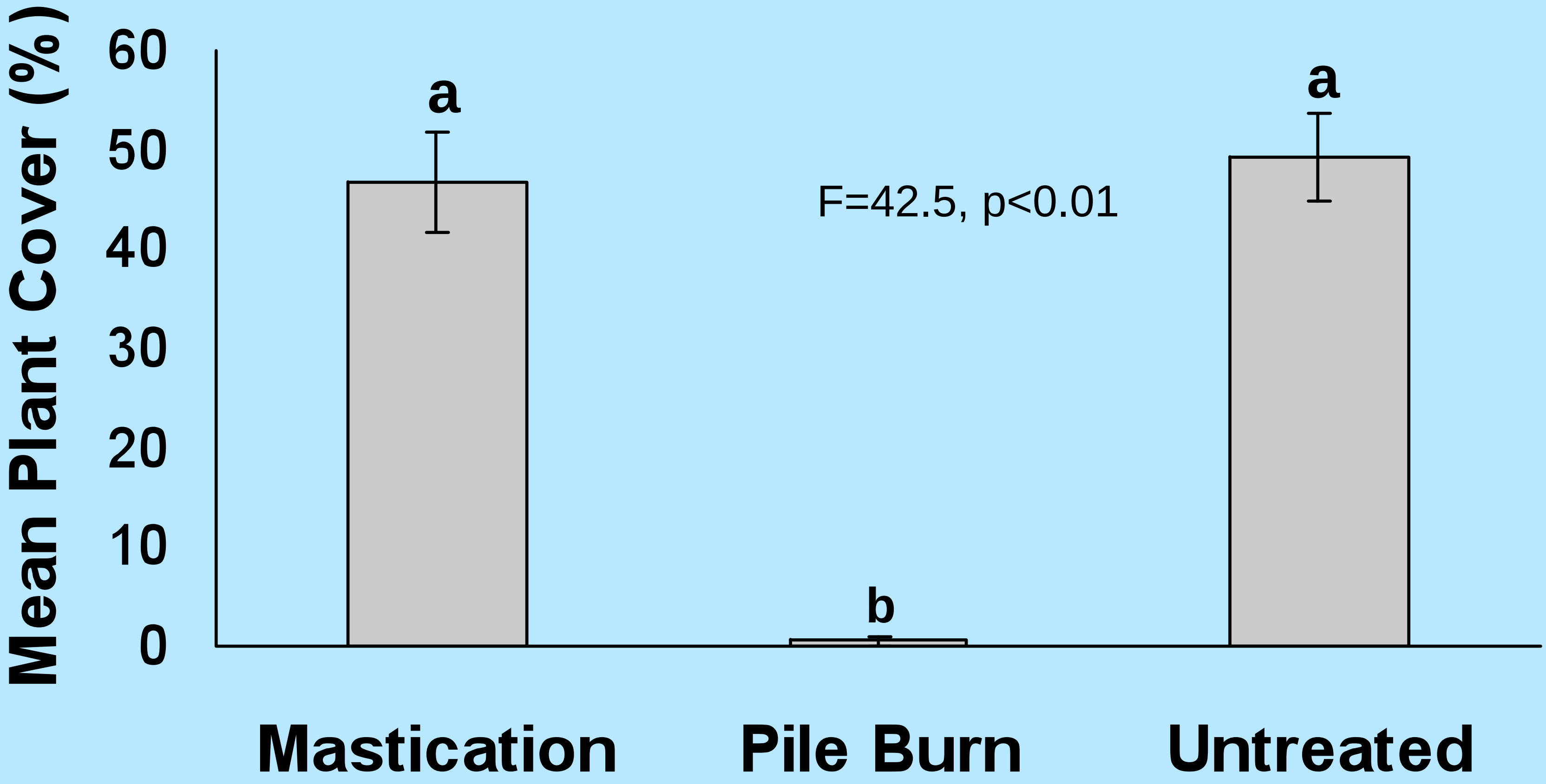
□ Mastication
● Pile Burn
+ Untreated

G. constrictum

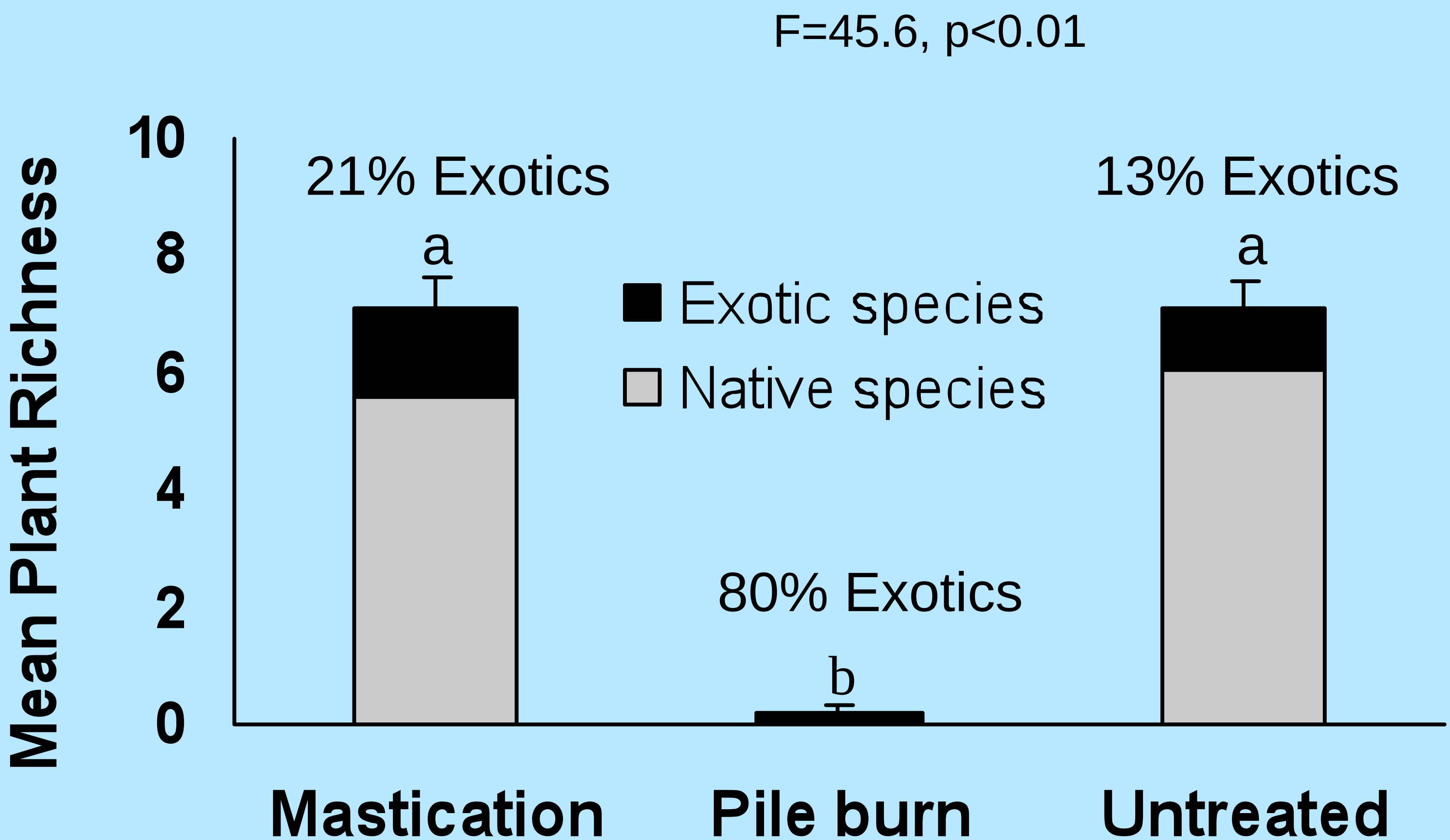


S. calospora

Plant Cover Lowest in Pile Burns



Plant Richness Lowest and % Exotics Highest in Pile Burns



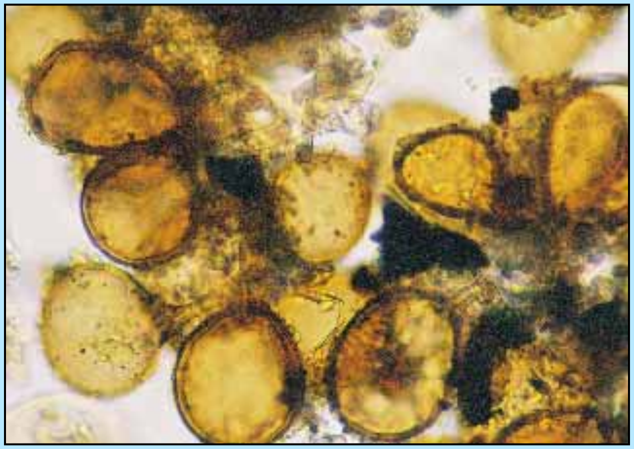
Trends 2.5-years post treatment

- Pile Burns: Same trends – except no difference in AMF spore abundance
- Mastication:

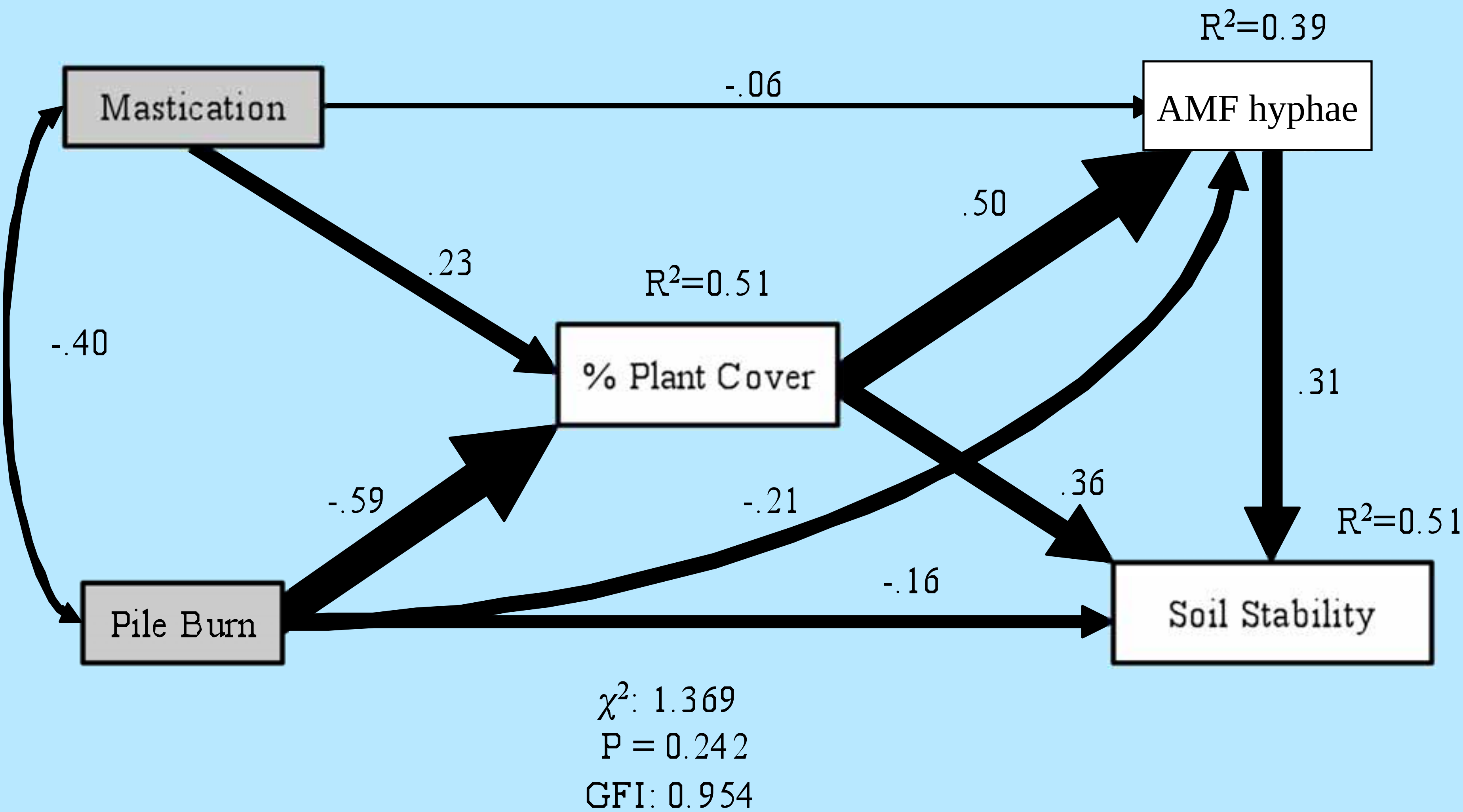
↑ Plant cover
Exotic plants
(cheatgrass)
[NH_4^+]

↓ Temp
AMF Richness

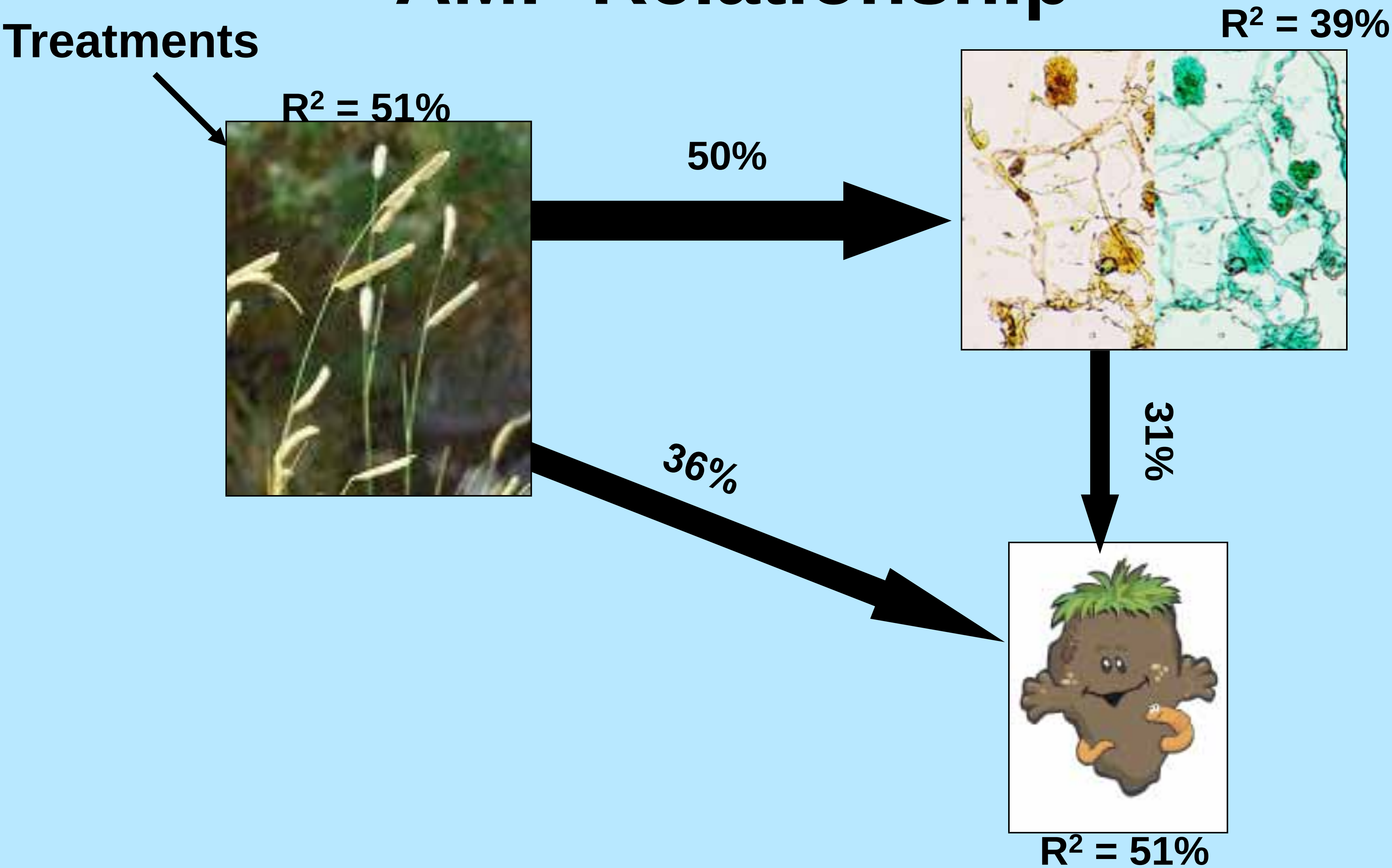
How do Soil, AMF and Plants Interact?



SEM: Soil-Plant-AMF relationship



SEM Results: Plant, Soil and AMF Relationship



Pile Burning Creates Long-Lasting Disturbance

- **Soil Erosion**
  - **Exposed mineral soil and low soil stability**
- **Nutrient leaching**
  - **High [available nutrients] & low plant cover and moisture**
- **Loss of Native species (both plants and AMF)**

Mechanical Mastication

- <u>Short term:</u> Only difference - ↑ soil moisture and ↓ soil temp.

- <u>2.5 years later:</u> Main concern is loss of AMF species and more cheatgrass over time
  - (combination of disturbance, neighboring seed source and high soil moisture?)

Ecological & Management Implications

Mastication creates fewer disturbances (in the short term); Long-term?

Pile burns – may reduce functionality

Treat in only high-priority areas and continue monitoring for exotic species

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