Plant-microbe interactions affect biomass production of *Spartina pectinata*, a potential bioenergy crop

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Introduction:

Fig. 1: Arbuscular mycorrhizal symbiosis of *S. pectinata* colonization with *Rhizophagus irregularis*. Shown are fungal hyphae and spores.

Arbuscular mycorrhizal (AM) fungi are obligate biotrophs that:

- Form mutualistic interactions with 65-80% of all terrestrial plants (Fig. 1);
- Help in nutrient uptake of P, N, Mg, S (Newsham et al., 1995);
- Provide resistance against biotic (pathogens) and abiotic (heavy metals, salinity, etc.) stresses; and
- Can serve as potential biofertlizers.

We studied the potential of AM fungi to increase the biomass production of *Spartina pectinata* (prairie cordgrass) because this potential bioenergy crop:

- Has a wide distribution across the U.S. (Fig. 2);
- Produces large biomass yields on marginal lands (Boe et al., 2009);
- Provides a habitat for wildlife;
- Assists in CO_2 sequestration (Boe et al., 2009); and
- Helps with erosion control and wetland restoration (4).

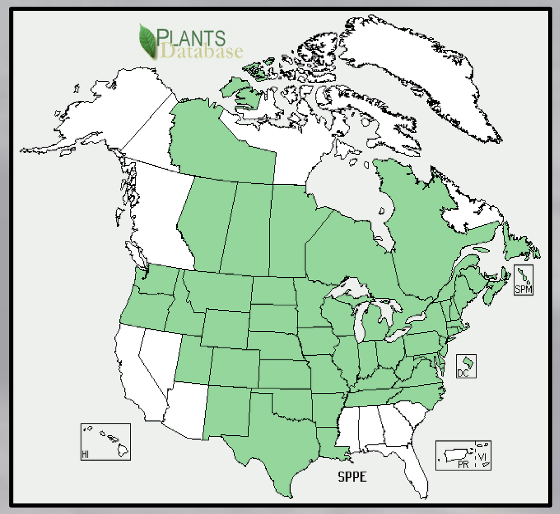

Fig. 2: Distribution of prairie cordgrass across the United States (USDA, 2012)

Materials and Methods:

- Seven genetically distinct prairie cordgrass genotypes collected from around the Northern Great Plains were transplanted into pots and grown under standard greenhouse conditions.
- Half of the plants were inoculated with spores from *R. irregularis* and the other half remained non-mycorrhizal.
- Plants were potted with a mixture of 70% sand, 20% organic soil, and 10% perlite and every 5-6 weeks the plants were fertilized with their respective nutrient solution.
- We varied the P and N supply conditions by adding a modified fertilizer solution containing no P or N (0P/0N), P but no N (100P/0N), N but no P (0P/100N), or P and N (100P/100N), and other nutrients commonly found in marginal lands (Fig. 3).
- The plants were harvested after one year and we analyzed the number of tillers, fresh shoot and root biomass, dried root and shoot biomass, mycorrhizal colonization rate (McGonigle et al., 1990), and P content (Fellbaum et al., 2014).

Chemical	Concentration (mM)
NH_4NO_3	*1.000*
KH_2PO_4	*0.050*
KCl	0.617
$CaCl_2 \cdot 2H_2O$	1.000
Fe-EDTA	0.015
$MgSO_4 \cdot 7H_2O$	0.625
$MnCl_2 \cdot 4H_2O$	0.003
H_3BO_3	0.016
Zn-EDTA	0.000113
$CuCl_2 \cdot 2H_2O$	0.000372
$Na_2MoO_4 \cdot 2H_2O$	$3.4 \cdot 10^{-5}$

Fig. 3: Nutrient supply conditions added to plant systems. Only the nitrogen and phosphorus concentrations were varied.

Results:

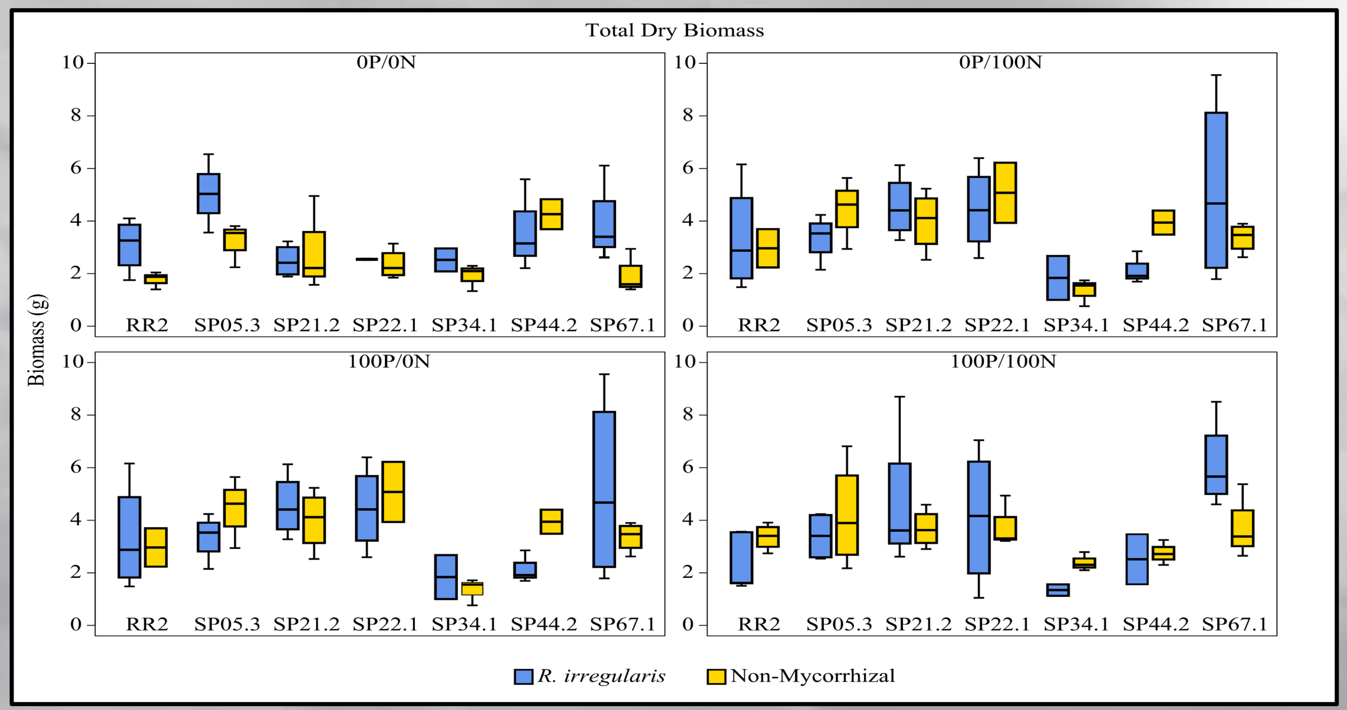

Fig. 4: Total plant dry mass of mycorrhizal (blue bars) and non-mycorrhizal (yellow bars) plants of seven prairie cordgrass genotypes after growth under different nutrient supply conditions. Shown are boxplots with median and range of the data.

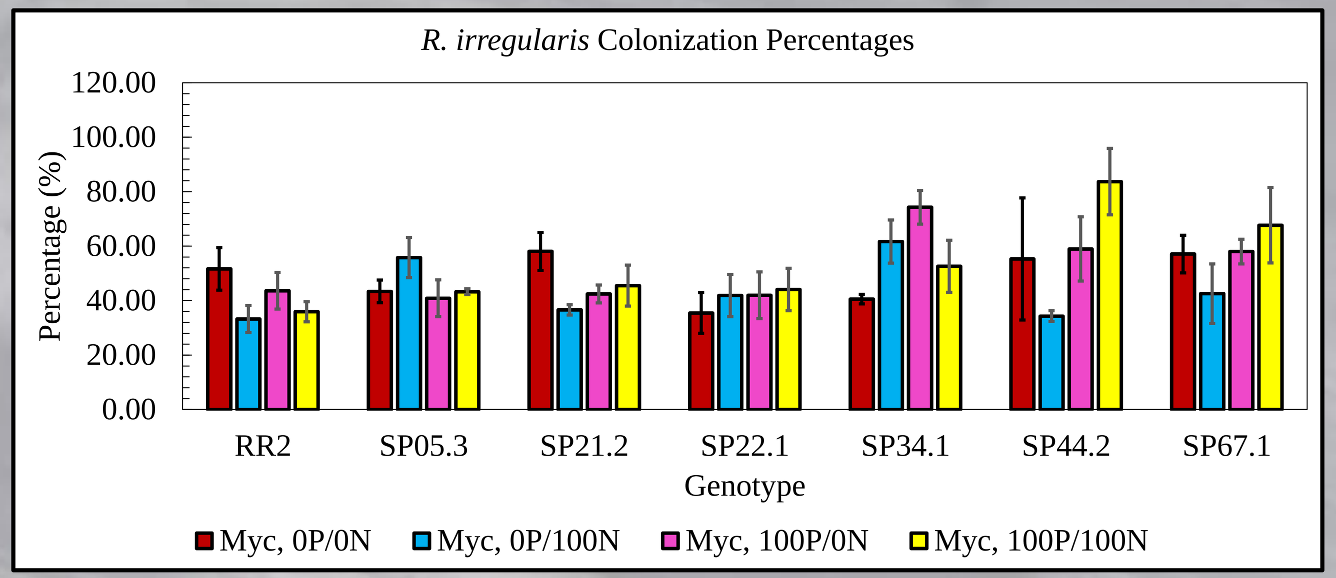

Fig. 5: Mycorrhizal colonization rates of *R. irregularis* in the seven prairie cordgrass genotypes grown under different nutrient supply conditions.

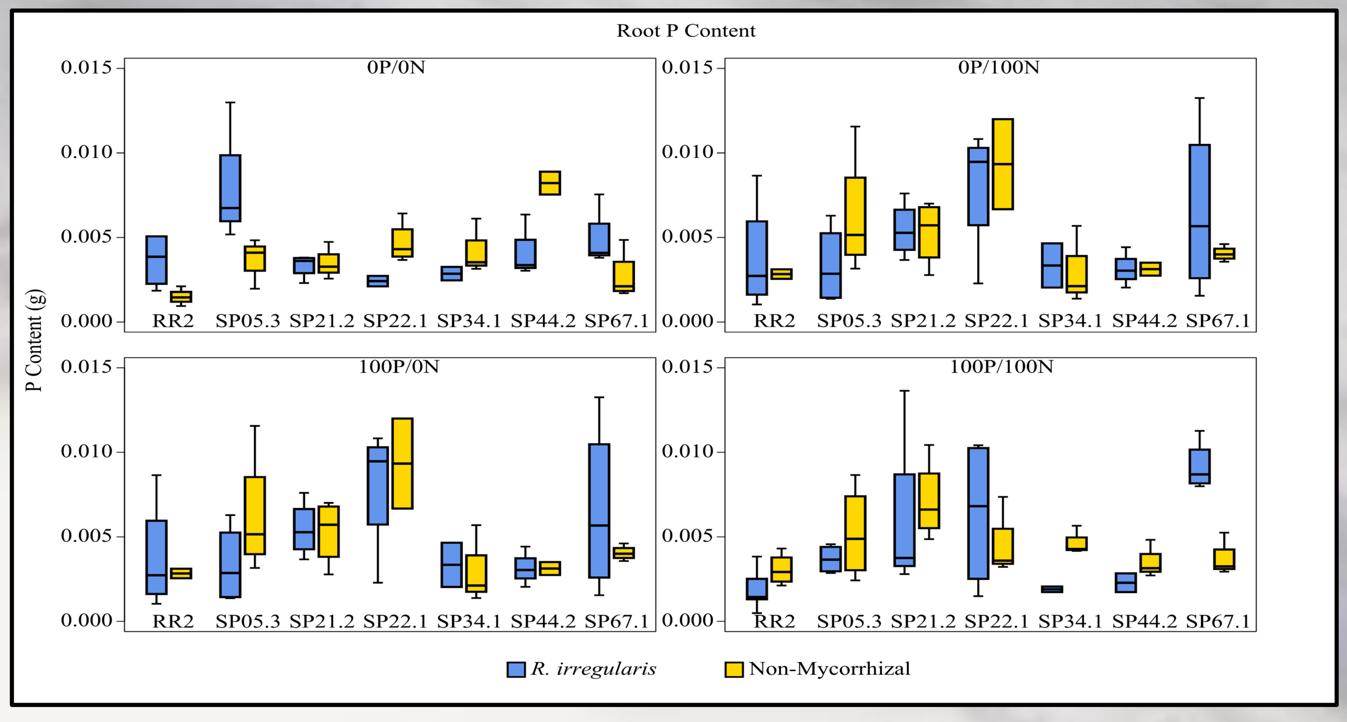

Fig. 6: Root P contents of mycorrhizal and non-mycorrhizal plants of all seven prairie cordgrass genotypes under different nutrient supply conditions

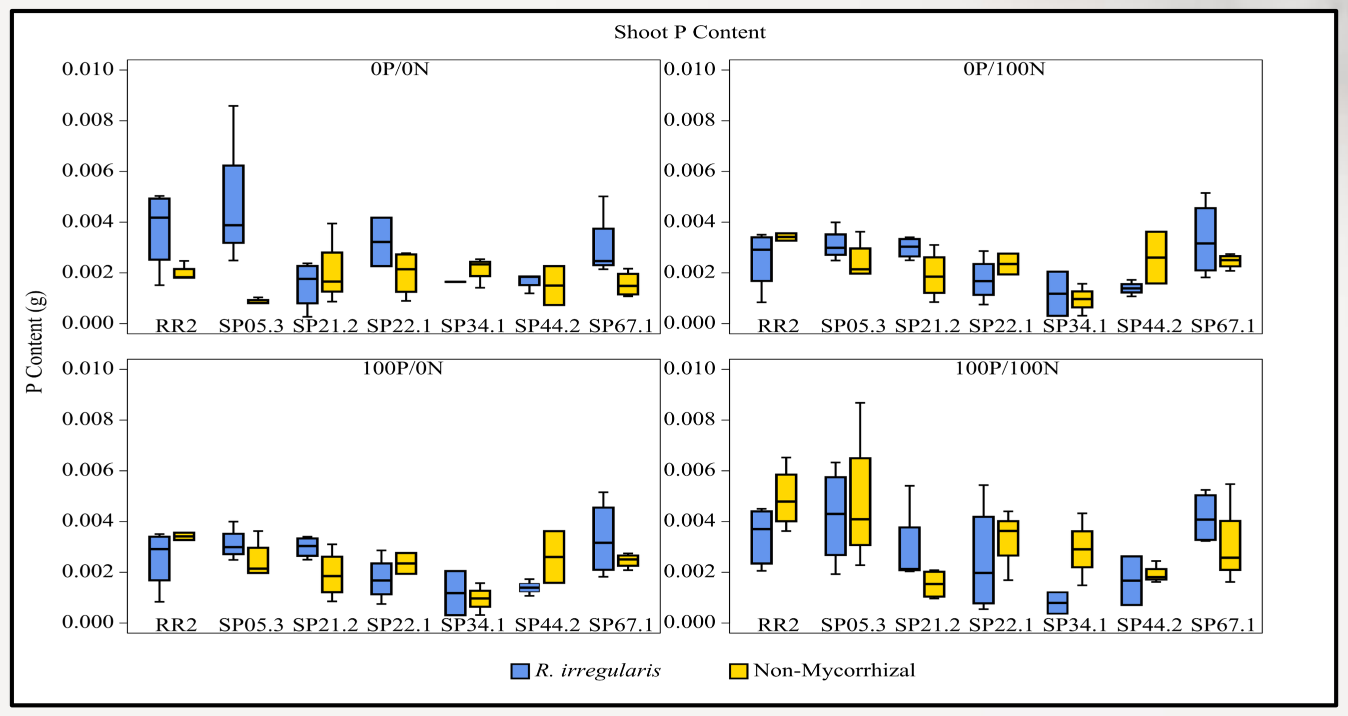

Figure 7: Shoot P contents of mycorrhizal and non-mycorrhizal plants of all seven prairie cordgrass genotypes under different nutrient supply conditions

Results Continued:

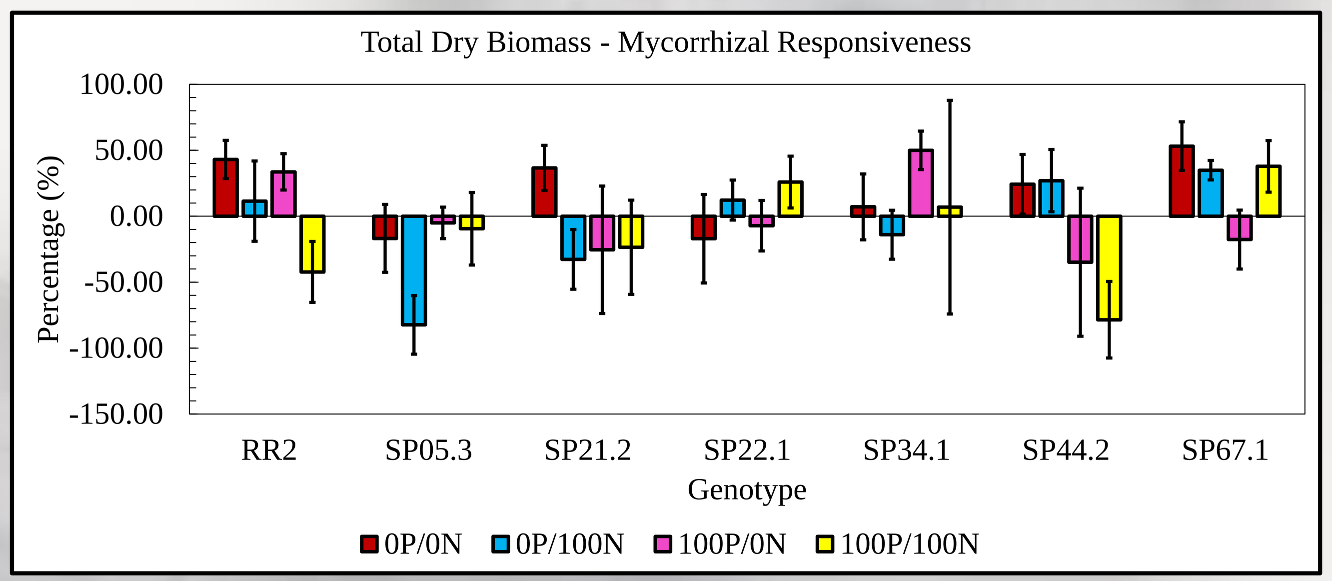

Fig. 8: Mycorrhizal responsiveness the prairie cordgrass genotypes in terms of total biomass under different nutrient supply conditions.

Conclusions:

- Though the genotypes differ widely in the amount of biomass they produce under different nutrient conditions, mycorrhizal plants of RR2, SP21.2, and SP 67.1 form the highest biomass under low nutrient (0P/0N) conditions (Fig. 4).
- The AM colonization rates of all genotypes were relatively high (Fig. 5) and the genotypes RR2, SP21.2, and SP67.1 showed the highest growth impact under 0P/0N conditions. Other genotypes such as SP44.2 had very high colonization rates but did not significantly benefit from the colonization in overall biomass production.
- Both the shoot and the root content of phosphorous varied (Fig. 6 and Fig. 7) but plants such as the mycorrhizal inoculated RR2 in 0P/0N had higher phosphorous contents within the shoots and the roots than its non-mycorrhizal counterparts.
- In most of the genotypes the mycorrhizal responsiveness (Fig. 8) was higher in the inoculated plant systems compared to that of the non-inoculated (Non-Mycorrhizal counterparts) showing that some genotypes have greater growth responses with AM colonization.
- Future work will include taking height, biomass, and AM colonization rate data in native Prairie Cordgrass field plots where mycorrhizal growth is suppressed by using Topsin M, a newly emerged fungicide for these types of experiments. Also identifying community composition within these plots using denaturing gradient gel electrophoresis (DGGE) methodologies.

References:

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