



# The Effect of Root Architecture on Phosphorus Uptake in Alfalfa (*Medicago sativa*)



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## Introduction

- Previous research has selected alfalfa (*Medicago sativa*) for high fibrous (HF; UMN3979) and low fibrous (LF; UMN3980) root structures, but cultivars have not been tested in the field for differences in nutrient uptake potential
- Forage yields and P uptake in pure alfalfa stands and in alfalfa grass mixtures were compared in soils with and without added P
- Can plant selections based on root system architecture increase soil P availability to alfalfa?

## Project Details

- This project is part of the University of Minnesota (UMN) Undergraduate Research Opportunities Program (UROP)
- It is being completed in conjunction with the United States Department of Agriculture- Agriculture Research Service (USDA- ARS)

## Methods

- Experiment established at the UMN Southern Research and Outreach Center in Waseca, MN in 2010 and sampled in 2011
- Cultivars grown in pure stands and in grass mixtures (combination of reed canary and orchard grass) in plots with and without added P
- Randomized complete block design (6 reps)
- Sampled total yields and alfalfa and grass composition at 3 harvests
- Determined P concentration in plant tissue (dry ash combustion) to calculate annual P uptake in alfalfa and grass as a weighted average over 3 harvests



**Picture 1: Cycle 2 root structures**  
Alfalfa plants were hand selected based on displaying either highly fibrous or low fibrous root structures over three cycles



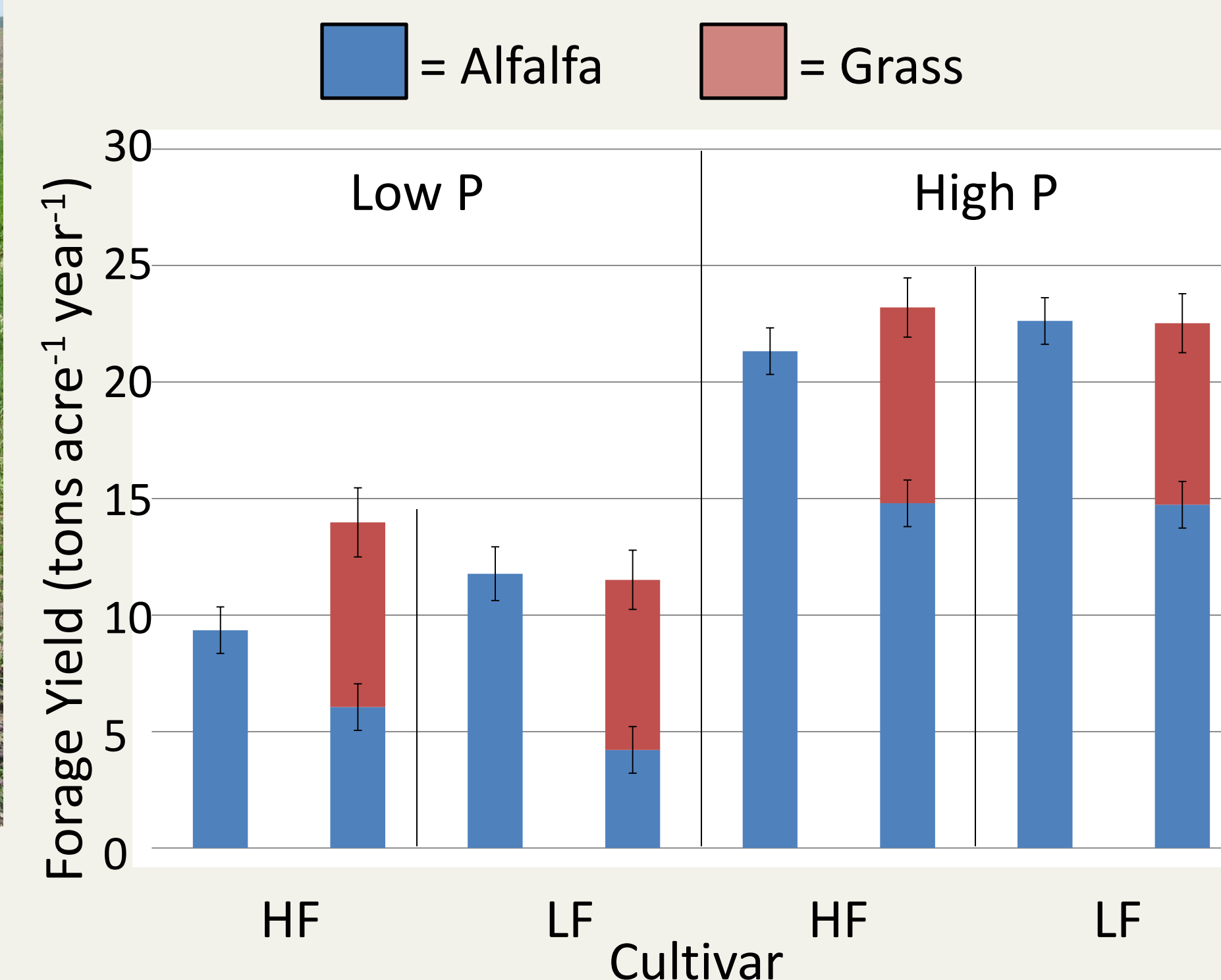
**Picture 2: Plots at Waseca**  
Phosphorus was added before planting, then plots were established and additional P applied in the spring of 2011



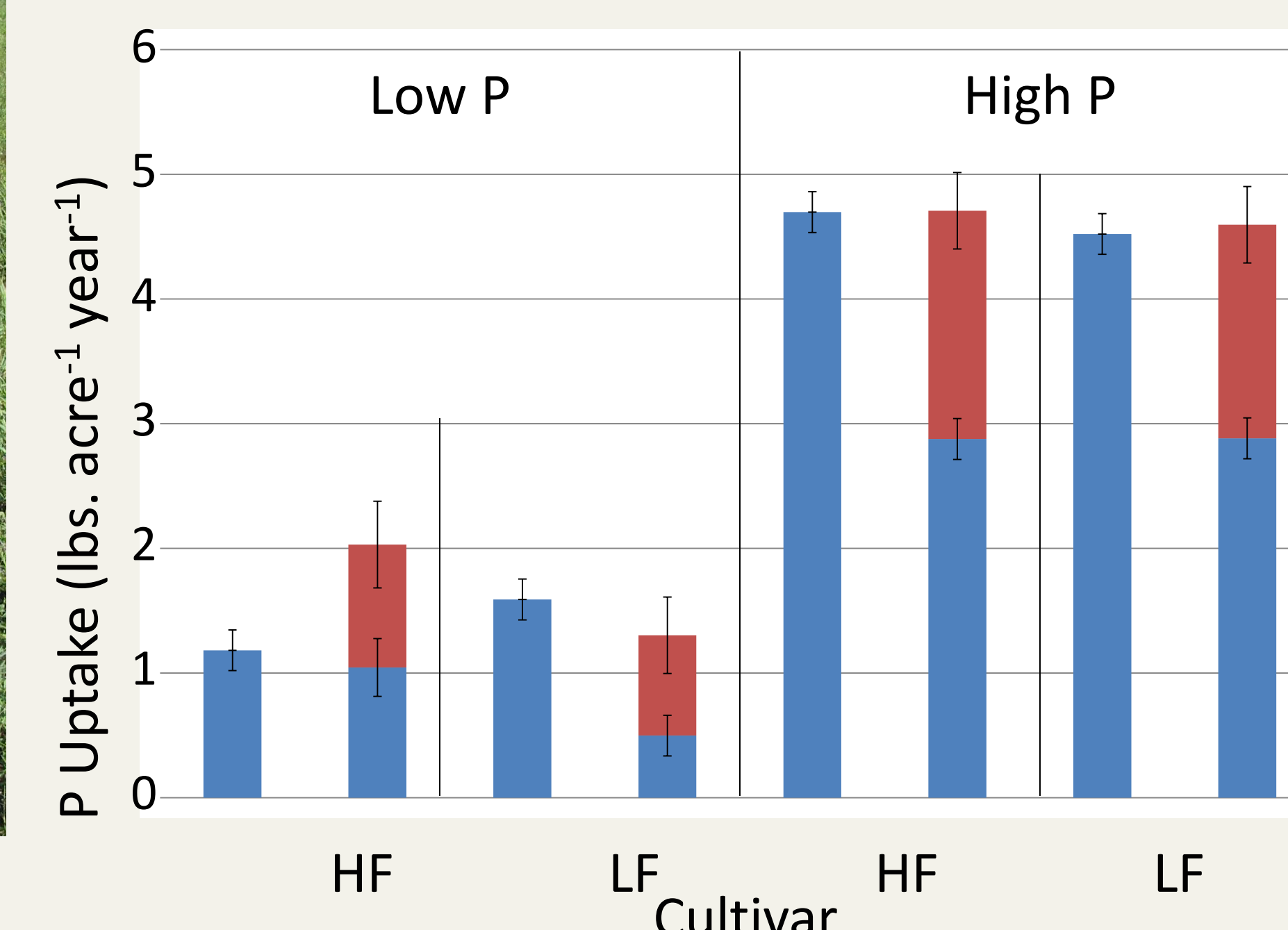
**Picture 3: Field Harvesting at Waseca**  
Plots were sampled for grass and alfalfa composition and cut mechanically for total forage yield

TRT	Cult	Alfalfa	Grass
0	HF	0.16	--
0		0.17	0.16
0	LF	0.17	--
0		0.14	0.14
P	HF	0.28	--
P		0.25	0.27
P	LF	0.25	--
P		0.25	0.27

**Table 1: Percent P in Plant Tissue**



**Figure 1: Yield comparison among root structure, P treatment, and mixture**



**Figure 2: P uptake comparison among root structure, P treatment, and mixture**

## Results

- Reduced yield and P uptake and concentration were seen in all stands and cultivars in low P plots as compared to the high P plots
- In pure stands, LF yields were greater than HF when averaged across P treatment
- Alfalfa yield and P uptake generally decreased when mixed with grass under low and high P (with the exception of P uptake under low P conditions with HF roots)
- In low P soils, total yield and P uptake of mixed stands was highest with HF root structure

## Conclusions

- Added P maximized yield for all cultivars and there was no yield benefit to having grass in the mixture in these soils
- When growing alfalfa in low P sites, using a HF cultivar and mixing the stand with grass may improve P availability and forage yield
- All conclusions are preliminary from one site and year of research

## Further Research

- The UMN Rosemount Research and Outreach facility is also being utilized to study the effect of root structure on P uptake in alfalfa. Research will continue in 2012
- Further research is examining mycorrhizae through an analysis of nucleotide differentiation of fungi present on the roots; Results will be compared with plant P concentration, P uptake, and yield to evaluate the correlation between P acquisition and mycorrhizal abundance and diversity