Corn Response to Conventional versus Alternative Phosphorus Fertilizer Sources in Five Different Soils

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INTRODUCTION

Increased demand for meat, milk and eggs has lead to intensification of livestock production systems in the US. These systems generate large amounts of manure rich in essential nutrient (WSDA, 2011). To mitigate excessive storage and odors, manures in these systems are typically processed through composting and anaerobic digestion (AD). The product of these two manure handling strategies contain appreciable amounts of phosphorus (P) that can be be recycled into crop production. Efficient re-use of these processed manures will not only reduce environmental pollution, such as eutrophication, but will also reduce our sole reliance on mineral P fertilizer which is obtained and refined from mined phosphate rock. Phosphate rock is a non-renewable resource, whose reserves are projected to only last for the next 50-100 years (Cordell et al., 2009). However, for efficient re-use as P fertilizer, P availability to and the crop response need need to be evaluated.

OBJECTIVES

(1) To determine the effect of composted and AD manure application on corn growth and P utilization.

(2) To determine the effect of soil characteristics on P availability for corn

METHODOLOGY

A corn pot study consisting of 25 treatments replicated 5 times in a randomized complete block design was conducted in WSU-IAREC at Prosser, WA (lat. 46°15'36"N; long. 119°43'12"W). Treatments included 5 soils (Table 1), 4 fertilizers (Table 2) and a non fertilized control. Soils were sieved through 2 mm sieve and transferred into plastic pots and fertilizers treatments applied at rates shown in Table 3.

Table 1: pH, organic matter (OM) , clay and sand content of test soils

Soil type	pH	OM %	Clay %	Sand %	P mg kg^{-1}
Houston Black	7.9	3.0	32.3	45.5	11.0
Skagit silt loam	6.1	3.7	17.7	38.3	18.0
Palouse silt loam	6.2	1.8	16.0	47.1	18.0
Warden silt loam	8.0	0.9	5.2	72.1	8.0
Quincy sand	7.4	0.4	2.7	91.7	6.0
Method	1:1 in water	Dry combustion	hydrometer		Olsen
Reference	McLean (1982)	Schulte and Hopkins (1996)	Gee and Bauder (1979)		Olsen and Sommer (1982)

5 Soils

Table 2: N, P and K contents of the four fertilizers used

Fertilizer type	N (%)	P (%)	K (%)
AD dairy manure	3.2	1.0	1.3
Composted chicken manure	3.0	2.0	2.0
Vegetable compost	1.9	1.0	1.3
MAP	11.0	22.0	0.0

4 Fertilizers

Table 3: Application rate based on soil P test

Soil type	P fertilizer Rate (kg/ha)
Skagit silt loam	9
Palouse silt loam	9
Quincy sand	81
Warden silt loam	63
Houston black	36

Sampling and data collected

- Pots were destructively sampled every 2 weeks beginning 2 weeks after emergence for a total of 18 weeks (9 sample times).
- Variables measured were: Shoot dry biomass, root dry biomass, shoot P concentration and root P concentration.
- Soil samples were also collected at each sampling date and analyzed for Olsen P (data not given).
- At 3rd, 6th and 9th sampling date, soil were also analyzed for inorganic P fractions (data not given)

RESULTS

Effect on shoot and root dry biomass

- Fertilizer treatments had little to no relationship ($P > 0.05$) to plant biomass (Fig.1).
- Early growth showed shoot and root biomass differences ($P \leq 0.05$) with soil type (Fig. 2)
- By the end of the experiment shoot and root biomass was lower in Houston Black than all other soils ($P \leq 0.05$)

View of the experiment in summer 2015

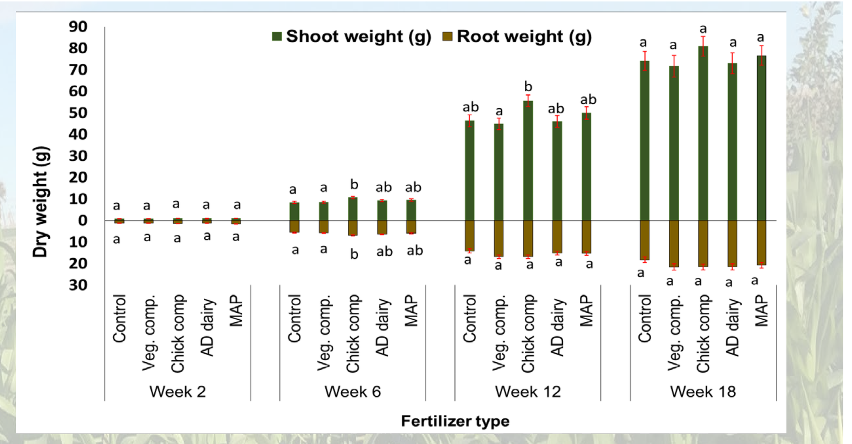

Fig. 1: Shoot and root dry biomass for the four P fertilizer sources and a control for selected sampling intervals

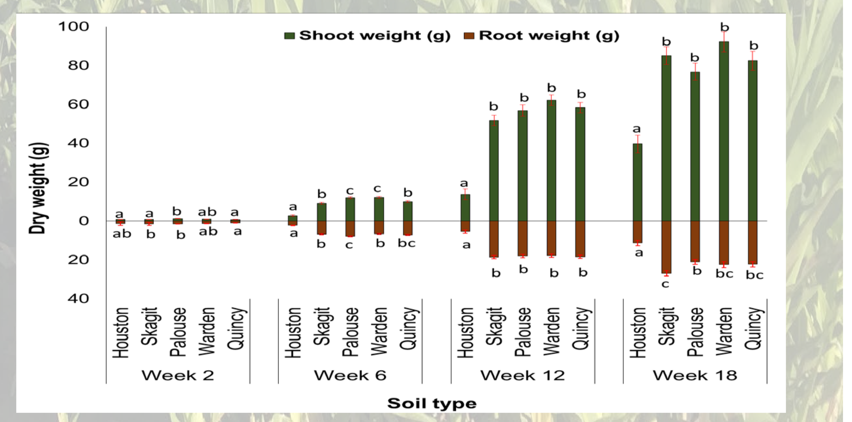

Fig. 2: Shoot and root dry biomass for the five soil types for selected sampling intervals

Effect on shoot and root P concentration

- Corn P concentration across treatments were the highest during week 2 sampling.
- P concentration decreased after week 2, showing P dilution with plant growth (Fig. 3 and 4).
- If there was a difference in root or shoot P concentration, it was highest ($P \leq 0.05$) with MAP (Fig. 3).
- Soil type effect on shoot and root P concentration differed for each sampling time and therefore there was no clear trend on which soil type was better at allowing corn to accumulate P relative to others (Fig. 4).

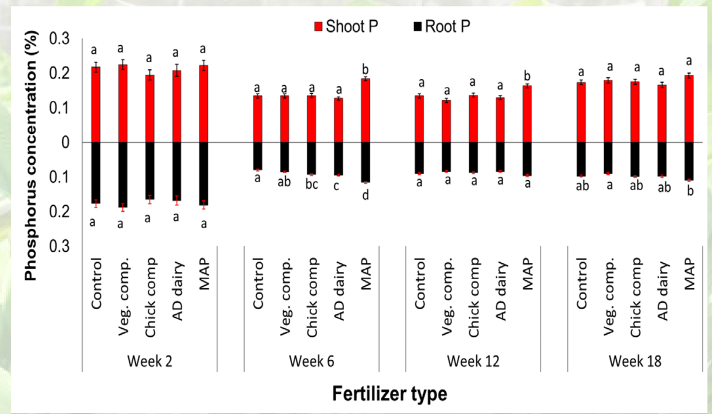

Fig. 3: Shoots and roots P concentration for the four P fertilizer sources and a control for selected sampling intervals

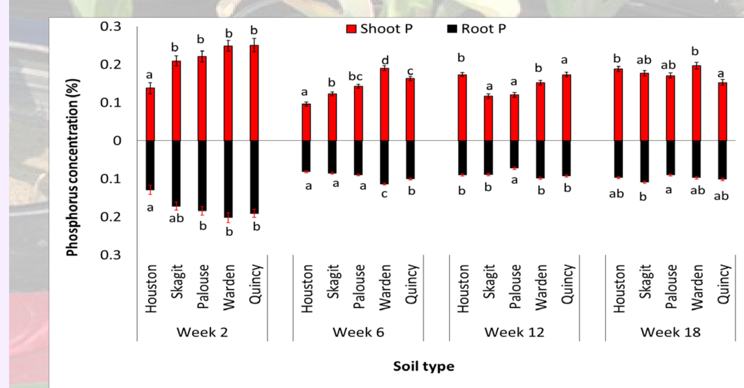

Fig. 4: Shoots and roots P concentration for the five soil types for selected sampling intervals

CONCLUSIONS

- Study results suggests that dry matter response of corn to the application of composted chicken manure and AD manure does not significantly differ from the response obtained when using MAP.
- Shoot and root P concentration was significantly higher when using MAP, particularly during the mid season (week 6 and 12).

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