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Initial Soil Nutrient Trends of Polyculture in Long Term Rotation

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Abstract

This poster reports on an initial trend relating to the use of polycultures and soil fertility. Soil nitrate and phosphorous levels have been monitored in the long term rotations study located at Swift Current where, for the last two years, a 12 species mix (triticale, barley, oats, corn, sorghum, German millet, hairy vetch, field pea, forage pea, forage radish, purple top turnip and kale) has been included in the rotation.

Introduction

Intercropping or mixed cropping or polycultures, is a traditional cropping system still in existence today in developing countries. The modern benefits of mixed cropping potentially include: higher productivity, less reliance on chemical inputs (fertilizers and pesticides), improved soil health, conservation and biodiversity as well as better land use efficiency[1,2]. Here at SPARC (Semiarid Prairie Agricultural Research Centre) we are interested in the use of polycultures for forage production along with reported benefits of pest control (weeds, insects) and improved soil health. In 2012, a 12 species polyculture was included as part of the "old rotations" study with the primary goal being a long term study looking at effects of the seeded mix on soil nutrients. This poster shows preliminary data on the flux in two soil nutrients (nitrates and phosphates) and speculates on long term trends for the polyculture plots over time.

Objective

To determine under semiarid conditions if a polyculture will provide benefits for use within a rotation.

Materials and Methods

In 2012 the polyculture treatment plots were placed within the ongoing 65 year old rotation study at SPARC located in Swift Current, Saskatchewan. Prior rotations for these plots were: summer fallow 2011, wheat 2010, alfalfa/grass (dahurian wild rye) mix 2006 – 2009 (terminated in the fall of 2009) and wheat in all years prior to 2006. Plant species for the polyculture rotation were selected from four functional groupings: a) cool season grasses (triticale, barley, oats), b) warm season grasses (corn, sorghum, German millet), c) legumes (hairy vetch, field pea, forage pea), and d) root crops (forage radish, purple top turnip, kale). The plots were seeded with a Flexi-Coil air drill with 9 inch row spacing. Since the air drill has three tanks, a fine, medium and coarse mix of seed was created and each mix placed in separate tanks. Flow was re-routed so all seed went down the bottom chute of the opener. The targeted seeding rates were 49.9 kg/ha for the coarse mix (corn and peas), the medium mix was set at

15.9kg/ha (cereal grains) and the fine mix was set a 9.4 kg/ha (remaining seed). This mix represents a seeding ratio of 1:1:1:1:1:1:1:1:1:1:1:1. Seeding took place in early June each year (seeding dates June 7, 2012 and June 12, 2013). The legumes were not inoculated and no fertilizer was applied to the plots. Plots were swathed in mid - September to 15 cm from ground, baled and bales removed. Harvest timing is targeted for when cereals are in soft dough stage in order to maximize digestibility and minimize seed shatter. Soil samples were obtained prior to seeding in the spring and after harvest in the fall for a period of 8 years prior to and including 2013 for both soil phosphorous and nitrate. Soil depths were: a) depth 1 (0-15 cm), b) depth 2 (15-30 cm), c) depth 3 (30-60 cm), d) depth 4 (60-90 cm), e) depth 5 (90-120 cm). The same plots will be re-seeded to the same mix in 2014 growing season.

Initial Observations

Figure 1. Soil phosphorous estimations of the same plots over time; plot averages from three soil samples/plot

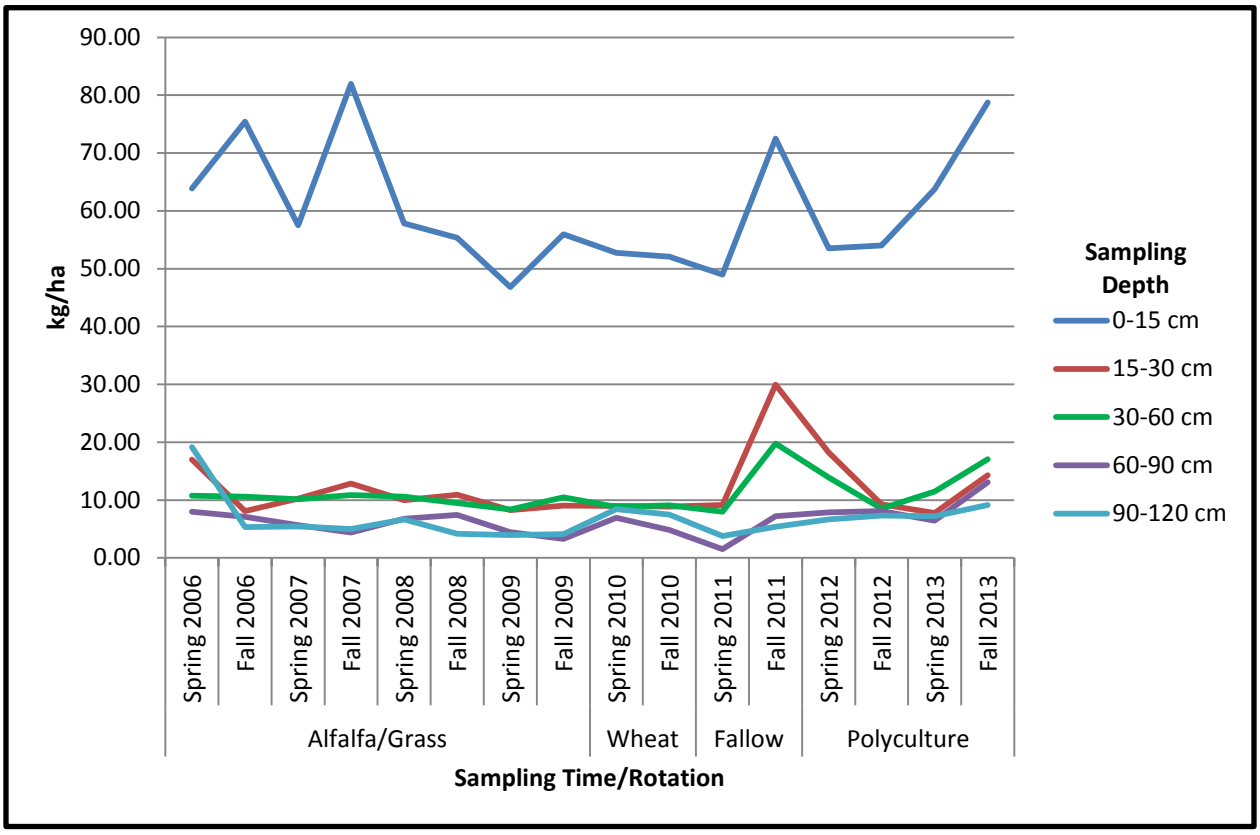
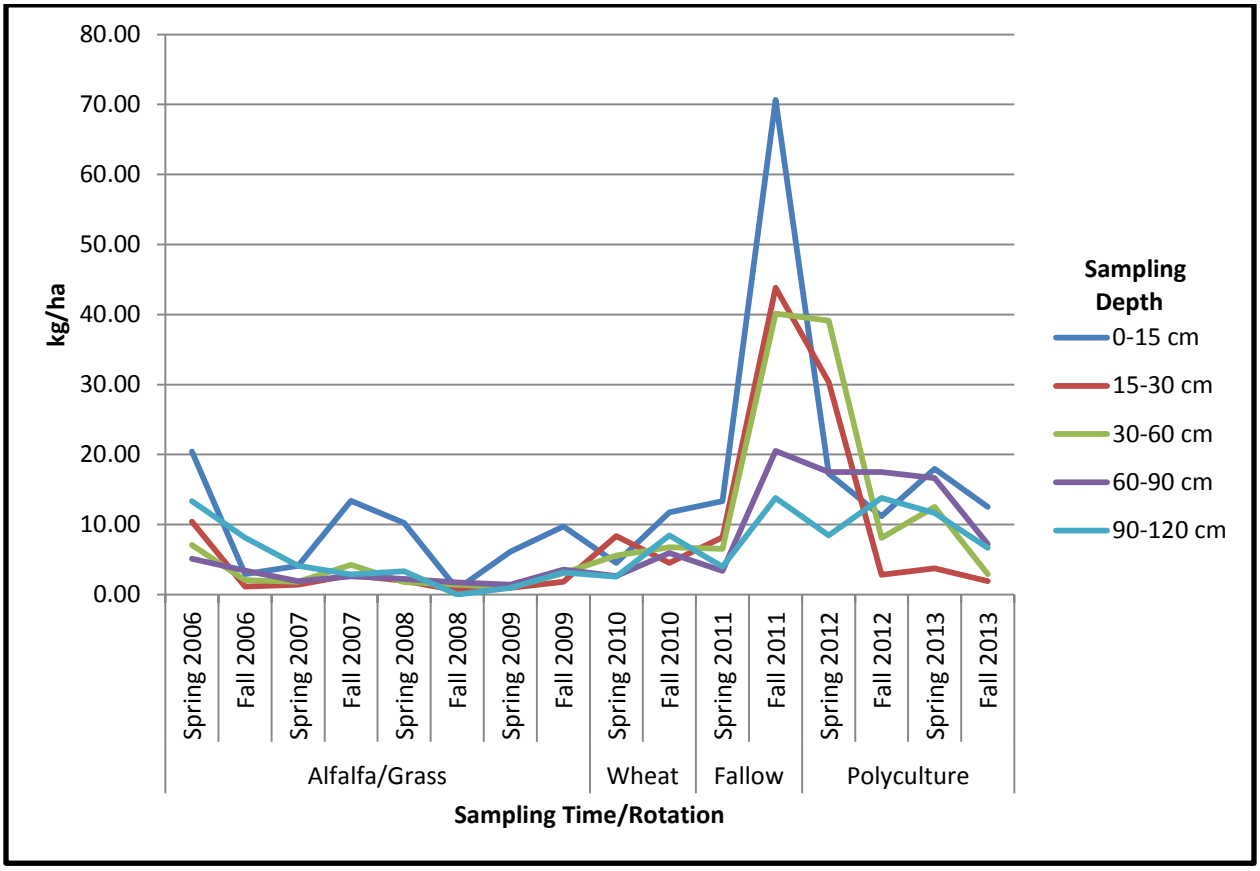


Figure 2. Soil nitrate estimations of same plots over time; plot averages from three soil samples/plot



Observations and Trends:

Soil Phosphorous:

Soil Phosphorous levels at depths measured past 15 cm (depths 2-5) are generally stable across time and across sampling periods.

There is a general decline across time in phosphorous levels at depth 1 (0-15 cm) from 2006 to spring 2011.

Changes in soil phosphorous levels are seen in 0-15 cm (depth 1) samples from spring 2012 to fall 2013 where levels trend higher. Fall phosphorous levels show a significant drop from 2011 – 2012 (due to change in rotation) with a sharp recovery in fall 2013. The greatest increase in phosphorous levels appears to be in the 0-15 cm soil layer (depth 1) for the polyculture rotation, although all soil depths are trending higher.

Soil Nitrate:

Soil nitrate levels are similar across depths 2 – 5 (15-120 cm) from 2006 until 2011 where a change in rotation to summerfallow causes levels to surge in the fall at all sampling depths. A drop in soil nitrate

levels between spring and fall 2012 at depths 2 (15-30 cm) and 3 (30-60 cm) indicates large nitrogen usage by the polyculture crop.

Fall 2012 to spring 2013 some nitrate is returned to the soil at certain sampling depthsA trend appears towards a net deficit in soil nitrate use in 2013 which can only be confirmed once the 2014 spring results are obtained.

Little soil nitrate remains based on 2013 fall sampling results.

Implications

More data is necessary to make any solid conclusions about the role of polycultures and soil nutrition, however, a few early trends appear:

• The data suggests the polyculture mix is contributing to a net balance of phosphate; possibly due to the decay of root crops and other plant material not removed after baling in the fall

• Nitrogen is being depleted faster than legumes are able to replace either due to the mix of high nitrogen using plants and/or to a lack of inoculation of legumes.

Additional Research

In the future, it would be interesting to find out if nitrate levels would increase if either: a) legumes were inoculated or b) if the mixture were to change in species number and/or functional group. This is currently being examined at SPARC by the Schellenberg research group. Grazing and grazing timing would be expected to impact relative abundance of species and their contributions to the system but has not been investigated at this time.

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References

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2. Malézieux, E., Crozat Y., Dupraz, C., Laurans, M., Makowski, D., Ozier-Lafontaine, B., Rapidel, S., de Tourdonnet, Valantin-Morison, M. (2009) Agronomy for Sustainable Development 29(1): 43-62.

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