



Closing the Alfalfa Yield Gap while Improving Soil Fertility and Health

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BACKGROUND & OBJECTIVES

- Alfalfa is an important forage in the US, providing high nutritive value to animals, and ecosystem services.
- There is a yield gap of two- to threefold between average and top-tier producers.
- Understanding better management practices and farm differences can revive alfalfa production and its efficiency.
- Alfalfa in crop rotations can improve soil health, potentially increasing productivity as well.

Objectives:

Identify management practices on-farm that increase alfalfa yields, based on farmers' surveys.

Conduct a soil health study on-farm, gather forage yield, and quality data.

Construct statistical models to identify relationships between soil health indicators, management practices, and alfalfa productivity indicators.

Communicate results describing how soil health indicators and management practices impact alfalfa forage yields and quality, and how better soil management can close alfalfa yield gaps.

METHODOLOGY

- Farmer's survey for alfalfa yields and management practices.
- Forage samples for nutritional value.
- Soil samples collection to a depth of 30 cm.
- Key soil health indicators:
 - fertility and chemical indicators (P, K, S, Ca, Mg, Fe, Mn, Zn, pH)
 - physical parameters (bulk density, and aggregate stability)
 - biological factors (PLFA: microbial community structure, and diversity, POX-C, and SOM)

RESULTS – YIELD & MANAGEMENT PRACTICES

- Higher yields:
 - second year stands (**Figure 1**)
 - positive association with number of cuts, tillage, and manure application, K and S in the first year (**Table 1**)

Figure 1. Distribution of yield (ton/ac) in relation to stand age.

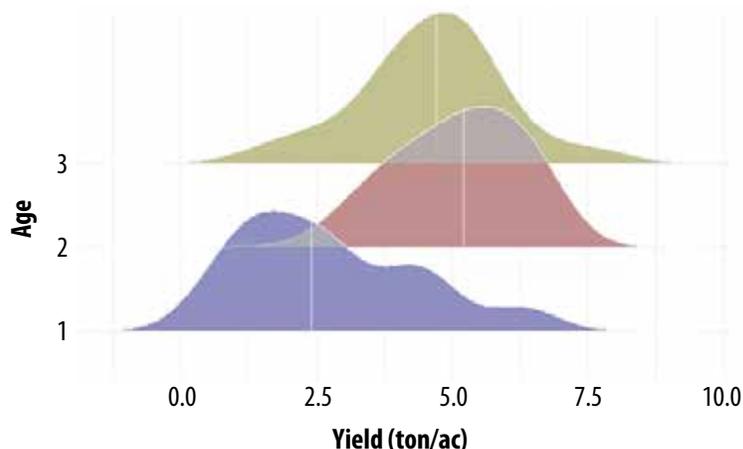


Table 1. Frequency (%) of fields in each management practice associated with yield group.

		Low yield (n=21; <3.5 ton/ac)	Medium yield (n=23; 3.5 to 4.4 ton/ac)	High yield (n=22; >4.4 ton/ac)
Cuts	1	25	13	0
	2	25	13	2
	3	25	31	13
	4	25	38	80
	5	0	6	4
Tillage	No	0	6	13
	Vertical	75	56	47
	Conventional	25	38	40
Manure 1st year	No	100	63	69
	Yes	0	38	31
K 1st year	No	75	63	64
	Yes	25	38	36
S 1st year	No	75	69	71
	Yes	25	31	29

RESULTS – SOIL HEALTH

- Strong positive association between carbon pools of soil (SOM, POX-C) (Figure 2).
- Positive correlation between SOM and several macronutrients important for alfalfa growth (N, Mg, K, Ca, and S), clay content, CEC, and pH.
- POX-C positively associated with Na, K, and N, tended to be associated with pH and Mg and negatively correlated with BD.
- Total Bacteria and Fungi Biomass, Actinomycetes Biomass, Gram (-) and Gram (+), tended to be positively associated with SOM (Figure 3).
- POX-C presented negative correlation with PLFA (Figure 3).

Figure 2. Relationship between soil carbon pools (POX-C and OM).

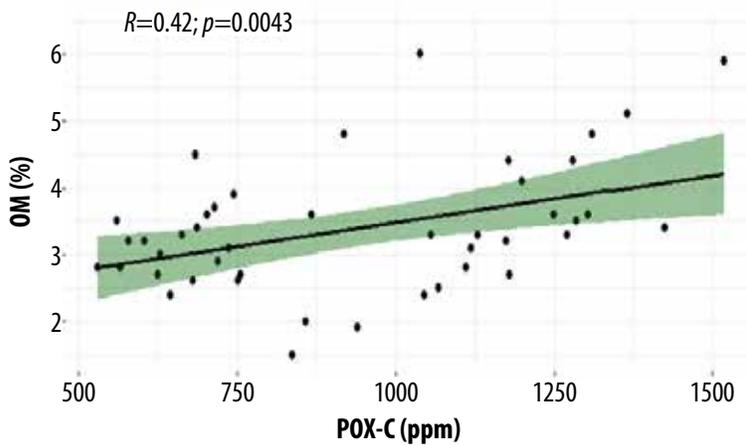
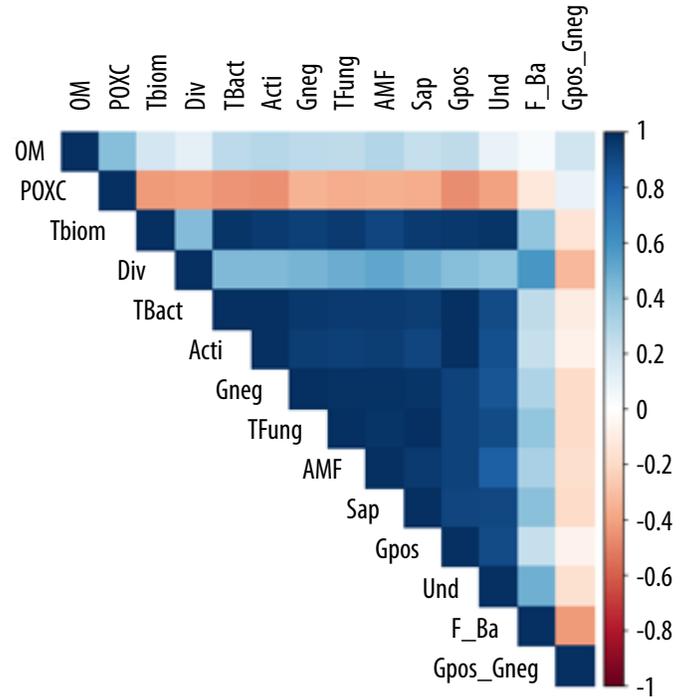


Figure 3. Correlation matrix between carbon pools of the soil (POX-C and OM) and PLFA components across 44 fields in 2021 and 2022.



Values closer to 1 or -1 suggest high/significant correlations (OM = soil organic matter; Tbiom = total biomass; Div = diversity index; TBact = total bacteria biomass; Acti = actinomycetes biomass; Gneg = gram (-) biomass; TFung = total fungi biomass; Sap = saprophytes biomass; Gpos = gram (+) biomass; Und = undifferentiated biomass; F_Ba = fungi:bacteria ratio; Gpos_Gneg = gram (+):gram (-) ratio).

CONCLUSIONS

- Nutrient application, particularly K and S, in the establishment year is positively associated with greater alfalfa yields throughout the life of the stand.
- Soil results suggest a fertile and healthy soil condition characterized by balanced nutrient availability, active microbial communities, and positive interactions among soil components, indicating a favorable soil environment for alfalfa productivity.
- Further in-depth analysis is essential to ensure precise results that can be effectively communicated to the farming community.