Application and evaluation of a rapid nitrate-N test for soil solution under perennial peanut (*Arachis pintoi*) living mulch.

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INTRODUCTION

- Maintaining adequate levels of plant-available nitrogen is a historical concern in agricultural systems (1,2) and soil nitrogen may be increased biologically by using leguminous groundcovers.
- *Archais pintoi* (perennial peanut) is a common tropical legume used for forage, ornamental ground cover, and living mulches.
- Anecdotal evidence suggests that perennial peanut may increase the soil availability of nitrate and improve tree growth when used as a living mulch.
- Lack of baseline information severely limits growers ability to optimize nutrient contribution of legume living mulches and reduce the application of off-farm inputs.
- Extensive testing with laboratory methods can be expensive and time consuming, therefore the validity of rapid test methodologies should be explored.

OBJECTIVES

- 1) Evaluate a commercial electrode-based meter for measuring soil solution nitrate-nitrogen concentrations under a perennial peanut living mulch in two mixed orchard systems in Hawaii.
- 2) Determine the influence of soil type on measurement accuracy and precision.

Figure 1. Installation of lysimeters at the Poamoho field site. Lysimeters were installed to 30 cm and soil solution collected periodically

METHODS

- **Orchard Study:**
- Site 1, Poamoho orchard:
  - Certified organic with irrigated perennial peanut at various levels of establishment (1-3 years).
  - Soil Series: Oxisol, Wahiawa series.
  - Installation: 6 Lysimeters, 30 cm deep in high, medium, low canopy densities (Fig. 1).
- Site 2, Waimanalo orchard:
  - Integrated orchard with un-irrigated perennial peanut established over 15 year old peanut stands.
  - Soil Series: Lolekaa.
  - Installation: 18 Lysimeters, 15-30 cm deep at 6 different locations on the property.
- **Column Study:**
  - Ammonium-nitrate solutions leached at various strengths through columns.
  - 3 Agricultural soils (Wahiawa, Lolekaa, and Waialua series).
  - 3 replications.
  - Analyses by portable electrode-based meter and standard laboratory colorimetric method.

RESULTS

Orchard Study:

- Correlation between the methods completed on 79 field soil solution samples (**Figure 2**).
  - Site 1, Poamoho orchard 56 samples.
  - Site 2, Waimanalo orchard 23 samples.
- Correlation between Cardy Meter and standard laboratory method was high across soil types with a r^2=0.92 for all field samples.
- However, correlation strength between methods differed by location.
- Site 1, Poamoho - Wahiawa r^2=0.929.
  - Nitrate-nitrogen values by Cardy meter were consistently under reported in 75% of the samples.
- Site 2, Waimanalo – Lolekaa r^2= 0.573.
  - Overestimates in nitrate-N values by Cardy meter were attributed to higher chloride concentration in the soil solution (data not shown).
  - Chloride concentrations were 10-15 times greater than nitrate-nitrogen concentrations.

Column Study:

- Leachate recovered from soil columns, methods were correlated but there were differences in precision (r2) and accuracy (slope) among the soil types (Figure 3, Table 1).

Figure 2. Relationship between nitrate-nitrogen concentrations analyzed by the rapid ion selective electrode in the Cardy meter and by colorimetric technique performed by the ADSC lab for field soil solutions collected in two different soil series (n=79).

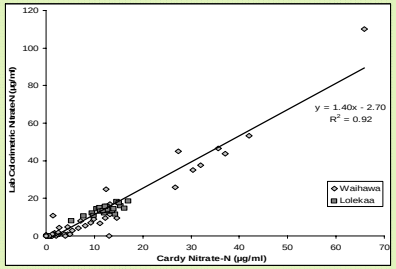

Table 1. Characteristics of soil series used in study.

Soil Series	Soil Order	Soil Classification	Textural Class	Mineralogy	Soil pH	Potential N mineralization
Wahiawa	Oxisol	Haplustox	Clay	Kaolinite	5.6-7.1	Low
Waialua	Mollisol	Haplustoll	Silty- Clay	Smectite/	6.4-6.7	Intermediate
				halloysite		
Lolekaa	Ultisol	Palehumults	Silty- Clay	Kaolinite	4.5-5.1	Intermediate

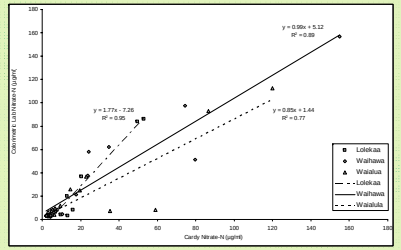

Figure 3. Relationship by soil type between nitrate-nitrogen concentrations analyzed by the Cardy meter colorimetric techniques collected from soil column study (Wahiawa n=17, Lolekaa n=14, Waialua n=12).

DISCUSSION AND CONCLUSIONS

- Cardy meter was successful in being able to rapidly determine nitrate levels in the soil solution under a perennial peanut living mulch as well as in controlled lab trials.
- Overall, strength of the correlation between the two methods suggests that rapid nitrate analysis by Cardy meter may be used for real time nitrate monitoring.
- Correlation between methods differed by soil type.
- We conclude that electrode based rapid methods for nitrate determination may be used to rapidly and accurately track soil solution nitrate levels within a single soil type.
- This method may not be appropriate in heterogeneous soils or to compare nitrate levels between locations with different soil types.

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