Estimating in-situ N mineralization rate with a buried bag method

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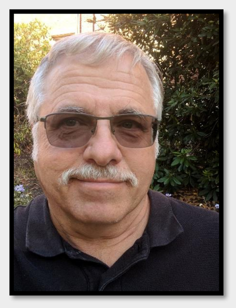


INTRODUCTION

Accurate estimates of soil nitrogen (N) mineralization rate and timing are needed for refining N management practices.

This paper describes a buried bag method that has been successfully included within agronomic field trials in the Pacific Northwest, USA.

The method has been around for a long time (Westermann and Crothers, 1980). We have found this method to be technically simple and reproducible, and less prone to adverse field events than other in-situ N mineralization methods.

This poster

1. Describes and illustrates the buried bag method
2. Shows two adaptations of the method used within southern Idaho and western Oregon cropping systems

We welcome your collaboration and suggestions for further standardization/adaptation of the method.

METHOD DESCRIPTION

Bags: 4-mm low density polyethylene (LDPE) tube shaped bags. Supplier: Wagner Packaging Solutions, Salt lake City, UT. Bags are cut to length, allowing enough extra length for sealing the bags on top and bottom. One end of the bag is tied before adding soil.

Soil collection. Typically, soil collection takes place in a cultivated field so that crop residue is not present on the soil surface. Moist "as-is" soil is collected from the field using a 5.7 cm (2.25 inch) diam. auger.

Soil preparation. Moist soil is composited and sieved through a coarse screen. Trials in Idaho (silt loams) typically use a 6-mm screen, while Oregon trials on heavier textured soils have used a 10-mm screen. In Oregon trials, supplemental moisture was added when soils appeared dry. Target gravimetric soil moisture for Oregon silt loam soils was 20 to 25%. Idaho trials used soil moisture present at time of sample collection. The question of how much soil moisture content affects the outcome (Nmin rate) has not been specifically studied using this buried bag method. Soil moisture content needs to be below field capacity to facilitate aeration within bags.

Bag filling. Soil is added to bags in approx. 8-cm depth increments. As the bag is filled, soil is gently packed by vertical shaking. Bags are typically 30-cm length, but length can be adjusted to reflect desired soil sampling depth(s). Bags can be sealed with a knot or with a bag sealer. Typical data collected on initial soil sample includes gravimetric soil moisture, total C and N (combustion), and inorganic N (NH_4 + NO_3-N).

Bag placement. Bags are placed in the field prior to, or shortly after crop seeding. Bags are placed parallel to crop row to facilitate equipment traffic in field, and to achieve uniform shading of the soil surface by the crop canopy. Soil in bags experiences the similar temperatures as soil in the field.

Bag harvest and N determination. At prescribed intervals, bags are destructively harvested and subsampled to determine inorganic N accumulation. Soil extracted at "as-is" moisture to avoid the flush of mineralization that often accompanies soil drying and rewetting. Ammonium + nitrate-N are determined by a standard colorimetric method.

HELPFUL HINTS

Below are a few tips and tricks that we have used to address potential issues that can arise from burying soil in polyethylene bags in a tilled agricultural field.

- Composite the soil collected by auger from at least ten locations per plot, if the goal is to represent the entire treatment area. This will reduce variability in measured N mineralization rate.
- Bury a minimum of 2 extra bags per plot, for backup. Bags described in this poster were relatively thick and did not tear or leak easily. However, bags do occasionally tear, followed by water leaking into the bags.
- Use a soil auger with a diameter slightly larger than the diameter of the buried bags. If the auger is too small, the bags will not fit in the hole. We used a 5.7 cm diameter auger to match the diameter of the bags described here.
- Consider double knotting the bags on each side, to further prevent water leakage issues.
- Use the bags within 5 years of purchase. The plastic ages and becomes brittle over time, which can cause more leakage and breakage issues.

PRECISION AND ACCURACY

Our N mineralization data was obtained in irrigated, tilled cropping systems, where actual soil moisture and actual soil disturbance by tillage is similar to that of soil in the buried bags.

Precision

Coefficient of variation for net N mineralized (0-30 cm depth) over a 90 -120 day growing season is typically 10 to 20% (n = 4 bags per treatment).

Accuracy

Inorganic N recovered from buried bags was similar to N accumulated by sugar beet in ID trials (see Idaho example).

Buried bag installation techniques

Collect, composite, and sieve field-moist soil

Fill pre-knotted polyethylene bags with soil

Place bags into auger holes parallel to crop row

Destructively harvest bags during crop growing season

Extract moist soil with 2M KCl for inorganic N determination. Measure "as-is" gravimetric moisture.

Idaho example: In situ N mineralization on manured fields

Objective: Measure N available to crop (mineralized N plus preplant fertilizer N) for fertilizer and manure treatments within a replicated field trial.

Protocol: Soil was collected from the field before planting, but after N fertilizer application and tillage. Soil samples collected and buried bags installed in the auger holes in a single day.

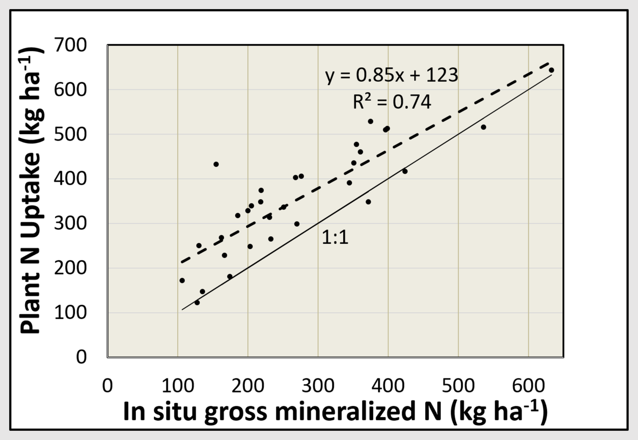
Advantages:

Avoid soil sample storage

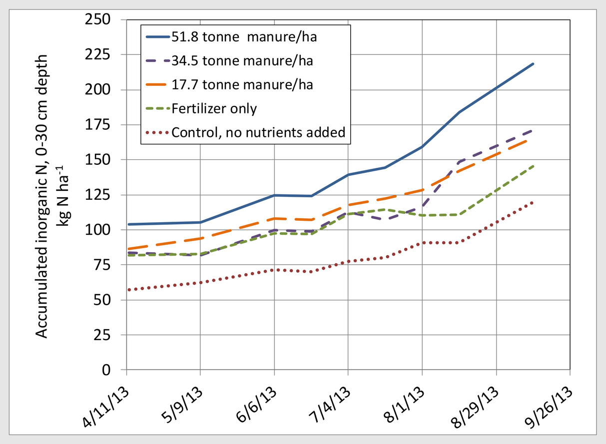
Relate timing and quantity of N mineralized from fertilizer/manure treatments to N uptake by the crop

Limitations:

If sidedress N fertilizer applied to crop, then comparison of nitrate-N accumulation in buried bags to crop N uptake is more complicated.



Sugar beet N uptake and gross inorganic N monitored in buried bags, 2014. Kimberly, ID. Mineralized N was measured to a depth of 0-60 cm.



Gross inorganic N in buried bags from replicated field plots, Kimberly, ID. Manure applied Oct. 2012. Buried bags installed Mar. 12, 2013, a week after seeding spring barley. Manure application rates on dry weight basis.

Oregon example: In situ N mineralization from various soils under organic production

Objective: Measure N provided by mineralization of soil organic matter in the absence of current season N inputs in soils used for organic vegetable production.

Protocol: Soil collected from grower fields before spring fertilizer application. Soil was collected following heavy winter rains and drainage to field capacity or to below field capacity. Soil held without sieving under refrigeration until planting time. Buried bags installed in a field a week after seeding sweet corn.

Advantages:

Compare N mineralization rates across different field histories, soil characteristics

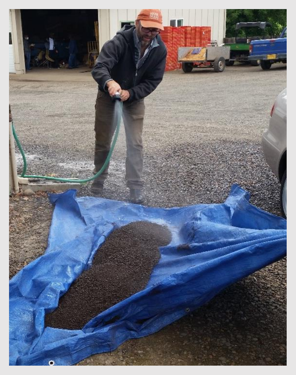
Manage one field site, instead of many field sites

Limitations:

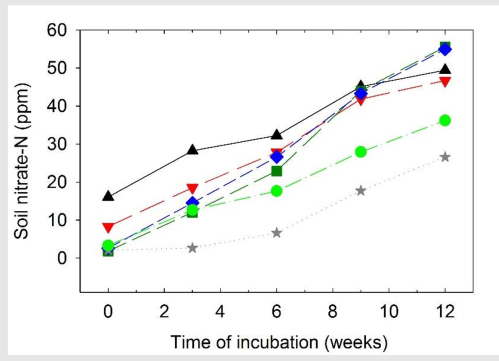
Soil must be collected before growers apply fertilizer in the spring.

Can make only relative comparisons in N mineralization rate/amount among soils sampled from different fields

Soil moisture. It is more difficult to assure uniform soil moisture conditions (e.g. moisture near field capacity) when using soils that vary in water holding capacity and tilth.



Water was added to some of the drier soils after sieving



Gross inorganic N produced from six soils collected from organic farms. Willamette Valley, OR. Incubation period: June 16 to Sept. 6, 2016.

REFERENCE

Westermann, D.T. and S.E. Crothers. 1980. Measuring soil nitrogen mineralization under field conditions. Agron. J. 72: 1009-1012.