NITROGEN SYNCHRONIZATION FROM ORGANIC MANURE APPLICATIONS AS MEASURED FROM SOIL SOLUTION AND SPAD READINGS FOR GROWING SWEET CORN

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Summary: Nitrogen is essential for plant growth and yield. In organic farming, applying organic fertilizer without prior knowledge of nitrogen (N) mineralization and crop needs can result in N deficiency at critical crop growth stages and nitrate (NO_3-N) leaching. Our work showed that NO_3–N concentration within and below the root zone and the plant leaf greenness were significantly higher under the chicken manure treatments followed by the dairy manure treatments relative to the control. The optimal synchronization period likely occurred between 60 to 75 days after manure application or 30 to 45 days after seeding for good growth of sweet corn.

Nitrogen (N) is essential for plant growth and yield. In organic farming, N is supplied through organic amendments in forms of manures and/or compost at application rates of 150 to 200 kg/ha. Applying organic N fertilizer without prior knowledge of N mineralization and crop needs can result in nitrate-nitrogen (NO_3–N) leaching below the root zone and potential groundwater contamination. Furthermore a lack of synchronization may cause N deficiency at critical crop growth stages and NO_3–N leaching below the crop root zone.

Analytical indicators of available soil N are useful to schedule nutrient applications for optimum crop yield.
Suction cup lysimeters (Soil moisture Equipment Corp, Santa Barbara, CA, USA) are low-cost, easy to use, non-destructive, and thus common soil solution sampling devices used to collect representative soil solution, especially for NO_3–N determination at various crop growth stages and soil depths.

The Minolta SPAD 502 meter is a hand-held light meter used to measure the relative greenness of leaves in a rapid manner. (SPAD is an acronym for Soil Plant Analysis Development.) SPAD 502 determines the relative amount of chlorophyll present by measuring the transmittance of the leaf in two wave bands (600-700 and 400-500 nm). It gives a reading in arbitrary unit that is proportional to the amount of chlorophyll present, which could be used to predict crop N requirements.

We believe that relative chlorophyll content (RCC) can be used to identify the synchronization between N released by organic manures and N needs by crop and that there is a strong relationship, up to a certain point, between RCC and N concentration in soil solution collected within the rooting depth. To test our hypotheses, two field experiments were conducted at the Waimanalo research station, of the University of Hawaii-Manoa (lat. 21° 20' 15"

N; long. 157° 43' 30" W); soil is classified as Waialua silty clay (*very-fine, mixed, isohyperthermic pachic haplustolls*), under sweet corn (*Zea mays*, cv. Super Sweet 10) grown on a tropical soil of Hawaii. Specific objectives were: 1) to evaluate the effect of types (i.e., chicken and dairy manures), rates (i.e., 0, 168, 336 and 672 kg ha^{-1} equivalent N), and application frequencies (one and two time applications) on a) NO_3–N concentration within and below the crop root zone, b) the RCC of sweet corn leaves, and 2) to quantify the relationship between RCC and NO_3–N concentrations within the root zone.
Two suction cup lysimeters were installed in each plot within and below the crop root zone, at 30 and 60 cm depth, respectively. SPAD device was used to measure RCC in sweet corn leaf. Soil solution samples were analyzed for NO_3–N concentration using chromotropic acid method.

Figure 1. Overview of experimental plots at the Waimanalo Research Station, with two suction cup lysimeters in each plot.

The results showed that NO_3–N concentration within and below the root zone and the plant leaf RCC were significantly higher under chicken manure treatments followed by dairy manure treatments relative to the control treatment. The optimal synchronization period apparently occurred between 60 to 75 days after manure application or 30 to 45 days after seeding for good growth of corn. Manure application rates and frequency of application had a significant effect on both NO_3–N concentration within and below the root zone and leaf RCC. Leaf RCC was linearly correlated with up to 20 mg/L (ppm) NO_3–N in the soil solution, then leveled off at reading 40 (Figure 2). It appears that leaf RCC can be used as an indicator of NO_3–N availability for sweet corn cultivated under the environmental condition and soil used in this study.

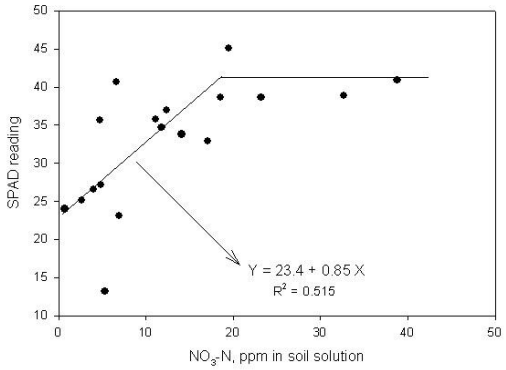

Figure 2. Relationship between SPAD readings and soil-solution NO_3-N at 30-cm depth.