IMPROVING NITROGEN MINERALIZATION BY INCREASING DIVERSITY OF SOIL BIOLOGY

Enlightened Soil Algae Application

ABSTRACT:

Nitrogen mineralization from organic fertilizer is highly correlated with soil biology/soil health. Improving diversity of soil biology may lead to improved nutrient mineralization. This may lead to a more sustainable organic farming, reduce input cost, and improve nitrogen mineralization/availability for crop uptake. Two field trials were conducted in Hawaii Kai and Waimanalo on Oahu Island to study the effect of algae application on sweet corn growth and yield under reduced nitrogen application.

The study was conducted using randomized complete block design (RCBD) with 6 replicates. The nitrogen application was split into 2-halfes, 50% was applied pre-planting and 50% after a month of seed germination. Three sweet corn varieties were tested, Venture, Inspiration, and Patriarch. Drip irrigation system was installed for each site. The algae was applied twice as soil drench and 1 application as foliar. The soil application was applied at 50 dilution rate after seed germination and after the 2nd fertilizer application. The 3rd application was foliar 2-weeks after the 2nd application at the same dilution rate. The nitrogen was applied at 200 lb N/acre total using Feather meal fertilizer (12-0-0). Other nutrients were applied based on soil nutrient chemical analysis recommendations. All other agronomical treatments were applied based on each site needs. The results of plant growth and yield showed that the Chlorophyll content (r=0.95 correlation coefficient was highly significant correlation with soil NO_3-N content) showed that the chlorophyll content was sufficient for healthy/optimum crop growth with the N-reduction to 35%, then went below the optimum rate with 40% N-reduction. The results also showed that the reduction in nitrogen up to 35%+Algae produced similar corn ears yield compared to 100% N application.

INTRODUCTION:

Hawaii state imports about 85% of the consumed food and there's roughly two-week worth of food locally at any given time. Local food production is costly due to high inputs cost, especially fertilizers. Soil health have been receiving more attention and focus in the recent years, mainly due to its high correlation to nutrient availability for crop uptake and crop growth and yield. Soil health may contribute to improving local crop production, especially under organic farming. Healthy soil benefits plants, people, and the environment. Benefits of healthy soil includes: 1) Healthy soil leads to healthy plants, 2) Healthy soil holds moisture and prevents erosion, 3) Healthy soil suppresses weeds, 4) Healthy soil captures and stores carbon, and 5) Healthy soil improves nutrient availability for crop uptake.

MATERIALS & METHODS:

Field trials:

Two field trials were conducted on Oahu Island at Hawaii-Kai Honolulu and Waimanalo. Each plot measured 12 X 50 ft for total area of 3,600 sq. ft. The studies were conducted using randomized complete block design (RCBD) with 6 replicates. Drip irrigation system was used at both sites. Sweet corn was planted at the plant population of 30,000 plant/acre. (3 ft spacing between rows and 8 inch spacing between plants). All agronomical treatments were applied based on each site.

Hawaii Kai Trial

Waimanalo Trial

Figure (1): Study sites on Oahu Island.

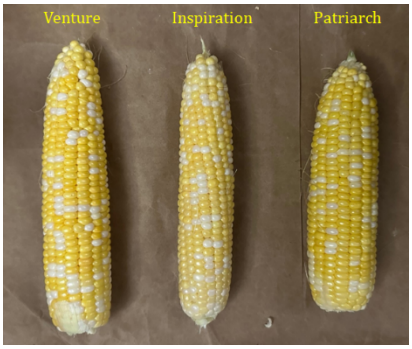
Fertilizer and Algae Application:

Initial trial was conducted using three rates of nitrogen at 100% (control), 75%+Algae, and 50%+Algae. The results showed that 75%N+Algae led to a crop yield numerally similar to 100% N application rate, However, 50%N+Algae showed a significant reduction in crop yield. The 2nd set of trials were decided to include smaller intervals below 25% reduction in nitrogen application rates.

Soil macro- and micro-nutrient content was analyzed prior to initiating the field trials. Fertilizer application was adjusted based on each soil nutrient content. However, nitrogen was applied at 200 lb./acre for both sites (control plot). The reduced nitrogen application rate included the following rates: 100%+Algae, 75%+Algae, 70%+Algae, 65%+Algae, 60%+Algae, and 100% (control) for total of 6 treatments. Feather meal (12-0-0) was used as the nitrogen source for both sites. The nitrogen application was split into two-halves. Half application pre-plant and 2nd half a month after sweet corn germination. Enlightened algae was applied as sol drench after seeds germination and after the 2nd fertilizer application. The 3rd application was applied as foliar application 2-weeks after the 2nd application. 50 dilution rate was used and 8 ounce/acre.

Sweet corn varieties:

Three sweet corn varieties (Venture, Inspiration, and Patriarch) were purchased from Stokes seeds company (https://us.stokeseeds.com). The sweet corn varieties were selected based on disease resistance and adaptability characteristics, including Maize Dwarf Virus (MDV) and Mosaic Chlorotic Mottle Virus (MCMV) resistance-tolerance.



Data collection and analysis:

At harvest, 5 random plants from each replicate was selected for data collection. Plant height (in), SPAD leaf chlorophyll, corn ears with husk weight (ounce), corn ears husked weight (ounce), and sweetness (BRIX) were measured. All collected data were subject to analysis of variance to measure significance.

RESULTS & DISCUSSION:

Sweet corn ears with husk yield:

The study results showed that there was no significant effect on nitrogen reduction till 0-35% when EnSoil Algae applied for the three sweet corn varieties. However, the reduction of 40% in nitrogen application rate caused a significant decline in sweet corn ears weight (Figure 2-4). Also, the results showed that the application of EnSoil Algae with 100% nitrogen application rate did not impact the sweet corn ears yield.

It's clear from the results that the improvement in soil microbiology with the application EnSoil Algae has improved nitrogen availability to a level covered on the reduction in nitrogen application up to 35% (65% of the total nitrogen rate was applied). It is known that soil microbiology and nutrient release/availability for crop uptake are highly and significantly correlated.

Additionally, the three sweet corn varieties showed similar pattern. Which is expected since nitrogen is one of the most limiting nutrient for sweet corn. It's also known that sweet corn is a heavy nutrient feeder, reduction of 35% in nitrogen application can lead to a significant decline in yield, but it is clear from the results that EnSoil Algae have reduced the impact by increasing nitrogen availability for the sweet corn.

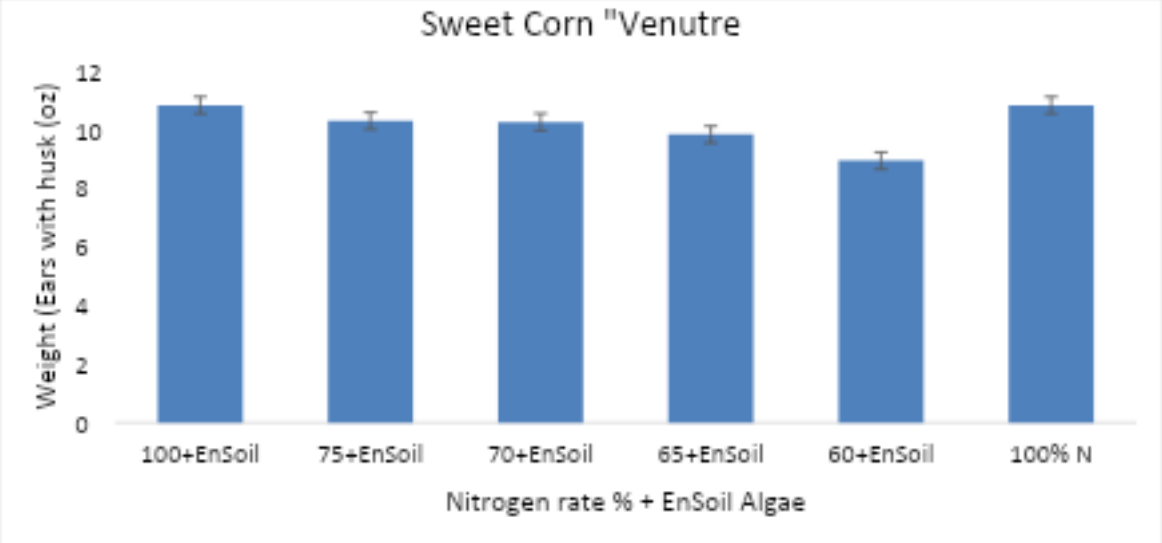


Figure (2): Sweet corn ears with husk "Venture" variety weight under the trial treatment.

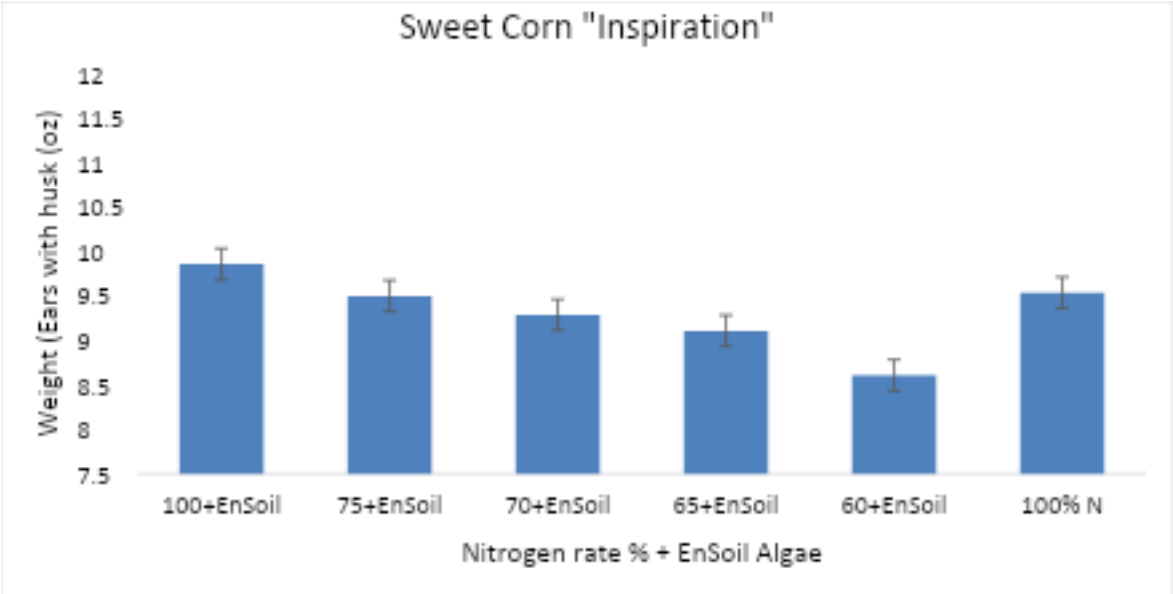


Figure (3): Sweet corn ears with husk “Inspiration” variety weight under the trial treatment.

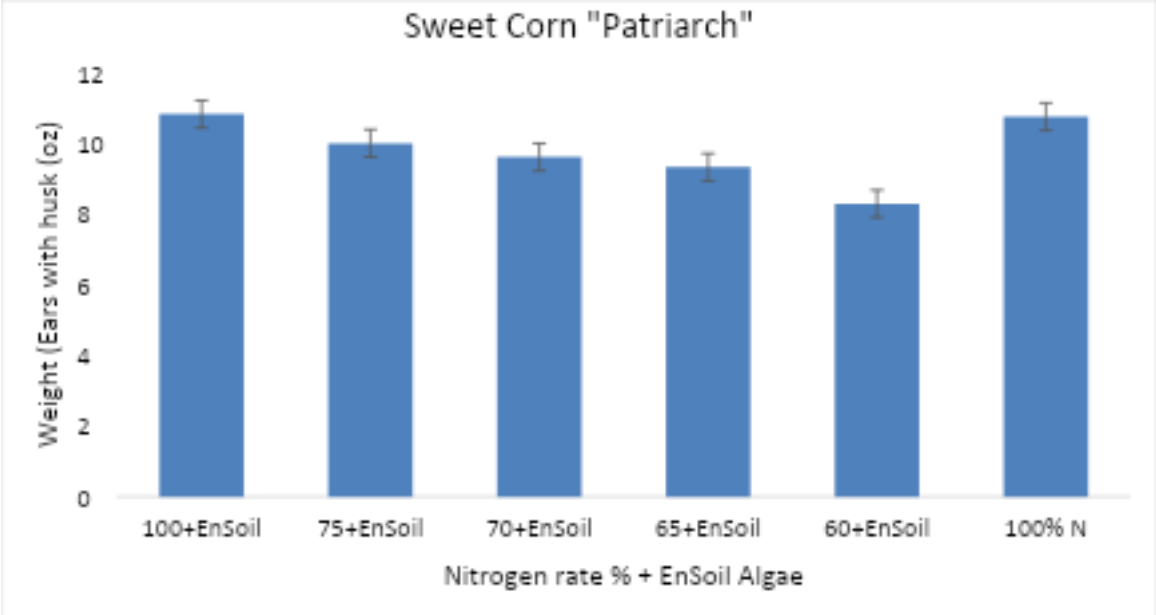


Figure (4): Sweet corn ears with husk “Patriarch” variety weight under the trial treatment.

Sweet corn ears (husked) yield:

The study results of sweet corn husked ears followed the same pattern seen in unhusked sweet corn ears. There was no significant decline in husked sweet corn ears weight between 0-35% reduction in nitrogen application rate when EnSoil Algae was applied with it. However, when the reduction in nitrogen application reached 40% (with Algae application), the sweet corn husked

ears weight declined significantly (Figure 5-10). Also, the results showed that the application of EnSoil Algae with 100% nitrogen application rate did not affect the sweet corn husked ears weight.

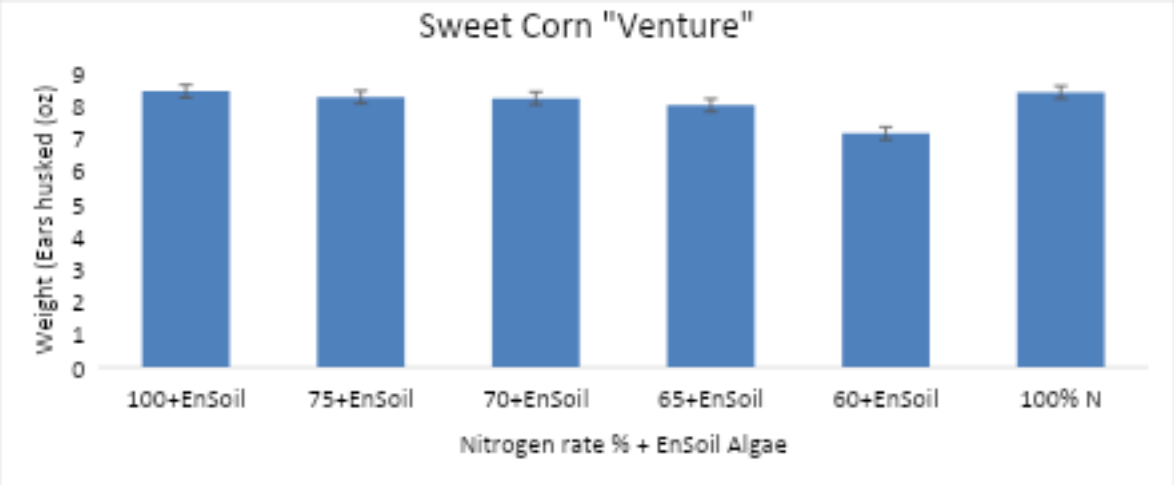


Figure (5): Sweet corn ears husked “Venture” variety weight under the trial treatment.

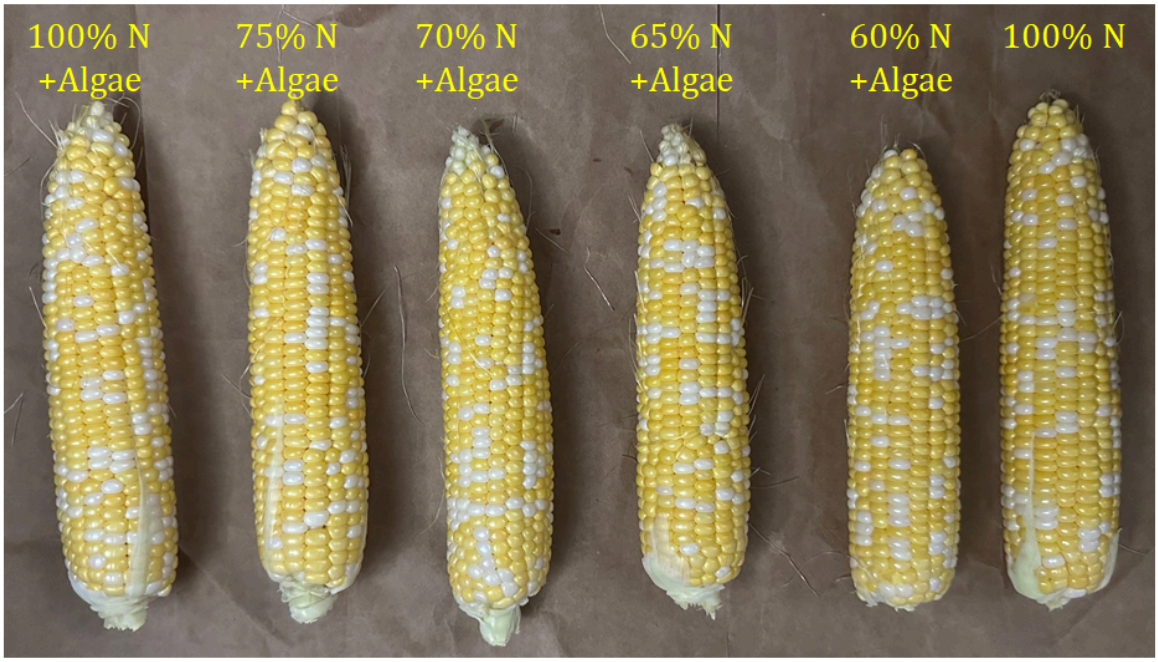


Figure (6): Sweet corn “Venture” ears harvested under reduced nitrogen application rates.

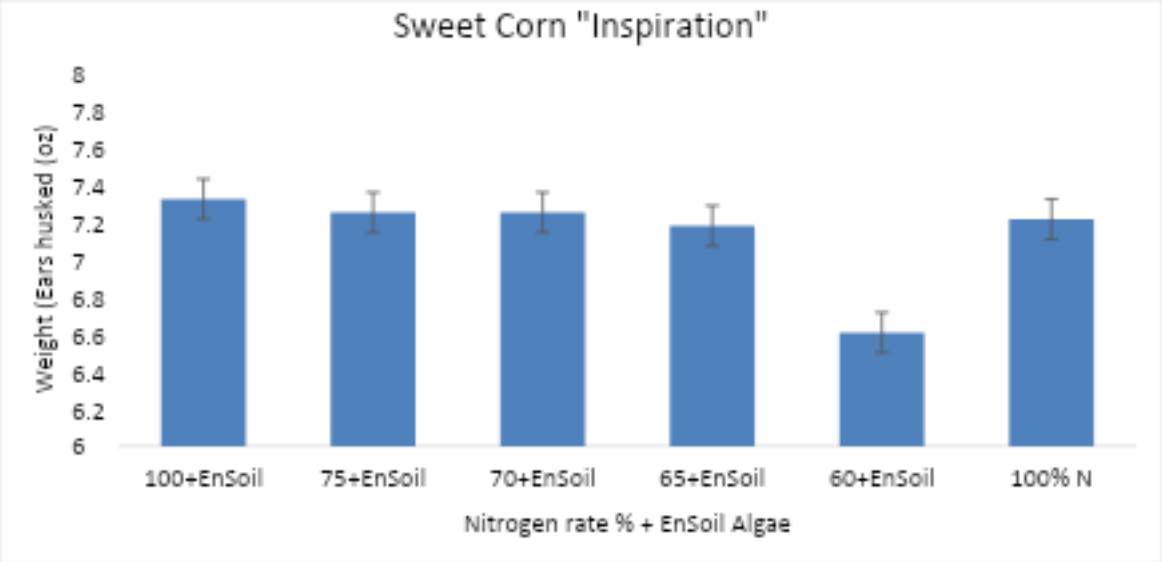


Figure (7): Sweet corn ears husked “Inspiration” variety weight under the trial treatment.

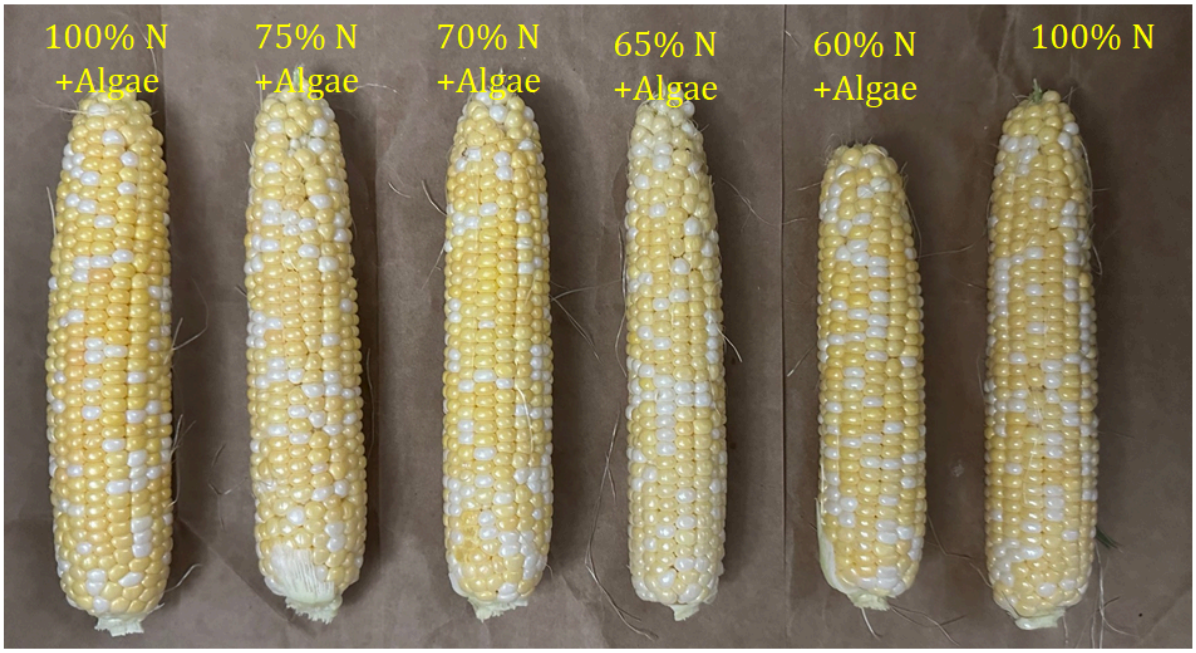


Figure (8): Sweet corn “Inspiration” ears harvested under reduced nitrogen application rates.

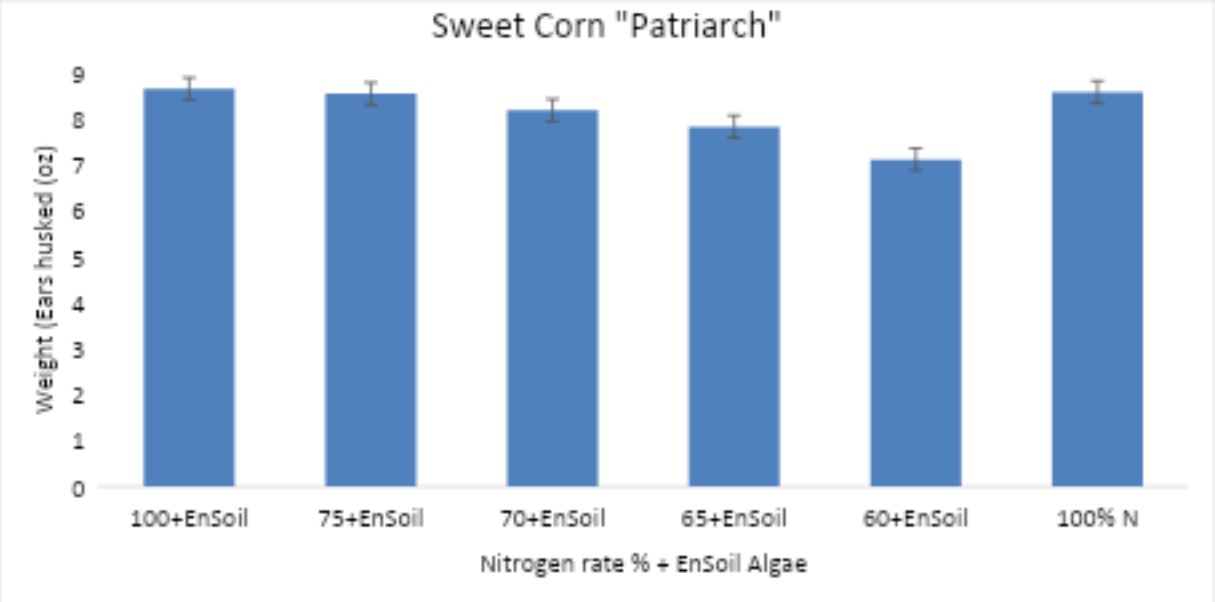


Figure (9): Sweet corn ears husked "Patriarch" variety weight under the trial treatment.

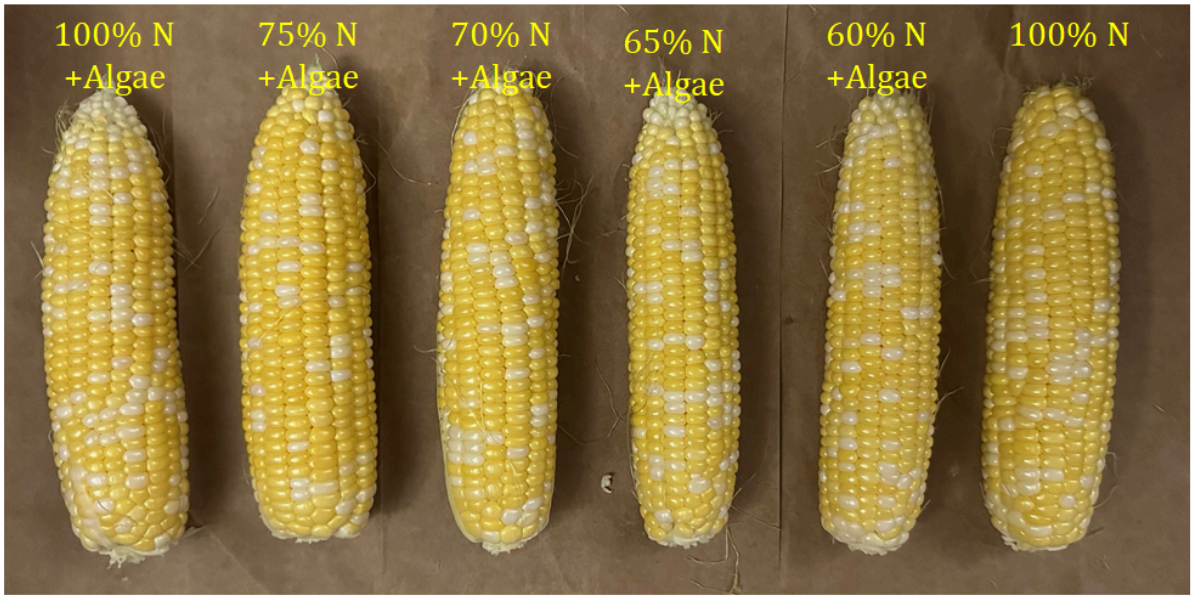


Figure (10): Sweet corn "Patriarch" ears harvested under reduced nitrogen application rates.

Sweet corn ears length (in):

Soil samples were collected The results data analysis showed that there was no significant effect of the study treatments (Nitrogen application rate+Algae) on sweet corn ears length for the three varieties (Figure 11-13). It might be related to that sweet corn ears is a genetic variable and it does not response to the nitrogen application rates, unless the nitrogen level drops below the crop need. From Figures (17-19) they showed that the total leaf chlorophyll did not drop

below 40 SPAD value as been reported Ahmad, et al. (2014) as a crucial value for optimum sweet corn growth and yield under Hawaii condition. It is clear that the algae application has helped in keeping the soil nitrogen at level suitable for optimum sweet corn growth.

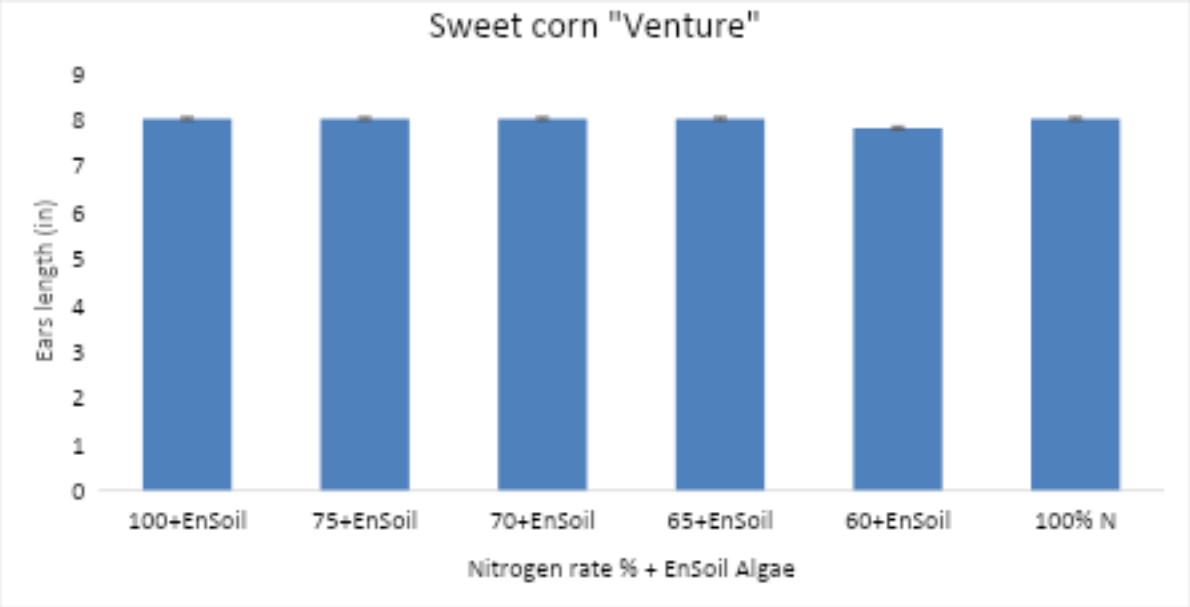


Figure (11): Sweet corn “Venture” ears length (in) under reduced nitrogen application rates.

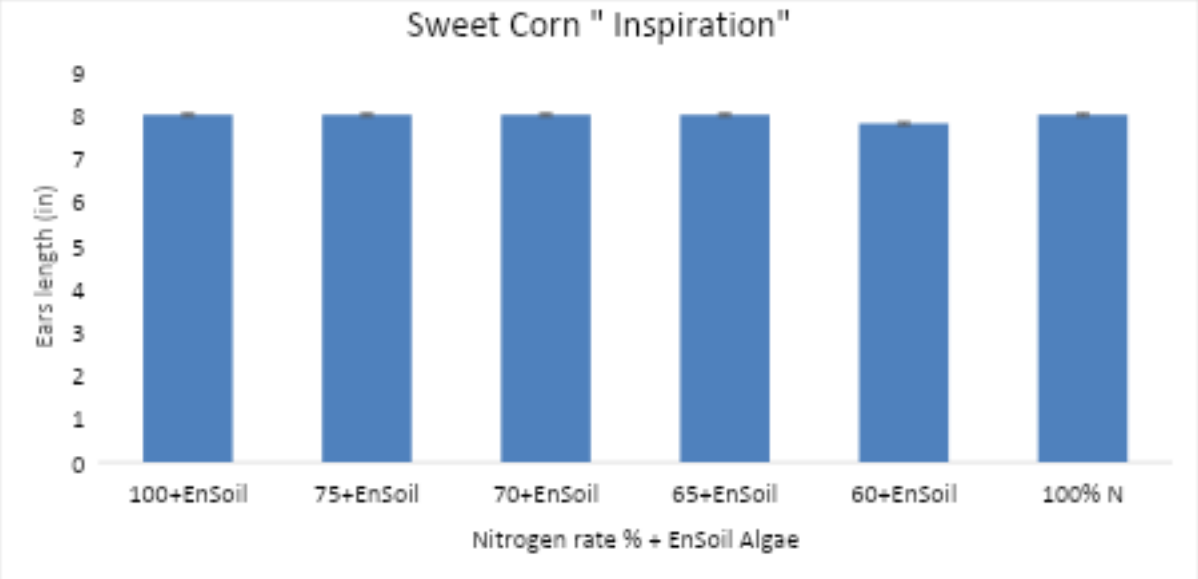


Figure (12): Sweet corn “Inspiration” ears length (in) under reduced nitrogen application rates.

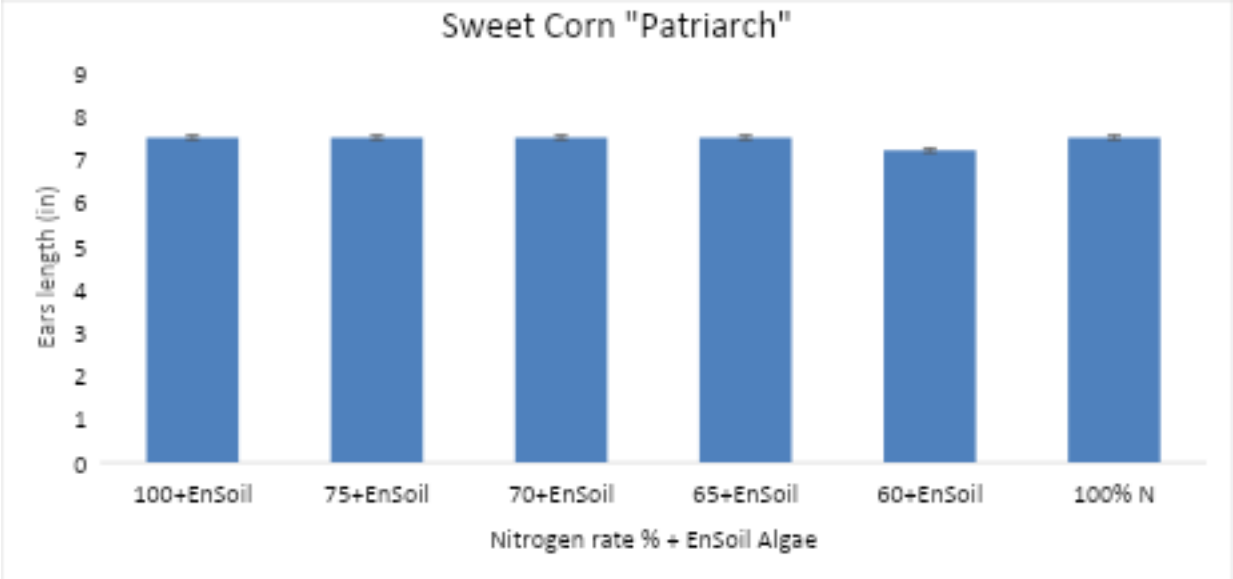


Figure (13): Sweet corn “Patriarch” ears length (in) under reduced nitrogen application rates.

Sweet corn sweetness (BRIX):

The results showed that although there was no significant difference between the treatments (nitrogen application rates + Algae) on each of the sweet corn varieties sweetness (BRIX) level (Figure 14-16). However, Inspiration and Patriarch varieties sweetness level showed a numerical decline with the reduction in nitrogen application. Also, the results showed that sweet corn sweetness under 100% nitrogen application and 100%+Algae resulted in very similar sweetness (BRIX) value.

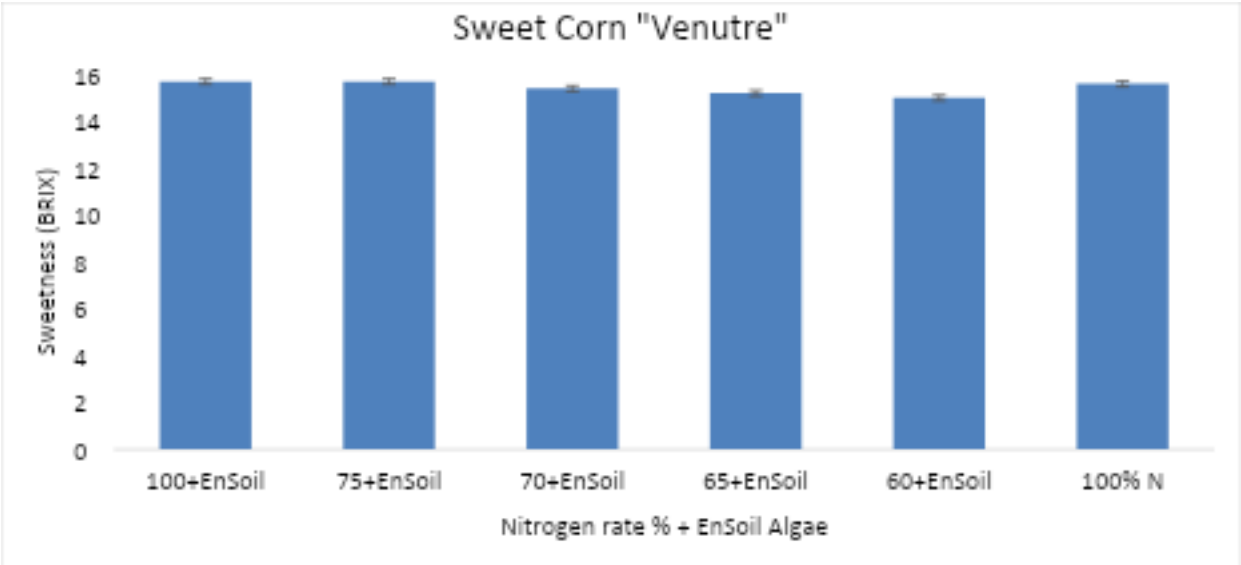


Figure (14): Sweet corn “Venture” sweetness (BRIX) under reduced nitrogen application rates.

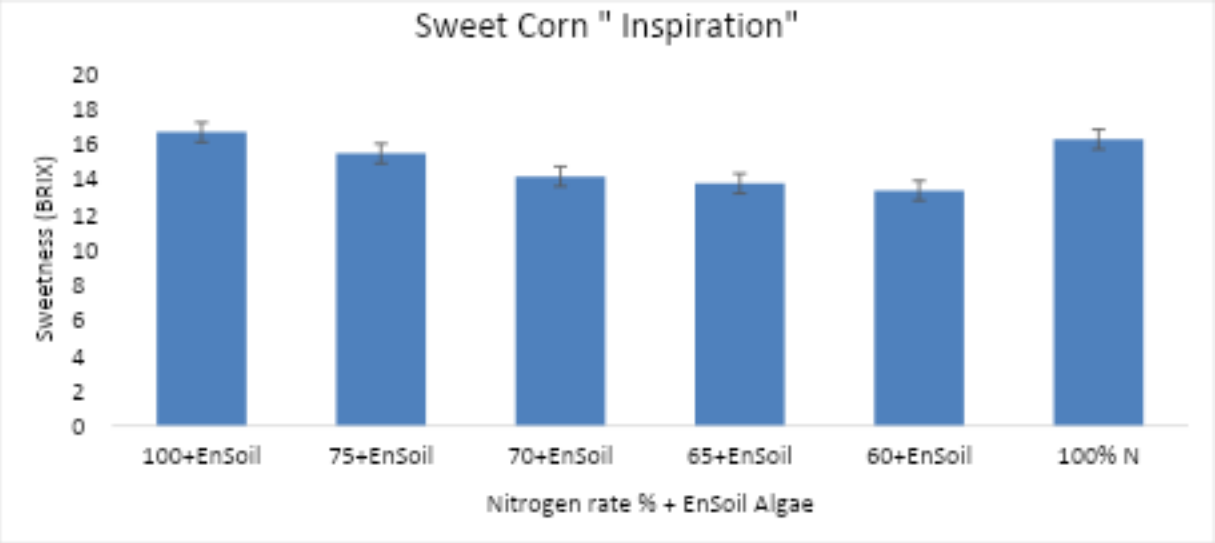


Figure (15): Sweet corn “Inspiration” sweetness (BRIX) under reduced nitrogen application rates.

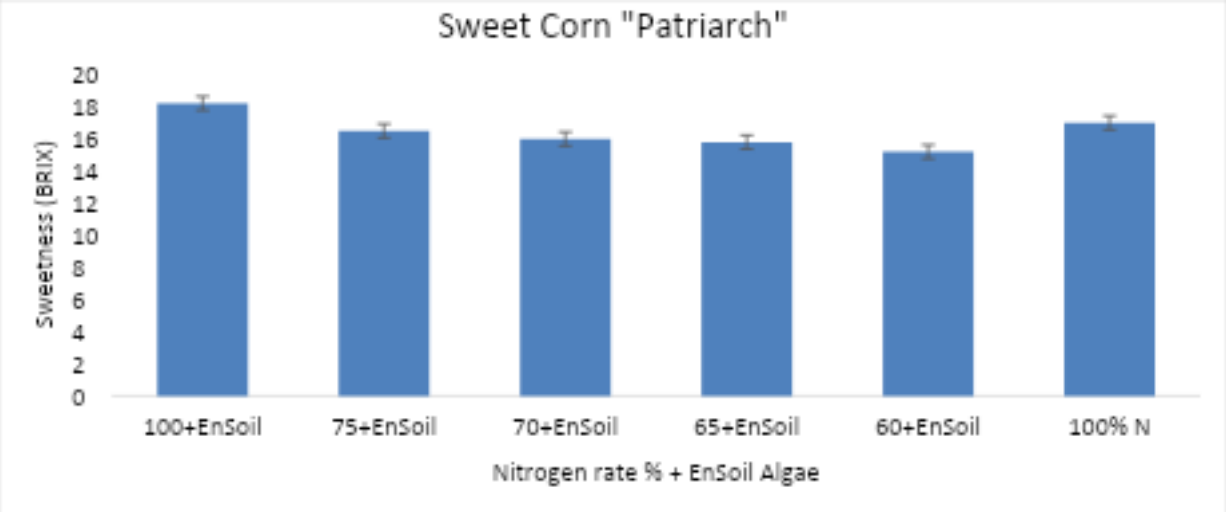


Figure (16): Sweet corn “Patriarch” sweetness (BRIX) under reduced nitrogen application rates.

Sweet corn leaf chlorophyll content:

The SPAD total chlorophyll results showed that the sweet corn leaf had sufficient chlorophyll throughout the growing season till harvest time. Additionally, There a non-significant small decline in the total chlorophyll with the reduced nitrogen application amount till 65% (35% reduction) in Venture variety and to 70% (30% reduction) in Inspiration and Patriarch variety (Figure 17-19). The results might be related to the difference in growth habit and yield between the varieties (There was a difference between the varieties plant height and umber of ears per plant). It’s believed that these factors may have impacted the need for more nitrogen from Inspiration and Patriarch variety compared to Venture.

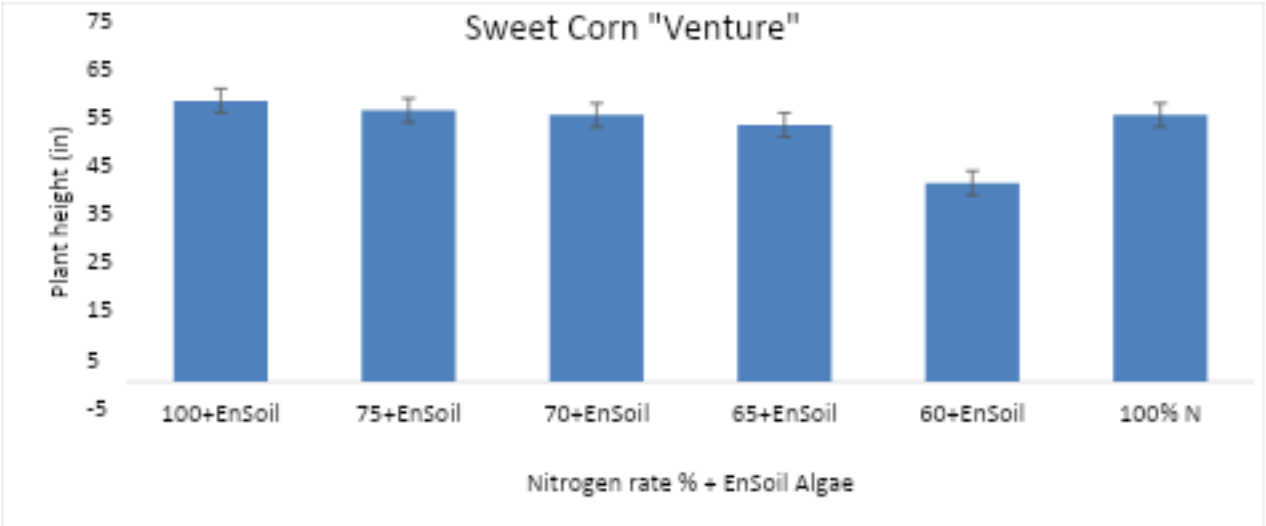


Figure (17): Sweet corn “Venture” leaf chlorophyll (SPAD) under reduced nitrogen application rates.

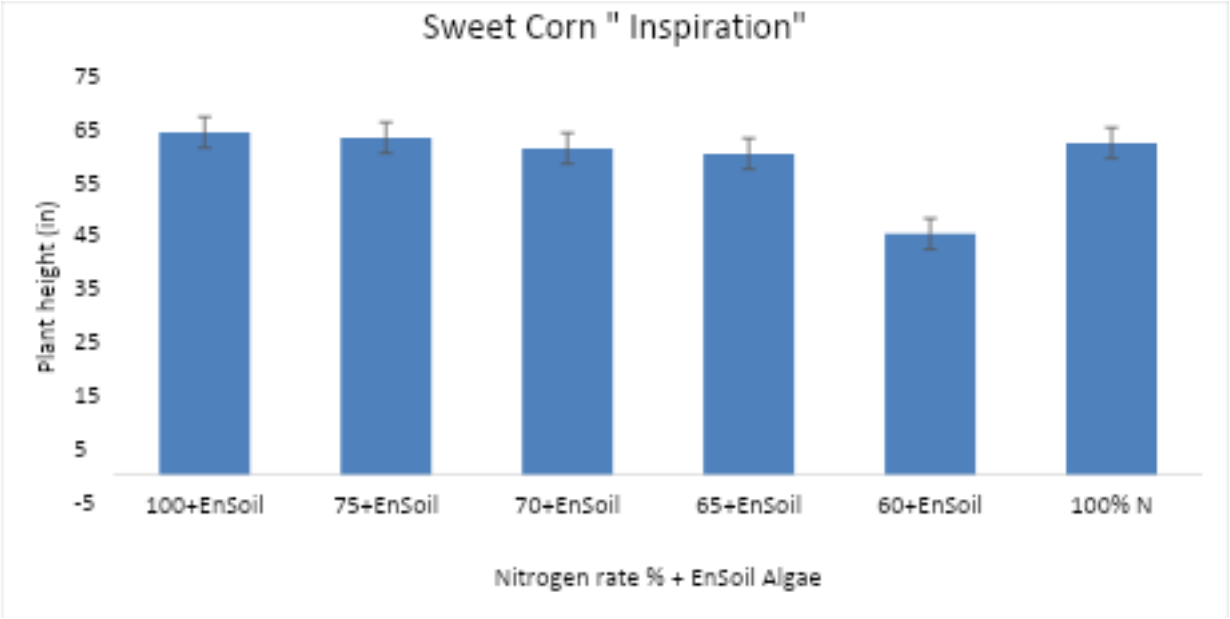


Figure (18): Sweet corn “Inspiration” leaf chlorophyll (SPAD) under reduced nitrogen application rates.

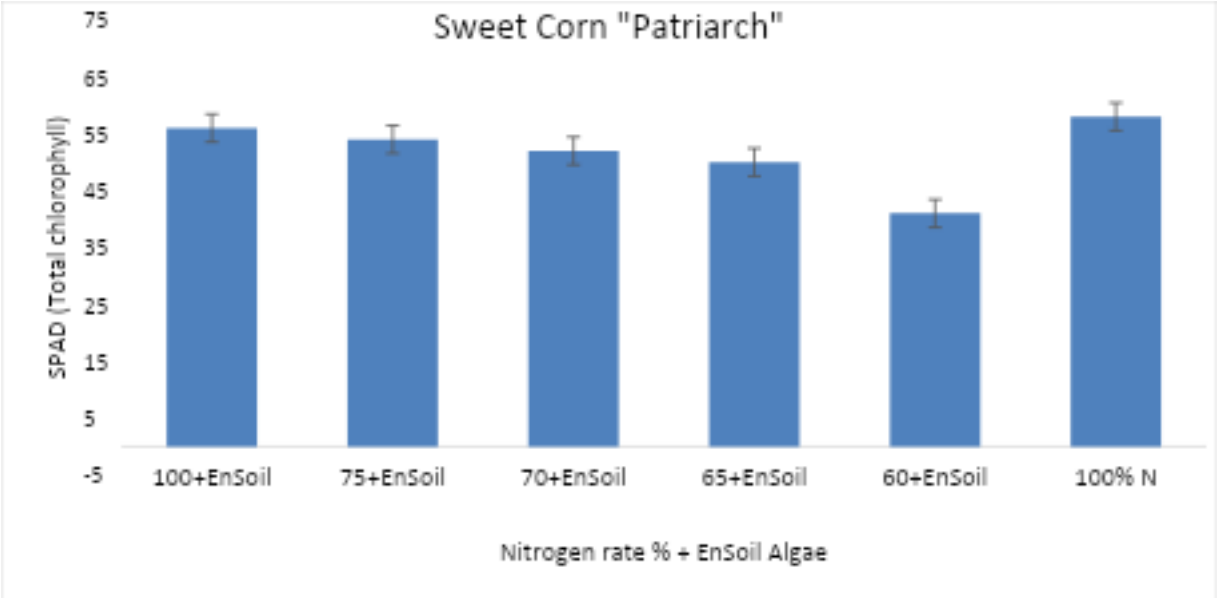


Figure (19): Sweet corn "Patriarch" leaf chlorophyll (SPAD) under reduced nitrogen application rates.

Leaf chlorophyll content and Soil Solution NO_3-N Content Relationship:

Soil solution Nitrate-Nitrogen (NO_3-N) content was plotted against the Relative Chlorophyll Content (SPAD) reading. The correlation between the two measurements were highly correlated with a correlation coefficient of 0.889-0.930 (Figure 20-22). The relationship shows that SPAD measurement can be sufficient to measure NO_3-N availability for crop uptake. It also helps to plan for nitrogen/fertilizer application based on the reading. The reading of SPAD below 45 was correlated to NO_3-N below 25ppm.

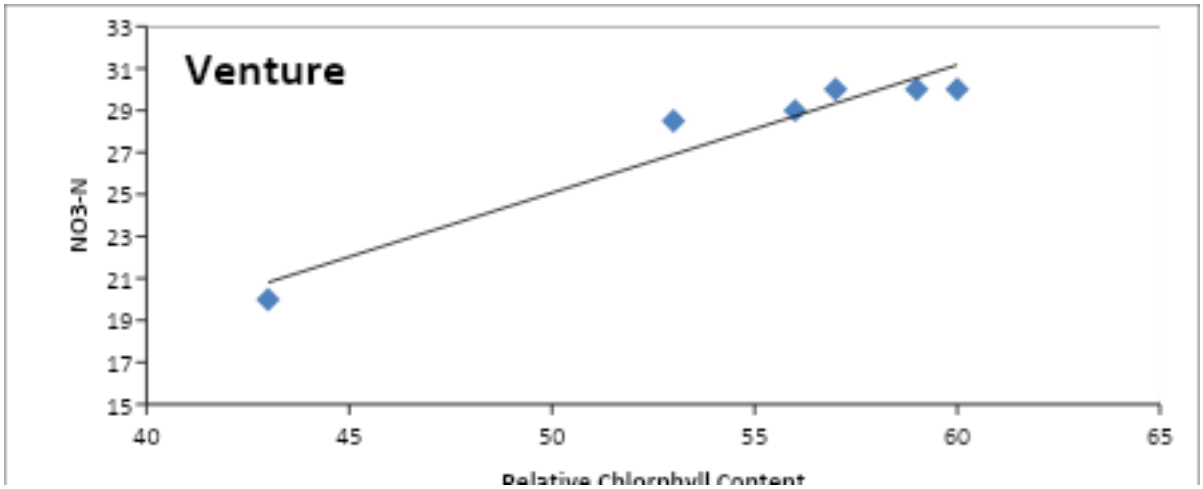


Figure (20): Relative Chlorophyll Content and NO_3-N soil solution content for Venture Sweet corn.

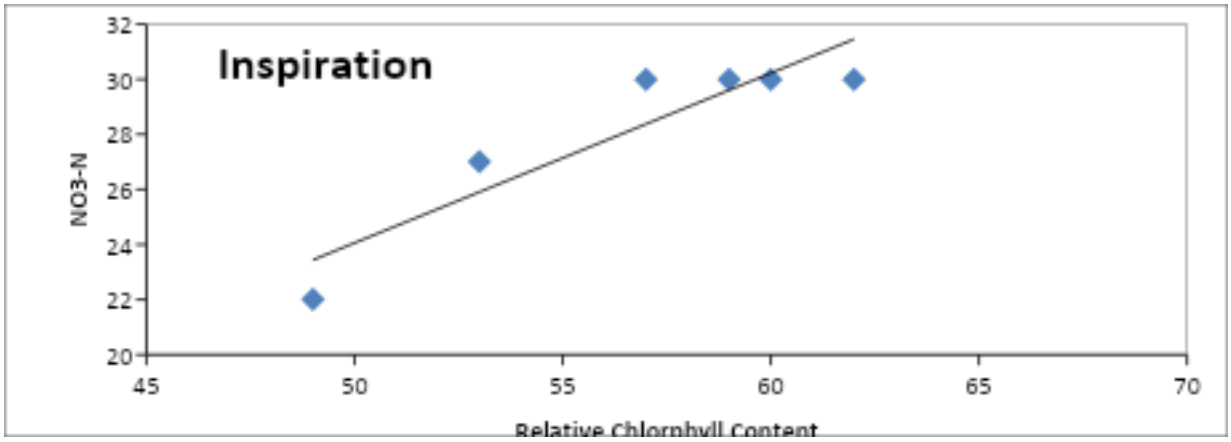


Figure (21): Relative Chlorophyll Content and NO_3-N soil solution content for Inspiration Sweet Corn.

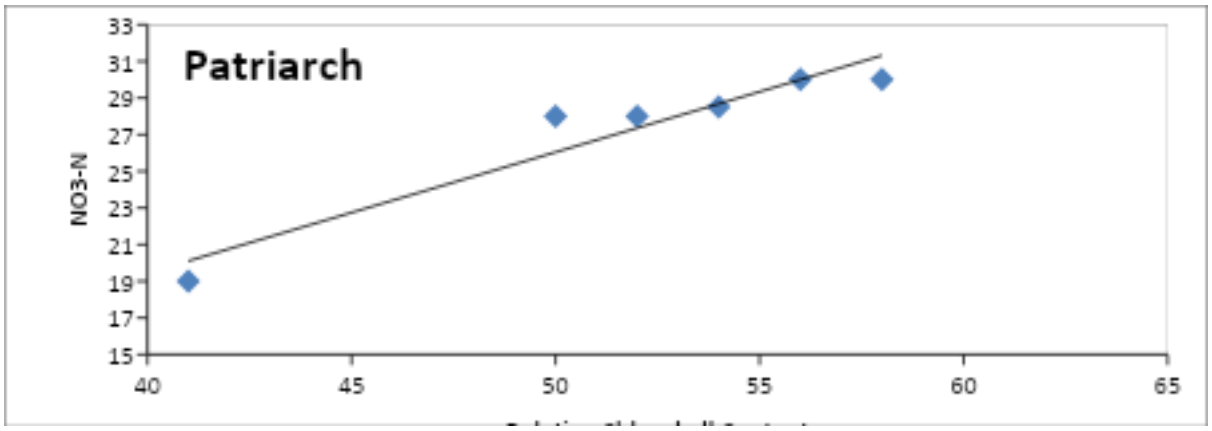


Figure (22): Relative Chlorophyll Content and NO_3-N soil solution content for Patriarch Sweet Corn.

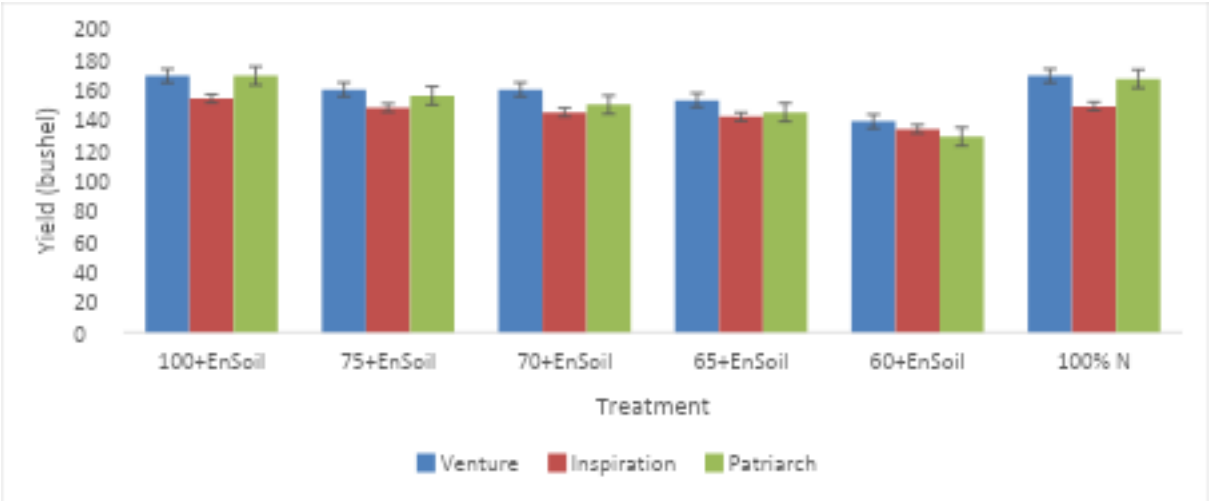


Figure (23) Sweet corn yield (bushel) under the different treatments.

CONCLUSIONS:

The results highly and significantly suggest that the increased diversity of soil microbiology (EnSoil Algae) lead to improved nitrogen availability (Mineralization) for crop uptake. Regardless of soil properties (two study site), the application of EnSoil Algae benefitted the crop. The Algae application benefitted the sweet corn when there was a reduction in the nitrogen application down to 65% of the total recommended rate. We believe that cutting down of nitrogen application by 25% with EnSoil Algae application will lead to many benefits, including: improving farmers net profitability, protecting the environment by reducing nitrogen leaching, while keeping the crop healthy and at its optimum yield.

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