Investigation of production increases in strawberries / celery rotation with the addition of technical organic soil amendments to usual grower practice.

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Abstract: Refinement methods have allowed the latest generation of Technical Organic Acids (TOA) to resolve the reliability in field results from basic leonardite extractions (humic, fulvic acids). Two market leading products are independently tested over 4 crop rotations, under scientifically valid and commercial relevant field conditions, to increase the production of a strawberry-celery-celery-strawberry production system.

The first crop was strawberries planted in October 2013, harvested April, 2014. At a cost of US$80/acre, the first TOA amendment increased nett return to the farmer by $1,145/acre (1,356% ROI). The second TOA amendment, at a cost of $60/acre, increased profit by $1,048/acre (1,653% ROI).

The second crop in the rotation, celery, was planted 1st September, 2014 and harvested 1st December, 2014. At the same amendment costs as the first rotation, the first TOA increased nett return to the farmer by US$557 per acre, with the second TOA increasing profits by US$578 per acre.

Key Words: strawberry, celery, production, technical organic acids, soil amendments

Background: The opportunity to increase production using organic soil amendments has been known to farmers since before recorded history[1]. Extracts of organic acids (humic, fulvic, ulmic) from leonardite ore have long been touted as useful, though met with varied success, since first adopted in the late 18th Century[2].

The efficacy of commercial products generally classed as humic and fulvic acids, is governed by a wide array of factors including; mother ore composition, extraction method, refining method, and filtration. Many commercially produced products are “basic” extractions using a hydroxide bath method, settling, some filtration and little else. The variability in end product active ingredients using basic methods is a lead cause of variability in field results from this class of products.

Several modern manufacturers have developed method to further refine basic products to produce “technical organic acids” (TOA). TOA refinement can include manipulation of functional groups, pore size and distribution, molecular surface area and exchange capacity characteristics as well as add other biocatalysts, mineral elements, and biostimulants.

Unfortunately, these refinements are difficult to differentiate at the farm level as different from the underperforming basic method products which may look and feel the same. It is this reason that farmers must be presented results and information from testing conducted under three strict criteria:

1) Conducted by Independent Research Company/Organisation
2) Scientifically Valid method
3) Commercially Relevant operations

This investigation looks at two related Technical Organic Acid products, supplied by EcoCatalysts Pty Ltd, ability to increase production economics (dollar returns to the farmer), by adding TOAs to the usual fertilizer and soil program.

Location: Ventura, CA (Terry Farms)

Crop: Fragaria x ananassa – Garden Strawberries. Apium graveolens - Celery

Treatments:

1. Grower Standard Program (GSP)
2. GSP + EnhancePlus @ 1.6 gal/acre (15L/ha)
3. GSP + EnhanceTHA @ 1.6 gal/acre (15L/ha)

Grower Standard Practice
Strawberry: 500 lbs/acre 18-7-13 controlled release fertilizer at planting, top dress 900 lb/acre CAN 17, 1.5 gal phosphoric acid weekly for 8 weeks, mid-winter application of 500 lbs potassium thiosulphate.
Celery: 400 lbs N/acre (2240lbs/acre CAN 17)

Application Method:

In the first strawberry crop, fertilizer and amendments were applied via the drip irrigation system diluted in 20 gal/acre (200L/ha) water beginning at planting October 4th, 2013. Amendments were applied in one application on November 5th.

The second celery crop had the amendments applied with 20gal/acre water pre-planting on 29th August, 2014. Application by backpack sprayer to the bed surface.

Treatments are placed as close as possible in the same general area of the field, same variety of strawberries and celery, produced by the same nursery with the same dig and plant dates and lot numbers to reduce any variable that could occur with these parameters.

All other farm operations (e.g. irrigation, pest and west control, machinery and implements, etc,.) were conducted as normal on the entire farm.

Plots: 6 replications of each treatment, complete randomised block design, each plot 20' x 13' (6m x 4m). Test area represented 1.5ac (0.63ha) of a 20ac (8ha) field on an 82 acre (33ha) farm.

Results and Discussion:

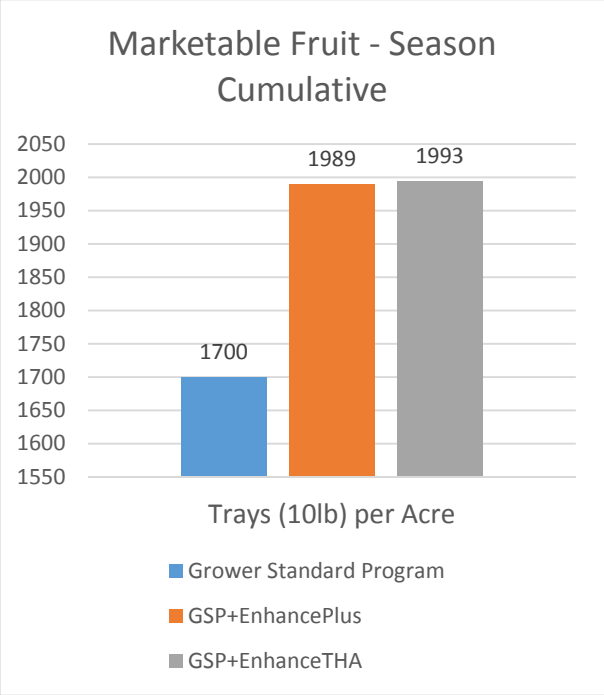
<u>Rotation 1 – Strawberries, 2014 harvest</u>

Pre-pick analysis of flower and fruit sets was taken weekly prior to the start of picking, though no significant difference was evidenced, EnhancePlus treated plots recorded a ~4.5% increase of fruits per plant over the GSP non-amended plots.

1 month after amendment application (on December 5th), 1 plant from each replication was pulled and the root fresh weight measured and averaged. Whilst no statistical significance was measured between treatments, the GSP averaged 9.1g/plant root mass, EnhancePlus 11.9g and EnhanceTHA 10.9g suggesting a trend that Enhance amended plots cause a greater root mass.

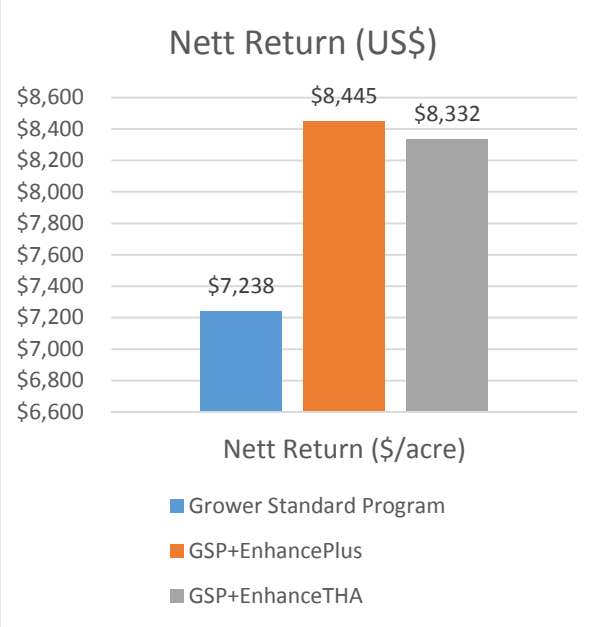
Picking began on January 13th, 2014 with final pick on April 8th, 2014. Whilst little to no difference in trays of marketable fruit per acre occurred early in the picking season, the gap between amended and non-amended plots became clearly evident in March with the gap widening further until final pick.

After final picking the cumulative trays (10lb) per acre of marketable fruit was GSP 1700 trays per acre (19.06t/ha), EnhancePlus recorded 1989 trays (22.3t/ha) (↑17%) and EnhanceTHA recorded 1993 trays (22.34t/ha) (↑17.2%).



From the yield data we can extrapolate the economic impact of the treatments. Pricing over the season varied from starting at approx. US$13.00 per tray, dipping to below US$2.00 late in the season but recovering to US$4.00. Using the USDA Shipping Point Market Prices for each day of picking, this represents the net back to grower after costs of approximately $6.00 per tray were removed that would represent picking labour, carton and tray costs, transportation to the cooler, and cooling costs associated with picking the strawberries.

The return to the farmer for each of the treatments is US$7,238 per acre (*A$23,353/ha) for Grower Standard Program, US$8,445 per acre (*A$27,090/ha) for GSP + EnhancePlus and US$8,332/acre (*A$26,727/ha) for GSP + EnhanceTHA.



The costs of amendment above the GSP is US$80 per acre (*A$104/ha) for EnhancePlus and US$60 per acre (*A$78/ha) for EnhanceTHA. This produces a net return on investment of US$1,085/acre (*A$14,091/ha) (1,356% ROI) for EnhancePlus and US$992/acre (*A$12,883/ha) (1,653% ROI) for EnhanceTHA.

*A$ calculated at 0.77 exchange rate

The daily market utilization for the berries picked during the season, which is the percent of marketable berries to the total weight of berries picked, the Grower Standard Program and Enhance Plus program showing a 57.6% utilization and the Enhance THA at 61.8% utilization on average.

Some small improvements with average berry weight were seen with both of the Enhance products over the grower standard. The GSP berries averaged 24.14 grams for the season compared to 25.01 grams for the Enhance Plus treated berries and 27.49 grams for the Enhance THA treated berries.

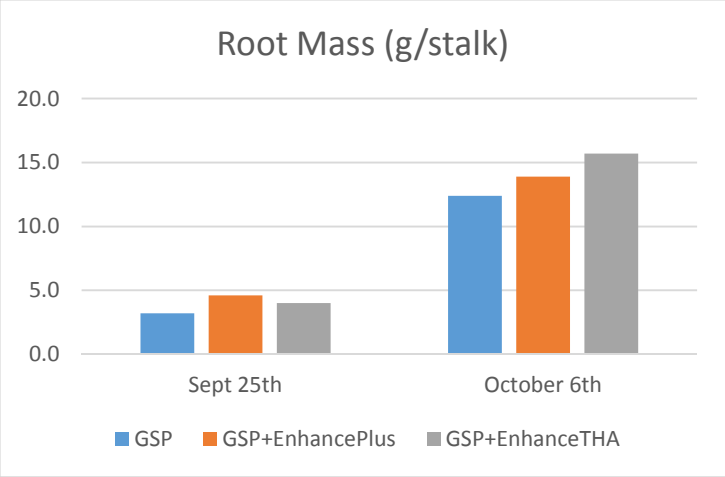
An end of season soil samples was taken and analyzed by A&L Western Agricultural Laboratories in Modesto, California. Report 14-093-015 shows low supplies of nitrate nitrogen residual in the Enhance treated soils (12ppm and 7ppm respectively), with more than 3 times higher results (44ppm) found in the GSP soil suggesting a marked increase in nitrogen use efficiency where Enhance treatments are applied. This is a typically expected of highly refined TOA products.

Report 14-051-006 taken mid-season and reports on leaf levels of all the major elements at the time of the analysis. Slightly better supplies of nitrogen, phosphorous, potassium, manganese, and zinc were found in the plants grown in the Enhance treated soils. Though not seen as significant, the consistency of these elements in the Enhance treated soils is a very positive sign.

All data rated as significant was done so utilizing the New Duncan's Multiple Test Range at a 90% confidence level.

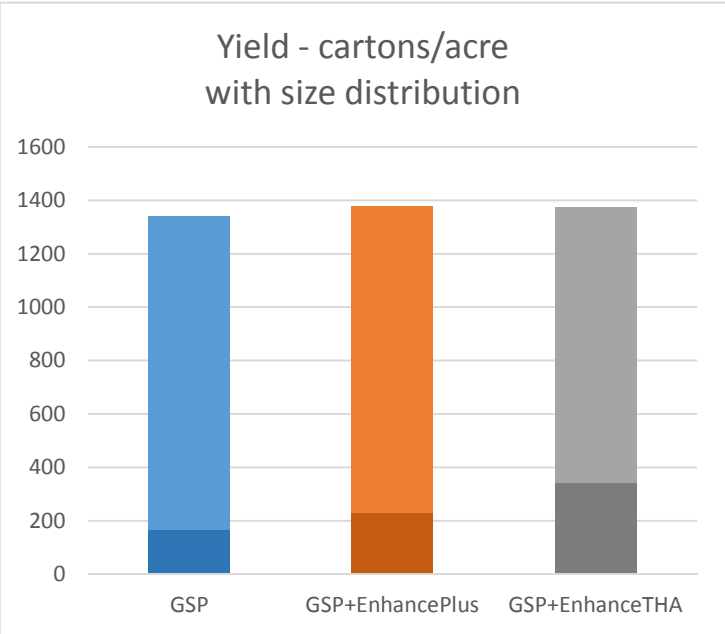
<u>Rotation 2 – Celery 2014 harvest</u>

In season monitoring consisted of taking samples of each replications for weighing. This occurred four times in the season (Sep 25th, Oct 6th, Oct 27th, Nov 18th) with the first two sampling weighing roots as well as above ground biomass. No significant differences were measured in stalk weights during the season though early root weights show a clear trend of greater root mass with both amendments.

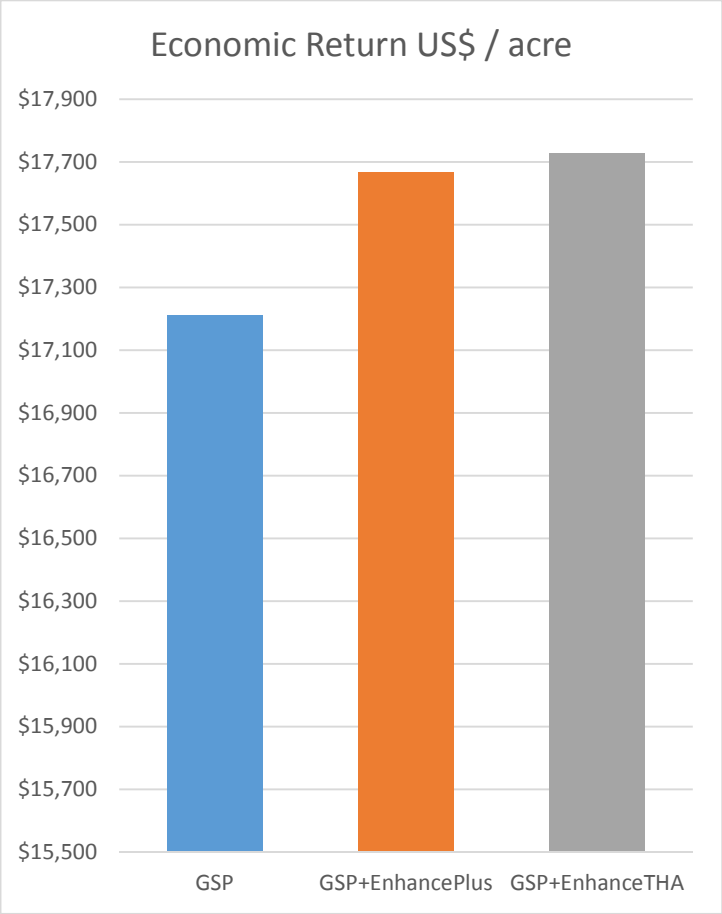


At harvest, 4 stalks were taken from each replication (24 stalks per treatment), cut and trimmed for packing and weighed. The three treatment produced average weights per stalk of 1215g, 1251g and 1250g respectively. Though not a significant increase, the trend of increased weight with the amendments is clear.

Along with incremental increases in stalk weight, the number of stalks also had some increases with the 3 treatments producing 1340 cartons/acre, 1380 cartons/acre and 1375 cartons/acre respectively. Celery is size graded for packing into a 60lb carton. Significantly the number of high value “18’s” (18 bunches per carton) compared to “24’s” (24 bunches per carton) was 33% higher in the GSP+EnhancePlus treatment (16.7% 18s) over the GSP (12.5% 18s) and a significant 100% higher in the GSP+EnhanceTHA treatment (25% 18s) over the GSP.

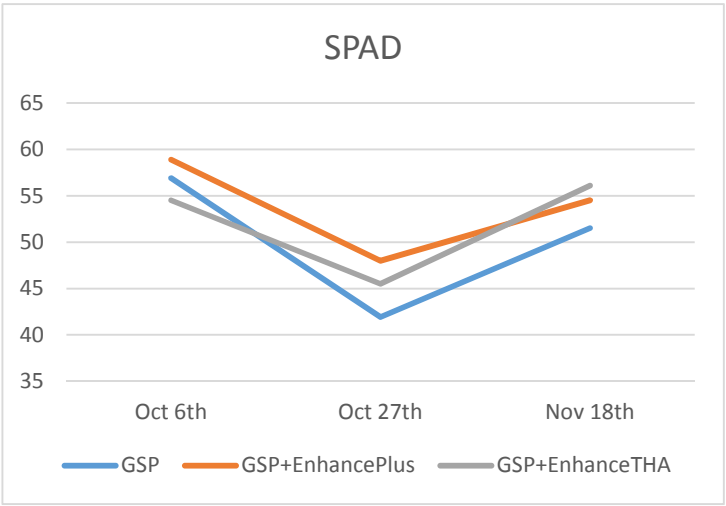


The cumulative gains in production (root mass, stalk weight, stalk numbers, and stalk quality), whilst not significant statistically on their own, have added to a large and significant increase in production economics and returns to the farmer. Using the USDA Market News data on the day of harvest we can determine that the nett grower returns, that include US$6.00 per carton removed for labour, packaging, transportation and cooling, was US$13.50 per carton for 18's and US$12.75 per carton for 24's. Extrapolating this information and adding in the costs of treatment, we find the nett grower returns per acre for each treatment are US$17,211 for GSP, US$17,688 for GSP+EnhancePlus and US$17,729 for GSP+EnhanceTHA.



We can further analyse the economics to determine the return on investment from the amendments. EnhancePlus treatment costs $80/acre and returned an additional $557/acre with EnhanceTHA costing $60/acre and returning $578/acre. Returns on Investment are therefore 596% and 863% respectively.

SPAD readings were taken three times during production (Oct 6th, Oct 27th, Nov 18th) to determine relative petiole chlorophyll content as an indication of the plants nitrogen utilization, the higher the number the higher the utilization. Significant differences were measured later in the season with the addition of both amendments but particularly the EnhanceTHA amendment.



This is supported by pre-plant (Sep 18th) and post-harvest (Dec 5th) soil analysis where pre-plant nitrate levels were 11ppm, post-harvest GSP plots recorded 58ppm whereas the EnhancePlus and EnhanceTHA amendments recorded 23ppm and 10ppm respectively. Petiole nitrate levels were measured twice in production (Nov 17th, Dec 5th) with insignificant differences between treatments recorded and all treatments within accepted ample ranges.

Conclusion:

The results of first two crops, in the four crop rotation, confirm a trend of highly desirable economic increases from the use of the amendments. It is apparent so far, that it is the sum of incremental increases across a variety of growth factors (root development, flowering/fruiting, mass density, nutrient use efficiency, etc) and not one large increase in one factor that is responsible for the economic gains.

With cumulative returns on investment well over 1000%, the addition to EnhancePlus or EnhanceTHA to a grower standard program is an economic and environmental win in this farming system.

REFERENCES

[1] Lapedes, Daniel N., ed. (1966). "McGraw-Hill encyclopedia of science and technology: an international reference work, Volume 12". McGraw-Hill. p. 428.ISBN 0070452652. The value of adding organic matter to the soil in the form of animal manures, green manures, and crop residues for producing favorable soil tilth has been known since ancient times"

[2] Achard, F.K. *Crell's Chem. Ann.* 2, 391-403 (1786)