Insights, Experiences, and Opinion of Tank's Green Stuff Compost

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Abstract

Composted materials are important to agriculture. They are the resultant product of decayed organic matter that provide nutrients required for plant growth as well as foundational materials for sustainable soil health, structure, and biological activity. Thus, properly dosed and applied quality compost material can be a great plant nutrition input and a valuable soil amendment that stimulates biological activity, improves Cation Exchange Capacity, reduces the negative effects of abiotic stress, and suppress the impact of plant disease. *Tank's Green Stuff Compost* is a high-quality organic compost material available to growers in America's desert southwest.

Disclosure

The commentary shared within this document include my professional observations regarding *Tank's Green Stuff Compost* and are based on my experiences as a Certified Crop Advisor (CCA). I approach this with over 20 years of experience within diverse organic and conventional crops, primarily in agricultural production fields in the American desert southwest. *Tank's Green Stuff Compost* is a material that I currently include in recommendations to clients.

This white paper was produced at the request of Tank's Green Stuff, with the intent of sharing my professional opinion on their compost product based on my own experience and insights as an independent Certified Crop Adviser, who has used Tank's Green Stuff Compost as a component of

Crop Nutrition Recommendations developed for clients in Arizona. Tank's Green Stuff provided compensation for this piece, however I had full flexibility on content. The final draft was reviewed by a representative from Tank's Green Stuff to improve clarity and accuracy. No alterations were made that effect my message.

1. Introduction

In response to the public's appetite for sustainably grown foods and the corresponding increase in organic certified crops produced, the demand for composted materials for agricultural production has gained momentum. To successfully produce organic crops, growers in the desert southwest must supplement with additional organic material inputs in their cropping systems to improve quality and yield. Due to the complexity of plant-soil-input interactions, the concise data driven justification for use of organic inputs remains elusive. However, the benefits of including organic materials in the cropping system are evident and well understood amongst organic producers and agronomists.

When discussing organic production systems, is important to understand the cost-to-benefit relationship in the context of how organic materials work. It is difficult and expensive to satisfy plant nutritional needs due to time constraints, as well as uncharacterized soil and nutrient interactions. However, certain organic production methods have proven very successful across organic and conventional production systems.

For example; the cost per unit N of organic certified nitrogen fertilizers, such as the increasingly popular soy-hydrolysate based fertilizers (i.e. True Organics 13-0-0, Growers Secret 14-0-0, Explorer 16-0-0, etc.) are much higher than the cost per unit of nitrogen (N) supplied by conventional fertilizers. However, these materials can be valuable tools in conventional and organic production systems to improve plant performance under certain conditions of abiotic stress (non-living

stressors such as climate, mineral, mechanical damage, etc.). Economically, the correct conditions can frequently justify the increased unit cost of these more expensive fertilizers. Further, less-expensive, synthetic fertilizer products are not permitted for use in organic production systems, and may add factors that increase abiotic stress, therefore are not on equal grounds for comparison.

The widespread use of commercial and synthetic fertilizers has created a commodity view on agricultural inputs, where composts and fertilizers are valued by the content of a limited number of chemical nutrients alone. In other words, the value is set based on a specific amount of chemical nutrient content, rather than the effect on plant performance. In the field however, growers obtain better results when fertilizing materials are considered in the context of the overall benefits provided. Consider for instance conventional N fertilizers such as anhydrous ammonia and ammonium sulfate. For many applications, the less expensive anhydrous ammonia may actually be detrimental to the overall performance of the crop production system due to unintended consequences, or side effects. This phenomenon is especially pronounced when considering finished compost materials which consist of more diverse tag-along content than an isolated elemental fertilizer. Not only do compost materials provide chemical nutrients for plant use, but through diverse bio-interactions, they also have lasting beneficial impacts in soil structure, biodiversity, bioactivity, pH, nutrient holding capacity, and overall cropping system health. It is important to consider the comprehensive impact of applying any organic material and have a clear understanding of what the product actually consists of.

2. Description

Tanks Green Stuff Compost is an Organic Materials Review Institute (OMRI) listed, temperature stable ("finished"), no foul odor, agricultural grade compost manufactured near Tucson AZ. It is the product

of the aerobic decomposition of combined green landscape debris, cow manure, and added beneficial microbes. *Tank's Green Stuff Compost* is manufactured at a purpose-built facility designed to process large quantities of material, homogeneous mixing of parent materials, building the composting windrows, and timely turning while managing the product to meet optimum moisture and temperature parameters. The finished product is temperature stable and has no unpleasant odor. Tank's Green Stuff representative Emily Rockey, describes the manufacturing process as follows:

"The compost is required to maintain an internal temperature of 131^0 F and must be turned at least 5 times in a 15-day period, according to US composting Council's standard to which Tank's adheres. When the temperatures indicate that the composting process is complete, the material is screened to ¼" minus. Then it begins the curing phase which is at least 1 months' time, or more if available."

3. Materials

1) Green landscape debris /waste: The principal component of this compost (70%) is fresh green matter collected from home, commercial, and golf course landscapers in the Tucson, AZ area. The debris includes leaf, stem, and trunk material and is void of grass clippings. The materials are deposited at Tank's Green Stuff composting facility, sized, mixed and processed year-round.

2) Manure: Fresh, organic, cow manure comprises 30% of the ingredients. It is procured from a local Shamrock Organic Dairy Farm and tested to meet accepted quality standards.

3) Other materials: To enhance performance, Tank's compost is inoculated with Bactifeed Soil System, a commercially available, OMRI-listed organic soil product, containing several species of beneficial bacteria. (Bactifeed is commercially available from Terra Sana LLC, South Jordon, UT). To

manage compost pH Tank's Green Stuff adds Tiger Brand Organic Elemental Sulfur throughout the process.

Tank's Green Stuff goes above and beyond industry standards by performing monthly 3rd party lab analysis for nutrient content, heavy metals, and biological batch testing (for stability and maturity) on their material. This third-party testing is performed by independent labs in compliance with the US Composting Council's "Seal of Testing Assurance". Furthermore, Tank's Green Stuff performs annual testing of an extensive panel of pesticides to assure no residual chemicals are inadvertently applied to their client's soils. The company openly shares lab analysis and certification documentation with their clients, creating a high level of transparency which is very useful for documenting due diligence, making well supported recommendations, and building end-user trust.

4. Benefits and Importance of Using a Finished Compost

A high-quality finished compost can be a valuable tool to manage certain conditions that limit plant performance in the desert. Desert growers face extreme temperatures, calcareous soils, marginal quality water, limited water resources, low Organic Matter (OM), and high salinity (EC). Any one of these conditions can pose a real challenge to experienced growers, but in desert cropping systems, all of these conditions exist simultaneously.

High ambient temperatures and low humidity, and to a lesser extent soil chemistry and the limited quantity and quality of irrigation water, prevent building organic matter in the soil. In essence, the organic material that normally would deposit in the soil to build replenishable stores of organic matter is desiccated and consumed by the severe ambient conditions, locally referred to as "solarized". Low OM limits biodiversity and biological activity, which are essential to the natural expression of plant functions. Thus, growing in the desert under conditions of reduced water use

efficiency, poor soil structure, extreme temperatures, marginal quality water, and limited nutrient availability can be very challenging. In some extreme cases these adverse conditions can increase pressure from pests and disease, by suppressing the natural defense mechanisms of the plant and the soils.

However, the desert southwest offers a unique production window during both summer and winter months, where temperatures are ideal for many high-value and desirable crops. The judicious applications of compost can support a more suitable quantity of bioactive OM in these mineral soils, alleviating many of the challenges described above. Adding a finished compost allows growers to take advantage of the unique traits of the desert southwest by replacing the soil carbon lost as CO2 via microbial respiration during the hot, dry summer months.

When choosing a compost, it is important to choose well finished materials such as *Tank's Green Stuff Compost*. While unfinished materials usually have lower acquisition costs and may have higher nitrogen concentration, savings quickly vanish with the introduction of abiotic stress factors detrimental to plant performance. Unfinished composts typically introduce performance limiting factors such as unbalanced nutrient content, excessive carbon that can immobilize supplemental nitrogen, phytopathogens, high salinity, and/or weed seeds. Since the digestion process of unfinished materials is incomplete, decomposition must continue in the soil, leading to unpredictable nutrient release characteristics, including a net negative effect on plant available nitrogen for unspecified periods.

Unbalanced nutrient quantities can also limit plant performance, especially when high quantities of salts are present in the compost. High electrical conductivity (EC) in the root zone caused by excessive amounts of soluble nutrients can limit plant uptake of necessary nutrients and water, resulting in reduced yields and/or produce quality. Sodium should receive special attention, as it is

present in significant quantities in well water. Soil conditions with elevated EC cause developmental damage on root hairs and young roots which is of specific concern because new root hairs are required for uptake of Ca. Many of the blossom end rot issues experienced in the desert are not caused by a lack of calcium in the soil solution, or enough irrigation water, but by the effects of excess in salinity which inhibits that plants means for Calcium uptake. Since composts are applied in relatively high quantities, it is important to choose materials with moderate EC and low sodium in order to avoid building soil quantities that may affect soil structure and nutrient uptake. *Tank's Green Stuff Compost* lab analysis reports low EC values around 5.3 ds/m compared to typical dairy or beef manure which can range from 9-40 ds/m.

Extreme pH and/or excessive amounts of individual micronutrients may limit the uptake of other nutrients. For instance, high pH often limits micronutrient availability, as is the case of excessive iron (Fe) limiting manganese (Mn). A common practice is to develop recommendations by calculating the total amount of nitrogen (N) required for desired yield, while ignoring the content of other nutrients. This approach is simple and straightforward, but it may lead to inadvertently applying excessive amounts of non-target nutrients.

A better practice is to consider beforehand as much information as possible about the soil, water, and crops, then estimate the needed quantity of the most limiting nutrient. Since calcareous soils have high buffer capacity (meaning the soil resists changes in pH), the risk associated with fluctuations in pH is secondary to the potential of unbalancing nutrients by inadvertently applying too much of one particular nutrient. It is advisable to limit the amount of compost by the highest risk factor, and supplement N, P, or K with other forms of fertilizer. This reduces the risk of unintentionally over-applying risk nutrients like chloride (Cl) or sodium (Na). While this approach may not yield the cheapest possible recommendation (especially true when using organic certified materials, like soy

hydrolysate nitrogen fertilizers mentioned before), it does reduce the potential for high salt damage and nutrient imbalance.

Nitrogen immobilization is also a major limiting factor to crop performance and should be an important consideration when selecting compost materials. In the presence of high quantities of carbon, supplemental nitrogen is consumed by microorganisms to build complex organic molecules within their bodies. As microorganisms live, the nitrogen is temporarily made unavailable and the carbon is released as CO2. As the microorganisms die off their organic compounds decompose, the nitrogen is released back into the soil, making it available for plant use. In this context immobilized N refers to unavailable nitrogen, temporarily held in an organic form, which will slowly become available through mineralization.

A practical measurement to manage the risk associated with nitrogen (N) immobilization is to consider the carbon to nitrogen ratio, or C:N ratio, of composted materials. Independent lab analysis show *Tank's Green Stuff Compost* has a C:N ratio of 14:1, assuring the user that a substantial portion of the nitrogen contained in their compost is available for plant use (mineralized), and will not help immobilize other forms of N in the soil. As mentioned elsewhere in this opinion paper, high amounts of carbon in soils can immobilize nitrogen by converting otherwise available N into unavailable forms. Generally, ratios above 25:1 favor N immobilization (unavailable), while those below this value tend towards N mineralization (available). When nitrogen, carbon, water, heat and other nutrients are present in soils, biological activity increases due to micro-organism utilizing the carbon and nitrogen in their metabolic processes. As the microbial population growth stabilizes, the C:N ratio lowers as carbon is released by respiration (CO2), and some of the nitrogen becomes available for plant use when C:N approaches and falls below the 25:1 value. Lower than 25:1 C:N ratios are indicative of higher amounts of N available for plant use. Fundamental understanding of C:N ratios and how it affects cropping systems is important to avoid unintended consequences. *Tank's Green*

Stuff Compost has a low 14:1 C:N ratio, suggesting a very low risk of tying-up nitrogen, and immediate availability of some of the N contained in the compost.

To further assure full maturity, quality, and stability, Tank's Green Stuff conducts bio-assay testing that includes germination of cucumber, respiration rates, and Ag Index (ratio of beneficial nutrients to detrimental salts, where a number below 2:1 is poor and above 10:1 is considered excellent). Tank's Green Stuff freely shares lab analysis with their clients. The values obtained by these analyses demonstrate Tank's Green Stuff materials will not impact germination rates, the compost is mature and stable, and have low amounts of Na and Cl in comparison with other nutrients. The company prides itself in meeting the highest standards of quality for composts, as defined by the US Composting Council.

My understanding of the biological impacts of Carbon-to-Nitrogen ratios in soils came from an experience I had years ago. I came across a well-respected group growing Hatch peppers in the southwest who were looking to increase the sustainability of their operation and following their interpretations of the benefits of increased Organic Matter (carbon) in the soils as explained by their local NRCS advisors. They began incorporating left-over corn stalks into the ground with the goal to improve soil structure and overall soil health. The standard practice was to take tissue samples at several stages of growth to develop fertilizer recommendations. The season progressed normally, until a spike in nitrate N was detected in the tissues, a condition detrimental to the pepper's shelf life.

By incorporating the previous crop's stalks into the soil, the group had inadvertently increased the C:N ratio and the growers compensated for N deficiencies by adding supplemental N fertilizer. Since supplemental nitrogen fertilizer was added to keep tissue levels within accepted sufficiency ranges early in the crop life, a nutrient loading condition occurred in the soil. As the season progressed and

the C:N ratio began to lower, the plants had more nitrogen available than they required at the tail end of the season, having the unintended consequence of affecting crop's quality.

Tank's Green Stuff supplies documentation showing their compost is fully mature, meaning the composting process has reached a point where the measurements confirm that the biological degradation has reached industry accepted values. Their lab reports (see Appendix for sample) show C:N ratios around 14:1, a significantly low number where no N immobilization is expected to occur. As a CCA I feel assured that their compost does not tie-up nitrogen, and that the amount of N reported on the lab analysis can be used as available for calculating fertilizer recommendations. This has been consistent with the post application soil lab analysis and plant performance in my client's fields.

It has been my first-hand observation that finished compost will have a more favorable beneficial vs. detrimental micro-organism ratio (BMs;DMs). While this is an unscientific and an overly simplistic personal narrative to illustrate the characteristics finished compost, it is variable I consider when choosing composted materials. Many first order decomposers arriving early to consume fresh tissue at the compost mix are facultative saprophytes, decomposers who prefer consuming live tissue but may, under certain conditions, adapt to consume dead tissue. A better explanation from an internet source shares:

> *An example of facultative parasitism in fungi, is the Armillaria species. Armillaria or honey fungus are trees or woody shrubs parasites. They can cause "white rot" root disease of forests. As facultative saprophytes, Armillaria also feed on dead plant material, allowing them to kill their host unlike other parasites who avoid their host's death. Some Armillaria can ingest dead wood without any parasitic activity at all. As such, although they are important ecological agents of nutrient recycling by microbial decomposition, they become pests in their role as destructive agents of wood rot. (From https://www.quora.com/What-are-the-examples-for-facultative-parasites)*

As the composting process progresses, the population of saprophytes (feeding on dead tissue), and obligate saprophytes (feeding exclusively on dead tissue and incapable of causing plant disease) increases. For illustrative purposes, I refer to these risky early decomposers as "detrimental microorganisms" (DMs). As the composting process evolves, these early decomposers run out of their preferred food and begin to weaken and die off, themselves becoming food for their natural predators. These crop protecting predators and the non-risky, non-living tissue decomposers are beneficial microorganisms (BMs). BMs help release nutrients from the soil to the plant and reduce the pressure of plant pathogens. A finished compost will have a higher ratio of BMs:DMs.

While low C:N ratio alone does not directly relate to the depth of the compost's decomposition, a stable temperature profile, low respiration rate, high Ag Index, no foul odor and low C:N are indicators of a well finished material.

Additional benefits of applying a good compost to agricultural soils include;

- Improve soil structure, tilth, and water percolation
- Improve general soil fertility
- Indirectly reduce costs associated with nutrition and pest control by providing the plant with improved growing conditions that favor natural nutrition and pathogen resistance mechanisms
- Stimulate bioactivity and biodiversity
- Reduce negative impact of abiotic stress factors

Table 1: Below is a simple table, outlining some compost related issues that have potential to influence yields, listed by cause, effects, and solutions. Tank's Green Stuff lab analysis address these common issues;

Cause	Effect	Solution
High C:N ratio	Make N unavailable for plant uptake	Use composts with documented low C:N ratios
Pathogens / Weed seeds	Introduce / increase risks associated with plant pathogens and weed pests	Only use well finished, mature composts
High Salts (EC)	Damage / slow new root development. Interfere with nutrient availability and uptake	Calculate and limit dosage to maximum risk limiting factor. Consider Ag Index values.
pH	Extreme pH can burn root tissue and limit micronutrient availability	Use finished materials with pH close to neutral
Excess sodium	Elevate pH, interfere with other nutrient uptake and/or availability, affect soil structure	Look for low Na content and higher Ag Index in compost analysis.
Low biological activity	Slow nutrient mineralization process. Anaerobic decomposition of organic matter	Do not use or limit the amounts of composts that emit foul odor

5. My personal experience with Tank's Green Stuff Compost

A few years ago, I needed high quality compost for a client's certified organic nutrition program. As part of my due diligence I contacted Emily Rockey, Tank's Green Stuff sales representative, and asked many specific questions regarding Tank's Green Stuff Compost. This led to an invitation to a complete tour of the facilities and suitable answers with a "no trade secrets" approach. Of great importance were the depth and completeness of the 3rd party documentation provided. I recommended the use of *Tank's Green Stuff Compost* along with a supplemental beneficial bacterial product like the one used by Tank's Green Stuff in their compost. When analyzing 5 years of soil lab data of samples taken from

the same field, at similar depth and times of the season, a substantial spike in soil measurable phosphates (Olsen method to determine plant available phosphorous) was observed, from an average of 7 ppm to 26 ppm. Nitrates (a plant available form of nitrogen) rose from an average of 14 ppm, to 25 ppm. While these were only observations and not part of a replicated study, there were unquestionable indicators of mineralization of N and P in these soils.

Nitrogen and phosphate are commonly the most important limiting factors to yields. P is a key player in photosynthesis, involved in providing the chemical energy required to convert carbon dioxide and water into sugars. In our desert soils the high Ca content tends to bind P, forming calcium phosphate, a very low solubility component of desert soils. The typical approach developed by the University of Arizona is to apply high amounts of P fertilizer like monoammonium phosphate (aka MAP) and 11-52-0 in a single pre-plant application. This practice not only increases crop production expenses, but in my opinion, can be wasteful when used in biologically inactive soils. The amounts of calcium in desert soils is very high, giving soils the capacity to make high quantities of the applied phosphorous unavailable shortly after being applied. Furthermore, when P is applied in amounts in excess of plant requirement, it may be released into the environment as pollutant. The same can be said about nitrogen, which can leach into ground water reservoirs, leech via tailwater, and create excess nitrate problems to growers.

Having worked for over 20 years in the organic/sustainable crop production industry, I've come across several techniques used by manufacturers to legally enhance their product's performance. Formulators and manufacturers secretly add adjuvants, surfactants, penetrants, inoculants, micronutrients, and other materials to the basic formulation, but are not required to disclose the details on the label. While I do not necessarily disagree with these practices, they can be a source of error in developing recommendations, a waste for growers, and occasionally create yield limiting

conditions. Tank's Green Stuff openly discloses of the content of their compost, an uncommon practice that I truly appreciate as CCA.

6. Conclusions

Biologically active soils will modulate the release of nutrients into soil solution, including nitrogen and phosphate, making them gradually available for plant uptake throughout the season. It is a natural time-release process. Using a finished and biologically active compost like *Tank's Green Stuff Compost*, will not only increase the amount of plant available nutrients, but allow for predictable and repeatable nutrient management strategies in organic production systems. *Tank's Green Stuff Compost* has shown to help multiple of the other risk factors common to agricultural production in the desert southwest, including salt management, water percolation, and crop disease response. *Tank's Green Stuff Compost* has proven to me to be a reliable, high-quality compost that is manufactured by an approachable, transparent, and responsible company.