Root stimulation using vermi-products in grape vine propagations

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Abstract

Vermi-products are byproducts produced from earthworms digesting and decomposing a natural material into another. Liquid teas or extracts of vermi-products are another form of leachate material found in the completed compost bin. These products are not high in essential plant macronutrients, have an average neutral pH (around 7.0), and are known for living microbial population.

Grapevine propagations cut from the Trestle Vineyard at California Polytechnic State University, San Luis Obispo were used to observe root growth development using steer compost, vermicompost, and vermi-extract. Propagations used were dormant Pinot Noir clone 777. Compost subsamples tested 5%, 10%, 20%, and 40% by volume compost: soil media. California Polytechnic State University provided steer compost from on-campus animals and operations. Subsamples tested steer compost at volumes of 5%, 10%, 20%, and 40% by volume steer compost: soil media. Vermivision, Inc. (San Diego, CA) supplied both the compost and extract

for this study. Vermicompost subsamples tested 5%, 10%, 20%, and 40% by volume weight of vermicompost: weight of soil media. Vermi-extract was applied weekly at rates of 2.5mL, 5mL, 10mL, and 20mL. After propagations were callused, rooted, and subdivided, treatments were left for eight weeks. The variable measured in these treatments was root growth and development during this period. Data analysis was completed by ANOVA, using the Tukey HSD test for mean separation, with $p<0.05$ at the level of significance. Tukey test results show no difference between vermicompost or steer compost and vermicompost or vermi-extract. However, there was a significant difference between steer compost and vermi-extract. Roots that were treated with vermi-extract were 15% longer than roots treated with steer compost.

Introduction

Compost is an alternative form of a previously existing biodegradable product. Composting is the act and process of changing an initial material into another through biological and chemical processes. Composting mixtures are often heterogeneous, utilizing positive attributes of multiple products to create a type of "slurry". Generally used for agriculture production purposes, compost is made from animal manure, which contains the highest nitrogen content compared to other starting compost materials, and is accordingly used to return those nutrients back to the soil.

Earthworms are found in the Oligochaeta subclass of taxonomy. They are commonly found about 10 cm long and 1 cm wide with a cylindrical segmented body (Oligochaete, 2014). Earthworms are able to move about and within the soil contracting and elongating their bodies. Beneficial gains from these worms are the chemical conversions of organic matter, biological improvement of soil fertility, and amended physical soil structure through tunnels enabling aeration and water drainage (Oligochaete, 2014). Earthworms are essential for numerous reasons, but most importantly, quickening the availability process of nutrients to plants. This is done by way of fragmentation mixing of soil layers, degradation, and digestion.

There are two basic vermi-products sold and distributed on the current market: vermicompost and vermicompost tea or extract. Vermicompost as a product from aerobic and mesophilic microbial processes involving complex interactions between earthworms and microorganisms (Arancon, Edwards, Lee, 2002). This relationship between earthworms and material stabilizes the organic matter, reduces the carbon: nitrogen ratio, and makes the nutrients that it contains readily available to plants. This compost product is a dry material, dark in color, soft texture, able to be banded or broadcast onto soil by a tractor compost spreader.

Other vermi-products commonly confused with name interchanges are tea and extract. Vermi-extract is made per batch and is similar in composition to the liquid leachate in the compost bin. By comparison, vermi-tea is brewed for a given time period, allowing the liquid to aerate (Ausoworm, 2011). Both concoctions are secondary products to the compost created, however, concentration density and physical processes change the term choice.

Researchers in India were one of the earliest to study vermi-products more than 30 years ago. One project design included vermicompost originally composed of paper, food, and cattle manure. This study was examining the effects of compost on nematode populations. Three types of nematodes were tested for nematode related disease dispersion using broadly categorized parasitic, bactivorous, and fungivorous nematodes (Arancon, Edwards, Lee, 2002). Conclusions stated in vermicompost treated soil, parasitic nematodes were significantly suppressed. Additionally, in vermicompost treated soil, bactivorous and fungivorous nematodes were significantly increased compared to inorganic fertilizer, and reduced populations in unfertilized grape plots.

Scientist C. Buckerfield (1998) from South Australia tested vermicompost on grapevines. Two site trials were conducted on Pinot Noir and Chardonnay varieties resulting in significant yield increases in each. Site A responded with a 56% yield in Pinot Noir and site B Chardonnay with a 34% yield increase. Speculation about this yield increase may be constituted by compost application and incorporation promoting vine balance. Site A and B used worm species *Eisenia fecida* and *Eisenia Andrei* creating vermicompost from grape marc (site A) and from cattle manure (site B). After the vermicompost application under the vines in the vine row near the rootstock base, straw was added for extra decomposable nitrogen/organic matter. Results were based on Brix (%), juice (pH), and Titratable acidity (g/L). Soil moisture from the first 10 cm was also taken to compare for future information (Buckerfield, 1998). Results showed the absolute significance of covering compost compared to previous trials not covered as a direct result of yield estimates. Compost that was covered promoted the product to be naturally intermixed by decomposition, as well as, preventing photo degradation. A proposed explanation Buckerfield stated due to the great success was minimal leaching of vermi-product from lack of irrigation and forced vine stress. Furthermore, the applied product was available within the root zone and not leached.

Vermicompost teas have been tested for foliar applications on the grapevines against pathogens. Research suggests teas are extremely useful preventing fungal phytopathogen diseases like *Botrytis cinerea*, or *Rhizoctonia solani* in varying crop commodities (Marin, 2013). Studies conducted by Marin, Santos, Dianez, and research team from the University of Almeria, Spain, investigated the characteristics of compost teas from different sources and their suppressive pathogens effects. Two crop composts, including grape marc, and one vermicompost was tested with 8 different pathogens. Each type of tea had an aerated and non-aerated formulation. The type of extractions method used to create the compost tea did not directly affect the results. Compost composition determines the microbial population present (Marin, 2013). Furthermore, this sample resulted non-sterilized compost teas (filtrates) provoked a significant inhibition on pathogen mycelial growth, regardless of extraction method (aerated or non-aerated) and compost to water ratio tested (Marin, 2013).

Vermi-products are natural usable byproducts created by earthworms through digestion of decomposing material. The resulting compost or extract/tea is marketed and sold as a soil amendment for production purposes promoting plant vitality. Application processes vary and are able to suit many users' needs. This product is not a high nutrient fertilizer, however, it provides to the crop with the addition of soil microbes unlike synthetic products. Further research considerations include extensively testing this product for average nutrient content and potential microbial populations present.

Materials and Methods

Site description: Experiments were conducted at the greenhouse above Building 11 on Cal Poly Campus in San Luis Obispo, California in the 2013 growing season.

Experimental design:

While in the vineyard, approximately 300 Pinot Noir clone 777 dormant canes were cut. These were dormant wine grapevine propagations from lignified canes. In order to minimize variation among subjects, propagations should be the same genetic clone and from vines approximately the same age. An average maturity was established of all cuttings. Once cut, propagations were placed in a refrigerator to use at a later date. By doing this, one ensures dormancy. When ready, cuttings were removed from the cold environment and prepared for treatments.

Due to exposure in various environments to pathogens, fungi, etc., cuttings were sterilized by placing them in a 10% solution of bleach and water for one minute. After, wet cuttings were placed onto a table to air-dry. Cuttings were prepared for initial callus and rooting media using a 50:50 peat moss and sawdust mix. Place plant flats on heating pads in a controlled greenhouse-like environment for controlled temperature and humidity. Individual cuttings were placed in mixed media flat with slight spacing between each propagation. Planting media never dried and was always kept moist. Cuttings were not tampered with until "bud swell" which indicated initial callusing and root development. Once "bud swell" and leaves were released from buds, preliminary rooting occurred.

Sample groups were created and subsample group variable requirements:

i.e. sample group for vermicompost testing subsamples with variable amount of product at 5, 10, 20, 40% by volume

Propagations were divided into sample and subsample groups with no less than 20 cuttings per subsample. Control sample was advised to double average subsample size (i.e. 40). The appropriate variable media type per subsample testing was created, for example this experimental design vermi-products were tested.

Control sample contained only peat moss and perlite: 40 cuttings used

Vermicompost by volume mixed with perlite and peat moss: total 20 replications

Subsample 5% by volume- 5 replications per subsample

Subsample 10% by volume- 5 replications per subsample

Subsample 20% by volume- 5 replications per subsample

Subsample 40% by volume- 5 replications per subsample

Steer compost by volume mixed with perlite and peat moss: total 20 replications

Subsample 5% by volume- 5 replications per subsample

Subsample 10% by volume- 5 replications per subsample

Subsample 20% by volume- 5 replications per subsample

Subsample 40% by volume- 5 replications per subsample

Vermi-extract applied once per week: total 20 replications

Subsample 2.5mL- 5 replications per subsample

Subsample 5mL- 5 replications per subsample

Subsample 10mL- 5 replications per subsample

Subsample 20mL- 5 replications per subsample

Plots consisted of four cuttings, each in a 5-centimeter wide cell, within a 20-centimeter wide by 20-centimeter deep plastic container. Planting date was recorded along with subsample variations. Subsample variation observations were made over the 8 weeks trial period. Plants were watered frequently to maintain a constantly moist soil. Treatments were applied once per week for vermi-extract, and applied compost initially. One sample was taken from each of the 5 replications. Findings we recorded based on plant appearance until data collection day. Data were collected by photography using a cell phone camera, inputted into the computer and zoomed in to actual life size. After which, a ruler was used to measure the longest root length in the plot. Results were concluded based on current findings. Data analysis was completed by ANOVA, using the Tukey HSD test for mean separation, with $p<0.05$ at the level of significance.

Results

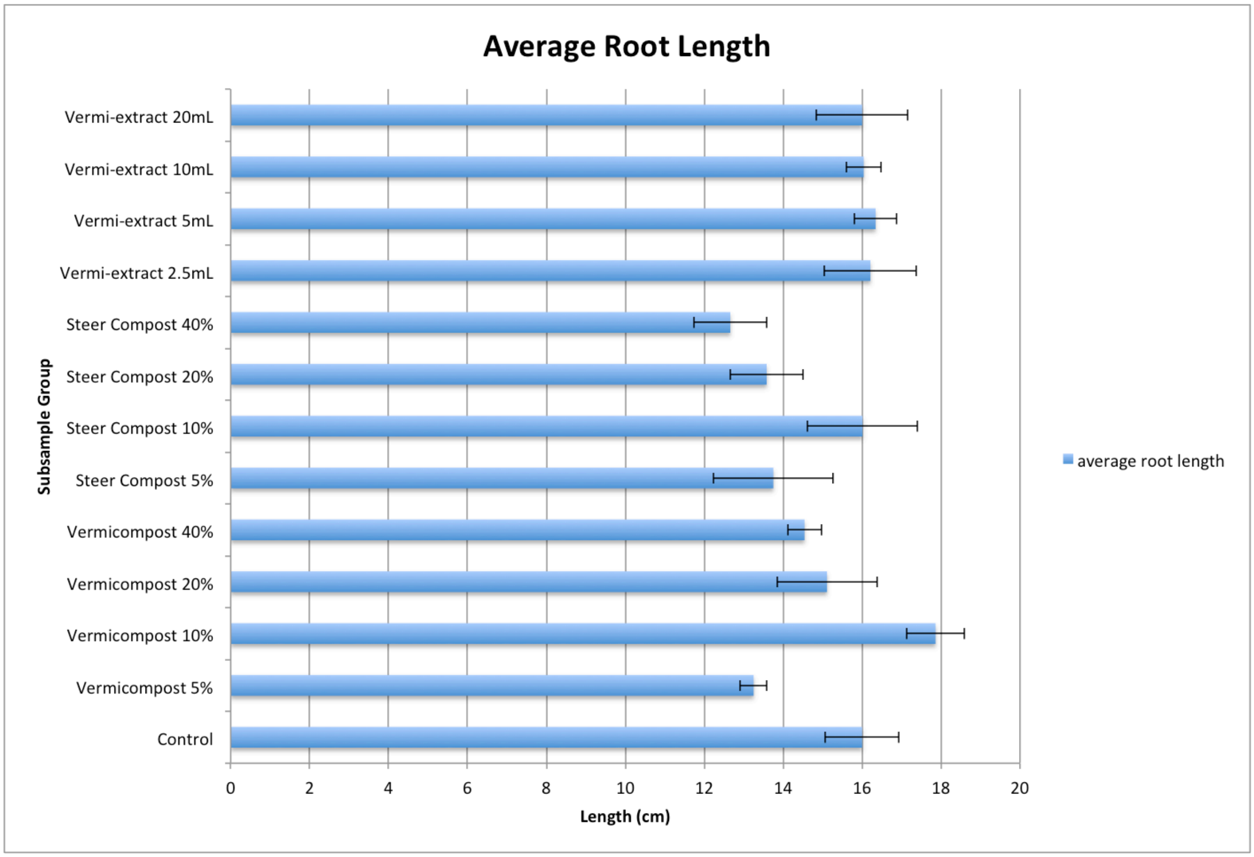
There were overall significant differences in root length for the compost treatments ($p=0.008$) and concentration ($p=0.018$) treatments. There was significant difference in concentration on root width (p=0.049) but not area (p=0.292). Tukey test results show no difference in root length between vermicompost or steer compost and vermicompost or vermi-extract (Table 1). However, there was a significant difference between steer compost and vermi-extract. Roots that were treated with vermi-extract were 15% longer in length than roots treated with steer compost (Table 1). Tukey test results show no difference in root area between vermicompost or steer compost and vermicompost or vermi-extract (Table 1). Roots that were treated with vermi-extract were 40% higher in area than steer compost (Table1).

Table 1. Tukey mean separation test for length and area.
Values are for root length (cm) and area cover (% per cell).

Length	
Compost	
VC	15.2 ab
Steer	14.0 b
VE	16.1 a
Concentration	
1	14.4 b
2	16.7 a
3	14.9 ab
4	14.4 b

Area	
Compost	
VC	1.6 ab
Steer	1.5 b
VE	2.5 a

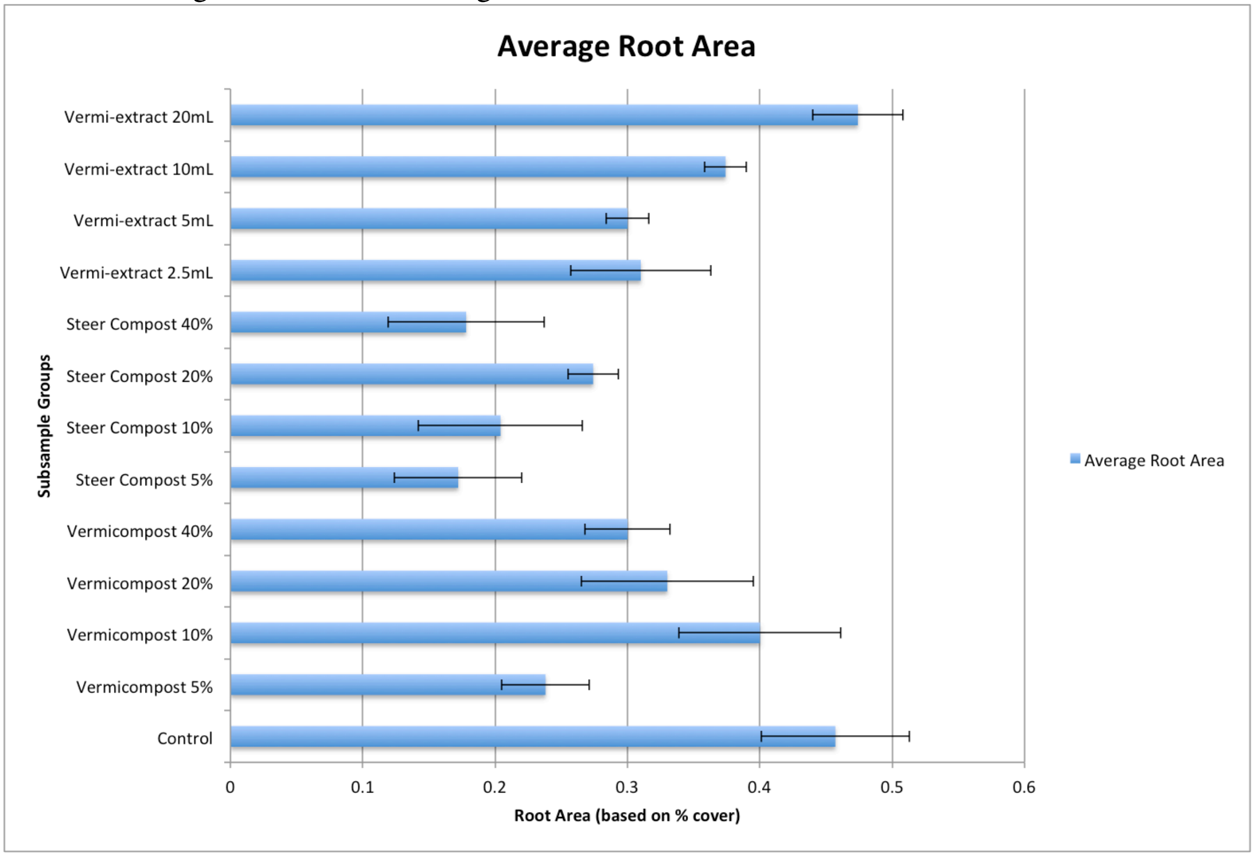
Chart 1. Average Root Length including Standard Error



The data results above describe each subsample average root length and the specific subsample calculated standard error.

Results showed an average root width consistent throughout the experiment with the exception of Vermi-extract 2.5mL application rate that had an increased root width average value (0.26 cm). Application rate of 2.5mL, Vermi-extract sample root width and length increased. In general, Vermi-extract subsamples contained constant root length results. Vermicompost 10% by volume showed root length increase more than other subsamples; while root width data had a standard assessment. Interestingly, Vermicompost 5% by volume showed an extreme drop of numbers in all categories. All Steer compost trials contained constant number of roots analyzed.

Chart 2. Average Root Area including Standard Error



The data results above describe each subsample average root area analyzed and the standard error, specifically.

Based on the data above, Vermicompost 10% by volume provided the best results with increased root length and root area analyzed compared to those of higher concentration. Without any other comparative variables, a thorough explanation cannot explain why Vermicompost applied at 10% by volume surpassed other concentrations. Vermicompost applied at 5% by volume resulted approximately half the values compared to the double applied amount at 10% by volume. This is possibly due to half the required nutrients and beneficial soil microbes available to 5% by volume subsample plants. As previously stated, Steer compost resulted in overall lower values than the control and other subsample groups. This material contains fewer nutrients and is more acidic than vermi-products, both attributes explaining these results.

Discussion

My study found that vermi-extract increased root length compared vermi-compost or steer compost. It is unclear why, however, speculated the beneficial microbes and root interaction. Due to constant watering, plants may have been more efficient at water uptake, therefore, extract uptake. Comparable research was conducted on pak choi, however, focused on vermi-product nutrients.

A study hosted by researchers at the University of Hawaii analyzed the effects of vermi-products on pak choi (Pant et al, 2011). Soil medias tested were two different soils compared to a peat-perlite medium. Conclusions from these researchers include: the beneficial enhancements of plant yield, mineral nutrient content, and total carotenoids in plant tissue under both compost and Osmocote fertilizations. The significance of this finding was substantial based on the following results: above ground plant fresh weight, above ground plant dry weight, root dry weight, and total root length. In these findings, amongst the variables of compost fertilization, aerated vermicompost teas and non-aerated vermicompost teas did not show a significant difference. However, both were extremely more successful than the control or mineral nutrient solution. Of the three soil mediums used, peat-perlite showed the best results followed by Oxisol then Molisol. An explanation for peat-perlite showing the best results might consider the original starting material contained the least available nutrients and soil structure. Due to the neutrality of vermicompost tea, it did not affect the pH of growth media, although it increased the electrical conductivity, nitrogen and potassium content. My research is similar to this study using the same soil media, peat perlite, with results promoting vermi-extract.

Vermi-product research has shown to be potentially beneficial, although, more research needs to be conducted. Based on the research information collected, the examples cited presents a situation where vermicompost and vermi-extract/tea needs to be addressed more directly by agriculture production leading to expansion on a commercial basis. There is no researching suggesting negative or harmful results due to vermicompost or vermi-extract/tea.

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