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Using Compost in the Vineyard

by Philip Roth

Editors' Note: Philip Roth is the proprietor of Roth Vineyard in Fairfield, Adams County, Pennsylvania. Composting in vineyards on the East Coast is not a common practice, and his experiences should be of interest to many readers.

The ancient Chinese knew that plant residues, when returned to the soil, would benefit crop yield. The Egyptians knew it, the Greeks knew it, and George Washington in colonial America knew it - practicing what today we call composting. Archaeologists have excavated what Washington called his "dung repository," a 32 x 1 2 foot building just east of Mount Vernon's stables. One 1796 reference from Washington's papers instructs, "Let others rake and scrape up al I the trash of every sort and kind about the houses, and in the holes and corners, and throw it... into the dung repository."[1]

Is there anything new under the sun? Yes: significant insights regarding soil biology. In the mid-1980s, ecological papers began to surface defining in notable detail how soil organisms interacted, and the evidence indicated that there was more to good plant health than pH, nitrogen, phosphorus and potassium. The soil/food web concept was expanded and refined. Some long-held and cherished notions regarding the processes of plant nutrition were getting trashed. And the microbiological environment ascended to equal status with soil chemistry in matters of plant husbandry.

Background

The process of photosynthesis has been known and acknowledged for many years. Between five and twenty-five percent of the sugars manufactured by the plants are translocated to 'the roots where they are exuded into the soil to feed the micro-organisms. that in turn release nutrients to the plant. The uptake of water, nutrients and other elements by the plants support increased photosynthesis, growth, cell processes, production of seeds/fruit and carbohydrate reserves. In short, the process can be thought of as a dynamic communications interconnection between plant and soil, with the interconnection being a vascular loop taking in sunlight and $C0_2$ while giving up oxygen topside, giving up carbohydrates and taking in water and chemical elements below ground. There is a momentary net gain powered by sunshine, as evidenced by plant growth and seed/fruit development. The microorganisms may or may not be able to deliver the nutrients in the amounts and variety the plant calls for. The plant-soil exchange requires a reasonably good balance of physical, chemical and biological soil characteristics for this interconnection to operate optimally.

The new information highlighting the role of soil biology to plant nutrition suggests how growers can in fact influence this interconnection by fostering the soil's ecological equilibrium through modifying soil texture, increasing water-holding capacity, aeration, reducing compaction, using natural sources of chemical elements and adding/nurturing biological organisms. The key to all this is soil organic matter. Scientists have been revisiting the old concept that organic matter is central to the soil's function and the basis for natural fertility.

Moreover, research has demonstrated that elevating microbial activity to higher levels could control soil pathogens. The good guys would defeat the bad guys by out-competing the disease-causing organisms for living space, or feed on the bad guys, or produce antibiotics to kill pathogens and thereby eliminate them, or create a soil environment where the pest survived but was incapacitated and unable to cause trouble. Beneficial organisms were found to reduce nutrient losses and to help degrade toxic soil compounds. Microbiological life at this level, however, can only be sustained in soils with relatively high organic matter.

One can scarcely escape a sense of awe at the unseen scheme of things underfoot. There is also that sense of seeing only the elephant's tail. As our capacity to comprehend expands, what other consequential dimensions still escape our understanding?

In recent years, farmers and the chemical industry that farmers rely on for pesticides have responded to one pest crisis after another. Many thoughtful growers increasingly believe that chemical agriculture today is flawed. We have been trying to control or eliminate pest problems synthetically for more than seventy years, and today we have more pest problems than we did previously. There must be a better way. Ignoring natural processes in our rush to find a quick, economical short-term fix for each crisis is causing economic distress, not to mention environmental mischief. Over the years chemical agriculture increasingly caused organic matter to fall into neglect. Interestingly, the technology developed to manufacture gunpowder was diverted to synthetic nitrogen fertilizers following World War 1. There was excess production capacity and synthetic fertilizers became dirt-cheap. Synthetic commercially manufactured fertilizer made American farmers the envy of the world economically, but unfortunately it did for plants what steroids do for athletes. The immediate results were impressive, but ignored the future consequences.

Synthetic fertilizers have a relatively high sodium content not found in natural fertilizers which displace calcium, potassium, magnesium and destroy soil physical qualities by causing the soil aggregate to collapse. The net result is that synthetic fertilizers drive organic matter, cation exchange capacity (a chemical measure of fertility) and pH lower. This has a devitalizing effect on soil microorganisms. Biologically speaking, synthetics tear things up and cause chaos and mayhem. As natural fertility declined, the grower became caught up in a cycle of spending more on purchased fertilizer inputs and chemical pest control, to maintain a mere status quo. In short, using synthetic fertilizers and chemical pest control measures created a state of dependency on repeat applications and resulted in declining natural fertility due to lower organic matter levels and reduced biological reproduction and activity.

What are the options for increasing soil organic matter to shake loose from this pervasive dependency? Using plant residue as the ancient Chinese did is one option. A second would be crop rotation, taking land out of production (for agronomic crops) every third or fourth year to grow an unharvested cover crop. These alternatives are today generally rejected as uneconomical and therefore impractical. Grape growers can maintain organic matter by astutely managing sod middles, but organic matter can rarely be significantly increased by this practice alone. Another option would be the use of animal manure, but spreading manure on a bearing vineyard at rates high enough to impact organic matter is analogous to throwing gasoline on a fire. The nitrogen component gives rise to rampant growth and a lower quality vintage.

A much better option, closer to nature's method of recycling plant residue, is composting, a combination that often utilizes both plant residues and animal manure.

The Practice of Composting

Composting is the natural process of organic decomposition, accelerated. Consider the tree that falls over in the woods. How long will it take before that tree loses its distinguishable form as a tree to that of a ribbon of humus on the forest floor - I 0 years? 20 years? If we chip that same tree, add nitrogen and water, stir frequently to keep the microbes supplied with oxygen, we can reduce that tree, whatever its original size, to very nearly the same pile of organic rubble in six months.[2]

Much is made of the carbon:nitrogen ratio (C:N). The optimum ratio is 30 parts carbon to one part nitrogen. Every organic substance has a distinctive ratio and by weighted average math a would-be composter willing to measure ingredients can come close to this ideal. However, as a practical matter, close is good enough. What matters is getting the ratio low enough to generate sustained temperatures over 130° F for a few weeks to kill pathogens and weed seeds.

The literature abounds with varying composting techniques for smaller quantities of compost and where the end result before soil application is also somewhat variable. For example, alternatives to thermophilic composting is vermiculture (using worms) and static pile composting that exchange time for temperature. Also, a grower can use compost as a carrier for trace elements or any major element by simply blending whatever element might be desired into the windrow before application. This practice has the advantage of minimizing nutrient losses and operational efficiency by reducing trips through the vineyard. It becomes clear that finished compost can vary biologically and chemically by reason of variability in original carbon and nitrogen sources, and the kind and quantity of amendments.

Little can go wrong if given moderate attention, particularly in the first three weeks, to keep temperatures under 160° F by adding water and mixing the compost windrow. Later in the process the material can become too wet from rain if not covered or if the compost is situated where water accumulates at the base. The compost can then go anaerobic, and disagreeable things happen. The condition is easily identified by texture, color and/or smell. In general, something good will happen by mixing carbon, nitrogen, water and stirring occasionally. It's almost guaranteed.

What are the benefits of compost? In contrast to synthetic fertilizer practice that only benefits the soil's chemical realm and negatively impacts the physical and biological aspects, compost has positive affects on all three aspects of soil. The physical aspect - water-holding capacity, aeration, tilth and compaction - are all improved. The chemical aspect - nutrient balance, nutrient retention and nutrient availability on plant demand - are likewise improved. And both the addition to and the nurturing of the soil's biological life are served.

A common misconception is that compost and mulch are the same, but the two are different. We think of mulch as conserving moisture in the soil under it and creating a barrier through which weeds can't grow. Organic mulch has two serious drawbacks: it attracts vermin and it lowers available nitrogen when first applied. Compost layered like mulch doesn't have those disadvantages, but it does have another in that it will not control weeds. Compost, however, is two steps up on mulch: 1) in addition to conserving moisture in the soil, compost additionally absorbs and holds moisture itself, and 2) compost stimulates growth and generally improves plant health.

I have observed that in terms of deeper green color and vigor, a vine's response to compost seems to be in excess of the expected response from the same quantity of nutrients in synthetic fertilizer. That is to say, compost numbers are understated when compared to synthetic fertilizer. Petiole and soil chemistry analyses show nutrient levels to be on the high side of normal to high, but not at levels considered excessive. That seems to argue for the increased efficiency of compost relative to synthetic fertilizer and less waste by leaching and oxidation. Regarding chemical soil analysis, it is noteworthy that as Organic matter, pH and cation exchange capacity rise with the application of compost, the percent base saturation numbers corresponding to calcium, potassium and magnesium shift into what plant scientists consider nearly ideal alignment for optimum plant growth.

Compost at high rates like 30 to 60 tons/acre has shown impressive results in replant sites for strawberries and vegetables. The impact of compost on soil biology as well as physical and chemical properties in these circumstances and at these high rates, is getting continued research attention. It is certainly reasonable to think in terms of transferring that success as it might apply to establishing new vineyards and troublesome replant sites. (On the other hand, 5 tons per acre may well suffice in an established vineyard.)

It is my understanding that by some consensus the nutrient levels suggested as normal on soil and petiole test reports, relate to best vine growth. Nowhere is there a mention of juice/wine quality. Is it correct to assume optimum growth produces great wine? For as long as I can remember, the theory that a vine needs to struggle to produce great wine prevailed. How do we reconcile this apparent contradiction? The answer to that enigma is likely to come from empirical field trials and from growers inclined toward innovation and applied research.

What are the economics of composting for wine grapes? In a vineyard like mine where grapes grow in poor but well-drained soil that will not support any other commercial crop, how much in the way of nutrients does a 4 ton/acre grape crop remove? Intuitively, I would say not much. If quality compost is valued at $30/ton and we use 5 tons/ acre, the per year cost would be $150/acre. Is that affordable, considering the increased production and improved overall vineyard health? Or is this driving a tack with a sledgehammer, in view of the low nutritional requirements for wine grapes? Considering the proliferation of benefits across all three soil facets (physical, chemical and biological), a definitive answer is elusive, but I see it as a fair exchange in our thin topsoil situation.[3]

If we elevate organic matter and natural fertility with compost overtime, would it be possible to save the equivalent of the operating expense of irrigation? For example, suppose we spent the capital investment of irrigation and spread it over 5 to 6 years building our soil's water-holding capacity with compost. The total cost could be written off in the year incurred, a benefit at tax time, and the saved irrigation operating expense put in the bank. Our resources wouldn't be put into depreciable assets that would eventually waste away and need additional investment to replace. Instead, we would have a non-depreciable asset that has long term benefits and doesn't come with malfunctions, cash repairs, or annual labor to operate. It might pay anyone to pause a minute and crunch the numbers. In the third year of composting, our vineyard on average had the highest per acre yield ever in the driest growing season of two decades. No doubt, 1998 helped set up 1999's record yield. Nonetheless, building water-holding capacity, improving soil texture and fertility with compost looks like a promising alternative in our situation.

The Roth Method

Beginning in 1997, 1 applied 22 tons per acre for three consecutive years. Using a Millcreek mulcher machine, compost was used to hill up around each vine in November for wintertime low temperature protection. In the spring, just before bud break, we raked away the compost and spread it between the vines under the trellis, 2 inches thick. After three years the compost band extended 1 1/2 feet on each side of the vine. Starting in 2000, when the vines were 7 years old, and each year thereafter, the plan is to broadcast a maintenance rate of 4-5 tons per acre every fall with a modified manure spreader. A wet lime spreader would be the preferred broadcast spreader method, if I had one. Manure spreaders are not designed for spreading compost, but by fabricating a rear bulkhead to make the discharge uniform, any used rear discharge spreader makes an adequate and economical compost spreader. It is also possible to broadcast compost in early spring as soon as the vineyard floor can support equipment traffic without soil compaction. I avoid broadcasting during the hot summer or during the frozen snow months. The jury is still out about the value of lightly incorporating broadcast applications of compost. Intuitively, we could maximize the benefit with shallow incorporation. To avoid tearing up sod middles, I settle for broadcasting when rain is forecast. In early December after the composting pad is cleared of finished compost, we build new windrows with whatever carbon material is on hand. Breaking open hay bales, adding sawdust, wood chips and leaves, mixing and allowing it to weather over winter gets us off to a good start the following spring. Additional or varied other carbon sources can be distributed over the windrows during the winter months. Food-processing waste such as grape pomace is an excellent carbon addition to compost. Spreading pomace lightly in the vineyard row middle is better than sending it to the landfill, although it pulls hard on nitrogen, lowers soil pH and has no significant nutrient value. Pomace as a composting ingredient (50%

of the total carbon by weight) adds to the diversity of raw carbon sources and that in turn adds to compost quality.

As weather permits in late February, gypsum (calcium sulfate) is added at 5% of the total weight. We're fortunate to have a convenient source of clay on the farm - spoil from an abandoned limestone quarry - added at 5-1 0% of total weight. Any nitrogen source in the form of animal or poultry manure (I prefer bovine manure) is then added and all ingredients are immediately turned and blended to form a peaked windrow five feet high and ten feet wide at the base. Now the decomposition process begins in earnest and temperatures need careful monitoring for the next month.

A great source of compost raw material is mushroom substrate, often referred to as spent mushroom soil. I mix in as much as I can afford to truck over a distance of 90 miles. Mushroom growers work magic in making compost; they add several natural elements and thereby create higher nutrient levels. They have developed the composting process to a near-perfect science by closely controlling moisture, $C0_2$ and temperature. For growing mushrooms the compost can be used before it has stabilized; that is, before carrying the process to its natural conclusion. Unfortunately, the nutrient level, immaturity and amendments coincident to growing mushrooms build sodium to levels that grapes will not tolerate with applications year after year. The solution is straightforward: restart the composting process and add a minimum of 15% new carbon (by weight). Detoxification by pervasive, unrelenting microbes is one of nature's many miracles and only requires brief, knowing and welcoming human involvement.

Water is sprayed into the windrow as it is being machine blended. Although I can't document my observation, water quality and/or the water source significantly impact the compost process. We have two composting sites, one serviced with creek water and the other with pond water. The fresh stream water compost gives the impression of composting rapidly and steadily in comparison to pond water. Additionally, chlorinated water should not be used, or only as a last resort, and then only after taking steps to eliminate the chlorine.

In four to six months compost that has been processed over the spring and summer months will be sufficiently stabilized for vineyard use. Composting works well in the wintertime if under roof; otherwise the snow and mud makes turning the windrow disagreeable to impossible, depending on one's tolerance for frustration.

I've experimented a bit with covers. They are a lot of work to handle; they must be removed to turn, then replaced after turning. Covers conserve moisture and support more uniform decomposition throughout the windrow. In addition, covers conserve nutrients and reduce carbon losses. I suspect that the added labor is a trade-off against reduced turnings. Using covers after the initial high temperature phase when turning becomes less frequent isn't perfection, but strikes a reasonable compromise. I'm planning to use more covers in 2001.

Conclusion

By relying on chemicals alone, the results are generally consistent and predictable from application to application and from year to year. With compost the results will vary and be less predictable, given the current state of the science. There is a widely circulated quote by John Williams of Frog's Leap Winery in Napa Valley for the reason he does composting: 'I'm not trying to save the world. I just want to make good wine." That quote accurately expresses the view for those of us making the effort to work in harmony with natural processes. Working with the soil's biological dimensions does indeed require a shift in approach as I have attempted to illustrate.

There isn't much of a downside to using compost. It is a low-risk vineyard input with no known negative soil or plant side effects, which is something we can't say for most manmade synthetic/chemical Inputs. Compost has broad-spectrum benefits for soil and for plants. It is a very forgiving material when reasonably made and applied. One would need to be uninformed or downright reckless to screw it up. The major uncertainty is how the benefits interplay with economic considerations.

My guess is that we will look back on the latter half of the 20th century as a period of transition following the pendulum swing to an extreme in about 1980. The pendulum is now seeking equilibrium, leading to greater collaboration with natural principles, and to a more benign, less destructive fertilization and pest control system in the 21st century.

Notes

1. “The Earthier Side of George Washington" by Dennis J. Pogue, Director of Restoration at Mount Vernon, and Robert Arner. Visitors to Mount Vernon can observe in more detail Washington's farming experiments.

2. Not quite the same because in the forest the tree is in contact with the soil, and the first part of the tree to decompose is being metabolized into the soil while the remaining parts are in various stages of decomposition.

3. There are products that claim to substitute for compost. One such product is humate, extracted chemically, usually from soft coal. Humates are manufactured worldwide and vary greatly in quality not unlike compost-in the sense that the variation depends on the processing and amendments applied. Humates are inert, that is, without oxygen or biological activity as in compost. Some vendors have developed methods of adding certain biologicals like mycorrhiza. Other vendors mix humates with natural fertilizers. Apparently, humates have some quiescent ability to stimulate biological activity when amended to soil in the presence of water and oxygen. Limited research to date has shown some unusual productivity increases. Humates are generally compared to synthetic fertilizers. Interesting data would be humates compared to compost on a long-term horizon. Compost adds microflora in a way humates can't, right from the bag. There are also a host of inoculants, mates are generally compared to products that aim to feed or activate biiological activity and reproduction. They fall under the same heading as humates, and merit the same scrutiny.

Why Compost?

It might seem puzzling. Why would a lifelong, ready-to-retire farmer type spend the money and time resources to start composting? Why, indeed, especially when that farmer had only an orchard and vineyard operation without having a problem of livestock manure or food processing waste to deal with? Well, it happened to me on my way to retirement.

In 1994 I added seven acres of Chardonnay and Pinot Noir to my vineyard, and I was looking for the most economical way to cover the graft unions for low temperature wintertime protection. My vineyard is on a rocky slope and using a mechanical hoe was impractical, if not impossible. Compost seemed as if it might be a reasonable alternative to topsoil. None was available locally, so I investigated making compost on my farm.

It was not long before I discovered other reasons for composting. After the second year I began to notice favorable effects on vigor and general vineyard health. I also started learning about the dynamics between plants and soil that confirmed the importance of organic matter as central to plant nutrition. Further, I became acquainted with research that started in the 1980s demonstrating that elevating microbial activity to high levels could control soil pathogens. What particularly caught my attention was the realization that without exception the starting point for good plant health and nutrition was the building of soil organic matter, often with compost.

In my lifetime chemical agriculture has migrated from one pest crisis to another. I suspect we all share, in varying degrees, the growing suspicion that present day pest control is flawed. Why is it that after 70 years of trying to solve pest problems chemically we actually have more problems? In retrospect, by the simplest logic, that adds up to failure. I believe the chemical/fertilizer boat stopped dead in the water some years ago when the growth regulator Alar went over the side and sank into the swamp.

I think there is a short answer to my question about whv I continue to make and use compost. Quite simply, I've seen enough in a few short years to want to know more.