Wood Chips in Vegetable Production

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A major problem in vegetable production is maintaining high soil quality in the face of typical practices that work against it. Vegetable growing involves intensive tillage, cultivation, exposure of almost-bare soil to the sun and rain for long periods, and heavy traffic from people and equipment. All of these tend to destroy soil organic matter and soil structure while increasing soil compaction. This reduces yield over the long run because it creates a poor environment for root growth and function; also the soil biological community is adversely affected. Soils with poor quality cannot retain sufficient nutrients and moisture.

We can address this problem in several well-known ways. These include—

- Adding compost, manure , mulches, and other organic residues
- Reducing the intensity and frequency of tillage
- Growing cover crops, especially legume sods
- Restricting wheel and human traffic to specific areas of the field, such as grass aisles or drive lanes

In addition to these common methods, it appears that there is another—adding wood chips to the soil. From 1951-1965, a remarkable experiment was carried out on a Soil Conservation Service research farm in Marcellus, NY. The project is written up in a 1971 Cornell bulletin called, "Soil Management for Vegetable Production on Honeoye Soil with Special Reference to the Use of Hardwood Chips" by G. R. Free. This 15-year study used a 5-year vegetable rotation of sweet corn, beans, tomatoes, cabbage, and peas. It compared 14 different treatments, including several in which 10 tons per acre moist weight (7 tons dry weight) of wood chips were added each year. Other treatments looked at using overwintered ryegrass or bromegrass cover crops, and more extensive rotations in which legume sod hay crops were substituted for the beans and tomatoes. The hay crops were harvested and removed, not simply plowed under. Crops were fertilized with chemical fertilizers and (as seems likely) probably sprayed for pests and weeds. Crops were also cultivated for weed control.

Some results were apparent within a few years and continued for the duration of the project. Yields of most crops were improved with the addition of wood chips and best when the chips were topdressed on the soil surface after the crops were planted instead of being plowed under. Over the years, soil organic matter (SOM) and nitrogen increased in the chip-amended plots, while they dropped in the chipless plots without cover crops. Including yearly grass cover crops allowed SOM and soil nitrogen to stay at about an even level over the 15 years.

	Standard Vegetable Practices	Standard + Hardwood Chips, Topdressed	Standard + Grass Cover Crops	Standard with Legume Sod + Grass Cover Crops
Soil Organic Matter (Initial Value 4.0%)	3.8	5.1	4.2	4.2
pH	7.2	6.8	7.1	7.0
		Comparative Yields#		
Sweet Corn	100	94	90	94
Snap Beans	100	123*	115*	(alfalfa)
Tomatoes	100	114	88	(alfalfa)
Cabbage	100	134*	113*	100
Peas	100	108	100	96

Results at the end of the 15-Year Vegetable Soil Management Trial, Marcellus, NY

Average of 3 Seasons in Rotation over 15 Years, Standard=100
* Statistically different from Standard Yield

This is an important finding. In other words, adding 10 tons/acre of wood chips each year did more to maintain soil quality than adding grass cover crops or resting the soil with harvested alfalfa sod hay crops. I don't understand why few, if any studies, followed up on these findings. Perhaps the expense of the wood chips discouraged their use by farmers, and therefore researchers, in the years after this study. Nonetheless, it seems that such positive benefits should have stimulated more research and wider awareness.

More recent research on wood chips has been done in Quebec, though with a different emphasis. While the Marcellus project used chips from stems up to 6" in diameter, the Quebec research focused on hardwood chips less than 3" in diameter, called "ramial". The percentage of nutrient-rich bark and buds is much higher if the branch diameter is held to less than 3". In practical terms, the volume of chips produced is also greatly reduced, but wood over 3" in diameter can be used for firewood.

The Quebec researchers feel that smaller diameter wood also contains less developed lignin that in turn is converted by fungi into long-lived humus in the soil. They also obtained positive results on both crop yields and soil quality using ramial applications. A drawback of ramial is that it is hard to get. Chips easily obtained from tree services are generally made from large branches.

Combining the results from these two studies, it would seem that the ideal way to use wood chips for vegetable production would be to topdress 5-10 tons of remial chips per year, worked into the soil surface during cultivation. If an area is to be bare over winter, chips could be spread after harvest to protect the soil before being tilled in the spring. Hardwoods chips are preferred over those from coniferous species.

Wood chips that heat up and partially decompose can produce volatile organic compounds that inhibit seed germination and plant growth. These should be avoided; chips should either be used fresh or after they cool down. Also, the carbon/nitrogen ratio of chips is rather high, about 200:1 for chips made from 6" stems (lower for ramial). Since the C/N ratio is high, if the chips are worked into the soil, they will tie up some nitrogen as they decompose. However, the effect is far less than it would be for the same amount of sawdust, since the surface area for sawdust to interact with the soil is hundreds of times higher than for chips.

In fact, nitrogen tie-up was not seen in the Marcellus study, which greatly surprised the researchers. Since the study was done on a rich Honeoye soil which was initially high in SOM, enough nitrogen may have been released to overcome any tieup that occurred. More work needs to be done to clarify this. The Quebec researchers also indicate that there is no N-tieup if the ramial is applied in the fall. However, trying ramial out in my garden, I observed apparent N-tieup for 2 seasons. If chips are used as a mulch on the soil surface and not tilled in, nitrogen tie-up is not a problem. Over the years a rich black soil develops under such a mulch. As they break down, typical hardwood chips release about 4 lb. of N, 2 lb. of phosphate, and 4 lb. of potash per ton, as well as calcium and micronutrients.

If chips are tilled in, a good practice is probably to apply about 10 lb of nitrogen for each ton of wood chips applied; perhaps ½ to one ton of compost for each ton of chips.

Growers can try chips out on small plots. For instance, use a field of a clean-cultivated crop and treat it normally in all ways, except—add chips to the soil next to 15-foot sections of row, shortly after planting or transplanting. If your rows are 2.5 feet apart, a 2.5 x 15' strip of row is about 1/1000 acre. If you spread 20 lb of wood chips on this area, straddling the row, this would mimic an application of 10 tons/acre of chips on that small area. One could make several such test strips along the rows of a planting. In all other ways, treat the test strips normally. The middle 5 or 10 feet of these mini-plots could be harvested separately and weighed, for comparison to the yield from untreated areas of the rows. Taking things a bit further, one could add an available N product at 10 lb of N per ton of chips applied, to some of these treated strips, carefully keeping track of which. This allows one to see if N-tieup is a problem with the chips alone. For our 1/1000 acre test plots with chips applied at 10 tons per acre, this translates to 14 oz of blood meal (@11% N) or 2 lb of a 5% N granular product per test strip. Apply the extra N when you apply the chips.

If test plot plants are yellowish and yields are lower, N-tieup was likely. Hopefully, this will not be the case. If yields are the same or higher, then chips can be safely used to provide all the other positive effects on soil quality noted above. I suspect that different soils with differing levels of organic matter and different biological communities will behave differently, so it is best to test small areas first.

Another safe way to use chips is to spread them on legume crops such as alfalfa or vetch before plowing them under. Since these crops release an abundance of N, any tie-up by the wood chips can even be beneficial, as some N will be held and released slowly over time.

With on-farm trials such as this, you can find out how much, if any, extra nitrogen needs to be added to the chips on your soil for good crop growth and production. Then you can confidently apply chips to larger areas and reap the long-term benefits of improved soil health.