'Using hardwood ramial woodchips as a time saving mulch for weed control'
Farmer/Grower Grant Final Report FNE01-387

Goals:

1. To determine if using wood chips as a mulch on bedded vegetable crops will decrease the amount of time necessary to manage weed growth by at least half.
2. To assess the effect that wood chips will have on the germination of crop seeds, transplant establishment, vigor of vegetables and soil nutrients over time.
3. To see if the use of IRT plastic covers in early spring will help raise the temperature of the soil and therefore counteract the expected decrease in heating of the soil under the wood chips.

This third year, as in the second, I ran the experiment without my partner, Bob. The project cooperators, Jeremy Barker-Plotkin and Richard Bonanno were helpful in the first two years as noted in the previous reports. I did not feel the need to seek their advice during this third year other than to ask for a suggestion on how to fertilize the crops without removing the mulch cover. Foliar feeding was the suggestion given and used.

I continued the experiment in much the same manner as in the second year. There were no changes in the amount or location of the land farmed for the experiment. Each year the same nine contiguous beds were divided into three groups of three beds each and each bed was divided into three sections with onions, beets or broccoli grown in each section as usual. In each group of 3 beds, 2 were mulched with chips, one was not mulched. One of the mulched beds in each group was covered in IRT in early spring and the other was left uncovered in order to determine if the IRT helped to remediate the cooling shade of the chips prior to planting. All weeding was done by hand (hand-held rototiller was not used to weed in spring).

The onions and beets were transplanted by hand at the end of May/early June into furrows hoed through the chips in the mulched beds and the broccoli was direct seeded into holes through the chips in July. Transplanting and seeding in the unmulched beds were also done by hand. The chip mulch was not removed from the beds at all. Mulch was added onto beds before planting as needed to insure at least 2" of thickness. The most fertilization was done at the time of planting when liquid fish & kelp fertilizer was added into the planting furrows and holes. The growing plants were foliar sprayed minimally (due to lack of time) during the growing season. No manure or compost was added to any beds because, in order to do so, the chips would have had to be removed and then replaced resulting in a lot of mixing of soil with the chips, thereby hastening the breakdown of the chips and possibly tying up nitrogen in the process.

Humidity was measured by sight and feel and soil temperatures were taken and recorded several times until the beginning of July.

RESULTS

Reduction in weeding labor

The results of this experiment certainly demonstrated that a chip mulch on beds prevents most weeds from growing and cuts down the time necessary to weed. Below is a table of the amount of time it took on average to weed each bed in 2001, 02 and 03.

	01	02	03
bare beds	115 mins./bed	112 mins./bed	58 mins./bed
chipped beds	80 mins./bed	21 mins./bed	17 mins./bed

As you can see the chips repressed weed growth substantially, thereby reducing the time needed to weed. Except in 2001 (in which documentation of labor time was not done well) the reduction in time was between 2/3 and 4/5. This was far better that the stated goal of cutting weeding time by half. However, what is not added into these figures is the time to 1. gather, transport and chip wood or buy chips, 2. place them on the beds initially and then 3. replenish them each year as needed. Replenishing chips took 14 minutes per bed on average, which still kept the experiment within the goal of a 50% reduction in the time needed for weeding. However the whole chipping process the first year took 30 hours alone (see first year's report) plus the time to place them on the beds. If that had to be done every spring when labor is already intense on a farm, it would not be workable. Buying the chips (which is what we did in the second and third years) is certainly more efficient, although it adds a small amount to the cost of production.

Germination, transplant viability, vegetable growth and soil changes
The second goal of the experiment was to monitor germination, transplant success, vegetable growth and soil changes. Germination and transplant viability were severely compromised by the chip mulch. Both may have been more successful if the chips had been raked off in the spring and then replaced around the plants once they had taken good hold. But it was very apparent that that would take an inordinate amount of time and would result in mixing too much soil with the chip mulch. In addition the chips had to remain in place to deter the early growth of weeds. Waiting for seeds to grow big enough before replacing the mulch allowed weeds to grow as well. So after the first year's experiment, seeds and transplants were placed into furrows or holes through the mulch. The problem that arose in this process, however, was that the chips kept falling into the furrows and holes due to gravity, rain and watering. Seeds were not able to come up through the fallen chips and many tender transplants got knocked over and buried by the chips. Labor was increased by having to check the furrows and holes and pick out the chips that had fallen in.

Vegetable growth and health also seemed to be adversely effected by the chip mulch. Over the three-year experimental period the unmulched beds produced better-sized vegetables as well as greener leaves. Tastes did not seem to differ between the vegetables in the chipped or bare beds. The taste of the beets in general grew less sweet each year. My best guess is that the decrease in sweetness was probably due to the fact that fertilization was reduced. After the first year, once the chips were placed on the beds, neither manure nor compost was added. No amendments were added except at the time of planting in the third year when liquid fertilizer was added to the furrows and holes. Minimal foliar spraying was done before harvest. Below is a table that shows the average soil nutrient values of the chipped beds and the bare-soil beds.

	pH **01 to 03**	**OrgMat.** **%** **01 to 03**	**P** (lbs/A) **01 to 03**	K (lbs/A) **01 to 03**	**Mg** (lbs/A) **01 to 03**	**Ca** (lbs/A) **01 to 03**	**CEC** **01 to 03**
Beds w/chips	7.4 - 7.1	3.0 - 2.5	259-231	472 – 191	414 – 280	2361 – 2198	8.4 - 7.7
Change	-.3	-.5	-28	-281	-134	-163	-.7
Beds no chips	7.4 - 7.2	3.1 - 2.4	244-236	437 – 160	396 – 297	2628 – 2317	8.7 - 7.6
Change	-.2	-.7	-8	-277	-99	-311	-1.1

There are a couple of things I think are noteworthy about the above values. One is that there is not much difference in the changes between the beds that had chips and the beds that had none. In fact all values and nutrients decreased in both sets of beds in quite similar amounts. So it does not seem that the chips had very much effect on the nutrients that were measured. Organic matter decreased in all beds because no manure or compost was added to any of them in years two and three. I am surprised that there was not much difference in the drop in pH between the mulched and un-mulched beds. I had expected the six mulched beds to become more acidic more rapidly than the other three. Perhaps in future years we would have seen an increase in acidity in the mulched beds as more of the chips decomposed.

A question to be asked is – why was the quality and quantity of growth of the vegetables in the un-mulched beds superior to those in the mulched beds if the nutrients weren't effected very differently from bed to bed? I think the answer may lie with the one nutrient that was not measured - nitrogen. Nitrogen was not measured because any such measurement gives only a picture of the amount of nitrogen in the soil at that particular time. One cannot measure the accumulation or decrease of nitrogen in the soil over time as one can with other nutrients. I think that it is likely that nitrogen was not as available to the vegetables in the mulched beds as to those in the un-mulched beds because, as is commonly known, the breakdown of organic matter in soil ties up nitrogen. Since I was not able to keep the chips cleanly on the surface of the soil, more chips became mixed in with the soil each year as weeds were pulled, and as vegetables were planted and harvested. I will assume that there was a fair amount of chip decay in the soil (there was obvious visible decay) that tied up nitrogen and made it less accessible to the vegetables.
There was also a good amount of fungi that grew on the chips. Whether that had an effect on the growth of the plants is unknown.

IRT and soil temperatures
The third goal of the experiment was to measure temperatures in the different beds to determine if the use of IRT plastic sheeting on some of the beds with chips helped increase the spring soil temperature thereby counteracting the cooling effect of the mulch which would slow down the growth of the transplants. Below is a chart of the different temperature ranges found in the no-chip beds and the chipped beds between early May and mid June.

	First temp.	Second temp.	Third temp.	Fourth temp.
Chip beds no IRT	55	60-68	60-67	80
Chip beds w/IRT	55-58	64-65	61-69	84-85
No chips	55-58	64-70	60-69	74-81

In general the temperatures were 3 to 5 degrees higher in the beds on which IRT had been placed and the temperature difference increased as the weather warmed up. However, the increase in temperature did not make a noticeable difference in the germination or success of transplants, since there were other more aversive factors that modified the growth and success of germination and transplants.
It was interesting to note that in the first two years of the experiment, the beds without a mulch covering did generally seem to warm up faster (3-7 degrees difference) than the mulched beds. In the third year, as can be seen above, there was not as large a difference, even as the weather warmed up.
Although there were no measurements for humidity, it was obvious through observation that the chipped beds retained their humidity much more effectively than the beds without mulch. On dry hot summers, this would be an advantage to vegetable growth. It would also mean less irrigation would be required on those mulched beds.

Economics

There were no economic findings, neither cost nor income accounting, since the land was not farmed to produce vegetables for market except in the first year of the experiment. The first year was actually the last year in which we marketed any of our vegetables. The second and third years were continued in order to complete the experiment and provide worthwhile data for future enterprises.

Summary

It might be said that this experiment was a failure since a major outcome was a decrease in quantity and quality of vegetable growth. However experiments are only failures, to my mind, if the structure or procedures of the experiment fall apart, i.e. the parameters are not adhered to, the procedure is changed halfway through, the variables are not taken into account, etc.

This success of the experiment was that it showed us many things that can be of use to future farmers who are deciding whether to use mulch, how to use it and what kind to use. Listed below is what was learned:

- Ramial wood chip mulch (at least 2 inches thick if not 3) does decrease weeding labor by a considerable amount, especially if it can be purchased rather than collected and produced.
- The mulched beds did tend to be a few degrees cooler than those unmulched. IRT covering over the mulch does increase the temperature of the soil in the spring. Whether it increases it enough to make a difference in the growth of the seeds and young plants is hard to tell since there were other factors that effected the germination and transplanting success.
- Wood chip mulch does not effect the pH of the soil as much as expected, at least in the first three year after it is put on the beds.
- Wood chip mulch does conserve humidity in the soil.
- Laying down chips in any way other than in sheets on the soil before planting, i.e. laying it down between young plants or between furrows or between planting holes is labor intensive without some mechanical way of doing it. In addition, waiting until young seedlings are large enough to add chips only gives the weeds time to grow before the chips are added.
- It is difficult to devise an effective means of adding compost/manure or other nutrients to the soil under the mulch covering without the labor-intensive activity or removing the mulch and then replacing it after nutrients are added. Mechanization may be the answer to this challenge.
- Removing and replacing chips each season, even if done mechanically, would increase the mixing of soil with the chips thereby decreasing the weed inhibiting effect of the chips (i.e. weeds can grow in the soil mixed with the chips) and possibly increasing the amount of nitrogen tied up in the chip-decaying process.
- There was no obvious way to keep the chips and soil from mixing either during the creation of furrows and holes for planting, or during harvesting.
- Chip mulch decreased the success of germination and transplanting due to simple problem of the chips falling into the furrows or holes in which the plants or seeds were and thereby knocking them down or covering them and preventing them from growing well.

Suggestions

- It might be effective to remove the chips each spring, add fertilizer and then either clean and replace them or add new chips if a mechanized process were invented
- A mechanized process might be devised to protect the germination of seeds or the young transplants from falling chips which would go a long way to insuring better initial viability such as plastic furrow walls or plastic hole containers.
- A longer experiment of 5 to 10 years would need to be devised to determine, 1. if the decay of chips were actually tying up nitrogen availability to a detrimental level; 2. if decaying wood chips would add beneficial minerals and other nutrients into the soil as well as organic matter over time and 3. whether there are any other detrimental or beneficial effects of chips over time.

In general, without mechanization of the mulching process (including removal and replacement of chips in order to add soil amendments) and without mechanization of the planting process (to protect seedlings), the reduction of weeding time cannot make up for the loss in plant viability and plant quality.

Outreach

This report will be made available, or at least a summary of the report will be made available to NOFA-Massachusetts (an any other NOFAs that may be interested). If NOFA feels it worthwhile, it could be included in an issue of 'The Natural Farmer' that focuses on mulches.

Michael Pollitt
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USDA Farm Bill Conservation Programs in West Virginia
2003

Agricultural Management Assistance (AMA)

- No funding for new contracts was received by NRCS in FY2003
- Administered by NRCS
- For practices that reduce financial risk to producers
- 75% cost-share, $50,000 annual payment limit
- Continuous signup, applications collected and ranked as funds are available
- WV has targeted assistance for conversion to organic farming, truck crop farmers, woodland erosion on old harvest roads, pest control to allow hardwood regeneration, and tree planting for windbreaks and air quality around poultry houses.

Conservation Reserve Program (CRP)

- Administered by FSA
- For practices that reduce erosion, water pollution, benefit wildlife
- 50% cost-share, 10-15 year contracts to retire land
- Continuous signup

Conservation Reserve Enhancement Program (CREP)

- Administered by FSA in partnership with other federal and state agencies
- For practices that establish riparian buffers, reduce water pollution and benefit wildlife.
- 10-30 year contracts to retire land; acreage payment based on land use
- Continuous signup as long as acreage cap has not been met
- Enhanced payments for higher water quality benefits
- Available in most parts of the state, but not all

Conservation Security Program (CSP)

- Program details not developed yet.
- Up to 75% cost-sharing to install practices
- 5-10 year contracts to maintain practices. Payments of 5-10% of annual rental rate, plus practice payments, plus enhancement payments are provided for in the legislation.

Environmental Quality Incentives Program (EQIP)

- Administered by NRCS
- For practices that reduce erosion, water & air pollution, benefit at risk species
- Up to 75% cost-share (most practices at 50%), up to 90% for limited resource and/or new and beginning farmers in 2003.
- Continuous signup, applications collected and ranked as funds are available
- WV has targeted grazing management, animal waste, water quality, cropland erosion, woodland erosion, water quantity and quality for livestock
- $4.5 million allocated to WV in 2003. Funded 256 contracts

Farm and Ranchland Protection Program (FRPP)

- Administered by NRCS
- For 30 year or permanent conservation easements
- Applications accepted from entity that will hold the easement
- Conservation plan required
- $977,536 allocated to WV in 2003; funded 7 Cooperative Agreements

Grassland Reserve Program (GRP)

- Will be jointly administered by FSA and NRCS
- 30 year or permanent grassland easements or 10, 15, 20, or 30 year contracts
- Land must be maintained in grass, can be grazed or hayed
- Continuous signup
- Applications accepted from landowner (easement) or owner-operator (contracts)
- Conservation plan required
- $612,324 allocated to WV in 2003; funded 8 rental contracts, three 30 year easements, and one permanent easement

Wildlife Habitat Incentive Program (WHIP)

- Administered by NRCS
- For practices that create, restore, and enhance wildlife habitat
- Up to 75% cost-share
- Continuous signup, applications collected and ranked as funds are available
- WV has prioritized rare or threatened and endangered species habitat, riparian habitat, and farm wildlife species. Woodland wildlife habitat is also considered.
- $280,625 was allocated to WV in 2003, 52 contracts were funded

Wetland Reserve Program (WRP)

- Administered by NRCS
- 30 year or permanent easements, or wetland restoration agreements available
- Up to 75% cost-share to restore wetlands
- Continuous signup, applications collected and ranked as funds are available
- No new contracts funded in 2003. Several projects in progress of restoration.