Mulching choices for warm-season vegetables

A summary of SARE funded mulching research

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Mulching suppresses weeds, conserves soil moisture, and can improve crop yield or quality. However, when it comes to warmseason crops like tomatoes or melons, growers face a dilemma. Organic mulches such as hay, straw or leaves help replenish soil humus, but they lower soil temperatures and can thereby delay maturity or reduce yields in these vegetables. Plastic film mulches warm the soil and thereby promote early yields. Plastic also gives excellent weed control, but it does not feed the soil, and it becomes a non-renewable waste that must be disposed of at the end of the season.

Mulches that contribute organic matter while promoting good yields and timely ripening are important to sustainable vegetable production. The objective of VABF's SAREfunded mulch research is to work with growers to explore sustainable alternatives to plastic film mulch. Toward this end, we conducted on-farm experiments in 1993 and 1994, and interviewed 72 growers to learn about existing mulching practices, their benefits and problems, and growers' innovations and ideas on the subject. Thus far the advantages and drawbacks of plastic and organic mulches have been examined, and some experimental paper film mulches were evaluated as biodegradable alternatives to plastic. During the coming season, we plan to draw on growers' ingenuity to design and evaluate mulching strategies on a site-specific basis.

On-farm field experiments

In 1994, various mulches were tested on 'Roma' paste tomatoes grown at five biologically managed farms representing a range of climates and soils (Table 1). Treatments were applied to small plots (25 feet of a single crop row) replicated three times at each site. We evaluated mulch effects on crop yield, earliness and quality; soil temperature, moisture, tilth and earthworm populations; and weeds, pests and diseases. Labor requirements for final soil preparation, planting, mulching and weed control using manual methods were also compared.

The plastic mulch we used was 1.2 mil embossed black polyethylene (PE), which is widely used by commercial growers. Paper mulches consisted of 40-lb recycled kraft paper, similar in color, texture and thickness to paper shopping bags. Oiled paper was prepared by submerging rolls of kraft paper in waste cooking oil for 12 hours, then allowing them to drain. Hay and straw were applied at 7 to 8 tons per acre (approximately one square bale per 100 square feet). Composted yard waste (mostly tree leaves) spread at a depth of about two inches, was tested at three sites. At Site 1, a winter cover crop of rye + vetch was mowed before planting and left in place as mulch.

Film mulches (plastic, paper and oiled paper) were applied just before planting. The soil was raked smooth and level, the mulch was laid and anchored along all edges with soil, and planting holes were cut with a sharpened bulb planter. Organic mulches were spread two to five weeks after planting to allow the soil to warm up before being covered. For the oiled paper + hay treatment, oiled paper was laid before planting, and hay was applied several weeks later.

Our first finding was that mulching is important for tomato production. Plastic, paper and organic mulches all improved yields in most instances. Plastic increased soil temperatures (measured at a depth of 3-4 inches) by 2 to 4 degrees F, and prevented weed competition, but hindered the entry of rainfall, causing some soil moisture depletion. In contrast, hay and straw lowered afternoon soil temperatures by nearly X degrees F and allowed a few weeds to break through, but maintained higher soil moisture levels. Yet both mulches produced healthier plants than bare soil, and improved yields by an average of 6 tons per acre. Unmulched plants were severely stunted in 1993 (a drought year) and also in 1994 at Site 1, whose sandy soil has a very low moisture holding capacity.

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At Site 3, tomatoes grown in plastic gave somewhat higher early yields than tomatoes in hay or straw, but total yields actually slightly higher in the organic mulches (Figure 1). Similar trends were also observed in 1993, and at sites 1 and 2 in 1994. Statistical analysis indicated that the differences in early yield are significant, meaning that they probably reflect an actual effect of the different mulch treatments. Observed differences in total yield were not significant, which means that they more likely arose from random variability in the data and may not indicate a treatment effect.

The growers at Site 3 observed that in both years, "the crop seemed to come on quicker in the plastic, but then it petered out early." Other studies have shown that tomatoes grow best at a root zone temperature of 75 to 80 degrees F, and suffer stress at 85 degrees or higher. Thus the soil-heating effects of plastic may be beneficial early in the season, but detrimental during hot weather. In warmer regions such as Georgia and coastal Maryland, tomatoes have been reported to yield better in organic mulches than in plastic. Eggplant, melons and summer squash prefer higher soil temperatures, and may show more dramatic yield responses to plastic.

In 1994, the two Appalachian sites were severely affected by late blight, which destroyed the tomato crop at Site 4 in early August. Green tomatoes over 2 inches long were harvested, divided into visibly blighted and unblighted fruit, and weighed. Nearly all of the unblighted fruit were successfully sunripened, and their weight was recorded as marketable yield. Tomatoes also suffered late blight at Site 5, but a small yield of marketable ripe fruit was harvested. At both sites, tomatoes in plastic produced a higher marketable yield and a lower percentage of blighted fruit than tomatoes in hay.

Another tomato disease, early blight, was observed at four sites, but infestations were light and directly affected fruit only at Site 5. Unlike late blight, this disease damaged more fruit in plastic or paper mulches than in hay.

Hay and straw mulches performed similarly, except for poorer weed control by straw at Site 4. However, the straw bales used at this site were much lighter than average, so that we ended up with only 5 tons of mulch per acre, which did not keep the ground well covered in the latter half of the season. Compost kept the soil slightly warmer than hay or straw, probably because of its darker color. However, compost required much longer to apply than hay, did not suppress weeds as effectively, and showed no clear advantages in terms of crop yield, quality or disease prevention.

Tomatoes grown in the mowed cover crop at Site 1 were initially stunted, and yielded only half as much as tomatoes in plastic or hay. Because the cover crop clippings amounted to only 1.5 tons mulch per acre (dry weight), they did not cover the ground effectively, thus producing conditions similar to bare soil. The tomato crop suffered severe competition from weeds as well as excessive soil heating and drying. However, other experiments by growers and researchers have given widely varying results with mowed cover crops, with some real success stories. Winter cover crops sometimes yield 2.5 to 4 tons of mulch per acre, and have been reported to enhance yields of tomatoes and squash.

As mentioned in a previous article (Virginia Biological Farmer, Fall-Winter 1995), both untreated and oiled 40-lb kraft paper broke down too quickly, with loss of weed control. A heavier 65-lb kraft paper used in 1993 and in a supplemental experiment in 1994 gave considerably better results. Adding hay to oiled 40-lb paper several weeks after planting also minimized the problem.

We had hoped that laying oiled paper before planting and adding hay several weeks later would com-

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Table 1. 1994 On-farm Experimental Sites and Treatments

Site No.	County	Region	Soil type	Frost dates: spring	fall
1	King & Queen	Coastal Plain	Loamy sand	Apr 17	Oct 17
2	Loudoun	Blue Ridge foothills	Sandy loam	Apr 25	Oct 8
3	Louisa	Piedmont	Loam	Apr 20	Oct 20
4	Floyd	Appalachian Plateau	Silt loam	May 15	Oct 5
5	Floyd	Appalachian Plateau	Sandy loam, stony	May 25	Oct 5

Table 2. Soil conditions, tomato yields and late blight under plastic, hay, and oiled paper + hay mulches in 1994.[a]

	Plastic	Hay	Oiled paper + hay
Soil temp, before hay[b]	73.2	69.8 *	75.5 *
Soil temp, after hay[b]	78.2	73.0 *	72.3 *
Soil moisture, summer, %	14.3	19.4 *	18.1 *
Soil moisture, fall, %	20.4	20.2	20.7
Earthworms, individuals/sq. ft	7.1	14.1 *	13.5 *
Early marketable yield, tons/acre	4.5	2.5 *	2.8 *
Total marketable yield, tons/acre[a]	16.9	18.2	19.4

[a] mean of all five sites, except mean of Sites 1, 2, 3 and 5 for total yield.
[b] mean of morning and afternoon temperatures, measured at 3 to 4 inch depth.
* significantly different from plastic.

Raw goat mil issue goes to Federal Cour

Fifteen years is a long time. That is how long have been trying to get an exemption to the Virgi milk regulations when selling goat products off small farm. We are presently in federal court.

Christine Solem, the primary litigant in this cas appearing for herself in court, because lawyers expensive. The Commissioner of the Departmen Agriculture and Consumers Services (VDACS), is defendant. The issue is the on-the-farm sale of unprocessed goat milk. The consumer comes to farm seeking the raw product for his own consu tion, not to resell it. The milk is not ill commerce.

Why federal court? So that the state milk reg tions, promulgated by VDACS, will have to pass scrutiny oL the US Constitution, and may be revie by the US Supreme Court. We are using the Amendment, Section 1, which involves prop rights and due process.

Under Magistrate Judge Waugh Crigler, Chris survived the pre-trial hearing in early Novem 1994. On Dec.8, the day of the second pre-trial h ing, the State's attorney asked the above judge to miss the case. Christine had good arguments for various points the state brought up, but the judge missed the case. Christine later read the hearing script, spent many hours at the UVA library and covered that the judge had made several signifi errors, which hopefully would allow the case t appealed to the 4th District Court of Appeal Richmond.

In March 3 Christine handed in her formal bric the brief is accepted, the Appeals Col_lrt will ren the cace back to the district court for trial.

The following background informations wil the current litigation in perspective. Our conflicts VDACS started in the Fall of 1979. We first wer court in 1980. From then until 1990 we went thr "Rent-a-goat," "Share-agoat," and "Own-a-g strategies to move our milk. We won in Circuit and lost on appeal in the Virginia Supreme Co twice. Christine has been under injunction since no raw goat milk has been "sold" during that time raw milk has been "moved" using various plans.

By 1990 we realized we had exhausted any p bility of relief from the State Court system. In we had contacted our local delegate, eorge A about introducing a raw goat milk bill int Virginia General Assembly. He was all for it, and is as Governor. He could not take to bill to the General Assembly because he ran for and beca Representative to Congress. We introduced the b 1992, 1993 and 1994, first using Delegate Mitch Yahres, then Delegate Peter Way, both from Charlottesville/Albemarle County area. The raw milk bill became a nasty, controversial issue, not ticularly politically advantageous to the Dele sponsoring it. There was little opposition i House, but strong opposition in the Senate. In 19 lost in Senate Committee by one vote. It never g the floor of the Senate.

Just before the 1994 session adjourned, we g exemption from an animal feeds bill to sell raw milk for animal consumption y. Unable to trus burearcratic intention, in April 1994 we went to

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