LOW INPUT HYBRID MULCHING APPROACH

FINAL REPORT

Northeast Sustainable Agriculture and Education

Project FNE 00-309

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1. Project Overview and Results Summary

The purpose of this project was to demonstrate a hybrid mulching approach that used plastic mulch placed in a field pre-planted or inter-planted with a "green cover" mulch that was cut down in late spring. This "hybrid" mulching approach would be compared to more conventional "no-till" planting approaches where plants are set into living or recently cut back field of living mulch.

In general, the trials went extremely well and demonstrated the utility of hybrid mulching approaches. I believe this trial could, and should, lead to widespread use of hybrid mulching in vegetable production in the Northeast.

Some of the important lessons that were learned in this trial are:

Fall preparation of hybrid-mulched fields is preferable to spring preparation.

Plastic mulch laid in living mulch field's lasts much longer than plastic mulched laid in unseeded fields.

Heavy (1.5 mill) non-embossed film lasts longer in the field than lighter embossed film.

Red or brown -red mulch warms the soil faster in the spring than black or green infrared transmitting (IRT) mulch, and appears to last longer in the field.

Cutting the mulch between rows in spring should be done as late as possible to provide best weed control, and plant protection.

The protective microclimate produced by the narrow trough in the uncut rye with a plastic floor promotes very rapid plant development.

Second (and third) year preparation of the mulched fields is time consuming but could be made easier with a specially designed cultivator- seeder.

In a wet year such as 2000, there is not a great difference in the final yield of winter squash planted in the hybrid approach vs. planting in grain mulch, though there is a difference in spring vigor and earliness of the crop.

Some important considerations that remain to be determined in using a multi-year Hybrid Mulching program are:

How is soil fertility under the plastic maintained over several years?

How many years could plastic be left before removal becomes too difficult?

Is disease carry-over (even among rotated crop groups) a limiting factor in a hybrid mulching approach?

What are the economic trade-offs in multi year hybrid mulching vs. conventional mulching approaches?

In the discussion of the field trials carried out, each of the lessons learned and lessons remaining to be learned will be discussed in more detail.

2. Hybrid Mulching Trials Conducted

The trials conducted included tomatoes, summer and winter squash, and melons. Some trials were for direct comparison of growing techniques and others were simply trials of specific techniques without comparative plantings. The trials can be summarized as follows:

A. Winter squash planted on plastic with inter-row grain (hybrid mulching) vs. identical squash planted at the same time in grain mulch alone.

B. Tomatoes planted using hybrid-mulching technique with spring planted grain mulch.

C. Melons planted on ***second year*** plastic in hybrid mulching plot.

D. Summer squash planted in extra thick, fall planted grain mulch.

In the following paragraphs each trial is discussed.

A. WINTER SQUASH IN FALL PLANTED HYBRID MULCH FIELD

In these trials winter squash was planted in parallel rows of the same field with the rows about 8 feet apart. The field had been planted in Winter Rye during late September of the previous year (1999). Rye was planted with a small Ontario Grain Drill with 7 inch disk spacing (fig A1.) By April of 2000 the rye was growing well (fig A2) and by May was a lush stand (Fig A3). In figure A2 the red plastic from the previous summer can be seen on the left. This was planted with tomatoes in 1999 and would be one of the test rows for winter squash in the 2000 trials. The other winter squash row would be planted in the mulch in the right where there was no red plastic.

Fig. A1 *Fall Planting Rye with Ontario Grain Drill*

Fig A2. *Rye growth in April 2000*

Fig.A3 Rye surrounding plastic rows in May

During the season from June through September temperature and moisture measurements were made in the grain-seeded area as well as under the plastic. The moisture measurements were not of much value since the ground was saturated with water throughout the period. The temperature readings were more interesting, showing that the soil under the plastic was about 5 degrees warmer in June and 10 degrees warmer in September. This is important since one concern was that in early spring the shading from the uncut grain would keep the ground cool, eliminating one of the key advantages of plastic mulch. This data is shown and discussed in section E.

On June 12th, I mowed the rye grain in preparation for planting the winter squash. Mowing was done in open parts of the field with a side mounted sickle bar mower on the Ford NAA Tractor, and between the rows of plastic with a Gravely sickle bar mower attachment (fig. A4). The field with rye grain just forming seed mowed very well. The field looked beautiful with the freshly cut grain almost completely covering the red plastic (fig. A5).

Fig. A4. Cutting the Rye between the rows.

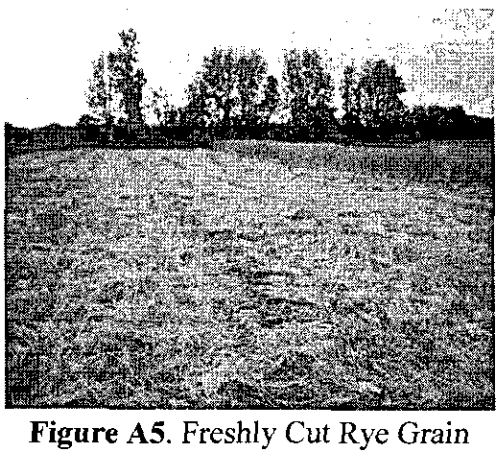


Figure A5. Freshly Cut Rye Grain Field

On June 17th I began planting field with Melons and Winter Squash. I decided to leave the rye where the summer squash were to be planted, growing for another week or so. This rye is seen standing on the right side of fig. A5.

Growth of the winter squash was slow at first, particularly in the row where there was no plastic. This can be seen in figure A6, where the winter squash in the foreground is planted in the rye mulch with no plastic. On July 13th, when this picture was taken the soil temperature in the red plastic row was 78 degrees, and that in the grain mulched row was only 66 degrees. This warmer soil temperature in the plastic row greatly accelerated the growth of the squash during the first month after planting, and resulted in an earlier and better crop, with yields about 20% higher than in the grain mulch only row.

In spite of a very wet summer, and late planting our winter squash including *Red Kuri, Delicata, Big Mama*, and *Early Acorn* did very well. Only the *Pennsylvania Neck Pumpkins* failed to mature.

Weed pressure was greatly reduced with only a minimum of hand weeding required to remove a few tall weeds.

Fig. A6. Winter Squash grew faster in the Hybrid Plastic Mulch Row than in the Rye Grain only row.

B. TOMATOES IN SPRING PLANTED HYBRID MULCH FIELD.

The spring planted hybrid mulch trial used oats as the grain mulch and tomatoes on red plastic as the cash crop. Figure B1 shows the field just after planting rye and setting plastic on the left (June 1) and after three weeks of growth on the right. Everything was done about two weeks later than desired due to the extremely wet weather. This is in fact a big drawback to the spring planting approach; the dependence on the weather during a very unpredictable time of the year. It is also the busiest time of the year on most farms, which is another factor that argues for the fall planting and plastic laying approach.

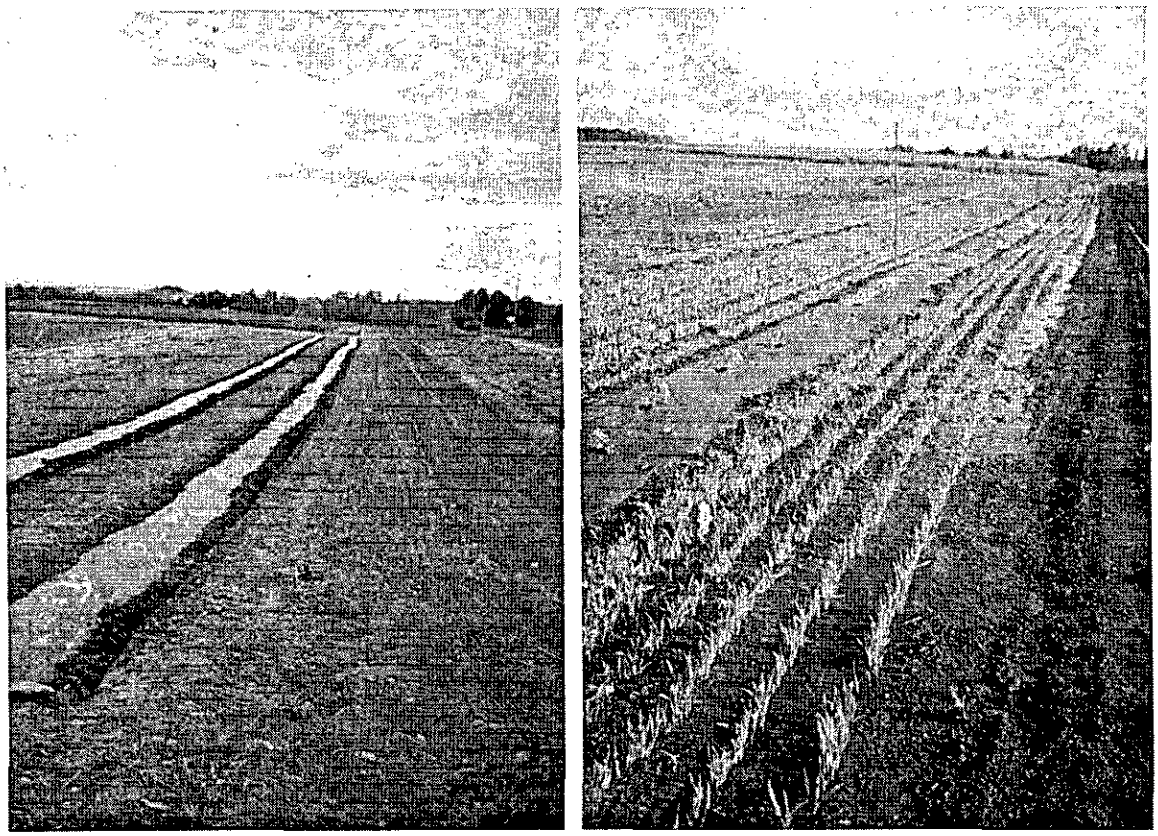
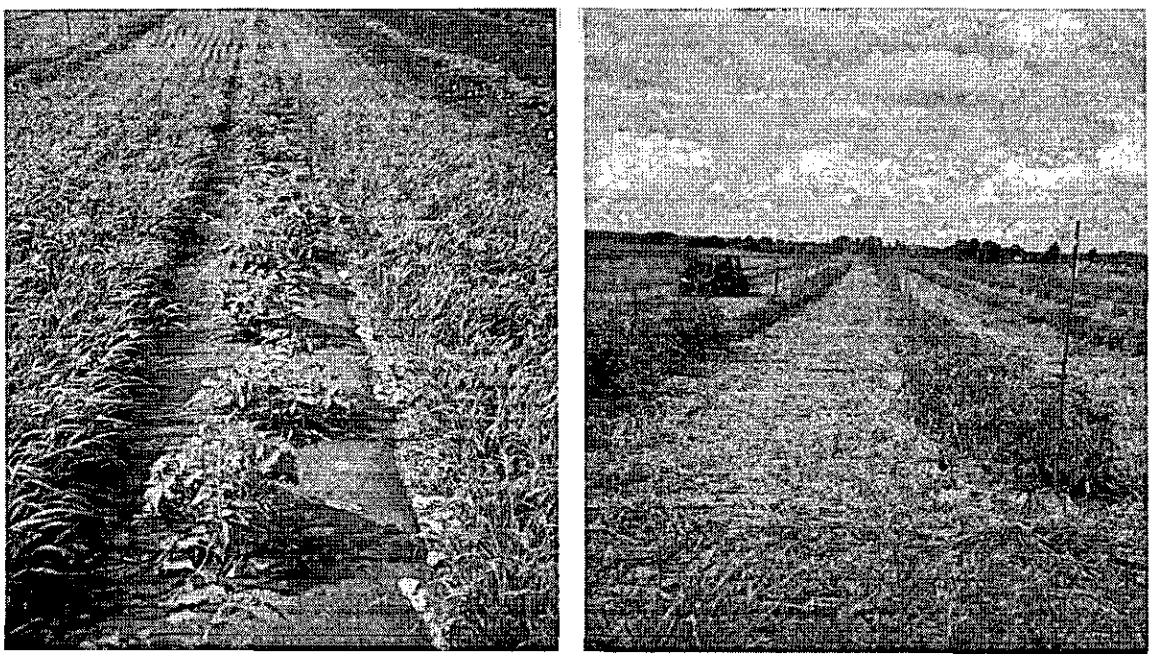


Figure B1. Spring Planted Hybrid Mulching with Oats between rows of Red Plastic Mulch.

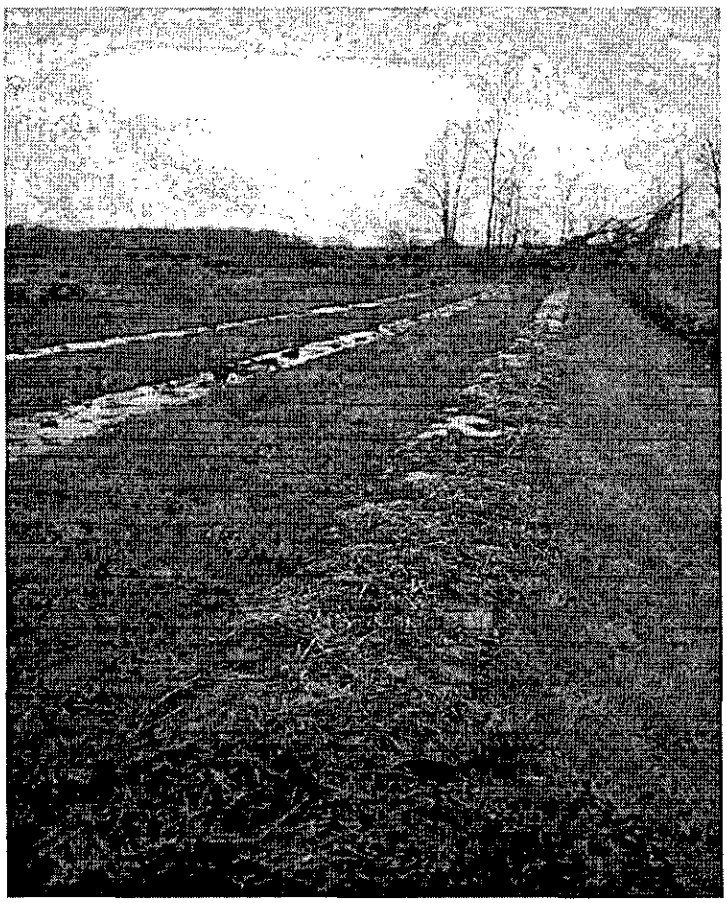
The tomatoes in this trial field grew well, but the oats did not get well established before cutting, leading to a moderate amount of weed pressure. The field is shown I later growth stages in figure B2. Note the standing water in the rye on the right.



C. MELONS PLANTED ON SECOND YEAR PLASTIC IN HYBRID MULCH FIELD

In this trial melons were planted on mulch that was used with tomatoes last year (1999). The purpose was to see how well the mulch would hold up a second year, and to determine if there would be any detrimental effects on the melon plants from the previous years crop.

To prepare the field, the tomatoes were removed from the field after the first frost in 1999. The residue was removed from between the rows and the inter-row space (about 7 feet) was re- planted with rye grain. As shown in figure C1. the rye grain got a good start in the late fall of 1999. Some of the tomato residue was left on the plastic to help protect it over the winter. This residue caused some problems with re-seeded tomato "weeds" in the melon patch the following summer, but no disease problems.



The grain grew well the following spring (2000), and was cut when about three feet high in early June. The melons were planted on June 15th, and grew rapidly in the 75-degree soil. Some organic 2-4-4 fertilizer was put in each hole to correct for our spring soil test indication of low potassium and phosphorus.

Figure C1. Melons Planted in Second Year Hybrid Mulch Field (June 15th left and July 30th left)

A decent crop of melons was harvested, but the yield was somewhat lower than usual due to the very cold wet summer. The plastic held up well through the second year, and in our plastic tensile strength evaluation, tested only slightly weaker than at the end of 1999. I believe this test showed great promise for using the plastic for at least two years and most likely three years in the hybrid mulch approach. The inter-row grain protects the plastic from harmful sunlight, and from damage done by attempting to cultivate or weed, or from spring wind or rain erosion. Three- year use of the plastic would fit well into our overall farm rotation plan. During the fourth year the plastic would be removed, and the field would be prepared for potatoes or corn.

One of the major advantages of this hybrid mulch approach is that while the field is in production approximately 2/3 of the land is constantly is in cover crops, and gaining the weed reduction and soil improvement benefits associated with that cover.

D. SUMMER SQUASH GROWN IN DENSE GRAIN MULCH WITHOUT PLASTIC MULCH

The final trial involved planting summer squash transplants into a double thick-planted cut mulch. In this trial the rye grain was fall seeded at twice the rate normally used, or about 150 pounds per acre. The grain was also allowed to mature about two weeks longer than in the other hybrid fields (at the risk of reseeding). The transplants were set on June 27th, a week after cutting the heavy mulch. They got off to a slow start due to the cold soil under the extra thick mulch. The soil temperature at planting was only 64 degrees. Figure D1 shows the field at planting and just before first harvest on August first.

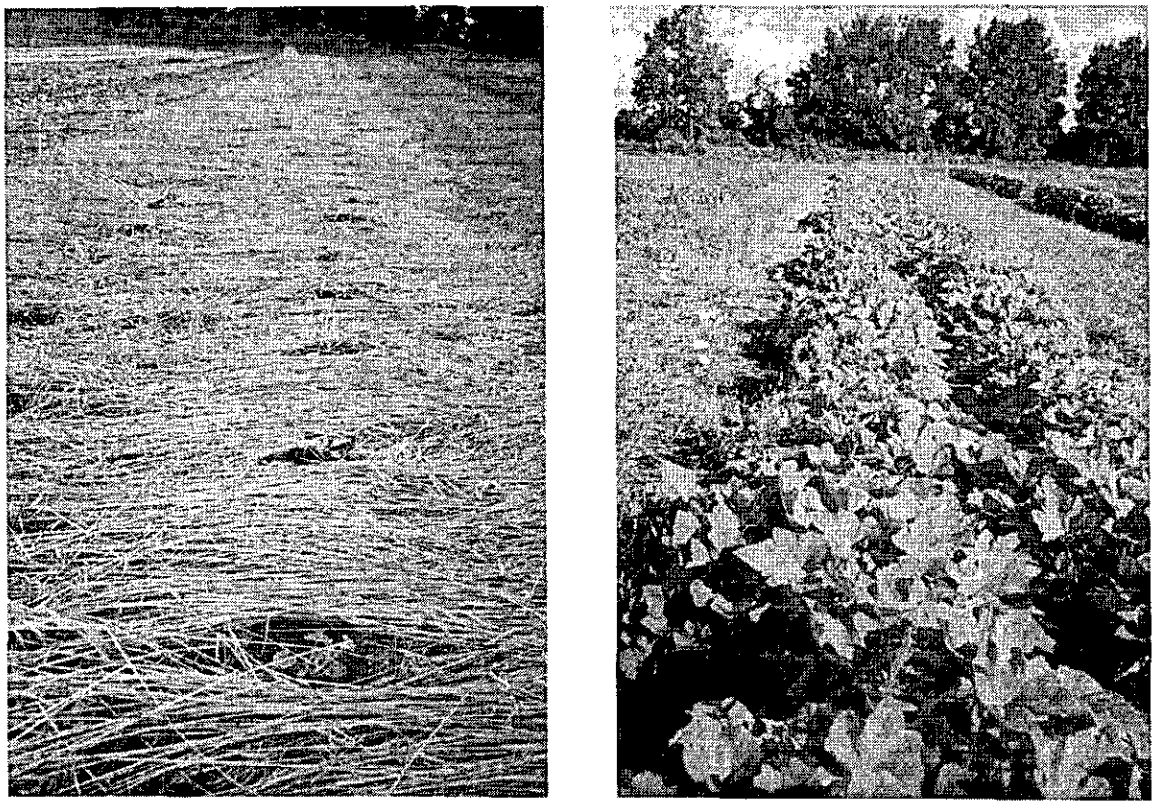


Figure D1. Summer Squash In Extra Thick Fall Planted Rye Mulch at Planting and Harvest

This squash did very well with little weed or disease pressure, in spite of a very wet season. The only plant protection used was T22 "Top Shield" applied several times during the season.

The real disadvantages to this cut- mulch- only system are the late season soil warm-up, and the potential for lack of plant moisture in a dry year. We intend to try this again during the summer of 2001.

E. TEMPERATURE AND MOISTURE PROFILES

Data was collected on the temperature and moisture levels in the grain mulch between the rows and in the grain only fields, and under the red and black plastic mulches. Due to the cool wet summer the variance in the data was low. In a more normal summer with hotter and drier summer months this data would have had more spread and been more indicative of the differences between hybrid and either plastic or killed grain mulch. Nonetheless it is interesting to note some tendencies in the data Figures E1 and E2.

The temperature under both the red and black plastic was significantly higher at planting time than in the cut grain areas. This was true in spite of the fact that much of the plastic was covered by grain after cutting. I'm not sure if this is because of early warming of the plastic prior to grain cutting or is caused by sunlight heating the grain covering the plastic and the heat getting trapped beneath the plastic...or both. In any event it was certainly responsible for the faster spring development of the plants in the areas where plastic lie under the cut mulch

The overall differences in the soil temperature throughout the summer under the plastic were within a 10 degree range- smaller than anticipated. I believe that this is in part due to the fact that the plastic is insulated to some extent by the rye straw mulch cover during most of the summer. This provides a beneficial moderating or damping effect on what otherwise might be large temperature swings in the soil under a conventional plastic mulched field.

The moisture levels were high in all fields throughout the summer. Only in late August did the soil under the grain mulch begin to loose some moisture. It is hard to draw any conclusions from this data due to the extreme wetness of the summer.

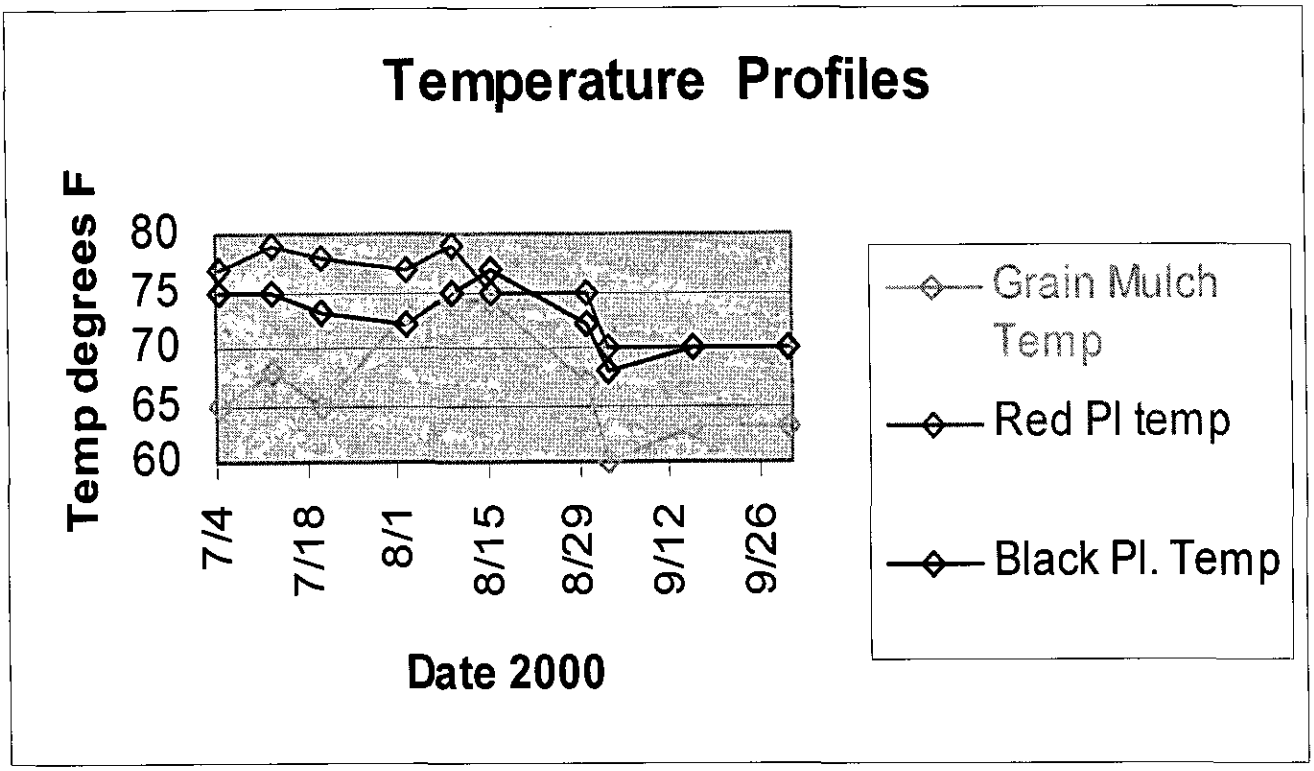


Figure E1. Temperature Profiles in Mulched Fields

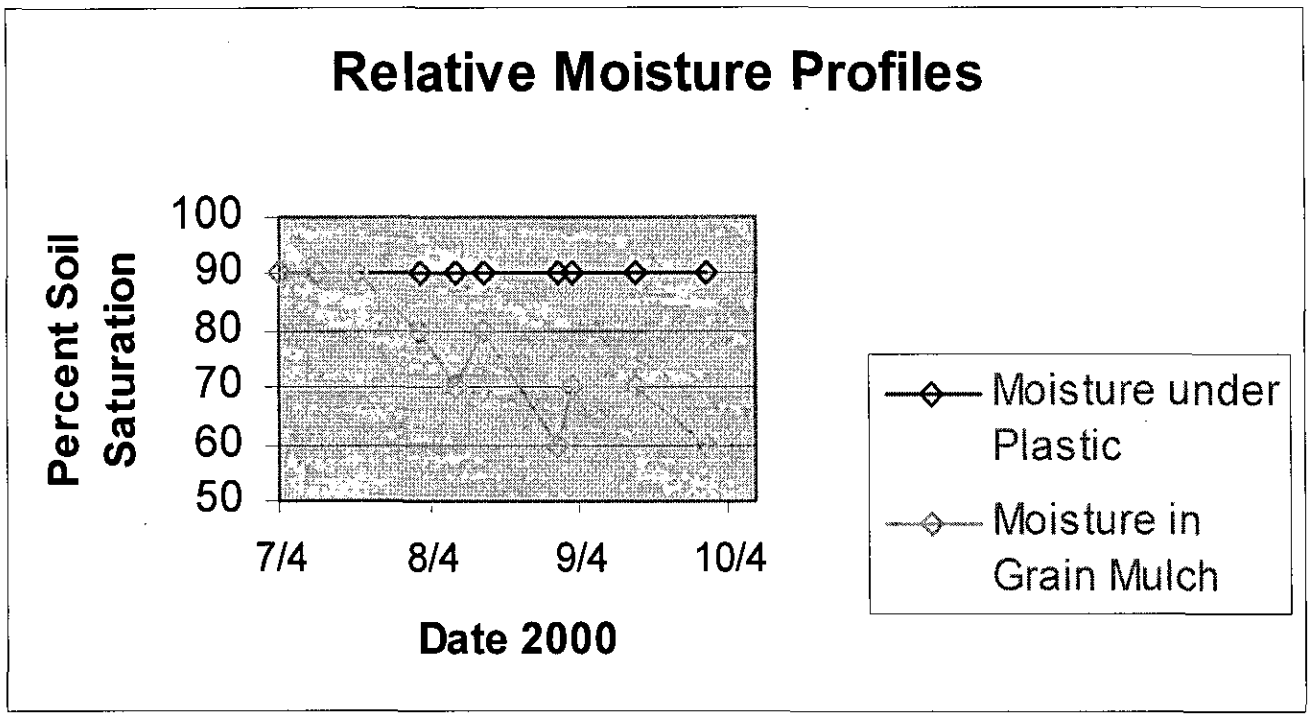


Figure E2. Moisture Profiles in Mulched Fields

SUMMARY AND CONCLUSIONS

We have conducted many fruit and vegetable field management system trials on our farm over the past fifteen years, but no trial we have conducted has shown more benefits to the land, the crops and the farmer time and cost efficiency than this trial. I also believe, but cannot be sure, that while many of the separate benefits of plastic mulch and cut living mulch have been separately demonstrated, this is the first documented field demonstration of a hybrid plastic/grain system.

The advantages of this system that have been demonstrated in this trial are:

1. **PLASTIC REUSE** – The protection that the rye grain provides to the plastic from the sun, wind, and rain during the early season prior to crop coverage provides a two to three fold increase in the field life of the plastic. The benefits are not just the cost of the plastic and labor to lay and remove it, but the environmental benefits derived from two thirds less plastic disposal, and fuel use.

2. **EARLY PLANT DEVELOPMENT**- An unexpected benefit of the system is the very rapid development of the seedlings or transplants that take place during the early season. This is due to both the warming of the soil through the plastic, and to the protection that the grain provides from early spring winds. Whether the young plants are set out into the narrow rows of uncut grain or are planted into the field after the grain is cut, the environment for early growth is excellent.

3. **LATE SEASON PLANT PROTECTION** - The hybrid mulch approach continues to protect the plant throughout the season by providing covered soil both in and between the rows. Between the rows weeds are suppressed by the allelopathic effect of the rye and by the dry mulch cover. In row weeds are suppressed by the plastic, and the plants are held up from the plastic by the mulch cover over the plastic. The plants are protected from heat extremes under the plastic by the light cover of the mulch that has fallen over the plastic. During very dry years moisture is retained by BOTH the plastic in the row and the cut mulch between the rows, and during very wet years the soil is protected by the mulches from rain erosion.

4. **LAND USE BENEFITS**- The hybrid mulching approach protects the soil in the field from erosion and compaction that can result with frequent cultivation. In addition the field remains 67% in cover crops for as many years of rotation that the plastic is used. On our farm this will be a crop rotation of tomatoes, melons or squash, and peppers/eggplants planted in succession for a three-year period.

OUTREACH

A paper on this Hybrid Mulching Technique was presented at the NOFA NY Annual meeting on January 14th. Many favorable comments were received and requests made for copies of this final report. The report will also be sent this week to my technical advisors for distribution.