Final Report

Multiseason use of Plastic Soil Mulches in Vegetable Production

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FINAL REPORT

ADF PROJECT NO: 93000161

MULTISEASON USE OF PLASTIC SOIL MULCHES
IN VEGETABLE PRODUCTION

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Abstract

This study evaluated the feasibility of using plastic soil mulches through two or more vegetable cropping seasons in Saskatchewan. The study conclusions are:

a) that the commonly utilized thicknesses of black and wavelength selective mulches have definite potential for multi-season use.
b) that clear plastic cannot be used without some adequate means of weed control
c) fumigation provided the weed control necessary for multi-season use of clear plastic but the economics of this practice are questionable.
d) for several test crops, use of clear plastic and fumigants produced the highest yields of any mulch tested.
e) multiple use of appropriate plastics reduced costs and labor needs while speeding spring work.
f) some increased care was required to maintain integrity of the plastics during the cropping seasons.
g) aside from weed problems under the clear plastic, there were no indications of any increased pest problems associated with re-use of the plastics.
h) a widely spaced crop is preferred as the first crop in the planting series.

Based on the results from this study, a grower scale trial of multi-season plastics appears warranted.

Project Background

Effective use of soil mulches can increase yields and profitability of vegetable production. However, the cost of the mulch ($400-750/a), combined with the labor costs involved in its installation in the spring and removal in the fall can be restrictive, particularly as the mulch is normally used for only a single season. Preliminary observations from trials conducted at the Horticulture Science Department indicated that certain mulch types, if handled properly, could be left in place over the winter and re-used a second year. This would effectively halve both the cost of materials and labor involved in mulching. Issues such as; which type of mulches are best suited for multi-season use, and what impact would multi-season use have on weed, insect and disease levels need to be addressed before growers can consider adopting this practice.

This study examined the feasibility and management implications of utilizing plastic soil mulches through two or more vegetable cropping seasons in Saskatchewan.

Methods

During the 1993 cropping season, trials were conducted at the U of Saskatchewan Horticulture Research Stn (Saskatoon) to evaluate various plastic soil mulches in the production of cucumbers (direct seeded) and melons (transplanted). The mulches tested were:

- Black - (smooth, 1.0 mil, Rainflo Inc.).
- Clear - (smooth, 1.0 mil, Rainflo Inc.)
- Wavelength Selective - (IRT, 1.0 mil, Rainflo Inc.).

The mulches were selected as representative of typical types utilized by Saskatchewan vegetable growers. Black mulches provide excellent weed control but only limited soil
warming. Conversely, clear mulches provide excellent soil warming but no weed control. Wavelength selective mulches are designed to combine the weed control characteristics of the black mulches with the soil warming of the clear. The wavelength selective mulches are approximately double the cost of the clear or black mulches. All mulches were of the same thickness and produced by the same manufacturer to minimize differences in their chemistry beyond the color factor. The mulches were laid with a commercially available mulch layer.

Normal management and harvest practices were employed for the 1993 crop although reasonable care was taken to avoid damaging the mulch during field operations. No herbicides were used in conjunction with any of the mulch treatments. A heavier than normal amount of phosphorus (P) was applied prior to laying the mulch in anticipation of the limited potential for applying additional P once the mulch was in place. In the fall of 1993, the vines were removed from between the mulch rows using a harrow and any vines remaining on the mulch were cut away by hand. The next spring field preparation was limited to;
a) pre-transplanting or pre-emergence application of a non-selective herbicide to control weeds between the rows and weeds emerging from any holes in the plastic.
b) pre-transplanting or pre-seeding application of 50 kg N/ha through the drip irrigation system installed under each row of mulch.

The crops tested on the various types of year old mulch were;
Peppers - transplanted (cv. Calwonder 300) - 60 cm spacing - twin rows.
Corn - direct seeded (cv. Northern SuperSweet) - 20 cm spacing - twin rows.
Melons - transplanted (cv. Earligold) - 30 cm spacing - single rows.
Each crop was grown on 4 m section of mulch with 2 m between mulch rows. There were four replicates of each mulch type, arranged in a randomized complete block design.

Data Collected
The status of the various mulch types was evaluated;
a) in the fall of the first cropping season
b) after the first winter, prior to planting
c) in the fall of the second cropping season
At each rating period the mulches were evaluated for their physical integrity ie; extent of tears, indications of wear etc and their efficacy in controlling weeds and enhancing crop growth.
Timing and total yields of the test crops were determined on the various mulch types. Notes were taken on crop quality and disease or pest problems.

Results
1993 cropping season
Crop Responses - The 1993 cropping season was abnormally short and cool with above normal precipitation and below normal sunshine hours. Melons failed to mature on any of the mulch treatments, although the crop on the clear mulch was most advanced when the first killing frost hit. Cucumber yields on the wavelength selective
mulch were 40% greater than on the black and 60% greater than on the clear. The superior soil warming provided by the wavelength selective mulch likely explains the superior yields versus the black mulch. Weed growth reduced stand establishment, growth and yields on the clear mulched plots.

Mulch Status - at the end of the 1993 cropping season, both the wavelength selective and black mulches were still in excellent condition, with very few holes, no signs of wear and minimal weed growth either under the plastic or in conjunction with the planting holes. By contrast, weed growth under the clear was so severe that some sections had been lifted free of the soil by the developing weeds. In other areas perennial weeds such as thistles has punctured the plastic at many points. In areas where the weed pressure was less intense, the clear plastic appeared in good condition although crop yields had still suffered due to weed competition. It was decided that the clear plastic could not be considered for a second season of use unless the weeds could be controlled. The only practical option for controlling weeds under existing plastic is via the injection of a appropriate volatile fumigant. Fumigation is a widely practiced weed and disease management technique in many areas of the United States. In this trial, Vapam (ICI Chipman, metham sodium, 900 kg product/ha) was introduced under the existing rows of clear plastic mulch via the trickle irrigation system on October 1 1993. Snow covered the field soon after the fumigation treatment, preventing evaluation of its effects on the existing weed population.

1994 Cropping Season

Mulch status - all mulch treatments overwintered in good condition. Early and persistant snow cover may have protected the mulches from light and wind damage. The efficacy of the fumigation treatments were evident from the very early spring. Winter annuals such as stinkweed were abundant under the non-fumigated year-old clear plastic within two weeks of snow melt. This demonstrates the efficacy of the pre-applied clear mulches as a means of warming the soil in the spring. However, the headstart this provided to the weeds would be disastrous for any crop planted onto these mulches. In this trial, weed growth was so extensive by planting time that the clear non-fumigated plots had to be abandoned. By contrast, early weed growth was minimal in the fumigated clear plots, even though soil temperatures were favorable for weed development. Winter annuals emerged more slowly in the cooler soils under the black and wavelength selective mulches. These weeds were confined to the holes punched for the previous crop and were consequently easily controlled by the application of a non-selective herbicide just prior to establishment of the 1994 crop.

Two new clear mulch treatments were introduced in the spring to replace the lost year-old clear non-fumigated treatments; a) clear and b) clear laid over soil treated with an appropriate preplant herbicide. Treflan (trifluralin) was used for the peppers, Eradicane (EPTC) for the corn and Alanap (napalm) for the melons.

Weed Control

Weed control was strongly influenced by both the crop and the mulch type (Figure 1). The clear + fumigated treatments were established the previous fall and therefore presented an extended opportunity for weed growth prior to crop
establishment. However, early weed growth was minimal in these treatments suggesting
that the fumigation had been effective. The few escapes were at the extreme edges of
the mulch at the greatest distance from the point of application of the fumigant. These
escapes were only a problem where the test crop grew too slowly to shade them out (ie;
peppers). The clear + herbicide treatments provided good season-long weed control in
all crops. Early weed growth was surprisingly light in the clear/untreated rows.
However, by mid-season weed pressure in these treatments was quite high in the pepper
plots but was still low in the melons. This reflects differences in the rate of growth and
shading potential of the two crops.

The black mulch provided excellent weed control in all crops. The IRT provided
excellent weed control in the corn but was less effective in the peppers and melons. It
appears that seedlings germinated under the IRT received enough light to grow out to
the holes cut for the transplants. These weeds competed for light and space with the
slower growing crops.

Yields

Peppers

Growth and yields of the peppers were strongly influenced by the mulch
treatments; and specifically the weed control + soil warming provided by these
treatments (Figure 2). The IRT produced the best yields, followed by the black mulch.
The black mulch had provided superior weed control, but the IRT was more effective at
warming the soil. The clear + herbicide treatment produced the best yields of the clear
mulch treatments. This treatment provided weed control equivalent to the IRT, but for
some reason did not enhance yields as well as the IRT. The clear/untreated and
clear/fumigated treatments produced poor yields; this can be attributed to problems with
weed control in these treatments.

Corn

Time of harvest was more strongly influenced by the mulch treatments than total
yields (Figure 3a + b). The three clear mulch treatments produced mature cobs earlier
than the IRT or black mulch treatments. Maturity was also more uniform on the clear
treatments. Weed control was better on the IRT and black than on any of the clear
treatments, but soil temperatures under the clear were higher than the IRT or black. Of
the clear treatments, the fumigated treatments were best; this again may be related to
this treatment being established early, thereby allowing superior soil warming.

Melons

Yields of melons were less influenced by the mulch/treatment combinations than
the other two crops (Figure 4). The clear/fumigated treatment produced the greatest
fruit yields, however, most of this yield enhancement occurred in the latest (least
profitable) harvests.
Mulch Status (fall 1994) - By the end of the second cropping season, most mulch rows had many punctures or tears which were allowing weeds to encroach on the crop plants. Weed growth was also fairly abundant in the numerous planting holes used for the fairly closely spaced test crops. This demonstrates the importance of minimizing the number of planting holes, at least in the first year of use. Clearly widely spaced, single row crops such as pumpkins and other cucurbits would be the preferred first crops in a multi-year mulching program. Extensive perforation of the plastic would also reduced the efficacy of weed control by fumigation as the fumigant is quickly lost to the atmosphere through punctures.

Conclusion

This study demonstrated that multi-season use of some types of plastic soil mulches was both feasible from a management perspective and desirable as a means for reducing costs and waste without sacrificing yields. Both the black and wavelength selective mulches were in almost perfect condition at the end of the two cropping seasons except for punctures caused by planting or harvesting operations. However, the limited potential for introducing nutrients under the mulches probably limits their useful lifespans to two years. Problems with weed control limited the potential for multi-season use of clear plastics which are otherwise the materials of choice in terms of efficacy and low cost. Fumigation appeared to control this weed problem but at ca. $550/acre its cost is roughly equivalent to applying new plastic. There are also increasing concerns about the ecological impact of using non-selective pesticides such as fumigants.

The results suggest that trials of multi-season mulching are warranted on a grower scale.

Budget to project completion (January 1, 1995)

Allocated ................ $ 1000
Expenditures ............. $ 1000
Balance ................... $ 0

Project related extension activities

1) Field plots toured by; SVGA, U of S degree and diploma Agriculture classes and on several occasions by groups of researchers, industry support personnel and the general public.