ABSTRACT

A strip cultivation system was tested in processing tomatoes to determine the feasibility and economics of such a system. Wind induced damage to the tomatoes was virtually eliminated with this system. The strip till system used 22.5% less fuel per hectare than the conventional method of tillage. This reduction in fuel use, as well as reduction in wind damage translates to a payback on the initial cost of the equipment of less than 10 years.
Feasibility of Strip Cultivation in Processing Tomatoes
by
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INTRODUCTION

Processing tomato growers are caught in a time where they have to manage their operations carefully to maximize their profits. The costs for transplants, fertilizers, sprays, and labour continue to rise.

EIGHTY percent of the processing tomatoes grown for the H.J. Heinz Company are grown on light, highly erodeable sandy soil. Excess tillage on this type of soil is not required, but certain tillage must be carried out to accomplish; seedbed preparation, incorporation of fertilizers and herbicides, and bed shaping etc.. The key to reduction in fuel input lies in combining as many of these operations as possible.

The strip cultivation system is one way of accomplishing multi-purpose operations. The main piece of equipment for this project was a Johnson AP 360 All Purpose Plantivator. This machine is a 3 point hitch, PTO powered, rotor tiller 4.6m wide, capable of working 3 beds simultaneously. The tines on this machine can be easily changed to alter the length of tines or tine spacing.

The strip cultivation was seen as a system which would drastically reduce the sand blasting damage associated with direct seeded tomatoes. Since the industry is heading towards more direct seeding, testing in this area of wind protection was felt necessary.

OBJECTIVE

An on-farm test was set up in cooperation with Palichuk Farms to determine the feasibility and payback for the strip tillage system. By comparing fuel use per hectare for each of the three systems, namely; conventional tillage, reduced tillage, and strip tillage, fuel savings should become evident.
TEST

Three different tillage systems were compared to establish the fuel use per hectare in spring preparation of the seedbed, up to and including planting. All the land scheduled for tomato production for this test at Palichuk Farms near Leamington was planted with a cover crop in the fall of 1982. At the same time as the cover crop was being planted, two 25 cm tool bar mounted shovels spaced 1.5m apart were used to premark the tomato beds.

Two types of cover crops were tried, one being oats, the other rye. Oats achieved a height of 10 to 15 cm before being winter killed. The rye survived through the winter and was sprayed with Paraquat in the spring when it reached a height of 40 cm. Gramoxone was sprayed on at a rate of 2.3L per hectare to kill the rye.

The operations carried out in the various tillage systems are listed below:

Conventional Tillage

This system is typical of the tillage carried out by many farmers in preparation of fields slated for tomato production. The operations carried out were as follows:

- Broadcast fertilizer
- Disc and packer to work in lime and fertilizer
- Plow and packer
- Triple-K cultivator and packer
- 2 X Triple-K cultivator and packer to incorporate herbicide
- Skid bedding
- Planting

Reduced Tillage

This tillage system is a reduced version of the conventional system where the Johnson Plantivator was used as a power bedder. The operations involved were as follows:

- Broadcast fertilizer
- Spray Paraquat and Sencor to kill rye
- Plow and packer
- Disc and packer
- Triple-K cultivator and packer to incorporate 28% N
- Power bed with Plantivator and incorporate herbicide
Strip Tillage

As mentioned earlier the major piece of equipment for this tillage system is the Johnson Plantivator. The operations involved are as follows:

Broadcast fertilizer

Work strips 15 cm deep with Plantivator to incorporate cover crop

Work strips 5 cm deep with Plantivator to incorporate herbicide

Planting

Work area between tomato rows and incorporate herbicide with Plantivator (1 X for oats, 2 X for rye)

The strip cultivation system as the name implies, involves only working strips in the centre of the preformed beds. The first pass over the field with the Plantivator only works a strip .6m wide and 15 cm deep in the centre of the 1.5m wide beds. With this machine the farmer was able to do three beds at once. This first pass was primarily to work in the cover crop, ground speed approximately 4 km/h. With the second pass over these same strips, the soil was only worked 5 cm deep to incorporate herbicide. Ground speed for the second pass was roughly 7.3 km/h. Cage type packer wheels had to be made up and installed to firm the soil behind the Plantivator. Without these packer wheels, the soil was left too fluffy and too prone to wind erosion. One row of cover crop at each edge of the bed remained more or less in tact after these two tillage operations.

After the plants had reached a height of 30 cm the Plantivator was used to work the area between the tomato rows and reshape the beds simultaneously. The soil was worked to a depth of 10 cm at a speed of 4 km/h. Herbicide was also sprayed on these strips at this time to control weed growth. Accuracy in driving the tractor in this operation was essential, as the tunnels which guided the plants under the Plantivator were only 15 cm wide. This working of the interrow spaces required one pass in the oat cover crop and two passes in the rye cover crop. After this last pass through the field it was virtually no different in appearance than a conventionally tilled field. Before this working of the interrow spaces, remaining cover crop and some weed growth made the field look trashy - all this plant growth, however, is destroyed in the process of the two tillage operations.
BASIC STEPS IN STRIP TILLAGE

STEP 1. - strip centre of beds
- work in cover crop
- 60 cm wide, 15 cm deep
- 4 km/h ground speed

STEP 2. - work strips shallow
- incorporate herbicide
- cage packers to firm strips
- 60 cm wide, 5 cm deep
- 7 km/h ground speed
- plant

STEP 3. - work area between rows
- incorporate herbicide and cover crop
- 30 cm wide strip over row untouched
- 10 cm deep
- 4 km/h ground speed
The tractor which powered the Plantivator was also equipped with dual saddle tanks which held the herbicide mixture. Two sets of nozzles each with separate manifold systems were fastened onto the front of the Plantivator to spray herbicide, one set to spray the strips, the second set to spray between the rows.

Moveable shields inside the Plantivator were used to contain the flying soil from the tines within the strips being worked.

RESULTS

Differences in fuel use did show up in the three tillage systems. The fuel use in litres per hectare for the three tillage systems outlined earlier in the report are shown in the following graph.

Figure 1. FUEL USE COMPARISON
From this graph it can be seen that the strip tillage system used 22.5% less fuel than the conventional tillage system in seedbed preparation for tomatoes.

Because of the sheltering effect of the cover crop which was left standing after the tomatoes were planted, no wind damage was experienced. This is the first year the cooperators have not had to replant any tomatoes due to wind damage. Typically, losses due to wind damage can be as high as 2 to 3% annually. This would cost the farmer for transplants or loss of yield if damage occurred late in the season.

PROBLEMS

1. Rye 60 cm tall was hard going through the Plantivator.
2. Rye stubble and root balls bunched up under the planter shoe every 3m causing it to rise, resulting in inaccurate planting depth. Because of this, the majority of rye cover crop was plowed and worked in the conventional manner.
3. Since the strips worked by the Plantivator were left fluffy and loose, packer wheels had to be made up to firm the soil.
4. There was little wind protection from the oat cover crop in the spring. The oats were pretty much flat to the ground. Wheat will replace rye as the cover crop next year.
5. Time required to change the tines and shields on the Plantivator amounted to 1 1/2 man days.

In an effort to eliminate many of the problems caused by the rye cover crop, wheat will be used in its place next year. Since the wheat is not as vigorous as the rye, no chemical sprays will be required to control its growth. A number of different trials will be carried out. In the fall after the tomato ground has been worked with a chisel plow, oats will be broadcast on the field along with the fertilizer. The Plantivator will then be used as a skid bedder to form the beds. A modified grain drill will then be used to seed one row of wheat on each side of the beds. This one row should remain more or less in tact until the interrow stripping is carried out. The grain drill was set up at a seeding rate of roughly 30 kg wheat per hectare. All the openings except the ones seeding on the borders of the beds were blocked off. Another test will involve no oats being broadcast, leaving the field bare except for the wheat strips on each edge of the field.
PAYBACK

To arrive at some sort of payback, the farm unit will be taken as 40 ha of tomato production. The following assumptions were used to calculate the payback period for the Plantivator strip tillage system:

1. 40 ha of tomato production.
2. Fuel saving with strip till vs. conventional = 22.5% = 15.1 L/ha.
3. Fuel cost $0.40/litre.
4. Historically 3% of acreage replanted, cost for transplants $740/ha.
5. Historically 10% of acreage has 10% yield reduction due to wind damage = 4.49 t/ha.
7. Cost of Gramoxome will not be included as rye is being eliminated from the project in future.

Initial Cost

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantivator, tanks, nozzles</td>
<td>$25,347.82</td>
</tr>
<tr>
<td>Packer Wheels</td>
<td>800.00</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$26,147.82</strong></td>
</tr>
</tbody>
</table>

Since the Plantivator can replace a skid bedder for bed formation, the cost for this equipment can be deducted from the initial cost of the Plantivator. Cost for this equipment ranges from $6400 for a Johnson S-360-42 to $16,000 for a Lilliston Rolling Cultivator with Shaper Attachments and markers.

\[
\text{Fuel savings} = 15.1 \text{ L/ha} \times 40 \text{ ha} = 604 \text{ litres}
\]
\[
\text{Cost of fuel saved} = 604 \times \$0.40 = \$241.60
\]

Cost for replanted tomatoes, 3% of acreage at a cost of $740/ha = 40 \times 0.03 \times \$740 = \$888

This would be saved annually because strip till system eliminates losses due to wind damage. As well, yield reductions due to wind damage would also be eliminated, which translates into more savings.
Yield reduction due to wind damage is historically 10% or 4.49 t/ha on 10% of the acreage. Price for tomatoes = $118/tonne.

\[ \text{Loss which would normally occur} = 40 \text{ ha} \times 0.10 \times 4.49 \text{ t/ha} \times \$118/\text{t} = \$2119.28 \]

\[ \text{\textit{Savings/year}} = \text{Fuel savings \& costs for replants \& Losses due to wind damage} = \$241.60 + \$888 + \$2119.28 = \$3248.88 \]

Maintenance costs/year on Plantivator = $400.00

\[ \text{\textit{Net Savings/year}} = \$3248.88 - \$400.00 = \$2848.88 \]

\[ \text{\textit{Simple Payback}} = \frac{\text{Net Cost}}{\text{Net Savings/year}} = \frac{\$10647.82}{2848.88} = 3.74 \text{ years} \]

Therefore with subtracting the cost of skid bedder from the initial capital cost of the Plantivator, the system has a payback of roughly 4 years.

If the cost of a skid bedder is not deducted from the capital cost, simple payback is: \[ \frac{\$26147.82}{2848.88} = 9.2 \text{ years} \]

Therefore, even without subtracting the cost of a skid bedder from the initial capital cost the payback for the system is around 9 years.
CONCLUSIONS

1) Strip tillage system used **22.5% less fuel per hectare** than the conventional tillage system, and **5.6% less fuel per hectare** than the reduced tillage system.

2) No wind damage of transplants was experienced, due in part to the sheltering effect of the cover crop and some weed growth between the rows. Overall **little** wind damage was experienced in the Leamington area this year.

3) The same tomato variety planted in the strip tillage system were ready to harvest one week before the ones planted at the same time in the conventional system. This can only be attributed to better growth. This is a definite advantage at harvest time.

4) One person working with the Plantivator can easily keep ahead of **2 three row transplanters**.

5) The strip tilled field remained slightly drier than the conventionally tilled field with no water accumulation throughout the summer.

6) In the spring after a rain, work on the strip till could progress **2 to 3 days earlier** than on the conventionally worked field where the water seemed to be held by the soil. One possible reason for this is that all the wheel traffic in the strip tillage system is in the furrows between the beds.

7) There appears to be a definite savings in time for field preparation with the strip tillage system.

8) Since field work can start earlier with the strip tillage system, direct seeded fields which failed to emerge properly could be planted to transplants very easily.

9) The tunnels which guide the transplants underneath the Plantivator will be made wider so that they are 30 to **45 cm wide**. The original tunnels were too narrow.

10) Plantivator can be used as a skid bedder by merely removing the tines and pulling unit across the field.

11) No **4 wheel drive tractors are required for this strip tillage system**.

12) With the strip tillage system less equipment and manpower is required to prepare the fields.

13) Tomato yields were as good if not better than conventional tillage. On the average yields in strip tillage were **10 - 20%** above conventional tillage in Essex County.
No problems were experienced at harvest time because of winter cover crops.

This was the first year the cooperators didn't have to do any replanting of tomatoes because of wind damage.

This year the cooperators had \( \frac{1}{3} \) of their crop in strip tillage, next year they will go to \( \frac{2}{3} \) of their crop.

Management with the strip tillage system has to be good so that the tomatoes do not get too large to enable stripping of the interrow spaces to be carried out.

The strip cultivation system shows a payback of 4 to 10 years.

**SUMMARY**

The strip tillage system does show a definite fuel saving of 22.5% or 15.1 litres per hectare as compared with conventional tillage in tomatoes. Even with this reduction in fuel use, tomato production was as good if not better than conventionally tilled tomatoes.

With this system offering a means of providing some protection from the wind for young plants, it brings the feasibility of direct seeded tomatoes one step closer to reality.

**ACKNOWLEDGEMENTS**

The author would like to thank the cooperators, Wayne and James Palichuk of Leamington for their excellent cooperation in recording fuel used for various tillage operations.

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Figure 2. Tractor with saddle tanks and Plantivator attached.

Figure 3. First pass through the beds in the spring.
Figure 4. Closeup of Cage packer wheels used to firm strips.

Figure 5. Tomatoes planted in strips. Note the cover crop remaining between the strips.
Figure 6. Working area between the tomato rows.

Figure 7. Closeup of plants coming out behind Plantivator.