UNIVERSITY OF SASKATCHEWAN

VEGETABLE CULTIVAR AND CULTURAL TRIALS

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Saskatchwan Agriculture and Food

Tunnel Materials for Tomatoes

Previous trials have demonstrated the benefit of using row covers to enhance early growth of warm season crops like melons and peppers. There are many types of covers available and it is important to select the type of covering material that best suits the needs of the crop. This trial examined the performance of tomatoes grown with different types of row cover.

The trial was conducted at the University of Saskatchewan Horticulture field Research Station in 2009, 2010 and 2011. This site features a Sutherland Series heavy clay soil which is slow to warm in the spring. The site was prepared by rotovating one week prior to transplanting the test crops. Three days before transplanting a wavelength selective (2009 and 2010) or black plastic mulch (2011) was applied to the test plots. Drip irrigation lines were located beneath the mulch. Six week old tomato transplants (cv. Celebrity in 2009 and 2010 and cv. Defiant in 2011) were planted out into the mulched rows once the risk of frost had passed in early June. The plants were spaced 50 cm apart within each row. Each test plot was 5 m long and the rows were 2m apart. Immediately after transplanting, row covers were installed on all plots except for a non-covered control. The cover materials tested were;

a) perforated clear polyethylene – transmits about 85% of the light in the visible spectrum. Clear perforated polyethylene creates a very warm environment.

b) non-perforated clear polyethylene – would be expected to create an environment even warmer than the equivalent perforated clear poly.

c) perforated green polyethylene - filters out about 41% of incoming light within the visible spectrum, resulting in cooler temperatures. Filtering certain wavelengths out of the incoming light may also alter the growth pattern of the covered crops.

d) perforated white polyethylene - filters out about 26% of the incoming visible light.

e) Novagryl woven polyester - filters out about 20% of the incoming visible light and is also highly perforated.

The covers were supported by metal hoops (45 cm tall at peak) installed over each row to create a low tunnel. Each treatment was replicated 3 times in a randomized complete block design. Temperatures and crop condition were monitored inside the tunnels. The tunnels were removed once the crop started to flower - except for the non-perforated treatments where the tunnels had to be either opened or removed earlier due to problems with overheating and crop stress. No problems with insect pests or diseases were observed in the 2009 trial. In 2010 and to a lesser extent in 2011, repeated rain events early in the season kept the soil saturated for extended periods which impaired crop vigor.

Tomatoes reaching the breaker stage of maturity were harvested weekly. Any fruit remaining on the plants was harvested just after a killing frost (Oct 5 in 2009, Sept 15 in 2010 and Sept 13 in 2011).

Results

2009 growing season – May and June of 2009 were exceptionally cool. Frost was recorded on four occasions after the trial was established (June 1, 4, 6 and 9). Some frost damage was observed on the plants covered with clear polyethylene as well as the non-covered plants. This frost damage coupled with wind damage resulted in the loss of about 10% of the plants in the treatments that were not protected by a row cover. Temperatures remained slightly below normal through July and August, but September was exceptionally warm, with the first frost delayed by two weeks relative to the long-term norm. The near-perfect fall conditions allowed the otherwise delayed crops to mature. The total length of the frost free season in 2009 was about 10 days shorter than normal.

2010 growing season – Below normal temperatures and record rainfall were characteristic of the 2010 growing season. The timing of the first fall frost (Sept 15) was near normal.

2011 growing season – May and June of 2011were again unusually cool and wet. No frost events occurred once the crop was transplanted out. The covered crops were protected from wind damage associated with several storms which occurred soon after the crop was transplanted out. A heavy rain event in mid-June waterlogged some sections of the plot and plant vigor in those areas was negatively affected. Growing conditions were more favorable through July and August but harvesting was cut short by a fairly early killing frost (Sept 13).

Row Cover Temperature Profiles - Temperature profiles under the various tunnel materials for the period when the tunnels were in place in 2009 (June 3-July 3) are presented in Fig. 1, the temperatures for 2010 (June 3 to July 13) are presented in Fig. 2 and the data for 2011 (May 30 to June 28) are presented in Fig. 3. Temperature monitors in the Novagryl treatment failed in 2009 and no data were collected. Temperature profiles for the various tunnel treatments were similar in the three years of testing. On sunny days, all of the covering materials increased air temperatures inside the tunnels relative to having no cover. The tunnels had little impact on temperatures at night or on cloudy days. During the frost events that occurred in 2009, none of the tunnel treatments provided any significant degree of frost protection.
Daytime temperatures under the opaque materials (white, green and Novagryl) were comparable, running 3-5^{o}C warmer than ambient air temperatures. Temperatures inside tunnels constructed of clear poly were far higher than for the other materials tested. The perforated clear poly tunnels produced daytime temperatures that were a few degrees cooler than the non-perforated covering.

The clear poly coverings were clearly beneficial to growth of the crops early in spring when conditions were cool. Once outside temperatures began to increase, the clear poly tunnels became extremely hot. Peak temperatures inside the non-perforated clear poly tunnels exceeded 55^{o}C in 2009 and many of the transplants either died or showed severe and lasting symptoms of heat stress. Fewer problems with overheating were observed in the clear tunnels during the cooler cloudier conditions that prevailed through the spring of 2010 and 2011. There were no obvious differences in crop growth under the various opaque coverings. At the time of tunnels removal, all covered crops appeared to be larger than the crop grown without a covering but it did not appear that flowering was advanced or enhanced by the tunnels.

Yields
The impact of the cover treatments on tomato yields was not consistent from year to year. In the 2009 trial the white poly tunnel treatment produced the greatest early season (prior to mid-Sept) yields of mature red fruit. In 2010 all of the tunnel treatments reduced early yields of mature red fruit relative to the non-covered controls, but in 2011 the opposite treatment effect was observed - all of the covered treatments had higher early yields than the non-covered control. The white tunnel treatments in 2009 produced greater total yields of mature fruit and a higher proportion of fruit that ripened prior to frost relative to the non-covered controls. In 2010 none of the tunnel treatments enhanced any of the total yield parameters relative to the non-covered controls. In both 2009 and 2010 use of the non-perforated clear tunnel had a very negative effect on the tomato crop, with many plants dying due to heat stress and the surviving plants showing delayed development and low yields. By contrast, in 2011 the non-perforated clear tunnel treatments produced the greatest yields in all categories (early red, total red and total fruit yield).

Conclusion - this project demonstrated the potential value of low tunnels in the production of warm season crops like tomatoes within the relatively short and cool growing season available in Saskatchewan. However the results also show that the optimum cover type is highly dependent upon the weather conditions that prevail during the period the crop is covered. In years when it is consistently cool, covers that produce the warmest microclimate around the crop may be most beneficial. However if conditions turn warm these covers have the potential to damage the crop, leading to a corresponding delay in maturity and reduced yields and crop value. Cover materials that provided a more moderate level of enhancement of air temperatures (Novagryl and white perforated plastic) appeared to provide consistent benefits with minimal associated risk of crop damage due to excessive temperatures.

Fig 1. Average daily air temperatures under various opaque (a) or clear (b) tunnels in 2009.

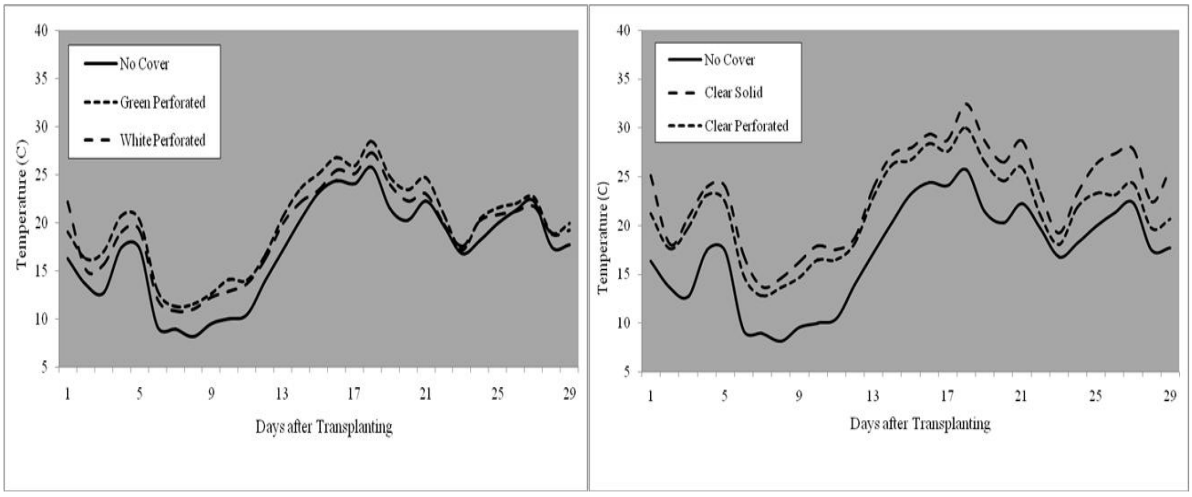

Fig 2. Average daily air temperatures under various opaque (a) or clear (b) tunnels in 2010.

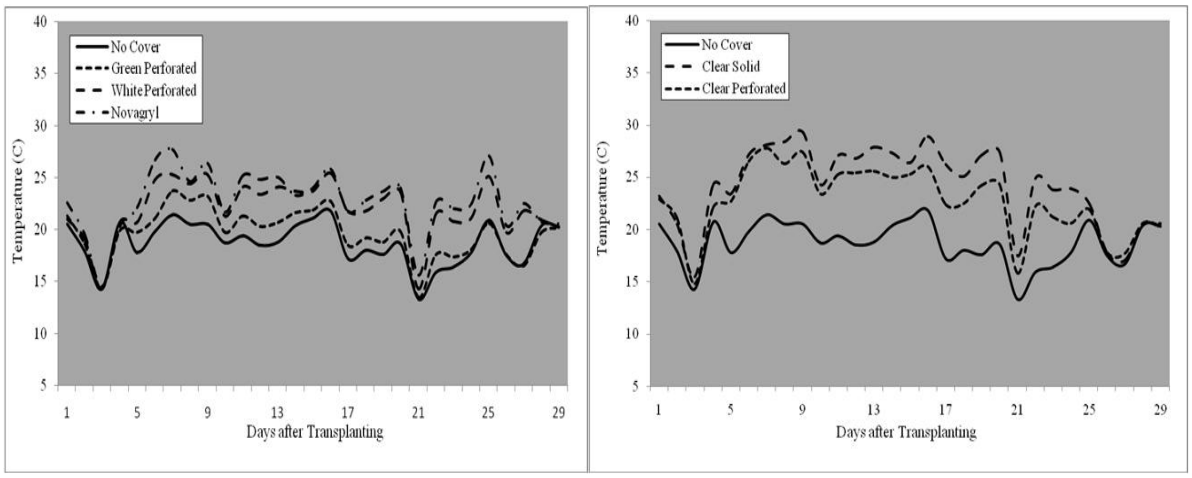

Fig 3. Average daily air temperatures under various opaque (a) or clear (b) tunnels in 2011.

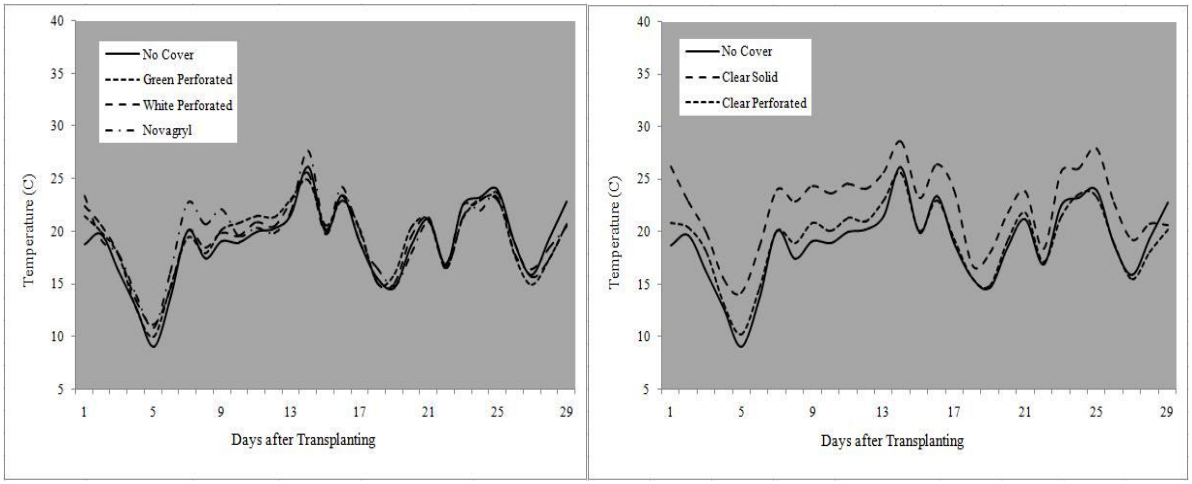

Table 3. Influence of various types of tunnel covering on yields of tomato in 2009, 2010 and 2011.

Covering Material	Early [1] (kg/m row)	Mature (kg/m row)	Total (kg/m row)	Mature %	Avg. Fruit Wt. (g)
2009					
Clear (non-perforated)	0 c[2]	0.9 d	16.4 c	5 c	39 b
Clear (perforated)	1.2 b	5.0 bc	21.7 b	23 b	72 a
White	3.9 a	7.0 a	23.7 ab	30 a	74 a
Green	0.8 b	3.9 c	22.4 ab	17 b	69 a
Novagryl	1.5 b	6.1 ab	20.8 b	29 a	76 a
No Cover	1.3 b	5.0 bc	26.3 a	19 b	78 a
2010					
Clear (non-perforated)	0 c	1.4 c	3.0 c	1 b	101 d
Clear (perforated)	0.2 c	5.5 b	8.5 b	10 b	124 c
White	1.4 b	10.3 a	12.2 a	27 a	145 b
Green	2.0 b	10.1 a	13.0 a	26 a	150 b
Novagryl	1.9 b	10.8 a	12.8 a	25 a	172 a
No Cover	3.2 a	10.9 a	13.6 a	31 a	173 a
2011					
Clear (non-perforated)	3.7a	6.1a	10.6a	57	141a
Clear (perforated)	3.1ab	4.4ab	8.5ab	52	123b
White	2.6ab	4.6ab	9.0ab	51	87c
Green	2.3ab	3.2b	6.6b	51	122b
Novagryl	3.0ab	4.7ab	8.3ab	56	115b
No Cover	1.6b	4.3ab	10.2a	42	113b

[1] *Early harvests = yields by mid-Sept.*

[2] *Values within columns followed by the same letter are not statistically different (P=0.05)(n=3)*