High Tunnel Temperature Observations
2000

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Funded by:
AGRICULTURE DEVELOPMENT FUND & AGRI-FOOD INNOVATION FUND

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On several occasions during the spring of 1999, night time temperatures outside the tunnels dropped close to the freezing point (Figure 1999-1). Temperatures inside the high tunnel were marginally higher at this time - but the degree of heat retention suggests only limited potential for early planting within these structures.

On September 2 and 9 overnight temperatures outside dropped slightly below 0°C (Figure 1999-2). These frost events did not cause any noticeable damage to the crop. However, on September 13, temperatures outside dropped below 0°C, resulting in substantial damage to the frost sensitive crops growing outside the high tunnel. The crop inside the high tunnel survived this first frost event with little damage. On September 29 and 30 more severe frost killed the crop inside the high tunnel. Throughout these low temperature events, the high tunnel maintained temperatures about 4°C higher than outside. In some years, this degree of frost protection would add significantly to the growing season.

The temperature profiles for the high tunnel, standard tunnel and in the open at the Saskatoon site are presented in Figures 1999-3 and 4. Growing degree days for warm season crops such as melons and peppers are calculated using a base temperature of 10°C. Early in the growing season, temperatures in the high tunnel were consistently higher than in the standard tunnels and the temperatures in the standard tunnel were considerably above the outside conditions (Figure 1999-3). With the removal of the standard tunnel in mid-July, the temperature regime in the standard tunnel treatments became equivalent to the no cover treatment. The high tunnel regime continued to produced higher temperatures, although the degree of increase was muted by the fact that the sides of the high tunnel were raised for most of this period.
Crop growth is largely determined by the accumulated growing degree days. As illustrated by Figure 1999-4, growing degree days accumulated more rapidly in the high tunnels than in the standard tunnel or in the open air. The differential between the treatments widened as the season progressed. By the end of the 1999 growing season, the crop in the high tunnel at the Saskatoon site had accumulated 1900 GDD versus 1500 in the standard tunnel and 1100 with no cover.

Figure 1999-3. Temperature profiles in the high tunnels in 1999.

Figure 1999-4. Cumulative growing degree days in the high tunnels in 1999.
Early planting represents a desirable method of increasing yields of warm season crops if problems with frost and chilling can be avoided. A frequently asked question about the high tunnels is “how early can you plant without risk of frost?”. Based on the temperature profiles obtained for the high tunnels in the spring of 2000, the answer is - “not very early” (Figure 2000-1). At best, the high tunnels provided 1-2C frost protection relative to the outside air. Similar results were seen in the previous years.

There is also an expectation that the high tunnels could extent the production season in the fall by protecting the crop from early frosts. Again the 2000 data (Figure 2000-2) suggests that the frost protection provided by the high tunnels is minimal (1-2C). On September 21 and 23 overnight temperatures outside dropped slightly below 0C, resulting in substantial damage to the frost sensitive crops growing outside the high tunnel. The crop inside the high tunnel survived this first frost event with little damage. On October 3 more severe frost killed the crop inside the high tunnel.

Figure 2000-1. Minimum air temperatures in the spring of 2000 inside and outside the high tunnels

Figure 2000-2. Minimum air temperature during the fall of 2002.
The temperature profiles for the high tunnel, standard tunnel and in the open at the Saskatoon site are presented in Figures 2000-3. Daytime temperatures for the covered treatments averaged 15°C above the outside air during late May through to late June. During this time, temperatures in the low tunnels were consistently higher than the high tunnels. This reflects the limited volume of the low tunnels and the limited ventilation provided by either the perforations in the clear poly or the woven material used in the Reemay. With the removal of the standard tunnel in mid-July, the temperature regime in the standard tunnel treatments became equivalent to the no cover treatment. The high tunnel regime continued to produce higher temperatures, although the degree of increase was muted by the fact that the sides of the high tunnel were raised for most of this period.

Crop growth is largely determined by the accumulated growing degree days. Growing degree days for crops such as melons and peppers are calculated using a base temperature of 10°C. As illustrated by Figures 2000-4, growing degree days accumulated more rapidly in the first month of the growing season in the low tunnels than in the high tunnels or in the open air. Once the low tunnels were removed, GDD in the high tunnels began to catch up, surpassing the standard tunnels in mid-August. By the end of the 2000 growing season, the crop in the high tunnel at the Saskatoon site had accumulated 1900 GDD versus 1400 in the standard tunnel and 1200 with no cover.
Figure 2000-4. Cumulative GDD (base 10) during the 2000 growing season for high tunnels, standard tunnels, and in the open in Saskatoon.

Figure 2000-5. Comparison of 1998-2000 cumulative GDD (base 10)
Comparison of 1998 - 2000 temperature data.

Data for the daily and cumulative GDD inside the high tunnels and in the open in 1998, 1999 and 2000 at the Saskatoon site are presented in Figure 2000-5. The 1998 growing season was considerably warmer than the 1999 or 2000 seasons. However, the GDD accumulated under the high tunnels was greater in 1999 than in 1998 (Figure 7). This reflects differences in tunnel management between the two years. In 1998, we were concerned that temperatures in the tunnels were exceeding the published optima for the crops. We observed no signs of temperature stress on the crop but nonetheless opened the sides of the tunnels. In 1999, we opted to leave the tunnels closed and to let temperatures rise based on our observation in 1998 that the crop did better under warmer conditions. In 2000 we again opted to keep the sides of the high tunnels closed for much of the season. However, the cloudier than normal weather during 2000 kept temperatures in the high tunnels relatively low.

Temperatures inside both the standard and high tunnels often reached or exceeded levels considered damaging to even the most heat loving vegetable crops - yet there were few indications of heat stress observed on either the plants or fruit inside the tunnel than outside. Stress related to dehydration may have been avoided through careful attention to soil moisture availability. Daytime humidity levels inside the tunnels were also high. This may have slowed water use - thereby reducing the risk of heat related moisture stress. In the 2000 trial, the Roadside Red tomatoes in the high tunnels showed significant levels of physiological leaf roll, while plants growing in the open had no symptoms of this disorder. Physiological leaf roll occurs when plants with a genetic predisposition to this disorder are exposed to hot dry conditions. Physiological leaf roll has little impact on growth, yields or fruit quality.