Yukon Agriculture Research & Demonstration

2004 Progress Report

Yukon
Energy, Mines and Resources

Table of Contents

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~ Tables ~

~ Graphs ~

~ Diagrams ~

~ Photographs (provided by the Agriculture Branch)~

Agriculture Research & Demonstration Site

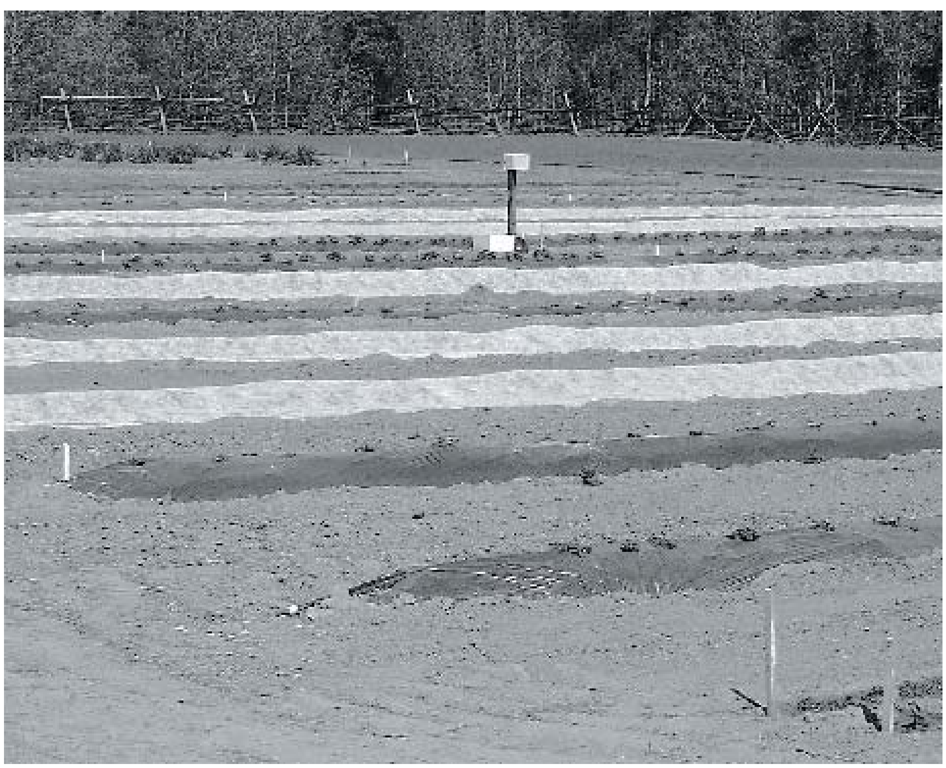
Introduction

The 2004 growing season recorded the warmest temperatures at the Takhini agriculture test plots since trials were initiated in 1988. The agroclimatic rating was class 2, with 1252.8 effective growing degree days, which is three classes higher than the average class 5 rating with 700 – 900 effective growing degree days. June's mean temperature averaged 5.1º C higher than normal and May, July and August were all above average as well. The warm weather allowed grain crops to ripen, potatoes to reach maturity prior to frost and a second cut of hay to dry for many Yukon farmers.

The main focus of the work at the Takhini site was to continue work on an input management trial that was initiated in 2002, to determine optimum irrigation and nutrient inputs for growing perennial berry crops. The purpose of the trial is to examine best management practices combining fertilization, irrigation, row cover and mulching techniques to optimize production of these crops under Yukon conditions. Another aspect of the trial is to examine the usefulness of emerging delivery system technologies that can be used to supply nutrients and irrigation water to the plants.

This was the second summer that harvest data was collected from the input management trial. Unfortunately, the strawberry crop suffered severe winter damage which affected harvest weight to the extent that comparison of management practices was not possible. The plots that received straw mulch in the fall were not as severely affected as the plants that did not receive straw mulch; although fruit production was severely impaired. The raspberry orchard showed no winter damage and developed strong growth throughout the summer, filling in the rows. Harvest results will be recorded in the summer of 2005.

Two new forage plots were added to the test site in August, 2003 in preparation for a trial to determine



~ Photo 1 ~
Strawberry rows with/without floating row covers (CR10 Data logger on post)

nitrogen mobilization in hay crops under irrigated conditions. By understanding the movement of soil nitrogen in a hay field under irrigated conditions we will be able to maximize the benefits of applied fertilizer nitrogen. Using fertilizer more effectively means less fertilizer may be required, resulting in cost reductions for both the farmer and the environment. One pure stand of smooth brome grass and one plot of pure timothy were developed over the summer of 2004. Nitrogen movement within these plots will begin in the summer of 2005.

Agrometerology

Climate is the major limiting factor to agriculture in the Yukon because of the short frost free period and lack of heat units during the growing season. Agroclimatic capability ratings are a measure of the degree of limitation imposed by climate on agricultural production. These ratings are derived from 30-year normal data collected by the Meteorological Service of Environment Canada. They represent a measure of the amount of heat available to crops during the growing season. The agroclimatic rating is modified to account for local climate patterns, such as frost occurrences, which affect the length of the growing season. As shown in Table 1, agroclimatic classes range from Class 1 (no restrictions) to Class 7 (unable to be used for any agricultural purpose).

The number of Growing Degree Days (GDD) are calculated beginning the fifth consecutive day of the year with daily mean temperatures above 5^{o}C, and terminated the day of the first killing frost (-2.2^{o}C) occuring after mid-July; specifically July 15. This killing frost temperature does not need to occur as a daily mean temperatutre, but rather at any moment of a day. For example, if the daily mean temperature is 10^{o}C, the GDD total is 5. Similarily if the daily mean temperature is 16^{o}C, GDD equals 11. However, in the instance that a mean temperature is 5^{o}C or lower, GDD would equal 0.

During the 2004 growing season the *Gunnar Nilsson & Mickey Lammers Research Forest: Research Farm,* just outside of Whitehorse, recorded 1062 GDD. This temperature factor is adjusted upward by 18% to account for the boost plants receive from the long hours of daylight north of 60^{o} latitude. As you head further north the GDD is adjusted incrementally higher (Dawson City is adjusted by 22%). Therefore, the 1062 GDD recorded in 2004, becomes 1253 Effective

~ Table 1 ~
Definitions and Operational Constraints of Land Capability Classes for Cultivated Agriculture in the Yukon Territory (Tarnocai *et al*. 1988)

Class 1 1400-1600 GDD	These lands have no significant limitations that restrict the production of the full range of common Canadian agricultural crops (none in Yukon).
Class 2 1200-1400 GDD	These lands have slight limitations that restrict the range of some crops but still allow the production of grain and warm season vegetables (none in Yukon, based on a 30 year average).
Class 3 1050-1200 GDD	These lands have moderate limitations that restrict the range of crops to small grain cereals and vegetables (in a few localized areas in Yukon).
Class 4 900-1050 GDD	These lands have severe limitations that restrict the range of crops to forage production, marginal grain production and cold-hardy vegetables (valleys of central Yukon).
Class 5 700-900 GDD	These lands have very severe limitations that restrict the range of crops to forages, improved pastures and cold-hardy vegetables (the most common class of agricultural land in Yukon).
Class 6 <700 GDD	These lands have such severe limitations for cultivated agriculture that cropping is not feasible. These lands may be suitable for native grazing.
Class 7	These lands have no capability for cultivated agriculture or range for domestic animals.

Growing Degree Days (EGDD) at the Research Farm. The first killing frost occurred on September 1. Hence, the agroclimatic rating for 2004 was Class 2 (1200-1400 EGDD), which allows for the production of grain and warm season vegetables, yet still has slight limitations which restrict the range of some crops. This is an abnormal agroclimate classification for this area (see tables 2 and 3) and is a direct result of unusually high summer temperatures.

~ Table 2 ~
Agroclimatic Data for the 2004 Growing Season at the Gunnar Nilsson & Mickey Lammers Research Forest: Research Farm

Climate Factor	May	June	July	August	Total
Max Temp (^oC)	23.0	34.1	28.6	28.2	-
Min Temp (^oC)	-8.7	-4.0	-0.2	-0.9	-
Daily Mean (^oC)	9.45	16.93	15.65	13.64	-
30 Year Normal *	6.9	11.8	14.1	12.5	-
Total Precipitation (mm)	16.23	9.39	27.67	41.6	94.89
30 Year Normal *	13.0	29.7	41.4	38.5	122.6
Growing Degree Days	105.8	357.8	330.2	268.0	1061.8
Effective Growing Degree Days **	124.8	422.2	389.6	316.2	1252.8
Frost Free Period ***	-	-	July 6 - 26	-	18 Days
Killing Frost Free Period (-2.2 ^oC)	-	June 4	------------------	September 1	88 Days

* 30 year normals are derived from the Whitehorse Airport weather station 1971-2001.
** The temperature factor is adjusted upward by 18% to account for the boost plants receive from the long hours of daylight north of 60^o latitude.
*** Whitehorse Airport records a 30-year mean frost free period of 87 days. This is longer than the 2004 frost free period and most others recorded at the Research Farm. The airport site regularly receives winds which tend to keep the temperature above freezing, while the forest sheltered nature of the Takhini Valley site reduces air movement, making frosts more common.

~ Table 3 ~
Summary of Weather Data 1996-2004 for the Gunnar Nilsson & Mickey Lammers Research Forest: Research Farm

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
EGDD	595	901	972	957	784	838	729	758	1253
Land Capability Class	Class 6	Class 4	Class 4	Class 4	Class 5	Class 5	Class 5	Class 5	Class 2
Frost Free (days)	25	45	35	50	50	51	18	40	18
Killing FF (days)	50	74	81	85	68	77	51	54	88
Precip (mm)	162	125	57	145	179	159	98	98	94.89
Max Temp (^oC)	29.6	28.7	34.1	33.2	35.0	30.8	27.3	27.3	34.1

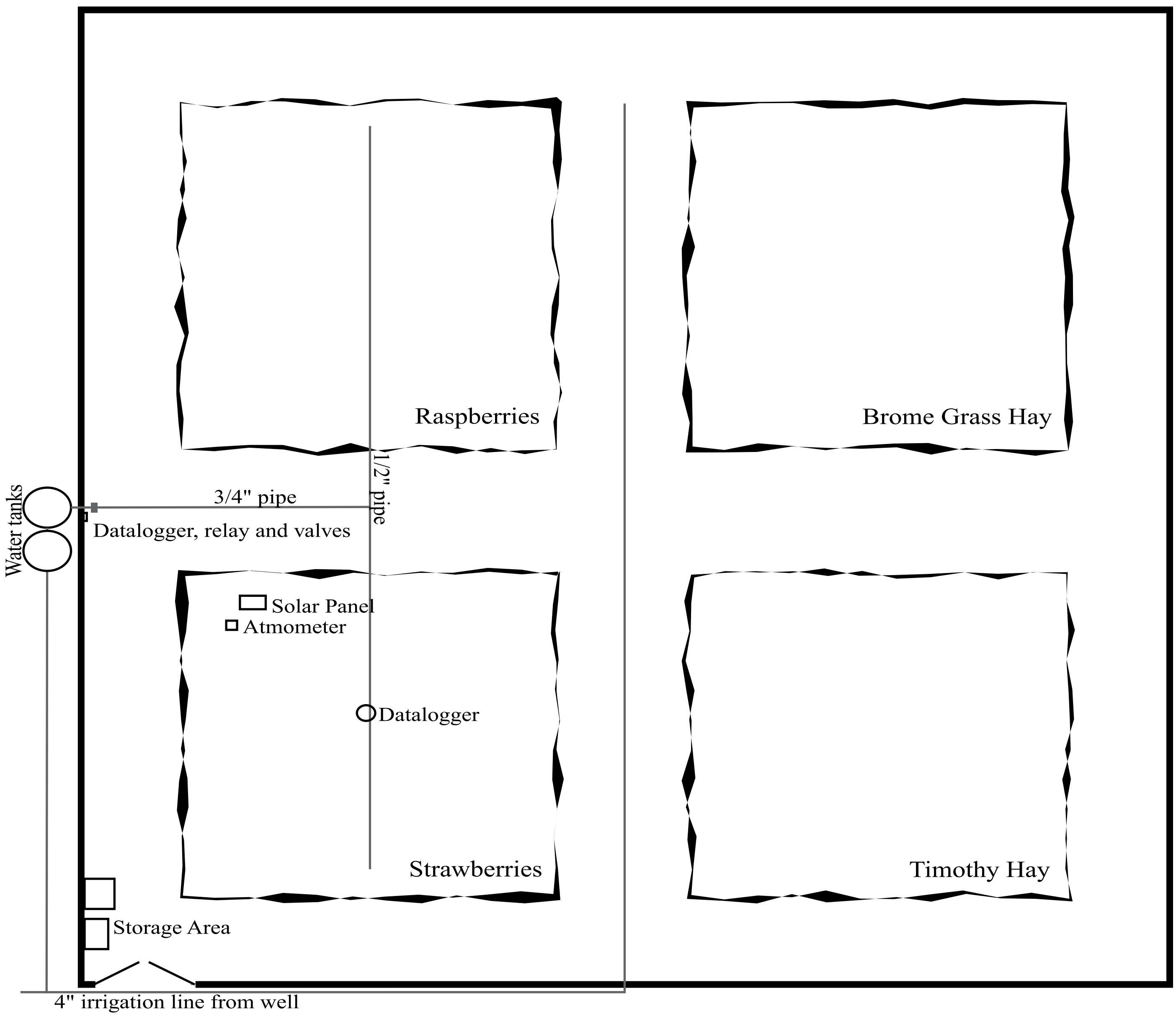
Soils

The fine textured soils at the demonstration plot vary from silt loam to sandy loam, and their potential for agricultural production is rated as fair to good. These soils belong to the Lewes soil association and are characterized as loam, with an average particle size breakdown of 42% sand, 47% silt and 11% clay throughout the four fields. The average soil pH in these plots is around 7.0 (neutral) and is trending downwards over the years. Average soil organic matter is 2%, which is low, and somewhat surprising considering the soil building effort that has occurred on this piece of land.

Site Preparation and Plot Design

The agriculture research and demonstration site is located at the Research Farm situated south of the junction of the Klondike Highway and the Takhini Hotsprings Road. The demonstration site is located on a level, sheltered 0.98 hectare field which is divided into four 40 m x 35 m test plots (Diagram 1). All crops are grown under irrigated conditions. The soil, landscape and climatic properties of the site are typical of those encountered at many farms in the southwest region of the Yukon.

~ Diagram 1 ~
Layout of the Agriculture Research & Demonstration Site



Trial on Optimizing Irrigation and Nutrient Inputs to Yukon Crops

In collaboration with Peter Parchomchuk & Denise Neilsen, Pacific Agriculture and Agrifood Research Center

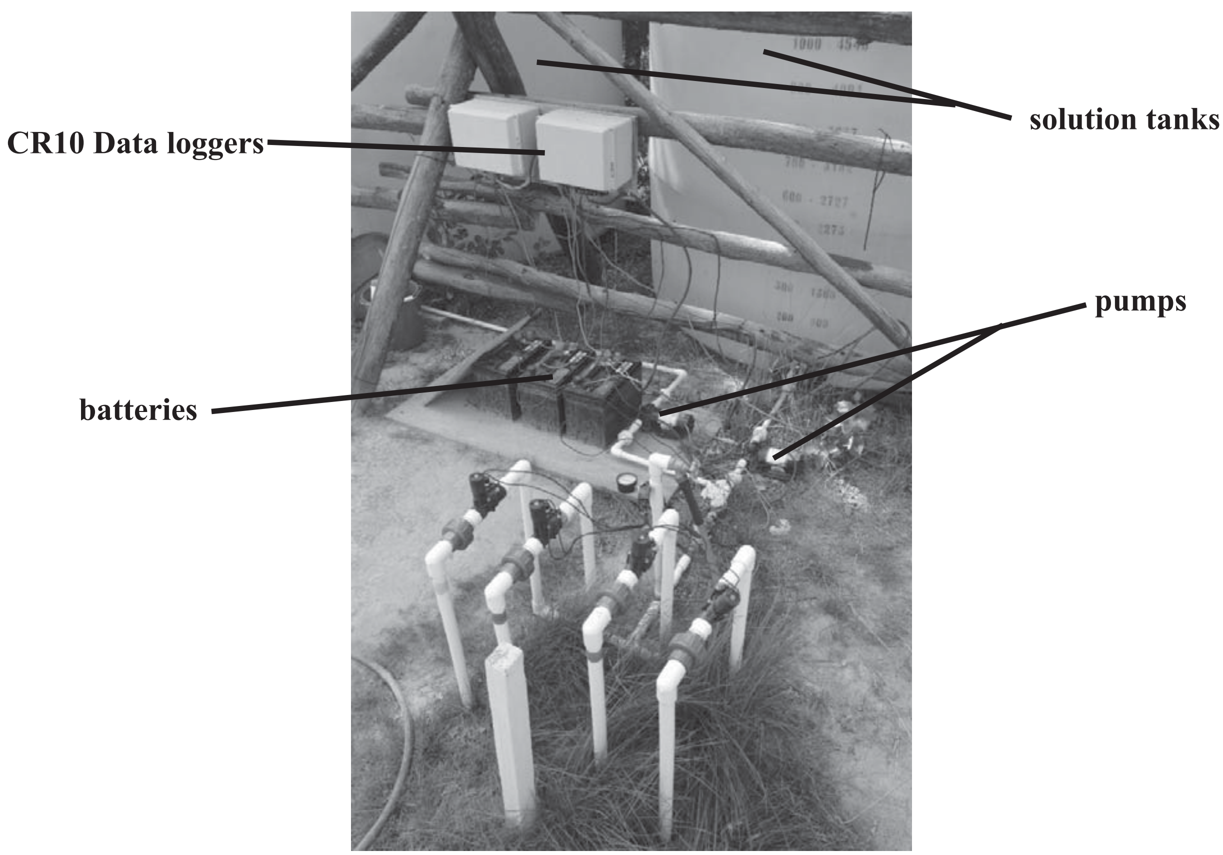
Introduction

A trial on optimizing irrigation and nutrient inputs was initiated in 2002 with collaboration from the Pacific Agri-Food Research Centre in Summerland, BC. The purpose of the trial is to examine best management practices for fertilizing and irrigating Yukon crops. By applying only as much water and fertilizer as is needed water resources can be conserved and the risk of nitrate leaching can be reduced.

The key to minimizing water use is to have a clear understanding of how much moisture is used by the plant, how much is transpired through the leaves, and how much is lost through the soil. Using various crop monitoring technologies, information on soil moisture and evapotranspiration (ET) is computed and water is automatically delivered as required. This trial will also help determine the usefulness of new technologies in Yukon applications. Crop management experience was gained during the Small Fruit Variety Trial initiated in 1998, which was incorporated into this new trial. Our hope is that some of these new techniques could be applied to other Yukon field crops such as potato, grain and forage crops.

Site Design

Two 30 X 40 m plots are used, one for the raspberry and the other for the strawberry trial. Each trial has two guard rows on either side to act as a buffer against environmental extremes. The strawberry varieties were randomly laid out in half row sections and one of two irrigation lines was randomly chosen for each row.



~ Photo 2 ~
Fertilizer solution tanks, CR10/batteries, pumps and headworks

Methods

For this trial two strawberry and three raspberry varieties are used. The two strawberry varieties, Cavendish and Kent, were chosen because they performed well in the Small Fruit Variety Trial. The three varieties of raspberries chosen were Kiska, Boyne and Souris. Boyne and Kiska were both brought from the Small Fruit Variety Trial and the Souris was imported from Alberta. All these varieties have proven viability in the north.

For this trial a variety of automated technologies are being used to apply the fertilizer and water in required amounts. An atmometer (evaporation meter) takes readings throughout the day and sends the data to a CR-10 data logger. This data logger computes values for evapotranspiration and sends a signal to a relay that turns on the water pump for a specific amount of time on each seperate line. Fertilizer is applied during every irrigation (Table 4). Ethanol was added to the water in the atmometer in early August, to avoid freezing the frost sensitive equipment.

Another data logger is located in the middle of the strawberry plot and compiles data from moisture sensors and temperature sensors beneath the plastic mulch. Examination of this data provides assurance that the system is functioning properly and helps determine soil moisture levels. All the data is downloaded onto a laptop computer once a week.

Rows were mounded with a bedmaker attachment on the rear of the tractor and wavelength selective thermal plastic mulch was used to cover the rows. This mulch provides soil warming, effective weed control and a clean surface for the berries to mature on.

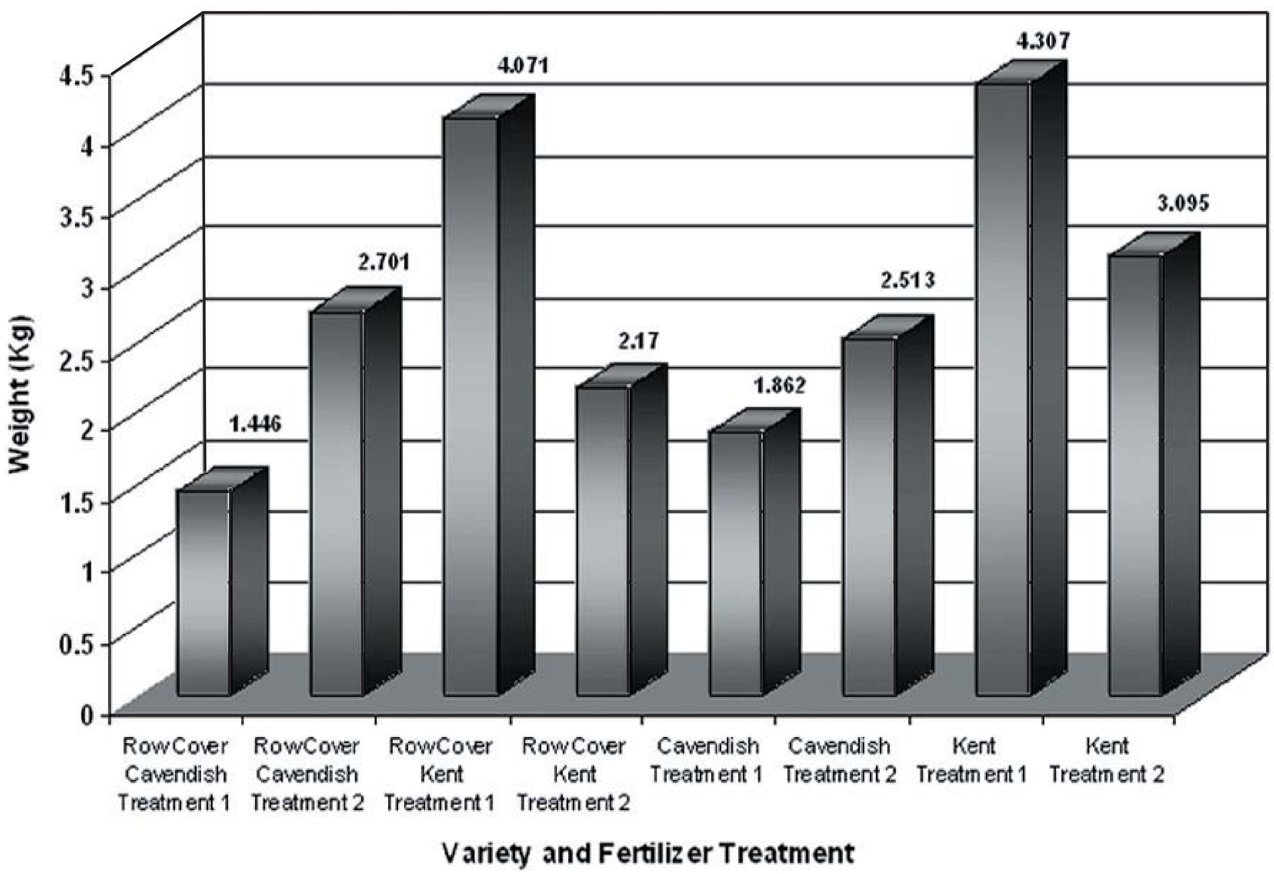
~ Table 4 ~
Fertilizer Treatment Schedule 2004

	Week 1 May 27 – June 02	Week 2-8 June 3 – July 19	Week 9-16 July 19 – Sept 03
Fertilizer Treatment 1	2.3kg 10-52-10 / tank	0.97kg 15.5-0-0 / tank	0.393kg 13-0-46 / tank
Fertilizer Treatment 2	2.3kg 10-52-10 / tank	1.94kg 15.5-0-0 / tank	0.393kg 13-0-46 / tank

Tanks are 1100 Imperial Gallons (5000 Litres)

~ Photo 3 ~
Top view of thermal plastic mulch layer mounted behind tractor

~ Graph 1 ~
Weight based on variety and treatment in 2004



2004 Strawberry Results

Over-wintering strawberry plant assessment took place on May 5 this year when the straw mulch applied to provide winter protection was removed. Out of 40 plots in the trial, only plots 15 – 24 were mulched with straw in the fall of 2003. Plants in all plots appeared to have died back although the plants that did receive straw mulch showed less damage and started to green up faster than plants that did not receive straw mulch protection.

Irrigation began on May 15 after runners were transplanted into the rows to replace the most severely damaged mother plants. At this point, the extent of the winter kill had become evident and it was determined that replacement stock would be required for the entire plantation if a meaningful comparison of row cover and various fertilizer treatments was to take place. The severity of damage was to affect flower bud development and plant vigour to such an extent that it became impossible to attribute harvest weight to anything other than extent of winter damage. Replacement stock was sourced and transplanted into many of the plots on June 9, but by this time it was too late to gather meaningful data (Graph 1).

The strawberry harvest began on July 6th in 2004, five days earlier than the start of the harvest in 2003 and ended August 9, which was 19 days earlier than the year before. This was largely due to the summer being much warmer in 2004, which caused the berries to ripen earlier and faster than in previous years.

There were two harvest results of note. The first being that 42% of the berries produced came from the plots that received straw mulch winter protection, which contained only one quarter of the plants in the trial. The second note would be that the Cavendish variety only produced 63%

as many marketable berries as the Kent variety in 2004 and this is in comparison to the 70% of Kent's production in 2003, when the plants had not been winter damaged. Although this is not enough data to suggest that Kent is hardier in the southern Yukon it would indicate that Kent is more productive than Cavendish in this region.

2004 Raspberry Results

2004 was the third stock building year since the initial root planting in 2002 and the most impressive in the development of the raspberry orchard. The rows have now filled in to the point where thinning of florocanes will take place in the spring of 2005 and harvest weights comparing fertilizer treatments can commence. Very little fruit was picked in 2004 so there was no assessment done on the different fertilizer treatments.

A trellis system was installed over the summer to train fruiting wood to the outside of the rows which will allow easier access in picking fruit when it matures later in August. Tying fruiting canes to the outside of the rows also allows space for the vegetative primocanes to grow up in the center of the row, where they can develop without risk of damage during harvest.

Soil tests taken in October 2004, showed a neutral pH (7.2) and low organic matter levels (1.8%) in the raspberry rows.

~ Photo 4 and 5 ~
Raspberry rows: early June (above) and late August (below)

CR10 Data

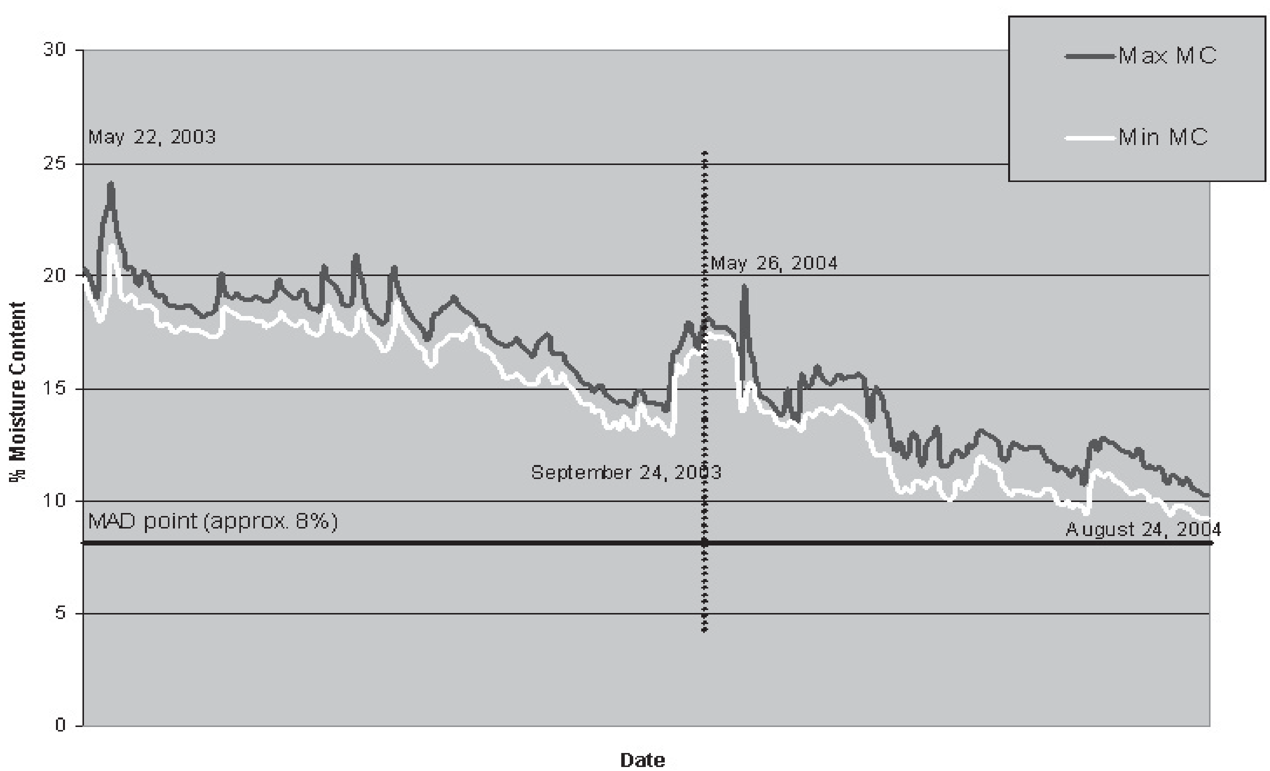
Information compiled from the CR10 data logger placed in the middle of the strawberry crop, which recorded throughout the 2003 and 2004 growing season, resulted in the soil moisture content trend found in graph 2.

Water is stored in the soil at or below field capacity. Any water above field capacity is pushed through the soil by gravity or as runoff from the soil surface. Since plants can only extract a portion of the stored water in soil without being stressed, it is important to calculate the Management Allowable Depletion (MAD) point. This is the percentage of water which can be removed from the soil by the plant prior to reaching its Permanent Wilting Point (PWP); where a plant dies. MAD point essentially describes the amount of water available to be used by crops between irrigations, hence providing an efficient use of water for best management practices.

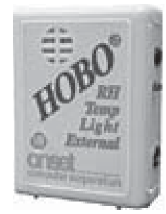
Using a soil index representative of the sandy loam soils at the plot, 38-40% moisture content was determined as the field capacity. The wilting point was estimated at approximately 7-8% moisture content. This means that the allowable amount of water to be used by plants would be between these percentages.

The trend exhibited in graph 2 shows a steady decrease in soil moisture throughout the two growing seasons. We can deduce from this data that the MAD point has been reached, and that any further decrease in moisture would lead past the wilting point, at which plants would undoubtedly show signs of stress. This decline in moisture is certainly attributable to the above average warm temperatures during the 2004 summer. These findings also indicate that irrigation run times will need to be increased in 2005 to ensure that higher moisture content is maintained. Future data analysis will also be able to quantify precisely how much water is required, within the Management Allowable Depletion for optimum plant growth and production.

~ Graph 2 ~
2003-2004 Growing Season Soil Moisture Content Trend from CR10 Data Logger



Takhini River Valley Agroclimatic Data Comparison



Intoduction

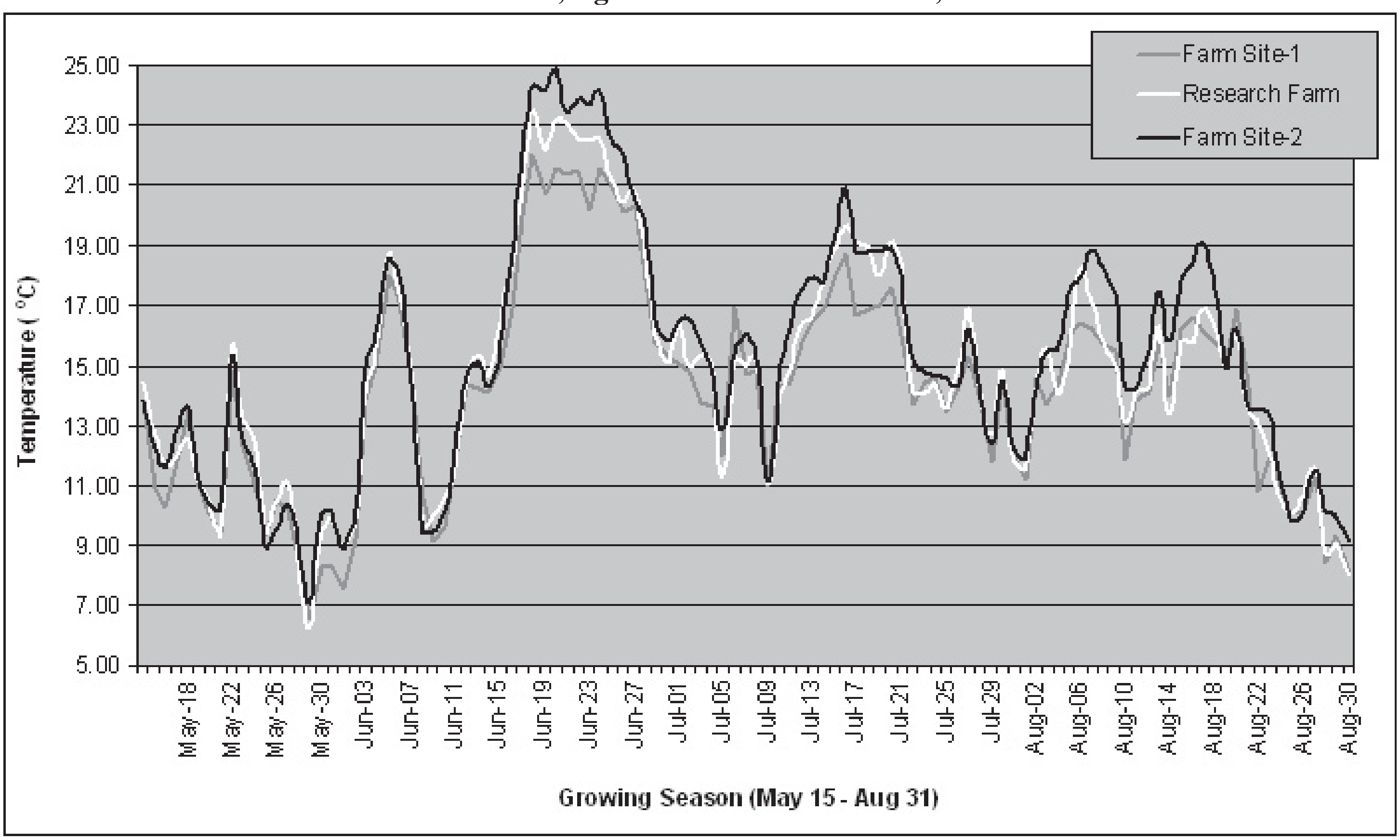
Climate data comparison in the Whitehorse area, specifically between the Agriculture Research Farm at the Gunnar Nilsson & Mickey Lammers Research Forest and the Whitehorse Airport have shown interesting contrasts regarding Growing Degree Days (GDD) and Effective Growing Degree Days (EGDD) respectively. These differences, based primarily on the locations elevation and overall wind affectedness could ultimately translate into identifying ideal agricultural site placement and production. The objective of this experiment is to compare and contrast microclimates in three locations differing primarily in elevation, within the same geographical area throughout the course of the growing season.

Methodology

Data loggers used to record ambient temperature throughout the growing season were placed at two different locations within the Takhini River valley. These small battery operated devices by the registered name HOBO (manufactured by Hoskin Scientific Ltd.), were fixed approximately 2 meters (≈ 6 feet) above ground on a steel bar using Stevenson screens, or plastic protective plates as shielding covers. The recording period lasted from May 14th to September 6th.

Recorded information from the data loggers was then studied for statistical analysis and compared to one another, as well as to the more sophisticated

~ Graph 3 ~
2004 Agroclimatic Data (Daily Mean Temperature) Comparison in theTakhini River Valley - Three Locations: Farm Site-1, Agriculture Research Farm, and Farm Site-2



meteorology data acquired near the Agriculture Research Farm, in order to determine microclimate inferences at various elevations in this area. This area sits topographically in between the others, at 642m in elevation. In addition, the 0.98 hectare field has a sheltered perimeter provided by a thick forest stand.

The first data logger was set up at Farm Site-1, which sits adjacent to the north side of the Takhini River at 611m in elevation. This area, approximately 4m above the waterline, is a flat bench at the foot of steeper topography often acting as a frost pocket. The second data logger was set up at Farm Site-2, located at 691m in elevation. This is a more open site surrounded with fields, not particularly sheltered and ideal for frost or cold-air drainage. Additionally, this type of region is usually subject to more drastic temperatures fluxes throughout the year.

Results and Discussion

Overall mean temperatures of the three locations were very similar to each other throughout the growing season (Graph 3) (Tables 5-7). Although the highest maximum temperature was found at the Agriculture Test Plots (34.1 oC), the highest daily mean was at Farm Site-2 (17.42 oC, June), which also displayed overall warmer temperatures. Furthermore, the Agriculture Test Plots also exhibited the lowest minimum temperature (-8.7 oC) as well as the lowest daily mean (9.45 oC, May) throughout the growing season (excluding Sept 1 – Sept 6 at Farm Site-2).

Atypical warm temperatures this summer lead to greater GDD and EGDD than usual growing seasons (refer to Table 1). As anticipated, EGDD and respective Land Capability Classes positively corresponded with elevation: Farm Site-1 had 1184 EGDD (Class 3), the Agriculture Test Plots had 1253 EGDD (Class 2), and Farm Site-2 had 1342 EGDD (Class 2).

Frost free periods differed significantly amongst the three locations. The shortest period was 18 days at the Agriculture Test Plots, followed by 72 days at Farm Site-1, and 98 days at Farm Site-2. Killing frost free periods on the other hand were very similar between Farm Site-1 and the Agriculture Test Plots, with 89 days and 88 days respectively. The longest frost free period was recorded at Farm Site-2 with duration of approximately 114 days (refer to Table 5 footnotes).

~Table 5~

Farm Site-1 (611m Elevation) Agroclimatic Data for the 2004 Growing Season (May 15th – Sept 1st)

Climate Factor	May	June	July	August	Total
Max Temp (^{o}C)	24.4	33.59	29.1	29.5	-
Min Temp	-3.37	-3.85	2.03	-1.97	-
Daily Mean	10.71	16.11	15.05	13.45	-
Growing Degree Days	97.08	333.27	311.42	262.01	1003.78
Effective Growing Degree Days*	114.55	393.26	367.47	309.18	1184.46 Class 3
Frost Free Period**	-	June 11	------------------	August 23	72 Days
Killing Frost Free Period (-2.2 ^{o}C)	-	June 3	------------------	September 1	89 Days

~Table 6~
Gunnar Nilsson & Mickey Lammers Research Forest (642m Elevation) Agroclimatic Data for the 2004 Growing Season (May 15th – Sept 1st)

Climate Factor	May	June	July	August	Total
Max Temp (°C)	23.0	34.1	28.6	28.2	-
Min Temp	-8.7	-4.0	-0.2	-0.9	-
Daily Mean	9.45	16.93	15.65	13.64	-
Growing Degree Days	105.8	357.8	330.2	268.0	1061.8
Effective Growing Degree Days*	124.8	422.2	389.6	316.2	1252.8 Class 2
Frost Free Period**	-	-	July 6 - 26	-	18 Days
Killing Frost Free Period (-2.2 °C)	-	June 4	------------------	September 1	88 Days

~Table 7~
Farm Site-2 (691m Elevation) Agroclimatic Data for the 2004 Growing Season (May 15th – Sept 6st)

Climate Factor	May	June	July	August	September	Total
Max Temp (°C)	22.09	33.17	28.31	27.52	19.42	-
Min Temp	-0.61	0.73	6.22	2.46	-1.06	-
Daily Mean	11.19	17.42	16.06	14.61	7.76	-
Growing Degree Days	105.31	372.65	342.82	297.77	18.79	1137.34
Effective Growing Degree Days*	124.26	439.72	404.53	351.36	22.18	1342.05 Class 2
Frost Free Period**	May 29	----------------	-----------------	-----------------	September 5	98 Days
Killing Frost Free Period (-2.2 °C)	Prior to May 14***	----------------	-----------------	-----------------	September 6	≈ 114 Days

* The temperature factor is adjusted upward by 18% to account for the boost plants receive from the long hours of daylight north of 60o latitude.
** Whitehorse Airport records a 30-year mean frost free period of 87 days. Typically, the airport site would receive more winds which tend to keep the temperature above freezing, while the forest sheltered nature of the Takhini Valley site reduces air movement, therefore making frosts more common.
***This particular data logger was activated May 14th. Climate trends related to this location would undoubtedly indicate an earlier start date for GDD computation. However, since data prior to this date does not exist, we must assume GDD computation beginning on the same day as the data loggers at the other two locations.

Conclusion

Although open sites at higher elevations indicate favorable EGDD, it is important to remember that these are also subject to greater temperature variations when compared to lower elevation sites. Subsequently, cold-air drainage into the Takhini River Valley bottom could add agricultural production restrictions due to frost. It is also essential to note that the determination of preferred agricultural locations can certainly not be based on temperature parameters alone, and that soil and moisture, irrigation availability, and accessibility to the site are factors to consider. Also, agroclimatic data reliability improves with longer sampling periods, therefore, it is notable that there are limitations to the applicability of a short term analysis such as this one.

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Tarnocai, C., Smith, C.A.S., and Beckman, D. 1988. Agriculture Potential and Climate Change in Yukon. *In* Proceedings of the Third Meeting on Northern Climate, September 7-8, 1988, Whitehorse, Yukon. Atmospheric Environment Service, Environment Canada, Downsview, Ontario, pp. 181-196.

Useful Internet Resources

Agriculture and Agri-Food Canada
http://www.agr.ca

Alberta Agriculture
http://www.agric.gov.ab.ca

BC Agriculture
http://www.gov.bc.ca/agf/

University of Alaska Fairbanks
http://www.lter.uaf.edu

Western Producer
http://www.producer.com

Yukon Agricultural Association
http://www.yukonaa.com/

Yukon Agriculture Branch
http://www.emr.gov.yk.ca/Agriculture/default.htm

Appendix 2

Strawberry Variety Descriptions

Cavendish – Developed by Agriculture Canada in 1990, it is a cross between Glooscap and Annapolis. This variety produces high yields of very large, medium firm to firm fruit. Flavour is good but berries are prone to excessive darkening when overripe and colour can be variable with white blotches evident under some conditions. Plants show low to medium vigour so planting densities should be increased. Resistant to red stele (A-6) but susceptible to powdery mildew and green petal. Suited to PYO or limited shipping.

Kent – Developed by Agriculture Canada it is a cross between Redgauntlet, Tioga and Raritan. Produces very high yields of large, bright red fruit. Berry flesh is firm but skin may be weak in hot weather. Flavour is fair to good. Has shown some tolerance to red stele (A-6) in some fields. Suited to PYO and limited shipping. Kent is the most widely grown strawberry variety in eastern Canada.

Appendix 1

Raspberry Variety Descriptions

Boyne – Developed at the Agriculture Canada Research Station at Morden, Manitoba and introduced in 1960, it is a combination of Chief and Indian Summer. It is the hardiest and most consistently productive cultivar for the Prairies; and the main cultivar for commercial production in all colder regions of Canada and the United States. Canes are medium in height, thick, erect and stocky, with many lateral branches. Fruit is medium sized, dark red, firm, juicy, aromatic and tart.

Kiska – Developed by Dr. Arvo Kallio at the Agricultural and Forestry Experiment Station, Fairbanks Alaska. Kiska raspberries have thin, willowy canes. Under optimum fertility and moisture, canes may easily reach 6-8 feet in height. These canes tend to bend outward and downward making harvesting difficult.

Souris – Developed by Agriculture Canada Research Station, Morden Manitoba. An improved selection of Boyne because it is better tasting, a heavier producer of fruit and it has 15% better spider mite resistance.

Appendix 3

Hay Variety Descriptions

Carlton - Registered in 1961 by Agriculture and Agri-Food Canada in Saskatchewan. A grass suited to the north with high forage and seed yeilding characteristics.

Climax - Registered in 1947 by Agriculture Canada in Ontario. A grass suited for pastures with cool moist peat soils. This timothy is a winter hardy, medium late maturing perennial bunch grass that lives for 4 to 8 years. Withstands spring flooding and acidic soils.

Glossary

Atmometer - An instrument used to measure evaporation.

CR-10 - Campbell Scientific programmable datalogger used to measure soil moisture, soil temperature, and water flow, also used to compute irrigation run times.

Effective Growing Degree Days (EGDD) - An upward adjustment made to the GDD value to account for the boost plants receive from the long daylight hours at northern latitudes.

Evapotranspiration (ET) - The combined water loss from soil evaporation and plant transpiration.

Field Capacity - The water content of the soil where all free water has been drained from the soil through gravity

Growing Degree Days (GDD) - Can be calculated in a number of ways, Agriculture branch calculates them by beginning the fifth consecutive day with mean temperatures above 5^{o}C, and terminating the day of the first killing frost (-2.2^{o}C) which occurs after mid-July.

Irrometer - Ceramic tipped soil water sampling device.

Management Allowable Depletion (MAD) - The percentage of water at field capacity which can be removed from the soil by the plant prior to reaching the wilting point, at which time irrigation should occur.

Permanent Wilting Point (PWP) - The soil moisture content at which the plant will wilt and die. Any remaining water in the soil is insufficient to meet the plant requirements.