YUKON AGRICULTURE RESEARCH AND DEMONSTRATION

2008 PROGRESS REPORT

Yukon
Energy, Mines and Resources

Executive Summary

The 2008 Yukon Agriculture Branch research and demonstration projects are a continuation of demonstrations and trials from previous years as well as new trials. In 2008, research focused on the evaluation of biodegradable mulch, forages, raspberry orchard production, oilseeds, and the analysis of yearly climate data.

The growing season for 2008 was marred by cold summer weather. The yearly analysis of the climate data collected from weather stations across the territory showed below average growing season temperatures and an agroclimatic capability below ten-year normals. The Central Yukon and Watson Lake agriculture regions continue to have the best agroclimatic capability, although these regions saw a drop in the range of crops that normally can be grown in these areas. Haines Junction and the Whitehorse area proved to be cool through the summer resulting in severe limitations that would restrict the range of crops to forages, improved pastures and cold-hardy vegetables. On the plus side the territory received above normal rainfall which improved dryland production and reduced the need for irrigation.

The forage demonstration is an ongoing project at the Agriculture Branch research farm. A variety of forage species have been planted and yearly assessments of winter survival and total yields continue to be recorded. Results show that although Carlton Smooth Brome may not be the most winter hardy, it continues to provide superior yields compared to other forages in this trial. One cut versus two cut systems were also evaluated; yields from each system varied depending on the forage grown.

A biodegradable mulch trial evaluated a new micro perforated biodegradable & compostable mulch film from BioTelo™. Initial results indicate the mulch is breaking down and will be able to be incorporated into the soil reducing the need for pick up and disposal costs. The evaluation is not complete and will continue in 2009 to determine if the mulch will completely decompose. The trial also evaluated the irrigation needs of the mulch and results showed the microperforation did allow for the transmission of overhead irrigation and rainfalls to the soil.

The oilseed evaluation finished its third year and the much cooler growing season provided valuable insight on the year-to-year suitability of oilseed production in the Whitehorse area. The cold season severely affected oilseed production resulting in poor to no maturity and much reduced yields compared to the previous two years. *Camelina sativa* and *Brassica rapa* (Polish canola) showed signs of marginal maturity, although the combination of low yields and poor quality would not warrant a harvest on a large scale. Disappointingly, the oilseeds evaluation in the Central Yukon was lost, although climate data and the previous year's results suggest that there were enough growing degree days in this region to mature *Camelina sativa* and *Brassica rapa*.

The raspberry orchard assessment continued to evaluate input management and the economics of production. Last year saw a dramatic decrease in production due to the cold season. The calculated economics of production showed a loss of profit for the orchard. However, results did show some profit would be achievable growing the Kiska raspberry variety developed in Alaska and selling at premium market prices with a management system that allows for reduced input costs.

Preface

This document is a record of agricultural demonstrations, experiments, and studies conducted in the Yukon. This is a yearly testimony of new and accumulated data and information set out to assist growers and researchers with future endeavours related to northern agriculture.

The target audience for this document is commercial agriculture producers, growers, and those interested in northern agronomic research.

Acknowledgments

The Yukon Agriculture Branch would like to thank all agricultural producers who participated and contributed with site locations, data collection, and field monitoring and observations. Recognition is also extended to the Forest Management Branch of the Department of Energy, Mines and Resources, as well as Environment Canada for contributing valuable climate data. In addition, the Agriculture Branch would like to thank the following individuals and companies: Kevin Falk and Richard Gugel (AAFC, Saskatoon Research Centre), Robert Stillwell (Agriculture Branch Summer Student), Bodycote Labs and all the raspberry pickers.

Prepared by:

Bradley Barton
Agriculture Research Technician

Matthew Ball
Agrologist

Table of Contents

Introduction

Agriculture research has been taking place in the Yukon for almost 100 years and has played an important role in the development and understanding of northern agriculture. Federal research stations in Dawson and Haines Junction have since been replaced by a Yukon government driven research program.

The Yukon government's Agriculture Branch began conducting its own research in co-operation with industry in the 1980s. In 1988, the Yukon government established a small research farm at the Gunnar Nilsson and Mickey Lammers Research Forest in order to carry out additional research. Even with the establishment of the research farm, projects continue to be conducted in partnership with industry in supplemental areas of the Yukon. The co-operation with industry takes advantage of on-farm expertise and site variation. As well, multiple sites provide insight into the diverse climate and soils showing the growing potential that exists in other areas beyond the research farm.

The research and demonstration reports enhance the knowledge base of agriculture north of 60^{o} and support the development of a sustainable Yukon agriculture industry. Over the years, the research and demonstration projects have been designed to evaluate one or more of the following:

- Crop varieties
- Soil enhancements and management techniques
- Agriculture technologies and management practices
- Economics of production

A climate assessment is also conducted on a yearly basis to support current research and demonstration project results. In identified regions across the territory the climate data is collected to better understand the diverse weather patterns and the season to season variability in growing conditions. The multitude of information collected from the research projects leads to recommendations for Yukon agriculture and the publishing of studies and reports.

Agriculture Regions and Site Descriptions

Yukon agriculture has been divided into four defined agricultural regions:

- Whitehorse
- Central Yukon
- Haines Junction
- Watson Lake

These agriculture regions are a result of either climate and/or current and past agriculture activities.

The Whitehorse and surrounding area has been identified as an agricultural region because it accounts for the majority of Yukon agricultural activity. This region is composed of the Takhini River valley and Yukon River valley between Marsh Lake and Lake Laberge.

The Central Yukon region is the largest of the agricultural regions and is recognized for having a warmer growing season. The region is also historically one of the first areas in the Yukon developed for agriculture production because of demand for fresh food from the influx of miners at the turn of the 20^{th} century. The Central Yukon agricultural region lies in the Yukon, Pelly, Stewart and McQuesten valley bottoms stretching from Carmacks to Dawson City, including Pelly Crossing and Mayo.

Haines Junction and the surrounding area is characterized by a cool growing season and high incidence of frosts. This area has been identified as an agriculture region because historically it was home to an Agriculture Canada Research station from 1944 to 1968 and is still home to a strong agriculture community.

The Watson Lake area has a stable agriculture industry and due to warmer continental temperatures and improved seasonal precipitation the area has been identified as having an enhanced agricultural potential.

These regions undergo climate monitoring and analysis. The climate data is collected by Environment Canada and the Yukon government. Each growing season is analyzed to determine the heat and growing season for producers and research projects in the regions.

The Whitehorse area undergoes additional climate monitoring to further develop our understanding of microclimates. The following is a list of participating climate monitoring sites and their general locations:

- BD Site - Circle D Ranch, located in the Takhini Valley.
- GZ Site - Zgeb family, located in the Takhini Valley.
- TA Site - Pradi deSanta Maria, located in the Yukon River Valley on the slope of Pilot Mountain.
- TR Site - Aurora Mountain Farms, positioned on an upper bench of the Takhini Valley.
- WG Site - El Dorado Game Ranch, located on a lower bench in the Takhini Valley.

A bulk of the research and demonstration projects are conducted in the Whitehorse area at the Agriculture Branch research farm (identified in this report as the RF site). In 2008, the research farm supported forage demonstrations, a raspberry orchard production assessment, an oilseeds evaluation and a biodegradable mulch evaluation. This site is located in the Gunnar Nilsson and Mickey Lammers Research Forest located at the junction of the Yukon and Takhini River valleys. The research site is two hectares surrounded by Lodgepole pine forest and soils are typical of those encountered at many farms in the southwest region of the Yukon. The area is within one kilometre of a Yukon government weather station.

Although most trials were conducted at the research farm, the oilseeds evaluation was conducted at two other locations in the Yukon. Site SM, Yukon Grain Farms, was the location for a second Whitehorse area oilseeds evaluation. The site was also home to an Agriculture Branch portable weather station, which provided additional climate data for the area. The SM site is located in the Yukon River Valley, near the southern tip of Lake Laberge. The weather station and field experiments were located on the northwest corner of a large 50 ha field.

Site HN, Crosby Creek Farms, was also home to the oilseeds research project. This was the only site in Central Yukon used by the Agriculture Branch for research. The site is located west of Pelly Crossing along the Pelly River near Crosby Creek. The site is on a north bench of the Pelly River, with good sun exposure. Climate data for this area was obtained from the Pelly Ranch weather station.

Photo: Watchdog weather station, measuring microclimate variations in the Whitehorse area

1.0 YUKON CLIMATE MONITORING

CO-OPERATORS: Agriculture and Agri-Food Canada (PFRA), Pradi de Santa Maria, Circle D Ranch, El Dorado Game Ranch, Yukon Grain Farm, Aurora Mountain Farms, Gary Zgeb

LOCATION: Various Agricultural Regions in Yukon

FUNDING: Government of Yukon, APF Science and Innovation

OBJECTIVE: To understand the variability in climate at various locations in the Yukon.

INTRODUCTION

Climate is the major limiting factor to agriculture in Yukon due to a short frost free period, lack of heat units, and rainfall deficits during the growing season. Last year proved to have its challenges and a tabulation of the climate data from the 2008 season indicates it was a cold summer in all agricultural areas of Yukon.

The climate data from the past growing season is collected and used to calculate agroclimatic capability. The agroclimatic capability is a measure of the degree of limitation imposed by climate on agricultural production and a measure of the amount of heat available to crops during the growing season. The agroclimatic capability is modified to account for local climate patterns, such as killing frost (-2.2°C), daily average temperature and day length. Table 1.1 defines the agroclimatic classes, from Class 1 (no restrictions) to Class 6 (severe limitations for cultivated agriculture, cropping is not feasible). The agroclimatic capability is based on Growing Degree Days (GDD). GDD is an accumulation of heat during the growing season using the average daily temperature minus a basic mean temperature of 5°C required for cool season crop growth. For example, if the daily mean temperature is 10°C, the GDD total is 5. Similarly if the daily mean temperature is 16°C, GDD equals 11. However, in the instance that an average temperature is 5°C or lower, GDD would equal 0. The basic premise is the more days with higher temperatures, the warmer the area is, creating better growing conditions, which is represented by the GDD value.

GDD is calculated beginning the fifth consecutive day of the year with daily mean temperatures above 5°C, and terminated the day of the first killing frost occurring after July 15. This killing frost temperature does not need to occur as a daily mean temperature, but rather at any moment of a day. Although the specific killing frost temperature differs between crops, for the purpose of determining the end of the growing season from year to year for the Yukon a temperature of -2.2°C is used as a standard killing frost for cool season crops.

Table 1.1: Definitions and operational constraints of agroclimatic capability classes for cultivated agriculture in Yukon

Class 1	1,400-1,600 GDD	These lands have no significant limitations that restrict the production of the full range of common Canadian agricultural crops.
Class 2	1,200-1,400 GDD	These lands have slight limitations that restrict the range of some crops but still allow the production of grain and warm season vegetables.
Class 3	1,050-1,200 GDD	These lands have moderate limitations that restrict the range of crops to small grain cereals and vegetables.
Class 4	900-1,050 GDD	These lands have severe limitations that restrict the range of crops to forage production, marginal grain production and cold-hardy vegetables.
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.
Class 6	<700 GDD	These lands have such severe limitations for cultivated agriculture that cropping is not feasible.

The longer day length experienced in the Yukon has a positive effect on crop growth which is not accounted for in a simple GDD calculation. To account for the boost plants receive from the long hours of daylight north of 60° latitude the GDD is adjusted upward and reported as Effective Growing Degree Days (EGDD) as outlined in the calculation of the day length factor in the Land Suitability Rating System for Agriculture Crops (Agriculture and Agri-Food Canada Technical Bulletin 1995-6E). For example, the 947 GDD recorded at the Whitehorse airport, is multiplied by a factor of 1.16 and becomes 1099 EGDD. The daylight factor changes with latitude, for example in Dawson City a factor of 1.18 is used and for Watson Lake a factor of 1.14 is used.

Over the years utilization of climate data from Environment Canada, Yukon government weather stations and portable weather stations from different regions across the territory have been used to calculate the agroclimatic capability in these areas. The comparisons of different regions have shown interesting contrasts between growing degree day (GDD) values. The regions, as outlined above, include

- Whitehorse and surrounding area
- Haines Junction
- Central Yukon
- Watson Lake

Weather station data has also been used to evaluate monthly precipitation for the agriculture regions, and historical data has been used to determine the 10-year average and extremes from year to year.

An in-depth evaluation in the Whitehorse area has been conducted over the last few years and this data has provided insight into the many microclimates that exist within this small area. The micro-climate analysis has provided a better understanding of the influence of site profiles; namely elevation, slope, aspect, and wind (i.e. frost drainage or entrapment by geography or forests) on the agroclimatic capability.

Materials & Methods

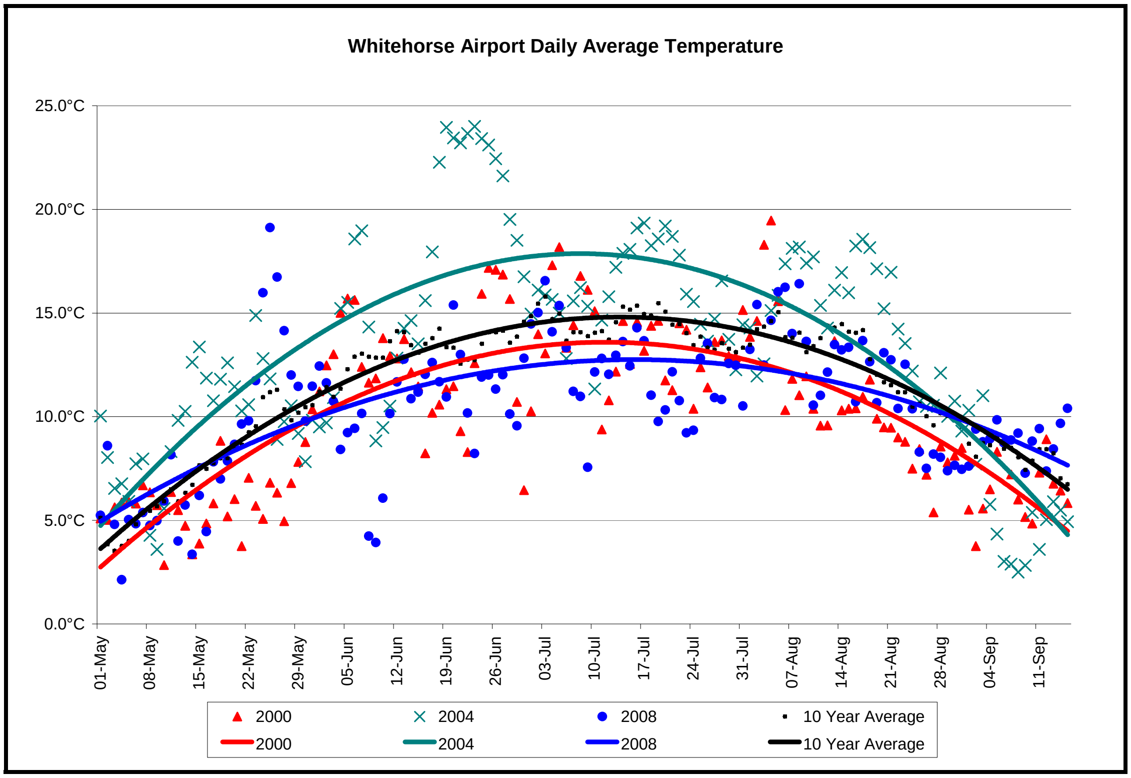
Weather stations were used to record temperature, wind speed and direction, relative humidity and rainfall. Data loggers were used to record ambient temperature throughout the growing season. Data was collected from various sites in the Whitehorse area, Haines Junction, Watson Lake and locations in central Yukon, including Dawson City, Mayo, Pelly Crossing, and Carmacks. Weather data was either downloaded from Environment Canada and Yukon government weather stations or recorded using the Agriculture Branch's own temperature data recorders or weather stations. The Agriculture Branch uses either HOBO (Onset® Computer Corporation) air temperature data recorders or WatchDog (Spectrum Technologies, Inc) weather stations. The HOBO is a small battery operated unit fixed approximately two metres (six feet) above ground on a steel bar with Stevenson screens (plastic protective plates) for solar shielding. The WatchDog remote weather stations are used to record real time weather information including temperature, wind speed and direction, relative humidity, rainfall, and solar radiation. The WatchDog weather stations were set up in open areas away from irrigation two metres above the ground.

The recording period for the Agriculture Branch climate data started in early May (depended on access to the site) and lasted until the end of September. The data from the government weather stations was downloaded online for the months of April through to the end of September. The data was imported into excel spreadsheets where average daily temperatures, minimum and maximum temperatures, and daily rainfall data was calculated for each of the sites. The calculated data was used to further determine agroclimatic capabilities, season to season comparison, and 10-year range and averages.

Results and Discussion

As the Whitehorse airport data proved, 2008 was a cool summer as observed in Graph 1.1. Graph 1.1 shows June and July temperatures well below the 10-year average and also below temperature data from the year 2000, a comparatively cool summer. An in-depth evaluation of historical monthly average temperatures found that June, with an average temperature of 10.5° C in 2008, has not been this cool since 1987. Also, Whitehorse has not experienced a cooler July for over 30 years. July 1974 was as cool as the 12.4°C average temperature experience in July 2008. Included in Graph 1.1 is the summer of 2004, which in contrast was an extremely hot summer resulting in forest fires across the territory.

Graph 1.1: Average daily temperature for Whitehorse airport, evaluating specific events including the extreme warm and hot summers between 1998 and 2008



Further evaluation of the graph shows that the start and end of the 2008 growing season were slightly above the 10-year average which would allow for early and late growth of frost hardy crops. Although the warmer start and end to the growing season added to the growing degree days, 2008 still remained either the coldest or the second coolest in the last 10 years (Table 1.2).

Table 1.2 summarizes the growing conditions for the four Yukon agricultural areas. The table summarizes EGDD, start and end of the growing season, number of frosts and the agroclimatic land capability. For all locations across the territory, 2008 was a cool season as shown by the below average temperatures calculated from the previous 10 years. The range or extremes recorded over the previous 10 years showed that Research Farm and Haines Junction had the coldest growing season since 1998 and the remaining locations were all at the low end of the range for 2008.

Table 1.2: 2008 season summary, including the range and average for the previous 10 years

		Year	2008	Range 1998 to 2007			10-Year Average
Whitehorse Area	Whitehorse Airport (EC)	EGDD	**896**	815	-	1,350	1,072
		Start of growing season	**May 21**	Apr 24	-	May 19	May 7
		End of growing season (-2.2°C)	**Sept 25**	Aug 30	-	Sept 30	Sept 15
		Agroclimatic capability	**Class 5**	Class 5	-	Class 2	Class 3
		Number of frosts during growing season	**5**	4	-	22	11
	Research Farm (YT)	EGDD (98-00 from research report)	**681**	693	-	1,263	886
		Start of growing season	**Apr 29**	Apr 27	-	May 22	May 10
		End of growing season (-2.2°C)	**Aug 10**	Aug 01	-	Sept 2	Aug 19
		Agroclimatic capability	**Class 6**	Class 5	-	Class 2	Class 5
		Number of frosts during growing season	**32**	5	-	38	22
Central Yukon	Pelly Farms (YTG & EC)	Sum EGDD:	**1130**	991	-	1,529	1,224
		Start of growing season:	**Apr 29**	Apr 26	-	May 17	May 5
		End of growing season (-2.2°C)	**Aug 31**	Aug 19	-	Sept 22	Sept 6
		Agroclimatic capability	**Class 3**	Class 4	-	Class 1	Class 2
		Number of frosts during growing season	**13**	6	-	29	14
	Mayo Airport (EC)	EGDD	**1065**	1,042	-	1,470	1,283
		Start of growing season	**Apr 30**	Apr 21	-	May 17	May 03
		End of growing season (-2.2°C)	**Aug 31**	Aug 19	-	Sept 27	Sept 14
		Agroclimatic capability	**Class 3**	Class 4	-	Class 1	Class 2
		Number of frosts during growing season	**7**	2	-	21	11
	Dawson Airport (EC)	EGDD	**1011**	833	-	1,348	1,086
		Start of growing season	**Apr 29**	Apr 26	-	May 17	May 8
		End of growing season (-2.2°C)	**Aug 29**	July 21	-	Sept 24	Aug 30
		Agroclimatic capability	**Class 4**	Class 5	-	Class 2	Class 3
		Number of frosts during growing season	**15**	1	-	24	13
Haines Junction (EC)		EGDD	**626**	773	-	1,159	947
		Start of growing season	**May 13**	Apr 27	-	May 22	May 9
		End of growing season (-2.2°C)	**Aug 10**	Aug 21	-	Sept 26	Sept 6
		Agroclimatic capability	**Class 6**	Class 5	-	Class 3	Class 4
		Number of frosts during growing season	**19**	12	-	38	18
Southern Yukon	Watson Lake Airport (EC)	EGDD	**1070**	993	-	1,332	1,153
		Start of growing season	**May 11**	Apr 23	-	May 22	May 10
		End of growing season (-2.2°C)	**Sept 22**	Sept 8	-	Sept 30	Sept 21
		Agroclimatic capability	**Class 3**	Class 4	-	Class 2	Class 3
		Number of frosts during growing season	**7**	1	-	15	8

The climate data continues to highlight the improved agroclimate capability in central Yukon. Central Yukon, although below average for 2008, still had class 3 to 4 growing conditions, compared to the class 5 to 6 found in the Whitehorse area. Central Yukon would only have moderate limitations that restrict the range of crops to small grain cereals and vegetables, while the Whitehorse area would experience severe limitations that restrict the range of crops to forages, improved pastures and cold-hardy vegetables.

Whitehorse climate for 2008 did result in poor growth for some crops, although the response to the cooler temperatures did not always result in large yield losses. Brome hay crop yields in the Whitehorse area were not affected by the cold June and July as observed by reported yields that were on par with much warmer summers. The cool-season hay fields faired well because of the warm start to the season, a cooler summer and above average precipitation (shown in table 1.4) which resulted in less plant stress.

Evaluation of micro-climates in the Whitehorse area continued for 2008. Observation of the data continues to support the findings that the Takhini River valley has its own climate compared to Whitehorse's Yukon River valley area. The poor accumulation of EGDD and resulting Class 6 climate in Table 1.3 for the Takhini River valley makes for severe limitation in growth and maturity of even frost hardy crops although the brome hay in this area was not affected by the cool temperatures. The Whitehorse Yukon River valley area has a slightly warmer climate compared to Takhini River valley as seen in data in Table 1.3. The Whitehorse Yukon River valley area is represented by data from the Whitehorse airport, site TA and site SM. The research farm located at the junction of the two river valleys seems to be equally influenced by both valleys.

In 2008, data from the Yukon government weather station at Jakes Corner was collected to get a better understanding of the climate immediately south of Whitehorse. The climate was very similar to the Whitehorse data as observed by the class 5 agroclimatic capability.

The cool 2008 weather in Whitehorse was highlighted by an early end to the season, marked by a killing frost in early August at most locations in the Whitehorse area. The exception to this early end of the season was Whitehorse airport, site TA and Jakes Corner. The airport, site TA and Jakes Corner all have excellent frost drainage either due to sloping terrain or in the case of the airport a large cleared area above bluffs. This type of geography results in the movement of frost to lower lying areas. The large cleared area of site SM also has good frost drainage. Even so, the frost event on August 10 was recorded at this site, but remarkably, the frost only slightly affected the potatoes. The same frost event observed down the highway at the research farm resulted in killing the whole potato crop. The research farm's small area enclosed by trees does not allow for frost drainage making the event more severe, whereas at site SM the good frost drainage reduced the effect of a killing frost. Cold years like 2008 highlight the need for good frost drainage as it can go a long way to extending the growing season and the accumulation of EGDD.

Table 1.3: Agroclimatic data for the Whitehorse area

2008	Yukon River Valley			Valley Jct.	Takhini River Valley		Jakes Corners
	Whitehorse Airport	Site TA	Site SM	Research Farm	Site TR	Site WG	
Sum of GDD	772	718	621	587	526	529	660
EGDD	896	833	720	681	611	614	765
Start of growing season	May 21	May 21	May 11	Apr 29	May 21	May 21	May 21
End of growing season (-2.2°C)	Sept 25	Sept 21	Aug 10	Aug 10	Aug 10	Aug 10	Sept 12
Agroclimatic capability	Class 5	Class 5	Class 5	Class 6	Class 6	Class 6	Class 5
Frost experiences during growing season	5	3	9	32	20	11	14
Frost experiences before July 15	1	0	9	30	13	9	10
Frost experiences after July 15	4	3	0	2	7	2	4

Rainfall for 2008 was above average across the territory as seen in table 1.4. The greatest amount of rainfall in 2008 fell in the Mayo area, with heavy rain events in July and August resulting in well above average accumulated precipitation. Similar to most years, across the territory the bulk of precipitation arrived in July and August with very little precipitation when it is needed most, in May.

Table 1.4: 2008 precipitation summary, including the range and average for the previous 10 years

Area	Station	Month	**2008 Precipitation (mm)**	Range 1998 to 2007			10-Year Average
Whitehorse Area	Whitehorse Airport (EC)	May	**5.8**	2.0	-	31.6	15.5
		June	**49.6**	12.8	-	82.2	34.6
		July	**50.4**	16.4	-	61.0	34.4
		August	**48.3**	9.9	-	82.1	37.7
		September	**17.9**	7.2	-	51.2	28.0
		Total:	**172**	76.4	-	230.5	150.2
	RF (YT)	May	**12.7**	2.5	-	16.7	10.8
		June	**52.32**	7.9	-	62.7	36.0
		July	**62.46**	12.9	-	50.8	37.6
		August	**64.25**	14.9	-	98.9	43.5
		September	**9.39**	15.4	-	52.0	31.1
		Total:	**201.12**	116.8	-	184.0	141.9
Central Yukon	Pelly Farms (YTG & EC)	May	**12.16**	2.0	-	32.6	15.8
		June	**18.49**	20.6	-	62.8	37.2
		July	**62.38**	19.4	-	99.4	54.9
		August	**95.1**	3.8	-	78.6	37.7
		September	**28.4**	9.0	-	77.6	31.4
		Total:	**216.53**	113.6	-	315.7	178.3
	Mayo Airport (EC)	May	**30.4**	7.8	-	46.1	23.7
		June	**27.7**	11.6	-	72.4	37.1
		July	**95.2**	13.2	-	75.3	50.0
		August	**89.3**	9.0	-	78.8	45.3
		September	**58**	21.2	-	56.0	37.6
		Total:	**300.6**	101.4	-	274.7	193.6
	Dawson Airport (EC)	May	**11**	12.5	-	44.7	30.7
		June	*****	12.8	-	60.5	33.4
		July	*****	16.0	-	99.0	49.1
		August	**6***	23.2	-	78.3	43.1
		September	**28**	21.8	-	41.7	32.5
		Total:	**45***	150.2	-	251.8	180.5
Haines Junction (EC)		May	**8.86**	2.8	-	30.4	16.2
		June	**58.61**	6.2	-	47.6	25.2
		July	**29.61**	15.3	-	64.5	35.1
		August	**35.95**	10.5	-	74.8	32.7
		September	**28.69**	5.5	-	36.8	25.1
		Total:	**161.72**	55.1	-	235.4	130.2
Southern Yukon	Watson Lake Airport (EC)	May	**25.4**	9.5	-	66.5	34.2
		June	**93.8**	15.2	-	114.8	56.7
		July	**31.2**	23.0	-	167.3	67.5
		August	**52.3**	20.4	-	80.6	46.7
		September	**53.6**	27.4	-	67.1	39.8
		Total:	**256.3**	180.3	-	320.9	244.9

Note: Highlighted in grey, incomplete data for 10 year range and average

* Missing data

2.0 FORAGE DEMONSTRATION

LOCATION: Research Farm (Site RF), Whitehorse Region

FUNDING: Government of Yukon

OBJECTIVE: To assess the yield and hardiness of various forage species in south central Yukon conditions.

INTRODUCTION

Forage demonstration plots were set up in 2005 at the Yukon government research farm. A series of 24 plots were established on the south side of the research farm for a demonstration of various forage species in Yukon conditions.

MATERIALS & METHODS

The site is on a slightly shaded, flat aspect within the two hectare cleared area of the research farm. Irrigation and fertilizer are applied to provide optimum conditions.

An overwintering assessment was carried out in the spring to quantify winterkill. The percent cover pace point intercept method was used to determine the percent cover and infer the rate of winterkill. A transect was delineated through the middle of each plot and at half metre paces the point of a bar was placed down randomly on the ground. Walking through the plot from west to east, researchers recorded what the point of the bar contacted – weed grass/legume, bare ground or dead patch. If more than one contact is made, both are recorded. Each point is recorded and the percent of plant surviving in the stand is estimated.

Above ground biomass yields were assessed throughout the season using a one square metre sample. Samples were harvested and placed in paper bags, dried and weighed.

RESULTS

Table 2.1: Winter Survival

Species	Inferred Winter Survival
Kentucky bluegrass	86%
Richmond timothy	52%
Boreal creeping red fescue	71%
Slender wheatgrass	86%
Carlton smooth bromegrass	72%
Kirk crested wheatgrass	58%
Violet wheatgrass	95%
Tufted hairgrass	55%
Russian wildrye	90%
Fleet meadow bromegrass	83%
Peace alfalfa	13%

Okay orchardgrass, Bellevue reed canarygrass, AC Nordica alfalfa, 2065 MF alfalfa, and Tophand alfalfa did not overwinter. Ram red clover was not reseeded in 2007 and has been pulled from these trials.

Other than the canarygrass and the orchardgrass, most grass demonstrations overwintered successfully. Violet wheatgrass and russian wildrye had greater than 90% inferred survival. As with previous years, the legume survival overwinter was very low or zero. The only alfalfa to register any winter survival was Peace alfalfa, due partly to the age of this stand. It was established somewhat successfully in 2005 and so has always shown better results in the spring. Peace alfalfa is also developed for northern environments. The AC Nordica alfalfa, 2065 MF alfalfa, and Tophand alfalfa were all newly seeded in 2007. Unfortunately, all legumes are heavily grazed during the fall and through freeze-up by wild deer that occupy the area. This grazing likely contributes to the low winter survival.

Table 2.1 summarizes results from the percent cover assessment in the spring. Yields were assessed for each plot that had enough growth to harvest and on three different harvests: a double cut, one July 2 and the other August 20; a single harvest July 22.

In the spring of 2008 orchardgrass, reed canarygrass, Peace alfalfa, and Tophand alfalfa were all reseeded. Also Anik alfalfa, a yellow flowered variety, was added to the trial.

Discussion

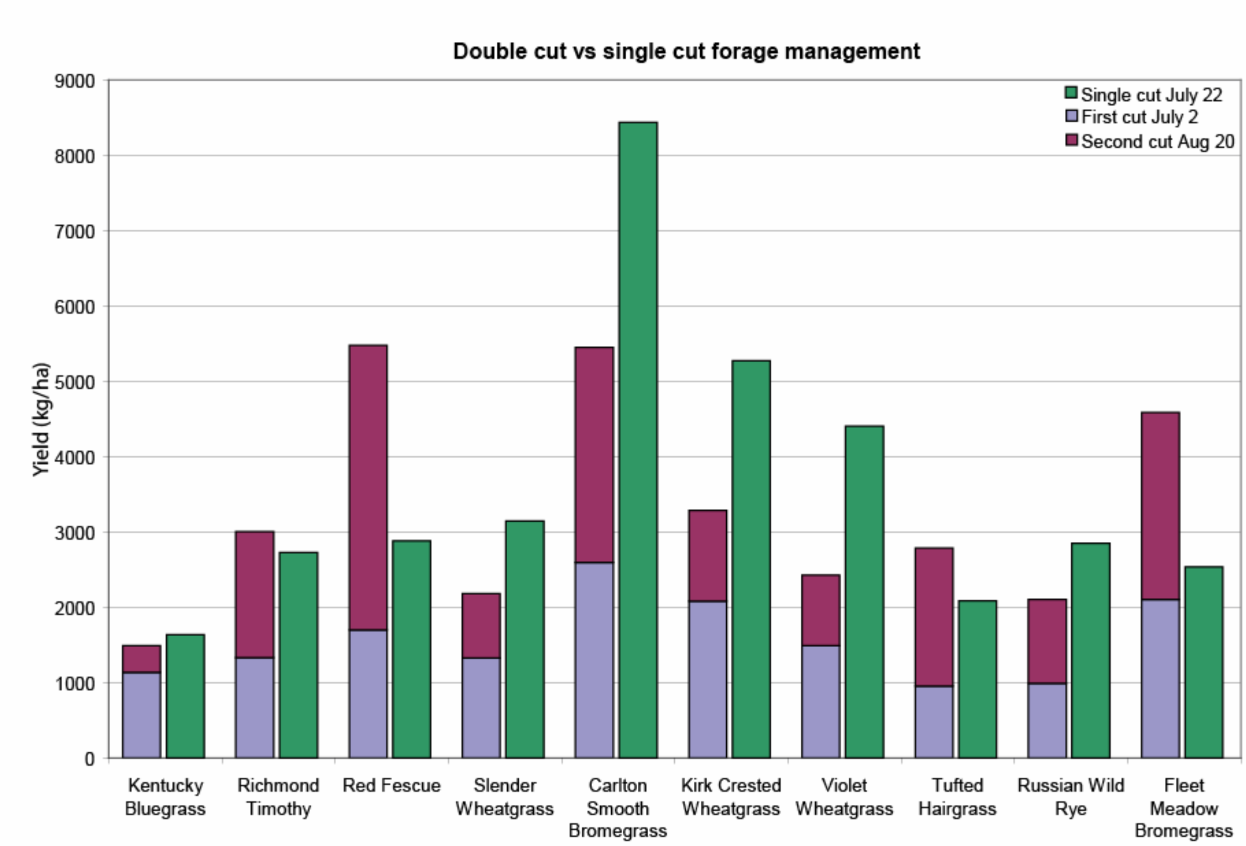
As in the previous years, the Carlton smooth bromegrass produced more than the other forages, both in a single or double cut system as illustrated in Graph 2.1. Surprisingly, the double cut smooth bromegrass did not produce more forage than the single cut and, in fact, was dramatically lower. The single cut system produced over 8 T/ha and the double cut system only produced 5.5 T/ha. It is theorized that this is because of the cool summer. The majority of growth occurred early in the year and the early harvest in the double cut system on July 2 cut the photosynthesizing leaf forcing the plant to draw up energy from the roots for regrowth. Since the summer was cold, the regrowth was very slow and the second cut yield was low.

Some grasses responded very well to the double cut system. As with last year, the Boreal creeping red fescue had double the production under a two cut system, matching the production of the double cut bromegrass stand. The legumes all performed relatively poorly, they were all reseeded in 2007 and again in 2008 and have yet to produce well.

Winterkill was assessed in early May using the percent cover method. The most successful overwintering grasses were violet wheatgrass, russian wildrye, slender wheatgrass and kentucky bluegrass. Although the successful establishment of orchardgrass and reed canarygrass was noted last August, they had to be reseeded because no plants survived.

Physical pulling of plants was used for weed control. The main problem species were Hawksbeard and Scorpion weed. There was very limited disease incidence.

Graph 2.1: 2008 Forage demonstration, yield assessments of single vs. double cut



3.0 BIODEGRADABLE MULCH EVALUATION

LOCATION: Research Farm (Site RF), Whitehorse Region

FUNDING: Government of Yukon, APF Science and Innovation

OBJECTIVE: To evaluate the use and breakdown of a biodegradable mulch.

INTRODUCTION

With the increased availability of biodegradable agricultural mulches entering the market, a demonstration project was conducted to further assess the mulches for:

- Durability and ease of use
- Water requirements of a perforated mulch
- Impact on yields
- Degradation rate in Yukon conditions

Mulches in the past have been shown to improve soil temperature, limit weeds, prevent erosion, and protect fruit and edible parts from direct contact with the ground. Using plastic mulches can be cumbersome to remove and not easy to dispose of after use, along with being environmentally unfriendly.

The biodegradable & compostable mulch film from BioTelo™ used in this evaluation is a black micro-perforated mulch made of Mater-Bi™, a non toxic corn starch based raw material that is promoted as being biodegradable and compostable. Temperature, humidity, and micro organisms in the ground breakdown the mulch into water, carbon dioxide, and biomass which saves on removal, recycling and land fill costs associated with plastic mulches. The micro perforations in the mulch are designed to allow for the penetration of rains and overhead irrigation into the soil.

MATERIALS & METHODS

An evaluation of the biodegradable mulch was conducted at the research farm in 2008. Broccoli and potatoes were planted under the mulch, and also planted with no mulch as a control. The mulch was evaluated with drip irrigation or with overhead sprinkler irrigation. The evaluation with the overhead irrigation was conducted to understand if the perforated mulch would limit overhead irrigation/rainfall, thereby limiting plant access to water.

Vegetable beds were prepared in the spring and set up with eight different sub-sections to conduct evaluations of potatoes and broccoli with and without mulch and with drip or overhead irrigation. The beds were fertilized based on soil analyses from Bodycote Testing Group. The mulch was applied directly over the designated beds, burying the edges to keep the mulch in place.

After the beds were prepared, the broccoli was transplanted into holes cut in the mulch. The potatoes were planted into hills prior to laying down the mulch and holes were cut in the mulch after the potatoes showed signs of emerging (in future, holes will be made at the time of planting and the potatoes will be planted into the holes).

During the season, the garden was managed with minimum inputs other than irrigation. The control and mulch test beds were not weeded to aid in the understanding of the benefits of mulch on weed prevention and erosion. Observation of growth and weed incidence was conducted and recorded. The potatoes were harvested late August and the broccoli was harvested as the plant matured, starting with the first harvest August 15th and ending Sept 9th. Harvest weights were recorded and tabulated.

Results & Discussion

General observations during the season found that the mulch cover did reduce weed growth, as seen by the higher incidence of weeds in the control beds without mulch, although the weed incidence and impact on growth was low at this site. The winds, rains and overhead irrigation over the season significantly reduced the size of the potato hills without mulch, indicating that the mulch decreased erosion of the beds. Although, in a normal potato operation the potatoes would be hilled during the season to accommodate the large tubers and reduce erosion.

It is expected that the black mulch increased ground temperature, although this was not monitored nor was it observed in the potatoes. The potatoes under mulch did not germinate earlier than those without mulch as was expected. The mulch temperature effect was observed to benefit the development of the broccoli as noted by the earlier harvest of the broccoli with mulch versus the broccoli without mulch. The bulk of the broccoli with the mulch was harvested about a week earlier than the broccoli without the mulch. It was also observed that a majority of the broccoli with drip irrigation was harvested about a week earlier than the broccoli without drip irrigation.

The potatoes and broccoli yields are summarized in tables 3.1 and 3.2. The potatoes showed no significant difference between the overhead irrigated beds with or without mulch as seen by the similar yields. The potato evaluation with the drip irrigation did show a marked increase in yield in the mulch covered trial, although it was surprising to see a lower yield of the control with drip irrigation versus the control without drip irrigation.

Table 3.1: Potato harvest yields

		Med		Small		Totals	
		Number of potatoes	Weight (g)	Number of potatoes	Weight (g)	Number of potatoes	Weight (g)
No Mulch	Drip	4	226	59	1,313	63	1,539
Mulch	Drip	29	1,848	64	1,534	93	3,383
No Mulch	No Drip	26	1,655	48	1,370	74	3,025
Mulch	No Drip	28	1,891	49	1,192	77	3,082

In the broccoli evaluation a few transplants died which impacted total yields. As a result the estimated yield per plant was calculated. The evaluation with the drip irrigation showed little variation between the control and test, whereas the beds with the overhead irrigation resulted in increased yields of the broccoli with mulch. The broccoli with no mulch and no drip irrigation was the only bed to yield below 400 grams per plant, which suggests the mulch and drip irrigation has a beneficial effect on production.

Table 3.2: Broccoli harvest weights

		Total harvest (g)	# of plants harvested	Estimated yield per plant (g)	Harvest period
No Mulch	No drip	1,036	3	345	Aug 22 to Sept 9
Mulch	No drip*	859*	3	429*	Aug 22 to August 31
No Mulch	Drip	1,272	4	424	Aug 15 to Aug 26
Mulch	Drip	2,018	5	404	Aug 15 to Aug 22

*missing weight of broccoli head, estimated weight per plant adjust for lost weight.

It should be noted that observations during the season found the soil to be dry to the touch under the mulch with overhead irrigation although there were no noticeable signs of water stress in the plants during the season. Conflicting yield results did little to provide conclusive evidence that overhead irrigation and/or rainfall was or was not reaching the plants.

Observation of the mulch at the end of the season found the mulch to be more brittle than at the start of the season. Although the mulch was intact, it is decomposing slowly. The mulch still needs to be worked into the soil to aid in the breakdown of the product and to provide data on the decomposition of this product in Yukon soils. Also an assessment of the tilling in of the mulch needs to be completed to understand if the mulch can be easily worked into the soil without the accumulation of the mulch around the tiller blades.

Conclusion

Biodegradable mulch can provide market gardeners some management options to improve soil temperature, limit weeds, prevent erosion, and protect plants. There is no hard evidence indicating the need for drip irrigation under the perforated mulch, although there are some indications that a drip line may improve yields or at the least be a good management strategy for conserving water.

The initial evaluation indicates the mulch is breaking down. Work will continue in the spring to determine if the mulch can be worked into the soil and if the mulch will break down enough to reduce pick up and disposal costs.   A final report of the tilling, breakdown and decomposition of the mulch will be included in the 2009 Research and Demonstration Report.

4.0 OILSEEDS PRODUCTION POTENTIAL IN THE YUKON FOR BIODIESEL

LOCATION: Research Farm (Site RF) and Yukon Grain Farm (Site SM), Whitehorse Region; Crosby Creek Ranch (Site HN), Central Yukon Region

FUNDING: Advancing Canadian Agriculture and Agri-Food ACAAF

OBJECTIVE: To evaluate oilseed production in the Yukon

INTRODUCTION

The evaluation of oilseed production in the Yukon has been conducted over the last three years to determine if:

- Oilseeds can be grown and matured in the Yukon?
- What oilseeds produce the best yields and total oil content?
- Which agricultural areas perform best?

The first two years of the trial indicated that there is some potential for growing oilseeds in the Yukon and with this success the trial was continued to determine the year-to-year variability of production. Last year was a cold growing season even by Yukon standards, and the cooler temperatures resulted in poor growth and limited oilseeds production. Over the past three years, false flax (*Camelina sativa*), polish canola (*Brassica rapa*), argentine canola (*Brassica napus*) and Flanders flax (*Linum usitatissimum)* have been evaluated with varying levels of success. The results of the previous two years showed that *C. sativa* and *B. rapa* have the best potential as an oilseed crop for the Yukon, while the *B. napus* and *L. usitatissimum* would not be suitable. In 2008, all four varieties of oilseeds were evaluated and yields were poor because of the cool season. The cooler temperatures experienced this past year would be considered the worst case scenario.

MATERIALS & METHODS

The trial has kept to the same four oilseed crops grown in year one. Table 4.1 provides the detailed information for each of the oilseeds tested in 2008.

The varieties selected were planted at two sites in the Whitehorse area (RF & SM site) and one site in central Yukon (HN site). Each site was setup with 16 two-metre by two-metre plots, and each variety was randomly planted into four of plots per site.

The plots were seeded middle to end of May as noted in Table 4.2. At the time of seeding composite soil samples were taken and sent out for testing to assess optimum fertilizer rates. Fertilizer was added according to the recommendation of Bodycote Labs.

At minimum, monthly visits were made to each site to record presence of species, stage of growth, plant height, and pod stage. Climate monitoring was conducted at the RF and SM sites and climate data obtained from a local weather station for the HN site. Climate data was collected to assess the growing season and heat units at each site.

Table 4.1: Oilseeds evaluated

Common name	**False Flax**	**Polish Canola**	**Argentine Canola**	**Flanders Flax**
Species	*Camelina sativa*	*Brassica rapa*	*Brassica napus*	*Linum usitatissimum*
Seed name/ variety	Voronezskij 339 CN30476	SW Spirit River	6803-01	Flanders
Supplier	Plant Gene Resources Canada	Bonis & Co. Ltd	HyTech Productions ltd	Se-Can Association
Breeder	-	Svalof Weibull Ltd	DSV Canada	Crop Development Centre, Saskatoon
Seeding rate	5 kg/ha (2g/plot)	8 kg/ha* (3g/plot)	8 kg/ha (3g/plot)	30 kg/ha (12 g/plot)

*seeding rate was adjusted to account for poor germination tests.

Table 4.2: Seeding and harvest dates

	Seeding Dates	**Harvest Dates**
Site HN	May 15/08	Not harvested
Site RF	May 23/08	Sept. 23/08
Site SM	May 29/08	Sept 24/08

The plants were harvested from each plot and bagged into large paper bags to be thrashed at a later date. A standard area of one square metre was harvested from each plot using hand trimmers and a one square metre frame.

The harvested plants were thrashed using a small seed thrasher. The thrashing separated the seeds from the plant stock or straw material. Following trashing the seed required further cleaning, that was done by a Clipper Seed Cleaner/Separator. The Clipper did a final separation of the seed from the left over scrap material. The samples were then weighed to determine yields for 2008. No further analysis was conducted due to the poor yields and seed quality for 2008.

Results

The 2008 growing season was cool as noted by the below average accumulation of growing degree days (GDD) and the high incidence of frost experienced during the growing season. Tables 4.3 to 4.5 summarize each of the site's growing season along with showing the data from the previous two years of the trial and a 10-year average. For site SM the Whitehorse airport 10-year average was used because data for Site SM has only been collect for the trial years. It should be noted that site SM is very comparable to the Whitehorse airport with the exception that the airport does not see the same frost events due to optimum frost drainage at the airport, and this would result in slightly longer growing season and a few more GDD.

Table 4.3: Site RF Agroclimatic data summary for each year of the trial

	RF			
	2006	2007	**2008**	10 Year Average
Sum of GDD	787	831	**587**	777
EGDD	912	964	**681**	886
Start of growing season	May 19	May 18	**Apr 29**	May 10
End of growing season	Sept 2	Aug 27	**Aug 10**	Aug 19
Agroclimatic capability class	Class 4	Class 4	**Class 6**	Class 5
Number of frosts during growing season	24	20	**32**	22

Table 4.4: Site SM Agroclimatic data summary for each year of the trial

	SM			
	2006	2007	**2008**	Whitehorse Airport 10 Year Average
Sum of GDD	865	900	**621**	924
EGDD	1,003	1,043	**720**	1,072
Start of growing season	May 18	May 16	**May 11**	May 7
End of growing season	Sept 5	Aug 27	**Aug 10**	Sept 15
Agroclimatic capability class	Class 4	Class 4	**Class 5**	Class 3
Number of frosts during growing season	12	9	**9**	11

Table 4.5: Site HN Agroclimatic data summary for each year of the trial

	HN (Used Pelly Farms data for climate)			
	2006	2007	**2008**	10 Year Average
Sum of GDD	1,024	1,296	**957**	1,037
EGDD	1,208	1,529	**1,130**	1,224
Start of growing season	May 6	Apr 26	**Apr 29**	May 5
End of growing season	Aug 22	Sept 22	**Aug 31**	Sept 6
Agroclimatic capability class	Class 2	Class 1	**Class 3**	Class 2
Number of frosts during growing season	14	23	**13**	14

Most plots showed good emergence with the exception of the *B. rapa*. Table 4.6 summarizes the significant events observed during the season.

As noted in Table 4.6, site HN was lost to wildlife and weeds resulting in the trial being aborted. The other two sites were harvested in late September. During harvest there was noticeable lodging in most plots and some shattering. The Flanders flax was still in the soft dough stage at both sites and therefore not harvested. At site RF only two plots of the *B. napus* were harvested due to the lack of maturity and severe frost damage of the seeds. All the *C. sativa* and *B. rapa* was harvested at the RF site. A decision was made to only harvest two plots of the *B. rapa*, *B. napus* and *C. sativa* from the SM site because of the poor seed development observed before harvest.

Table 4.6: Summary of significant observations during the growing season

	Observations
Site HN	• High weed infestation through all plots early in season. Good germination, although it appears something is grazing on the canola. • Second visit. Severe damage to canola and *C. sativa* from grazing by wildlife, no plants remaining. The Flanders Flax is getting out competed by severe weed growth. **Trial aborted**.
Site RF	• All plots showing germination by June 2 • *B.rapa* showing poor germination. • Mid season: good growth in all plots, although the flower to pod stage has been delayed due to the cooler weather. • Seeds not maturing, mostly in green seed or soft dough before harvest. Flanders flax seed development delayed.
Site SM	• Volunteer canola and *C. sativa* observed in the first four plots. Some weeding done in plots to remove volunteers, with the exception of volunteer in plots of the same species. • *B. rapa* showing poor germination, with the exception of one plot with volunteer plants, which appears to have good germination. • Early season: Volunteers already at flower with the remaining plots at multi leaf stage. • Mid season: good growth in all plots, although the flower to pod stage has been delayed due to the cooler weather. • Flanders flax and *B. napus* have not matured. They show either a lack of seeds in pods or seeds only at soft dough stage. Some frost damaged has been observed in seeds of *B. napus*.

The samples collected from the harvested plots were thrashed, cleaned and weighed. The weight of the harvested seed was used to calculated average yield per hectare at each site. Table 4.7 shows the results of the harvest and calculates the yield per hectare and yield per acre.

Photo: Agriculture Branch research farm oilseeds trial in the foreground

Table 4.7: 2008 oilseed results

Site	Oilseed	Plot	Weight per m^2	Calculated tonnes/ hectare	Calculated tonnes/ acres	Observation
RF	*Brassica napus*	16	16.3	0.163	0.066	Extreme frost damage, overall poor quality
RF	*Brassica napus*	1	18.2	0.182	0.074	Extreme frost damage, overall poor quality
SM	*Brassica napus*	3	9.9	0.099	0.040	Extreme frost damage, overall poor quality
SM	*Brassica napus*	7	23.8	0.238	0.096	Extreme frost damage, overall poor quality
RF	*Brassica rapa*	4	44.3	0.443	0.179	Poor quality (green seed, frost damage, deformed immature seeds)
RF	*Brassica rapa*	13	57.2	0.572	0.231	Poor quality (green seed, frost damage, deformed immature seeds)
RF	*Brassica rapa*	15	38.6	0.386	0.156	Poor quality (green seed, frost damage, deformed immature seeds)
RF	*Brassica rapa*	12	72.1	0.721	0.292	Improved quality, but still high levels of green seed, frost damaged and deformed immature seed
SM	*Brassica rapa*	15	131.7*	1.317*	0.533*	Improved quality, but still high levels of green seed, frost damaged and deformed immature seed
SM	*Brassica rapa*	8	68.8	0.688	0.278	Poor quality (green seed, frost damage, deformed immature seeds)
RF	*Camelina sativa*	9	107.7	1.077	0.436	Seeds lack maturity as noted by small flat size. Dark, possibly frost damaged seed present.
RF	*Camelina sativa*	14	98.4	0.984	0.398	Seeds lack maturity as noted by small flat size. Dark, possibly frost damaged seed present.
RF	*Camelina sativa*	11	53.5	0.535	0.217	Seeds lack maturity as noted by small flat size. Dark, possibly frost damaged seed present.
RF	*Camelina sativa*	7	48.3	0.483	0.195	Seeds lack maturity as noted by small flat size. Dark, possibly frost damaged seed present.
SM	*Camelina sativa*	16	53.7	0.537	0.217	Better maturity as noted by more uniform colour and less dark seed. Seed could sizeup more.
SM	*Camelina sativa*	14	59.4	0.594	0.240	Better maturity as noted by more uniform colour and less dark seed. Seed could sizeup more.

*****harvested from plot with volunteer canola growing.

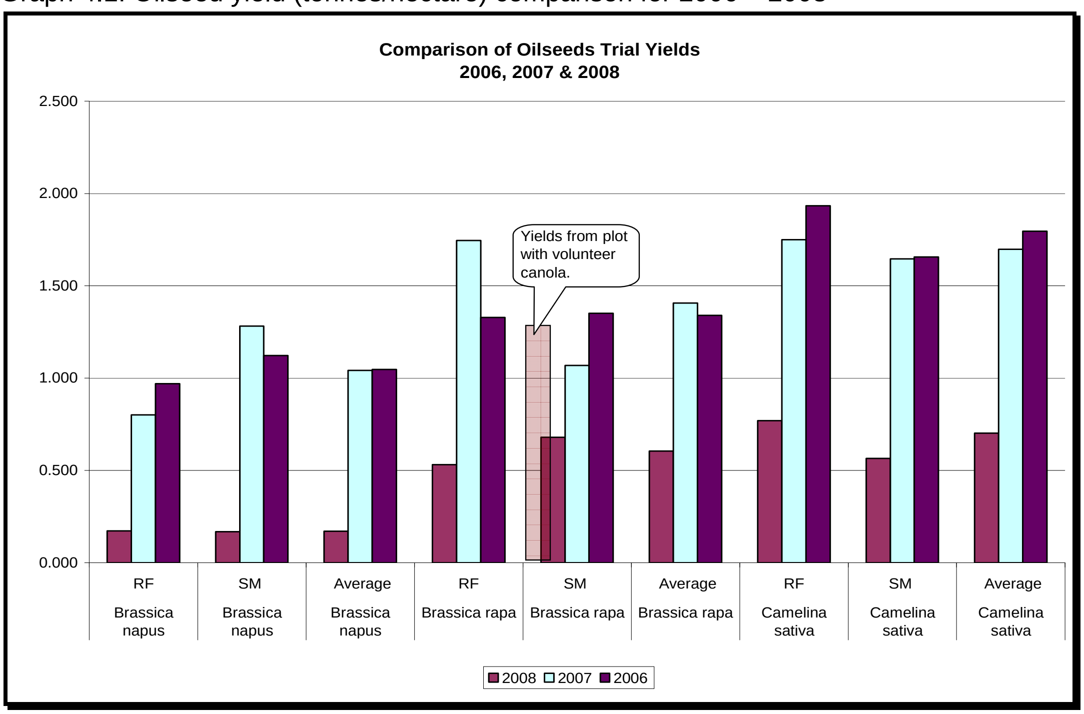
Discussion

Last season has been one of the coolest seasons of the new millennium, which made for a good evaluation of the season-to-season challenges of growing oilseeds north of 60°. The weather for 2008 was below normal across the territory. Evaluation of the data for the Whitehorse area sites found 2008 to be either the coldest or second coldest growing season in the last 10 years. The cool summer was mostly due to the cooler temperatures experienced in June and July. For the Whitehorse airport, June and July average temperatures have not been this cool in over 20 years. The cool season also resulted in numerous frosts and a -2.2°C killing frost event occurring as early as August 10th for both Whitehorse sites. Central Yukon has warmer summers and a better agroclimatic capability. Although central Yukon was below average for 2008, the climate in this area was still warmer than any of the trial years in the Whitehorse area. It is unfortunate that the trial in central Yukon was lost, because in the previous trial years, *B. rapa* and *C. sativa* have been grown in cooler conditions in the Whitehorse area.

Yields for 2008 were significantly lower compared to the previous two years with results as shown in Graph 4.1. The Flanders flax did show good germination and growth in 2008, however the plants did not reach maturity therefore they did not require harvesting. The *B. napus* also showed poor maturity in 2008, and as a result a decision was made to harvest only half of the plots. The yield for the *B. napus* was very low and the quality was extremely poor. The *B. rapa* and *C. sativa* showed marked improvements in yields compared to the *B. napus*, although these yields were still marginal and significantly lower compared to the results of previous years. The seed harvested in 2008 also had very poor quality, and as a result of the poor quality and low yields samples were not sent to the lab for oil analysis.

A plot of *B. rapa* at site SM was influenced by the growth of volunteer canola from the previous year's trial. The volunteer canola significantly improved yields and quality, resulting in yields on par with results from previous years. The trial with the volunteer canola was not sent to the lab for further analysis and it should be noted that the seed would have undergone more cleaning to eliminate some of the frost damaged seed still present in the sample, this in turn would reduce calculated yields even further. The volunteer canola plot suggests there may be the potential for a winter seeding of canola that could result in earlier germination and increased yields, although this would need to be proven with a planned and controlled seeding.

Graph 4.1: Oilseed yield (tonnes/hectare) comparison for 2006 – 2008



Conclusion

This past season was a good news and bad news trial year. The good and bad news was that it was one of the coolest summers in the last 10 years. On the positive side having a much cooler summer provided needed data on the year-to-year variability in yields. On the negative side 2008 was a disastrous year for oilseeds in the Whitehorse area.

It was unfortunate that the site in central Yukon was lost, because climate data and results from previous years suggest that there was enough growing degree days in central Yukon to mature *C. sativa* and *B. rapa*.

The unplanned volunteer canola at site SM provided research ideas for evaluating a winter seeding. A winter seeding of frost hardy crop such as *B. rapa* and *C. sativa* may allow for early germination which extends the growing season and maturity of the crop. A trial evaluating winter seeding of oilseeds would be required to further understand if winter seeding is the best management practice for oilseed production in Yukon.

5.0 RASPBERRY INPUT MANAGEMENT AND ECONOMICS OF PRODUCTION TRIAL

LOCATION: Research Farm (Site RF), YT

FUNDING: Government of Yukon, APF Science and Innovation

OBJECTIVE: To employ best management practices around orchard production and determine the economics of raspberry production in the south central Yukon.

INTRODUCTION

This trial is the result of work initiated in 2002 with collaboration from the Pacific Agri-Food Research Centre in Summerland, B.C.. As a result of the collaboration a raspberry orchard was developed at the research farm to evaluate:

- Different varieties of raspberries.
- Economics of raspberry production.
- Effects of row covers to increase production.

The orchard also examines best management practices for irrigation and fertilizing. The key to optimizing irrigation 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. This not only conserves water resources, but it also reduces the cost of production and risk of fertilizer leaching.

MATERIALS & METHODS

The raspberry orchard was planted in 2002 and took approximately three years to reach maturity before producing a meaningful harvest in 2005. The orchard is 30 metres (100 feet) long by 40 metres wide, divided into 12 rows with four sections per row. An automatic drip irrigation system splits the rows in half where the drip irrigation heads are located. Each half of the row receives water and fertilizer automatically from one of the two irrigation holding tanks. The irrigation system is controlled by a CR-10 computer system which uses data from soil moisture and evapotranspiration (ET) sensors to determine the optimum water requirements for the orchard. The irrigation system is also used to deliver fertilizer to the orchard. Soluble fertilizers are added to each of the irrigation tanks that in turn are added to the orchard through the automated system. Different levels of fertilizer are evaluated to determine the effects of fertilizer treatments on raspberry production. Fertilizer treatments are applied at a full rate from one tank and half rate from the second tank, each tank supplying selected sections of the orchard.

Each section of the orchard is planted with either Kiska or Souris/Boyne raspberries. The Kiska is an Alaskan developed variety with a medium size fruit and very tall canes. The Souris and Boyne are similar varieties of raspberries and have been grouped together in the evaluation. The Souris/Boyne is a short season southern variety of raspberry and produces a larger, firmer berry more in line with a tabletop or eating berry. There has been some movement of the varieties in the orchard resulting in some sections having a mixed stand of the Kiska and Souris/Boyne. The orchard has been assessed with nine sections of Kiska, 23 sections of Souris/Boyne and the remainder of the plot is mix stands or buffer rows. Four sections of the Kiska receive half fertilizer treatments, and five sections receive the full treatment. There are 12 sections of the Souris/Boyne receiving the full fertilizer treatment and 11 with the half treatment.

During harvest, pickers collected and weighed the berries from each of the sections harvested. The data is then tabulated and used to determine the effect of the fertilizer treatment on raspberry yields and to determine yields for each of the varieties. Further analysis of the data calculates the economics of the orchard.

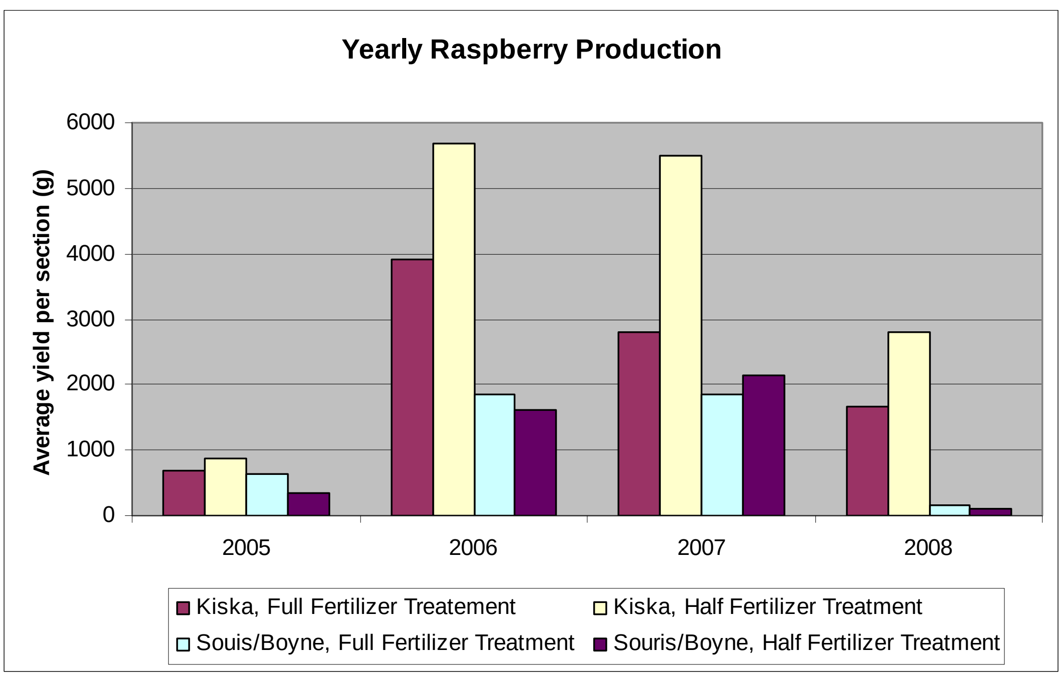
The economics of production evaluates raspberry production against input costs. The raspberry production is calculated based on the total yield for the orchard and on the average and maximum yields for each of the varieties. Value is estimated per hectare based on a combination of market price and operation setup, i.e. u-pick versus harvest operations. The market prices evaluated include a B.C. wholesale price, a B.C. roadside estimated sale price, a Yukon u-pick price, and an estimated Yukon farmers' market price.

The input costs are calculated using the record of man hours spent managing and harvesting the orchard or using an input cost provided from the British Columbia Ministry of Agriculture factsheet on Planning for Profit (http://www.agf.gov.bc.ca/berries/factsheets.htm#top). These two input costs combined with the 4 choices of market prices provide the full range of results for the economics of production.

Results

The raspberry production in 2008 was affected by environmental stresses such as a cool growing season, frequent frosts, and a high incidence of winter damage to the primocanes. Total harvest for 2008 was 27 kilograms, significantly lower than the yields from previous years as shown in Graph 5.1. Graph 5.1 evaluates the yearly production of the raspberry orchard since 2005. It should be noted that low 2005 yields are a result of the relatively young age of the orchard and 2006 & 2007 yields improved as the orchard matured. Environmental stresses in 2008 resulted in a significant decrease in raspberry production from 2006 and 2007 levels.

Graph 5.1: Yearly raspberry production - average yields per variety and fertilizer treatment



The 2008 harvest shows different production levels for variety and fertilizer treatment. As in every year Kiska produced significantly better compared to the Souris/Boyne and was less affected by the poor conditions of the 2008 growing season. The poorer production was a result of delayed fruit development in 2008, a late first pick, and a short picking period (from August 20th to September 8th).

The fertilizer treatment shows that Kiska responds better to lower fertilizer levels as observed by the improved yields in the half fertilizer sections. Yields from the Kiska ranged from 0.7 kilogram in a full fertilizer treated section to 3.4 kilograms per section in a half fertilizer treated section, as reported in Table 5.1.

The Souris/Boyne plants resulted in poor to no production due to the environmental stress of the cold season. We must thank our pickers for going through the Souris/Boyne sections with little to no production and in a commercial orchard these sections would not warrant any harvesting or picking.

Table.5.1: Tabulated raspberry production for 2007 based on variety and fertilizer treatment

	Average weight per section (kg)	Min (kg)	Max (kg)	Standard deviation
Kiska, Full Fertilizer (K1)	1.7	0.7	2.4	0.8
Kiska, Half Fertilizer (K2)	2.8	2.4	3.4	0.5
Souris, Full Fertilizer (S1)	0.1	0.0	0.8	0.2
Souris, Half Fertilizer (S2)	0.1	0.0	0.8	0.2

This data excludes sections 4, 13, 20, 21, 22, 23, 24, 20, 34
The row cover on section 28, Kiska with full fertilizer yielded 3.5 kg
The row cover on section 27, Sours/Boyne full fertilizer yielded 0.0 kg

A row cover was added to sections 27 & 28 late in the season. The installation of the row cover was too late to have any beneficial effects to the Souris/Boyne as they required the cover much earlier in the season. The row cover did indicate a possible improvement in yields in the Kiska as the section with the row cover was the highest yielding section of the orchard; 3.5 kilograms compared to the 3.4 kilograms from highest yielding section without row cover.

Photo: Raspberry orchard showing section in background with row cover

DISCUSSION

An assessment of the economics of production was conducted on the 2008 production levels which use 2008 yields to determine the estimated income per hectare. The income per hectare of production utilized prices derived from B.C. berry and nut production values from the B.C. Ministry of Agriculture, Food and Fisheries - Horticultural Statistics and a Yukon price developed to represent a Yukon u-pick operation or the extra value that can be fetched for a fresh Yukon grown product sold at the Fireweed Community Market. The prices are as follows:

- $3.30/kg ($1.50/lb) represents an estimated whole sale price.
- $6.60/kg ($3.00/lb) represents a B.C. roadside price and/or a Yukon u-pick price.
- $9.90/kg ($4.50/lb) represents a Yukon grown, fresh market price.

1 hectare = 2.5 acres
1000m^2 = ¼ acre

1kg = 2.2 lbs

The estimated income per hectare is calculated with the three different price ranges minus expense. The time and expenses noted from managing the research orchard was compared to a modified British Columbia Ministry of Agriculture factsheet, titled Planning for Profit. The level of expenses was found to be quite different as shown in Table 5.2, and the net income varied depending on which expense cost was used in the calculation. The difference between expense costs created some concern and loss of confidence between both calculated expenses. The B.C. fact sheet data was adjusted to create a boost in expenses for:

- inefficiencies in picking in low yield orchards
- inefficiencies in pruning cost in smaller operations
- higher Yukon labour costs

Even with the adjustments to the B.C. fact sheet the Yukon expenses remained almost double.

Table 5.2: Comparison of expenses per hectare base on Yukon tabulated man hours vs. B.C. fact sheet expenses

	Yukon Expenses		Modified B.C. Fact Sheet Expenses	
	Time	Cost per hectare (wage $15.00/hr)	Expense rates	Cost per hectare
Pruning & Trellising	400 hrs	$6,000.00	$1,779.00/hectare*	$1,779.12
Weeding	60 hrs	$900.00	$247.00/hectare	$247.10
Irrigation		-	$124.00/hectare	$123.55
Harvesting	400 hrs	$6,000.00	$3.97/kg**	$4,246.06
Packaging		-	$0.75/kg***	$802.03
Total expenses		$12,900.00		$7,197.86

*adjusted to represent less experienced pruning and trellising
** adjusted by a factor of six for reduced picking efficiency and higher labour costs
*** double to represent higher packaging cost

It should be noted that the B.C. raspberry planning for profit fact sheet is based on a 16 hectare operation which would have efficiencies not seen in a small operation and the warmer climate in B.C. allows for higher yields.

Realizing this difference in expenses, the net income was reported in two separate tables. The profit margins reported in Tables 5.3 and 5.4 are a starting point for a cost analysis, and both tables should be evaluated understanding that expenses are very much different. A comparison was also conducted between incomes in a u-pick operation versus the income for a picked and packaged (P&P) product.

Table 5.3: 2008 Yields, net income per hectare based on three different price levels and a modified B.C. expense calculation, including a u-pick operation based on B.C. modified expenses minus harvest cost

			Picked and Packaged (P&P)			U-pick operation		
	2008 Yields (kg/ha)	Projected expenses per hectare based on a modified B.C. factsheet	Net income per hectare @ $3.30/kg	Net income per hectare @ $6.60/kg	Net income per hectare @ $9.90/kg	Net income per hectare @ $3.30/kg	Net income per hectare @ $6.60/kg.	Net income per hectare @ $9.90/kg
Total Harvested	274	$3,403.11	-$2,497.35	-$1,591.59	-$685.83	$35.76	$941.52	$1,847.28
Average Souris Yields	60	$2,392.40	-$2,195.08	-$1,997.76	-$1,800.44	-$672.68	-$475.35	-$278.03
Highest Yielding Souris Section	331	$3,674.76	-$2,578.59	-$1,482.42	-$386.25	$226.17	$1,322.34	$2,418.51
Average Kiska Yields	1119	$7,390.53	-$3,689.85	$10.84	$3,711.52	$2,830.69	$6,531.37	$10,232.06
Highest Yielding Kiska Section	1360	$8,526.59	-$4,029.60	$467.38	$4,964.37	$3,626.99	$8,123.97	$12,620.96
Kiska with row cover	1408	$8,751.73	-$4,096.93	$557.86	$5,212.65	$3,784.79	$8,439.58	$13,094.38

Table 5.4: 2008 Yields, net income per hectare based on three different price levels and a Yukon expenses, including a u-pick operation utilizing Yukon expenses minus harvest cost

			Picked and Packaged (P&P)			U-pick operation		
	2008 Yields (kg/ha)	Projected expenses per hectare based on Yukon estimated expenses	Net income per hectare @ $3.30/kg	Net income per hectare @ $6.60/kg	Net income per hectare @ $9.90/kg	Net income per hectare @ $3.30/kg	Net income per hectare @ $6.60/kg.	Net income per hectare @ $9.90/kg
Total Harvested	274	$12,900.00	-$11,994.24	-$11,088.48	-$10,182.72	-$5,994.24	-$5,088.48	-$4,182.72
Average Souris Yields	60	$12,900.00	-$12,702.68	-$12,505.35	-$12,308.03	-$6,702.68	-$6,505.35	-$6,308.03
Highest Yielding Souris Section	331	$12,900.00	-$11,803.83	-$10,707.66	-$9,611.49	-$5,803.83	-$4,707.66	-$3,611.49
Average Kiska Yields	1119	$12,900.00	-$9,199.31	-$5,498.63	-$1,797.94	-$3,199.31	$501.37	$4,202.06
Highest Yielding Kiska Section	1360	$12,900.00	-$8,403.01	-$3,906.03	$590.96	-$2,403.01	$2,093.97	$6,590.96
Kiska with row cover	1408	$12,900.00	-$8,245.21	-$3,590.42	$1,064.38	-$2,245.21	$2,409.58	$7,064.38

A P&P product sold at whole sale prices ($3.30/kg) and at roadside prices ($6.60/kg) would create little to no profits, and in most cases would result in a loss to the operator. A P&P operation would be able to achieve profitable income selling at the premium farmer's market price of $9.90/kg, although this level of profitability was largely dependent on growing Kiska and expenses would need to be at the lower level, in-line with the B.C. costs.

A u-pick operation had a much greater opportunity for profit, again you would want an orchard growing Kiska, to have expenses as low as possible and a supply of customers wanting to pick and pay $6.60/kg. There was some room for selling u-pick Kiska raspberries at $3.30/kg but expenses are critical to being profitable.

The Souis/Boyne raspberries would not be profitable in 2008, there is the possibility of a profitable Souris/Boyne operation if an operator could maximize yields and obtain a premium price in a u-pick operation, but the lower levels of productivity and harder picking may discourage some pickers.

Conclusion

The Kiska raspberries and lower expenses from the B.C. rates would provide an opportunity to run a profitable raspberry orchard. The 2008 production levels would direct an operation towards a u-pick operation. A u-pick operation of Kiska makes good sense as this type of raspberry is best suited as a berry for jam which is in-line with the end use of most u-pick customers. The row cover had a positive effect on the raspberry production and extending the use of the cover would create an opportunity to increase yields. An extended use of the row cover on the Souris and Boyne raspberries may also help with fruiting and provide a firmer berry that suits a pick and packaged for sale at the Fireweed Community Market or other farmers' market. The irrigation system provides the orchard with the required water and fertilizer with minimal input, reducing time spent in the orchard. Based on this year's data it appears that the half fertilizer treatment works best under Yukon conditions.

Work will continue into 2009, with a focus on:

- Extending the use of the row cover in the spring and better management of the row cover in the fall.
- Reducing the gap between expenses calculated using the B.C. data versus expenses achieved in the trial operation.
- Continuing evaluation of irrigation and optimum fertilizer levels.