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RESULTS -- FINAL REPORT
on
The effect of temperature and precipitation
on yield and quality of canola cultivars

by

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i) Abstract: Over the years 1989, 1990 and 1991, the yields of cultivars among sites in western Canada were positively related to precipitation in June, July and August and were negatively related to average maximum temperatures for July and August. For example, the lowest estimated yield of Westar, 1.27 tonnes per ha, (22.7 bu./ac.) was obtained at a site with June, July and August precipitation of 80 mm and an average maximum temperature of 26.0 °C for July and August. The highest yield, 3.54 tonnes per ha (63.1 bu/ac) was obtained with precipitation of 400 mm and average maximum temperature of 20 °C. The ranking of canola (*Brassica napus* L.) cultivar yields changed among sites in western Canada. However, for three cultlivars, the differences in yield among sites were not great and the temperature and precipitation model could not be used to estimate significant differences in cultivar yields.

Heat units or degree-days (accumulated average daily temperature over 5.6 °C for the growing season) were not related to the yield of canola. This would indicate that lower temperatures, except in the case of frost, did not reduce yield. On the other hand, high temperatures, in the late stages of growth resulted in reduced grain yields. Heat units were not related to the maturity of canola.

With only a limited amount of data from 1991, temperature and precipitation were not related to oil and protein content of canola. Because of the relatively dry years, nitrate-nitrogen in soils has been very high. This would result in higher concentrations of protein in canola, even with wet soil moisture conditions. With low protein content of the meal, oil content was proportionately higher and conversely, with high protein, oil content was low, which resulted in a negative correlation between oil and protein content. Seeding date affected maturity with the optimum seeding dates of May 14 to 16 producing the earliest maturity date.

ii) Background and Objectives:

Previous research with fertilizer trials has shown that temperature (maximum) and precipitation have a dramatic effect on yield of canola (*Brassica napus* L.)(Nuttall et al. 1992)*. Because cultivars may respond differently to environmental factors, a project was proposed where temperature and precipitation effects among cultivar trials be used in order to determine which cultivar would produce best under high soil moisture stress conditions (low precipitation and high temperature) and which cultivars responded most to low moisture stress (high precipitation and low temperature). Previous work has indicated that the canola grain crop is most sensitive to July and August maximum daily temperature and precipitation.

As with grain yields, fluctuations in oil and protein content occur with changes in environment. With good soil moisture conditions, protein content of grain tends to be lower because of the dilution effect of higher yields. If the protein content is low, then the oil content likely will be higher than average. If the available nitrogen in the soil is quite high, then, protein content will likely be high even if soil moisture conditions are good (low temperatures and high precipitation).

Degree-days or heat units have been used with several crops for estimating when crops will mature. The assumption is that each crop, in a given location, needs a specific number of "growing degree-days" or "heat units" to mature. The objective was to determine how such measurements relate to the growth and maturity of canola.

*Nuttall, W.F., A.P. Moulin, and L.J. Townley-Smith. 1992. Nitrogen, phosphorus, precipitation and temperature effects on yield of canola. Agron. J. 84:765-768.

iii) Experimental method:

The Western Canada Co-operative canola/rapeseed cultivar trials conducted throughout the Prairie Provinces from 1989 to 1991 was the database for determining yield, quality and other agronomic characteristics of canola cultivars in relation to weather variables of temperature and precipitation. Temperature and precipitation records were taken from Atmospheric Environment stations located near or at the experimental sites (total of 68 trials). Canola cultivars for comparison were selected in conjunction with Dr. R.K. Downey.

A statistical analyses was performed (SAS, GLM) to determine if there were interactions between cultivars, sites and years affecting canola yield and quality.

Degree-days were calculated from the temperature data to determine if this computation could be related to yield and maturity.

iv) Results and Discussion:

Over the years 1989, 1990 and 1991, the yields of cultivars among sites and years in western Canada were positively related to precipitation in June, July and August and were negatively related to average maximum temperatures for July and August. For example, the lowest estimated yield of Westar, 1.27 tonnes per ha (22.7 bu./ac), was obtained with June, July and August precipitation of 80 mm and an average maximum temperature of 26 ^{o}C for July and August. The highest yield, 3.54 tonnes per ha (63.1 bu/acre) was obtained with precipitation of 400 mm and average maximum temperature of 20 ^{o}C (Table 1). This table can be used to estimate yields with temperature and precipitation data obtained from environmental weather stations. For example, at Beaverlodge, the average maximum temperature (1989-1991) for July and August is 22.4 ^{o}C and the average precipitation for June, July and August is 245 mm. From Table 1, the estimated yield of Westar would be 2.10 t/ha. Similarly for Saskatoon, the average maximum temperature was 25.6 ^{o}C and average precipitation was 165 mm, giving an estimated yield from Table 1, of 1.54 t/ha. The yield ranking of selected canola (*Brassica napus* L.) cultivars changed among sites in western Canada (Table 2). This interaction between site and cultivar can partially be accounted for by temperature and precipitation effects on the growth of canola plants. However, estimates of yield from temperature and precipitation are not precise enough to show differences in yields of cultivars. Similar information with (*Brassica campestris* L.) cultivars would be useful to farmers in selecting early maturing cultivars to plant.

Heat units or degree-days (accumulated average daily temperature over 5.6 ^{o}C for the growing season) were not related to the yield of canola. This would indicate that lower temperatures, except in the case of frost, would not reduce yield. High temperatures in the late stages of growth resulted in reduced grain yields. Other models, rather than heat units, may be useful in computing the relationship of temperature to maturity.

With only a limited amount of data from 1991 temperature and precipitation were not related to oil and protein content of canola. Because of previous dry years, nitrate-nitrogen in soils has been very high, which could result in higher concentrations of protein in canola. With wet soil moisture conditions and high available nitrogen in soils, protein content could be high. With low protein content of the meal, oil content was proportionately higher and conversely, with high protein, oil content was low (Fig. 1) resulting in a significant negative correlation between oil and protein content. Seeding date affected maturity with the optimum seeding dates of May 14 to 16 producing the earliest maturity date (Fig. 2).

v) <u>Impact - conclusions:</u>

Because yields of canola cultivars (*Brassica napus* L.) can be related to temperature and precipitation, potential yields can be estimated for different areas of the prairies dependent on these weather variables. This information would be valuable to farmers in selecting cultivars for planting in their area. Similar information with *Brassica campestris* L. would aid farmers in selecting early maturing canola cultivars for planting. The estimate of maturity in relation to the seeding date of cultivars in May is useful in determining an early maturity date. Early maturity will help to avoid seasonal frost damage.

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Table 1. Effect of temperature and precipitation on yield of Westar Canola, 1989-1991

Max. Temp. $^{o}C^{*}$	May, June July, Precipitation (mm)				
	80	160	240	320	400
	-------grain yield, tonnes per ha-------				
20	2.52	2.77	3.03	3.29	3.54
22	1.68	1.94	2.19	2.45	2.71
24	1.28	1.53	1.79	2.05	2.30
26	1.27	1.52	1.78	2.04	2.30

*Mean of maximum temperatures for July and August.

Table 2. Yields of canola cultivars at two sites in western Canada

Site	Code	Variety	Rank	Grain yield
				tonnes per ha
Brandon	1	Westar	2	1.869
	9	Profit	4	1.713
	14	Legend	1	1.987
	19	Delta	3	1.771
Ellerslie	1	Westar	3	1.960
	9	Profit	4	1.947
	14	Legend	2	2.157
	19	Delta	1	2.346
L.S.D. (0.05)				0.087

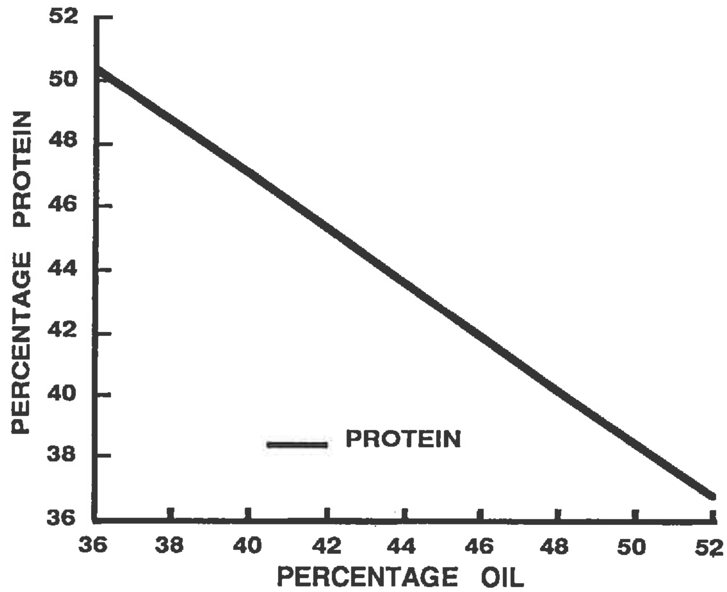

Fig. 1. The relationship between protein and oil content of Westar, 1989 - 91

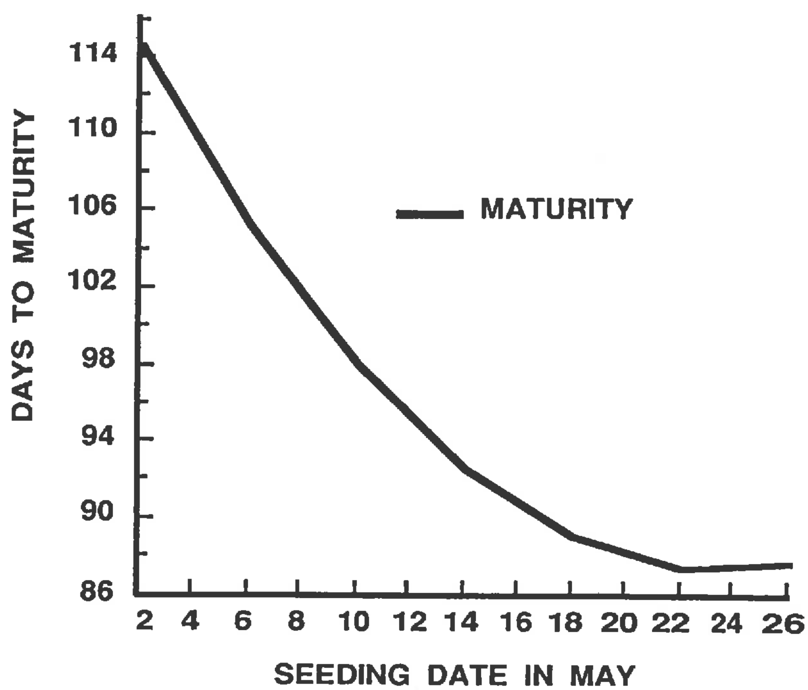

Fig. 2. The relationship between days from seeding to maturity and seeding date of Westar, 1989 - 91