1995 UPDATE ON ESSENTIAL, OILS IN SASKATCHEWAN SPICE CROPS

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INTRODUCTION

The 1995 spice crop was the second set of well-matured seed available for quality testing in our laboratory. This was obtained from the numerous trials conducted by the plant breeders and agronomists on anise, caraway, coriander, cumin and diiseed as part of on-going research project to develop the spice industry in Saskatchewan with funding from an Agricultural Development Grant.

The first quality parameter being measured in our laboratory is essential oil content. This parameter is important because it provides the spice's aroma and flavour. A mixture of 5 to 20 grams of ground spice and 20 volumes of distilled water is steam distilled for two hours in a Clevenger-type apparatus that allows the collection and measurement of the distillate. The result is expressed as % essential oil (v/w). This distillate is analyzed on the gas chromatograph where the principal constituents can be quantitated. As an example, the amount of linalool, the principal constituent of coriander, can be measured in the oil.

The second quality parameter is the oleoresin content. Oleoresin is the viscous material extracted from the ground spice by various organic solvents and contain both the essential oils and other nonvolatile components. It provides a more complete flavour profile and its use has increased tremendously over the years. The procedure involves extraction of three grams of the ground spice in a Soxhlet apparatus for 4 hours after which the excess solvent is evaporated and the residue weighed. The results are expressed as % oleoresin (w/w).

CORTANDER

Effect of Seed Size

The six highest-yielding large-seeded and small-seeded coriander varieties planted at Saskatoon and Yellow Creek were analyzed and a summary of the results is given in Table 1. As expected, the average 1 OOO-seed weight of the large-seeded cultivars was greater than that of the small-seeded cultivars at both locations. The average essential oil content of the large-seeded cultivars, 0.9%, is about 28% less than the average essential oil content of the small-seeded cultivars, 1.25%. Both mean values, however, are in the upper half of the, desired level of **0.4-1 .4%** essential oil in coriander.

Coriander essential oil should contain between 60-70% linalool. The mean levels of linalool in the essential oils of both large-seeded and small-seeded varieties were all within this range. The mean levels tended to be higher in the essential oils of seeds grown in Saskatoon than in Yellow Creek with the difference being more pronounced among the large-seeded varieties. The percent oleoresin was slightly greater in seeds grown at Saskatoon compared to Yellow Creek for both large-seeded and small-seeded varieties.

Table 1. Effect of seed size on the seed yield and oil concentration and composition of coriander grown at Saskatoon and Yellow Creek, 1995.

Variety	Yield kg/ha	1000-seed wt., g	Essential Oil, % (v/w)	Linalool % of Oil	Oleoresins[1] % (w/w)
Large-seeded Varieties					
Saskatoon	2135	10.2	0.8	66	17
Yellow Creek	935	9.7	1.0	61	16
Small-seeded Varieties					
Saskatoon	1870	7.7	1.2	69	19
Yellow Creek	715	8.1	1.3	66	17

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

Effect of Location

The results from the large-seeded and small-seeded varieties can be combined and averaged to show the differences in seed yield and chemical composition between Saskatoon and Yellow Creek (Table 2). The average seed yield at Saskatoon was about 2.5 times greater than the seed yield at Yellow Creek. No differences in the 1000-seed weight, essential oil, and the % linalool in the oil are apparent.

Nitrogen fertilizer tests were conducted at Goodale and Yellow Creek. While differences in seed yield and chemical composition due to varying levels of nitrogen at both locations were not significant, the effect of location was quite evident. The seed yield and seed size were about 84% and 2 1% greater at Goodale than at Yellow Creek respectively. The mean % essential oil content of the seeds grown at Goodale was about 30% lower at Goodale than Yellow Creek but had a 10% greater amount of linalool in the essential oil.

Table 2. Effect of location on essential oil concentration and composition of coriander, 1995.

Location	Yield (kg/ha)	1000-seed wt., g	Essential Oil % (v/w)	Linalool % in Oil
From Yield Test				
Saskatoon	2060	9.2	1.0	67
Yellow Creek	855	9.1	1.1	63
From: Nitrogen Fertilizer Test				
Goodale	1855	11.9	0.7	66
Yellow Creek	1010	9.8	1.0	60

Effect of Seeding Date

One variety of coriander (Chinese) was seeded on four diierent seeding dates in Saskatoon. The results show (Table 3) that the highest seed yield and the maximum seed size were obtained when the seeds were planted on May 20. In terms of essential oil content, the values increased, while the level of of linalool and the percent oleoresins decreased with delayed seeding.

Table 3. Effect of seeding date on seed yield, essential oil concentration and composition and oleoresin concentration in coriander (var. Chinese) grown at Saskatoon, 1995.

	Seeding Date			
	May 4	May 13	May 20	June 2
Yield (kg/ha)	2825	3079	3254	2089
1000-seed wt., g	11.1	11.4	12.3	8.6
Essential Oil (% v/w)	0.7	0.7	0.8	1.0
Linalool (% in Oil)	66	65	64	61
Oleoresins (% w/w)[1]	17.4	16.5	16.7	15.8

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

CARAWAY

Effect of Location (Biennial Caraway)

Three varieties of biennial caraway (Bleija, Elders 90 and Richters Common) were seeded at Saskatoon and Melfort in 1994 and harvested in 1995. The results (Table 4) illustrate differences in seed yield and chemical composition depending on location. The mean seed yield at Saskatoon was at least twice the average seed yield at Melfort. The mean essential oil level of the cultivars grown at Melfort (5.6%) was 36% greater than the mean level of the same cultivars grown at Saskatoon (4.1%). The values from Saskatoon were within the desired range of 3.2% to 5.3% for biennial caraway (Bouwmeester and Kuijpers, 1993). while the values from Melfort were beyond this range. The mean value from Saskatoon was also quite similar to the 4% for Dutch caraway while the mean value from Melfort was quite similar to the 5% for Polish caraway (Fleisher and Fleisher, 1988). The values from Saskatoon are slightly below while the values from Melfort were well within the range of 4.2 to 7.6% obtained by Hirvi et al. (1987). The mean levels of carvone and limonene in the essential oils at both locations were quite similar while the percent oleoresins were 26% greater at Melfort than at Saskatoon.

Table 4. Seed yield and chemical composition of biennial caraway grown at Saskatoon and Melfort in 1994 and harvested in 1995.

Variety	Yield kg/ha	Essential Oil % (v/w)	Carvone % of Oil	Limonene % of Oil	Extractables[1]
Location: Saskatoon					
Bleija	1728	3.9	53	46	15.2
Elders 90	1423	4.3	54	45	16.5
Richters Common	825	4.1	54	45	16.4
Average	**1325**	**4.1**	**54**	**45**	**16.0**
Location: Melfort					
Elders 90	918	5.3	57	43	20.2
Bleija	709	4.7	58	42	20.2
Richters Common	251	6.8	53	47	20.2
Average	**626**	**5.6**	**56**	**44**	**20.2**

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

In another test, no differences were found in seed yield and chemical composition due to seeding rate. However, when averages were calculated for the two locations used in the test, the average seed yield was 4.5 times greater at Saskatoon than at Elrose (Table 5). The average essential oil content of the seeds grown at Elrose was 73% greater than the essential oil content of seeds grown at Saskatoon. Differences in the % carvone and % limonene in the essential oil and in the % oleoresins were similar at the two locations.

Table 5. Effect of location on concentration and composition of oil in caraway grown at two locations in 1995.

Location	Yield kg/ha	Essential Oil % (v/w)	Carvone % of Oil	Limonene % of Oil	Extract-ables[1] % (w/w)
Saskatoon	2891	2.6	51	48	16
Elrose	649	4.5	50	49	17

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

Effect of Seeding Date in Annual Caraway

One variety of annual caraway (var. Karzo) was seeded on four different seedmg dates at Saskatoon. The results (Table 6) show that the best seeding date for annual caraway is around May 20 where the highest seed yield was obtained. This is similar to the 1994 crop wherein the highest seed yield was obtained when the seeds were planted on May 26, although the average seed yield taken across the four seeding dates was much lower than the corresponding value for this year's crop.

Essential oil content increased with delayed seeding with the highest value on June 2. When the seed yield is also taken into account, the largest amount of essential oil was from seeds planted on May 20. In the 1994 crop, the highest essential oil content was from seeds planted on May 26.

Table 6. Effect of seeding date on seed yield and concentration and composition of oil in caraway (var. Karzo) grown at Saskatoon, 1995.

	Seeding Date			
	May 4	May 13	May 20	June 2
Yield (kg/ha)	2152	2109	2511	1004
Essential Oil (% v/w)	3.2	3.4	3.3	4.5
Carvone (% in Oil)	51	48	47	43
Limonene (% in Oil)	48	51	52	5 5

ANISE

Anise Yield Test

Four varieties (Schweitzer-92, Schweitzer-93, Richter-93 and Preston) were seeded at Saskatoon. The results (Table 7) show that among the four cultivars tested, Richter-93 had the highest seed yield in 1995, as well as in 1994. In addition, the average seed yield of the 1995 crop is at least three times greater than the seed yield obtained in the 1994 crop.

Anise should contain 1.9-3.1% essential oil. Preston yielded the highest essential oil concentration, while the mean essential oil content of the other three cultivars, 3.2%, is slightly lower than the mean value (3.4%) obtained for the same three cultivars in the 1994 crop. All these values, however, are still greater than the normal range.

Anise essential oil contains about 90% t-anethole (Buccellato, 1990; Burdock, 1995). Schweitzer-93 gave the highest value (88%) in this year's crop, while the other three cultivars yielded between 83 to 86%. In the 1994 crop, Schweitzer-92 yielded 91.0% t-anethole compared to this year's 83 .O% in 1995. The average percent oleoresins was about 45% higher in 1995 compared to the 1994 crop.

Table 7. Seed yield and chemical composition of oil for four anise varieties grown at Saskatoon, 1995.

Variety	Yield (kg/ha)	Essential Oil % (v/w)	t-Anethole % of Oil	Oleoresins[1] % (w/w)
Richter 93	2771	3.2	85	21
Schweitzer 93	2615	3.2	88	20
Schweitzer 92	2434	3.2	83	20
Preston	1571	3.9	86	21

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

Effect of Seeding Rate

Two varieties of anise (Richters-93 and Schweitzer-92) were seeded at 20 and 30 seeds/ft^2 at Saskatoon. Results show (Table 8) that seeding rate had an inconsistent effect on seed yield. A higher seeding rate (30 seeds/ft^2) resulted in a higher seed yield for var. Richters 93 and in a lower seed yield for var. Schweitzer-92. In terms of the essential oil content, a lower seeding rate (20 seeds/ft^2) resulted into higher essential oil values for both cultivars. These values were all higher than the desired level of 1.9-3.1% essential oil. The percentages of t-anethole, meanwhile, were correspondingly lower at the lower seeding rate. Seeding rate had no effect on % oleoresins.

Table 8. Effect of seeding rate on seed yield and chemical composition of oil in anise grown at Saskatoon, 1995.

Variety/ Seeding Rate	Yield (kg/ha)	Essential Oil % (v/w)	t-Anethole % of Oil	Oleoresins[1] % (w/w)
Richter 93				
20 S/ft^2	**2104**	**3.9**	**86**	**24**
30 S/ft^2	**2624**	**3.4**	**88**	**23**
Schweitzer 92				
20 S/ft^2	**2333**	**4.0**	**84**	**23**
30 S/ft^2	**1804**	**3.2**	**86**	**24**

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

Effect of Seeding Date

One variety (Schweitzer-93) of anise was planted on four seeding dates in Saskatoon. The results (Table 9) show that the highest seed yield was obtained from the earliest seeding date. The highest essential oil content, however, was obtained from seeds planted on May 13. When the total amount of essential oil available is calculated from the total seed yield and the percent essential oil, the highest value was obtained from seeds planted on May 13.

Seeding date had a variable effect on the percent t-anethole in the essential oil. The highest values obtained were on May 4 and May 20 with the value obtained on May 13 being slightly less. The value obtained on June 2 was the lowest. These four values, however, were all below the desired 90% level of t-anethole. Seeding date had a more pronounced effect on the percent oleoresins. The highest value was obtained on May 4, while the values for the other subsequent seeding dates were slightly lower.

Table 9. Effect of seeding date on seed yield and concentration and chemical composition of oil in anise (var. Schweitzer-93) grown at Saskatoon, 1995.

	Seeding Date			
	May 4	May 13	May 20	June 2
Yield (kg/ha)	1657	1420	1372	635
Essential Oil (% v/w)	3.4	4.2	4.0	2.9
t-Anethole (% in Oil)	85	84	87	79
Oleoresins (w/w)[1]	18	14	14	13

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract&. of sample) x 100.

DILLSEED

Effect of Location

Six cultivars of dillseed were seeded at Saskatoon and Yellow Creek. The results (Table 10) show that the average seed yield for Saskatoon in 1995 (1920 kg/ha) was at least 4.5 times greater than the average seed yield from the same location in 1994. The average seed yield in Yellow Creek was 80% less than that of Saskatoon.

Dillseed contains between 2-4% essential oil (Dziezak, 1989). Between the two locations used for the 1995 crop, the average essential oil content was about 44% higher in Yellow Creek. Meanwhile, the % carvone was only slightly higher in the essential oil of seeds planted in Saskatoon, while the percent oleoresins were slightly higher in Yellow Creek.

Table 10. Effect of location on seed yield and concentration and chemical composition of oil in dillseed, 1995.

Location	Yield kg/ha	Essential Oil % (v/w)	Carvone % of Oil	Oleoresins[1] % (w/w)
Saskatoon	1920	2.6	44	12
Yellow Creek	368	3.8	42	14

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

Effect of Seeding **Date**

One variety of dillseed (var. Bouquet) was seeded on four seeding dates at Saskatoon. The results show (Table 11) that the highest seed yields were obtained when the seeds were planted on May 20 with the seed yield from May 13 being only slightly less. In the 1994 crop, the highest seed yield was obtained when the seeds were planted on May 26. The 1994 seed yield was also four times less than the seed yield obtained from the 1995 crop.

The highest essential oil content was obtained with the May 13 crop (3.0%). Along with the values obtained from the other seeding dates, this value was within the desired level (2-4%). Meanwhile, in the 1994 crop, the highest value was obtained with the April 2 1 crop. When the seed yield is considered in order to determine the total amount of essential oil available during each seeding date, the results of both the 1994 and the 1995 crops revealed that May 13 was the most appropriate date for seeding. The percent carvone in the essential oil decreased with delayed seeding, while the percent oleoresins was quite similar except for the value for June 2 which was slightly higher.

Table 11. Effect of seeding date on seed yield, essential oils and oleoresins in dillseed (var. Bouquet) grown at Saskatoon, 1995.

	Seeding Date			
Yield (kg/ha)	May 4 2097	May 2504 13	May 20 2557	June 2 2084
Essential Oil (% v/w)	2.8	3.1	2.9	2.9
Carvone (% in Oil)	45	44	45	48
Oleoresins (w/w)'	12	13	12	14

[1] % Oleoresins = (wt. of non-volatile methylene chloride extract/wt. of sample) x 100.

CONCLUSIONS

1. Coriander

The results of the 1995 coriander crop have confirmed that varieties with small seeds produce a higher essential oil yield than varieties with large seeds. Small-seeded varieties are later maturing and may not yield well in cool short season areas. In the nitrogen fertilizer test, the seed yields and the chemical composition varied depending on the location.

The highest seed yield and largest seed size for coriander (var. Chinese) was obtained when seeding was done on May 20. The percent essential oil in the seeds increased, while the percent linalool in the essential oil declined with delayed seeding.

2. Caraway

The three cultivars of biennial caraway tested produced essential oil levels within the desired range cited in the literature. The average percentages of linalool in the essential oil, 54%, was less than the value obtained by one group of researchers (65%), but was within the range (50-60%) cited by another group, both for biennial caraway.

Annual caraway produces lower essential oil and lower % carvone than biennial caraway. Like the results for coriander, the location played an important role in determining the seed yield and chemical composition.

The optimum seeding date for annual caraway (var. Karzo) is May 20 since this resulted in the highest seed yield and highest amount of essential oil. The carvone levels in

the essential oil and the percent oleoresins decreased with delayed seeding with the highest values obtained when seeding was done on May 4.

3. Anise

A lower seeding rate resulted in a higher essential oil content in the two cultivars tested. Further work must be done to confirm the effect of seeding rate on seed yield.

Four varieties of anise can be grown successfully in Saskatoon with acceptable levels of essential oil. Further work must be done to increase the level of t-anethole in the essential Oil.

The highest seed yield was obtained from the earliest seeding date, May 4, but the highest essential oil content was obtained from seeds planted on May 13. Further work must be done to clarify the effect of seeding date on the percent t-anethole in anise essential oil. The percent oleoresins declined with delayed seeding.

4. **Dillseed**

The six cultivars of dillseed grown in Saskatoon and Yellow Creek produced acceptable levels of essential oil. The location was an important factor in determining the seed yield, essential oil content and percent oleoresins, whereas the levels of d-carvone in the essential oil from seeds grown in both locations were quite similar.

In terms of seeding date, planting on May 13 or May 14 resulted in the highest seed yields, while the highest essential oil yield was obtained from seeds planted on May **13.** The level of d-carvone in the essential oil increased with delayed seeding.

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