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1996 UPDATE ON ESSENTIAL OILS IN SASKATCHEWAN SPICE CROPS

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INTRODUCTION

The 1996 spice crop was the third set of well-matured seed available from the numerous trials conducted by the plant breeders and agronomists at the Crop Development Centre. The quality testing on anise, caraway, coriander, and dillseed is an integral part of a research project funded by the Agriculture Development Fund to develop the spice industry in Saskatchewan. As in the previous two years, two quality parameters, namely essential oil content and oleoresin content, were measured (Arganosa et al., 1996).

CORIANDER

Thirteen varieties were seeded at Saskatoon., Rosthem, Melfort and Goodale (two locations) in 1996. An additional yield test involving twenty-one varieties was also seeded at Saskatoon. Seed yields, 1000-seed weights and the essential oil composition of eight large-seeded and five small-seeded varieties are tabulated (Tables 1 and 2).

Among the large-seeded varieties, Autumn and Richters Long, followed closely by Richters-93, Chinese and ND-1, had the highest seed yields averaged across four locations (Table 1). Chinese and Richters-93 appear to be consistently high-yielding, having the highest seed yields in the 1995 yield tests. PGR-5741 had the highest seed yield among the small-seeded varieties (Tables 2). It also had the second highest seed yield averaged across three locations in 1995. The large-seeded varieties also had a higher average seed yield (1881 kg/ha) compared to the small-seeded varieties (1683 kg/ha).

Table 1. Seed yield, 1000-seed weight and oil composition of eight large-seeded coriander varieties averaged across four locations (1996)*

Variety	Yield kg/ha	1 000- seed wt., g	Essential Oil, % (v/w)	Linalool % of Oil	Extract- ables* * % (w/w)
Autumn	2001	8.7	0.92	61.5	19.9
Richters Long	1992	9.1	0.86	62.1	19.2
Richters-93	1948	9.3	0.87	58.4	19.2
Chinese	1945	9.4	0.80	61.9	19.2
ND-1	1938	8.7	0.98	59.7	18.9
Roumain	1804	8.8	0.82	63.6	19.5
Santo	1767	8.8	0.89	60.2	18.9
Starcross	1654	8.5	0.99	60.0	20.5

* The locations used were: Saskatoon (two yield tests), Rosthern, Melfort and Goodale (2 locations). ** % Extractables = % non-volatile methylene chloride extract = (wt. of extract/wt. of sample) x 100.

Among the locations used for the 1996 yield tests, the mean seed yields, calculated across varieties, were the highest at Saskatoon for both yield tests and for both large-seeded and small-seeded varieties (Tables 3 and 4). The lowest mean seed yield was obtained at Melfort for both seed sizes. Differences in 100-seed weight, essential oil content and linalool levels were also found among the different locations for both large-seeded and small-seeded varieties.

Table 2. Seed yield, 1000-seed weight and oil composition of five small-seeded coriander varieties averaged across four locations (1996). *

Variety	Yield kg/ha	1 000-seed wt., g	Essential Oil, % (v/w)	Linalool % of Oil	Extract- ables* % (w/w)
PGR-5741	1749	7.1	1.32	64.9	21.6
PGR-10057	1700	7.2	1.32	66.3	20.2
PGR-10056	1670	7.3	1.28	64.2	20.6
Sask. Early	1665	7.1	1.29	64.3	20.9
PGR-5742	1632	7.0	1.31	62.6	21.0

* The locations used were: Saskatoon (two yield tests), Rosthem, Melfort and Goodale (2 locations). ** % Extractables = % non-volatile methylene chloride extract = (wt. of extract/wt. of sample) x 100.

Table 3. Seed yield, 1000-seed weight and oil composition of large-seeded coriander varieties harvested from various locations in Saskatchewan in 1996. *

Variety	Yield kg/ha	1000- seed wt., g	Essential Oil, % (v/w)	Linalool % of Oil	Extract- ables* % (w/w)
Saskatoon (Y 1)	2449	9.9	0.91	63.4	20.6
Saskatoon (Y2)	2383	10.1	0.89	62.7	20.8
Rosthem	1780	7.8	0.96	59.7	16.4
Goodale (L1)	1746	9.9	0.82	62.1	20.0
Goodale (L2)	1729	9.4	0.83	62.8	18.3
Melfort	1200	6.4	0.94	49.1	n.a.

* The varieties used were: Richters Long, Richters-93, Chinese, Autumn, ND- 1, Roumain, Santo and Starcross. (Y1) Yield Test 1; (Y2) Yield Test 2; (L1) Location 1; (L2) Location 2. ** % Extractables = % non-volatile methylene chloride extract = (wt. of extract/wt. of sample) x 100.

The mean 1 000-seed weights of the large-seeded varieties and the small-seeded varieties, when calculated across varieties and locations, were 8.9 and 7.1, respectively (Tables 1 and 2). This was quite similar to the 10.4 g and 8.0 g for large-seeded and small-seeded varieties, respectively, obtained from the 1995 yield tests. In the 1996 crop, the seeds for both large-seeded and small-seeded varieties were noticeably smaller at Rosthem and Melfort suggesting that the seeds may have not developed to full maturity. The plots at Rosthem and Melfort were seeded quite late on May 22 and June 3, respectively.

Table 4. Seed yield, 1 000-seed weight and oil composition of small-seeded coriander varieties harvested from various locations in Saskatchewan in 1996. *

Variety	Yield kg/ha	1 000- seed wt., g	Essential Oil, % (v/w)	Linalool % of Oil	Extract- ables* % (w/w)
Saskatoon (Y2)	2015	8.1	1.33	65.1	22.1
Saskatoon (Y 1)	2010	7.9	1.36	66.8	22.4
Rosthem	1762	6.4	1.43	63.2	19.1
Goodale (L2)	1583	7.4	1.27	64.6	20.1
Goodale (L1)	1425	7.4	1.15	65.2	20.5
Melfort	1242	5.8	1.26	58.0	n.a.

* The varieties used were: PGR-574 1, PGR-10057, Saskatoon Early, PGR- 10056 and PGR-5742. (Y 1) Yield Test 1; (Y2) Yield Test 2; (L1) Location 1; (L2) Location 2.

** % Extractables = % non-volatile methylene chloride extract = (wt. of extract/wt. of sample) x 100.

Essential Oil Contents

Coriander should have an essential oil content between 0.4-1.4%. The mean essential oil contents of the large-seeded varieties grown in 1996 ranged from 0.82-0.83% at the two locations at Goodale to 0.89-0.94% at Saskatoon and Rosthem. The overall mean was 0.88%, which compares favourably with the 0.86% and 84% in 1994 and 1995, respectively, for the same varieties. Meanwhile, the mean essential oil contents of the small-seeded varieties ranged from as low as 1.15% at Goodale (Location 1), 1.26% at Melfort, 1.27% at Goodale (Location 2), 1.33% and 1.36% at Saskatoon and 1.43% at Rosthem. The overall mean is 1.3 1%, which is slightly greater than the mean of 1.21% obtained in 1995 but 9% lower than the mean of 1.44% obtained in 1994. These mean values of 0.88% and 1.3 1% for the large-seeded and small-seeded varieties are all within the 0.4-1.4% range reported in the literature.

Percent Linalool

Coriander essential oil should contain 60-70% linalool. The linalool levels in the essential oil from both the large-seeded and small-seeded varieties planted in 1996 at the various locations were within the desired 60-70% range except for the levels at Melfort. The linalool levels at Melfort were 49% and 58% for the large-seeded and small-seeded varieties, respectively. The overall mean linalool level for the large-seeded varieties, calculated across varieties and locations, was 60.9% compared to 62.3% obtained in 1995. For the small-seeded varieties, the mean linalool levels were 63.9% in 1996 and 66.5% in 1995. The results for both 1995 and 1996 confirm the relationships between seed size, essential oil content and level of linalool. Smaller seeded coriander varieties have higher essential oil contents with a higher linalool levels compared to the larger-seeded coriander varieties.

Percent Extractables

The percent extractables varied between 16.4% to 20.8% for the large-seeded varieties and between 18.6% to 21.9% for the small-seeded varieties. When calculated across varieties and locations, the overall means were 19.4% and 20.9% for the large-seeded and small-seeded varieties, respectively. These two means were both 18% greater than the 16.4% and the 17.7% means obtained for the large-seeded and small seeded varieties, respectively, for the 1995 crop. In 1995 and 1996, the percent extractables of the small-seeded varieties was slightly greater than the percent extractables of the large-seeded varieties. The lowest levels of percent extractables for both seed types were obtained from seeds grown at Rosthem.

Effect of Nitrogen and Phosphorus Levels

Three varieties of large-seeded coriander (Chinese, Richters and Roumain) were seeded at 0 and 60 kg N/ha and 0 and 60 kg P_2O_5 /ha at Saskatoon in 1996. The seed yields and essential oil composition are tabulated in Table 5. Based on the means calculated across the three varieties, nitrogen fertilisation increased the seed yield by 7%. While nitrogen fertilisation had no effect on the 1000-seed weights, the essential oil contents of the seeds were lower and the linalool contents of the essential oils were higher with nitrogen fertilisation. These results are in contrast to the results from the 1995 test wherein there were no improvements in the seed yield and essential oil composition due to nitrogen application.

Table 5. Seed yield, 1 000-seed weight and oil composition of three large-seeded coriander varieties grown at Saskatoon with nitrogen and phosphorus fertiliser application (1996). *

Nitrogen or Phosphorus Level	Yield kg/ha	1 000-seed wt., g	Essential Oil, % (v/w)	Linalool % of oil	Extractables* % (w/w)
0 kg N/ha	2250	10.0	0.85	62.2	19.5
60 kg N/ha	2406	10.0	0.78	67.2	20.0
0 kg P_2O_5 /ha	2301	10.0	0.81	66.9	20.0
60 kg P_2O_5 /ha	2381	10.2	0.89	62.0	19.4

* Varieties used were: Chinese, Richters and Roumain **% Extractables = % non-volatile methylene chloride extract = (wt. of extract/wt. of sample) x 100.

With phosphorus fertilisation, the mean seed yield increased by a mere 3%, while the 1000-seed weights were similar. Phosphorus fertilisation had the opposite effect compared to nitrogen fertilisation wherein the essential oil contents of the seeds were higher and the linalool contents of the essential oils were lower with phosphorus fertilisation. There were no differences in the percent extractables due to either nitrogen or phosphorus fertilisation.

DILL

Yield Tests

Six varieties of dill (Bouquet, Dill R, Dukat, Leaf Mammoth-92 and Vierling) were seeded at Saskatoon, Rosthem and Melfort in 1996. The seed yields ranged

between 608 kg/ha for Dill R to 1132 kg/ha for Mammoth 92. The essential oil contents were within a narrow 3.3 to 3.7% range while the percent carvone was between 43.5 to 45.7%. Meanwhile, the seed yields and oil composition of dill at the three locations, calculated across varieties, are shown in Table 6.

Table 6. Seed yield and essential oil composition of dill at Saskatoon, Rosthem and Melfort, 1996.

Location	Yield (kg/ha)	Essential Oil % (v/w)	Carvone % of Oil
Melfort	1003	2.9	44.3
Rosthem	863	3.7	45.2
Saskatoon	664	4.2	44.4

The mean seed yield for Saskatoon in 1996 (664 kg/ha) was 65% less than the mean seed yield for the same location in 1995 (1920 kg/ha) but 71% more than the mean seed yield in 1994 (388 kg/ha). The mean seed yield at Melfort in 1996 (1003 kg/ha) was 48% greater than the mean seed yield for the same location in 1994 (676 kg/ha). Among the locations seeded in 1996, the mean seed yield at Melfort (1003 kg/ha) was 16% greater than the mean seed yield at Rosthem (863 kg/ha) and 51% greater than the mean seed yield at Saskatoon.

Essential Oil Contents

Dill should contain 2-4% essential oil (Dziezak, 1989). The mean percent essential oil of the seeds of the 1996 crop at Saskatoon (4.2%) was about 62% greater than the mean value (2.6%) obtained in 1995 and 27% greater than the mean value (3.3%) obtained in 1994, which were all from the same location. In addition, the mean value for Melfort was 17% higher than the mean value for Rosthem and 45% higher than the mean value for Saskatoon. The three mean values from the locations used in 1996, 2.9%, 3.7% and 4.2% were either within or beyond the reported 2% to 4% range indicated above and the 2.4 to 4.4% range obtained from the analyses of other dill samples in our laboratory.

Percent Carvone

Dill essential oil should contain at least 40% d-carvone (Buccellato, 1990). The carvone levels in the essential oils of seeds planted at the three locations in 1996 were quite similar (Table 6). In addition, the carvone levels in the seeds planted at Saskatoon have been fairly consistent for the past three years, varying from 43.0% in 1994 to 43.9% in 1995 and now at 44.4%. In Melfort, the mean carvone levels began at 41.4% in 1994 and currently is at 44.3%. The range of values obtained for the 1996 crop were also within the 39.7% to 49.4% range obtained from other dill samples submitted by farmers from Saskatchewan for analyses by our laboratory.

CONCLUSIONS

1. Coriander

The results of the 1996 coriander crop have confirmed that large-seeded varieties have higher seed yields, but small-seeded varieties were higher in essential oil contents

and linalool levels. Location affected the seed yields, 1000-seed weights, essential oil content and linalool levels in the essential oil.

While nitrogen fertilisation had no effect on the 1000-seed weights, the essential oil contents of the seeds were lower and the linalool contents of the essential oils were higher with nitrogen fertilisation. Phosphorus fertilisation had the opposite effect compared to nitrogen fertilisation wherein the essential oil contents of the seeds were higher and the linalool contents of the essential oils were lower with phosphorus fertilisation. There were no differences in the percent extractables due to either nitrogen or phosphorus fertilisation.

2. **Dillseed**

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

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