LABORATORY AND GROWTH ROOM SEED VIGOR TESTING OF CERTIFIED CANOLA SEED

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INTRODUCTION

Three years of field testing different seed lots of Canada Certified No. 1 Brassica napus var. Westar, and B. campestris var. Tobin, across western Canada has shown that different seed lots of the same variety, when seeded at the same density, gave significantly different stand establishments and seed yields (Paper #1016, GCIRC Rapeseed Congress, 1991).

Whilst the canola industry is concerned about consistency of performance of a variety with respect to its quality characteristics, farmers are interested primarily in maximum seed yield. Since the choice of certified seed lot as seed for crop production can result in different yields, a method of predicting seed yield potential of a seed lot is of interest to farmers as well as to the seed industry. This paper shows the results from seed and seedling vigor tests used on Westar and Tobin certified seed lots, and compares their results with those same seed lots' seed yields in field tests.

MATERIALS AND METHODS

Studies were conducted in the laboratory, growth chamber and field, using seed lots that were field tested at locations across western Canada in 1989. Stand establishment and yield data result from tests at Melfort, Saskatoon, Scott, Beaverlodge, Ellerslie and Lethbridge.

Seed lots were produced in 1988, apart from Westar 6 and Tobin 6 produced in 1987 and field tested in 1988 with above average performance, and Tobin 5 which was produced in 1986 and which was used as the Tobin check in the 1989 Western Canada Canola Rapeseed Cooperative Trials.

Germination:

Germination values of seed lots were determined by placing 100 seeds onto Whatman #1 filter paper moistened with 5 ml of distilled deionozed water. The filter papers were in lidded petri dishes in a growth room at 18 °C. Four replicates of each seed lot were tested. Seeds were considered germinated if the radicle emerged through the testa. Germination counts were taken until no further seeds were observed to germinate.

Germination at 10 °C:

This was the same as previously described, except petri plates were kept at a constant temperature of 10 °C, and germination counts taken after 72 and 96 hours for the Tobin and Westar seed lots respectively.

Germination After a Period of Controlled Deterioration:
The method of Ellis and Roberts (1980) was used. Moisture content of the seed lots was determined gravimetrically by oven drying sub-samples of the lots at 130 °C. Distilled deionized water was added by micropipette to 3 replicates of 100 seeds to bring the seeds to 18% moisture content on a fresh weight basis. Seeds with moisture added were hermetically sealed in vials which were placed in a 0 °C room for 96 hours to allow the moisture to equilibrate through the seeds. The vials with seeds were placed in a water bath at 45 °C for 34 hours. Germination levels were then determined as previously described.

Emergence and Dry Matter Production in the Growth Chamber:
Four replicates of 25 seeds each were sown at a depth of 2.5 cm in pots of soil less mix. Pots were placed on tin trays in a growth chamber set to emulate soil temperatures experienced in Melfort, Saskatchewan, during the first two weeks of May—a diurnal temperature range of 6 to 14 °C with a mean temperature of 10 °C. Water was added to the trays which were drained once water had equilibrated through the soil less mix in the pots. Water was added as needed during the 14 days of growth. Emergence was noted after 14 days and plants harvested at soil level and dried at 130 °C to determine dry matter production.

Emergence with Rhizoctonia solani in the Growth Chamber:
This was as described for emergence in the growth chamber except seeds were covered with 2.5 cm of soil less mix containing 1500 active propagules per litre of *Rhizoctonia solani* grown on rye grains.

Emergence with Rhizoctonia solani in the Field:
Four replicate rows of 200 seeds together with *Rhizoctonia solani* inoculum grown on rye grains were sown using a single row seeder into 6 m rows at a depth of 2.5 cm. A randomized complete block design was used. Emergence was noted after 14-21 days.

Establishment and Seed Yield in Western Canada Field Trials:
The randomized complete block design was used with 6 replicates. Each seed lot replicate consisted of 6 by 6 m rows of 200 seeds. Seeds were planted at a depth of 2.5 - 3.0 cm. Emergence counts of the two centre rows were made after 14-21 days. At maturity plants were either swathed and combined, or direct combined. Seed was dried, cleaned and weighed.

Statistical procedures:
Results from all studies were subjected to analyses of variance. Only results showing significant differences at the 5% level or less are reported in Tables 1 and 2.

RESULTS

The Westar Seed Lots:
Results from the various tests for the Westar seed lots are shown in Table 1.

All Westar seed lots apart from Westar 2 had germination levels greater than 90%. Westar 2 the poorest performer in the field tests and in almost all the laboratory and growth chamber tests was obviously a sub standard seed lot. Data from this seed lot bias values obtained from correlation analyses between seed yield in the field and the other performance parameters

Analyses of variance showed significant differences between seed lots of Westar for all tests. As predictors of seed yield, omitting data obtained from Westar 2, only emergence and dry matter production in the growth chamber gave significant correlations with seed yield data from the field tests

Of interest is Westar 3, a seed lot with an outstanding germination level after a period of controlled deterioration, excellent emergence in the growth chamber emergence study, and excellent emergence with Rhizoctonia solani inoculation in the growth chamber and field. Westar 3 yielded a below average 98% of the mean of all Westar seed lots (Westar 2 data omitted from mean calculation).

Correlation coefficients (see Table 1) show that seed size, germination levels and field stand establishment of the Westar seed lots were not correlated with their final seed yield.

The Tobin Seed Lots:

Results from the various tests for the Tobin seed lots are shown in Table 2. The Tobin seed lots showed significant differences in 1000 seed weight, % germination, germination at 10°C, % germination after a period of controlled deterioration, in dry matter production in the growth chamber and in stand establishment and seed yield in the field.

Of interest are Tobin 10 and Tobin 3. Tobin 10 showed an excellent germination level, an average germination level at 10 °C and excellent germination after a period controlled deterioration, yet it gave the lowest stand establishment in the field and the poorest seed yield. Tobin 10 had the lowest 1000 seed weight of any Tobin seed lot.

Tobin 3, gave the highest seed yield in the field tests, had below average germination levels at room temperature and at 10 °C, very poor germination after a period of controlled deterioration, and apart from Tobin 10 gave the poorest stand establishment in the field. Tobin 3 had an above average 1000 seed weight, but was not ranked first in this respect, Tobin 8 being the Tobin seed lot with the largest seed size.

Using data from all Tobin seed lots, there were significant correlations between seed yield and 1000 seed weight; percent germination after a period of controlled deterioration, (a negative correlation suggesting that poorer germinators yielded more); and stand establishment in the field.

Omitting data from Tobin 10 from the correlation analyses resulted in no significant correlations between seed yield and any of the seed and seedling vigor tests, or between seed yield and stand establishment in the field.

DISCUSSION

In 1989, different certified seed lots of the Westar and Tobin gave different stand establishment and seed yields in field tests in western Canada (see Paper 1016).

Germination:

Westar 2 with below 90% germination showed below average performance in all tests, and gave the lowest seed yield of the Westar seed lots. Apart from Westar 2, germination levels of the seed lots, whether under stress conditions or after a period of controlled deterioration, were poor predictors of both stand establishment and final seed yield.

Seed Size:

Major (1977) showed that within a seed lot, seed size was positively related to seedling dry matter production in the growth chamber, but not to seed yield in the field.

These studies similarly showed no correlation between seed size and seed yield. Results from Tobin 10 and Westar 3, both seed lots with very low 1000 seed weight, suggest that a seed lot with a very low seed weight but otherwise good germination and emergence characteristics and good viability after a period of controlled deterioration, might have reduced yield potential.

Stand Establishment:

Stand establishment in the field and in the laboratory was a poor predictor of final seed yield.

Controlled Deterioration:

Roberts (1986) suggests from many years work that viability curves constructed from germination levels of a seed lot obtained when sub-samples are removed from controlled deterioration conditions over time, are the best predictors of seed lot performance. A requisite of this procedure is that the seed lot is uniform with seed deaths within a seed lot distributed normally over time.

Uniformity of Seed Within a Seed Lot:

McCormac and Keefe (1990) have shown that the rate of imbibition of water into a seed is negatively correlated with vigor. Damaged testas of cauliflower (Brassica oleraceae) seeds, allowed faster imbibition of water with resulting vigor loss. Bringing soil moisture to field capacity immediately after seeding also lowered seedling vigor. All of the laboratory tests discussed in these studies have added water in such a way as to allow rapid imbibition, especially by seeds with damaged testas.

Petrie and Seidle (personal communication, 1990) have indicated that Altenaria brassicae and A raphani infection of seed can cause lowered germination levels in seed lots of Tobin.

While a seed lot would have seeds of similar physiological status, it might have some seeds with damaged testas and some seeds with fungal infections and some seeds with both. Different ratios of these "imperfect" seed types in different seed lots, and the inclusion of seed lots of small seed size, might account for the differing performances in the germination, vigor and seed yield of seed lots described in this paper.

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Table 1. Performance of 1989 Westar Seed Lots in Field Tests, and in Growth Chamber and Laboratory Germination and Vigor Studies. Correlation of Tests with Field Seed Yield are Shown.

seed yield in field (gm)	1000 seed weight (gm)	% germination	% germination at 10 °C	% germination after c.d.[1]	% emergence in g.c.[2]
W4 1111	W1 4.33	W4 100	W10 81	W3 94.9	W4 100
W6 1099	W6 4.32	W7 100	W1 79	W4 74.0	W3 98
W1 1099	W12 4.29	W5 100	W11 79	W7 53.0	W7 96
W5 1071	W2 4.10	W3 99	W5 76	W9 39.0	W6 96
W9 1065	W11 4.01	W6 99	W3 68	W11 31.4	W9 96
W11 1039	W7 4.00	W8 99	W12 67	W12 28.9	W1 96
W7 1035	W4 3.98	W10 99	W6 50	W10 23.7	W5 95
W3 1031	W10 3.97	W11 99	W7 36	W6 14.1	W8 94
W8 1007	W9 3.82	W12 99	W2 19	W2 12.4	W10 93
W12 1004	W12 3.71	W9 98	W4 18	W1 7.9	W11 91
W10 1003	W3 3.62	W1 92	W9 16	W8 3.1	W12 91
W2 960	W5 na[3]	W2 66	W8 11	W5 na[3]	W2 52
lsd: 78	0.049	4.31	6.68	10.7	7.89
Corr[4]:	n.s.[6]	n.s.	n.s.	n.s.	r=0.665*
Corr[5]:	n.s.	n.s.	n.s.	n.s.	r=0.647*

g.c dry matter (gm)	g.c.dry matter /plant (gm)	% emergence with *R. s.*[7] in g.c.	% emergence with *R. s.* in field	% stand establishment in field
W5 1.987	W5 0.084	W5 89[8]	W5 65.3[8]	W5 52.0
W6 1.956	W6 0.082	W3 47	W4 49.5	W7 50.0
W7 1.897	W7 0.079	W6 43	W3 49.3	W9 50.0
W4 1.835	W9 0.075	W4 36	W11 48.1	W4 49.5
W9 1.800	W4 0.073	W1 36	W7 47.8	W11 49.0
W3 1.778	W10 0.073	W7 34	W10 47.3	W10 48.0
W10 1.703	W3 0.073	W9 33	W12 47.3	W12 48.0
W1 1.685	W1 0.071	W10 27	W1 46.9	W3 47.5
W11 1.483	W2 0.070	W11 18	W6 46.5	W6 47.0
W12 1.420	W11 0.065	W12 16	W8 43.5	W1 46.5
W8 1.158	W12 0.062	W8 14	W9 41.5	W8 45.0
W2 0.921	W8 0.049	W2 8	W2 20.6	W2 23.0
lsd: 0.279	0.011	3.5	8.48	11.81
Corr[7]: r=0.753**	n.s.	r=0.722*	n.s.	r=0.596*
Corr[8]: r=0.607*	n.s.	n.s.	n.s.	n.s.

1 c.d., controlled deterioration
2 g.c., growth chamber
3 na, not available, seed lot treated with fungicide
4 correlation with seed yield, includes seed lot Westar 2
5 correlation with seed yield, excludes seed lot Westar 2
6 n.s., not significant
7 *R. s.*, Rhizoctonia solani
8 this seed lot, previously treated with fungicide, not included in this correlation analyses
* significant at the 5% level
** significant at the 1% level

Table 2. Performance of 1989 Tobin Seed Lots in Field Tests, and in Growth Chamber and Laboratory Germination and Vigor Studies. Correlations of Tests with Field Seed Yield are Shown.

seed yield in field (gm)	1000 seed weight (gm)	% germination	% germination at 10 °C	% germination after c.d.[1]	% emergence g.c.[2]
T3 1044	T8 2.81	T10 100	T2 71	T10 66.1	N.S.D.[3]
T5 1013	T9 2.79	T6 100	T12 60	T1 45.4	N.S.D.
T8 1007	T3 2.71	T8 99	T8 52	T7 23.9	N.S.D.
T12 990	T1 2.65	T12 99	T4 50	T6 21.3	N.S.D.
T11 974	T12 2.62	T5 98	T1 50	T9 17.0	N.S.D.
T1 973	T11 2.61	T11 98	T10 49	T4 10.6	N.S.D.
T9 971	T2 2.60	T7 98	T9 44	T8 6.6	N.S.D.
T7 963	T5 2.52	T1 97	T11 43	T5 5.5	N.S.D.
T2 948	T4 2.49	T9 97	T3 41	T3 5.1	N.S.D.
T6 946	T7 2.39	T2 96	T7 31	T11 5.1	N.S.D.
T4 923	T6 2.28	T3 96	T6 27	T12 3.0	N.S.D.
T10 856	T10 2.05	T4 95	T5 21	T2 1.0	N.S.D.
lsd: 74	0.062	2.57	9.19	8.67	—
Corr[4]:	r=0.685*	n.s.[6]	n.s.	r=0.670[7]	—
Corr[5]:	n.s.	n.s.	n.s.	n.s.	—

g.c dry matter (gm)	g.c.dry matter /plant (gm)	% emergence with *R. s.*[8] in g.c.	% emergence with *R. s.* in field	% stand establishment in field
N.S.D.	T12 0.069	N.S.D.	N.S.D.	T8 36.0
N.S.D.	T11 0.066	N.S.D.	N.S.D.	T11 35.0
N.S.D.	T7 0.066	N.S.D.	N.S.D.	T9 34.0
N.S.D.	T1 0.063	N.S.D.	N.S.D.	T12 33.5
N.S.D.	T8 0.063	N.S.D.	N.S.D.	T1 33.0
N.S.D.	T5 0.061	N.S.D.	N.S.D.	T6 32.5
N.S.D.	T2 0.060	N.S.D.	N.S.D.	T5 32.0
N.S.D.	T3 0.058	N.S.D.	N.S.D.	T7 32.0
N.S.D.	T4 0.057	N.S.D.	N.S.D.	T2 31.0
N.S.D.	T9 0.056	N.S.D.	N.S.D.	T4 31.0
N.S.D.	T6 0.054	N.S.D.	N.S.D.	T3 30.0
N.S.D.	T10 0.046	N.S.D.	N.S.D.	T10 26.0
—	0.011	—	—	2.7
—	n.s.	—	—	r=0.593*
—	n.s.	—	—	n.s.

1 c.d., controlled deterioration
2 g.c., growth chamber
3 N.S.D.,not significantly different
4 correlation with seed yield, includes seed lot Tobin 10
5 correlation with seed yield, excludes seed lot Tobin 10
6 n.s., not significant
7 a significant negative correlation, strongly affected by Tobins 3 and 10
8 *R. s.*, Rhizoctonia solani
* significant at the 5% level