An Evaluation of the Vacuum / Pressure Moisturization Technique of Seed Grains and Oilseeds[1]

P.R. Hopkins, L.E. Cowell, S.A. Brandt, A.T. Wright, F. Selles and J. Ferrie[2]

Introduction

In the spring of 1987, a Vancouver based company promoted a new seed treatment to speed germination and emergence, and allow a more uniform and vigorous crop stand. Since stand establishment is an important step in yield maximization, a great deal of interest was expressed in investigating these advocated benefits. Researchers at the University of Saskatchewan, Agriculture Canada Research Stations and the Saskatchewan Wheat Pool initiated experiments to evaluate the treatment's potential with a number of crops and varieties. This paper attempts to draw together the results from these experiments.

Materials and Methods

The moisturizing, or imbibition process involves placing the seed under water and using a vacuum to remove air from the intercellular spaces of the seed. When the vacuum is released, water under pressure is forced into the spaces, raising the moisture content to approximately 35% (in the case of wheat). A period of surface drying must follow to allow good seed handling properties. Refer to Table 1.

Commercial sized batch seed treaters were leased by local Agribusiness, who in turn treated seed at a price of about $2 per bushel. The company promoting the process provided laboratory sized treaters, together with explicit instructions, to a number of the research groups involved. Treated seed for the experiments came from either source, depending on the size of the experiment.

Table 1. Lab Model Treatment Conditions

	Water temperature 18 - 22 °C		
	-90 kPa (26 in. Hg)	+35 kPa (5 PSI)	Drydown
Wheat, Barley,	6 min.	6 min.	8 hours
Durum	8 min.	8 min.	8 hours
Canola	6 min.	6 min.	4 hours
Alfalfa	10 min.	10 min.	4 hours

The primary experiments were field experiments using either field scale equipment (Soil Science Dept.) or small-plot seeders.

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[2] Department of Crop Science and Plant Ecology, Department of Soil Science - Innovative Acres Project, Agriculture Canada Research Branch (Scott, Melfort, Swift Current), and Saskatchewan Wheat Pool Product Development.

A wide range of seedbed moisture conditions existed. In most of these tests both emergence and yield were recorded. A number of subsidiary and follow-up growth room experiments have also been initiated, as resources allow and preliminary results suggest. Except for the field scale tests, experiments were split-plot or randomized complete block designs.

Results and Discussion

1) Spring wheat;

Work done at Scott found no significant effects on yields or emergence of either Katepwa or HY320. Crop Science Department work found a 14% yield reduction in one of three field tests. Emergence was increased 12% in the same test. Commercial scale field work at 6 sites done by the Soil Science Department gave one positive response of 230 kg/ha with 36% greater emergence, and one negative response of 370 kg/ha following a 36% reduction in emergence. Swift Current tests found a negative effect on Leader spring wheat yield, with an enhanced plant stand.

Growth room studies done by the Soil Science Department found no net effect on emergence seven days after treating, nor any effect of placement of treated seed in dry soil for a week on percentage emergence. Crop Science Department lab work found greater emergence uniformity of treated Columbus wheat, provided there was no dry spell after planting, but otherwise uniformity was reduced. After one week in a dry seedbed, emergence was the same for treated and untreated seed.

Table 2. Spring wheat field results

		Yield (kg/ha)		Emergence (P/M^2)	
Researcher	Variety	Check	Treated	Check	Treated
Scott	Katepwa	4480	4110	157	140
	HY320	3160	3400	136	111
Swift Current	Leader	3090	2890^{-}	168	176^{+}
Soil Sci.	commercial	2550	2180^{--}	163	105^{--}
	"	2760	2730		
	"	2340	2520$^{\sim}$	222	210
	"	2030	2260^{+}	132	180^{++}
	"	1950	1690$^{\sim}$		
	"	2320	2080$^{\sim}$		
Crop Sci.	(Katepwa,	1390	1200^{-}	148	167^{+}
	Columbus,	2460	2410	150	153
	Fielder,			117	114
	HY320)	2340	2240	111	126

+,- ++,-- = Significance increase or decrease at P=0.05 or P=0.01

2) Durum wheat;

Work done at Scott and by Crop Science found no effect on Wakooma and Wascana durum. Soil Science found a 260 kg/ha response at Assiniboia, and a 210 kg/ha nearly significant yield increase at Kyle. In the latter instance, seeding volume had not been adjusted to compensate for physical changes in the seed, so

the emergence was reduced by 26%. Swift Current field work found a 170 kg yield reduction with a 12% greater stand of Kyle durum.

Table 3. Durum wheat field results

Researcher	Variety	Yield (kg/ha) Check	Yield (kg/ha) Treated	Emergence (P/M^2) Check	Emergence (P/M^2) Treated
Scott	Wakooma	4680	4600	126	131
Swift Current	Kyle	3230	3060^{-}	158	177^{++}
Soil Sci.	commercial	1670	1930^{+}		
	"	3540	3750$^{\sim}$	146	108^{--}
Crop Sci.	Wascana	1140	1080	118	112
	"	2170	2110	98	113
	"			69	53
	"	687	991	56	56

3) Winter wheat;

Crop Science Department tests found significantly enhanced plant stands in two tests that were planted in mid-June. Fall seeded tests were subjected to extremely harsh seedbed conditions and desiccation, so plant stands were poor. All but one test had faster emergence.

Lab experiments done by the Soil Science Department found a negative effect on emergence if treated seed was placed in soil with a good moisture status. Crop Science work found about a half day advantage in time to 50% emergence in a soil near field capacity, but no effect if placed in an initially dry seedbed. Uniformity of emergence was reduced in moist seed beds, but increased in dry seedbeds.

Table 4. Winter wheat field results

Researcher	Variety	Emergence (P/M^2) Check	Emergence (P/M^2) Treated
Crop Science	Norstar	141	135
	"	108	133
	"	98	118^{+}
	"	115	156^{+}
	"	35	29
	Norwin	48	52
	Norstar	17	20
	Norwin	16	19

4) Barley;

Melfort work found no effect of treatment on yield or plant stand of Conquest barley, even if seeding was delayed for a week after treatment. Work at the Scott Research Station found no significant effect on Harrington, Bonanza and Leduc barleys. Soil Science field tests found no significant effects, although a negative trend was observed at Perdue. Crop Science Department tests, which included four varieties in each, found a 15% yield increase with Harrington at one site, despite a final plant population reduced by 18%.

Lab work done by Soil Science found no effect on the emergence of Bonanza barley.

Table 5. Barley field results

Researcher	Variety	Yield (kg/ha) Check	Yield (kg/ha) Treated	Emergence (P/M^2) Check	Emergence (P/M^2) Treated
Melfort	Conquest	2950	2820	218	217
Scott	Harrington	4900	5150	111	113
	Bonanza	4800	4470	110	131
	Leduc	5100	5210	116	108
Crop Sci.	(Argyle,	1700	1680	112	108
	Harrington,	2230	2170	109	107
	Scout, Tupper)			90	93
	"	3660	3460	122	116
Soil Sci.	commercial	4020	4080	127	151
	"	4060	3950		
	"	3220	3000	151	142

5) Oilseeds;

Tests with both Tobin and Westar canola, and Ochre yellow mustard at Scott found no significant effects of treatment. A substantial positive trend was noted in one test of broadcast-seeded Westar. Another trend noticed was the decreased plant emergence in all six tests, averaging 14%.

A Saskatchewan Wheat Pool test with Tobin canola found a 170 kg/ha yield increase following the treatment (data not shown). Plant stand data was not obtained, but since canola yield is usually more or less independent of plant population over a fairly wide range, it is speculated that emergence rate must have been enhanced, allowing an earlier stand to start flowering sooner, therefore extending the flowering period. Moisture uptake by the seed during the treatment procedure in this test was so minimal that the authors agreed that it indicated some malfunction of the treatment procedure.

Lab work by the Soil Science Department resulted in a significant negative effect on emergence, which was further reduced if treated seed was placed in a dry seedbed. Crop Science lab experiments found that although final plant stand was unaffected, uniformity of emergence was reduced.

Table 6. Oilseed field results

Researcher	Variety	Yield (kg/ha) Check	Yield (kg/ha) Treated	Emergence (P/M^2) Check	Emergence (P/M^2) Treated
Scott	Tobin	1600	1780	179	161
	"	1510	1600	127	91.2
	Westar	917	907	148	135
	"	528	905	83.1	76.6
	Ochre Y.Mustard	1870	1790	106	96.2
	"	1630	1700	83.1	62.5

At Scott it was found that treating flax caused the mucilage layer on the seedcoat to become sticky, resulting in lumps that made seeding impossible. The promoting company had advised researchers of this possibility.

6) General observations regarding emergence;

One Soil Science lab test indicated that the treatment is detrimental to alfalfa emergence. One field test found no effect of treatment of red clover placed in a seedbed that remained dry for three weeks.

Germinations tests at Scott indicated that germination percentage of treated seed was generally equal or less than that of untreated seed. Rate of germination in the cereals was unaffected, but in canola was hastened by 2-3 hours.

Radicle emergence of Tobin canola occurred within 24 hours of treatment. Since 24 hours was found necessary to adequately dry the seed coat for handling in seeding equipment, the emerged radicles were vulnerable to mechanical damage.

Maximum and final plant stand were quite different in many of the field tests. Significant plant die-back occurred following emergence in some tests, especially in the treated plots. Some example data averaged from four Crop Science tests is shown in Table 7. Soil Science research gave similar results in several tests. The obvious conclusion is that seedlings treated were more susceptible to either desiccation in a dry seedbed, or had a longer exposure to microbial attack.

Table 7. Some maximum and final percentage plant stand data

		Percentage plant stand from seed	
		Maximum	Final
Norstar HRWW	Check	55	48
	Treated	67	56
Columbus HRSW	Check	52	51
	Treated	63	58
Argyle Barley	Check	87	65
	Treated	80	59
Wascana Durum	Check	52	52
	Treated	54	51

Variation among seed lots has not been explored. It has been suggested in the literature that seed of good quality will respond less to a treatment such as is being evaluated here. While the quality of some seed sources tested is not available, the percent emergence data suggests that not all seed was of optimum quality.

Nonsignificant differences from Scott (Tables 1 and 3) and data from Crop Science (not shown) indicate that there are small varietal differences in treatment effect. The order of response seems to be COLUMBUS > HY320 > FIELDER > KATEPWA. The hulless

barleys SCOUT and TUPPER seem slightly more responsive than HARRINGTON and ARGYLE based on emergence data.

Saskatchewan Wheat Pool and Crop Science results suggest that variation in moisture uptake between and among seed sources can be substantial (30%). Within source variation suggests that the procedure may not be quite as consistent as might be desired.

7) Other considerations;

The Innovative Acres Project is an on-farm testing program of "innovative" management practices. Since part of the experimental setup and measurement were done by the farmers, they had an opportunity to convey their comments about the treatment procedure.

Risk of a change in the weather after soaking seed was one concern. It was also inconvenient to adjust seeding rate. Some observed seed bridging, packing and breaking in the cups. Seed flow out of the truck was noted to be slow by one co-operator. The most important complaint was the time required to treat the seed. This time loss, and the rapid germination of canola, are important logistical restrictions to the procedure under study.

Earlier maturity was noted in a few tests, later maturity in others.

Conclusions

A nonstatistical summary of results in Table 8 shows the mean effect of treatment over all field experiments was minimal. Only two significant yield responses and a few nearly significant positive trends were noted. Twice as many negative responses were obtained from the 35 tests. Considering the costs and problems associated with this treatment, and the number of trials, this frequency of responses does not support the recommendation of this seed treatment procedure on these field crops in Saskatchewan conditions.

Table 8. Mean yields of Normal vs Treated Seed across all tests

	Check	Yield kg/ha	Treated
Spring Wheat	2570		2290
Durum	2440		2500
Barley	3660		3600
Oilseeds	1340		1450

Emergence uniformity was reduced in lab experiments. Treated seed frequently had greater emergence, but died back. Plant population changes often did not lead to the same effect on yield. The field data indicate that emergence of winter wheat was hastened by the treatment, while populations of canola and mustard were reduced.