**Selecting Milling Wheat for Organic Production in New Brunswick**

A practical orientation to organic wheat production may help keep heritage wheat varieties alive and growing in New Brunswick. The Maritime Certified Organic Growers (MCOG) have started to collect and compare a number of old and new wheat varieties in the hopes of finding the ones best suited to a humid climate and organic growing conditions. This wheat selection initiative is a collaboration between the growers, a flour mill, the New Brunswick government, and Seeds of Diversity Canada (SoDC). The on-farm evaluation trials are unique and exciting because wheat seed from the Plant Gene Resources Canada, rare heritage varieties, varieties saved and selected over the years by organic farmers, as well as modern varieties have been brought together in one place for comparison (see Table 1).

Visitors who came to see the trial plots saw the heritage varieties holding their own next to the latest releases from Agriculture Canada's breeding program. We were impressed by how different each variety is from the rest. A range of different varieties were included in our trials, with the hope that some might possess characteristics sought by organic farmers (see Table 2). At the outset we assumed the modern varieties would have stronger yields, disease resistance, and bread-making quality than older varieties. Our preliminary results show, however, that there is no clear separation between modern and non-modern varieties. Each variety, it appears, has something to offer.

What prompted the initiation of these trials was demand for locally-grown, organic wheat in the Maritimes. Lately, however, demand has been greater than the supply. Farmers, on the other hand, were expressing dissatisfaction with the commonly-grown milling wheat variety, Roblin. They were looking for a more economically viable, higher-yielding variety. Also, other criteria were sought, such as ability to compete with weeds, ability to thrive in an organic production environment, and disease resistance in a humid climate. Speerville Mill also had to make sure the varieties used had good quality characteristics such as adequate protein and bread-making potential.

It was felt that wheat varieties bred and selected for Western Canadian dry conditions, under conventional management (using herbicides, synthetic fertilizers, fungicides, and other pest control products), were simply not meeting the needs of organic growers. It has also been demonstrated that varieties that do well in organic systems often have different yield rankings than those that do well in conventional systems. This is not surprising because on organic farms, selection criteria and soil management environments are different from

**Speerville Mill** [optional side-bar]

In New Brunswick in the late 1970s, there were no mills for processing bread wheats, and all flour used in the province was imported. This represented a loss in local food self-reliance, given that 100 years earlier most grain for human consumption was grown and processed locally. The germ of possibility for growing milling grains was still there, so a group of enterprising people put together the Speerville Mill Co-op and began to grind small amounts of wheat into flour.

Speerville Mill was created to encourage local growers to supply milling wheat, to create a market for organic grain products, and to sell these products bioregionally. Speerville's success in getting farmers to grow wheat, and selling the processed flour, gave them the credibility to ask for variety trials on milling wheats (organic and conventional) to be done by the Department of Agriculture.

Provincial wheat variety trials showed that it is possible to grow high protein (14%+) wheats with acceptable yields in New Brunswick, despite the conventional wisdom that all wheat should come from the famous Canadian Prairies.

conventional ones. It has been found in Germany that high yields in organic systems are closely related to high above-ground biomass and high straw yields, and that these factors are associated with greater root penetration and development, which is important for the nutrition of the plant and for anchorage where mechanical weed control is used. On most organic farms with livestock, straw is an important raw material for feed, bedding and manure management.

**Table 1. Categories of spring wheat varieties used in the trial**

| Modern varieties | Varieties favoured by organic growers | Varieties developed in the Maritimes | Heritage varieties |
|---|---|---|---|
| Barrie [R]<br>Grandin [R]<br>Roblin [R]<br>Teal [R]<br>AC Walton [R] | Coteau [S]<br>Huron [R]<br>Park [R]<br>'Speer' [S]<br>Teal [R] | Acadia [N]<br>AC Walton [R] | Acadia [N]<br>Coteau [S]<br>Huron [R]<br>Laura [S]<br>Marquis [S]<br>Red Fife [S]<br>Reward [S]<br>Selkirk [S]<br>Thatcher [R] |

[R] included in replicated trial, Speerville site
[S] included in non-replicated trial, Speerville site, due to initial shortage of seed
[N] grown out for next year's trials by Dr. Hans Nass, Agriculture Canada

**Table 2. Criteria for selection**

| Parameter | Details |
|---|---|
| Yield | More than 1.25 T/ha (.5 ton/acre), ideally 1.7-2.5 T/ha (~1 ton/acre) |
| Quality | Protein of 13.5% or more, good baking quality, nutritious |
| Growth | Competes well with weeds, good seedling vigour, able to use organic fertility |
| Straw | Livestock farmers would prefer to have more straw production |
| Maturity | 100 days or less, as early as possible in order to harvest before the wet fall |
| Resistance | Long-term disease resistance |

Organic farmers who are keeping soil organic matter levels high on their farms have an advantage in growing milling wheat. According to a Canadian study, high soil quality can have a more dramatic positive effect on wheat milling and baking characteristics than variety does.

One recent development that also makes organic farmers keen to have their own seed and varieties is the possible introduction of genetically engineered wheat, which may be so popular that non-genetically engineered varieties will not be easily available. Organic farmers are prohibited by standards from using genetically engineered crops [defined as crops with genetic material from another species], and will likely have to depend on each other for seed sources.

Thus MCOG and Speerville Mill, in co-operation with the Department of Agriculture, initiated on-farm milling wheat variety trials at three MCOG-member organic farms in the province in the

spring of 1998. The growers in the group have a very practical orientation towards genetic diversity; they would like to have a range of choices for producing wheat that thrives in the growing conditions on their farms. They are interested in saving their own seeds and possibly nurturing their own variety.

**Wheat trials**

To carry out effective trials, it was fortunate that we were able to find such a diverse collection of varieties to evaluate. The first step to finding a good variety for our needs is to have a large selection of germplasm to select from.

We were able to get very small samples (25 to 50 seeds) of various heritage wheats from Plant Genetic Resources of Canada. In general, these seeds did not germinate well. We were particularly interested in 'Acadia' because it was actually bred and selected for Maritime conditions in the 1940s before biocides were widely used. Out of our 50 Acadia seeds, only one germinated! We were shocked to think that such a potentially important wheat for the Maritimes was so close to fading into oblivion. Luckily, Dr. Hans Nass of Agriculture Canada was able to obtain and grow out a quantity of Acadia seed for us to use.

Seed of other heritage varieties was obtained through Sharon Rempel of SoDC. We were provided with samples of 100-300 g, but these were not big enough to include in our replicated[1] trial. The seed was in great shape, and germinated well. This year we simply increased the seed and did some preliminary evaluation. We found that protein levels and wheat yields were in the same range as the modern varieties (see Table 3).

We also obtained seed of four different varieties (Coteau, Huron, Park and Thatcher) from organic farmers who are using and saving their own seed, year after year. We noted that all of these seeds were released around the 50s and 60s. These seeds were particularly interesting to us. Seeds of a variety such as Park selected and saved on a conventional farm for ten years may be slightly different from seeds of the same variety selected and saved for ten years on an organic farm. Even though wheat varieties are homozygous and inbreeding, it is possible that populations from the two contrasting selection systems might have differences as a result of mutation and accidental crosses. Even within our own trials this year we found differences between populations of the same variety that came from different sources and were planted adjacent to each other.

Seed of modern varieties was obtained from seed dealers and conventional farmers who happened to have a supply. Even this was tricky as varieties that were only just a couple of years old were no longer being offered commercially.

**Results of first trial season**

**Yield**. Our yield goal for organic milling wheat is 1.7-2.2 T/ha. Yields of about 1 T/ha are the norm with the standard variety, Robln. At the Speerville site in 1998, where yields were lowest of our

[1] Replicated: each variety is planted in several plots, randomly assigned, and data is collected separately in each plot. This allows us to determine whether differences between varieties are 'real' or due to field variability.

three trial locations, yields of replicated varieties ranged from 1.0 to 1.6 T / ha (Table 3). Yield of Huron was low most likely because two distinct germinations occurred, one initially and another when it rained again, about a week later. Tests before seeding showed the Huron seed had a germination rate of only 20% compared with 76-100% for all other seeds. Its seeds are larger than the others, which leads us to believe they require a higher level of moisture to germinate.

**Table 3.** Spring wheat organic cultivar preliminary evaluations. Data is presented here for 'heritage' or 'saved' varieties, grown at the Speerville site (without replication, due to initial shortage of seed). Data from replicated trials is also included for comparison.

| Cultivar | Wheat yield (T $ha^{-1}$) | Wheat protein (%) | Mean wheat / weed seedling ratio | | Mean wheat height at harvest (cm) | Maturity ranking (1-green, 10- ready to harvest) |
|---|---|---|---|---|---|---|
| | | | day 7 after seeding | day 37 after seeding | | |
| | | | | | | Aug 18 |
| 'Speer' | 3.40 - | 12.23 | 6.7 | 5.5 | 73 - | 6 |
| Selkirk | 1.81 - | 15.23 | 8.7 | 7.0 | 101 - | 8 |
| AC Walton | 1.60 a | 14.10 | 3.9 | 3.2 | 83 c | 5 |
| Reward | 1.52 - | 15.94 | 4.3 | 3.4 | 110 - | 6 |
| Barrie | 1.48 ab | 15.90 | 9.0 | 4.7 | 84 c | 5 |
| Park | 1.25 bc | 16.28 | 2.4 | 3.6 | 95 b | 7 |
| Laura | 1.24 - | 15.27 | 4.3 | 2.8 | 87 - | 6 |
| Roblin | 1.21 bc | 15.89 | 1.5 | 2.5 | 76 d | 9 |
| Marquis | 1.17 - | 14.79 | 0.9 | 2.3 | 102 - | 5 |
| Teal | 1.12 c | 15.45 | 6.8 | 3.1 | 84 c | 8 |
| Grandin | 1.11 c | 14.16 | 1.2 | 2.3 | 70 e | 6 |
| Huron | 1.06 c | 13.13 | 1.4 | 2.2 | 101 a | 4 |
| Thatcher | 1.00 c | 15.47 | 3.7 | 2.2 | 92 b | 5 |
| Coteau | -- | 15.23 | -- | -- | 95 - | -- |
| LSD (0.05) | 0.29 | -- | -- | -- | 4 | -- |
| CV (%) | 19.3 | -- | -- | -- | 15 | -- |

* Means followed by the same letter within each column are not significantly different by LSD test (0.05). Means followed by dashes were not replicated and therefore not statistically analysed.

**Height, weeds, disease.** Organic producers are looking wheat varieties that have the ability to compete with weeds. The Speerville site was relatively weedy, making it a good site for evaluating competitiveness. Huron, Marquis, Reward, and Selkirk -- all older varieties -- were taller than the other wheats, while Grandin appeared to be too short to compete with the weeds. We found that so far, the tallest varieties were not all good competitors. 'Speer', Selkirk, Walton, Reward and Barrie all demonstrated higher wheat to weed ratios at 7 and 37 days after seeding (Table 3). These were also the highest yielding varieties at the Speerville location. These results must be interpreted with care because they are not all from replicated plots, and seedling vigour is both a function of seed quality as well as of varieties. In our trial, only Barrie and Grandin were from certified seed.

Preliminary disease evaluations show that Walton has the highest incidence of disease of all the varieties (data not shown). At this point, no general patterns showed that 'old' or 'new' wheat varieties had higher disease incidence.

**Protein and maturity**. All of the varieties in the trial at Speerville except Speer and Huron achieved a minimum milling protein level of 13.5% (required for selling as bread wheat). With the modern varieties, we found that the higher the yield, the lower the protein. With the older varieties, this relationship is not as clear. Many of the older varieties had unusually high protein levels, which was striking in a year when protein levels for milling wheat in New Brunswick were generally quite low.

Roblin, Selkirk, Teal and Park appear to be the earliest-maturing varieties, which is important to growers in New Brunswick. It is particularly important for farmers wishing to get their crop off before disease and the rainy season sets in.

Our bake test results are not yet ready, so they will have to be presented along with next year's results. Although no clear trends or generalizations can be made at this point, we hope that three years of data should help us to sort out which wheat varieties are most promising for organic growers in the Maritimes. This season we hope to include some of the more promising heritage or 'saved' varieties in replicated trials.

**Diversity**

Diversity within crop varieties is important even without the intention of any selection or breeding project for several reasons. It is important, particularly in ecological agriculture, for farmers to have a choice of different varieties to suit their production schedules, farm equipment availability, natural features on the farm, production goals, and markets. And it is important to have a variety of choices in case any of the above situations change over time.

Farmers are not only interested in having a range of varieties to choose from, they also want as much information that goes along with that variety as possible. Thus the diversity of varieties is only useful if a full package of information goes along with the seed. The closer to home that information was compiled, the better. Farmers are certainly willing to try different varieties, and there are individual variety preferences even among neighbours.

**Future plans and questions**

Judging from the number of people -- organic farmers, conventional farmers, researchers and even consumers -- who have either offered help and resources, or expressed an interest in our first year trial results, it appears that the project is relevant and 'useful'. The co-operation of producers, processors, and government personnel have been excellent.

In terms of our goals, we are only at the beginning of a multi-year effort. Already we see potential for expanding these goals. For example, we would like to experiment with mixing two or three varieties with similar maturity patterns to see if that could increase average yield and average quality of wheat stands. Also, it might be fruitful to cross some of the more promising wheats and

then proceed with field selection using the F2 generation of the cross. However, at this point we don't have the resources for this kind of work.

We would also like to find some way of assessing the nutritional quality of the wheat, with the objective of finding varieties that are very nutritive. Typically, high quality is associated with high protein and high gluten content which creates fluffy bread. Perhaps in the long-run this is a misguided goal as more people become gluten-intolerant. Perhaps the breeding programs emphasizing high protein and high yield wheats has led to imbalances and deficiencies in modern wheat varieties. Spelt, an old wheat, has become a very popular product in the health food arena. Generally people who are intolerant to wheat can eat spelt. This leads us to believe that perhaps older varieties of wheat possess qualities that make them a more complete or whole food.

We are also interested in investigating the relationship between growing conditions, fertility management, and wheat quality. The addition of too much synthetic nitrogen fertilizer, particularly late applications, can produce a high protein, high yielding wheat, but much of the nitrogen present can actually be non-protein nitrogen (NPN). The fast growth and assimilation by the plant of nitrogen can cause it to accumulate as NPN in the plant, without literally having time to be converted into protein. (Dough strength, for example, is not linearly dependent on protein content but rather is a measure of inherent quality. Inherent quality is determined by the quantity and type of amino acids that make up the total protein.) The NPN is also attractive to pests and can increase the incidence of diseases, requiring the use of fungicides. On the other hand, organic fertility, originating from the building of soil organic matter, provides fertility in a slowly available fashion, allowing for protein conversion and a healthy plant.

In essence, we are seeking the balance between acceptable yields and high quality, and likewise, between practical farming considerations, and optimum genetic diversity within the farm.

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