

# **Divergent Selection For Grain Viscosity In Spring Rye.**

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## Introduction

As a cereal crop, rye (*Secale cereale* L.) is well adapted to some of the harshest growing conditions. It is a cereal tolerant of low moisture levels and performs well in less fertile, sandy soils where wheat and barley would be less vigorous. Rye is also the most cold hardy of the cereals and as such is the only cereal that can be fall-seeded with minimum risk of winterkill. Fall-seeded crops provide cover for the soil in the fall and early spring, make better use of spring moisture and provide strong competition for annual weeds. Thus in terms of a sustainable agriculture, it would be very desirable to have an increased acreage of fall rye.

Although there is some use of rye grain in certain breads, most rye is used as animal feed. However, the cell walls of rye grain contain high levels of substances known as pentosans (long molecules composed of 5-carbon sugars) which have a negative impact on animal nutrition as their length causes high viscosity which can interfere with the digestive process. Thus the use of rye, the market for rye, and hence its acreage is limited. Alternatively, for the human diet, the high levels of pentosans are a source of soluble fibre, which is increasingly being recognized as being valuable for human health.

Scoles et al. (1993) demonstrated that within rye populations there was significant variability for extract viscosity caused by the pentosans. In this project selection for both high and low viscosity was performed in spring rye. Although spring rye is unlikely to become a significant crop, breeding progress can be made much quicker than in fall rye as two generations per year can be grown with time for viscosity screening between the generations. Selection for both high and low viscosity were performed: 1) to determine to what extent viscosity can be changed and 2) to develop as rapidly as possible adequate quantities of material with low viscosity to allow feeding trials to be performed in order to establish the value of low viscosity rye in animal diets.

## Materials and Methods

### The selection procedure

In 1993, **200** plants of the spring rye cultivar 'Gazelle' were harvested and threshed out individually. Grain viscosity of each plant was estimated (see below). Approximately 160 seed from a number of plants with high viscosity and 160 seed from a number of plants with low viscosity were selected, planted in isolation in a greenhouse and allowed to open pollinate. Seed from these plants was harvested in bulk and 200 seed from each of these bulks were planted as spaced plants in the field in isolation from each other and from other rye. Grain from these plants **was** again harvested and threshed out individually. This process has been repeated over the last four years.

### Viscosity testing

The grain (approximately 3 gms) from selected rye plants was ground using a Retsch mill (.50 mm screen). initially two hundred milligrams of ground rye was mixed with 1 .0 ml of 0.10 N Na-acetate buffer (pH 5.0) per sample (a 5:1 dilution) in 1.5ml Eppendorf tubes. The samples were incubated at **40.0°C** for 30 minutes. The tubes containing the slurries were centrifuged at 13,000 x g for 10 minutes. Five hundred microlitres of the supernatant was loaded onto a Brookfield Model DVII digital viscometer (CP-40 spindle) maintained at **25.0°C** and extract viscosity measured. For all samples three readings were taken using three sub-samples of the ground material.

In order to provide sufficient differentiation among the samples, a **3:1** dilution was required for the analysis of the 1996 and 1997 low viscosity material using 300 mg of ground rye mixed with 900  $\mu$ l of 0.10 N Na-acetate buffer (pH 5.0). Similarly, for the high viscosity material, a **6:1** dilution was utilized in 1997 as at very high viscosities readings from the viscometer become unreliable. Consequently for the analysis of high viscosity material in 1997 150 mg of ground rye was mixed with 900  $\mu$ l of 0.10 N Na-acetate buffer (pH 5.0).

## Results and Conclusions

Significant progress has been made in modifying the grain extract viscosity of rye over the four generations of selection (Figure 1.) Whereas previously the viscosity levels of rye and wheat could not be measured at the same dilution levels, the low viscosity material produced by this project can now be compared too wheat using the same protocol. In fact some wheats (possibly carrying rye chromosomes) have viscosity levels higher than our some of our low viscosity samples (Figure 2.). Remnant seed from both the low and high populations grown in 1996 was planted as an increase in 1997 and will be further increased in 1998. These samples will provide significant quantities of seed with very different viscosities for use in poultry and swine feeding trials in order to evaluate the potential of this material, particularly the extent to which the feeding

problems normally associated with rye have been alleviated through genetic manipulation. Meanwhile further rounds of selection will be carried out.

The material developed in this project will also be used in studies to try and understand the biochemistry of viscosity, to investigate the effects of viscosity on baking quality and the value of low viscosity rye as a feedstock for alcohol production.

Similar advances to those made in spring rye in this project should be possible in fall rye but will take more time. If low viscosity rye appears to provide a significant increase in feed value compared to conventional rye it is possible that in the future two types of rye may be grown. Low viscosity rye as an animal feed and high viscosity rye (with high soluble fibre) for direct human consumption. In order to differentiate these two crops we would suggest that the latter be designated Ryeola !

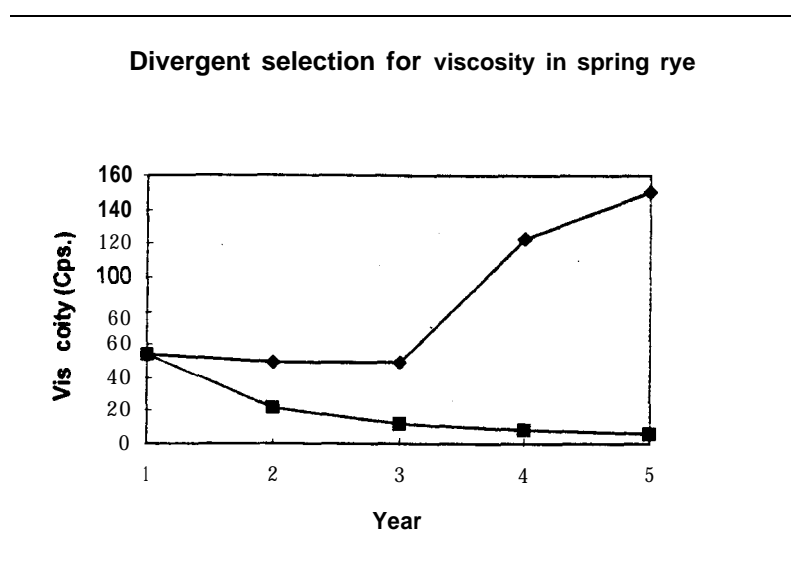


Fig. 1. Results of the divergent spring rye viscosities from the initial 'Gazelle' material planted in 1993, through subsequent generations until 1997.

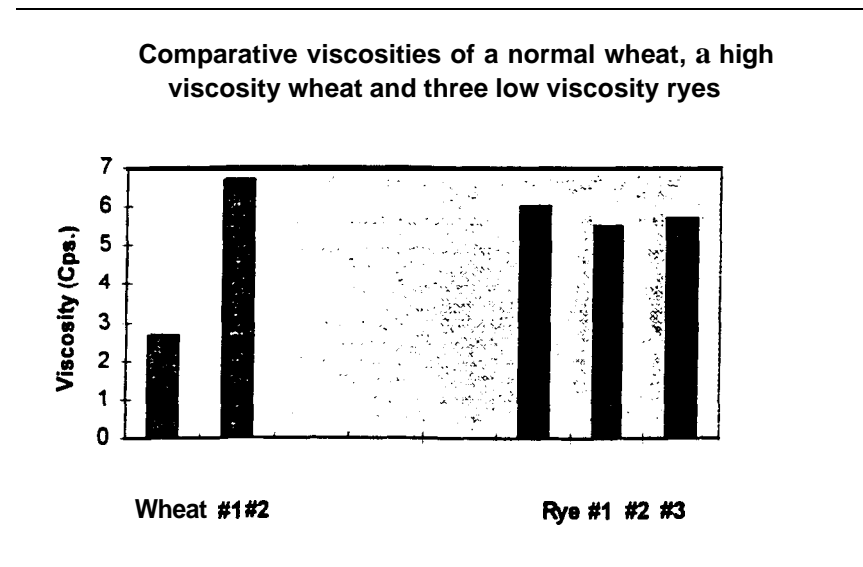


Fig. 2. The above comparison is between two wheats 'Katepwa' and '281 BWSN-121', and three low viscosity spring ryes from the 1997 population.

## References

Scoles et. al ,1993. Can.J. Plant Sci. 73: 1-6

## Acknowledgements

The work of Mr. Doug Voth in initiating the selection process and funding from the Saskatchewan Agriculture Development Fund are gratefully acknowledged.