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# A comparison of RVA and FN methods for measuring pre-germination in malting barley

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*Comparaison de l'analyse rapide de la viscosité (RVA) et de l'analyse de l'indice de chute pour mesurer le degré de prégermination de l'orge brassicole*

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# Background

Pre-germination, also referred to as pre harvest sprouting (PHS), is the initiation of germination while seeds remain attached to the parent plant. It can occur when physiologically mature barley is exposed to prolonged wet conditions prior to harvest. In the absence of sufficient dormancy, all Canadian malting barley varieties show a propensity to pre germinate under these conditions, although some varietal differences in predisposition to PHS have been observed.

Pre-germination does not negatively affect barley's germination energy (GE) right after harvest. It does, however, reduce its ability to retain GE during storage, especially under elevated temperature and humid conditions. Barley selected for malting requires a GE of 95% or greater.

If pre-germinated barley is malted shortly after harvest, it can produce good quality malt. To properly manage their supplies, barley selectors and producers need a rapid and objective test to identify sound, moderately and strongly pre-germinated barley.

# Measuring pre-germination in barley

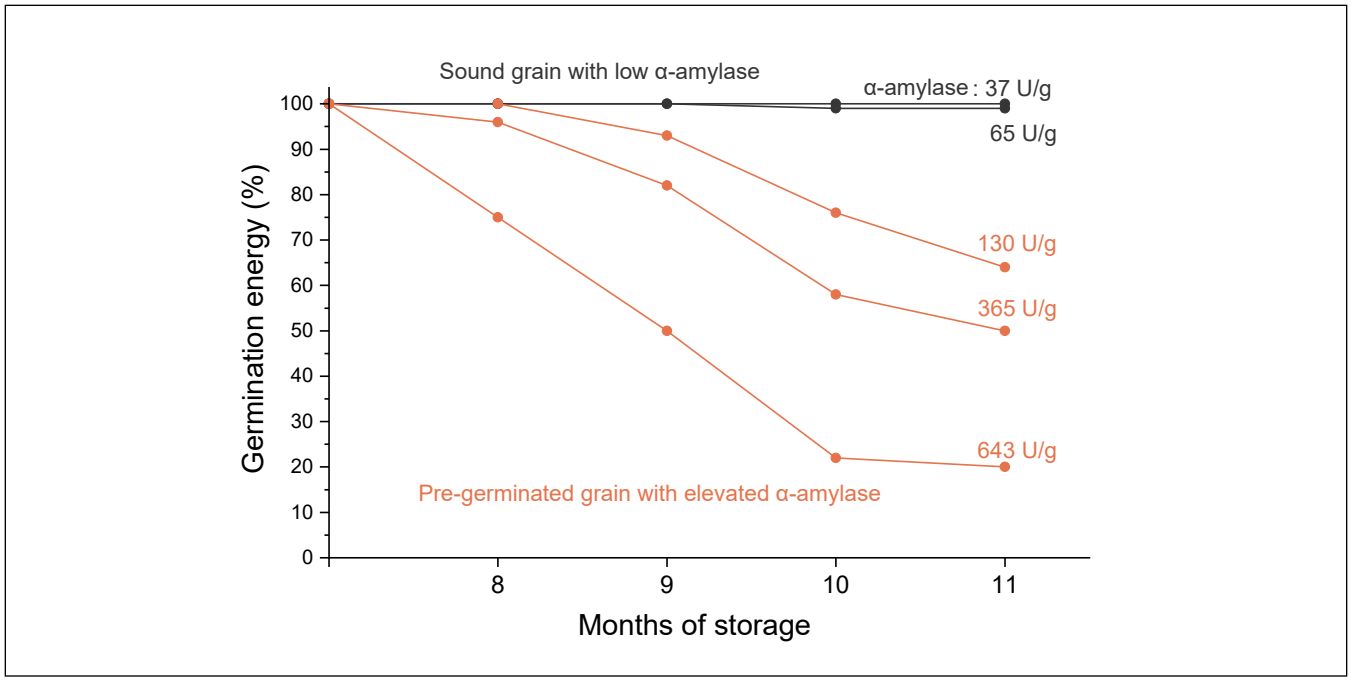
The germination energy (GE) test, commonly used to select barley for malting purposes, does not detect pre-germination in barley.

Severely sprouted grain can be identified by visual inspection, but the early stages of germination may not be visible on the kernel.

α-Amylase is one of the enzymes produced very early during the germination process. Since the level of α-amylase in sound grain is very low and increases as pre-germination progresses, the α-amylase content of grain can be used to detect and measure pre-germination (Figure 1).

Rapid Visco Analysis (RVA) is a technique that indirectly estimates the amount of α-amylase in barley and can be used to detect and measure pre-germination in malting barley.

Figure 1 Loss of GE during storage of barley with different concentrations of α-amylase




Sound barley with a low concentration of α-amylase can retain a high GE during storage. Pre-germinated barley with elevated α-amylase will lose GE during prolonged storage at the rate and extent proportional to the enzyme concentration.

# Objective tests for measuring pre-germination in malting barley

## Rapid Visco Analysis (RVA)

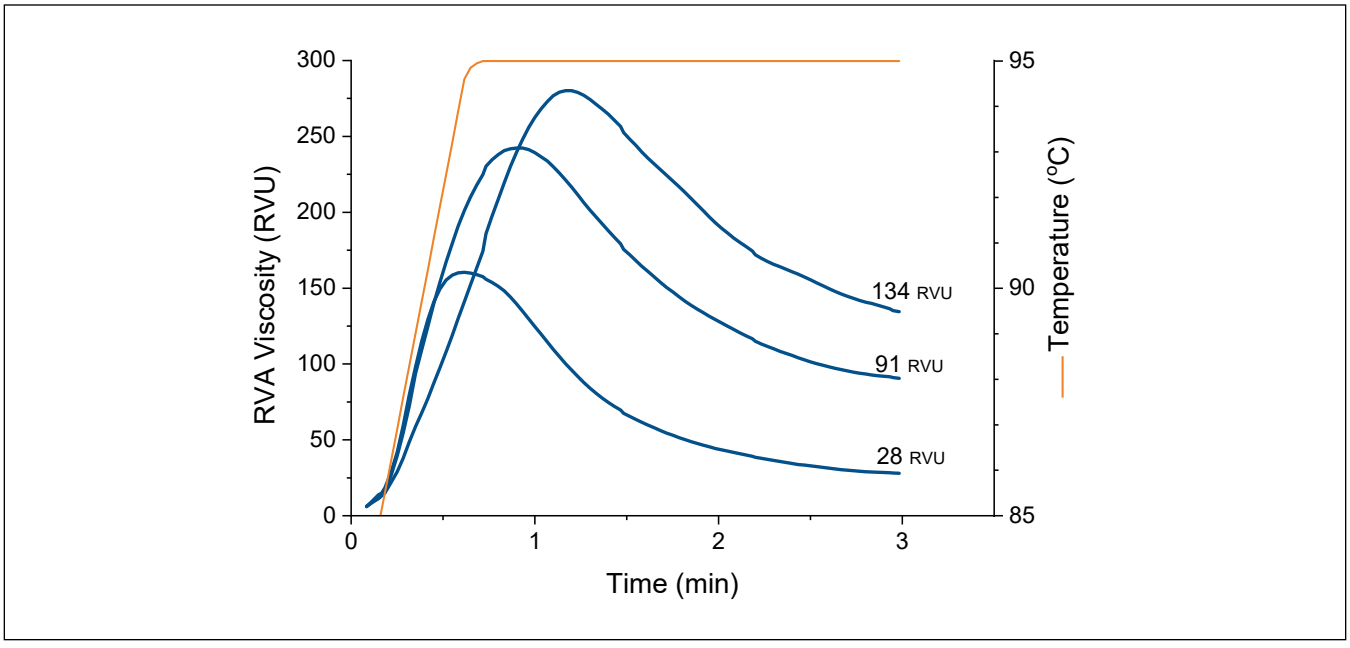
Since 2005, the Canadian Grain Commission has recommended the use of Rapid Visco Analysis (RVA) as a reliable and objective method for detecting and quantifying pre-germination in barley. According to the Canadian Grain Commission's annual harvest surveys, pre-germination in malting barley is a common occurrence, though its prevalence is heavily influenced by weather conditions during harvest. Barley selectors routinely use RVA to classify barley samples based on their degree of pre-germination.

The RVA test is based on the principle that α-amylase present in pre-germinated barley will partially hydrolyze gelatinized starch and reduce the viscosity of a barley-water mixture.

The extent of viscosity reduction is directly proportional to the concentration of α-amylase present in the grain, with higher enzyme levels leading to lower viscosity values. By monitoring changes in viscosity throughout the heating process, the RVA test provides a reliable indication of α-amylase activity and pre-germination (Figure 2).

Results from the RVA test are expressed in viscosity units, either as centipoise (cP) or rapid visco units (RVU), offering a standardized metric for measuring pre-germination in barley.

Figure 2 RVA viscosity results for three barley samples, expressed in rapid visco units (RVU)



# Falling Number (FN)

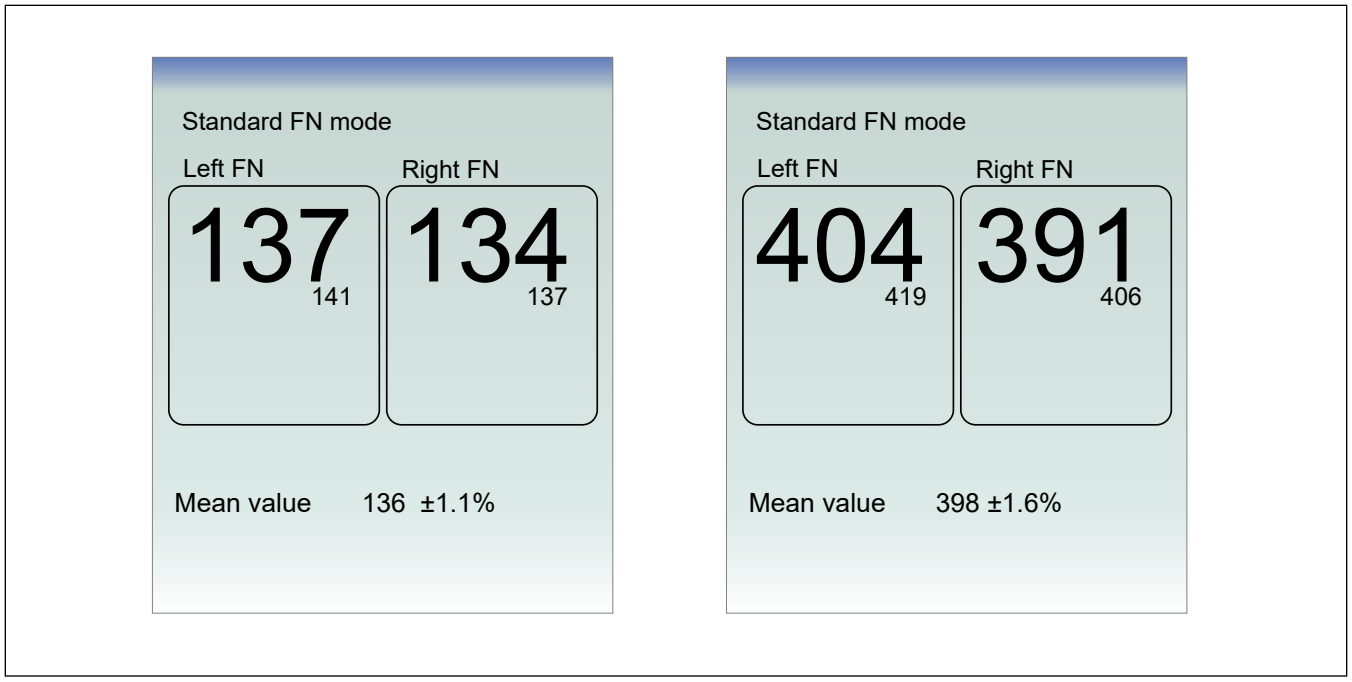
The Falling Number (FN) test is a widely used method for indirectly estimating the amount of α-amylase in grain, particularly in assessing the degree of sprouting in wheat.

The FN test is based on the principle that α-amylase present in pre-germinated barley will partially hydrolyze gelatinized starch and reduce the time it takes for a plunger to fall through a barley-water mixture due to the mixture's reduced viscosity.

The rate at which the plunger descends is inversely proportional to the concentration of α-amylase: higher enzyme levels result in lower viscosity and a shorter falling time.

The FN test records the time, in seconds, required for the plunger to pass through the heated mixture, providing a quantitative measure of α-amylase activity and pre-germination in barley.

Figure 3 Illustration of Falling Number (FN) results for two barley samples, reported in seconds



# Equipment and procedures

## Rapid Visco Analysis (RVA)

### Equipment

- RVA 4500 (PerkinElmer)
- NIR Analyzer with barley moisture calibration
- Lab Mill 3100 (PerkinElmer) with 0.8 mm screen

### Procedure

1. Determine moisture content in grain
2. Grind grain to pass through 0.8 mm sieve
3. Weigh 4 g (14% mc) into RVA canister
4. Add 25 ml of water
5. Mix with spatula and insert a paddle
6. Affix the canister on the RVA instrument
7. Record the final viscosity after 3 minutes of testing

Weigh 4 g (14% mc) into RVA canister

Add 25 ml of water

Mix with spatula and insert a paddle

Affix the canister on the RVA instrument

# Falling Number (FN)

## Equipment

- Falling Number 1000 (PerkinElmer) and ShakeMatic SM 1095
- NIR Analyzer with barley moisture calibration
- Lab Mill 3100 (PerkinElmer) with 0.8 mm screen

## Procedure

1. Determine moisture content in grain
2. Grind grain to pass through 0.8 mm sieve
3. Weigh two 7 g (14% mc) ground samples into long tubes
4. Add 25 ml of water to each tube
5. Shake tubes in the ShakeMatic
6. Place tubes in the FN instrument
7. Record the time after completion of the test

Weigh two 7 g (14% mc) ground samples into long tubes

Add 25 ml of water to each tube

Shake tubes in the ShakeMatic

Place tubes in the FN instrument

# Correlation between RVA and FN tests

The Grain Research Laboratory conducted a study to evaluate the reliability of the FN test in detecting and measuring pre-germination in barley.

Barley samples from 2021, 2023 and 2024 were tested in the Grain Research Laboratory using RVA and FN methods. We found a strong correlation between RVA results and FN results (Figure 4), suggesting that FN is also a dependable tool for assessing pre-germination in barley.

Table 1 shows how RVA and FN results correspond to the risk of losing germination energy during storage of barley. Samples with high RVA and FN values are considered sound and have a low risk of losing germination energy during storage, whereas strongly pre germinated samples show low RVA and FN values and are at high risk of losing germination energy and should be malted as soon as possible.

Figure 4 Correlation between FN and RVA results for malting barley

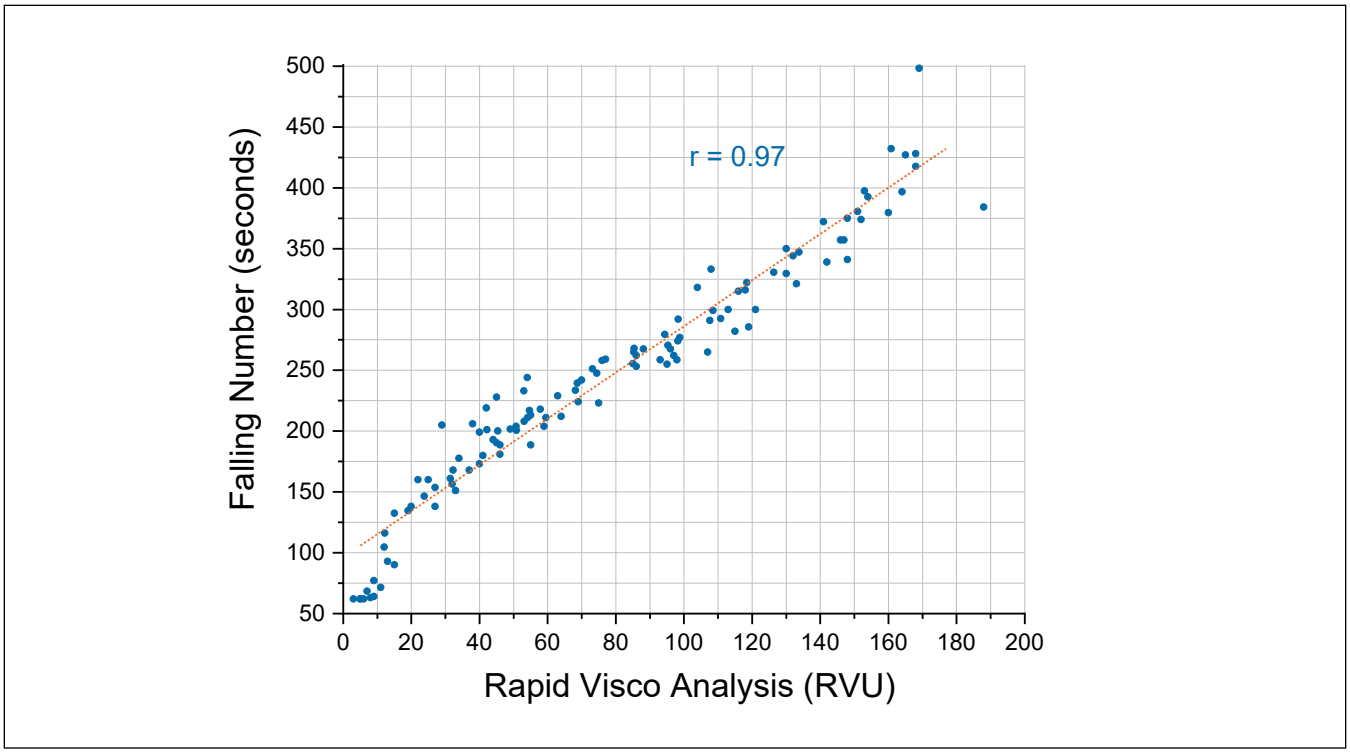


Table 1 Interpretation of RVA and FN results

| Risk of germination loss in storage | RVA viscosity (RVU) | FN (seconds) |
|---|---|---|
| Low | ≥ 120 | > 340 |
| Intermediate | 50 to 120 | 240 to 340 |
| High | < 50 | < 240 |

## Sources of variation in measurements

- Analytical: repeatability of duplicate analysis of same subsample
  RVA: ± 1 to 6 RVU
  FN: ± 1 to 15 seconds
- Biological: grain can originate from different parts of a field and is not homogeneous in terms of moisture, maturity and degree of pre-germination.

# Conclusions

The study demonstrated a strong correlation between RVA and FN results, indicating that FN provides a robust alternative tool for detecting and quantifying pre harvest sprouting in malting barley.