Critical Grading Factors & their Impact on Wheat, Flour & End Product Quality

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Wheat - End Users' Quality Requirements

- Protein Quality
- Protein Content
- Milling Properties
- Water Absorption
- End Use Properties

Wheat-End Users' Quality Requirements

These quality traits can be built into wheat varieties through traditional varietal development process to ensure that the starting material (seeds) have all the right attributes as they are being planted.

- Protein Quality
- Protein Content
- Milling Properties
- Water Absorption
- End Use Properties

Environmental Influence on Wheat Quality

Wheat quality is very much influenced by the environment.
The intrinsic quality of wheat cited earlier can all be positively or negatively influenced by environmental causes.

Environmental impacts of weathering , disease and insect damage influence the quality negatively.

Environmental Influence on Wheat Quality

Environmental influences are controlled through grading factors. These influences generally result in impacting physical condition/appearance of the wheat. This allows visual grading system to function reasonably well as the extent of damage relates well to the visual assessment. The tolerance levels for damaged and diseased wheat kernels are based on scientific tests to determine their impact level for assigning of appropriate numerical grade. Thus a grade is associated with level of damage that is impacting the quality.

Wheat Quality

- Foreign Material
- Test Weight
- Damaged
  and Diseased Kernels
- Shrunken and Broken Kernels
- Contrasting Classes
- Protein Quality
- Protein Content

Wheat Quality

- Foreign Material
- Test Weight
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  and Diseased Kernels
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Grade

- Protein Quality

Class

- Protein Content

Protein Segregation

Wheat Quality – Grading Factors

This presentation will review some of the gracing factors of high importance for their negative impact on quality to help provide an understanding of their relative relevance and with ways to mitigate their impact.

Wheat Quality – Physical condition

Damaged and Diseased Kernels

Midge:

Loss of flour yield

Impact on color & specks

Weakening influence on dough properties

Grading Factors – Ergot

Ergot

Ergot is primarily undesirable due to its toxicological aspect.

Apart from the edibility issues from aesthetics standpoint as well it is not desirable to have dark specks in flour or semolina.

In recent years the tolerance levels have been relaxed to reflect the easier removal of it using modern cleaning equipment such as optical sorters and high efficiency gravity separation based equipment

Ergot Tolerances - CWRS

Grades	Before 2014	After 2014
1 CWRS	0.01	0.04
2 CWRS	0.02	0.04
3 CWRS	0.03	0.04
Feed	0.1	0.1

Grading Factors – Hot and Dry Condition

1 **CWRS**

CWFD

Grading Factors – Hot and Dry Condition

WHEAT (13.5% mb)	CWFD	1 CWRS
Test weight, kg/hL	76.3	84.2
Weight per 1000 kernels, g	23.6	38.8
Protein , %	17.0	13.4
Falling number, s	464	362
Ash content, %	1.57	1.49
Particle size index,%	53	53

Grading Factors – Hot and Dry Condition

MILLING YIELD	CWFD	1 CWRS
Flour yield (total products basis), %	73.2	75.8
Flour yield (0.50% ash basis), %	71.6	76.9
FLOUR (14.0% mb)		
Protein, %	16.2	13.0
Wet gluten, %	46.0	37.3
Ash, %	0.53	0.48
Colour - L*	83.7	85.1
Starch damage, UCD	21.1	23.5
Amylograph peak viscosity, BU	886	842

Grading Factors – Hot and Dry Condition

FARINOGRAM	CWFD	1 CWRS
Absorption, %	67.7	65.6
Dough development time (DDT), min	8.8	4.1
Stability, min	14.0	12.1
Mixing tolerance index (MTI), BU	22	20

Grading Factors – Hot and Dry Condition

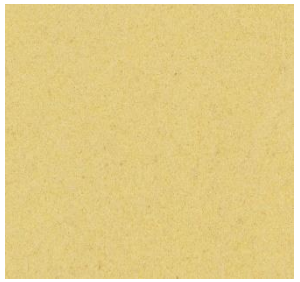
EXTENSOGRAM	CWFD	1 CWRS
Rmax, BU	536	421
A, cm2	149	121
E, mm	213	222
Rmax/E	2.5	1.9

Grading Factors – Hot and Dry Condition

ALVEOGRAM	CWFD	1 CWRS
P (height x 1.1), mm	105	108
L, mm	102	86
P/L	1.03	1.26
W,10^{-4} J	398	340

No. 1 CWAD

No. 4 CWAD



Grading Factors – Hot and Dry Condition

WHEAT (13.5% mb)	**No. 4 CWAD**	**No. 1 CWAD**
Test weight, kg/hL	76.7	82.3
Weight per 1000 kernels, g	33	45
Protein , %	17.7	13.0
Falling number, s	583	523
Ash content, %	1.79	1.40
Particle size index,%	40	42

Grading Factors – Hot and Dry Condition

	No. 4 CWAD	**No. 1 CWAD**
MILLING YIELD		
Semolina yield, %	60.8	66.7
Total yield , %	64.7	70.8
Semolina (14.0% mb)		
Protein, %	17.0	12.2
Wet gluten, %	43.9	32.9

Grading Factors – Hot and Dry Condition

	No. 4 CWAD	**No. 1 CWAD**
Ash, %	0.89	0.65
Minolta colour - L*	83.6	85.3
a*	-2.08	-2.22
b*	34.1	27.9
Yellow pigment content, ppm	13.7	8.6
Speck Count		
Total Specs, per 100 cm^2	13	23
Dark Specs, per 100 cm^2	6	8

Grading Factors – Hot and Dry Condition

	No. 4 CWAD	**No. 1 CWAD**
ALVEOGRAM		
P (height x 1.1), mm	103	91
L, mm	56	65
P/L	1.84	1.40
W,10^{-4} J	186	198

Heat Stress

Under the above condition often quality of wheat suffers from heat stress.

The implications of such impact has overall very similar end result as in frost damage conditions.

These similarities have prompted CGC to combine the two factors as one under frost and heat stress.

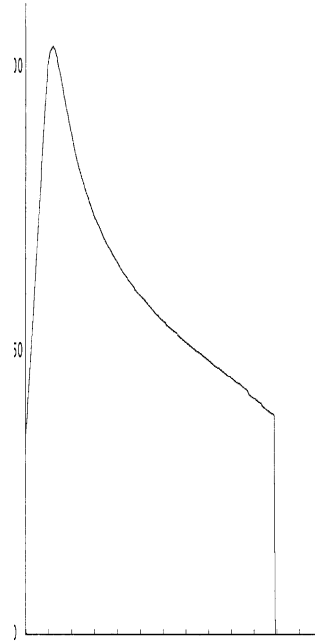
Grading Factors – Frost

Kernel texture becomes
Very hard due to weather
related damage resulting in

- Higher starch damage,
- Reduced flour yield,
- Higher flour ash content
- Poor flour colour

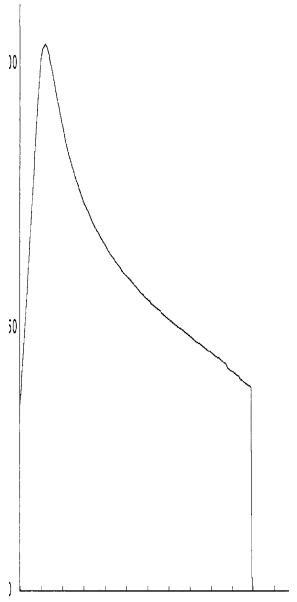
Grading Factors – Frost

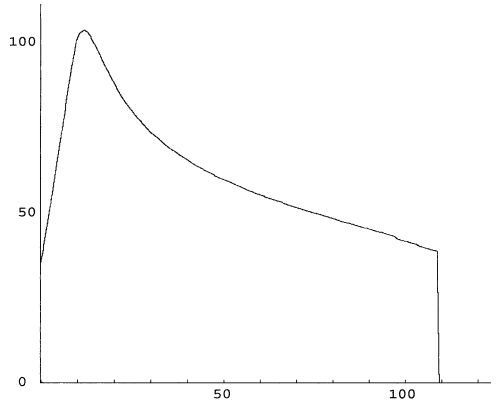
Due to elevated level of starch damage the Alveograph “P” value shows a higher value coupled with a lower “L” value suggesting strong dough properties.



Grading Factors – Frost

Based on such assumption treating flour with a reducing agent is not a right approach as the underpinning reason for the shape of the curve is stiffer dough on account of higher level of starch damage and not due to stronger gluten properties.





Frost & Heat Stress Damage
Influence on Amylograph Data

Properties	Grades			
	Western Prairies 2014	Eastern Prairies 2014	Western Prairies 2015	Eastern Prairies 2015
	No. 3 CWRS	No. 3 CWRS	No. 3 CWRS	No. 5 CWAD
Falling number, s	321	309	279	378
Amylograph peak viscosity, BU	275	375	121	272

Frost & Heat Stress Damage
Influence on Amylograph Data

Properties	Grades			
	Western Prairies 2014	Eastern Prairies 2014	Western Prairies 2015	Eastern Prairies 2015
	No. 3 CWRS	No. 3 CWRS	No. 3 CWRS	No. 5 CWAD
Falling number, s	321	309	279	378
Amylograph peak viscosity, BU	275	375	121	272
Reason for downgrading	FRHTS, GR, Mildew	Mildew	FRHTS, Mildew	FRHTS, Mildew

Grading Factors - Sprout Damage

- Sticky dough
- Dark crust color
- Higher gas production
- Reduced loaf volume

Grading Factors – Severely Sprout Damaged

Much higher level of α-amylase

activity. Therefore much more pronounced effect in terms of

sticky dough, dark crust color

higher gas production and

reduced loaf volume

Sprout Damage Tolerances - CWRS

Grade	Tolerance (2001), % Max.		Tolerance prior to 2001 Max.	
	Total sprout damage, %	Severely sprout damaged, %	Total sprout damage, %	Severely sprout damaged, %
No 1 CWRS	0.5	0.1	0.5	0.1
No 2 CWRS	1.0	0.2	1.5	---
No 3 CWRS	3.0	0.3	5.0	---

Conversion of Falling Number into liquefaction Number

LINEAR NUMBERS ARE THOSE THAT FOLLOW MATHEMATICAL RULES FOR EXAMPLE, FALLING NO. IS NOT LINEAR BUT LIQUEFACTION NUMBER IS WHICH IS AS FOLLOWS:

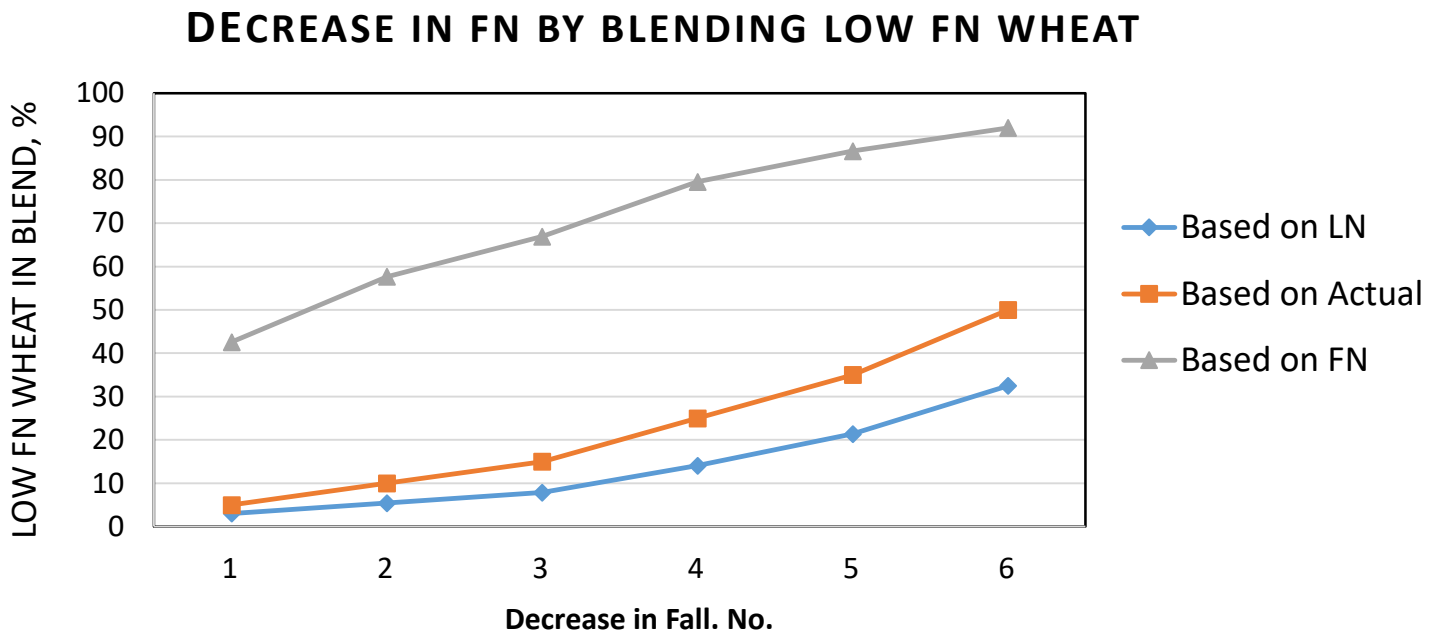
$$L.N. = \frac{6000}{F.N. - 50}$$

Wheat Blending to Target Falling Number – Basis Actual Fall. No., Liquefaction No. and Calculated Falling No.

		Blend Basis, %		
Fall. No.	Lq. No.	Lq. No.	Actual	Fall. No.
304	23.6	3	5	43
242	31.3	5	10	58
204	39.0	8	15	67
152	58.8	14	25	80
123	82.2	21	35	87
101	117.6	32	50	92

Data Source: B.X.Fu et al, Can. J. Plant Sci. 2014

Wheat Blending to Target Falling Number – Basis Actual Fall. No., Liquefaction No. and Calculated Falling No.

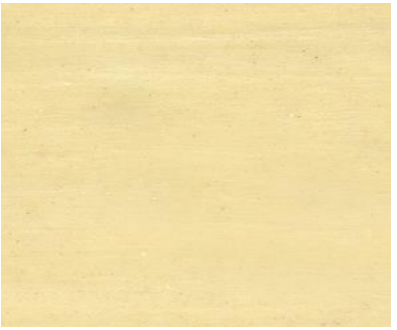


Falling Number Specification for Time Dependent Doughs

Wheat flour required for the production of fresh noodles and even unleavened flat breads made from prepared doughs require a falling number specification of 300 sec. min.

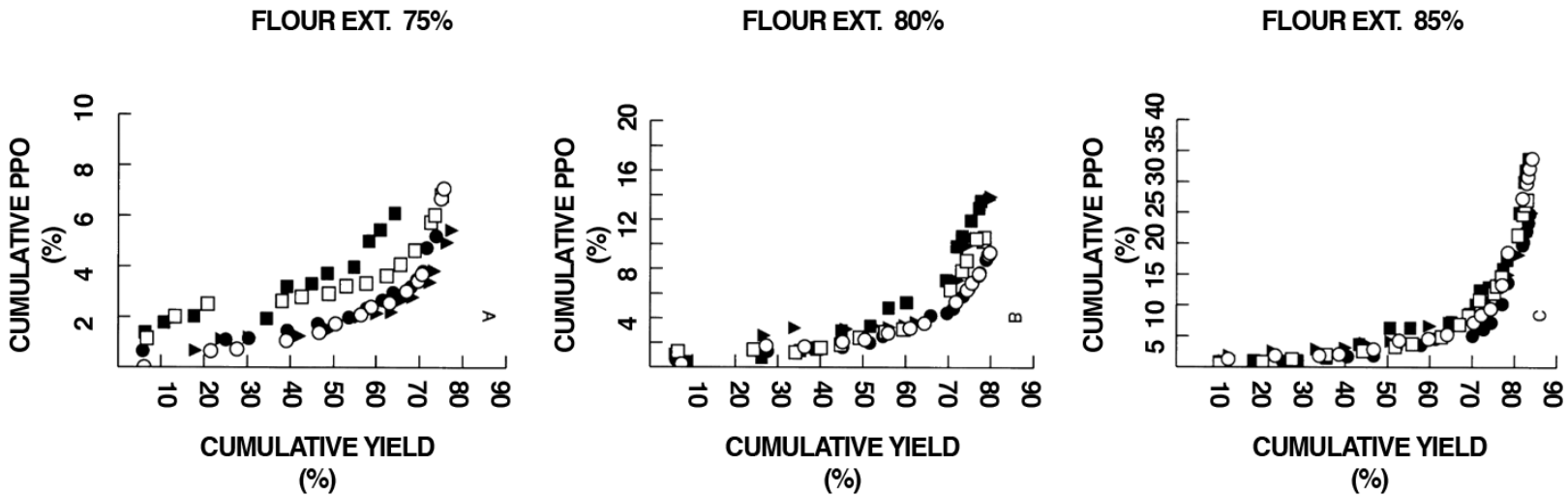
This is primarily due to the fact that a high level of α-amylase activity can be an indication of a high level of other enzymatic activity that promotes discoloration of the dough.

3.00 hrs



24.00 hrs

CUMULATIVE FLOUR YIELD / PPO



D. Hatcher & J. Kruger, Cereal Chem.

Grading Factors – Mildew

- Mildew

- Associated with sprout damage
- Dark flour color
- Resulting in dark crumb color
- Poor end product color

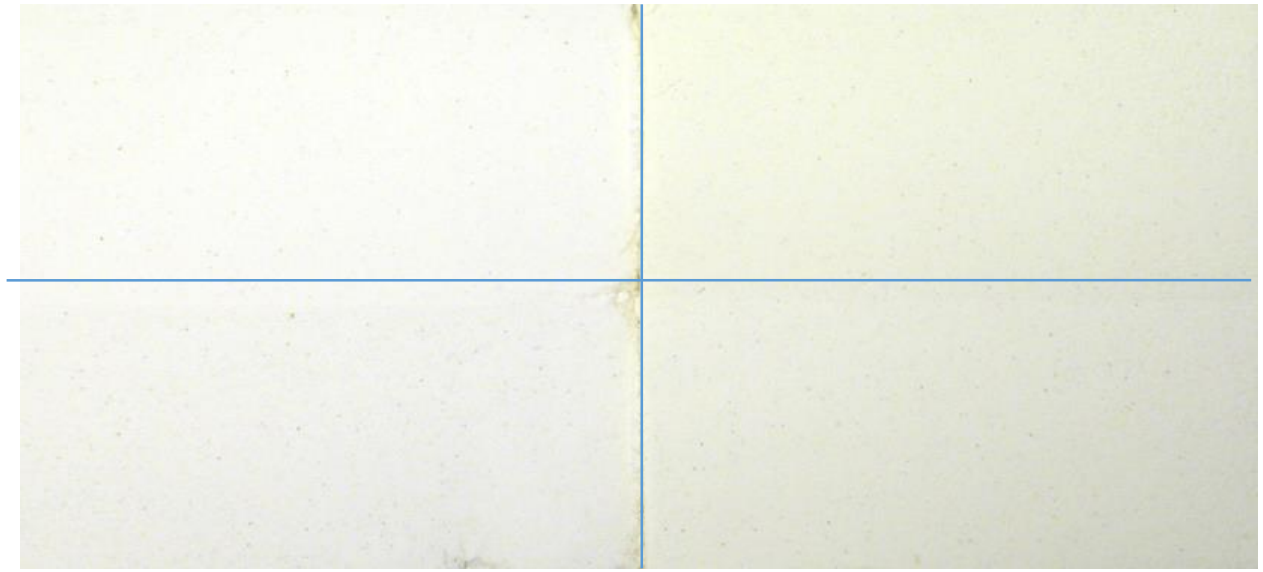
Grading Factors – Mildew impact on colour

New Crop 2002 - 2003

Mildew

Bleached flour

Bleached flour (Mildew)



Unbleached flour

Unbleached flour (Mildew)

Grading Factors – Fusarium

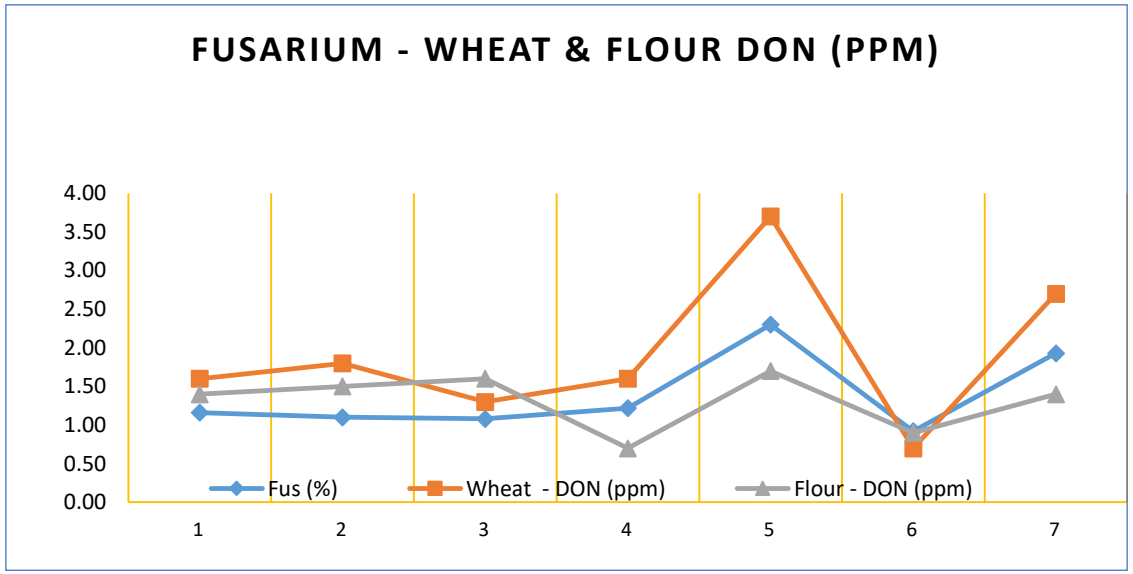
Fusarium Damage

- Apart from the edibility issues it
- Also reduces flour yields
- Poor flour colour
- Reduces flour functionality
  due to weaker dough properties
- Impacts end product quality

Fusarium Damage Tolerances - CWRS

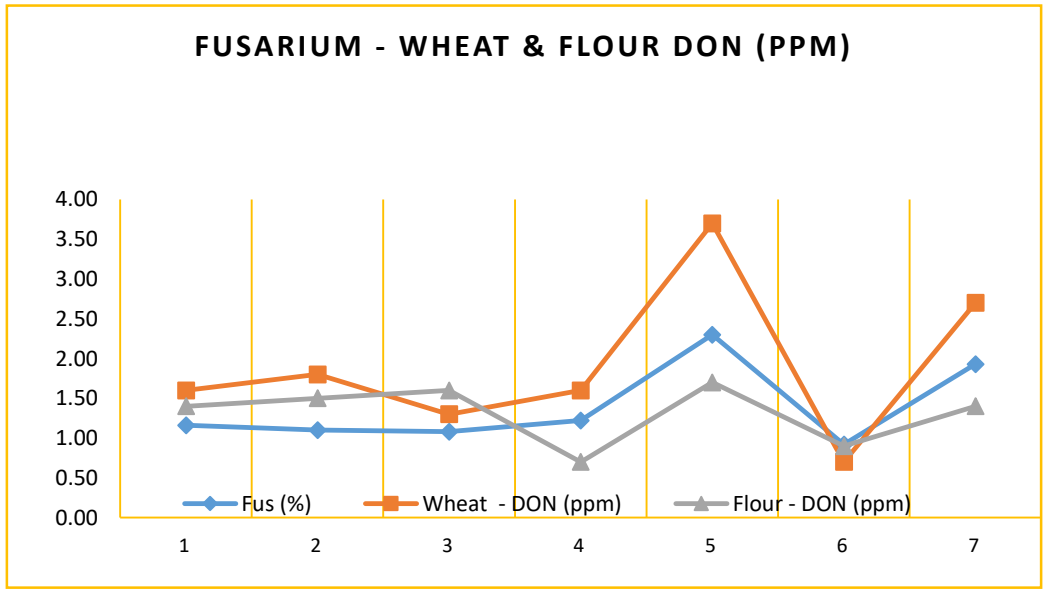
Grade	Tolerance (2010), %	Tolerance prior to (2010)
	Total Fusarium damage max., %	Total Fusarium damage max., %
No 1 CWRS	0.25	0.25
No 2 CWRS	0.8	1.0
No 3 CWRS	1.5	2.0

Fusarium Damage (%), Wheat & Flour DON (ppm) levels

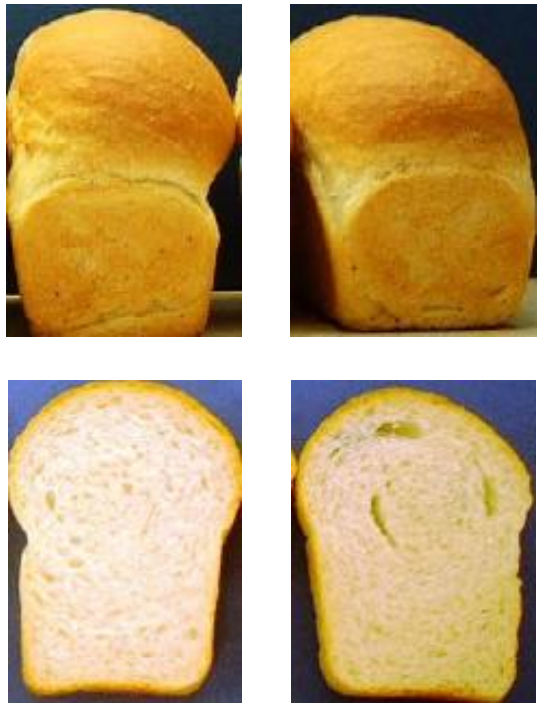


Fusarium Damage (%), Wheat & Flour DON (ppm) levels

Fus (%)	Wheat - DON (ppm)	Flour - DON (ppm)
1.16	1.6	1.4
1.10	1.8	1.5
1.08	1.3	1.6
1.22	1.6	0.7
2.30	3.7	1.7
0.92	0.7	0.9
1.93	2.7	1.4



Fusarium Damage – Influence on End product



Grading Factors – HVK

- HVK

Genetics and weather both influence HVK.

Prolonged cooler growing period could contribute to lower HVK.

Higher HVK is an important requirement for durum wheat as higher HVK is equated to higher semolina yield.

It is an important requirement for hard red spring wheat as well.

Higher HVK also means higher protein content and hard kernel texture also helps in generating desirable level of starch damage that helps in improved water absorption.

HVK – Influence on Protein, Hardness & Semolina Yield (CWAD)

Grades	1 CWAD	2 CWAD
HVK, %	93	72
Protein, %	14.4	14.0
Semolina Yield, %	66.6	64.9
PSI, %	37	40

Conclusion

In order to ensure high quality in wheat it is critical to have high quality varieties to begin with. While there is nothing much that can be done to control environment its negative impact can be managed through a good functional grading system that is capable of allocating appropriate grades to wheat based on quality that resonates with performance and protecting the quality expected of the grade.

A resilient system with scientific sub structure can achieve these goals on an ongoing basis.

Acknowledgement

CGC industry services support is much appreciated in providing samples

CIGI milling department help in milling samples and CIGI's analytical services department help in analyzing the samples are also very much appreciated

Stephen Hunter's (CIGI) help with Graphics support is also very much appreciated.