Milling and baking qualities of weathered soft wheats

Effects of pre-harvest sprout

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Weather is always a challenge beyond our control

"Strange weather patterns persist with snow only falling on states whose names start with an 'N.'"

"Should we blame this on the church or the state?"

Weathering

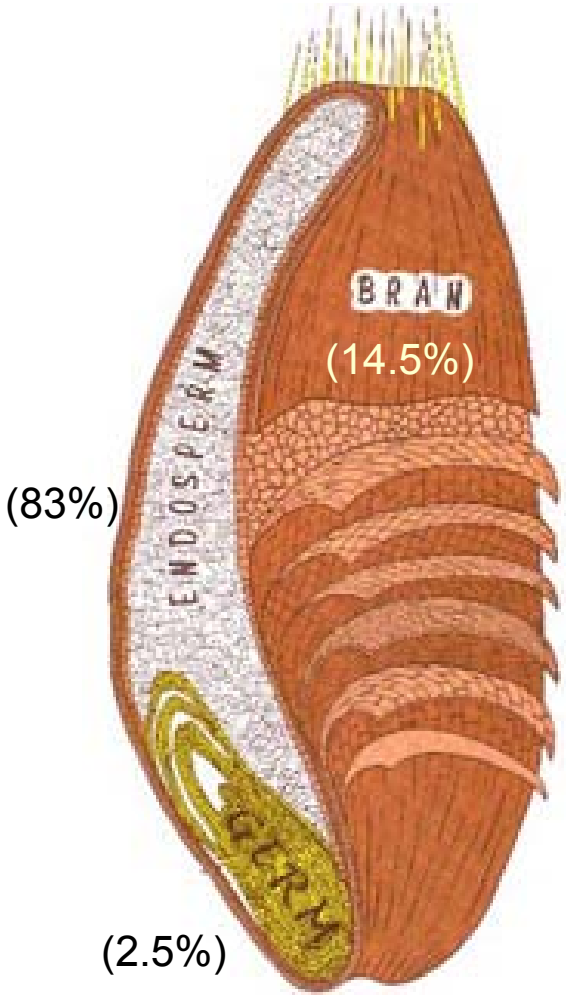
Wheat affected by exposure to the action of the weather

- Decrease density of grain associated with swelling caused by wetting.
- Reduce test weight.
- Loss of grain sheen and color – faded, roughened appearance.
- Pre-harvest sprouting, if wet weather condition persists.
- Internal fissuring of wheat kernel caused by cycles of wetting and drying.

Pre-harvest sprouting (PHS)

- Before harvest, wheat begins to germinate within the grain head, when wet weather conditions persist.
- White varieties are more susceptible to PHS than red ones, under similar environmental conditions.
- Genotypes with a short dormancy period show a higher risk of PHS.
- Hydrolytic enzyme activities (α-amylase, protease, and arabinoxylanase) increase.
- Grain yield and quality decrease – downgraded wheat and discounted price result in economic losses.

A kernel of wheat



Composition of flour

Water	**13 – 14 %**
Starch	**70 – 75 %** ←
Protein	**9 – 14 %** ←
Arabinoxylans	**< 2 %** ←
Fat	**< 1%**
Ash	**< 1 %**

Effects of weathering & PHS on soft wheats

- The effects of preharvest sprouting on soft white wheat milling and baking characteristics of sugar-snap cookies were relatively minor, even with high levels of sprouting damage (Sorrells et al 1989).
- Soft wheats puffed by weathering increased break flour yield, but didn't affect milling yield (Gaines et al 1998).
- Soft red winter wheats with weather damage due to delayed harvest decreased flour falling number and Farinograph breakdown time (Farrer et al 2006).
- Sponge cake volumes of cakes made with soft white winter wheats are acceptable when falling numbers are in the range from 400 to 140. As falling numbers decreased below 140, cake volumes decreased sharply (Finney et al 1981).

Experimental samples

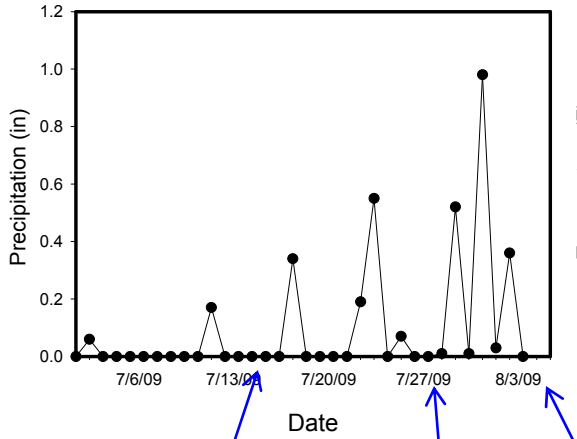
(1 SWW & 11 SRW cultivars, grown in Wooster, 3 harvest times)

Cultivar	Class	Spike	Plant height	Maturity
Chelsea	SWW	Awned	Medium tall	Late
Pat	SRW	Awned	Medium	Medium Late-Late
Kristy	SRW	Awnless	Medium	Medium Early-Medium
Crousty	SRW	Awnless	Very short	Late
Daisy	SRW	Awnless	Medium	Medium
Hopewell	SRW	Awnless	Medium	Medium-Late
McCormick	SRW	Awnless	Medium short	Medium
Neuse NC	SRW	Awnless	Medium	Medium
Patterson	SRW	Awnless	Medium	Medium
Red Giant	SRW	Awnless	Medium	Medium
Roane	SRW	Awnless	Medium short	Medium
Severn	SRW	Awnless	Tall	?

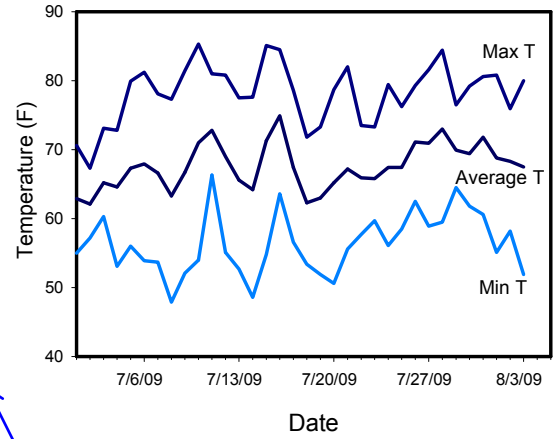
Weather and harvested time

(Wooster, OH)

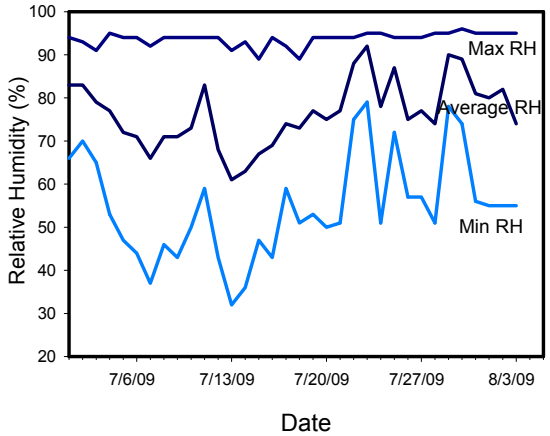
Rain precipitation



Temperature



Relative humidity



1st harvest
(7/15/09)

2nd harvest
(7/27/09)

3rd harvest
(8/3/09)

Analyses of the samples

- Visual evaluation
- Milling – flour with Miag and Quad. Jr.
- Falling number (FN) – flour and wheat meal
- α-Amylase analysis – with Amylazyme method
- Viscosity analysis with Rapid ViscoAnalyzer (RVA)
- Solvent Retention Capacity (SRC)
- Baking – cookies, crackers, pancakes, sponge cakes

Visual evaluation

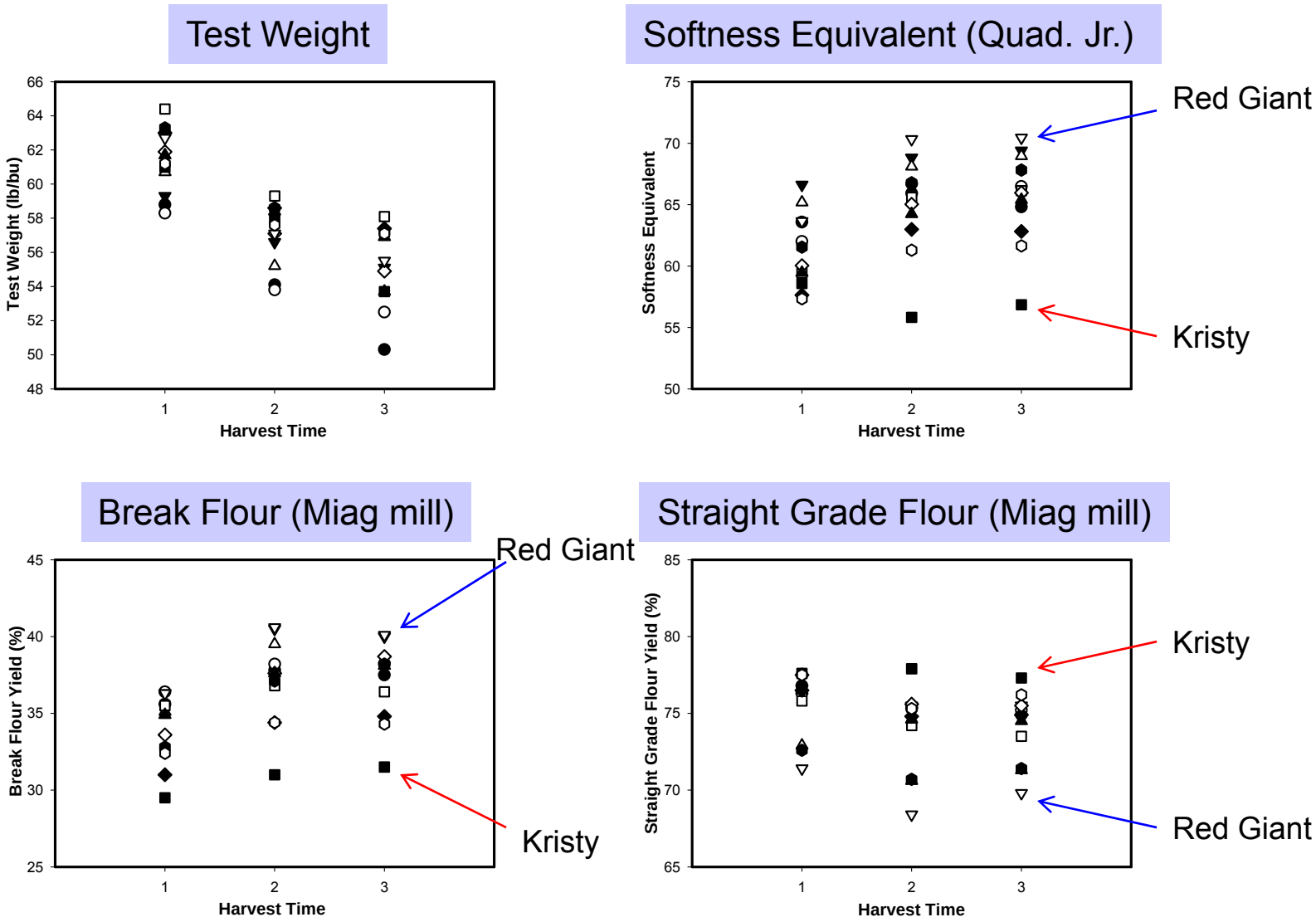
Cultivar	1st harvest (7/15/09)	2nd harvest (7/27/09)	3rd harvest (8/3/09)
Chelsea	**-**	**+++**	**++++**
Pat	**-**	**+++**	**++++**
Kristy	**-**	**+++**	**++++**
Crousty	-	?	++
Daisy	-	-	?
Hopewell	-	+	+
McCormick	-	?	+
Neuse NC	-	-	+
Patterson	-	-	+
Red Giant	-	?	+
Roane	-	+	+
Severn	-	-	?

Note: -, sound; ?, uncertain; +, slightly sprouted; ++, some sprouted; +++, significantly sprouted; ++++, heavily sprouted

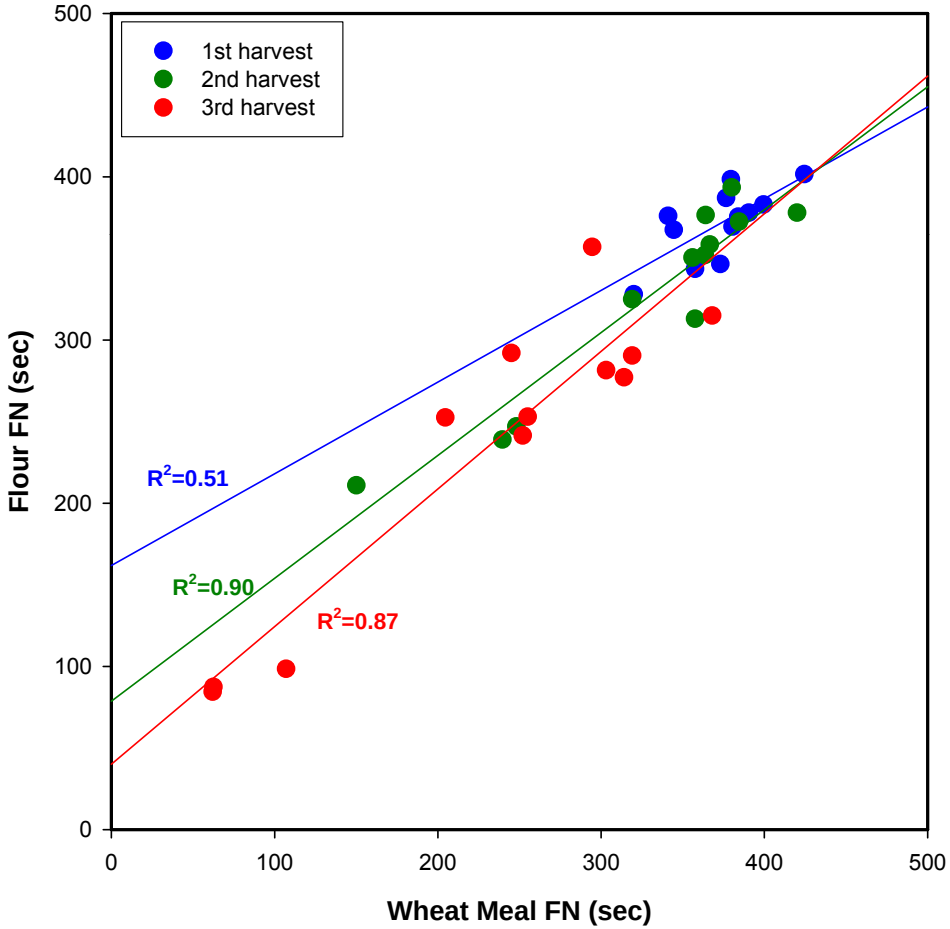
Color of weathered/sprouted soft wheats

	1st harvest	2nd harvest	3rd harvest
Chelsea (SWW)`			
L*	63.8	63.0	61.8
a*	9.0	7.8	7.7
b*	33.5	29.6	28.3
Pat (SRW)			
L*	56.8	57.6	57.2
a*	11.5	10.0	9.4
b*	30.1	26.5	25.2

Kernel and milling quality

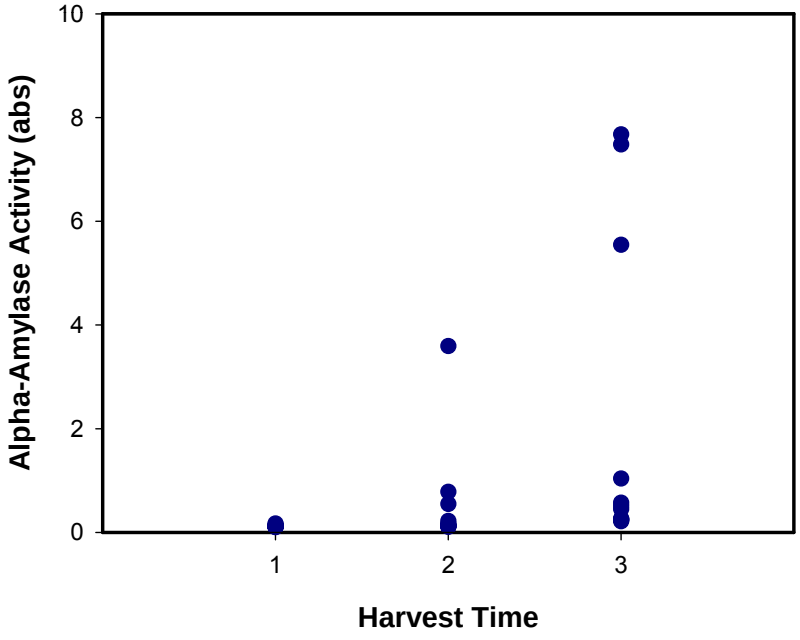


Falling numbers of whole meals and flours

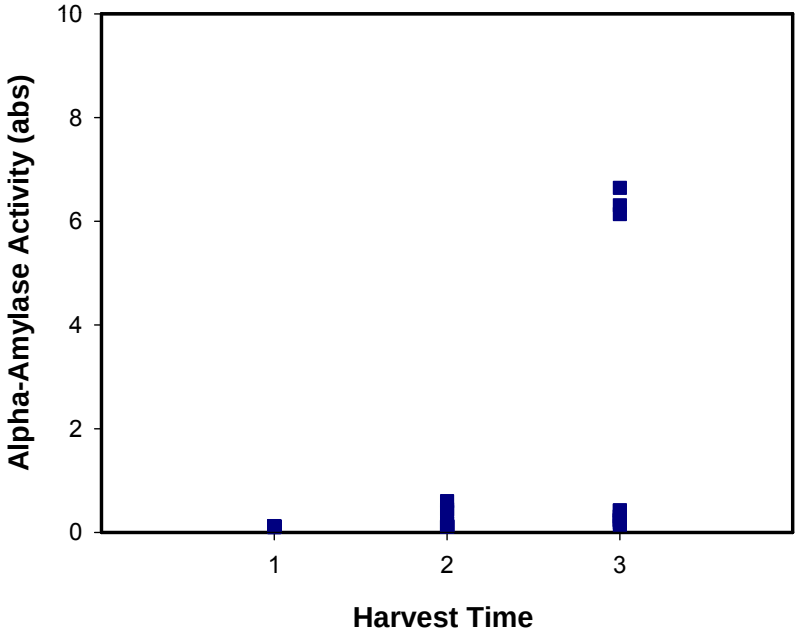


Alpha-amylase

Whole meal

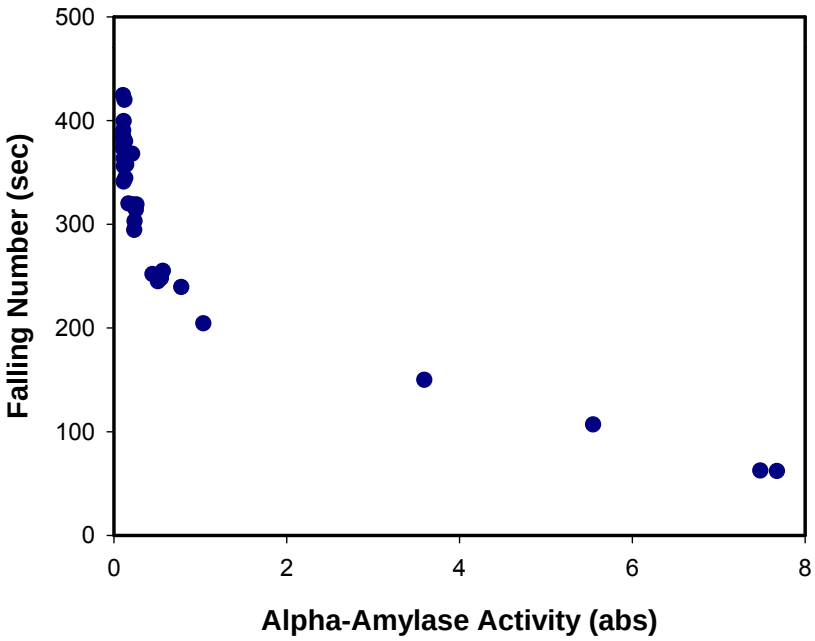


Flour

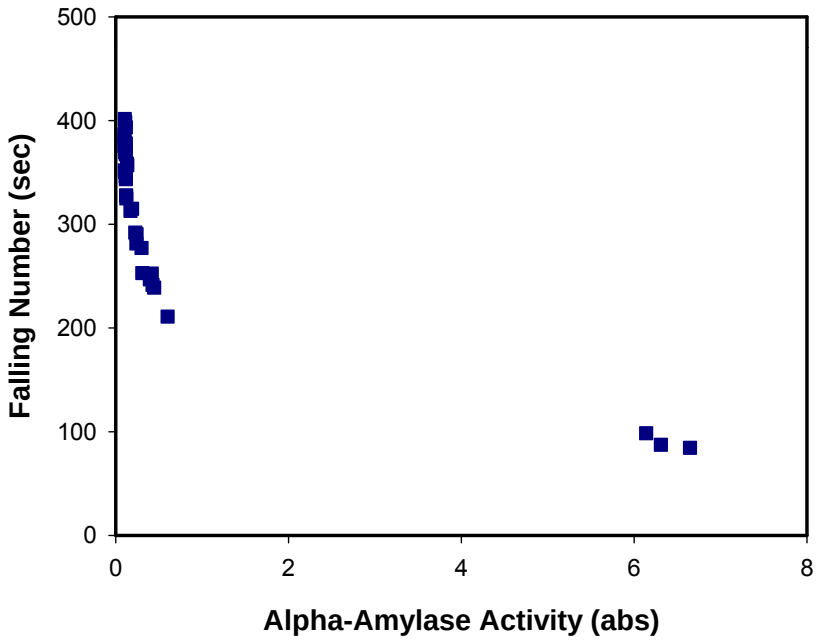


Alpha-amylase vs falling number

Whole meal

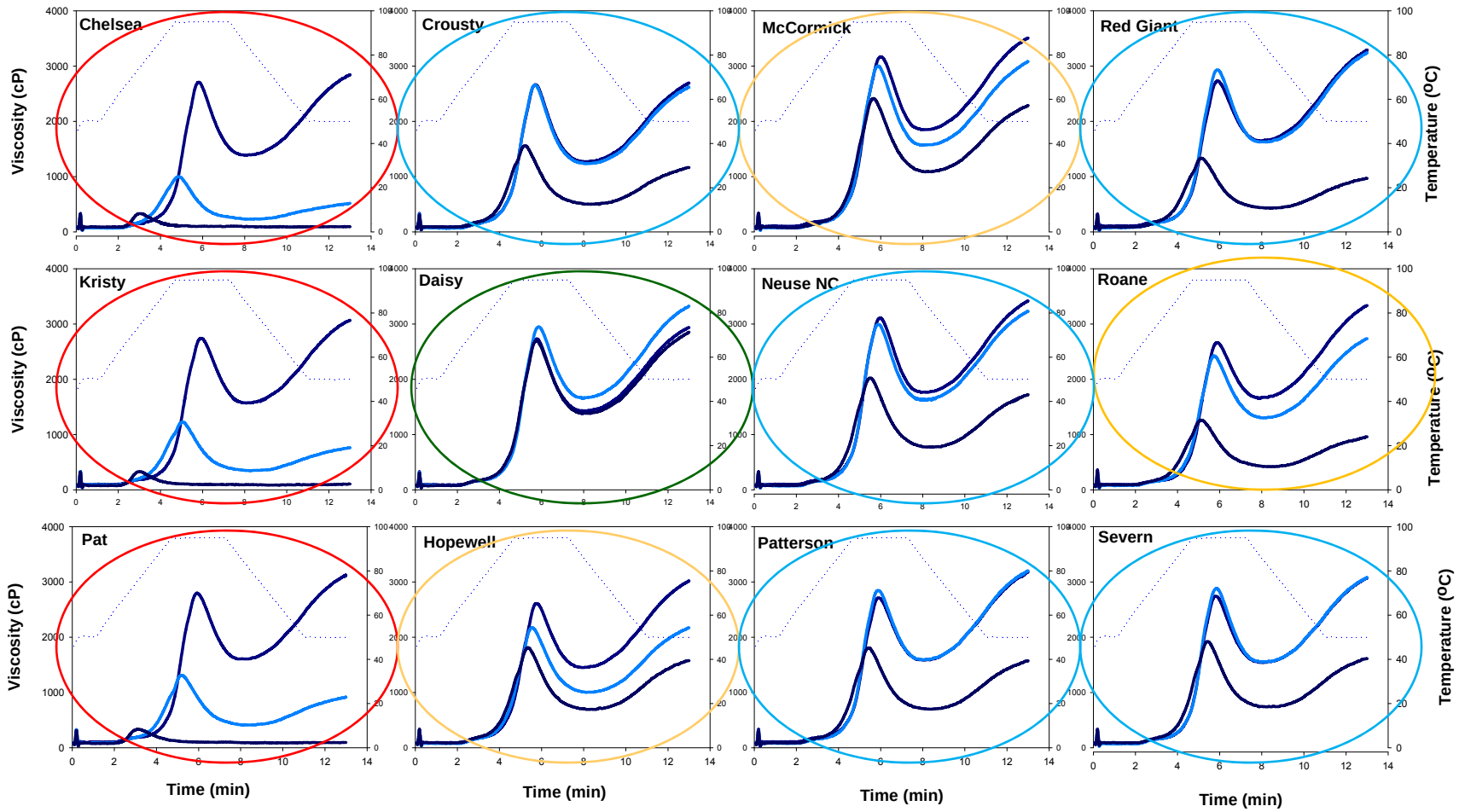


Flour

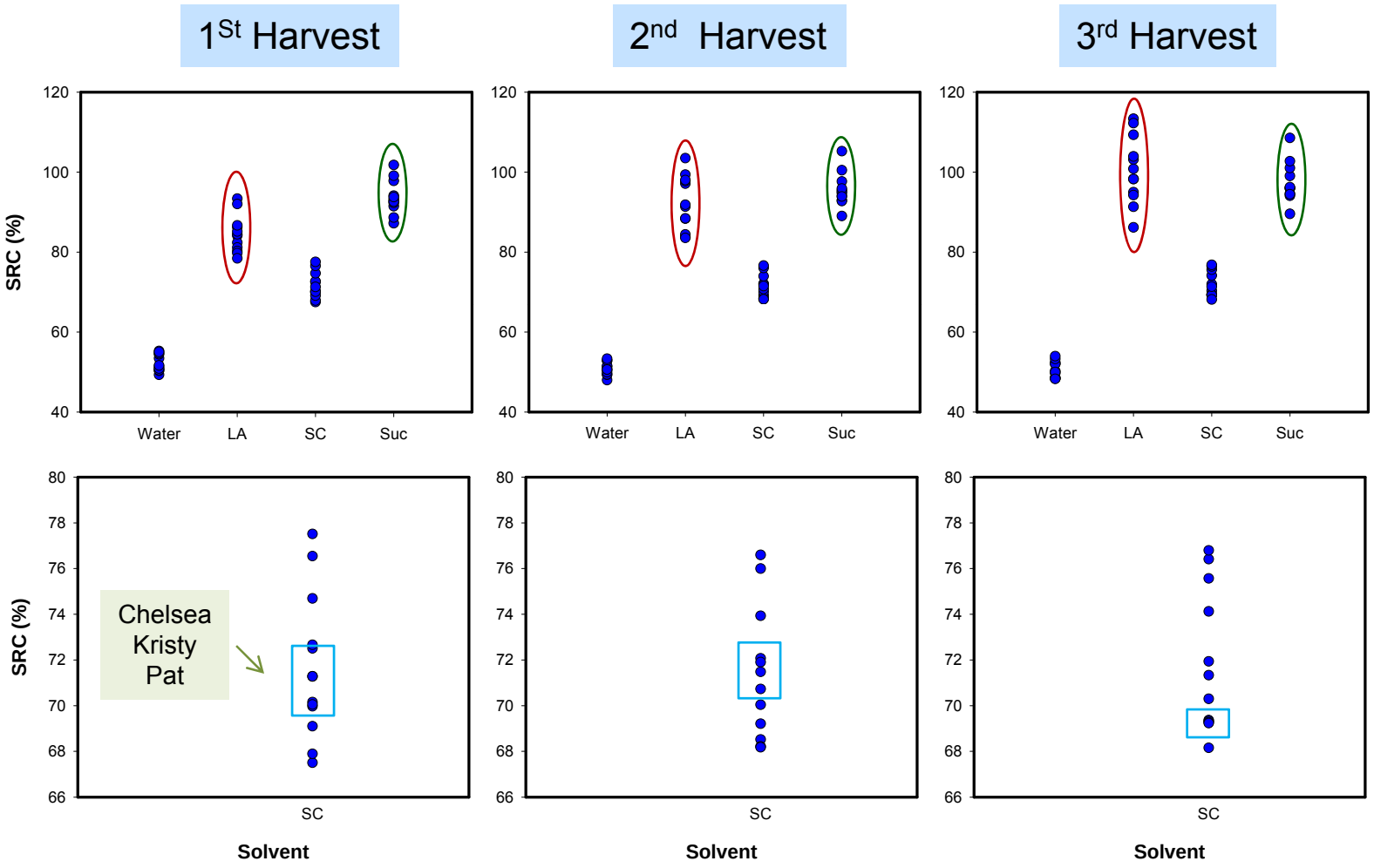


Starch pasting profiles of flour samples

(3.5g flour + 25mL water in RVA)



Solvent retention capacity (SRC)



pHs of lactic acid and sodium carbonate solutions are about 2 and 12, respectively, which are not favorable environments for protease and α-amylase activities.

Tested baking formulas

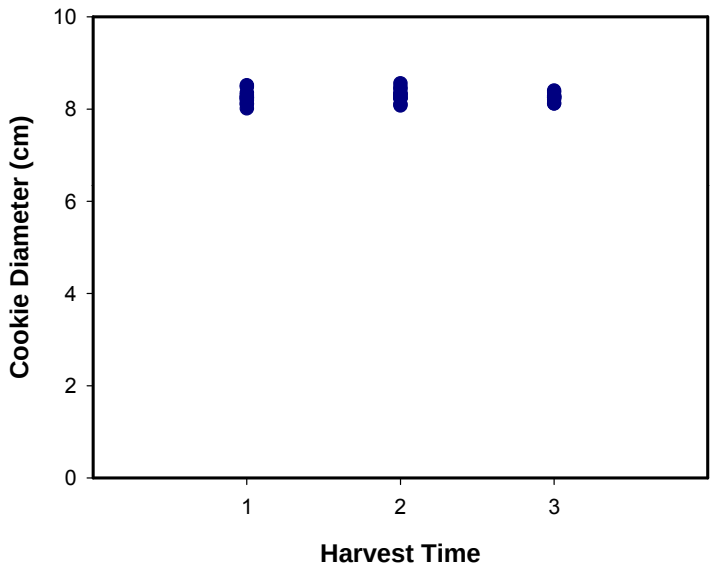
Formula	%S		TS	
Cookie	64	high	66	low
Cracker	24	low	38	low
Pancake	7	low	145	high
Sponge cake	47	high	213	high

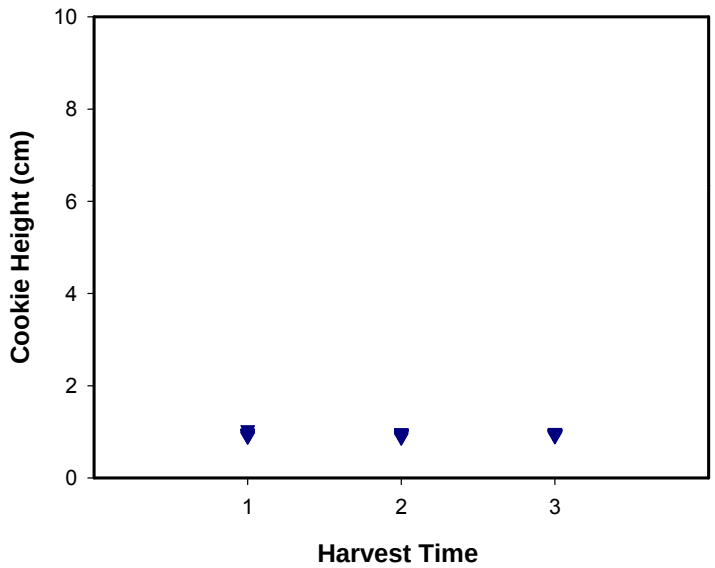
Enzymes generally favor low %S (below 30).

Cookies (all 12 cultivars)

(high %S & low TS)

(AACC Method 10-54: Wire-cut cookie baking)



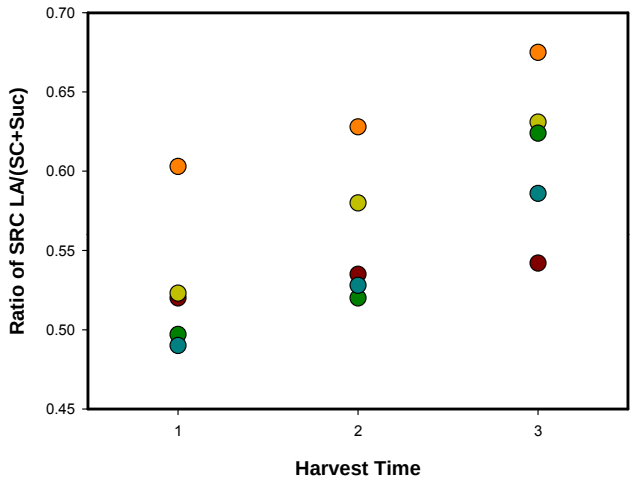


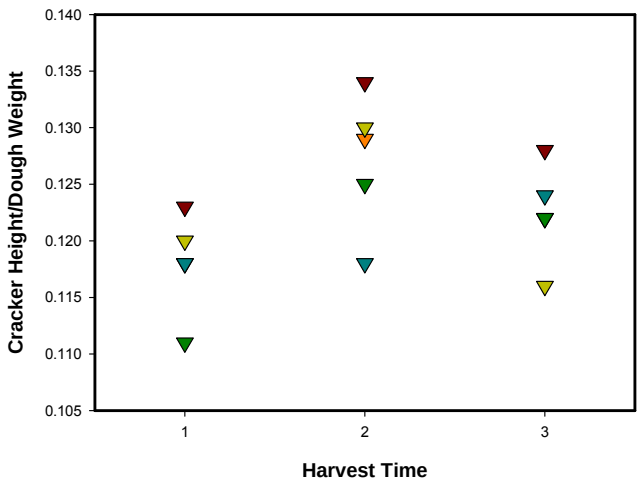
Average	1st harvest	2nd harvest	3rd harvest
Cookie Diameter (cm)	**8.25** ± 0.15	**8.30** ± 0.14	**8.27**± 0.10
Cookie Height (cm)	**0.95** ± 0.04	**0.94** ± 0.03	**0.95**± 0.02

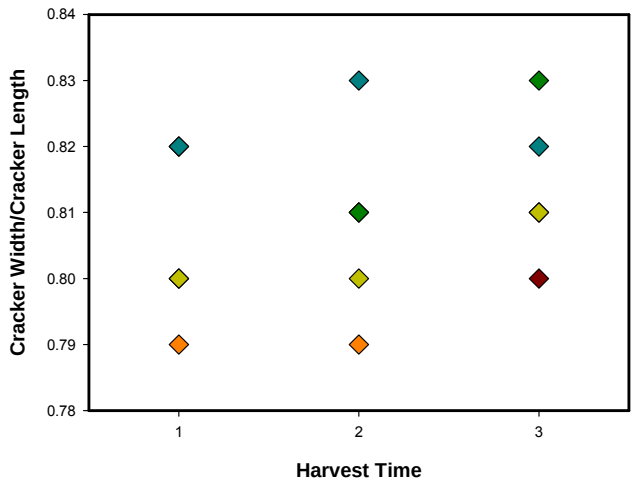
These results agreed with the sugar-snap cookie results reported by Sorrells et al (1989)

Chemically-leavened crackers (5 cultivars)

(low %S & low TS)







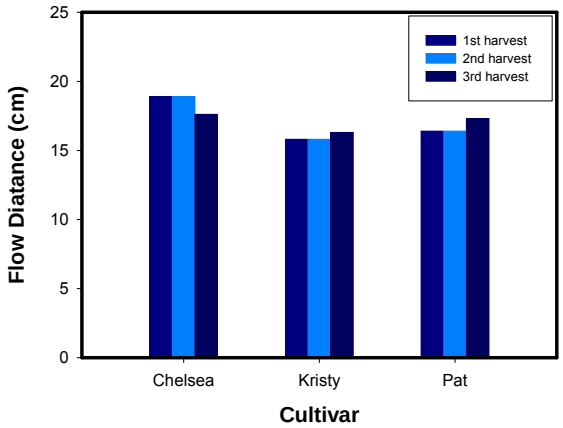
Pancake

(low %S & high TS)

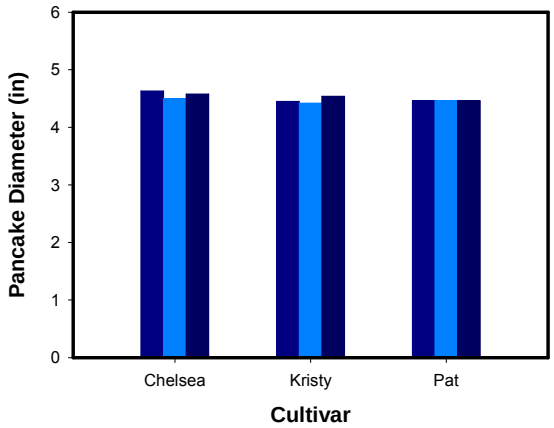
(Pancakes baked with most significantly sprouted cultivars)

Cultivar	Flour Falling Number (sec)		
	1st harvest	2nd harvest	3rd harvest
Chelsea	344	211	88
Kristy	378	239	85
Pat	376	247	99

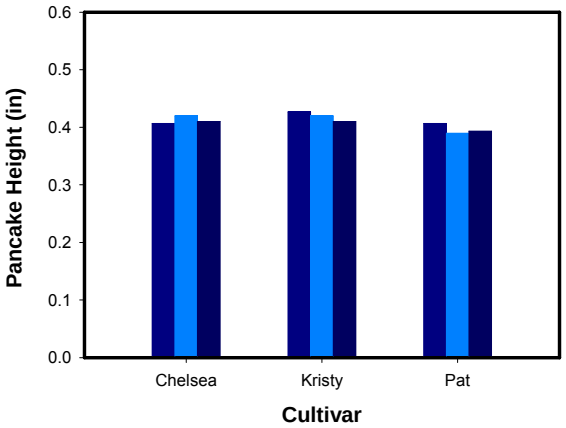
Flow distance



Pancake diameter



Pancake height

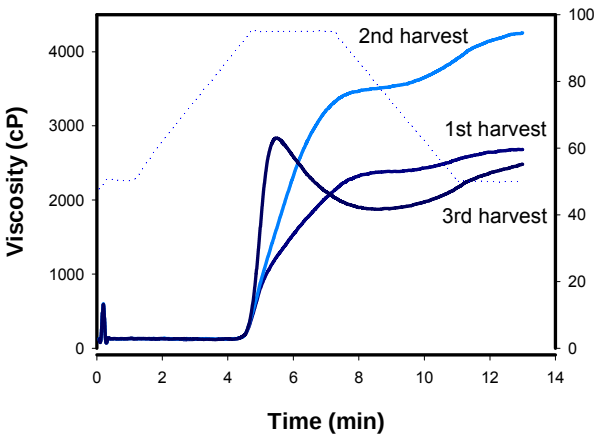


Flour RVA in sucrose

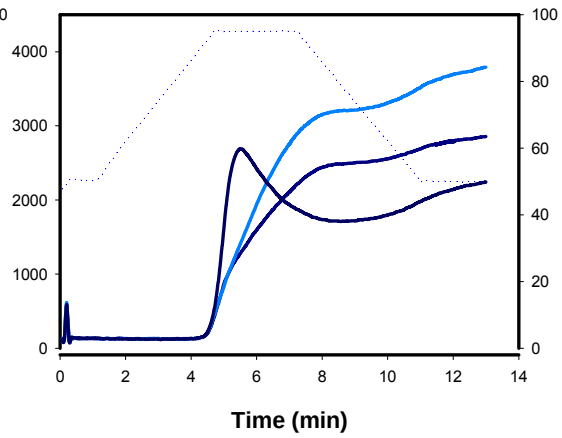
(in preparation for sponge-cake baking)

(3.5g flour + 25mL 50% w/w sucrose)

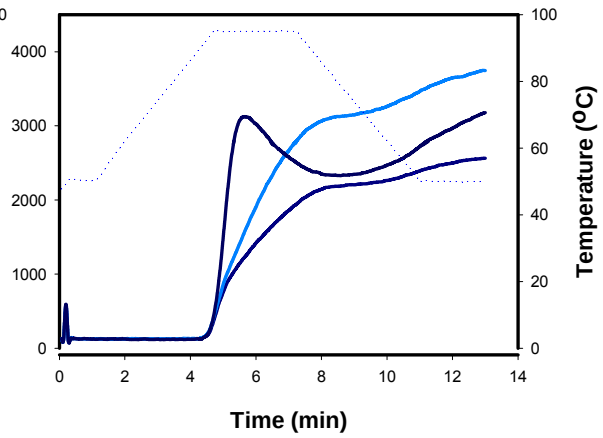
Chelsea



Kristy



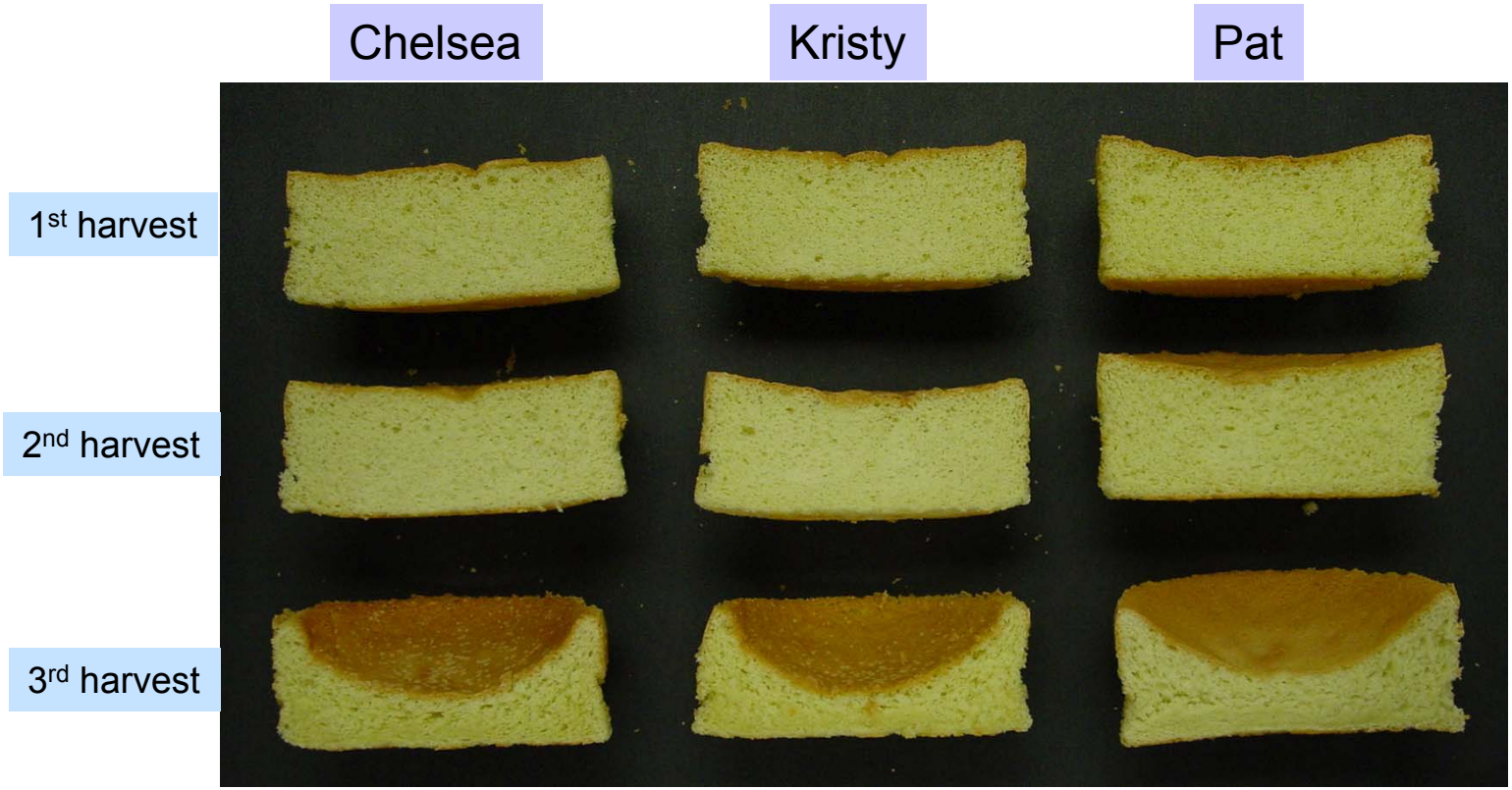
Pat



Sponge cake

(high %S & high TS)

(Sponge cakes baked with most significantly sprouted cultivars)



Conclusions

- The effects of weathered/pre-harvest sprouted wheats are dependent on genotype.
- Weathered/pre-harvest sprouted wheats increase break flour yield, but significantly decrease test weight.
- RVA profiles show 4 categories of behavior, which are dependent on genotype.
- SRC results show a small increase in sucrose values and a large increase in lactic acid values, which are unrelated to enzyme activities in the flours.
- Weathered/pre-harvest sprouted wheats did not impact the flow behavior of pancake batters when damaged starch content is low.
- Weathered/pre-harvest sprouted wheats did not impact the baking performance of cookies (as expected) or crackers (using a model formula without enzymes), but the effect on the baking performance of Japanese-type sponge cake was dramatic and dependent on genotype.

Acknowledgements

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