Development and Potential of High-Value Specialty Wheat Crops and Cultivars in the Eastern U.S.

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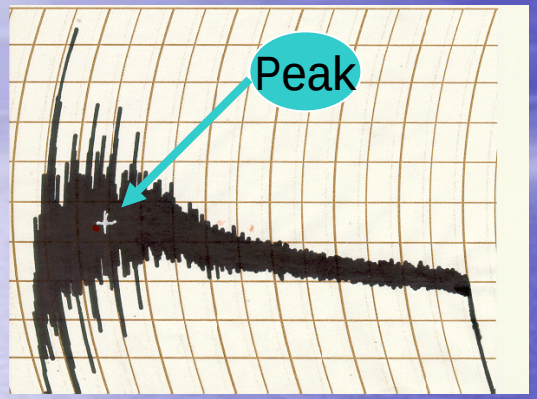
INTRODUCTION

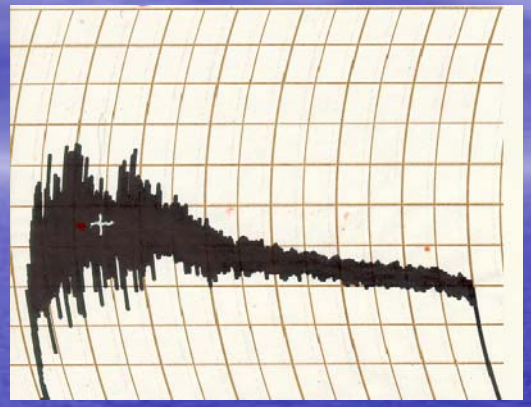
- The mid-Atlantic region of the U.S. has the milling capacity to utilize 6 million tons of wheat per year.
- A large portion of hard and strong-gluten wheat suitable for making bread, crackers, pasta, and other products is imported at considerable expense by regional mills from other wheat growing areas.
- Because the market exists for bread and durum wheat and it is usually of higher value than soft wheat, growers are interested in identifying adapted varieties and developing agronomic techniques to grow high quality bread and durum wheat in the mid-Atlantic region.

Wheat Genotypes with Weak Gluten Strength



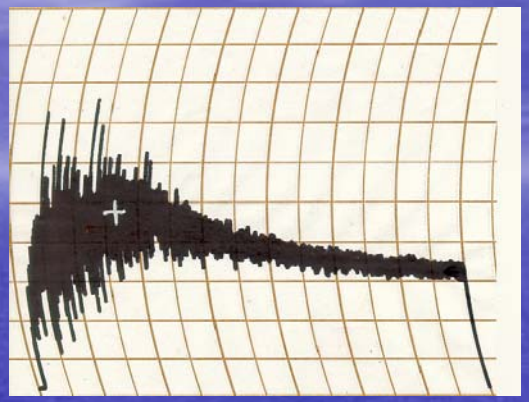
SISSON

Pro: 9.27, Mixo: 58.4



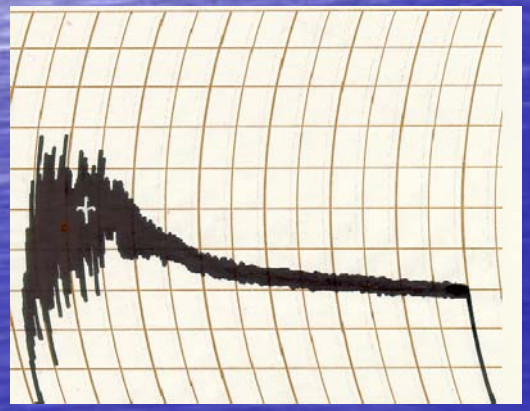
SS 550

Pro: 9.71, Mixo: 62.5



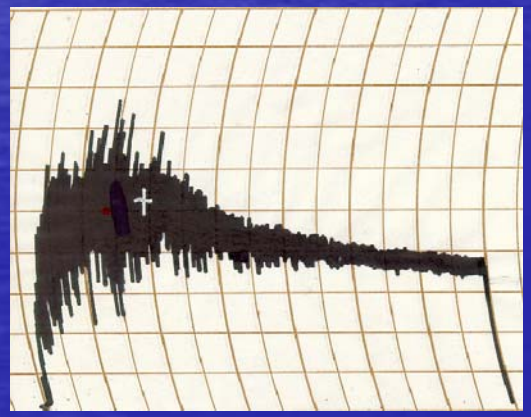
COKER 9835

Pro: 10.08, Mixo: 80.5



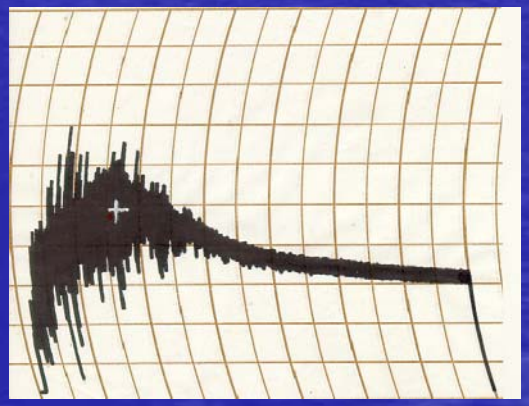
SS MPV 5.7

Pro: 10.22, Mixo: 66.4



CENTURY II

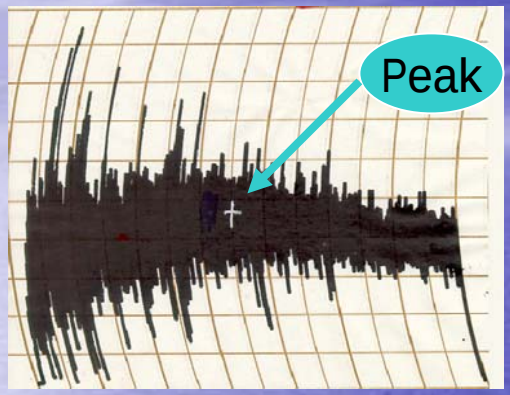
Pro: 10.96, Mixo: 108.3



AGRIPRO PATTON

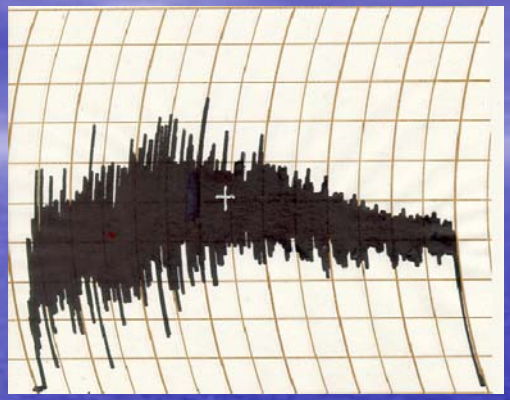
Pro: 11.93, Mixo: 102.4

Wheat Genotypes with Strong Gluten Strength



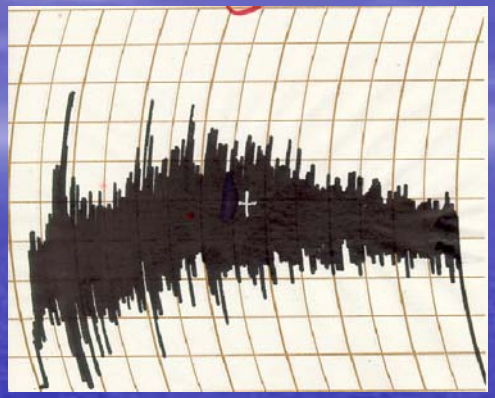
TRIBUTE

Pro: 9.39, Mixo: 154.5



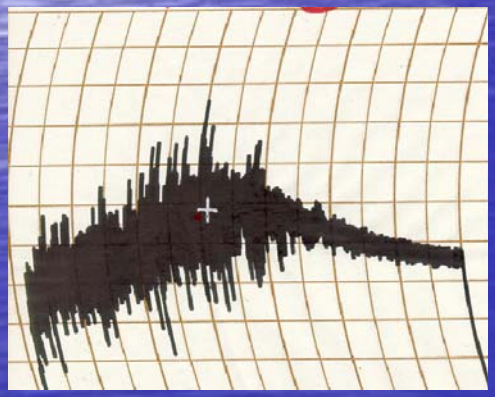
COKER 9663

Pro: 10.10, Mixo: 175.1



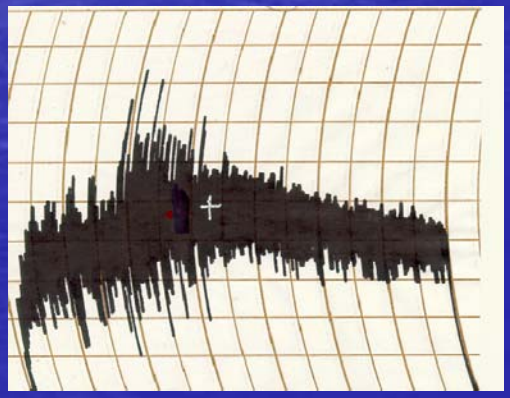
PIONEER 2643

Pro: 10.10, Mixo: 183.1



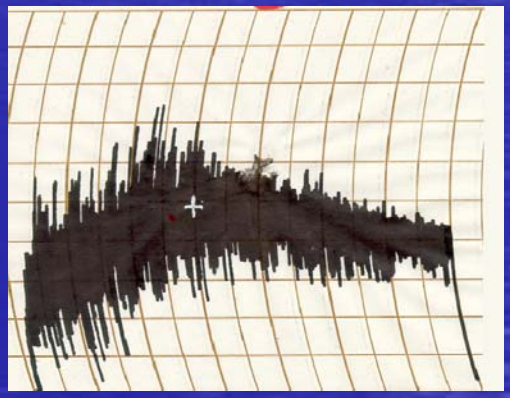
PIONEER 26R38

Pro: 11.07, Mixo: 173.6



RENWOOD 3260"s"

Pro: 11.49, Mixo: 185.4



VA 97W-469

Pro: 11.66, Mixo: 166.6

Cookies, Crackers & Bread

- Traditional SRW wheat → cookies & cakes
  - Soft texture, low damaged starch, low water absorption, low-medium protein %, weak gluten
- Strong gluten SRW → crackers & some bread
  - Soft texture, low damaged starch, low water absorption, medium-high protein %, medium to strong gluten
- HRW & HRS → Traditional White Pan Bread
  - Hard texture, high damaged starch, high water absorption, high protein %, strong gluten

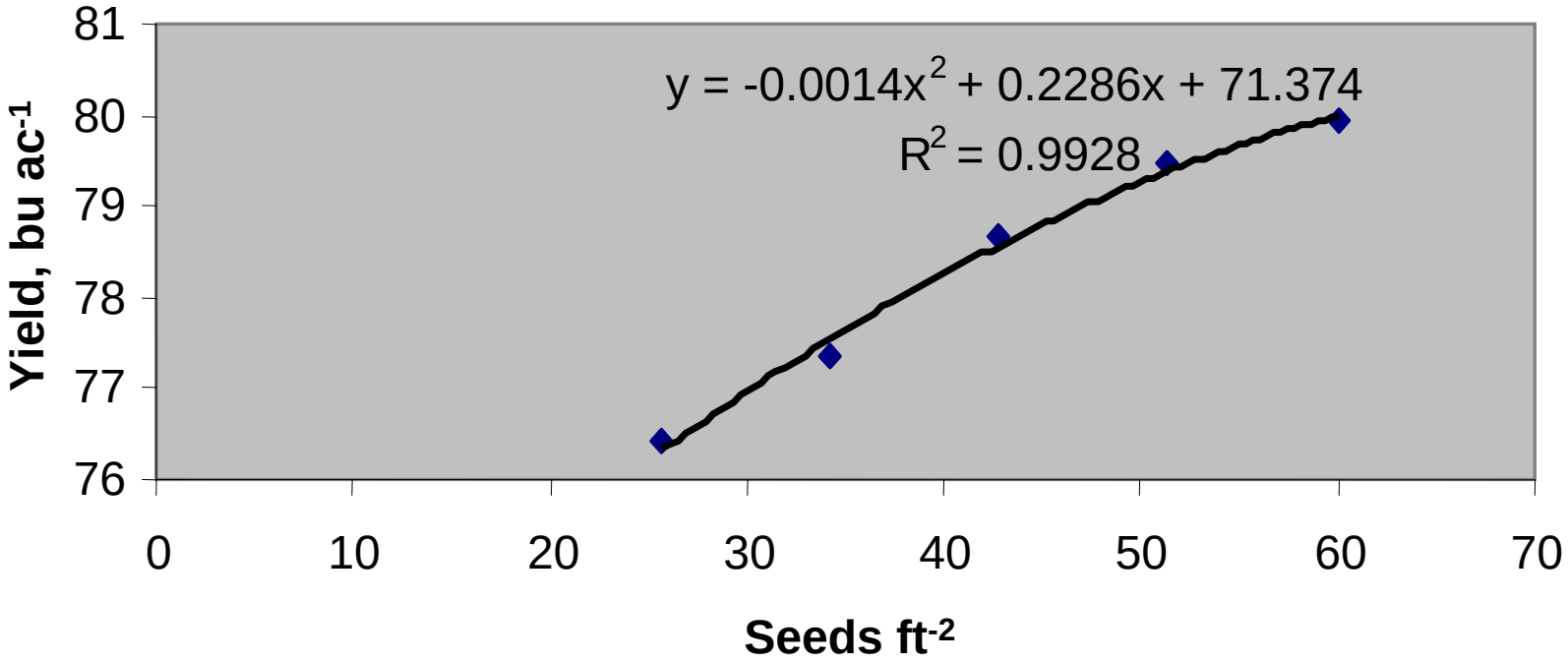
Successful IP Wheat Programs

- ConAgra → Platte HWW Wheat → Pizza Crust
- Pendelton Flour Mill → Klasic HWS → Tortillas
- General Mills→Stephens SWW→Curly Wheaties
- Nabisco → Pioneer 25R26 & Tribute SRW→ Crackers
- C&M Seeds Ontario→ Fundulea & new HRW → Blends → Bread
- Potential New Markets for Soft Wheat ???
  - Traditional (Breakfast Cereals), Ethnic (Tortillas) and Health Foods
  - Low Amylose (Waxy) and High Amylose Wheat
  - White Wheat
  - Whole Wheat

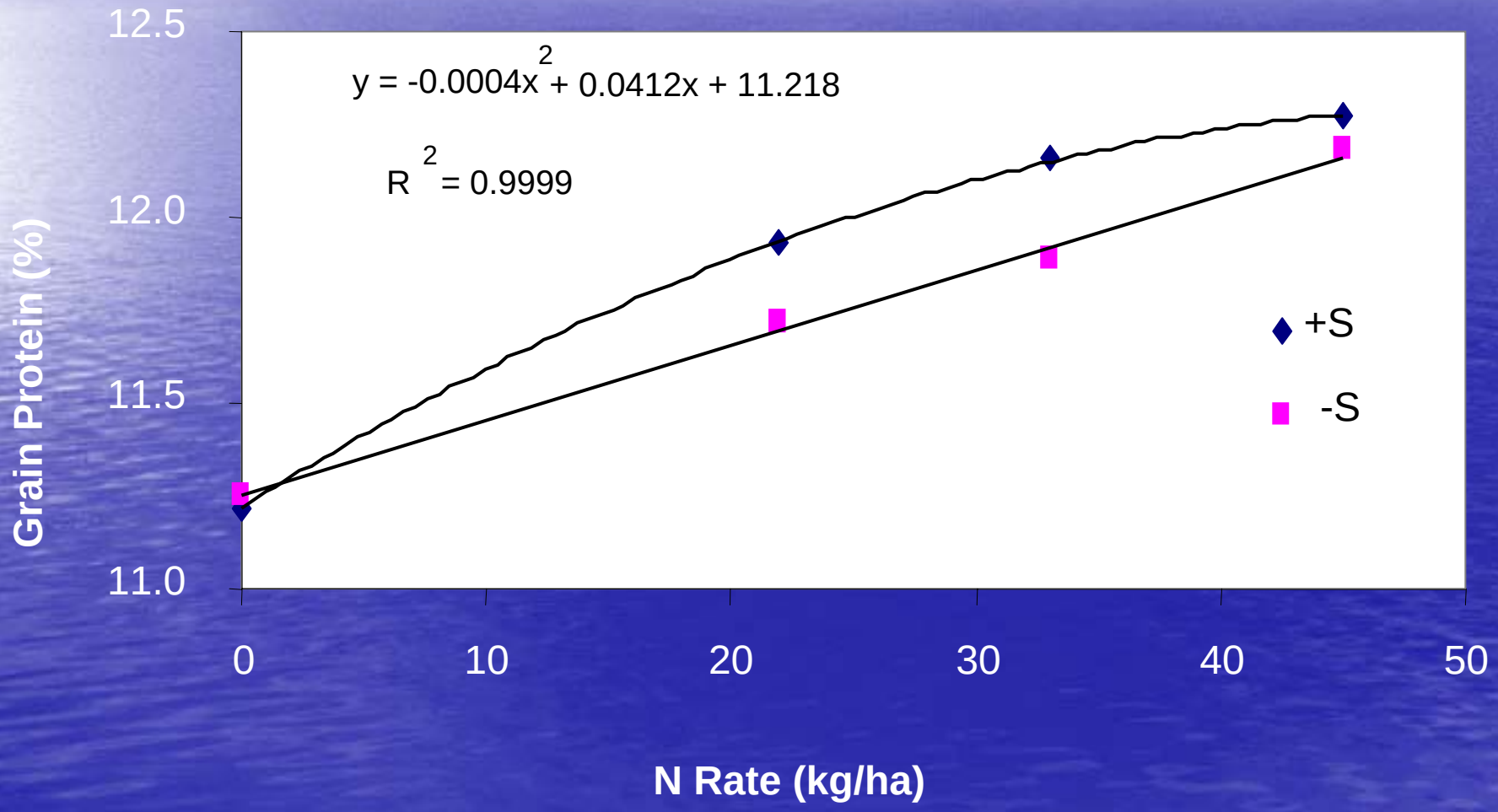
Production & Marketing of IP Products

- Product is unique & has specific end-use value
- Value is based on supply, demand and cost
- Value is based on end-use quality and yield
- Consistent end-use quality is key for success
  - Development & Use of Stable & Adapted Varieties
  - Use of Management Practices to Ensure Quality
  - Timely Harvest, Sound Grain Handling & Storage
- Develop reliable grain storage & delivery infrastructures to meet supply & demand schedules

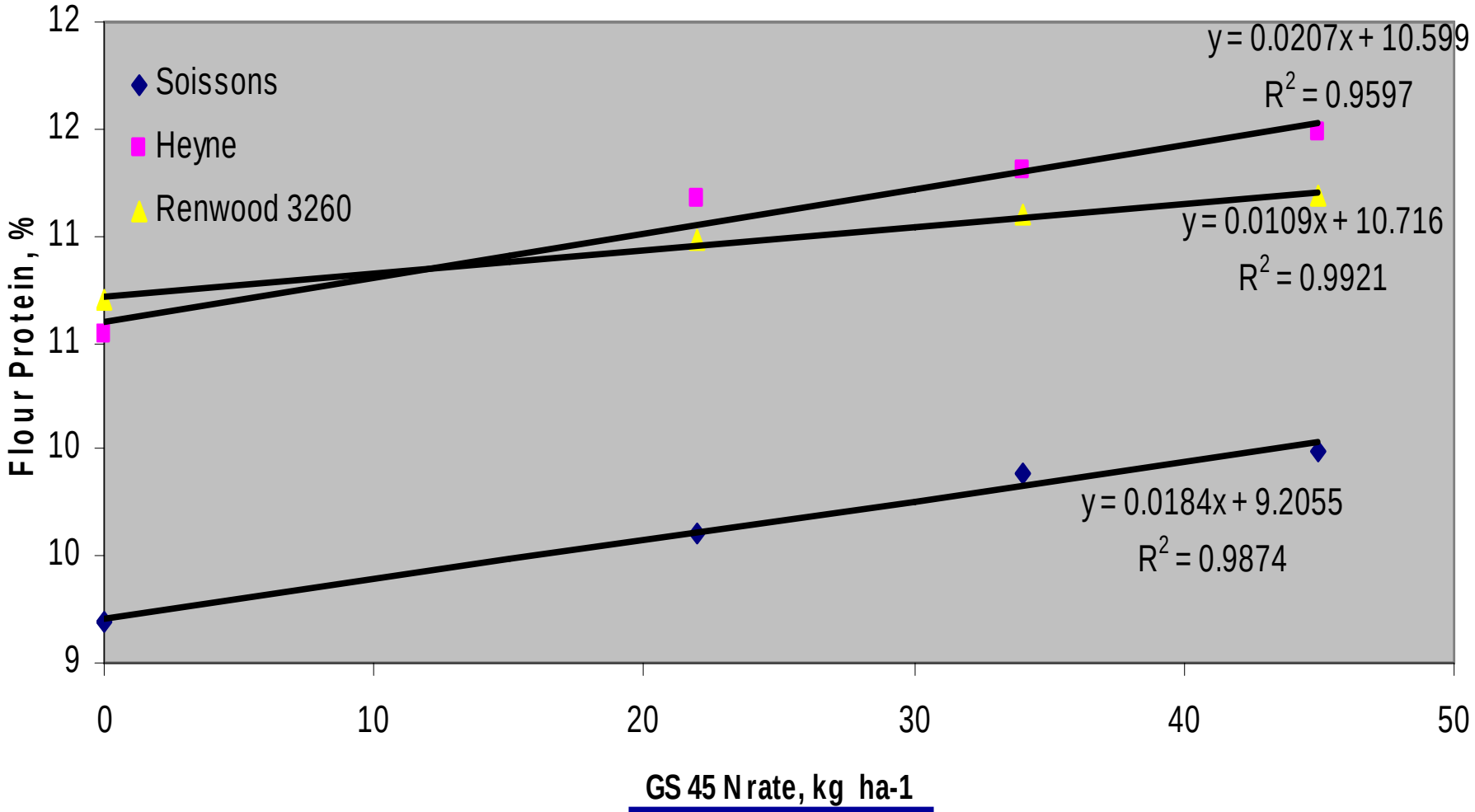
Management → Specialty Wheat Yields and Quality
Bread Wheat Seeding Rate



Grain protein response of Soissons wheat to late-season N with and without S

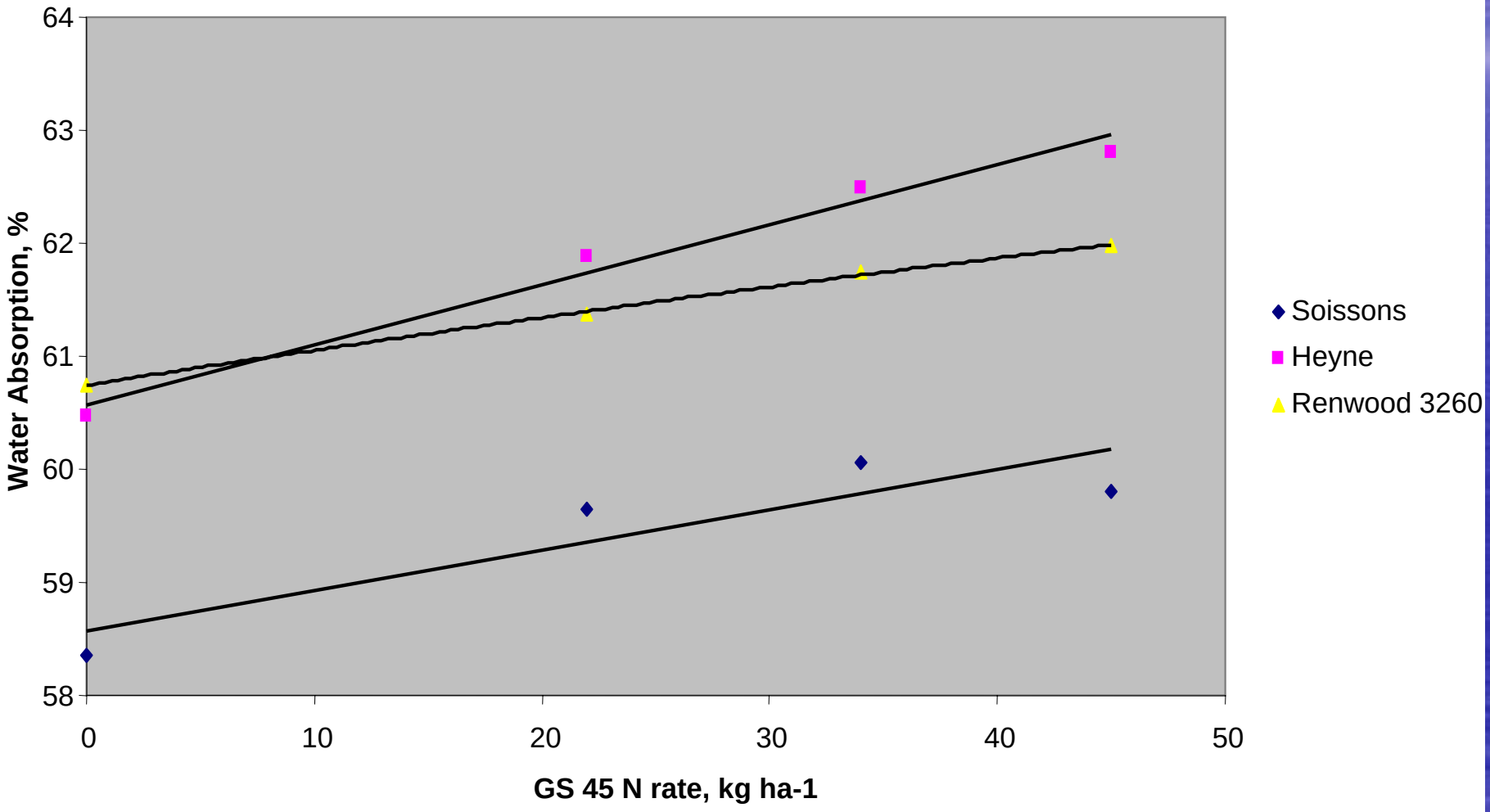


Flour protein of Soissons, Heyne, and Renwood 3260 winter wheat varieties as affected by late season N (with S), 2001-2003

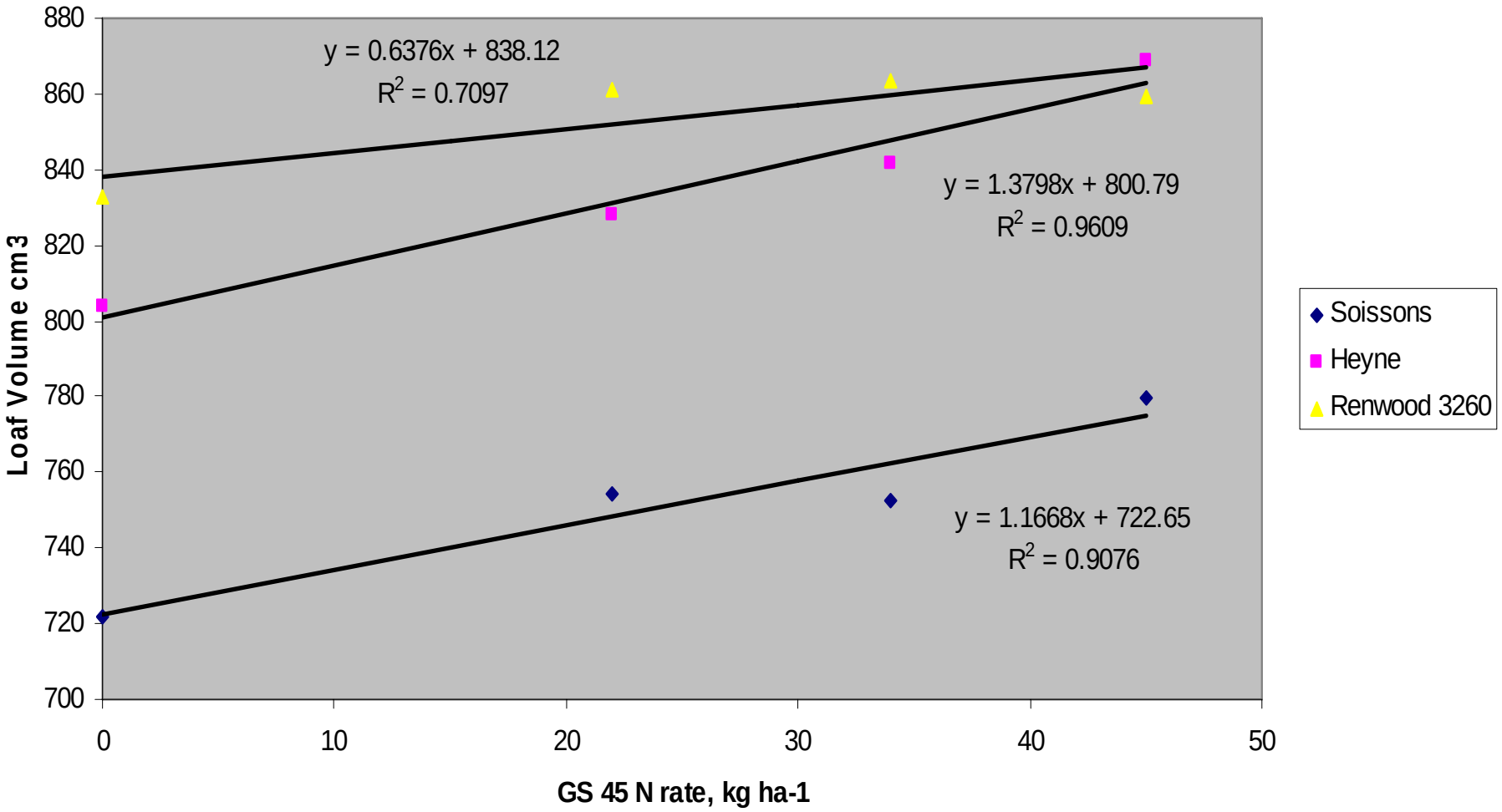


Boot Swollen

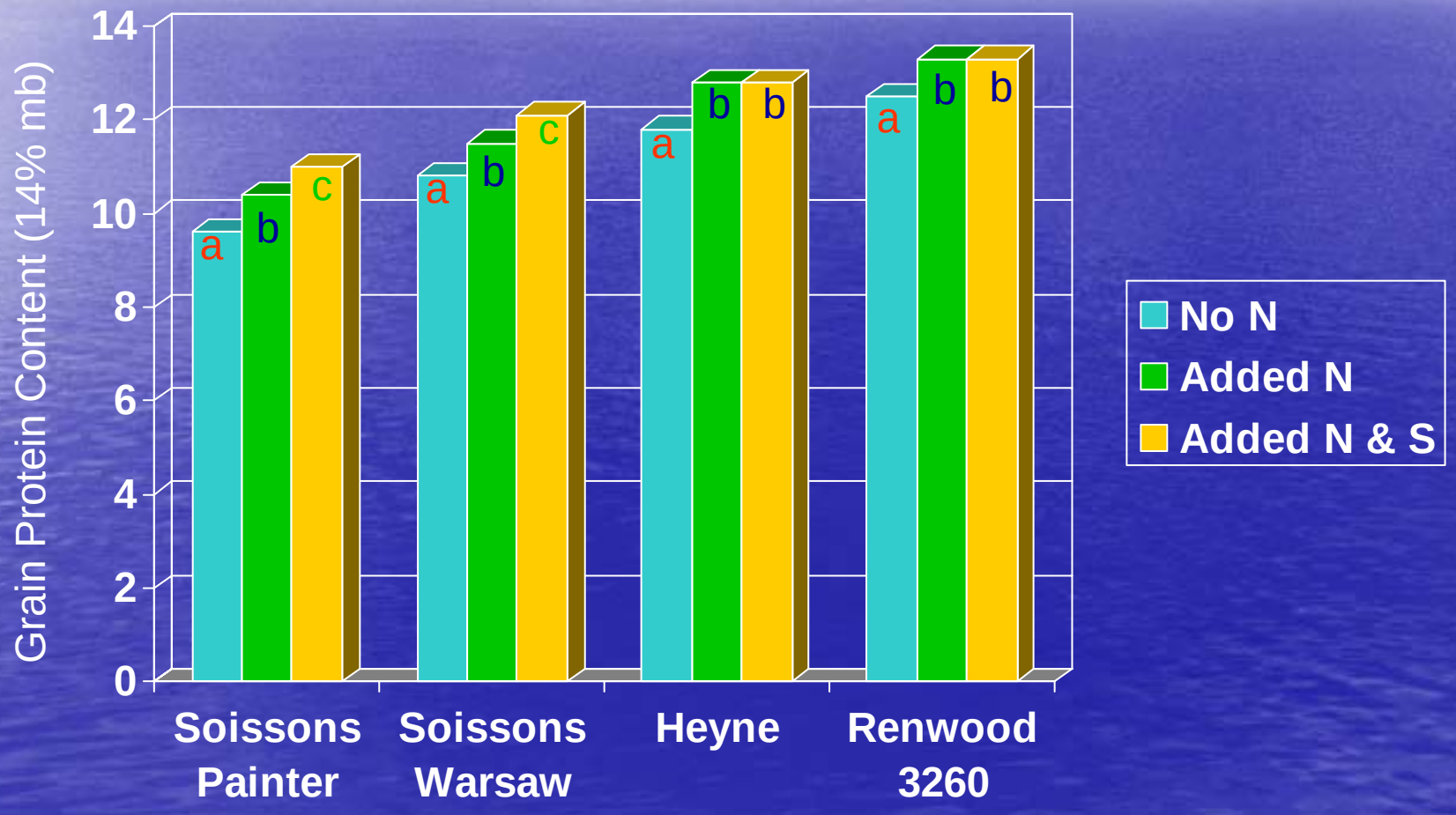
Water absorption of Soissons, Heyne, and Renwood 3260 winter wheat varieties as affected by late season N (with S), 2001-2003



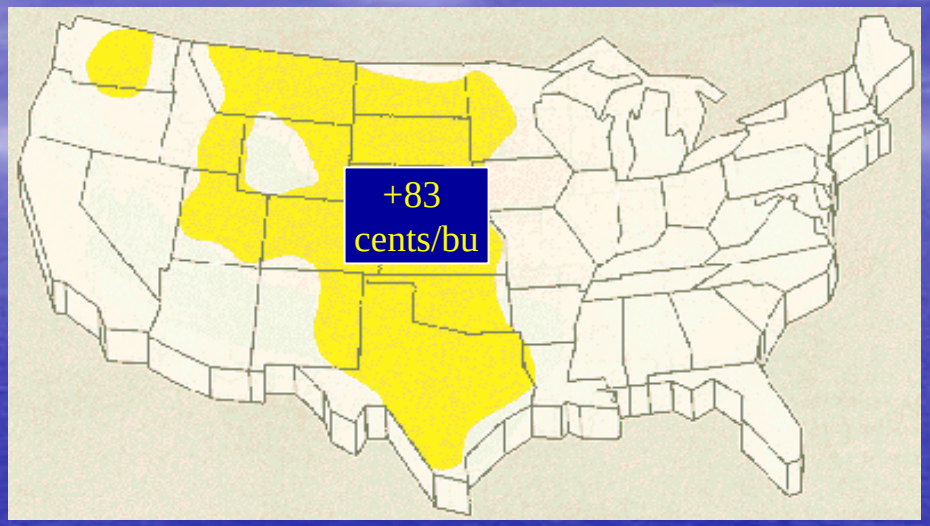
Loaf volume of Soissons, Heyne, and Renwood 3260 winter wheat varieties as affected by late season N (with S), 2001-2003



Grain protein increases following foliar applications of N and S, 2001-2003 (bars labeled with different letters within a variety are significantly different, $p<0.05$)



Development of Bread Wheat Varieties with High Value End Use Properties



Four-year Mean Performance of 92PAN2#26 and 00F5-58-3 HRW Wheat

LINE	Yield Bu/a	Test Wt. Lb/bu	Head Date Julian	Plant Ht. Inch	Lodge 0.2-10	Leaf Rust 0-9	Powdery Mildew 0-9	BYD Virus 0-9
TRIBUTE	90	61.2	122.4	30.6	0.4	1.6	0.3	1.8
RENWOOD 3260	83	60.1	120.6	32.1	0.5	2.3	0.2	1.6
92PAN2#26	81	58.2	125.3	30.8	0.2	4.3	2.0	2.3
SOISSONS	80	58.0	126.7	29.6	0.2	5.7	0.6	1.5
CULPEPER	80	59.0	124.4	32.3	0.2	1.1	2.7	2.3
TAM 302	78	57.9	126.0	33.4	0.8	1.1	1.7	2.4
00F5-58-3	77	60.4	122.1	31.4	0.4	2.2	1.2	2.0
Lakin	75	60.2	123.4	33.4	0.6	5.4	2.0	2.0
TAM 110	73	57.8	119.9	32.7	0.5	4.2	0.3	2.8
KARL 92	63	59.0	120.9	30.5	0.3	5.5	0.9	3.1
MEAN	73	58.6	123.2	31.7	0.4	2.5	1.1	2.2
No. of SITES	12	3	8	8	7	6	10	5

Performance of 92PAN2#26 HRW Wheat in the 2007 Uniform Bread Wheat Nursery at 10 Sites

Variety	Yield	Yield	Test Wt	Head Date	Plant HT	Lodge	Powd. Mildew	Stripe Rust	Leaf Rust	BYDV	SBMV	Freeze Injury	Flour Protein	Kernel Hardness
	bu/a	rank	lb/bu	Julian	inch	0-9	0-9	%	0-9	0-9	0-9	0-9	%	score
Roane	73.9	1	59.8	126	32	1.3	1.5	20	2.7	1.5	5.5	0.0	13.4	46.6
Tribute	70.7	2	61.2	123	31	0.5	0.8	30	2.7	2.3	7.5	1.0	13.5	43.9
92PAN2#26	69.3	3	58.0	126	31	0.3	3.3	8	3.3	2.8	6.5	0.3	14.5	82.9
AGS 2000	68.2	5	59.2	120	32	0.5	0.8	65	1.7	1.5	6.5	5.3	13.8	24.6
Endurance	66.0	7	59.2	124	35	2.0	2.5	15	1.7	1.3	4.0	0.0	13.3	72.1
Lakin	62.5	15	60.4	124	35	0.8	4.5	65	5.3	2.5	7.0	1.7	14.2	75.9
Hondo	56.2	39	60.1	129	35	1.3	0.5	80	4.3	3.3	4.5	0.7	15.2	92.4
Mean N=48	60.4		59.4	124	33	1.2	1.8	18	2.5	3.0	6.0	1.9	14.6	75.9
LSD (0.05)	7.3		1.3	1.8	1.9	2.0	1.6		2.6	1.8	2.2	2.5	0.88	5.5
No. of Sites	10		10	7	8	4	4	1	3	4	1	3	7	7

Milling & Baking Quality (Mennel Milling Co.) 92PAN2#26 and 00F5-58-3 HRW Wheat

Sample Name	Karl 92	Soissons	TAM110	Lakin	92Pan2#26	00F5-58-3	Tribute
Years Tested	4	4	4	3	4	3	4
Wheat Properties of Potential Bread Wheat Lines Grown by VPI for 3-4 Years							
%Protein @12%M	12.4	11.6	11.3	11.9	12.0	12.5	10.8
FN, sec.	408	397	407	345	432	415	368
Milling Properties of Potential Bread Wheat Lines Grown by VPI for 3-4 Years							
Flour Yield, %	69.1	73.7	69.3	68.9	70.3	69.4	70.2
Bu/cwt	2.42	2.27	2.41	2.42	2.38	2.41	2.38
Flour Properties of Potential Bread Wheat Lines Grown by VPI for 3-4 Years							
%Protein @14%M	11.4	9.6	10.2	10.8	10.8	11.0	9.6
WaterAbs., %	59.1	55.4	60.4	57.8	59.7	59.7	56.0
Stability, min	10.3	16.0	7.5	9.5	6.0	9.3	7.7
MTI, unit	41.3	23.9	41.5	41.2	53.5	42.0	57.3
Bread Baking Quality of Potential HRW Wheat Lines Grown by VPI for 3-4 Years							
Volume, cc	2660	2468	2531	2623	2512	2709	2258
Loaf	5.8	3.9	4.6	5.6	4.1	6.08	1.8
Grain	4.8	4.0	4.2	4.4	4.5	5.08	2.3
Overall Rank	5.2	3.9	3.9	4.6	4.3	5.2	1.6

Performance of VT HRW Wheat Lines

LINE	YIELD (Bu/A)	TWT (Lb/Bu)	HD (Julian)	HT (Inch)	LODGE (0 - 10)	LR (0-9)	PM (0-9)	BYDV (0-9)	Spr. Frez (0-9)
TRIBUTE	89	63.2	123	29	0.6	0.0	0.0	1.0	1.0
VA06HRW-79	84	59.6	122	29	0.2	2.0	0.0	1.5	2.3
VA06HRW-66	82	59.5	126	33	0.2	3.0	0.5	2.0	0.7
VA06HRW-87	82	59.8	124	32	0.6	3.3	0.0	2.0	1.7
VA06HRW-49	80	60.8	123	32	0.7	1.0	0.0	1.0	2.0
VA06HRW-30	79	61.5	125	31	0.2	5.3	0.0	2.2	2.7
SOISSONS	78	58.9	128	30	0.2	5.0	0.0	1.3	1.3
VA06HRW-33	78	61.5	123	31	0.9	5.3	0.2	1.3	1.0
LAKIN	77	62.5	125	35	0.6	5.7	2.2	2.8	0.3
Renwood 3260	76	61.6	122	31	0.4	1.0	0.5	1.8	1.7
VAK06HRW120	74	61.8	121	31	0.3	1.7	0.0	3.8	2.7
TAM 110	69	61.1	121	32	2.5	4.7	0.2	2.2	4.0
KARL 92	59	60.8	122	30	1.9	6.3	0.0	3.2	1.7
Mean	73.7	61	123.6	30.3	0.5	2.3	0.2	2.1	2.9
LSD(0.05)	9.1	2.9	7.5	2.0	0.6	1.5	0.8	1.5	24.5

VT HRW Wheat: Flour Yield & Protein

LINE	2007	2007	2006	2007	2006	2007	2006
	YIELD BU/A	FLOUR YIELD		WHEAT PROTEIN @12% MOISTURE		FLOUR PROTEIN @14% MOISTURE	
	BU / AC	70% +		12% +		10.5% +	
Tribute	89	69.7	70.3	10.8	12.2	9.1	10.3
Renwood3260	76	72.1	70.2	12.1	12.3	10.7	10.9
Soissons	78	76.8	70.4	11.1	11.9	9.8	10.8
Karl 92 = STD	59	69.3	67.6	13.7	12.8	12.5	11.7
TAM 110	69	73.6	69.9	11.5	12.2	10.2	10.9
Lakin	77	73.2	69.1	11.1	12.1	10.1	11.1
VA06HRW79	84	69.2	70.2	11.9	11.5	10.2	10.2
VA06HRW66	82	73.6	69.8	10.9	12.0	10.0	10.8
VA06HRW87	82	72.1	67.9	10.6	11.7	9.8	10.7
VA06HRW49	80	73.7	65.4	11.7	11.8	10.3	11.3
VA06HRW30	79	75.8	71.9	12.4	12.4	11.8	11.7
VA06HRW33	78	71.0	67.1	12.0	11.6	10.9	11.4
VAK06HRW120	74	68.4	66.7	12.3	12.8	10.6	11.3

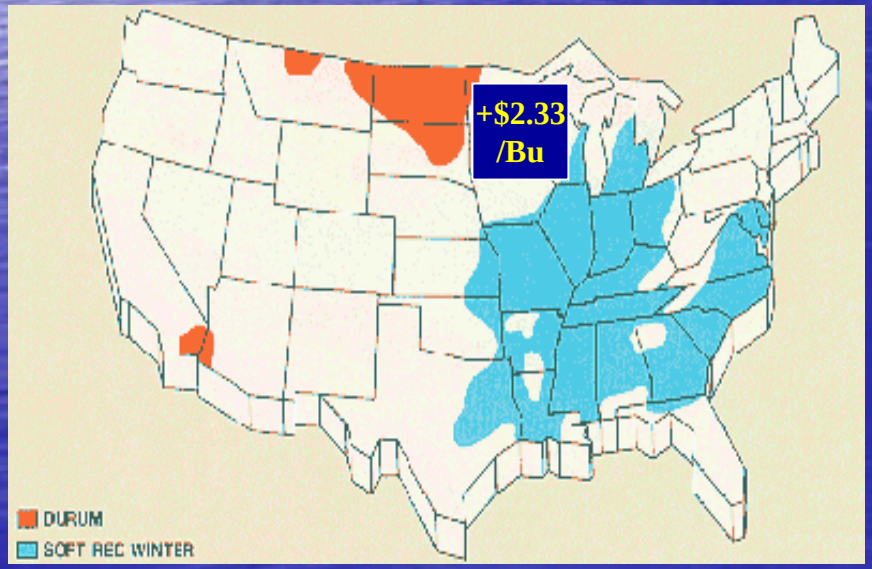
VT HRW Wheat: Farniograph Data

LINE	2007	2006	2007	2006	2007	2006	2007	2006
	WATER ABSORPTION		FARINOGRAPH PEAK TIME		FARINOGRAPH STABILITY		FARINOGRAPH MTI	
	55+		5 - 8		10+		25-45	
Tribute	56.2	55.4	1.8	4.4	6.5	9.7	49	38
Renwood3260	56.3	54.7	8.2	6.0	18.5	11.2	23	37
Soissons	56.1	55.1	2.3	2.5	13.8	12.6	31	32
Karl 92 = STD	62.3	60.7	3.3	2.7	18.2	9.4	28	37
TAM 110	65.5	60.9	2.2	2.5	3.4	6.2	63	48
Lakin	59.8	58.5	2.7	4.5	8.9	8.6	28	40
VA06HRW79	57.2	55.0	6.3	4.2	12.8	8.5	32	48
VA06HRW66	57.6	56.5	5.8	4.2	10.5	7.6	42	45
VA06HRW87	59.7	58.8	2.2	4.4	6.3	7.5	43	45
VA06HRW49	61.1	58.3	2.0	4.0	5.7	10.6	57	29
VA06HRW30	60.7	57.9	2.8	3.0	18.5	12.0	31	43
VA06HRW33	60.4	58.8	3.0	3.2	10.7	10.7	39	41
VAK06HRW120	61.9	60.2	4.0	4.5	18.8	14.3	0	22

VT HRW Wheat: Baking Quality

LINE	2007	2006	2007	2006	2007	2006
	LOAF VOLUME		CRUMB GRAIN		QUALITY SCORE	
	>2500		5 - 6		5 - 6	
Tribute	2100	2310	3.0	4.0	3.5	4.0
Renwood3260	2175	2490	4.0	4.0	4.0	3.0
Soissons	1975	2440	3.0	4.0	3.0	4.0
Karl 92 = STD	2250	2720	5.5	5.0	5.0	5.5
TAM 110	2200	2500	4.5	5.0	4.5	3.5
Lakin	2200	2560	4.5	4.5	5.0	4.0
VA06HRW79	2175	2600	5.5	4.0	4.5	4.0
VA06HRW66	2200	2650	4.0	5.0	4.5	5.0
VA06HRW87	2350	2650	4.0	4.5	4.5	5.0
VA06HRW49	2300	2590	5.0	5.0	5.0	4.5
VA06HRW30	2300	2620	5.0	4.0	5.5	5.0
VA06HRW33	2275	2620	5.0	4.5	5.2	4.5
VAK06HRW120	2400	2620	5.0	4.5	5.5	4.5

Winter Durum Wheat



Two-Year (2006-2007) Mean Performance of VT Winter Durum Wheat Lines

LINE	Yield Bu/A	Test Wt Lb/Bu	Head Date Julian	Plant Ht Inch	Lodge 0.2-10	Spr. Freeze 0-9
TRIBUTE	102.1	62.6	120	30.9	0.5	1
Renwood 3260	91.9	60.9	118	31.8	0.7	1
TAM 110	80.3	60.4	118	32.6	1.9	4
VA05WD-42	72.6	62.7	123	33.9	1.3	1
VA05WD-31	72.1	61.7	127	32.7	0.6	1
VA05WD-12	71.1	60.6	125	34.8	2.9	0
VA05WD-40	70.6	63.4	123	34.4	2.1	3
VA05WD-16	67.3	62.3	123	33.8	1.1	1
ODESSA#66	67.2	62.0	123	33.4	1.0	2
VA05WD-17	60.5	61.1	126	35.7	1.9	0
Mean N=25	70.3	61.5	122.7	32.5	1.6	1.5
No. Test Sites	4	4	4	4	4	1

Reaction of VT Durum Lines to FHB

LINE	06-07 Mean FHB Index	07 FHB Index	06 FHB Index	06-07 Mean DON VT-ND	07FHB Nur DON NDSU	06FHB Nur DON NDSU
Renwood 3260	6.3	7.4	5.3	0.5	0.7	<0.5
VA05WD-17	13.8	17.1	10.5	2.4	2.6	3.6
VA05WD-16	16.7	8.3	25.2	2.4	2.3	2.7
VA05WD-40	17.8	12.9	22.7	1.7	1.2	2.4
VA05WD-12	26.4	10.3	42.6	1.9	1.3	2.9
VA05WD-31	28.5	25.3	31.8	2.7	2.2	3.9
VA05WD-42	30.3	8.8	51.8	2.1	1.1	4.0
ODESSA#66	35.5	5.0	66.0	1.9	2.2	1.6
VA05WD-22	39.7	22.9	56.5	3.8	4.4	3.1
VA05WD-26	40.4	18.5	62.4	2.6	1.5	4.8
VA05WD-39	48.4	28.5	68.2	3.2	1.2	4.8
Mean N=25	27.6	15.0	40.3	2.3	2.0	2.6
No. Test Sites	2	1	1	2	1	1

Winter Durum Grain and Semolina Quality

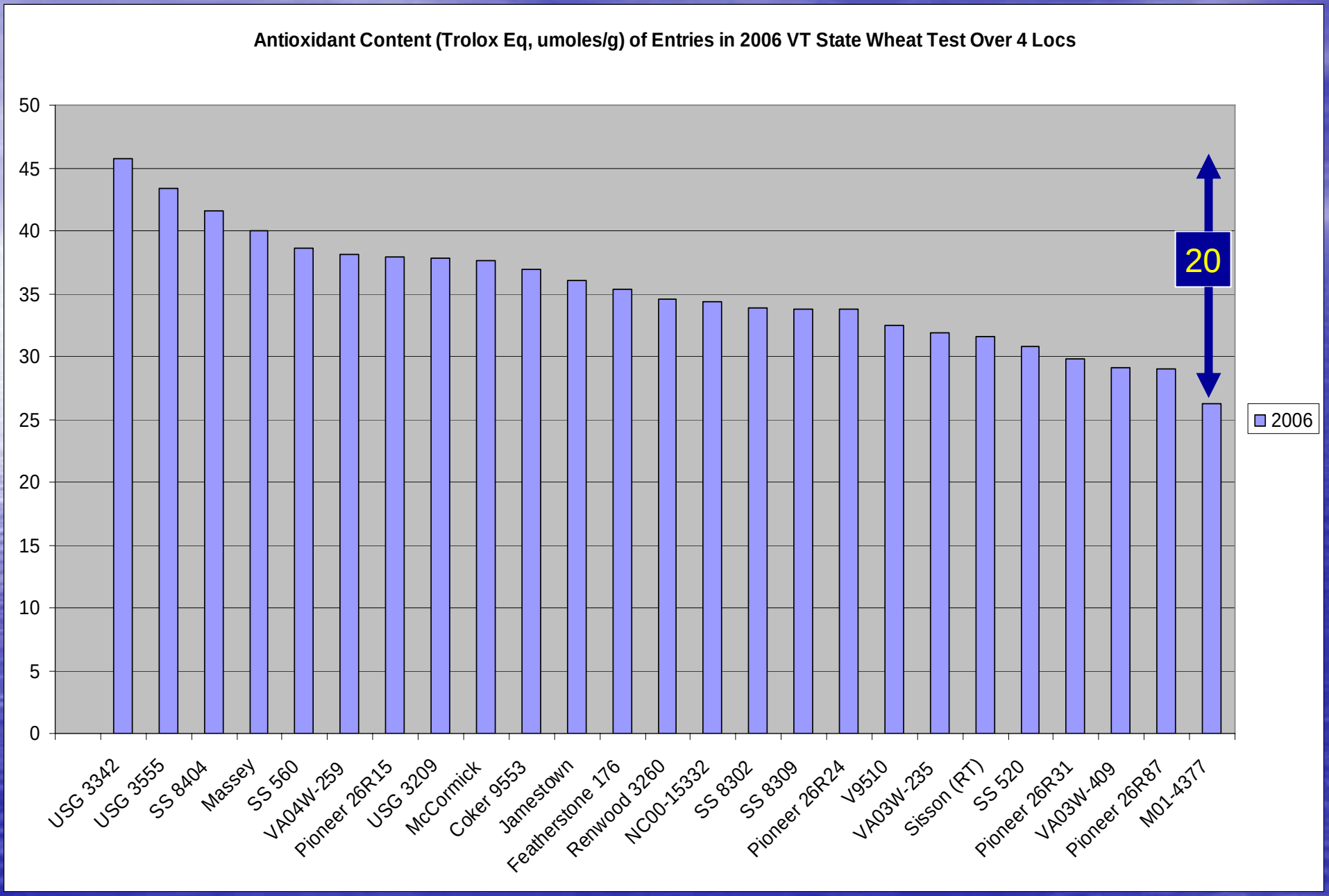
	1000 KWT	Kernel Size Large	WHEAT-GRAIN		SEMOLINA			
			LECO Protein	NIR	Extraction	LECO Protein	Color	
LINE	(g)	(%)	12%mb	Hardness	%	12%mb	L	b
VA05WD-12	51.5	88	13.2	116.7	61.5	12.1	78.4	21.4
VA05WD-16	54.6	96	13.3	115.6	59.9	12.0	77.9	21.0
VA05WD-17	53.2	94	13.2	107.4	65.3	12.3	79.5	20.0
VA05WD-31	44.8	83	11.6	102.9	59.3	10.5	78.4	19.3
VA05WD-40	40.8	80	12.7	110.6	58.9	11.8	78.8	20.8
VA05WD-42	50.3	91	12.5	111.6	60.4	11.4	78.5	22.8
ODESSA#66	51.8	94	13.1	116.5	59.3	12.0	77.8	20.6
ND-STD-ALKABO	37.3	42	14.8	94.7	58.5	14.0	79.6	24.5
Desired Value	Mean= 36	Mean = 65	>14	>90	60+	>13		20-25

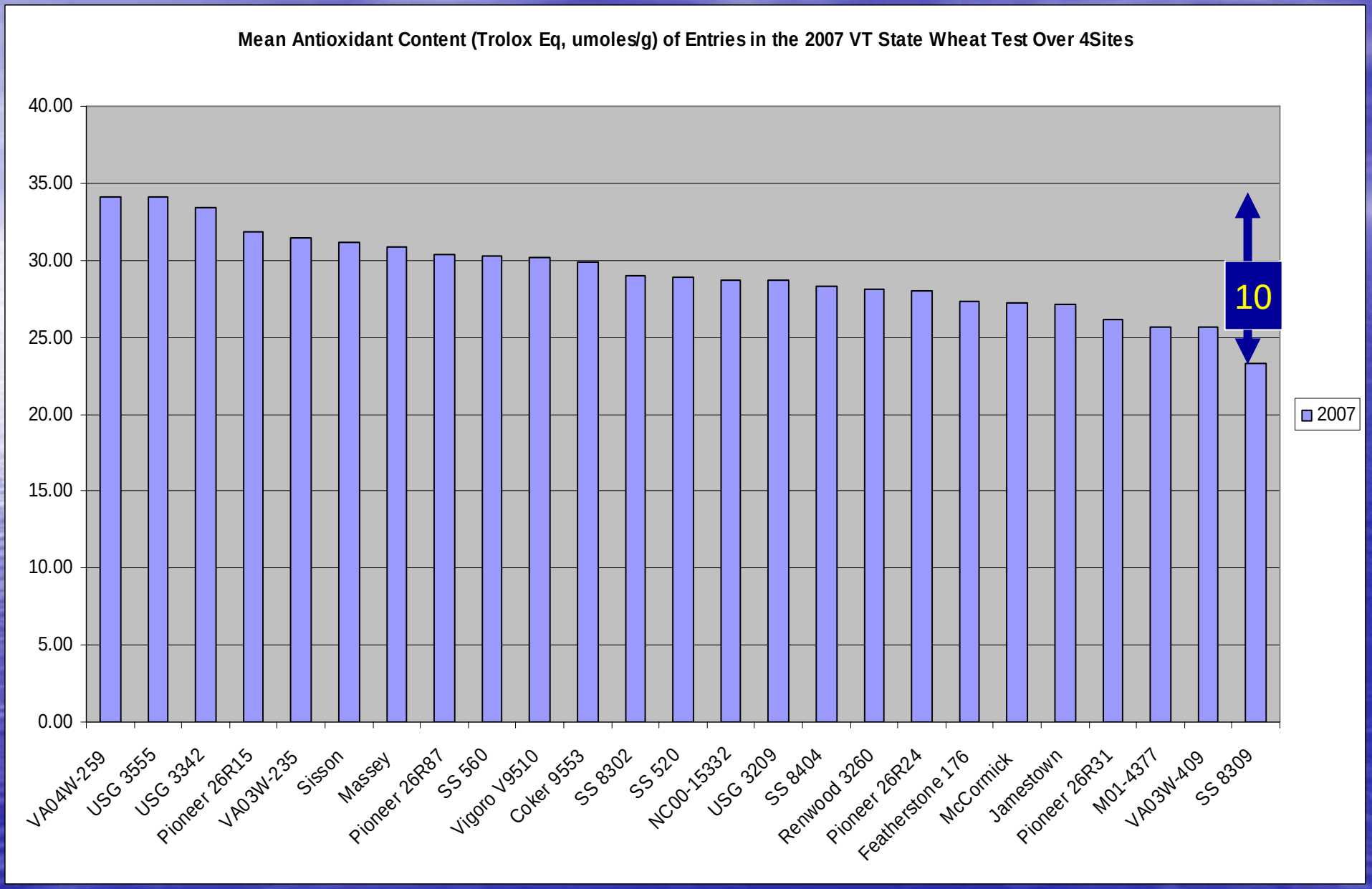
Winter Durum Spaghetti Pasta Quality

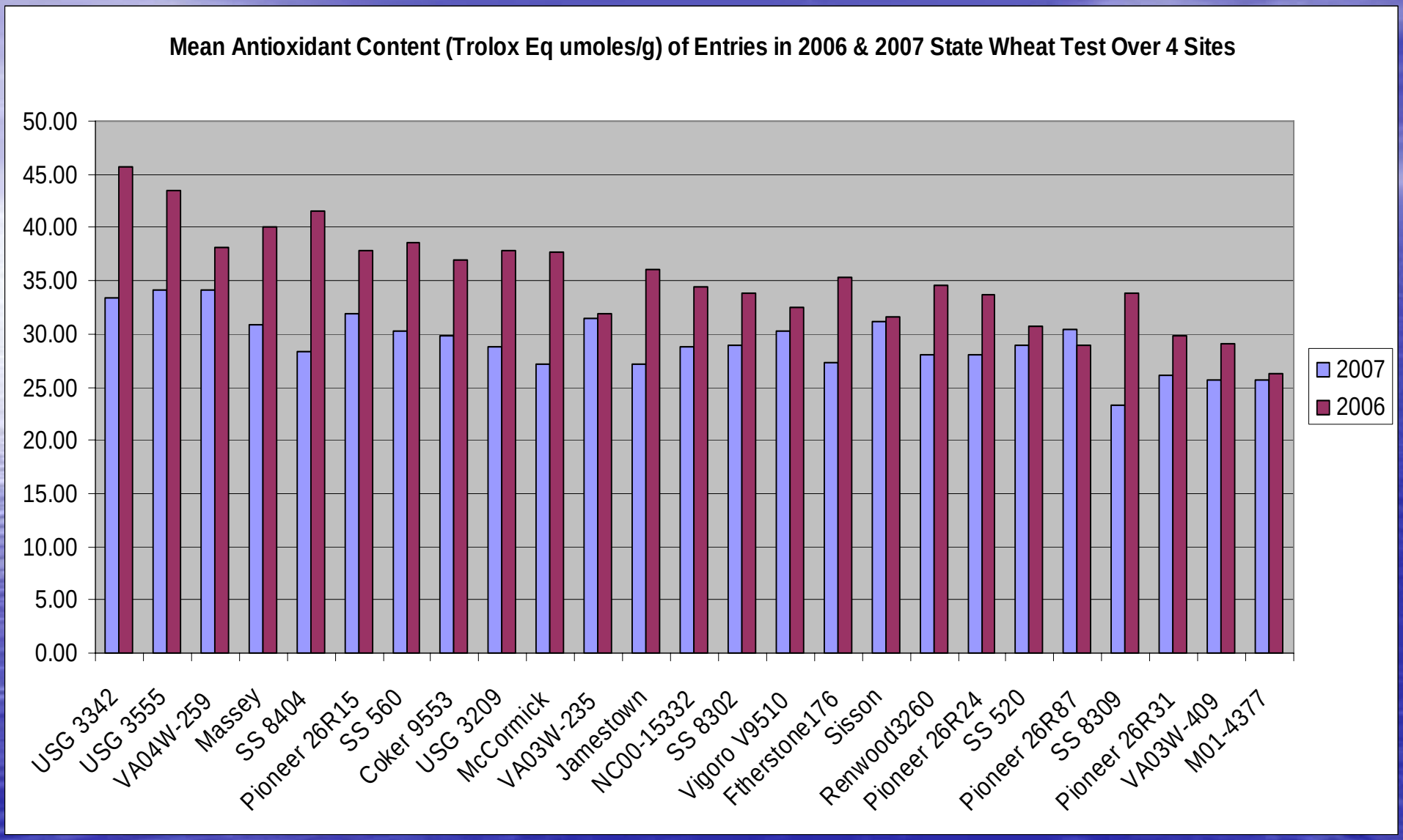
	MIXOGRAPH			SPAGHETTI		COOKED PASTA		
		PEAK	PEAK	COLOR		Cooked	Firm-	
	Pattern	TIME	VALUE			Weight	ness	Residue
LINE		MIN	%	L*	b*	g	g/cm	g
VA05WD-12	5	2.4	64.3	57.7	34.3	32.1	6.1	6.8
VA05WD-16	2	3.0	50.7	55.3	35.0	33.8	4.1	7.4
VA05WD-17	5	3.0	60.7	58.6	37.0	32.3	5.4	7.6
VA05WD-31	2	6.0	39.1	54.9	33.0	33.6	4.3	8.3
VA05WD-40	4	3.0	51.4	57.1	31.8	34.0	4.4	7.1
VA05WD-42	4	3.2	47.3	58.9	34.0	31.4	5.6	7.2
ODESSA#66	2	2.3	49.6	55.3	35.0	33.7	4.2	7.9
ND-STD-ALKABO	5	3.2	60.6	60.3	42.4	30.4	7.0	6.5
Desired#	6=Good	Area %Under				Mean=	Mean=	Mean=
		Mixog. Curve				30-32	5.5-7.0	5.5-6.0

Antioxidant Studies
Dr. Kevin Zhou, Virginia Tech

- Foods that score high in Oxygen Radical Absorbance Capacity (ORAC) "antioxidant analysis" may protect cells and their components (macromolecules) from oxidative damage.
- μmole Trolox equivalents/g (μmol TE/g)
- RDA >3000 μmol TE/g
- 20-30 μmol TE/g in Fresh Grapes
- 100-150 μmol TE/g in Soybean


Antioxidant Content (Trolox Eq, umoles/g) of Entries in 2006 VT State Wheat Test Over 4 Locs
50
45
40
35
30
25
20
15
10
5
0
20
2006
USG 3342
USG 3555
SS 8404
Massey
SS 560
VA04W-259
Pioneer 26R15
USG 3209
McCormick
Coker 9553
Jamestown
Featherstone 176
Renwood 3260
NC00-15332
SS 8302
SS 8309
Pioneer 26R24
V9510
VA03W-235
Sisson (RT)
SS 520
Pioneer 26R31
VA03W-409
Pioneer 26R87
M01-4377


Mean Antioxidant Content (Trolox Eq, umoles/g) of Entries in the 2007 VT State Wheat Test Over 4Sites
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
10
2007
VA04W-259
USG 3555
USG 3342
Pioneer 26R15
VA03W-235
Sisson
Massey
Pioneer 26R87
SS 560
Vigoro V9510
Coker 9553
SS 8302
SS 520
NC00-15332
USG 3209
SS 8404
Renwood 3260
Pioneer 26R24
Featherstone 176
McCormick
Jamestown
Pioneer 26R31
M01-4377
VA03W-409
SS 8309


Mean Antioxidant Content (Trolox Eq umoles/g) of Entries in 2006 & 2007 State Wheat Test Over 4 Sites
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
USG 3342
USG 3555
VA04W-259
Massey
SS 8404
Pioneer 26R15
SS 560
Coker 9553
USG 3209
McCormick
VA03W-235
Jamestown
NC00-15332
SS 8302
Vigoro V9510
Ftherstone176
Sisson
Renwood3260
Pioneer 26R24
SS 520
Pioneer 26R87
SS 8309
Pioneer 26R31
VA03W-409
M01-4377
2007
2006