Title: Cultivar Evaluation for Control of Common Smut in Sweet Corn and High Plains Virus in the Columbia Basin of Oregon and Washington.

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2006 Common smut

Planting date/cultivar evaluation: Thirty-one sweet corn cultivars were evaluated for resistance to natural infection by common smut (Table 1). Plots were seeded to 30,800 plants/acre on May 16 and Jun 23 on the Hermiston Agricultural Research and Extension Center on Adkins fine sandy loam (pH 7.0, 0.6% organic matter). The four 30 ft rows/plot were spaced 30 inches apart. The experimental design was a randomized complete block, with four replications.

Normal commercial production practices were followed. At ear maturity, plant stand was recorded, and the number and location (at base, between base and ear, on ear, between ear and tassel, on tassel) of smut galls were noted for each plant. Some plants had more than one infection location. Data were analyzed with the SAS GLM procedure following arcsine transformation. Duncans multiple range test was used for mean separation. Results are presented in Tables 3-6.

An additional trial planted on June 8 in a commercial field near Moses Lake to evaluate twenty sweet corn cultivars for resistance to High Plains virus was evaluated for incidence of common smut also (Table 5). The corn was detasseled, so there is no data for that location on the plants.

Results

Planting date/cultivar evaluations:
In general, disease pressure was very light in 2006 as compared to the previous years (Table 2). Over the eight years of this trial, the percentage of plants with smut infections at the different plant locations generally increased from the early to later planting (Table 2). In 2006, however, the percent plants with infections on the ear and upper stalk decreased from the early to late planting date (3.26 to 0.54% for ear, 2.66 to 1.07% for upper stalk).

Table 1. Sweet corn cultivars evaluated for common smut resistance, Hermiston, OR. 2006.

Cultivar	Source
su type	
CSUYP2-28	Crookham
GH 1703	Syngenta
GH 2547	Syngenta
GH 2690	Syngenta
GH 6462	Syngenta
Jubilee	Syngenta
Legacy	Harris Moran
Sockeye	Harris Moran
sh_2 type	
170A	Illinois Foundation Seed
179A	Illinois Foundation Seed
1183	Illinois Foundation Seed
Acclamation	Abbott & Cobb
ACX 1074YZ	Abbott & Cobb
ACX 4032W	Abbott & Cobb
ACX 610Y	Abbott & Cobb
ACR 1138Y	Abbott & Cobb
ACR 1262Y	Abbott & Cobb
Crisp n Sweet 710	Crookham
GSS 1477	Syngenta
GSS 2914	Syngenta
Krispy King	Syngenta
Marvel	Crookham
Max	Harris Moran
Overland	Syngenta
Shaker	Seminis
Summer Sweet #500	Abbott & Cobb
Summer Sweet #610	Abbott & Cobb
Supersweet Jubilee	Syngenta
XTH1174	Illinois Foundation Seed
XTH1182	Illinois Foundation Seed
XTH1377	Illinois Foundation Seed

As in past years, the different varieties responded somewhat differently, depending on planting date. At the earlier planting date, the varieties with the highest percent with galls on the base were Legacy, Jubilee and Overland (Table 3), but only Legacy had a significantly higher percent than all the other varieties. Jubilee had the highest percent galls on the lower stalk and ear,

Table 2. Effect of year and planting date on development of common smut of sweet corn,

Hermiston, OR, 1999-2006.

	Gall location				
Cultivar	Base	Lower stalk	Ear	Upper stalk	Tassel
Year[z]		*Percent (%)*			
1999	6.1 c	3.9 e	15.4a	9.3a	23.3 bc
2000	8.2 b	18.6 bc	6.2 cd	7.1 b	21.2 bc
2001	11.5a	22.9a	8.3 bc	5.8 bc	41.8a
2002	7.1 bc	20.1ab	8.9 b	5.8 bc	24.0 b
2003	5.4 c	20.9ab	4.4 de	5.0 c	15.4 d
2004	2.8 d	15.8 c	5.4 de	4.3 c	19.5 c
2005	1.4 d	7.0 de	6.7 bcd	1.8 d	2.8 f
2006	3.3 d	7.9 d	3.6 e	5.2 c	6.9 e
	****	****	****	****	****
Planting date[z]					
Apr/May	2.8	8.5	7.0	5.1	9.4
May/Jun	8.8	21.8	7.9	6.0	31.7
	****	****	NS	*	****

[z] Means of seven cultivars trialed in all 8 years. [NS, ****, *] Effect of year or planting date not significant or significant at P□0.0001 or P□0.05, respectively. Means followed by different letters significantly different at P=0.05 (Duncans multiple range test).

followed by Legacy. Krispy King had the most galls on the upper stalk, followed by Supersweet Jubilee; all the other varieties were similar. And Sockeye and GH 1703 had the highest percent galls on the tassels, followed by Krispy King.

With the later June 23 planting date, Overland, Krispy King and Supersweet Jubilee had significantly more galls on the base than the other varieties (Table 4). Krispy King had the most galls on the lower stalk, ear, upper stalk and tassel.

Disease pressure was greater at the Moses Lake location than at HAREC (Table 5). Krispy King and Supersweet Jubilee had the most plants with galls located at the base. And Jubilee again had the highest percent plants with galls on the lower stalk and ear.

Table 6 summarizes the most and least susceptible varieties of those included in at least 2 of the 8 years this trial has been conducted.

Table 3. Susceptibility of sweet corn cultivars to common smut,
May 16 planting, Hermiston, OR., 2006.

	Gall location				
Cultivar	Base	Lower stalk	Ear	Upper stalk	Tassel

su type				Percent (%)								
CSUYP2-28	0.3	b	3.1	bcde	1.3	bc	0.2	c	2.3	bcd		
GH 1703	0.9	ab	4.6	bcde	2.6	bc	0.8	c	16.6	a		
GH 2547	0.3	b	4.5	bcde	2.4	bc	0.2	c	1.5	bcd		
GH 2690	1.0	ab	6.0	bcde	5.3	bc	0.3	c	0.8	cd		
GH 6462	0.7	ab	2.3	bcde	1.1	bc	0.3	c	1.0	cd		
Jubilee	2.4	ab	12.2	a	26.6	a	4.0	c	7.3	bcd		
Legacy	2.9	a	7.5	ab	7.5	b	0.0	c	9.9	abc		
Sockeye	0.4	b	6.6	abcd	1.6	bc	0.2	c	17.5	a		
sh_2 type												
170A	0.3	b	0.0	e	1.5	bc	2.0	c	0.7	cd		
179A	0.5	b	0.7	de	4.1	bc	0.6	c	0.2	d		
1183	0.3	b	2.1	bcde	0.5	c	0.0	c	0.8	cd		
Acclamation	0.0	b	0.0	e	2.1	bc	0.4	c	0.8	cd		
ACX 1074YZ	0.7	ab	1.0	cde	4.4	bc	1.4	c	2.8	bcd		
ACX 4032W	0.3	b	0.0	e	5.3	bc	2.0	c	1.5	bcd		
ACX 610Y	0.0	b	1.7	bcde	0.9	bc	0.9	c	1.8	bcd		
ACR 1138Y	0.6	ab	0.2	de	3.3	bc	1.3	c	0.2	bcd		
ACR 1262Y	0.0	b	0.5	de	3.0	bc	3.2	c	5.4	bcd		
Crsp n Swt 710	0.0	b	7.2	abc	2.3	bc	1.0	c	2.6	bcd		
GSS 1477	0.0	b	1.0	cde	1.3	bc	1.8	c	1.6	bcd		
GSS 2914	1.0	ab	3.9	bcde	2.3	bc	4.1	c	3.5	bcd		
Krispy King	0.2	b	4.1	bcde	3.0	bc	27.9	a	10.4	ab		
Marvel	0.0	b	0.3	de	0.0	c	0.1	c	0.6	cd		
Max	0.0	b	1.2	bcde	4.4	bc	1.9	c	3.5	bcd		
Overland	2.2	ab	3.8	bcde	1.2	bc	2.7	c	4.3	bcd		
Shaker	0.0	b	0.9	cde	0.3	c	0.7	c	3.6	bcd		
Smmr Swt #500	0.0	b	0.8	de	2.0	bc	0.8	c	2.4	bcd		
Smmr Swt #610	0.0	b	0.2	de	0.1	c	2.1	c	1.9	bcd		
Sprswt Jubilee	0.0	b	1.0	cde	2.0	bc	11.8	b	7.0	bcd		
XTH1174	0.0	b	0.0	e	3.7	bc	4.7	c	0.8	cd		
XTH1182	0.0	b	4.1	bcde	2.2	bc	0.2	c	0.4	cd		
XTH1377	0.2	b	0.4	de	3.9	bc	3.8	c	2.8	bcd		
	*		****		****		****		****			

, ** Cultivar effect significant at P□0.01 or P□0.0001, respectively. Means followed by different letters significantly different at P=0.01 (Duncans multiple range test).

Table 4. Susceptibility of sweet corn cultivars to common smut, June 23 planting, Hermiston, OR., 2006.

	Gall location				
Cultivar	Base	Lower stalk	Ear	Upper stalk	Tassel
su type			Percent (%)		
CSUYP2-28	0.3 e	0.7 g	0.0 c	0.2 d	0.0 g
GH 1703	1.9 cde	2.0 fg	0.4 bc	0.2 d	14.1abcd
GH 2547	0.5 e	1.2 g	0.0 c	0.2 d	0.0 g
GH 2690	1.5 de	0.9 g	0.1 c	0.0 d	0.3 g
GH 6462	2.7 cde	3.1 fg	0.1 c	0.0 d	1.1 fg
Jubilee	3.8 cde	9.5 cdefg	0.3 bc	0.8 d	5.8 cdefg
Legacy	1.3 de	0.6 g	0.3 bc	0.0 d	0.0 g
Sockeye	0.7 e	1.3 fg	0.2 c	0.0 d	1.2 fg
sh_2 type					
170A	0.6 e	0.6 g	0.6 bc	0.2 d	15.6abc
179A	0.7 e	0.7 de	0.5 bc	2.3 cd	2.4 efg
1183	1.8 cde	3.9 fg	0.1 c	0.5 d	5.1 defg
Acclamation	0.7 e	1.0 g	0.5 bc	0.5 d	9.5 bcdefg
ACX 1074YZ	1.7 de	1.5 fg	0.2 c	1.4 c	10.1 bcdefg
ACX 4032W	1.6 de	3.0 fg	1.4abc	1.1 d	7.6 cdefg
ACX 610Y	3.2 cde	6.2 defg	0.2 c	0.0 d	2.9 efg
ACR 1138Y	2.9 cde	1.2 g	0.8 bc	1.3 c	3.7 defg
ACR 1262Y	2.3 cde	3.8 fg	0.5 bc	0.2 d	7.1 cdefg
Crsp n Swt 710	1.6 de	4.6 efg	1.9ab	0.8 d	4.6 defg
GSS 1477	1.2 de	3.1 fg	0.3 bc	0.6 d	0.9 fg
GSS 2914	6.9 bc	18.4ab	0.7 bc	4.1 bc	2.7 efg
Krispy King	10.9ab	22.3a	2.8a	9.9a	20.2a
Marvel	2.1 cde	1.6 fg	0.0 c	1.7 cd	4.1 defg
Max	2.7 cde	4.1 fg	0.0 c	0.5 d	1.6 fg
Overland	12.7a	15.1abc	0.5 bc	0.7 d	1.9 efg
Shaker	1.5 de	2.2 fg	0.9 bc	0.0 d	17.7ab
Smmr Swt #500	3.6 cde	4.9 efg	0.6 bc	0.8 c	11.4abcdefg
Smmer Swt #610	6.1 cd	14.1abcd	0.2 c	0.4 d	5.0 defg
Sprswt Jubilee	10.8ab	13.3 bcde	1.3 bc	6.3 b	4.2 defg
XTH1174	2.7 cde	2.1 fg	0.2 c	0.2 d	6.3 cdefg
XTH1182	5.1 cde	10.7 bcdef	1.0 bc	0.7 d	8.1 bcdefg
XTH1377	0.7 e	0.8 g	0.2 c	0.0 d	12.3abcde
	****	****	***	****	****

, ** Cultivar effect significant at P□0.01 or P□0.0001, respectively. Means followed by different letters significantly different at P=0.05 (Duncans multiple range test).

Table 5. Susceptibility of sweet corn cultivars to common smut, Friehe Farms, Moses Lake, WA., 2006.

	Gall location			
Cultivar	Base	Lower stalk	Ear	Upper stalk
su type		Percent (%)		
Elite	18.9ab	27.2 cde	2.1 bc	0.7
GH 2547	12.0abcd	16.4 ef	1.6 bc	0
GH 2690	8.2 bcd	26.6 cde	0.3 c	0
GH 6462	5.7 cd	13.9 efg	0.6 bc	0
Harvest Gold	1.9 d	3.0 g	0.8 bc	0
Intrigue	5.3 cd	20.2 def	1.4 bc	1.4
Jubilee	13.2abc	71.7a	6.7a	4.0
Legacy	13.8abc	15.6 efg	3.5abc	0
Sockeye	2.8 cd	16.0 ef	0.7 bc	0
su/se type				
Chase	9.2abcd	17.4 ef	0.7 bc	0
Powerhouse	4.8 cd	8.8 fg	0.3 c	0
sh_2 type				
Basin	3.2 cd	11.4 fg	2.0 bc	0
Crisp n Sweet 710	11.1abcd	32.2 cd	4.1ab	0.
Krispy King	19.7a	51.0 b	2.1 bc	0.6
Marvel	3.4 cd	2.2 g	0.3 c	0.2
Max	8.3 bcd	11.8 fg	3.4abc	0.2
Shaker	6.4 cd	18.6 ef	0.7 bc	0
Summer Sweet #500	10.3abcd	16.9 ef	3.9abc	0.2
Summer Sweet #610	10.2abcd	21.8 cde	1.2 bc	0.6
Supersweet Jubilee	20.4a	37.0 c	2.6 bc	1.7
	****	****	****	NS

NS, **** Cultivar effect not significant or significant at P#0.0001, respectively. Means followed by different letters significantly different at P=0.01 (Duncans multiple range test).

Table 6. Susceptibility of sweet corn cultivars[z] to common smut infection of the ear, Hermiston, OR., 1999-2006.

Cultivar	Ears infected	Years tested
	(%)	*(No.)*
Most susceptible		
1861	16.1	3
Jubilee	13.4	8
2684	12.5	3
Challenger	11.0	3
ACX1703	10.5	3
Supersweet Jubilee	9.5	8
Accession	8.4	2
Krispy King	8.0	8
Least susceptible		
Cinch	1.1	4
ACX232	1.1	5
Intrigue	1.0	3
Eliminator	0.9	3
GH2547	0.9	7
Marvel	0.7	7
Conquest	0.6	3
Maestro	0.6	2
Sockeye	0.6	6
GH2148	0.3	2

[z] Of the 60 cultivars evaluated in at least 2 of the 8 trial years.

High Plains Virus

To determine if there is High Plains virus resistance in commercial processing sweet corn cultivars, trials were conducted at the Hermiston Agricultural Research & Extension Center, and in two commercial sweet corn production fields near Moses Lake and Pasco, WA. At each location, twenty cultivars (Table 7) currently in production across the Columbia basin were evaluated. Four 30=rows/plot, 30@ apart, with 9@ between plants, were seeded on Jun 7 and Jun 8 with overhead center pivot irrigation at the HAREC and off-station (Friehe Farms and Ron Riemann Farms) sites, respectively. Normal commercial production practices were followed. The experimental design was a randomized complete block, with four replications.

Table 7. Cultivars evaluated for High Plains virus susceptibility, 2006.

Cultivar	Source
su:	
Elite	Syngenta
GH 2547	Syngenta
GH 2690	Syngenta
Harvest Gold	Seminis
Intrigue	Crookham
Jubilee	Syngenta
Legacy	Harris Moran
Sockeye	Harris Moran
se/su:	
Chase	Seminis
Powerhouse	Seminis
sh_2:	
Basin	Seminis
Crisp n Sweet 710	Crookham
Krispy King	Syngenta
Marvel	Crookham
Max	Harris Moran
Shaker	Seminis
Sheba	Seminis
Summer Sweet #500	Abbott & Cobb
Summer Sweet #610	Abbott & Cobb
Supersweet Jubilee	Syngenta

Plants were observed for symptom development during the growing season. At each observation, leaf samples of newly symptomatic plants were taken for lab confirmation of infection. Off-station plots were visually evaluated for HPV symptoms on Aug 4 and Aug 29,

while plots at HAREC were evaluated on Aug 11 and Aug 31. HPV infection was low at all three locations during 2006. Only 22, 22, and 15 plants from HAREC, Friehe Farms, and Riemann Farms respectively expressed symptoms associated with HPV infection. Leaf samples from those plants were tested by PCR for HPV and results indicated 0, 2, and 2 of the symptomatic plants were positive for HPV. As a result of the extremely low HPV infection at all three locations, conclusions on HPV resistance within the varieties tested can not be drawn.

At the HAREC location, 400 plants evenly distributed across a large block planting were evaluated weekly for symptom development. Each plant was sampled weekly, and samples stored for later PCR testing. By season end, 26 plants exhibited symptoms consistent with HPV infection. At maturity, ears were harvested from twenty-one symptomatic plants, and twenty-one non-symptomatic plants. Ear characteristics were then measured (Table 8). Data were analyzed using SAS GLM procedure. Ear fresh weight, length, and diameter were significantly reduced for the symptomatic as compared to non-symptomatic plants. However, laboratory PCR testing of leaf samples confirmed only 5 plants to be infected with HPV. Samples were then tested for Wheat Streak mosaic virus, and were found negative. Testing is currently underway for presence of Maize dwarf mosaic virus.

Table 8. Effect of apparent virus on sweet corn ear characteristics, Hermiston, OR., 2006.

	Fresh weight (oz)	Length (in)	Diameter (in)
Symptomatic			
Yes	8.1	6.85	1.70
No	12.0	8.86	2.09
	****	**	**

, ** Effect significant at P#0.01, or P#0.0001, respectively.

Processing Quality Evaluation

Methods: Five *su* corn varieties and four *sh*$_2$ (supersweet) varieties that have been shown to be smut resistant in field trials along with Jubilee as a standard were harvested on September 9, 2005, at the HAREC. Forty to fifty whole unhusked ears of each variety were packed in ice and driven to the OSU Food Science department in Corvallis that afternoon. All varieties were processed on the following day. After husking, six ears were selected for whole ear evaluation. Ears were blanched in a steam kettle, cooled, and frozen in the –35°F blast freezer. Kernels were cut from the remaining ears with a pilot scale TUC cutter, steam blanched on a continuous belt blancher, quickly cooled, packed in foil and plastic laminated pouches, and frozen in the –35°F blast freezer. Both whole ears and cut kernels were moved to –10°F for storage the following day.

Problems were encountered in harvesting at the correct maturity since all varieties were harvested on the same day. There was also some cross pollination of the sh_2 varieties which led to some contamination.

Varieties processed were:
Normal (*su*): Jubilee, GH 2547, Intrigue, Legacy, Powerhouse, Sockeye
Supersweet (*sh*$_2$): Basin, Max, Marvel, Shaker

Moisture tests performed on frozen kernel samples produced the following data:

Jubilee	75.3%
GH 2547	72.0%
Intrigue	66.5%
Legacy	69.2% (est.)
Powerhouse	69.6%
Sockeye	67.7%
Basin	72.3%
Marvel	74.4%
Max	76.8%
Shaker	71.8%

Industry Evaluation

Twelve industry members attending the November 2006 meeting of the Pacific Northwest Vegetable Association in Pasco, WA, rated frozen whole ear and cut kernel samples for color, kernel size & shape, flavor, tenderness, and ear shape. The rating scale ranged from 1 (totally unacceptable) to 9 (superior). Results were analyzed using Analysis of Variance (ANOVA) and Tukey's Honestly Significant Difference test (HSD). The ANOVA test yields a value for the mean score. Tukey's HSD test yields a value for the minimum difference required between two values for that difference to be statistically significant at the 95% confidence limit.

Results

Normal (su) varieties: There were no statistically significant differences among the samples for any attribute.

However –
Color: All varieties were rated similarly except Intrigue, which was rated the lowest.

Kernel Size and Shape: Jubilee was rated highest and Sockeye was rated lowest.

Flavor: Evaluators didn't like any for flavor but Jubilee was rated especially low.

Tenderness: GH 2547 was rated most tender for the second year. Sockeye was rated least tender.

Ear Shape: GH 2547 and Sockeye were rated highest for ear shape. Powerhouse, Jubilee, and Intrigue were rated lower.

Supersweet (sh_2) varieties: There were no statistically significant differences among the sample for ANY attribute except for Tenderness.

Color: Shaker was rated highest.

Kernel Size and Shape: Basin and Shaker were rated higher than Marvel and Max.

Flavor: Max and Marvel were rated higher than Shaker and Basin.

Tenderness: Marvel was rated highest and Basin was rated lowest. This was the only statistically significant difference found in this evaluation.

Ear Shape: Shaker was rated highest.