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Sugar-enhanced and Synergistic Sweet Corn Cultivar Evaluation for Northern Indiana, 2015

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Indiana sweet corn acreage harvested for fresh market averaged 5,133 acres annually from 2012-2014, with a yield of 68 hundredweight per acre (162 crates or 3.4 tons per acre) and an annual value of \$12.3 million (USDA NASS, 2015). Indiana ranked 13th among states for production of fresh market sweet corn and produced about 1.7% of the nation's total in 2014. The 2012 USDA Ag Census reported 535 Indiana farms producing sweet corn for fresh markets and 69 farms selling to processors. Sweet corn fields for fresh market sales are located throughout the state. In northern Indiana, bicolor corn is most commonly grown. Varieties with improved eating quality are of interest to both producers and consumers. Producers are also interested in yield, ear size, appearance, and agronomic characteristics.

This paper reports on seven bicolor and two yellow sugar-enhanced or synergistic sweet corn entries that were evaluated at the Pinney-Purdue Agricultural Center in Wanatah, Indiana.

Materials and Methods

The trial was conducted on a Tracy sandy loam. The fall 2014 soil test showed 1.6% organic matter, pH 6.3, and 94 ppm phosphorus (P), 92 ppm potassium (K), 125 ppm magnesium (Mg), and 600 ppm calcium (Ca). Potassium was applied in fall 2014 as 275 lb./A of 0-0-60. Nitrogen, 40 lb./A N from urea ammonium nitrate solution, was applied by injecting perpendicular to rows prior to final seedbed preparation in 2015. An additional 50 lb./A N from urea ammonium nitrate solution was injected on June 11.

The trial was set up as a randomized complete block design with three replications. Sweet corn entries were assigned to individual plots one row wide (30 inches) by 30 feet long. Corn was seeded May 14, 2015, with a finger pick-up planter set to drop seeds 10.125 inches apart (20,600 plants per acre) and later thinned to 35 plants per 30-foot row (20,328 plants per acre).

Weeds were controlled with atrazine (Atrazine 4L[®]) and s-metolachlor (Dual II Magnum[®]) applied preplant incorporated, cultivation, and hand weeding. Irrigation was applied from an overhead boom as needed.

Emergence was evaluated 13 and 21 days after planting (DAP) and final stand determined 21 DAP, after thinning. Plant vigor was evaluated 21 DAP and shortly before harvest. Also shortly before harvest, plant height, and the height from the soil to the middle of the top ear was measured for three plants per plot, and degree of tillering was rated. Each plot was harvested when corn reached marketable stage, which occurred 21 to 24 days after 50% silking.

For each plot the weight and number of marketable first ears and number of marketable ears that were fancy were recorded. Three ears from each plot were selected to evaluate degree of husk cover, husk tightness, degree of tip fill, flag leaf length, overall attractiveness, average ear diameter and length after husking, and shank length. Overall ear quality was also rated. Two people rated the flavor of all entries based on one uncooked ear per taster from each plot, and

additional individuals rated just some entries. Rating scales are described in table footnotes. Letter ratings for flavor were converted to numerical ratings for statistical analysis.

Quantitative data with equal variance across treatments ($P > .05$) were analyzed using ANOVA followed by mean separation using Fisher's protected least significant difference at $P \leq 0.05$. When one or two varieties showed a variance of 0 for a particular trait, ANOVA was conducted without those varieties to achieve equal variances. Regression analyses were used to evaluate correlation between mean responses for each entry and mean days to harvest (DAP); r^2 values for linear regressions significant at $P \leq .05$ are reported.

Results and Discussion

Temperatures were at or just below normal the first 10 days after planting, and averaged 0.3°F, 3.5°F, and 0.3°F below normal in June, July, and the first half of August, respectively. From July 6, when early varieties were just past 50% silking, to August 9, when most varieties had been harvested, growing degree day (GDD, base 50°F) accumulation was 40 GDD below normal. From May 11 to August 9 the accumulation was 1,635 GDD, 67 less than normal. May through the first part of July was fairly wet, with 15.9 inches and 33 days of rain from May 4-July 19, 5.6 inches above normal. No measurable rain fell from July 20 through August 15 except for 1.35 inches on August 3. (USDA NASS, 2015 and MRCC, 2015.).

By 13 DAP, emergence ranged from 14% to 88% of the desired stand of 20,328 plants per acre (Table 1). Varieties with emergence 70% or better did not differ significantly from the best (BC 0528) and included Sweetness, Alto, Aspire, and Latte. The lower emergence of the other varieties was most likely due to old seed (Temptation and Ambrosia) or lack of seed treatment (Who Gets Kissed, My Fair Lady, and Bling). The varieties without seed treatment were all certified organic.

Early plant vigor ranged from 1.0 to 6.7 on a scale of 1 (poor) to 9 (excellent) and averaged 4.4 (Table 1). Sweetness, Latte, Aspire, Alto, and BC 0528 all received ratings of 5.3 or above and did not differ significantly. Last year, Latte had the highest early vigor, and Alto, Profit, and Temptation were rated 5 or better (Maynard, 2015). Varieties with low early vigor this year included Bling, My Fair Lady, and Who Gets Kissed. Plant vigor ratings near harvest ranged from 5.3 to 8.3 and averaged 7.1 (Table 1). Significant differences among varieties could not be detected.

Plant height ranged from 4.9 to 6.5 feet and averaged 5.9 feet (Table 1). Varieties separated into two groups: those taller than 6 feet included Bling, BC 0528, My Fair Lady, Ambrosia, Aspire who Gets Kissed, and Temptation. Alto, Sweetness, and Latte were between 4.8 and 5.3 feet. Days to harvest explained 84% of the variation in plant height: later varieties tended to be taller. Corn was shorter this year than in 2014, but similar relative heights were observed: Latte was the shortest variety in both 2014 and 2015, and Alto was intermediate between the tallest and shortest varieties.

Tiller ratings ranged from 1.3 to 5.0 on a scale of 1 (no tillers) to 5 (many tillers tall enough to interfere with harvest) and averaged 3.2 (Table 1). Bling and My Fair Lady both consistently received ratings of 5, and Who Gets Kissed averaged 4.7. The low population of these varieties probably contributed to the growth of tillers; it is documented that corn produces more tillers at low plant populations. BC 0528 (4.3) and Latte (3.3) were not significantly different from Who Gets Kissed. Ambrosia, Temptation, Aspire, and Alto received ratings from 2 to 2.7 — not

significantly different from Latte. Alto and Sweetness, both with very few tillers (1.3) were rated significantly lower than Latte. Last year, Alto was also among the varieties with the least tillering.

Results for yield and ear quality are presented in Table 2. Per acre yields have been calculated by multiplying plot yields by the number of plots per acre and likely overestimate expected yield from field scale production. Marketable yield averaged 5.2 tons per acre, and ranged from 1.9 to 9.3 tons per acre. Differences among entries were highly significant. BC 0528 produced the greatest weight of marketable ears, 9.3 tons per acre, significantly more than any other variety. Aspire, Alto, Sweetness, and Latte yielded between 7.3 and 5.8 tons per acre, and did not significantly differ from one another. Varieties with low emergence and plant stand also had low yield.

Marketable ear yield in dozens per acre ranged from 306 to 1,436 and averaged 942. BC 0528 produced the greatest number but did not differ significantly from Sweetness, Alto, or Latte. Aspire was similar to Latte. Varieties with low emergence and plant stand also had low yield.

The number of fancy ears ranged from 145 to 1,291 dozen per acre and averaged 636 (data not shown). Differences among entries were significant. BC 0528, Aspire, and Latte produced more than 1,000 dozen fancy ears — significantly more than Sweetness, Temptation, Who Gets Kissed, and Bling (all less than 500 dozen). Ambrosia, My Fair Lady, and Alto averaged between 500 and 600 dozen fancy ears and did not differ significantly from one another or from Latte. The percentage of marketable ears that were fancy ranged from 21 to 94% and averaged 68% (data not shown). Differences among entries were borderline significant ($P < .06$). Aspire, My Fair Lady, Latte, and BC 0528 produced 88% or higher fancy ears. Half or more of the ears of Temptation (77%), Ambrosia (62%) and Who Gets Kissed (54%) were rated fancy. For Bling (49%), Alto (42%), and Sweetness (29%), less than half the marketable ears were rated fancy. Similar to this year, in 2014, Latte also produced more than 90% fancy ears, and about 80% of Temptation ears were fancy. Alto did not do as well this year as last, when it produced about 80% fancy ears.

Average weight per ear (including the shank) ranged from 0.70 to 1.08 lb. and averaged 0.97 lb. Differences among entries were highly significant ($P < .0001$). BC 0528, My Fair Lady, Aspire, and Bling all produced ears averaging more than 1 lb. and did not differ significantly from one another. Ambrosia, Who Gets Kissed, and Temptation produced ears between 0.9 and 1.0 lb. and did not differ from one another. Latte and Alto had ears of similar weight: 0.78 to 0.83 lb. Sweetness had the lightest ears: 0.70 lb. In 2014 also, ears of Temptation were heavier than ears of Latte or Alto, and numerically (though not statistically) lighter than those of Ambrosia. Days to harvest explained 85% of the variation in average weight per marketable ear, with later varieties tending to produce heavier ears.

Ear length ranged from 7.6 to 8.7 inches, and diameter ranged from 1.71 to 2.08 inches. Aspire, Ambrosia, Bling, and BC 0528 produced ears longer than 8.25 inches and did not differ significantly. Temptation produced the shortest ears, but not significantly shorter than Sweetness, Alto, My Fair Lady, or Latte. Who Gets Kissed was very close in length to Latte, both about 8 inches. Ambrosia, My Fair Lady, Bling, Temptation, and Who Gets Kissed had ears close to 2 inches in diameter and did not differ significantly. Sweetness had the narrowest ears, 1.71 inches, but not significantly narrower than Latte or Alto. Diameter of ears from BC 0528 and Aspire was intermediate, around 1.9 inches. For those varieties that were trialed in 2014, the relative ear

lengths and diameters were similar to this year. Days to harvest explained 48% of the variation in average length and 40% of the variation in average diameter per marketable ear, with later varieties producing longer and wider ears.

Shank length ranged from 3.1 to 7.1 inches and averaged 5.6 inches. Differences among entries were significant ($P < .01$). Shanks on Aspire averaged more than 7 inches, but were not significantly longer than those for Bling, My Fair Lady, BC 0528, Who Gets Kissed, Temptation, or Latte, which all had shanks averaging at least 5.6 inches. Shanks of Alto, Ambrosia, and Sweetness averaged between 3 and 4 inches and did not differ significantly. Ambrosia and Alto were also among the shortest-shank varieties in 2014. Days to harvest explained 52% of the variation in shank length, with later varieties producing longer shanks

Ear height from the soil to mid-ear ranged from 14.6 to 26.2 inches and averaged 21.8 inches. Varieties with ears 22 inches or more above the soil included Aspire, BC 0528, Who Gets Kissed, Ambrosia, and Bling. These did not differ significantly. Sweetness produced ears closest to the ground (14.5 inches), but not significantly different from Latte (17.3 inches). Latte was also among the varieties with ears closest to the ground in 2014. Alto, Temptation, and My Fair Lady had ears 17 to 22 inches above the ground, but did not differ significantly. Days to harvest explained 78% of the variation in ear height, with later varieties producing ears farther off the ground.

Husk cover ratings averaged 3.5 (on a 1 to 5 scale, with 5 best). BC 0508 received the top rating of 5.0. Others with ratings averaging greater than 3.5, meaning more than 1.25 inches of husk cover on most ears, included: Who Gets Kissed, My Fair Lady, and Aspire. Other varieties with at least 3/4 inch of husk covering the tip on most ears: Latte, Temptation, Bling, and Ambrosia. Alto and Sweetness had less than 3/4 inch of cover on most ears. Husk tightness rating ranged from 1.1 to 2.89 on a 3-point scale, and averaged 1.52. Aspire and BC 0528 received the highest ratings, but were not significantly different from Temptation (2.22). The remaining varieties received ratings less than 2 and did not differ significantly from Sweetness, which was rated 1.11 for husk tightness. In 2014 Temptation also received higher husk cover ratings than Ambrosia, Alto, and Latte. Days to harvest explained 42% of the variation in husk cover, with later varieties producing ears with better husk cover.

Tip fill rating ranged from 2.1 to 5.0 and averaged 3.8. Varieties with all sampled ears filled completely to the tip included Temptation and My Fair Lady. This was also true in 2014 for Temptation. Varieties with ears filled within 1/2-inch of the tip (rating greater than 4) included Alto, Latte, BC 0528, and Aspire. These varieties did not differ significantly. Ambrosia ears had at more than 1 inch unfilled on most ears (rating 2.1), but the rating was not significantly different than that for Who Gets Kissed (3.0). Sweetness and Bling averaged less than 1 inch of unfilled cob at the tip, putting them in between Who Gets Kissed and Aspire. In 2014, Temptation, Latte and Alto all had ratings of at least 4.9, and Ambrosia received the lowest rating of 2.2, showing consistency in this trait across years.

Overall ear quality rating ranged from 3.3 to 8.0 and averaged 6.1 on a 9-point scale. Latte and Temptation received ratings of 8 (Temptation received the highest rating in 2014 and 2013 also). Aspire, BC 0528, and My Fair Lady received ratings between 7.7 and 6.3 and did not differ significantly from each other or from Temptation. Who Gets Kissed received the lowest rating of 3.3, but this was not significantly lower than ratings of Bling, Sweetness, or Ambrosia. The low rating of Who Gets Kissed was in part due to the variation in ear size and color, which is not

unexpected for an open pollinated variety. Ambrosia received a low overall rating in 2014 also. Latte received a better rating this year than in 2014.

Flavor ratings by two people ranged from 2.2 to 4.2 on a 5-point scale and averaged 3.4 (Table 1). Varieties that received ratings of 4 or greater included Aspire (4.0), BC 0528 (4.0), and Temptation (4.2). Varieties that received ratings less than 3 included My Fair Lady (2.8), Latte (2.8), and Who Gets Kissed (2.2). Sweetness received a rating of 4.7 from one individual and 3.0 from the other.

Among the two varieties harvested 75-77 DAP, Latte stood out for its long (nearly 8-inch) ears, high overall ear quality, excellent tip fill, decent yield, and high proportion of fancy ears. Plants of Latte were the shortest in the trial, but had good early vigor. A number of ears had a second, very small, unmarketable ear attached. The other early variety, Sweetness, had the lightest ears in the trial, slightly (but not significantly) shorter and narrower than Latte, and with shorter shanks. Sweetness was notable for good emergence, good early vigor, and high numbers of ears produced. However, husks were loose and did not cover the ear well, allowing sap beetles easy access to kernels at the tip of the ear. Plants were short with ears close to the ground, as is often the case for early varieties, and produced few tillers.

Alto and Temptation were both harvested 78 to 81 DAP Alto yielded better than Temptation, due to low emergence of Temptation most likely explained by old seed. Temptation generally had better ear quality.

The three organic varieties, bicolors My Fair Lady and Who Gets Kissed, and the yellow Bling, were harvested 85 to 89 DAP. Yield was low in these varieties, due most likely untreated seed that led to low emergence. The wet weather around and after planting time provided a good environment for seed and seedling pathogens that could readily attack seeds that did not have protection from a fungicide. As a result of the low emergence our evaluation doesn't necessarily reflect performance at a typical sweet corn population. My Fair Lady produced ears just shorter than 8 inches long and about 2 inches across with good husk cover, acceptable tip fill, and long shanks. More than 90% of the ears were considered fancy. It is certainly worth another look in a trial. Who Gets Kissed produced ears more than 8 inches long with good husk cover, acceptable tip fill, and long shanks.

As mentioned above, this is an open pollinated variety. As a result, harvested ears did not appear uniform and kernel color varied from yellow to white to bicolor. This is not the norm for sweet corn. Without more feedback from final purchasers and growers it is hard to know whether the lack of uniformity will make this variety unacceptable. It is worth another look in a trial situation. Bling was among the last varieties to be harvested. Ears with yellow kernels were more than 8.5 inches long and 2 inches in diameter with acceptable husk cover and tip fill and long shanks. It had the lowest emergence of any variety in the trial. It is worth another look in a trial.

Aspire (yellow) and BC 0528 (bicolor) were both harvested around 88 DAP. These varieties yielded well and produced high percentages of fancy ears. Ears tend towards the long and narrow, with excellent and tight husk cover, good to very good tip fill, and long shanks. Ears are high enough for easier harvest (26 inches). Both of these varieties are transgenic.

Evaluation of results presented in Tables 1 and 2, combined with results from other locations and years should aid producers in selecting varieties best suited to their operations. The relatively small number of varieties in the trial reflects the growing interest in "supersweet" corn types as

opposed to those in this trial with sugar-enhanced and synergistic genetics. A separate trial evaluating supersweet varieties was conducted at the same location, and results are reported in a separate article.

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Table 1. Emergence, final stand, plant characteristics, and eating quality of sugar-enhanced and synergistic sweet corn varieties in northern Indiana, 2015. Varieties listed in order of harvest within kernel color.¹

Cultivar	Emergence %	Stand <i>plants/A</i>	Plant Ht. <i>ft</i>	Tillers ²	Vigor ²		Flavor ³
					<i>Early</i>	<i>Harvest</i>	
<i>Bicolor</i>							
Sweetness	86.7	17,618	4.9	1.3	6.7	5.3	3.8±0.2
Latte	70.5	14,326	4.9	3.3	6.3	6.7	2.8±0.4
Alto	80.0	15,875	5.3	1.3	5.7	<i>6.0</i>	3.5±0.3
Temptation	<i>19.0</i>	<i>5,421</i>	6.1	2.3	4.0	7.3	4.2±0.2
Ambrosia	<i>49.5</i>	<i>10,842</i>	6.3	2.7	4.3	<i>8.0</i>	3.5±0.3
My Fair Lady	<i>34.3</i>	<i>7,163</i>	6.4	<i>5.0</i>	<i>2.0</i>	7.3	2.8±0.2
Who Gets Kissed	<i>39.0</i>	<i>8,518</i>	6.1	4.7	2.3	7.3	2.2±0.2
BC 0528	87.6	18,198	6.4	4.3	5.3	7.7	4.0±0.6
<i>Yellow</i>							
Aspire	71.4	14,133	6.2	2.0	6.0	7.0	4.0±0.0
Bling	<i>14.3</i>	<i>3,485</i>	6.5	<i>5.0</i>	<i>1.0</i>	8.3	3.0±0.3
<i>Grand Mean</i>	<i>55.2</i>	<i>11,558</i>	<i>5.9</i>	<i>3.2</i>	<i>4.4</i>	<i>7.1</i>	<i>3.4</i>
<i>LSD .05⁴</i>	<i>22.1</i>	<i>4,432</i>	<i>0.6</i>	<i>1.9</i>	<i>2.0</i>	<i>NS</i>	—
<i>R² vs DAP⁵</i>	—	—	<i>0.84</i>	<i>0.36</i>	<i>0.35</i>	<i>0.60</i>	—

¹Means in bold do not differ significantly from the highest in that column. Cultivars with means in italics were not included in AOV for that response. Emergence is reported as percent of desired final stand before thinning. Stand was determined after thinning.

²Tillers: 5=most plants with tall tillers; 3=most plants have tillers, but not tall; 1=no or few tillers. Vigor:

9=excellent; 5=average; 1=poor. Mean ± s.e.m.

³Flavor: 5=excellent; 4=very good; 3=good; 2=medium; 1=poor.

⁴Means differing by more than this amount are significantly different at $P \leq .05$ based on Fisher's Protected LSD. NS=not significant. — AOV not performed.

⁵R-squared value for linear regression of response vs. mean of actual days to harvest, if regression significant at $P < .05$. NS=not significant. — Regression not performed.

Table 2. Yield, ear size, and quality of sugar-enhanced and synergistic sweet corn varieties in northern Indiana, 2015. Varieties listed in order of harvest within kernel color.

Cultivar	Seed Source ¹	Days to Harvest ²		Yield of Marketable Ears		Avg. Ear Weight <i>lb</i>	Ear Length <i>in</i>	Ear Dia. <i>in</i>	Shank Length <i>in</i>	Ear Ht. <i>in</i>	Husk Cover ³	Husk Tightness ³	Tip Fill ³	Overall ³
		<i>Pred.</i>	<i>Actual</i>	<i>doz/A</i>	<i>ton/A</i>									
Bicolor														
Sweetness	CR	72	74-78	1,404	5.9	0.70	7.82	1.71	3.07	14.6	2.3	1.1	3.7	5.0
Latte	RI	66	76-78	1,178	5.8	0.83	7.97	1.81	5.69	17.3	3.4	1.6	4.7	8.0
Alto	SY	72	78-81	1,307	6.1	0.79	7.88	1.78	3.85	21.4	2.4	1.2	4.8	5.7
Temptation	SM	72	81	484	2.7	0.93	7.65	2.03	5.97	21.3	3.3	2.2	5.0	8.0
Ambrosia	RU	75	81-85	903	5.3	0.97	8.61	2.08	3.79	22.9	2.8	1.8	2.1	3.7
My Fair Lady	HMS	78	85	613	4.0	1.07	7.89	2.06	6.60	20.8	4.1	1.3	3.3	6.3
Who Gets Kissed	HMS	78	85	629	3.6	0.96	8.10	1.97	6.43	24.7	3.7	1.8	3.0	3.3
BC 0528	SY	81	85-88	1,436	9.3	1.08	8.33	1.93	6.57	26.0	5.0	2.9	4.6	7.7
Yellow														
Aspire	SY	81	88	1,162	7.3	1.05	8.72	1.86	7.14	26.2	4.7	2.9	4.1	7.7
Bling	HMS	75	88-90	307	2.0	1.05	8.60	2.05	6.65	22.4	3.1	1.4	3.2	5.3
<i>Grand Mean</i>			83.2	942	5.2	0.94	8.16	1.93	5.58	21.8	3.5	1.8	3.8	6.1
<i>LSD .05⁴</i>			–	385	1.9	0.08	0.41	0.15	1.84	4.3	1.1	0.7	1.0	2.0
<i>R² vs DAP⁵</i>			–	NS	NS	0.85	0.48	0.40	0.52	0.78	0.42	0.3	NS	NS

¹Seed Source: CR=Crookahm; HMS=High Mowing Seed; RI=Rispens; RU=Rupp; SM=Seminis; SY=Syngenta.

²Days from planting to harvest. Predicted number is from seed supplier. Actual values are range for 3 replications.

³Husk cover: 5=more than 2 inches cover; 4=1.25-2 inches; 3=0.75-1.25 inches; 2=less than 0.75 inch; 1=ear exposed. Husk tightness: 1=loose; 3=very tight. Tip fill: 5=kernels filled to tip of cob; 4=less than 0.5 inch unfilled; 3=0.5-1 inch unfilled; 2=more than 1 inch unfilled; 1=more than 2 inches unfilled. Overall: 1=worst. 9 =best. Mean ± s.e.m.

⁴Means differing by more than this amount are significantly different at $P \leq .05$ based on Fisher's Protected LSD. NS=not significant. Means in bold do not differ significantly from the highest in that column. Cultivars with means in italics were not included in AOV for that response. – AOV not performed.

⁵R-squared value for linear regression of response vs. mean of actual days to harvest, if regression significant at $P < .05$. – Regression not performed.