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Sugar-enhanced and Synergistic Sweet Corn Cultivar Evaluation for Northern Indiana, 2014

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Indiana sweet corn acreage harvested for fresh market averaged 5,233 acres annually from 2011-2013, with a yield of 63 hundredweight per acre (149 crates or 3.1 tons per acre) and an annual value of \$13.9 million (USDA NASS, 2014). Indiana ranked 16th among states for production of fresh market sweet corn and produced about 1.2% of the nation's total in 2013. 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 nine bicolor and one 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 2013 soil test showed 1.5% organic matter, pH 6.3, and 79 ppm phosphorus (P), 164 ppm potassium (K), 165 ppm magnesium (Mg), and 650 ppm calcium (Ca). Nitrogen, 40 lb./A N from urea ammonium nitrate solution, was applied by injecting perpendicular to rows prior to final seedbed preparation in 2014. An additional 50 lb./A N from urea ammonium nitrate solution was injected three weeks after seeding.

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 20, 2014, 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 and with hand weeding. Irrigation was applied from an overhead boom as needed. Permethrin (Arctic 3.2EC[®], 4 fl. oz./A/application) was applied on July 8 and 21 to control caterpillars.

Emergence was evaluated eight and 13 days after planting (DAP) and final stand determined 13 DAP, after thinning. Plant vigor was evaluated 21 DAP and shortly before harvest. Also shortly before harvest, plant height, number and length of tillers, and the height from the soil to the middle of the top ear was measured for three plants per plot. On June 20 and July 1, after strong winds following rain caused lodging, corn was rated for leaning using a scale of 1 (corn flat on ground) to 9 (corn entirely upright). Each plot was harvested when corn reached marketable stage, which occurred 21 to 25 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. One person rated the flavor of all entries based on one uncooked ear 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 $P \leq 0.05$. 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 above normal the first couple of weeks after planting and most of June, then turned cooler than normal in July and early August. From July 6, when early varieties were at 50% silking, to August 10, when most varieties had been harvested, growing degree day (GDD, base 50°F) accumulation was 152 GDD below normal. From May 18 to August 10 the accumulation was 1,552, 94 less than normal. June was exceptionally wet, with 9.6 inches of rain from June 1-29, 5.6 inches above normal. July and early August had slightly below normal rainfall. (USDA NASS 2014).

By eight DAP, emergence averaged 94% of the desired stand; no significant difference among entries was evident (data not shown). Final stand after thinning averaged 19,457, and ranged from 18,392 to 20,328 (data not shown).

Early plant vigor ranged from 3.3 to 7.0 on a scale of 1 (poor) to 9 (excellent) and averaged 5.0 (data not shown). Due to unequal variances, analysis of variance and mean separation was not performed. Latte consistently received the highest rating given: 7 out of 9. Varieties rated as 'average' (5) or better included: Alto, Vitality, Profit, Ambrosia, and Temptation. GH 30932, Essence, Trinity, Utopia were rated as below average for early vigor. Last year at this location, early vigor for Temptation and Utopia was rated higher than for Profit, which in turn was rated as more vigorous than Ambrosia. Plant vigor ratings near harvest ranged from 5.0 to 7.0 and averaged 6.2 (data not shown). GH 30392 was consistently rated 7 out of 9, and Trinity 6 out of 9 for all replications. Ratings for other varieties varied among replications and differences could not be detected.

Plant height ranged from 5.2 to 7.2 feet and averaged 6.4 feet (data not shown). Utopia was taller than 7 feet and significantly taller than all other varieties except Essence. Essence, Profit, and GH 30932 were 6.8 to 7.0 feet and did not differ significantly. Ambrosia and Temptation were about 6.6 feet and did not differ significantly from GH 30392 or Profit. Trinity, Alto, and Vitality were from 5.9 to 5.7 feet and did not differ significantly. Latte was 5.2 feet tall, significantly shorter than all other varieties. Days to harvest explained 61% of the variation in plant height: later varieties tended to be taller. Corn was generally taller this year than in 2013, when excess rain and standing water early in the season appeared to limit plant size.

Tiller number per plant ranged from 0.6 to 2.0 and averaged 1.2. Differences among entries were significant (data not shown). Alto averaged 2.0 tillers per plant, but did not differ significantly from Vitality, GH 30932, Profit, or Utopia, which all averaged at least 1.2 tillers per plant. Trinity had no tillers.

On June 20, lean ratings ranged from 3.3 to 7.7 and averaged 5.2 on a scale of 1 (corn flat on ground) to 9 (corn entirely upright) (data not shown). Varieties with high ratings indicating little lodging included: Alto (7.7) and GH 30932 (7.3). Varieties with low ratings, indicating much

lodging, included Temptation, Latte, and Essence (3.3 to 4.3). Lean ratings recorded on July 1 ranged from 4.3 to 7.3 and averaged 5.9; differences among varieties were difficult to ascertain.

Results for yield and ear quality are presented in Table 1. 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 7.9 tons per acre, and ranged from 5.9 to 10.7 tons per acre. Differences among entries were highly significant. Utopia produced the greatest weight of marketable ears, 10.7 tons per acre, significantly more than any other variety. Utopia was also one of the top yielding varieties in 2013. GH 30932 produced the next greatest yield, 9.3 tons per acre, significantly more than any other variety except Utopia. Essence, Temptation, Profit, and Ambrosia yielded between 8.4 and 7.8 tons per acre, and did not significantly differ from one another. Except for Ambrosia, all yielded more than the remaining four varieties. Latte, Alto, Trinity, and Vitality produced between 7.0 and 5.9 tons per acre; Latte and Alto were significantly greater than Vitality. Days to harvest explained 57% of the variation in yield of marketable ears measured as tons per acre: later varieties tended to yield more.

Marketable ear yield in dozens per acre ranged from 1,436 to 1,613 and averaged 1,529. There were no significant differences among entries. The number of fancy ears ranged from 823 to 1,452 dozen per acre and averaged 1,184 (data not shown). Differences among entries were significant ($P < .01$). Profit and Latte produced significantly more fancy ears (1,452 and 1,371, dozen, respectively) than Trinity (1,016), Vitality (1,000), and Ambrosia (823), but not significantly more than the Temptation (1,275), GH 30932 (1,258), Utopia (1,242), Alto (1,210), or Essence (1,194). The percentage of marketable ears that were fancy ranged from 58 to 92% and averaged 78% (data not shown). Differences among entries were borderline significant ($P < .10$). Profit, and Latte had about 90% fancy ears; Essence, GH 30932, Temptation, Utopia, and Alto approximately 80%, and remaining varieties roughly 60 to 70%. In 2013, Utopia had a higher percentage of fancy ears than Profit.

Average weight per ear (including the shank) ranged from 0.65 to 1.13 lb. and averaged 0.86 lb. Differences among entries were highly significant ($P < .0001$), and mirrored the trend seen in yield measured as tons per acre. Utopia had the heaviest ears, followed by GH 30392, Essence, Ambrosia, and Profit — these varieties all differed significantly. In 2013 Utopia also had the heaviest ears in the trial. Ears of Temptation did not weigh significantly less than those of Profit, but were heavier than ears of Latte, Alto, Trinity, or Vitality. Vitality ears were lighter than any others in the trial. Days to harvest explained 65% of the variation in average weight per marketable ear, with later varieties tending to produce heavier ears.

Ear length ranged from 7.1 to 9.0 inches, and diameter ranged from 1.65 to 2.04 inches. Utopia and GH 30392 produced ears significantly longer than other varieties. Ambrosia was next at 8.6 inches, significantly longer than all except the top two. Essence and Latte produced ears close to 8 inches long, significantly longer than the remaining varieties. Temptation and Trinity had similar ear length of approximately 7.4 inches, and significantly longer than Vitality at 7.1 inches. Profit was slightly longer than Vitality, but didn't differ significantly from it or from Trinity and Temptation. Ambrosia, Essence, GH 30932, Utopia, and Temptation had ears close to 2 inches in diameter and did not differ significantly. Profit, 1.85 inches, did not differ significantly from Temptation, Trinity, or Alto. Latte was the narrowest variety at 1.65 inches, but did not differ significantly from Vitality or Alto. Days to harvest explained 49% of the variation in average length and 60% of the variation in average diameter per marketable ear, with later varieties producing longer and wider ears.

Shank length ranged from 3.4 to 6.9 and averaged 4.9 inches. Differences among entries were highly significant ($P < .0001$). Shanks on Profit averaged nearly 7 inches, but were not significantly longer than those for GH 30932 (6.6 inches) or Utopia (6.0 inches). Utopia, Latte, and Trinity had shanks of similar length, 5.3 to 6.0 inches, and did not differ significantly. Temptation, Essence, Ambrosia and Vitality had shanks from 3.5 to 4.4 inches and did not differ significantly. Alto, had the shortest shanks at 3.4 inches, but not significantly shorter than Vitality or Ambrosia.

Ear height from the soil to mid-ear ranged from 19.9 to 31.9 and averaged 25.1 inches. Due to unequal variances, analysis of variance was not performed. Varieties with ears 29 inches high or more above the soil included Essence, GH 30932, and Utopia. Varieties with ears between 24 and 28 inches included Ambrosia, Alto, and Temptation. Ear height of Profit, Latte, Vitality, and Trinity was between 19 and 22 inches. Days to harvest explained 88% of the variation in ear height, with later varieties producing ears farther off the ground.

Husk cover ratings averaged 3.8 (on a 1 to 5 scale, with 5 best). Two entries received the top rating of 5.0: Essence and Profit. Others with ratings averaging greater than 3.5, meaning more than 1.25 inches of husk cover on most ears, included: GH 30932, Temptation, and Trinity. Profit and Temptation rated high for husk cover in 2013 also. Other varieties had at least 3/4 inch of husk covering the tip on most ears: Alto, Utopia, Latte, Vitality, and Ambrosia (in order from greatest to least husk cover). Husk tightness rating ranged from 1.33 to 3.00 on a 3-point scale, and averaged 1.90. Essence consistently received the highest rating possible, indicating a very tight husk around the ear tip. GH 30932, Profit, and Temptation averaged between 2 and 2.7, indicating reasonably tight husks. The remaining varieties averaged between 1.8 and 1.3 for husk tightness: Trinity, Utopia, Ambrosia, Vitality, Alto, and Latte (in order from tightest to loosest husk cover).

Tip fill rating ranged from 2.2 to 5.0 and averaged 4.4. Varieties with all sampled ears filled completely to the tip included Latte and Temptation. Varieties with most ears filled completely to the tip included Alto, Utopia, and Profit. Utopia and Profit received high ratings for tip fill in 2013 also. Varieties with most ears having less than 1/2 inch unfilled included: Vitality, Essence, Trinity, and GH 30392. Ambrosia had notably worse tip fill than other varieties, with at least 1 inch unfilled on most ears.

Overall ear quality rating ranged from 3.0 to 7.7 and averaged 5.8 on a 9-point scale. Temptation averaged 7.7 (the same as in 2013), and Profit consistently received a rating of 7; in 2013 Profit was also above the trial average for overall ear quality. Essence, Trinity, Utopia, and GH 30932 were rated between 6 and 6.7 fairly consistently. Alto and Latte had the most variable ratings among reps, but averaged 6 and 5 respectively. Vitality and Ambrosia received the lowest overall ratings for ear quality, between 3 and 3.7.

Flavor ratings ranged from 2.3 to 4.3 on a 5-point scale and averaged 3.3 (data not shown). There were not statistically significant differences among entries.

Among the three varieties harvested 68 DAP, Latte stood out for its long, 8-inch ears, excellent tip fill, good yield, and high proportion of fancy ears. Plants of Latte were the shortest in the trial, but had good early vigor. Latte may have been harvested slightly early, based on the narrowness of the ears and notes made at the time of harvest. The other two varieties harvested 68 DAP, Trinity and Vitality, had shorter ears. Trinity had better husk cover, which is probably responsible for its slightly better overall rating compared to Latte.

Alto, Profit, and Temptation were all harvested 73 DAP. Profit looked very promising with a high yield of fancy ears. Although ears were short at 7.2 inches and had very long shanks, tip fill, husk cover and overall quality were comparable to Temptation. Ears of Alto were similar in length to Temptation, with short shanks, and easily 2 feet above the soil.

Between Utopia and Ambrosia, harvested 76 and 78 DAP, respectively, Utopia had the longer ears with long shanks and better tip fill, and produced more fancy ears per acre.

Essence and GH 30932 (yellow kernels) were the longest maturity varieties in the trial, harvested 80 to 85 DAP. Yield and ear quality were similar; GH 30932 had longer ears by about $\frac{3}{4}$ inch, with longer shanks. Tillers on GH 30932 were also long, averaging nearly 32 inches, compared to 18.3 inches for Essence.

Evaluation of results presented in Table 1 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. Yield, ear size, and quality of sugar-enhanced and synergistic sweet corn varieties in northern Indiana, 2014. Varieties listed in order of harvest.

Cultivar	Seed Source ¹	Days to Harvest ²		Yield of Marketable Ears		Avg. Ear Weight lb	Ear Length in	Ear Dia. in	Shank Length in	Ear Ht. in	Husk Cover ³	Husk Tightness ³	Tip Fill ³	Overall ³
		Pred.	Actual	doz/A	ton/A									
Vitality	RU	65	68	1,500	5.9	0.65	7.1	1.69	3.5	19.9±0.2	2.8±0.6	1.6±0.3	4.4±0.1	3.7±0.3
Latte	RI	66	68	1,533	7.1	0.77	8.0	1.65	5.4	21.2±0.1	2.9±0.2	1.3±0.2	5.0±0.0	5.0±1.0
Trinity	RU	70	68	1,468	6.1	0.70	7.4	1.79	5.3	19.8±0.4	3.8±0.1	1.8±0.2	4.1±0.1	6.0±0.6
Alto	SY	72	73	1,565	6.7	0.72	7.5	1.75	3.4	25.2±0.7	3.1±0.1	1.4±0.1	4.9±0.1	6.0±1.0
Profit	RU	72	73	1,581	8.2	0.87	7.2	1.85	6.9	21.6±1.1	5.0±0.0	2.0±0.0	4.8±0.1	7.0±0.0
Temptation	SE	72	73	1,613	8.2	0.85	7.4	1.94	4.4	24.9±0.5	4.6±0.3	2.0±0.2	5.0±0.0	7.7±0.3
Ambrosia	RU	75	76	1,436	7.8	0.91	8.6	2.04	3.7	27.2±0.3	2.7±0.2	1.6±0.3	2.2±0.2	3.0±0.0
Utopia	RU	76	78	1,581	10.7	1.13	9.0	1.96	6.0	29.3±1.9	3.0±0.3	1.7±0.3	4.9±0.1	6.7±0.3
Essence	RU	78	80-85	1,468	8.4	0.95	8.0	1.99	4.3	31.9±0.5	5.0±0.0	3.0±0.0	4.3±0.0	6.7±0.3
GH 30932	SY	82	85	1,549	9.3	1.01	8.8	1.96	6.6	30.4±2.3	4.8±0.1	2.7±0.2	4.0±0.2	6.0±0.0
<i>Grand Mean</i>			74	1,529	7.9	0.86	7.9	1.86	4.9	25.1	3.8	1.9	4.4	5.8
<i>LSD .05⁴</i>			–	<i>NS</i>	0.8	0.03	0.3	0.11	0.9	–	–	–	–	–
<i>R² vs DAP⁵</i>				<i>NS</i>	0.57	0.65	0.49	0.60	<i>NS</i>	0.88	–	–	–	–

¹Seed Source: RI=Rispens; RU=Rupp; SE=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. –=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.