Evaluation of Organic Corn Varieties and Organic Popcorn Varieties and Fertilization Southeast Research Farm, 2015

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Materials and Methods

According to the USDA National Organic Program, certified organic farmers must source organic seed (seed from organically raised crops). The organic seed industry is currently growing in Iowa and the Midwest, and with this growth, organic growers are looking for University-based recommendations on organic varieties to use in Iowa. The Organic Agriculture Program at Iowa State University has been using organic seed at the Southeast Research Farm for fourteen years with excellent results. In addition, a new organic fertilizer (Biotic Organic™ 4-4-4, Perfect Blend, Bellevue, WA) was tested beginning in 2013, and continued in 2014 and 2015, for its effect on organic popcorn production.

Hybrid Corn

There were four corn varieties selected for the 2015 organic variety trial. These included the following varieties: Viking 0.24-02N (Albert Lea Seedhouse, Albert Lea, MN), BR53H36, BR66B77, and BR56M30 (Blue River Hybrids, Ames, IA). Plots measuring 20 x 380 ft. were laid out in a randomized complete block design with four replications of each variety. Turkey manure (5 tons/acre; 3-2-1.5 N-P-K) was spread on the field on November 13, 2014, and plowed under with the 2014 red clover cover crop on April 17, 2015. The field was field-cultivated on May 29 to prepare for planting. Corn was planted at a 2–inch depth at 35,600 seeds/acre on June 1, 2015. Weed management included rotary hoeing on June 3 and June 11, and row cultivation on June 30 and July 6. Corn was harvested on October 16, 2012.

Experimental Organic Corn

Experimental organic corn lines from USDA-ARS were planted in the same field as the organic hybrid corn varieties. With a limited supply of experimental corn seed, there was only one replication of an average of 30 plants of each line. The experimental lines were treated exactly like the hybrid corn as far as field operations.

Plant populations were determined in three randomly selected areas in each replication of each variety on July 8, 2015. Grass and broadleaf weed populations were also counted in square-meter quadrats in three randomly selected areas in each replication of each variety on July 8. Corn plant height and number of ears were counted on three randomly selected plants in each replication on August 21. Stalk nitrate samples were taken on October 1. Harvest samples (200 g) were collected from each plot for grain quality analysis, which was conducted at the ISU Grain Quality Laboratory, Ames, IA.

Popcorn

The third year of the organic popcorn trial followed a conventional soybean field. Plots measuring 10 x 100 ft. were laid out in a randomized complete block design of two varieties (AP2204 and N15262) and two organic fertilizer treatments: with fertilizer and a control (no fertilizer). There were four replications of each treatment. On May 14, 2015, 60 lb/plot of Perfect Blend™ organic 4-4-4 fertilizer was applied to supply 100 lb

N/acre. Plots were field cultivated on May 29 and popcorn seeds were planted at 32,000 plants/acre the same day. Plots were rotary hoed on June 3 and 11; and row cultivated on June 30 and July 6. Plant and weed stands were counted on July 11, 2014. Popcorn harvest occurred on November 10, 2014.

Results and Discussion

A severe drought impacted growth and yield of crops throughout Iowa in 2012, with rainfall 6.4 inches below normal. Despite the drought, organic corn performance was excellent in southeast Iowa. Plant stands were excellent in 2012, averaging 26,604 plants/acre (Table 1). Organic corn yields were also excellent in 2012, averaging 156.3 bu/acre (Table 3). There was a statistical difference in yields among varieties, with organic BR53R57 yielding 143 bu/acre compared to the other varieties yielding 156 bu/acre. Corn stalk nitrate averaged 3,178 ppm nitrate-N, with no differences among varieties (Table 2).

Corn grain quality was good considering the drought (Table 4). Protein levels averaged 8.85% across all varieties, with differences among varieties: BR57H36 and BR53R57 had lower protein levels of 8.45% compared to the other varieties (Table 4). Carbohydrate levels averaged 60.2%, with BR57H36 and BR53R57 having higher levels than the other varieties (Table 4). Oil content averaged 3.75% across all varieties with BR63H30 having the highest oil content at 4.15% and BR53H57 having the lowest at 3.26% (Table 4). These results show great promise for organic seed.

Popcorn

Popcorn plant populations were similar between varieties and between fertilizer treatments, averaging 29,750 plants/acre (Table 5). Grass and broadleaf weeds were also similar between treatments, averaging <1 weed/m^2 for both grass and broadleaf weeds (Table 5). The excellent weed management was due to the rotary hoeing within 3 days of planting and timely cultivation after rotary hoeing. Organic popcorn yields with the use of the Perfect Blend™ organic fertilizer were numerically higher than the control, at 1,511 lb/acre compared to 1,242 lb/acre in the control (Table 6), but differences were not statistically significant, similar to first-year results. Yields were significantly lower than 2013 yields of 3,298 and 2,996 lb/acre, in the fertilized and control plots, respectively. This was due to poor weather, and an abundance of corn rootworm beetles migrating from GMO corn to the non-GMO popcorn and consuming popcorn silks. The organic popcorn needs to be grown away from GMO corn or pest management of beetles must occur to ensure silking. The N15262 variety yields were significantly greater than the AP2204 yields (Table 6). Ear length and percent fill were also different between varieties and fertilizer treatment (Table 7). The N15262 variety had significantly longer ears, at 6.58 inches, compared to 5.38 inches for the AP2204 variety. Popcorn ear fill at 74% in N15262 was also higher than the 31% average fill in AP2204 ears. The fertilizer application was associated with longer ears, averaging 6.4 inches, compared to 5.6 inches in the control (Table 7), but the fertilizer did not affect the ear fill, which averaged 52% across both treatments. We will repeat this trial in 2015.

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Table 1. Field corn stand and weed count in the field corn experiment, Crawfordsville Farm, 7/8/2015.

Variety	Stand (per acre)	Grass/m^2	Broadleaf/m^2
Experimental	27200.0	1.93±0.54a[x]	4.87±0.58a
Viking 0.24-02N	29000.0	0.13±0.54b	0.75±0.80b
BR53H36	28625.0	2.13±0.54a	1.38±0.80b
BR66B77	27375.0	2.50±0.54a	2.25±0.80b
BR56M30	28250.0	1.88±0.54a	2.50±0.80b
$LSD_{0.05}$	NS	0.8371	0.3695
p value ($\alpha = 0.05$)	0.4360	0.0311*	0.0009*

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 2. Height to tassel and number of ears in the experimental field corn, Crawfordsville Farm, 8/21/15.

Treatment	Height to tassel (cm)	# of ears
Experimental 2758901	196.33	1.33
Experimental 2758902	191.00	1.00
Experimental 2758903	185.00	1.00
Experimental 2758904	190.33	1.33
Experimental 2758905	209.33	1.00

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 3. Height to tassel and number of ears in the field corn experiment, Crawfordsville Farm, 8/21/15.

Treatment	Height to tassel (cm)	# of ears
Viking 0.24-02N	197.17±3.61b[x]	1.08
BR53H36	210.75±3.61a	1.17
BR66B77	211.83±3.61a	1.25
BR56M30	210.58±3.61a	1.33
$LSD_{0.05}$	4.375	NS
p value ($\alpha = 0.05$)	0.0181*	0.4926

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 4. Stalk nitrate analysis in the experimental field corn, Crawfordsville Farm, 10/1/15.

Treatment	NO_3^--N
Experimental 2758901	20
Experimental 2758902	20
Experimental 2758903	20
Experimental 2758904	20
Experimental 2758905	21.2

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 5. Stalk nitrate analysis in the field corn experiment, Crawfordsville Farm, 10/1/15.

Treatment	NO_3^--N
Viking 0.24-02N	69.25
BR53H36	542.75
BR66B77	1806.00
BR56M30	1063.67
$LSD_{0.05}$	NS
p value ($\alpha = 0.05$)	0.0906

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 6. Grain quality in the experimental field corn breeds, Crawfordsville Farm, 12/2/15.

Treatment	Moisture (%)	Protein (%)	Oil (%)	Starch (%)	Density (g/cc)
Experimental 2758901	29.2	7.2	4.0	59.0	1.271
Experimental 2758902	31.7	6.8	4.3	58.6	1.274
Experimental 2758903	30.5	6.5	3.7	59.1	1.231
Experimental 2758904	17.6	7.2	3.8	61.1	1.283
Experimental 2758905	16.0	8.0	3.7	60.8	1.326

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 7. Grain quality in the field corn experiment, Crawfordsville Farm, 12/2/15.

Treatment	Moisture (%)	Protein (%)	Oil (%)	Starch (%)	Density (g/cc)
Viking 0.24-02N	15.73	7.05	3.00±0.07c	62.35	1.293±0.01a
BR53H36	13.78	6.78	3.78±0.07a	61.28	1.238±0.01c
BR66B77	55.80	6.53	3.38±0.07b	62.13	1.275±0.01b
BR56M30	14.05	6.48	3.60±0.07a	61.68	1.231±0.01c
$LSD_{0.05}$	NS	NS	0.17541	NS	0.00212
Interaction p value ($\alpha = 0.05$)	0.3660	0.4776	<.0001*	0.2393	<.0001*

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 8. Yield in the experimental field corn, Crawfordsville Farm, 2015.

Treatment	Bu/ac	Moisture	Weight
Experimental 2758901	91.88	14.70	21.94
Experimental 2758902	73.74	17.70	18.25
Experimental 2758903	78.33	16.90	19.20
Experimental 2758904	96.94	17.00	23.79
Experimental 2758905	81.85	14.90	19.59

Table 9. Yield in the field corn experiment, Crawfordsville Farm, 2015.

Treatment	Bu/ac	Moisture	Weight
Viking 0.24-02N	164.34±2.32a[x]	16.07±0.13b	1148.33±16.59
BR53H36	141.60±2.01b	13.63±0.11c	961.45±14.37
BR66B77	160.93±2.32a	17.40±0.13a	1142.67±16.59
BR56M30	147.15±2.01b	13.90±0.11c	1002.40±14.37
$LSD_{0.05}$	10.354	0.9372	97.03
Interaction p value ($\alpha = 0.05$)	<.0001*	<.0001*	<.0001*

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 1. Stand and weed count in the Popcorn experiment, Crawfordsville Farm, 6/16/15.

Treatment	Grass/m^2	Broadleaf/m^2	Plants/acre
A variety, compost	0.20	1.40	29000.00
A variety, no compost	0.00	0.83	27666.67
B variety, compost	0.14	0.14	29428.57
B variety, no compost	0.00	1.83	27666.67
$LSD_{0.05}$	NS	NS	NS
Interaction p value ($\alpha = 0.05$)	0.8117	0.1737	0.8739

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 2. Stand and weed count in the Popcorn experiment, Crawfordsville Farm, 7/8/15.

Treatment	Grass/m^2	Broadleaf/m^2	Plants/acre
A variety, compost	0.00	1.00	28000.00
A variety, no compost	0.00	0.25	28500.00
B variety, compost	0.00	0.75	29250.00
B variety, no compost	0.00	0.25	26875.00
$LSD_{0.05}$	--	NS	NS
Interaction p value ($\alpha = 0.05$)	0.0000	0.6963	0.2879

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 3. Height and ear count in the Popcorn experiment, Crawfordsville Farm, 8/21/15.

Treatment	Height (cm)	# of ears
A variety, compost	186.25	1.08
A variety, no compost	165.42	1.00
B variety, compost	205.33	1.00
B variety, no compost	198.08	1.08
$LSD_{0.05}$	NS	NS
Interaction p value ($\alpha = 0.05$)	0.2364	0.1643

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 4. Corn stalk nitrate in the Popcorn experiment, Crawfordsville Farm, 6/16/15.

Treatment	NO_3^--N
A variety, compost	20.00
A variety, no compost	198.00
B variety, compost	20.00
B variety, no compost	20.00
$LSD_{0.05}$	NS
Interaction p value ($\alpha = 0.05$)	0.3370

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).

Table 5. Yield in the Popcorn experiment, Crawfordsville Farm, 2015.

Treatment	Bu/ac	Moisture	Weight
A variety, compost	46.29	27.93	64.40
A variety, no compost	31.43	28.78	44.26
B variety, compost	43.12	27.80	59.93
B variety, no compost	33.08	28.40	46.43
$LSD_{0.05}$	NS	NS	NS
Interaction p value ($\alpha = 0.05$)	0.5477	0.9295	0.5257

[x]Means followed by the same letter down the column are not significantly different at $P \leq 0.05$ or not significant (NS) (Fisher's Protected LSD Test).