Evaluation of Organic Corn and Popcorn Varieties and Fertilization

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Introduction

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 14 years with excellent results. In addition, a new organic fertilizer (Biotic Organic™ 4-4-4, Perfect Blend, Bellevue, WA) was tested for its effect on organic popcorn production beginning in 2013, and continued in 2014 and 2015.

Materials and Methods

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 × 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 November 13, 2014, and plowed under with the 2014 red clover cover crop April 17, 2015. The field was field-cultivated May 29 to prepare for planting. Corn was planted at a 2-in. depth at 35,600 seeds/acre June 1, 2015. Weed management included rotary hoeing on June 3 and June 11, and row cultivation June 30 and July 6. Corn was harvested October 21, 2015.

Experimental organic corn. Experimental organic corn lines from USDA-ARS (Ames, IA) 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 with an average of 30 seeds for 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 also were 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 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 × 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 May 29 and popcorn seeds were planted at 32,000

plants/acre the same day. Plots were rotary hoed June 3 and 11, and row cultivated June 30 and July 6. Plant and weed populations were counted June 16 and July 8, 2015. Popcorn harvest occurred October 14, 2015.

Results and Discussion

Despite the extreme weather and flooding periods in 2015, organic corn performance was excellent in southeast Iowa. Plant stands were excellent in 2015, averaging 28,313 plants/acre in the hybrid corn varieties, and 27,200 in the experimental lines, with no difference between varieties (Table 1). Weed management was excellent in 2015. Weed populations varied among varieties, with the Viking variety plots having the lowest amount of grass weeds (<1 weed/m^2) on July 8, compared to an average of 2 grass weeds/m^2 across all other varieties (Table 1). Broadleaf weeds averaged two weeds/m^2 in the hybrid varieties with higher populations in the experimental lines (averaging five weeds/m^2). Plant height overall was lower in the experimental lines (Table 2), averaging 194 cm, compared with 208 cm across all hybrid varieties (Table 3). The Viking variety was lower than the BR varieties, however, at 197 cm. The number of ears/plant averaged 1.13 in the experimental lines compared with 1.21 in the hybrid varieties. Though fertilized the same, stalk nitrate content was lower overall in the experimental lines, averaging 20.2 ppm nitrate-N (Table 4), compared with the hybrid varieties, which averaged 870 ppm (Table 5). Because of high variability among plants, there were no significant differences in stalk nitrate content between varieties.

Organic hybrid corn yields were excellent in 2015, averaging 154 bushels/acre (Table 6). This compares favorably to the 156.3 bushels/acre average in 2012. There was a statistical difference in yields among varieties, with organic Viking 0.24-02N yielding 164 bushels/acre and BR66B77 yielding 161 bushels/acre, which were significantly greater than the other two varieties, which yielded an average of 144 bushels/acre.

The experimental lines were lower yielding, at an average of 85 bushels/acre (Table 7). Moisture content, at 16 percent, was consistently lower at harvest in the experimental lines, compared with BR66B77 with a 17.4 percent moisture content (Table 6). Protein levels in the organic hybrids averaged 7 percent across all varieties (Table 8), with no differences among varieties. Oil content averaged 3.4 percent, with significantly greater levels (3.8 and 3.6%) in BR53H36 and BR56M30, respectively. Starch content averaged 61.9 percent, with no differences among varieties. In the experimental lines, protein levels averaged 7 percent (Table 9). The 2758905 line had 8 percent protein, but statistical differences could not be calculated due to a low supply of seed/plants for these lines. Oil content averaged 3.9 percent, and starch content averaged 59.7 percent, with 2758904 having a numerically greater starch level at 61.1 percent.

These results show great promise for organic hybrid seed, which is gaining in popularity for organic production in Iowa. The breeding lines for organic corn, however, will require additional years of testing and selection before being equivalent to commercial organic varieties.

Popcorn. Popcorn plant populations were similar between varieties and between fertilizer treatments, averaging 28,441 plants/acre on June 16 (Table 10) and 28,156 plants/acre after weed management operations on July 8 (Table 11). Grass and broadleaf weeds also were similar between treatments, averaging one weed/m^2 for both grass and broadleaf weeds on June 16 (Table 10) and the same broadleaf weed level, but no grass weeds

on July 8 (Table 11). The excellent weed management was due to the rotary hoeing within five days of planting and timely cultivation after rotary hoeing.

Popcorn plant height on August 21 did not differ statistically among varieties or compost treatments (Table 12), averaging 189 cm. However, the N15262 variety with the compost application averaged 205 cm. The number of ears/plant was uniform across treatments, averaging 1.3 ears/plant (Table 12). Corn stalk nitrate content was low, averaging 64.5 ppm nitrate-N (Table 13), suggesting high mineralization or leaching of nitrogen in 2015.

Organic popcorn yields with the use of the Perfect Blend™ organic fertilizer were numerically higher than the control, at 2,504 lb/acre compared with 1,806 lb/acre in the control (Table 14), but differences were not statistically significant, similar to first- and second-year results. The AP2204 variety, averaging 2,176 lb/acre, yielded similarly to the N15262 variety, which yielded 2,134 lb/acre across all treatments. Yields were more similar to 2013 yields of 3,298 and 2,996 lb/acre in the fertilized and control plots, respectively, compared with 2014 yields, which were much lower, due to corn rootworm beetle feeding on corn silks. Popcorn quality was excellent in 2015. We will repeat this trial in 2016.

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Table 1. Corn and weed populations of the organic field corn variety trial, 7/8/2015.

Variety	Plant populations (plants/acre)	Grass weed populations (weeds/m^2)	Broadleaf weed populations (weeds/m^2)
ARS Experimental lines	27,200	1.93a[x]	4.87a[x]
Viking 0.24-02N	29,000	0.13b	0.75b
BR53H36	28,625	2.13a	1.38b
BR66B77	27,375	2.50a	2.25b
BR56M30	28,250	1.88a	2.50b
$LSD_{0.05}$	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 and number of ears of the ARS Experimental organic field corn lines, 8/21/15.

Variety	Plant height (cm)	No. 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

Table 3. Height and number of ears of the organic hybrid field corn varieties, 8/21/15.

Variety	Plant height (cm)	No. of ears
Viking 0.24-02N	197.17b[x]	1.08
BR53H36	210.75a	1.17
BR66B77	211.83a	1.25
BR56M30	210.58a	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. Corn stalk nitrate analysis of the ARS Experimental organic field corn lines, 10/1/15.

Variety	NO_3-N (ppm)
Experimental 2758901	20
Experimental 2758902	20
Experimental 2758903	20
Experimental 2758904	20
Experimental 2758905	21.2

Table 5. Corn stalk nitrate analysis of the organic hybrid field corn varieties, 10/1/15.

Variety	NO_3-N (ppm)
Viking 0.24-02N	69.25
BR53H36	542.75
BR66B77	1806.00
BR56M30	1063.67
$LSD_{0.05}$	NS[x]
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. Organic hybrid field corn variety yields.

Variety	Bu/acre	Moisture (%)
Viking 0.24-02N	164.34a[x]	16.07b[x]
BR53H36	141.60b	13.63c
BR66B77	160.93a	17.40a
BR56M30	147.15b	13.90c
$LSD_{0.05}$	10.354	0.9372
P value ($\alpha = 0.05$)	<.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 7. Yield of the ARS Experimental organic field corn lines.

Variety	Bu/ac	Moisture (%)
Experimental 2758901	91.88	14.70
Experimental 2758902	73.74	17.70
Experimental 2758903	78.33	16.90
Experimental 2758904	96.94	17.00
Experimental 2758905	81.85	14.90

Table 8. Grain quality of the organic hybrid field corn varieties.[x]

Variety	Moisture (%)	Protein (%)	Oil (%)	Starch (%)	Density (g/cc)
Viking 0.24-02N	15.73	7.05	3.00c	62.35	1.29a
BR53H36	13.78	6.78	3.78a	61.28	1.24c
BR66B77	55.80	6.53	3.38b	62.13	1.28b
BR56M30	14.05	6.48	3.60a	61.68	1.23c
$LSD_{0.05}$	NS[x]	NS	0.1754	NS	0.0021
P value (α = 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 ≤ 0.05 or not significant (NS) (Fisher's Protected LSD Test).

Table 9. Grain quality of the ARS Experimental organic field corn lines.

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

Table 10. Stand and weed populations of the organic popcorn experiment, 6/16/15.

Variety	Grass weeds(weeds/m^2)		Broadleaf weeds(weeds/m^2)		Plant population(plants/acre)	
	Compost	No compost	Compost	No compost	Compost	No compost
AP2204	0.20	0.00	1.40	0.83	29,000	27, 667
N15262	0.14	0.00	0.14	1.83	29,428	27,667
$LSD_{0.05}$	NS[x]		NS		NS	
P value (α = 0.05)	0.8117		0.1737		0.8739	

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

Table 11. Stand and weed populations of the organic popcorn experiment, 7/8/15.

Variety	Grass weeds (weeds/m^2)		Broadleaf weeds (weeds/m^2)		Plant population (plants/acre)	
	Compost	No compost	Compost	No compost	Compost	No compost
AP2204	0.00	0.00	1.00	0.25	28,000	28,500
N15262	0.00	0.00	0.75	0.25	29,250	26,875
$LSD_{0.05}$	NS[x]		NS		NS	
P value (α = 0.05)	0.0000		0.6963		0.2879	

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

Table 12. Height and ear count of the organic popcorn experiment, 8/21/15.

Variety	Height (cm)		No. of ears	
	Compost	No compost	Compost	No compost
AP2204	186.25	165.42	1.08	1.00
N15262	205.33	198.08	1.00	1.08
$LSD_{0.05}$	NS[x]		NS	
P value (α = 0.05)	0.2364		0.1643	

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

Table 13. Corn stalk nitrate of the organic popcorn experiment.

Variety	NO_3-N (ppm)	
	Compost	No compost
AP2204	20.00	198.00
N15262	20.00	20.00
$LSD_{0.05}$	NS[x]	
P value (α = 0.05)	0.3370	

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

Table 14. Organic popcorn yields.

Variety	Yield (lb/acre)	
	Compost	No compost
AP2204	2,592.24	1,760.08
N15262	2,414.72	1,852.48
$LSD_{0.05}$	NS[x]	NS
P value (α = 0.05)	0.5477	0.5477

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