



2006 Evaluation of Converted Organics Granular 3-2-1 and Converted Organics LC 1-0-2 For a Reduced Nutrient Management Program

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July 3, 2006 – October 2, 2006

Objective

The objective of this study was to evaluate the effect of Converted Organics 3-2-1 and Converted Organics LC 1-0-2 products on golf turf fairway performance under reduced fertilizer programs.¹

Methodology

The experimental design was split plot with three replications. The main treatments included eight granular (Converted Organics 3-2-1) rate/interval combinations and six liquid (Converted Organics 1-0-2) rate/interval combinations. Standard fertilizer was the secondary treatment and included full rate, $\frac{3}{4}$ rate, $\frac{1}{2}$ rate and $\frac{1}{4}$ rate applied across treatments at 14-day intervals.

Initial application of standard fertilizer treatments was made on June 29. Initial application of Converted Organics products was made July 3. The experiment continued for 12 weeks.

Treatments were applied to experimental plots (4' x 3') established at the Cornell University Turfgrass Research Center in Ithaca, NY on a mixed stand of creeping bentgrass (*Agrostis palustris* "Putter") and annual bluegrass soil-based fairway turf (pH = 6.5). The plots were mowed three times per week at 0.5 inches.

Liquid compost and standard fertilizer applications were made with a handheld CO₂ sprayer at 40 psi (276 kPa) fitted with TeeJet XR8015 nozzles calibrated to deliver 2 gallons (7.6 liters) of water per 1,000 ft² (92.9 m²). Dry compost applications were made by hand.

Average daily temperatures for July, August and September ranged from a high of 75.9° F (24.4° C) and a low of 56.4° F (13.6° C). Precipitation during this period was approximately 3.6 inches above normal.

Data were collected weekly for turf quality and chlorophyll index. Tissue nutrient analysis was performed once, on clipping samples collected August 24.

¹ Converted Organics 3-2-1 and Converted Organics 1-0-2 were first generation products, but are representative of Converted Organics' current granular and liquid products. Converted Organics 3-2-1 is the base product for current Converted Organics 8-1-4 and 4-1-8 formulas. Converted Organics 1-0-2 is comparable to our current Converted Organics LC 1-1-1 fertilizer.

Data analysis was conducted using linear mixed models with compound symmetric covariance structure to assess overall treatment effects when repeated measurements were made on the same experimental unit over time. Treatment differences at individual measurement events were evaluated using analysis of variance and least squares means. The MIXED procedure in SAS/STAT software version 9.1 (SAS, Cary, NC) was used to perform the analyses.

General Observations

The unusually wet weather pattern created some unique management challenges. Regularly saturated soils forced many breaks in mowing and application schedules as well as having a significant effect on turf quality.

In general, the formulated granular product (Converted Organics 3-2-1) did not disperse well. The product was clumpy and remained at the surface for 48 to 72 hours application. We delayed mowing on some plots to allow for more thorough dissolution and still at the high rate (100 lbs.) it seemed we picked up as much as 25 percent of the applied product. (The extraordinarily high application rate of 100 lbs. per 1,000 square feet was designed to demonstrate an absence of phyto-toxicity and would not be recommended in normal applications.)

This application problem likely influenced the results as on several dates the high rate granular treatment had the lowest turf quality and clipping production. Chlorophyll content and tissue nutrient content also did not reveal significant effects of the Converted Organics treatments. The most important aspect in both years of our work with this product line suggests that standard nutrients rates can be significantly reduced with no measurable reduction in turfgrass quality and performance. This offers significant promise for organic based technology by replacing synthetically derived nutrients. Still, this year revealed potential problems with the granular formulations applied at excessive rates.

Table1. Treatment application regimes

	Product	Rate/1000	Interval
1	Converted Organics 3-2-1	100 lbs.	28 d
2	Converted Organics 3-2-1	75 lbs.	28 d
3	Converted Organics 3-2-1	50 lbs.	28 d
4	Converted Organics 3-2-1	25 lbs.	28 d
5	Converted Organics 3-2-1	10 lbs.	28 d
6	Converted Organics 3-2-1	50 lbs.	14 d
7	Converted Organics 3-2-1	25 lbs.	14 d
8	Converted Organics 3-2-1	10 lbs.	14 d
9	Converted Organics LC 1-0-2	60 oz	28 d
10	Converted Organics LC 1-0-2	30 oz	28 d
11	Converted Organics LC 1-0-2	15 oz	28 d
12	Converted Organics LC 1-0-2	60 oz	14 d
13	Converted Organics LC 1-0-2	30 oz	14 d
14	Converted Organics LC 1-0-2	15 oz	14 d

% Std	Element	Rate/1000	Interval
100 %	NH4SO4	0.2 lb N	14 d
	MAP	0.1 lb P	14 d
	KSO4	0.2 lb K	14 d
	Iron	0.4 lb Fe	14 d
75%	NH4SO4	0.15 lb N	14 d
	MAP	0.04 lb P	14 d
	KSO4	0.15 lb K	14 d
	Iron	0.3 lb FE	14 d
50%	NH4SO4	0.1 lb N	14 d
	MAP	0.05 lb P	14 d
	KSO4	0.1 lb K	14 d
	Iron	0.2 lb Fe	14 d
25%	NH4SO4	0.05 lb N	14 d
	MAP	0.013 lb P	14 d
	KSO4	0.05 lb K	14 d
	Iron	1 oz.	14 d

Turfgrass Quality

There was no main effect of Converted Organics treatment over the entire study. There was a slight main effect of standard fertilizer rate in the latter part of the study. Overall the interactive effect was the most significant statistical response and emerged in late July and then again in the autumn.

More than 80 percent of all the quality ratings were below acceptable levels for study. However, there appeared to be a trend for higher quality for granular versus liquid formulation. Interestingly the turfgrass quality ratings for the main effect of standard fertilizer were also unable to provide acceptable quality for the duration of the study. This is further indication of the difficult growing season.

There were sporadic interactive effects worth noting throughout the study. The high rate granular application consistently had lower turf quality ratings in the early part of the study and then provided significantly higher quality turf in the latter study period as air temperatures cooled and rainfall decreased.

There was a clear lag effect with the granular treatments. Later in the season granular treatments combined with less than 50 percent of the standard fertilizer regime produced significantly lower quality independent of formulation and rate. This is consistent with prior evidence that reduction of standard regime by 25-50% produced optimal results.

Table 2. Turf quality ratings by Converted Organics treatment where there was no Converted Organics* rate interaction.

	10-Jul	17-Jul	24-Jul	7-Aug	14-Aug	28-Aug	4-Sep	18-Sep	26-Sep
1	5.8	6.3	6.1	5.7	4.9	5.1	5.5	5.2	5.3
2	6.0	6.5	6.1	5.9	5.1	5.1	5.3	5.5	5.2
3	5.8	6.4	6.1	5.8	4.9	5.0	5.3	5.4	5.1
4	5.7	6.2	5.9	5.7	4.9	5.1	5.2	5.4	5.1
5	5.7	6.1	6.1	5.8	5.1	5.1	5.4	5.2	5.1
6	5.8	6.3	5.9	5.7	5.1	5.1	5.5	5.3	4.9
7	5.9	6.3	6.0	5.9	4.9	5.0	5.4	5.5	5.0
8	5.7	6.3	5.9	5.7	4.8	4.9	5.2	5.3	5.2
9	5.9	6.3	6.0	5.8	5.0	5.1	5.3	5.4	5.0
10	6.0	6.4	6.1	5.9	5.2	5.3	5.5	5.4	5.2
11	5.8	6.2	6.1	5.8	4.9	5.2	5.4	5.3	5.0
12	5.8	6.3	5.9	5.7	4.8	4.9	5.1	5.2	5.0
13	6.0	6.4	6.1	5.9	5.0	5.1	5.3	5.3	5.1
14	5.8	6.3	6.0	5.8	5.0	5.1	5.3	5.3	5.0
	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Turf quality ratings by N rate where there was no Converted Organics* rate interaction

100%	5.8	6.0	6.0	5.7	4.8	5.3	5.7	5.6	5.9
75%	6.0	6.6	6.1	5.9	5.4	5.2	5.4	5.7	5.4
50%	5.7	6.1	5.9	5.8	4.8	5.0	5.2	5.0	4.8
25%	6.0	6.5	6.0	5.7	4.9	4.8	5.0	5.0	4.6
	NS	NS	NS	NS	NS	NS	NS	0.2	0.2

lsmeans (p=0.05)

Table 4: Turf Quality Ratings where there was a significant Converted Organics* rate interaction

		31-Jul	21-	12-Sep	2-Oct			31-Jul	21-	12-Sep	2-Oct
1	100%	5.5	5.8	5.7	5.9	9	100%	5.1	5.9	5.8	5.9
1	75%	4.8	5.7	5.9	5.7	9	75%	5.1	5.5	5.7	5.2
1	50%	5.8	5.3	5.1	5.2	9	50%	5.7	5.3	5.4	5.0
1	25%	5.8	5.2	4.8	4.5	9	25%	5.6	5.3	5.1	4.7
	(p=0.05)	*	NS	*	*		(p=0.05)	NS	*	NS	*
2	100%	5.6	5.8	5.9	5.7	10	100%	4.4	5.7	5.7	5.6
2	75%	5.0	5.6	5.7	5.6	10	75%	6.0	5.7	5.7	5.4
2	50%	5.8	5.4	5.7	5.4	10	50%	5.8	5.5	5.5	5.3
2	25%	5.7	4.8	4.9	4.6	10	25%	5.9	5.5	5.3	4.9
	(p=0.05)	NS	NS	NS	*		(p=0.05)	*	NS	NS	NS
3	100%	5.8	5.5	5.8	5.5	11	100%	4.6	5.6	5.8	5.9
3	75%	5.2	5.7	5.8	5.8	11	75%	5.1	5.6	5.9	5.8
3	50%	5.3	5.1	5.3	4.8	11	50%	5.4	4.7	5.3	4.7
3	25%	5.7	4.9	5.3	5.1	11	25%	5.9	5.2	5.1	4.9
	(p=0.05)	NS	*	NS	NS		(p=0.05)	*	*	NS	*
4	100%	4.8	5.8	5.8	5.8	12	100%	5.1	5.4	5.9	5.7
4	75%	5.4	5.4	5.5	4.8	12	75%	4.7	5.0	5.7	5.4
4	50%	5.5	5.1	5.3	4.9	12	50%	5.1	4.9	5.0	4.7
4	25%	5.6	5.3	5.2	4.7	12	25%	5.4	5.4	5.1	4.8
	(p=0.05)	*	NS	NS	*		(p=0.05)	NS	NS	NS	*
5	100%	4.5	5.6	5.7	5.7	13	100%	5.7	5.5	5.6	5.7
5	75%	5.9	5.7	5.3	5.5	13	75%	4.9	5.5	5.8	5.2
5	50%	5.4	5.0	5.3	4.7	13	50%	5.4	5.5	5.7	5.3
5	25%	5.7	5.7	5.7	5.1	13	25%	5.3	4.7	5.3	4.5
	(p=0.05)	*	*	NS	NS		(p=0.05)	NS	NS	NS	NS
6	100%	5.1	5.7	5.7	5.7	14	100%	5.3	5.7	5.7	5.7
6	75%	5.2	5.5	5.7	5.2	14	75%	5.4	5.4	5.7	5.2
6	50%	5.5	5.3	5.5	4.9	14	50%	5.9	5.7	5.7	5.1
6	25%	5.8	5.1	5.1	4.7	14	25%	5.6	5.0	5.3	4.7
	(p=0.05)	NS	NS	NS	*		(p=0.05)	NS	NS	NS	NS
7	100%	5.3	5.3	5.8	5.6						
7	75%	5.1	5.9	6.2	5.7						
7	50%	5.5	5.2	5.5	5.3						
7	25%	5.3	4.9	5.3	5.0						
	(p=0.05)	NS	*	NS	NS						
8	100%	5.4	5.9	5.8	5.8						
8	75%	5.2	5.3	5.6	5.5						
8	50%	5.0	5.1	5.2	4.8						
8	25%	5.8	5.1	5.2	4.8						
	(p=0.05)	NS	*	NS	*						

Chlorophyll Index

The remote chlorophyll index measurement is obtained using the Field Scout CM1000 Chlorophyll Meter from Spectrum Technologies. The meter senses light at wavelengths of 700 nm and 840 nm to estimate the quantity of chlorophyll in leaves. The appropriate wavelengths of ambient and reflected light are used to calculate a chlorophyll index value, which are the values shown in the tables below. The higher the index value, the higher the chlorophyll content. Sand or completely scalped turf generally gives a reading of < 100. Typical readings for rough-high ryegrass or bentgrass are > 500.

Chlorophyll measurements were taken on 13 occasions, at the same time as turf quality ratings were recorded. At each rating data, three chlorophyll readings were taken at random spots in each plot. Results were averaged to obtain one value per plot.

This data revealed few significant differences among treatments however there was a trend observed for the Converted Organics LC 1-0-2 treatment having higher readings. There might be some measure of leaf darkening that obscures the meter.

Table 5 Chlorophyll index by Converted Organics treatment (no significant Gtrt*rate interaction)

Ls means (p=0.05)

Chlorophyll Index

	10-Jul	17-Jul	24-Jul	31-Jul	7-Aug	14-Aug	21-Aug	28-Aug	4-Sept	12-Sept	18-Sept	26-Sept	2-Oct
1	270.0	317.2	312.2	345.2	334.9	292.2	323.2	341.7	323.2	276.5	271.7	309.4	290.2
2	267.2	305.3	311.3	334.1	326.2	289.5	326.3	353.5	333.5	286.1	297.2	311.2	289.3
3	266.7	309.7	310.3	323.7	326.7	296.0	326.7	348.1	334.5	291.5	294.2	305.8	293.6
4	262.1	309.6	295.7	329.2	336.9	282.4	326.3	348.1	332.3	290.9	279.7	305.2	288.9
5	270.3	308.1	317.4	345.2	356.8	291.9	334.6	344.4	338.9	293.7	279.2	310.6	287.6
6	277.4	315.7	312.7	347.6	343.2	297.6	328.6	346.2	329.3	284.8	284.5	308.0	296.7
7	265.2	307.8	315.7	334.6	353.1	299.9	335.8	353.3	336.4	293.1	285.0	295.0	299.8
8	265.7	305.7	309.2	335.7	359.4	290.7	330.4	346.0	331.1	285.3	280.8	298.7	276.5
9	271.2	316.7	309.6	345.4	355.8	297.7	331.5	344.9	325.2	284.6	282.2	308.6	285.9
10	282.1	313.2	327.3	347.3	366.4	306.2	336.7	357.1	339.1	293.0	280.5	307.0	277.1
11	264.7	308.5	310.4	329.8	346.5	284.2	325.5	345.4	328.6	282.4	284.3	289.5	285.0
12	265.0	305.4	308.9	328.2	345.8	280.3	326.3	348.6	328.6	286.6	268.3	309.3	285.0
13	270.2	310.1	313.9	337.3	356.8	293.9	336.7	343.3	328.8	292.7	292.8	305.8	285.1
14	261.7	310.0	308.0	339.7	344.0	291.5	329.5	345.7	331.7	285.3	285.7	302.8	288.0
N Rate													
100%	264.2	306.2	314.2	326.8	341.1	267.3	330.1	352.2	327.6	292.7	282.9	318.2	292.7
75%	278.8	311.4	315.8	334.7	354.2	302.6	341.0	352.5	334.4	293.3	291.9	310.2	289.1
50%	262.9	309.3	304.8	342.9	346.8	299.3	324.2	345.7	327.3	284.6	278.0	303.4	290.9
25%	268.3	314.0	311.8	345.1	344.4	300.6	324.2	340.1	336.8	279.9	280.4	287.4	278.3
	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS

Clipping Production

Surprisingly there was only a main effect for Converted Organics treatment that developed very early in the study and persisted throughout for clipping production. The granular treatments did not provide consistent growth responses, however the liquid compound did provide exceptional growth.

As a result of the poor weather conditions throughout the study period however, the turf quality ratings are not well correlated with growth. It appears that while growth is enhanced significantly by the Converted Organics 1-0-2 there is little improvement in color and thereby quality.

Table 6 Clipping Production (g)

	10-Jul	7-Aug	26-Sept
1	15.5	14.7	17.4
2	17.2	16.3	19.3
3	16.8	16.0	18.8
4	15.9	15.1	17.8
5	15.7	14.9	17.6
6	17.7	16.8	19.8
7	16.9	16.1	18.9
8	15.4	14.6	17.2
9	22.1	21.0	24.8
10	23.4	22.2	26.2
11	20.9	19.9	23.4
12	27.8	26.4	31.1
13	24.5	23.3	27.4
14	22.5	21.4	25.2
	3.5	6.3	4.5

Ls means (p=0.05)

Nutrient Analysis

Tissue nutrient content did not reveal the observed differences in growth as most main effects except the 100 percent N rate were not significantly different. There were some interesting differences for the 10 lb Converted Organics 3-2-1 on 14 d intervals. This treatment was consistently lower than all other treatments for P, K, Ca, S, Cu and Zn independent of standard fertilizer application where the P and K were regularly applied. This might be related to product pick up issues however typically the low rate applications did not appear to have this issue.

Surprisingly there was little main effect of standard nutrition however the trend was for reducing nutrient levels as standard nutrition was reduced. It is safe to assume many of the nutrients came from the soil reservoir as only N, P, K and iron were applied.

Table 8 Nutrient analysis by treatment for August 24, 2006

	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Mn (ppm)	Fe (ppm)	Cu (ppm)	B (ppm)	Zn (ppm)	Al (ppm)
1	3.49	0.56	2.26	0.79	0.19	0.56	70.9	322.7	9.7	28.0	39.8	103.2
2	3.71	0.58	2.31	0.75	0.19	0.55	74.3	384.2	10.6	24.9	40.9	134.2
3	3.82	0.54	2.26	0.72	0.20	0.55	71.8	364.1	11.0	23.7	37.4	103.1
4	3.55	0.55	2.29	0.67	0.18	0.52	70.2	366.7	9.6	20.0	37.1	108.5
5	3.73	0.55	2.32	0.63	0.19	0.53	63.4	328.3	10.0	20.6	35.5	86.7
6	3.62	0.55	2.14	0.83	0.19	0.53	68.6	348.8	10.1	23.1	40.0	100.2
7	3.67	0.51	2.12	0.69	0.19	0.49	71.4	351.8	9.9	25.8	38.7	124.8
8	3.75	0.47	1.97	0.60	0.18	0.47	69.6	281.5	9.1	29.2	33.2	97.3
9	3.57	0.57	2.22	0.71	0.23	0.56	78.3	299.6	10.9	28.5	38.8	107.0
10	3.73	0.55	2.28	0.67	0.20	0.55	85.8	330.0	11.3	30.8	42.1	104.2
11	3.45	0.54	2.21	0.67	0.18	0.50	67.5	302.5	9.6	26.8	38.1	107.7
12	3.60	0.52	2.18	0.70	0.19	0.52	76.6	304.3	10.3	30.0	41.1	116.6
13	3.62	0.52	2.20	0.61	0.18	0.48	72.4	329.2	9.5	27.9	38.0	117.6
14	3.47	0.53	2.12	0.66	0.18	0.49	73.6	343.9	8.9	28.2	40.7	128.5

Table 9 Nutrient analysis by N rate for August 24, 2006

100%	3.88	0.54	2.28	0.68	0.19	0.58	87.5	434.0	10.5	29.4	40.7	114.7
75%	3.66	0.52	2.23	0.68	0.19	0.51	72.1	323.4	9.6	27.1	38.8	107.0
50%	3.54	0.54	2.19	0.70	0.19	0.51	68.9	297.4	9.8	25.4	37.9	100.9
25%	3.43	0.55	2.12	0.71	0.20	0.48	61.3	275.9	10.2	23.1	37.4	117.3
	*	NS	NS	NS	NS	*	*	*	NS	NS	NS	NS

Summary

In summary Converted Organics 3-2-1 and Converted Organics LC 1-0-2 continue to provide a significant opportunity to reduce the use of salt-based fertilizers as most of the responses suggest at least a 50 percent reduction is possible.

Several interesting responses were noted relative to the relationships among growth, quality and nutrient content. It is likely that the Converted Organics products might be having a undefined bio-stimulant effect on turf performance that is masked by other measurements. There could be soil microbial activity involved as well as plant hormone production.

More research will be needed to more clearly identify the potential for use as a fairway fertilizer, especially with regard to formulation.