USE OF OCEANGROWN™ PRODUCTS TO INCREASE CROP YIELD AND ESSENTIAL NUTRIENT CONTENT

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Introduction

OceanGrown™ (OG) products (Toronto, Ontario, Canada) are based on the stated requirement for humans and plants to have a balanced mineral intake of 95 elements found in seawater and that the relative ratios of essential plant micronutrients are essential to optimal nutrition. Because of this 'mineralization', the product information states that the use of OG products reduces or eliminates the need for supplemental fertilizers. The crops in the study were chosen for their use directly, or through purification, for direct human consumption. These crops were spring wheat, field corn, potato, pinto beans and sugar beets. The treatments consisted of a check without an essential fertilizer nutrient, an OG check with OG amendments only, a half-rate of an essential fertilizer nutrients, a half-rate of the essential fertilizer nutrient with OG amendments, a full-rate of an essential fertilizer nutrient and a full rate of an essential fertilizer nutrient with OG amendments. These treatments would enable the results to show if the OG amendments recommended by Ocean Grown representatives produced superior yield/quality compared to no fertilizer, a reduced rate of fertilizer or the full rate of fertilizer.

Materials and Methods

Spring wheat- This experiment was conducted on a commercial field about 50 miles west of Fargo and about 3 miles SE of Valley City, ND. Beginning soil test residual nitrate was 30 lb N in the top 2 feet of soil. Olson P was 10, pH 6.5, organic matter 3.5% and K was 190 ppm. The field had a long history of no-till cultivation. Current spring wheat nitrogen fertilizer recommendations suggested a total of 180 lb N/acre to grow the full potential of the spring wheat yield with adequate protein to prevent a dockage on delivery. From the 150 lb N/acre recommendation, a credit of 30 lb N from soil test, 40 lb N/acre due to the crop following soybean, and 50 lb N/acre from continuous no-till were subtracted, so the recommended rate of N was 60 lb N/acre. A half-rate of N was 30 lb N/acre.
The experiment was constructed as a randomized complete block design with 6 treatments and 4 replications. Individual plot size was 8 feet wide and 15 feet long with 5 foot alleyways separating replication blocks.

Treatments were:

Check (no added N or OG)
OG (Ocean Grown amendments only)
½ rate N
½ N + OG
Full rate N
Full rate N + OG

The Ocean Grown treatment consisted of a program of prescribed treatments described as ' Spring Wheat Generic Program, 2010'
Preplant- 3 gal/acre OceanGrown Liquid Calcium Component
Starter-In Row on Seed- 32 oz/acre OceanSolution + 1 gal/acre OceanGrown Humic Acid Component + 4 oz/acre OceanGrown Liquid PGS Component
1st Foliar- Carpet Stage – (3-leaf stage)- 32 oz/acre OceanSolution + 1 gal/acre OceanGrown Liquid-Carbon Component
2nd Foliar-Flag Leaf- 32 oz/acre OceanSolution + 16 oz/acre OceanGrown Liquid-Carbon Component

On 4/12, the calcium component was applied, mixed with 7 gal/acre water for a total of 10 gal/acre total mix to all oceangrown plots. Nitrogen as urea was applied to all N treatments on 4/15. The plot was seeded on 4/15 with Glenn spring wheat variety at 1 million live seeds per acre. Plot seeding was conducted using a 4-foot grain drill with liquid fertilizer attachments that directed fertilizer in with the seed. Premixed starter OG mix was applied as recommended to OG treatments.

The 3-leaf treatment was applied 5/15. The grower applied the herbicides Bison(Bronate) at 1 pt/acre, Rimfire Max at 2 oz/acre and Stratego at 5 oz/acre on June 1.
The flag-leaf treatment was applied 6/15.
The experiment was harvested 8/6 using a 4-foot combine. Grain was collected, cleaned, weighed, and a subsample taken for protein analysis through the NDSU wheat quality laboratory. Grain analysis was conducted at Agvise labs. A grain subsample was ground and about 0.2 g was diluted to 75 ml for acid digestion. A mathematical adjustment was performed on the Agvise results to compensate for their in-house dilution method contrasted with those of NDSU.

Corn
This experiment was conducted on a commercial field about 50 miles west of Fargo and about 3 miles SE of Valley City, ND. Beginning soil test residual nitrate was 53 lb N in the top 2 feet of soil. Olson P was 17, pH 5.8 organic matter 4.2 % and K was 115 ppm and DTPA Zn was 0.9 ppm. The field had a long history of no-till cultivation. The half-rate of nitrogen was 50 lb N/acre. The full-rate of nitrogen was 100 lb N/acre. N was applied preplant as ammonium nitrate. Individual plots were 10 feet wide and 20 feet long. The experiment was constructed as a randomized complete block with 6 treatments and 4 replications. The treatments were:

Check (no added N or OG)
OG (Ocean Grown amendments only)
½ rate N
½ N + OG
Full rate N
Full rate N + OG

The OceanGrown treatments were prescribed for a 'Field Corn Generic Program-2010'
Preplant- 3 gallons OceanGrown Liquid Calcium Component
Starter-In Row on Seed- 16 oz/acre OceanSolution + 2 gal/acre OceanGrown Humic Acid Component + 3 oz/acre Liquid PGS Component
1st Foliar- 6-12 inch corn- 32 oz/acre OceanSolution + 16 oz/acre Liquid-Carbon Component
2nd Foliar- 32 oz/acre OceanSolution + 1 gal/acre Humic Acid Component + 16 oz/acre Liquid-Carbon Component

The preplant OG treatments and the N treatments were applied 4/19. The experiment was seeded and the starter treatment applied with the seed on 4/27. The variety seeded was Panner 2E-409Vt3 with Pancho 250 TriflexFL BT with YieldGard/Triple at 28,200 planting rate.
The 1st foliar treatment was applied when the corn was 6 inches tall at 6/14. The 2nd foliar treatment was applied to 3 foot tall corn on 7/2.
The plots were harvested 9/20. A grain subsample was ground and 0.2 g was diluted with acid and digested. A mathematical adjustment was performed on the Agvise data to compensate for dilution differences between the two labs.

Pinto Beans-
This experiment was conducted about 2 miles NW of Prosper, ND on the NDSU Prosper Experimental Farm. The soil tests indicated adequate N and marginal Zn. The rates of commercial fertilizer varied were ammonium molybdate at 0.5 lb/acre Mo and zinc sulfate at 10 lb/acre 36 % zinc sulfate. The experiment was constructed as a randomized complete block design with 6 treatments and 4 replications. Each plot was 11 feet wide and 20 feet long, consisting of 4- 22 inch rows. The treatments were:

Check-no nutrient amendments
OG only
Ammonium molybdate
Ammonium molybdate + OG
Zinc sulfate
Zinc sulfate + OG

The OceanGrown program was

Starter in row on seed- 16 oz/acre OceanSolution + 1 gal/acre Humic Acid Component + 4 oz/acre PGA Component
1st Foliar- apply early- 32 oz/acre OceanSolution + 16 oz/acre OceanGrown Liquid-Carbon Component + 64 oz/acre Humic Acid Component
2nd Foliar- 32 oz/acre OceanSolution + 16 oz/acre OceanGrown Liquid-Carbon Component + 64 oz/acre Humic Acid Component

Pinto beans were planted 5/19/2010 and treated OG treatments received the starter treatment. Ammonium molybdate was sprayed on to plots 6/9 when the beans were in 1st trifoliate. The OG 1st foliar treatments were also made on 6/9. Zinc sulfate granule treatments were applied 6/9. Significant rain fell within 24 hours of application.
Herbicide Rezult B &G was applied at 1.5 pt/acre with 1.25 pt/acre MSO and 1% 28% v/v on 6/3 and 6/14.
The 2nd foliar OG treatment was made on 7/6.
Beans were hand harvested 9/13. A grain subsample was ground and 0.2 g was diluted to 75 g with acid and digested. A mathematical adjustment was performed on the Agvise results to compensate for dilution differences between the two labs.

Potato
This experiment was conducted 3 miles NW of Inkster, ND. Since soil test P was marginal and P is very important for potato production, the rate of in-row starter at seeding was varied by treatment. The experiment was constructed as a randomized complete block design with 10 treatments and 3 replications. The treatments were-
Control 1 no-OG or starter P
Control 2 no OG or starter P
Grower standard starter P rate (25 gal/acre 10-34-0)
½ Grower standard starter P rate (12.5 gal/acre 10-34-0)
Carbon Boost rate 1
Carbon Boost rate 2
Carbon Boost rate 3
Ocean Grown with no starter
Ocean Grown with ½ starter
Ocean Grown with Full rate starter

Nitrogen was applied at the grower standard rate to the entire plot area before planting.
The Ocean Grown program was as follows:

2 gal/acre OG Humic Acid Component applied as in-row starter at planting.

Soil application of OG Calcium Component 5 gal/acre banded over the hill
10 days after emergence- 32 oz/acre OceanSolution + 16 oz/acre Liquid Carbon Component
2nd Foliar Feeding- about 1 month after first foliar application, 32 oz/acre OS and 16 oz/acre LC
3rd Foliar Feeding- about 1 month later than 2nd foliar feeding- 32 oz/acre OS and 16 oz/acre LC

The experiment was planted 5/31.
The preemergence hill treatment was applied 6/15
The 10 days after emergence treatment was applied 7/1
The 2nd foliar treatment was applied 7/29
The 3rd foliar treatment was applied 8/26
The experiment was harvested 9/20

Measurements at harvest were total yield, usable yield, percent usable yield, percent yield over 6 oz, percent yield over 10 oz. Potato subsamples were freeze-dried, then ground and 0.2 g was diluted with 75 ml acid and digested. A mathematical adjustment was performed on the Agvise results to compensate for dilution differences between the two labs.

Sugarbeets

The experiment was conducted about 10 miles east of Perley, MN on Bearden silty clay loam soils (fine-silty, mixed, superactive, frigid Aeric Calciaquolls). The experimental design was a randomized complete block with 6 treatments and four replications. Two plots in the first block were damaged with standing water early in the season, and were eliminated from the analysis. Treatment protocols were developed by OceanSolutions for use in sugarbeets. Different protocols and fertilizer components were used for every crop.

Residual nitrate soil test was 50 lb/acre to a four-foot depth.

Sugarbeet treatments-

-Untreated Check, no N, no OceanGrown fertilizers

-OceanGrown fertilizers only, no N or P supplemented-

OceanGrown fertilizers consisted of:

1 gallon/acre OceanGrown Calcium Component applied preplant

In-furrow starter treatment of 64 oz/acre OceanSolution and 2 gallon/acre

OceanGrown Humic Acid Component, diluted with water to make a 3 gal/acre total volume treatment

Foliar fertilizer application 5/26, 6/18 and 7/28

Foliar fertilizerapplication- 32 oz/acre OceanSolution, 16 oz/acre

OceanGrown Liquid

Carbon Component, and 1 gal/acre Humic Acid Component

Foliar fertilizer was applied in a total solution of 10 gal/acre applied at 40 psi using flat fan nozzles

-OceanGrown fertilizers (as above) with ½ rate N (supplemental 15 lb N/acre as urea).

-OceanGrown fertilizers (as above) with full rate N (Supplemental 80 lb N/acre as urea).

-Half rate N treatment only- (15 lb N/acre as urea)

-Full rate N treatment only (80 lb N/acre as urea)

Preplant treatments were applied and incorporated with two field cultivator passes (set at 3 inch depth) immediately before seeding on May 5.

Results

Spring wheat

Spring wheat yield and protein increased with N rate. Neither yield nor protein was increased by the OG program treatments (Table 1). The full rate of N increase grain P content, but OG treatments did not affect P or any other elemental analysis (Table 2).

Table 1. OceanGrown and N treatment effects on spring wheat, Valley City, 2010.

Treatment	Yield, bu/acre	Test Weight, lb/bushel	Protein,%
Check	39.0 a*	66.6	11.4 a
Ocean Grown only	43.1 a	65.6	11.3 a
Ocean Grown + ½ rate N	47.3 ab	66.3	11.2 a
Ocean Grown + Full rate N	66.1 c	65.9	12.5 b
½ rate N	50.2 bc	65.6	11.4 a
Full rate N	60.0 c	66.0	12.7 b
LSD 5%	11.0	NS	0.8

* values with the same letters are not significantly different from each other.

NS = not significant differences

Table 2. OceanGrown and N treatment effects on elemental analysis of spring wheat grain, Valley City, 2010.

Treatment	P%	K%	S%	Ca%	Mg%	Zn	Mn	Cu	Fe	B
								ppm		
Check	0.48	0.47	0.15	0.76	0.22	37.2	52.2	7.45	22.4	18.6
OG only	0.50	0.46	0.15	0.76	0.22	55.5	53.6	7.40	38.9	35.8
½ N +OG	0.44	0.47	0.15	0.81	0.20	35.0	49.8	9.23	44.3	27.7
Full N +OG	0.54	0.50	0.15	0.85	0.24	40.9	53.9	7.43	39.1	31.5
½ N	0.45	0.46	0.15	0.78	0.22	40.9	50.2	7.43	27.9	16.7
Full N	0.52	0.52	0.15	0.83	0.24	42.4	57.2	7.38	29.5	20.0
F	3.35	0.76	1.88	1.58	1.58	1.07	0.36	0.95	1.06	0.68
P>F	0.03	0.59	0.16	0.23	0.23	0.41	0.87	0.48	0.42	0.68
Significance	Yes	No	No	No	No	No	No	No	No	No

Corn-

There was an increase in corn yield between the checks and the ½ rates of N treatments. There were no additional increases in corn yield due to the Ocean Grown treatments (Table 3). Zinc concentration in corn grain was greatest in the check and the half-rate of N with OG treatments. The higher zinc concentration in the check is understandable due to the lower yield of the check, but the higher concentrations were not consistent in the lower yields. OG treatments provided no clear increase in any elemental concentration.

Table 3. OceanGrown and N treatment effects on corn, Valley City, 2010.

Treatment	**Yield, bu/acre**	**Test Weight, lb/bushel**
Check	85 a *	55.3
OceanGrown only	98 a	55.4
OceanGrown + ½ rate N	132 b	55.7
OceanGrown + Full rate N	131 b	55.4
½ rate N	125 b	55.7
Full rate N	123 b	56.0
LSD 5%	20.0	NS

* values with the same letters are not significantly different from each other.
NS = not significant differences

Table 4. OceanGrown and N treatment effects on elemental analysis of corn grain, Valley City, 2010.

Treatment	P%	K%	S%	Ca%	Mg%	Zn	Mn	Cu	Fe	B
								ppm		
Check	0.37	0.39	0.08	0.75	0.15	20.5	7.46	3.72	0.12	44.7
OG only	0.30	0.36	0.08	0.77	0.13	15.0	7.49	5.61	0.13	31.8
½ N +OG	0.34	0.39	0.08	0.76	0.15	18.6	9.31	5.59	0.32	41.0
Full N +OG	0.30	0.32	0.08	0.80	0.13	13.0	9.30	1.87	0.08	33.5
½ N	0.30	0.35	0.08	0.74	0.15	14.8	7.42	5.58	0.31	25.9
Full N	0.33	0.35	0.08	0.73	0.15	14.9	7.45	1.85	0.13	35.4
F	1.14	1.74	1.74	0.72	0.72	3.97	0.74	0.65	1.47	0.65
P>F	0.38	0.19	0.19	0.79	0.62	0.02	0.67	0.67	0.76	0.67
Significance	No	No	No	No	No	Yes	No	No	No	No

Pinto Beans-

There were no treatment effects from the application of ammonium molybdate or zinc sulfate with or without the Ocean Grown treatments (Table 5). Zinc treatment increased pinto zinc concentration, but OG treatments had no affect on elemental analyisis.

Table 5. OceanGrown, molybdenum and zinc treatment effects on pinto bean yield, Prosper, ND, 2010.

Treatment	Yield, lb/acre
Check	2680
OceanGrown only	2500
OceanGrown + ammonium molybdate	2700
OceanGrown + zinc sulfate	2910
Ammonium molybdate only	2540
Zinc sulfate only	2220
LSD 5%	NS

* values with the same letters are not significantly different from each other.
NS = not significant differences

Table 6. OceanGrown and N treatment effects on elemental analysis of pinto bean, Prosper, 2010.

Treatment	P%	K%	S%	Ca%	Mg%	Zn	Mn	Cu	Fe	B
								ppm		
Check	0.50	1.56	0.22	0.91	0.26	35.4	16.7	9.30	52.1	26.1
OG only	0.52	1.54	0.22	0.91	0.22	57.7	16.7	11.16	67.0	26.0
Zn +OG	0.52	1.55	0.22	0.91	0.24	76.5	16.8	11.20	74.7	29.9
Mo +OG	0.50	1.53	0.26	0.90	0.26	28.0	14.9	13.10	87.8	22.4
Mo	0.52	1.55	0.22	0.91	0.22	28.0	14.9	9.31	57.7	20.5
Zn	0.50	1.55	0.22	0.88	0.24	42.8	14.9	11.18	68.9	22.4
F	0.35	0.08	0.62	1.16	1.16	4.24	0.52	0.32	0.40	0.67
P>F	0.88	0.99	0.69	0.37	0.37	0.01	0.76	0.89	0.84	0.65
Significance	No	No	No	No	No	Yes	No	No	No	No

Potato

There were no treatment differences between starter P rates or Ocean Grown treatments on total yield, useful yield, percent useful yield, percent of potatoes larger than 6 oz, or potatoes larger than 10 oz (Table 7). Results from Carbon Boost treatments are not shown. There were no differences in potato elemental concentration with OG treatment (Table 8).

Table 7. Starter P and Ocean Grown treatment effects on potato yield parameters, Inkster, ND, 2010

Treatment	Total Yield Cwt/acre	Useful Yield Cwt/acre	% useful Yield	% > 6 oz	% > 10 oz
Control 1	564	440	78.2	57.0	20.3
Control 2	538	406	74.5	50.3	18.5
Grower Standard P (GSP)	614	498	81.2	62.3	22.5
½ Grower Standard P	573	431	75.7	53.7	19.0
OceanGrown, no P	495	356	71.8	45.2	10.7
OceanGrown, ½ P	541	391	71.8	51.5	15.5
OceanGrown GSP	518	375	71.8	48.5	11.5
LSD	NS	NS	NS	NS	NS

Table 8 . OceanGrown and N treatment effects on elemental analysis of potato, Inkster, 2010.

Treatment	P%	K%	S%	Ca%	Mg%	Zn	Mn	Cu	Fe	B
								ppm		
Check	0.15	2.12	0.15	0.90	0.15	38.4	12.5	7.5	27.5	15.0
GSP	0.15	2.05	0.15	0.87	0.15	84.4	12.5	15.0	32.5	20.0
OG No P	0.15	2.10	0.15	0.72	0.15	32.0	12.5	10.0	20.0	22.5
OG ½ P	0.15	2.10	0.15	0.77	0.15	17.0	12.5	7.5	15.0	15.0
OG GSP	0.15	1.97	0.15	0.77	0.15	15.4	12.5	10.0	15.0	22.5
F	0.29	0.94	0.29	1.31	0.15	1.33	0.00	0.29	0.96	2.87
P>F	0.88	0.49	0.88	0.34	0.29	0.34	1.00	0.87	0.48	0.95
Significance	No	No	No	No	No	No	No	No	No	No

Sugar beets

There were no differences between treatments in harvest stand, recoverable sugar per ton, per cent loss to molasses or amino-N (Table 9). The OceanGrown fertilizers with no supplemental N treatment had a greater sugarbeet yield than the check, however, the treatment did not have a greater recoverable sugar per acre compared to the check. The OceanGrown treatment with the ½ rate of N was similar in sugarbeet yield and recoverable sugar per acre as the ½ rate N treatment without the OceanGrown products. The full rate of N treatment alone had greater sugarbeet yield and greater recoverable sugar per acre compared to the OceanGrown treatment with a full rate of N.

Table 9. Sugarbeet yield and quality components as affected by OceanGrown experiment treatments, Perley, MN, 2010.

Treatment	Sugarbeet yield Tons/acre	HarvestStand, plants/acre	Recoverable Sugar per ton Lb/ace	Recoverable Sugar per acre Tons/acre	% Loss To Molasses	Amino-N
Check	30.8	46,100	329	5.1	0.8	215
OG*	34.8	51,200	318	5.5	0.9	224
OG ½ N	33.2	47,500	316	5.2	0.9	206
OG Full	36.2	47,700	324	5.9	0.9	228
½ N	34.7	50,300	318	5.5	0.9	198
Full N	39.9	50,000	319	6.3	0.9	211
F	8.5	1.13	0.83	0.5	1.4	1.46
P	0.0009	0.39	0.55	0.5	0.29	0.27
LSD 5%	3.1	NS	NS	NS	NS	NS

*OG, Ocean Grown only
OG ½ N is Ocean Grown with ½ rate N treatment
OG Full is Ocean Grown with full rate N treatment
½ N is the ½ rate of N treatment only
Full N is the full rate of N treatment only

Summary

OceanGrown™ treatments recommended by the company representative were applied to spring wheat, field corn, pinto beans, potatoes and sugarbeets. There were no enhancements of yield or quality components of any crop due to OceanGrown treatments, but there was an increase in yield and protein of spring wheat due to N rate, an increase of corn yield with N rate and an increase in sugarbeet tonnage with added N.

Elemental analysis for P, K, S, Ca, Mg, Zn, Cu, Mn, Fe and B were conducted on acid digests of the grain of pinto bean, spring wheat and corn and on freeze-dried potato tubers. OceanGrown treatments had no effect on the elemental concentration of any of these elements in any crop tested. The OceanGrown treatments tested in these experiments appeared to have no value for the crops studied in our region.