NORTHWEST CROPS & SOILS PROGRAM

2023 GSR Fertilizer Tomato Field Trial

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THE UNIVERSITY OF VERMONT EXTENSION

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There is current interest in new fertilizer sources that optimize the use of natural resources while providing similar efficacy in crop fertilization and nutrient cycling as traditional fertilizers. GSR Solutions LLC (General Systems Research) produced an algae-based, naturally derived fertilizer. In this trial, the soil and leaf nitrate level and yields of tomato were evaluated to compare the GSR fertilizer to common nitrogen fertilizers during the 2023 field season.

MATERIALS AND METHODS

Tomato (var 'Galahad') seedlings were transplanted on 25-May into 10' x 5' plots. Plant spacing was 2' with 5 plants per plot (Table 1). The experimental design was a randomized complete block with four replicates. The soil type was Benson rocky silt loam with 3-5% slopes. Treatments included GSR's G3 fertilizer (3-0-0), Pro-Booster (10-0-0) by North Country Organics (Bradford, VT), Urea (46-0-0), hemp seed meal (6-1-1) produced at Borderview Farm (Alburgh, VT), and an untreated control. Soil amendments were applied at a rate to supply a total of 120 lbs N ac^{-1} (Table 2). Amendments were broadcast by hand and worked into the soil prior to transplanting.

Table 1. GSR tomato field trial specifics for Alburgh, VT, 2023.

	Borderview Research Farm Alburgh, VT
Soil types	Benson rocky silt loam with 3-5% slopes
Previous crop	Sweet Potato
Tillage operations	Pottinger TerraDisc®
Tomato variety	Galahad
Plot size (feet)	10' x 5'
Plant spacing (feet)	2'
Replicates	4
Planting date	25-May
Harvest dates	3-Aug, 9-Aug, 14-Aug, 21-Aug, 28-Aug, 6-Sep

Table 2. Field treatments & rates of application, 2023.

Treatment & fertilizer analysis	**Product application (lbs. $plot^{-1}$)**	**Product Application (lbs. ac^{-1})**
GSR (3-3-1)	4.60	4008
Pro-Booster (10-0-0)	1.38	1202
Urea (46-0-0)	0.30	261
Hemp meal (6-1-1)	2.44	2126
Control	0.00	0.00

Soil samples were collected for nitrate analysis on 22-Jun. Soil samples were analyzed at the University of Vermont Agricultural and Environmental Testing Lab (UVM AETL). Leaf samples were collected

from the center three plants of each plot on 30-Jun and 19-Jul. Thirty leaf petioles per plot were collected (10 petioles per plant), from the most recent mature leaves, into a composite sample and dried down prior to shipping. Samples were submitted to Dairy One Laboratory (Ithaca, NY) and analyzed for total nitrogen (%).

At harvest, the ripe tomatoes were picked from the center three plants in each plot, using the outside plants as buffers between treatments. Plots were harvested on six different occasions including 3-Aug, 9-Aug, 14-Aug, 21-Aug, 28-Aug, and 6-Sep. The number of ripe fruit and weight (lbs) were recorded at harvest.

Stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within the trial were treated as random effects, and treatments were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in project results can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. At the bottom of each table, an LSD value is presented for each variable (e.g. yield). Least Significant Differences (LSD's) at the 10% level of probability are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In this example, treatment A is significantly different from treatment C but not from treatment B.

Treatment	Yield
A	**2100***
B	1900*
C	1700
LSD	300

The difference between A and B is equal to 200, which is less than the LSD value of 300. This means that these treatments did not differ in yield. The difference between A and C is equal to 400, which is greater than the LSD value of 300. This means that the yields of these treatments were significantly different from one another.

RESULTS

Seasonal precipitation and temperature were recorded at Borderview Research Farm in Alburgh, VT and are displayed in Table 3. The average temperature during the growing period was 5.98°F cooler than the 30-year normal, while precipitation was 6.51 inches greater than the 30-year normal. With the cooler temperatures there were 62 Growing Degree Days (GDDs) fewer than the average during May to September. A total of 2487 GDDs accumulated from May to September.

Table 3. Seasonal weather data for Alburgh, VT, 2023.

	May	Jun	Jul	Aug	Sep
Average temperature (°F)	57.1	65.7	72.2	67.0	63.7
Departure from normal	-1.28	-1.76	-0.24	-3.73	1.03
Precipitation (inches)	1.98	4.40	10.8	6.27	2.40
Departure from normal	-1.78	0.14	6.69	2.73	-1.27
Growing Degree Days (50-86°F)	303	483	712	540	449
Departure from normal	1.00	-41.0	17.0	-101	62.0

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2020) for Burlington, VT.

Tomato harvests were only significantly different on the second (9-Aug) and fourth (21-Aug) harvest dates. On 9-Aug, the GSR fertilizer had a statistically higher number of ripe tomatoes than the control and a statistically higher weight harvested than both the control and the hemp meal fertilizer (Table 4). On 21-Aug, the urea fertilizer treatment had a statistically greater number of ripe tomatoes harvested and weight than all other fertilizer treatments but the control, which was not statistically different. When assessing total yield by treatment, the urea fertilizer had a statistically higher weight than both the Pro-Booster and hemp meal fertilizers, but was not statistically different from either the control or the GSR fertilizer (Table 5).

Table 4: Tomato harvest data by treatment and date, Alburgh, VT 2023.

Treatment	Harvest dates											
	3-Aug		9-Aug		14-Aug		21-Aug		28-Aug		6-Sep	
	# of fruit	lbs	# of fruit	lbs	# of fruit	lbs	# of fruit	lbs	# of fruit	Lbs	# of fruit	lbs
Control	5.25	3.45	2.00 b †	0.83 b	9.00	4.79	11.5 a	7.03 a	6.25	3.33	5.25	3.04
GSR	5.75	3.76	**4.50 a**	**2.65 a**	8.50	4.28	9.50 b	5.13 b	5.00	2.80	6.50	3.59
Pro-Booster	6.50	4.10	3.50 a	1.91 a	8.75	4.52	7.25 b	4.23 b	5.00	2.95	5.00	2.54
Urea	7.25	5.20	3.50 a	1.65 a	6.25	3.18	**12.8 a**	**7.25 a**	7.75	4.31	4.50	3.03
Hemp meal	6.50	4.40	2.75 a	1.37 b	7.50	3.70	9.50 b	4.93 b	5.25	3.04	4.75	2.34
LSD (0.10) ‡	NS§	NS	2.30	1.16	NS	NS	3.21	2.00	NS	NS	NS	NS
Trial Mean	6.25	4.18	3.25	1.68	8.00	4.09	10.1	5.71	5.85	3.28	5.20	2.91

† Treatments which share a letter are statistically similar. Within a column, the top performer is in **bold**.

‡ LSD- Least significant difference at p=0.10.

§NS- No significant difference between treatments.

Table 5: Total tomato harvest by treatment and date, Alburgh, VT 2023.

Treatment	Yield	
	# of fruit	lbs
Control	39.3	22.5 a †
GSR	39.8	22.2 a
Pro-Booster	36.0	20.2 b
Urea	42.0	**24.6 a**
Hemp meal	36.3	19.8 b
LSD (0.10)‡	NS§	3.92
Trial Mean	38.7	21.9

† Treatments which share a letter are statistically similar.
Within a column, the top performer is in **bold**.
‡ LSD- Least significant difference at p=0.10.
§NS- No significant difference between treatments.

Soil nitrate concentrations were statistically similar to each other, except for the control which had the lowest levels at 42.8 mg N kg^{-1} (Table 6). The Urea treatments had the highest levels of nitrate in the soil samples at 125 mg N kg^{-1}, but was not significantly different from the other fertilizer treatments. Leaf nitrate concentration had significant differences a month and 5 days after transplanting the tomatoes, but the sampling on 19-Jul showed no significant differences among treatments (Table 6). On 30-Jun, the urea fertilizer treatment had the highest levels of nitrate in the leaves at 5.19 mg N kg^{-1}, but was only significantly different from the GSR treatment which had the lowest at 4.74 mg N kg^{-1}.

Table 6: Soil and leaf nitrate concentrations by treatment, Alburgh, VT 2023.

Treatment	Soil nitrate mg N kg^{-1}	Leaf nitrate mg N kg^{-1}	
	22-Jun	30-Jun	19-Jul
Control	42.8 b †	4.88 a	4.20
GSR	84.8 a	4.74 b	4.16
Pro-Booster	121 a	4.87 a	4.28
Urea	**125 a**	**5.19 a**	4.30
Hemp meal	79.8 a	5.04 a	4.13
LSD (0.10)‡	49.0	0.33	NS§
Trial Mean	90.6	4.94	4.21

† Treatments which share a letter are statistically similar.
Within a column, the top performer is in **bold**.
‡ LSD- Least significant difference at p=0.10.
§NS- No significant difference between treatments.

DISCUSSION

This trial suggests slight differences between the GSR fertilizer and the other nitrogen fertilizers evaluated, as well as the control. Although, some data shows greater yields for the GSR on the 9-Aug harvest, it also shows fewer ripe tomatoes and weight on the 21-Aug harvest compared to the urea treatment. When comparing total pounds of tomatoes harvested, the GSR fertilizer did have a higher weight of fruit collected than both the Pro-Booster and hemp meal fertilizers, suggesting the GSR fertilizer may aid in more fruit development.

The soil nitrate levels for the fertilizer treatments were not statistically different, suggesting that they all had a similar nitrogen uptake. However, when looking at the leaf nitrate levels, GSR had the lowest levels when the samples were taken on 30-Jun, suggesting that more time is needed for nitrogen to become available to the plant. By the time of the second leaf nitrate sampling on 19-Jul, concentrations were similar which suggests nitrogen levels were similarly available among the different treatments. It is important to remember that these results only represent one field season of data.

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