EXI and Oasis Micro on Red Onion in Washington State

Research Summary for

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Background: Washington's Onion Industry

Onions are primarily divided into two production types: fresh market and dry storage. Onions varieties are also characterized by their shape, color, and day length requirements. Washington state farmers plant about 26,000 acres of onions annually (85% yellow, 10% red, and 5% white), producing over 20% of the nation's onion supply[3]. The overwhelming majority of Washington's onions are dry bulb and grown for storage. In 2012, this production equated to over $184 million in economic impact[1]. At just over 500 acres, organic onion acreage comprises only 2% of the state's total[2].

Onions are a high value crop and require significant inputs. Most onions in Washington State are grown in the Colombia Basin on well-drained, sandy loam soils. These soils are ideal for onion drying and preventing bulb rot. Irrigation systems include over-head pivot or sub-surface drip. Fertilizer is usually applied preseason, with in-season fertigation of nitrogen as needed. Herbicides, insecticides, and fungicides are commonly required in commercial production. Early season herbicide applications, which are typically applied at the two to three leaf stage, often stunt onion growth and cause tissue deformities and damage.

Most onion fields are direct seeded into prepared beds, and the plants grow very slowly until the 3-leaf stage. Bulbing begins as a response to day length, and water and nutrient demand is highest during this stage. At least 150 days after planting, bulb enlargement is near complete, and the onion tops begin to fall and dry. Typically, onions grown for storage are undercut, field cured, windrowed, and then harvested. The state average yield of storage onions hovers around 30 tons per acre[3].

The objective of this trial was to evaluate EXI and Oasis Micro on dry bulb onions. Onion herbicide damage, yield and quality were the measured variables.

[1]ERS USDA. 2012. US Onion Statistics. Economic Research Service USDA, Washington, DC.

[2]Granatstein, D., E. Kirby, and M. Brady. 2015. Trends and Economics of Washington State Organic Vegetable Production. Washington State University Extension, Pullman, WA.

[3]NASS USDA. 2016. State Agriculture Overview: Washington. National Agricultural Statistics Service USDA, Washington, DC.

Materials and Methods

The trial was established in Othello, Washington, in a conventional Marenge variety red onion field. The soil series is Neppel very fine sandy loam, a fertile soil with alluvium parent material. Plots were seeded April 11, 2017 at 182,000 seeds per acre. Four double rows (three inches apart) were planted on sixty-eight inch center-to-center beds, with two drip tapes installed four inches deep. Plots consisted of thirty feet of one bed, with one bed buffers. Treatments were replicated four times and arranged in a randomized complete block design.

The treatments consisted of untreated grower standard and a Soil Basics program (EXI at 3 pints per acre and Oasis Micro at 2 quarts per acre). A CO_2 powered backpack sprayer with a five foot boom (four TeeJet 8002 nozzles at twenty inch spacing) was calibrated to deliver twenty gallons of spray volume per acre (figure 3). Foliar applications of EXI and Oasis Micro were made at three-leaf stage, twenty days later, and forty days later (table 1). A composite tissue sample from each treatment was taken on July 13, and was comprised of the most recently matured leaf from at least twenty plants per plot.

A starter fertility package was placed with the seed at plant, and a total of 145 lb/ac of nitrogen was applied in weekly fertigation between May 1 and July 15. Goal (oxyfluorfen) and Buctril (bromoxynil) herbicides were applied on May 27. Fungicides and insecticides, including Pristine, Tanos, Lannate, and Vydate, were applied as needed to control pests.

On June 7, two five-foot sections in each plot were evaluated for herbicide injury. Damage to each onion was categorized as: severe, moderate, or none. Severe damage was defined as at least one leaf curled over its own axis, while moderate damage constituted a curl over 90° (figures 1 and 2).

Five-linear-foot sections of bed were hand-harvested in each plot on September 6, 2017. Onions were weighed, counted, and graded. Grade 2 onions included abnormalities in shape as designated by the USDA Onion Grade Standards (figure 4). All onions were individually sized for diameter with a digital caliper. Onions with rot were also counted. T-tests ($\alpha = 0.10$) were performed for statistical analyses in SAS 9.4.

Figure 1. Severe onion damage.

Figure 2. Moderate onion damage.

Figure 3. Foliar application with CO_2 backpack sprayer.

Figure 4. A grade 2 split onion.

Application Date	Growth Stage	Photograph
May 22	2 two leaf	
June 14	3 four to five leaf	
July 3	4 six to eight leaf, bulb initiation	

Table 1. EXI and Oasis Micro foliar application timings. Growth stage numbers adapted from Schwartz and Mohan 1995.

Results and Discussion

The plot area emerged uniformly. Weed pressure was minimal. Onion thrips (*Thrips tabaci*) population was moderate, and some pink root (*Phoma terrestris*) was seen late in the season. Overall, however, onions in the trial grew well.

There was visual herbicide damage on all plots following the Goal and Buctril applications, but EXI + Oasis Micro application appeared to mitigate the stress (figure 5). EXI + Oasis Micro treated plots had fewer severely damaged onions than the areas that did not receive any product, a reduction of 18% compared to untreated. Because the proportions of unaffected healthy onions in grower standard and Soil Basics treated were essentially equivalent, the percentage of moderately damaged onions was higher in Soil Basics plots. Essentially, the fertility and bio-stimulation in the EXI and Oasis Micro was able to mediate some severe damage, limiting the herbicide damage to only moderate. These differences were statistically confirmed, though not at the 5% confidence interval.

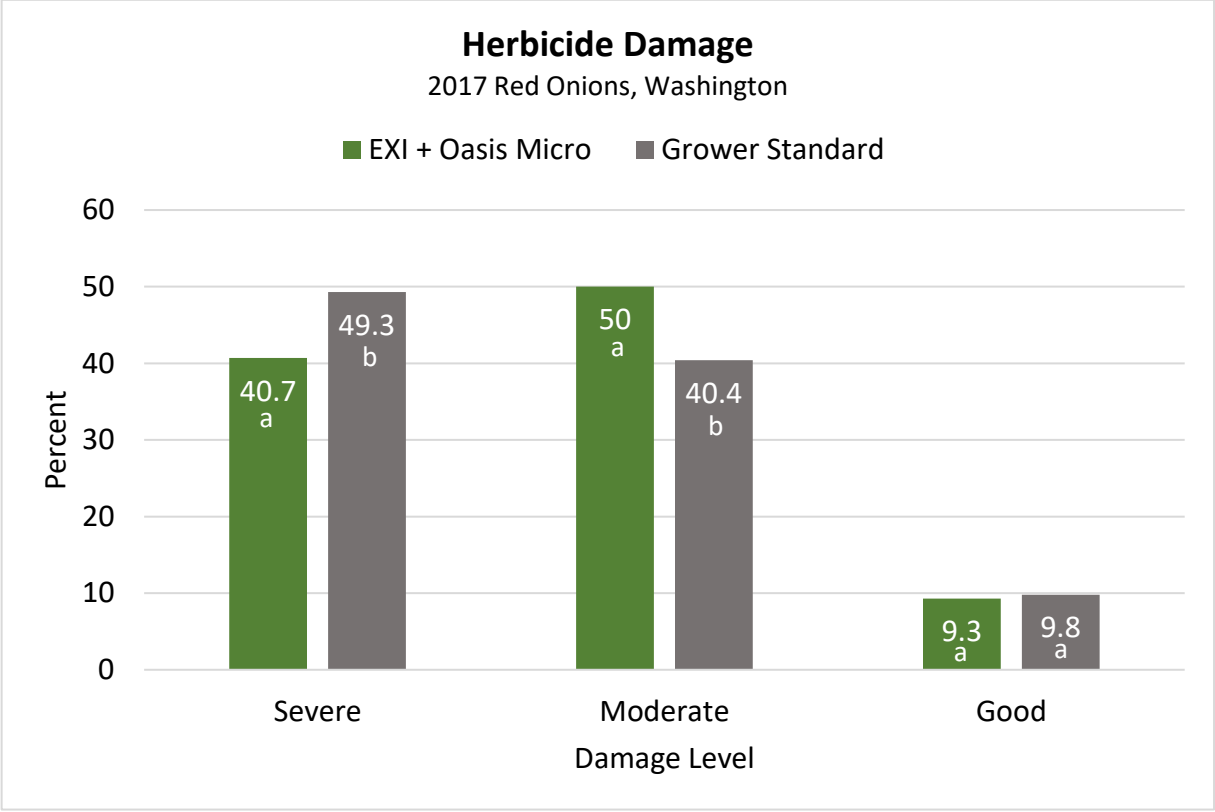


Figure 5. Average percent of injured onions for untreated and Soil Basics plots, as divided into severe and moderate damage levels. "None" indicates no visual herbicide injury. Within each damage level, values followed by the same letter indicate no significant difference ($\alpha = 0.10$).

In general, the nutrient concentrations in all three treatment samples fell within the adequate range as determined by university field correlations (table 2). Between grower standard and Soil Basics, differences were minimal; nutrient levels were nearly identical for most elements. EXI did not boost the P or K concentrations in the tissue as measured at this sampling time. However, Soil Basics-treated onion tissue did have higher copper content than grower standard, exceeding untreated by 32%. Additionally, the boron level was slightly higher in Soil Basics, but the iron concentration was 14% lower.

July 13 Tissue Sample				
Nutrient	**Unit**	**EXI + Oasis Micro**	**Grower Standard**	**General Sufficiency Range**
Total N	%	2.37	2.35	2.5 – 5
P	%	0.35	0.37	0.3 – 0.6
K	%	1.27	1.40	1.5 – 4.5
S	%	0.30	0.38	0.3 – 0.8
Ca	%	1.50	1.39	1 – 5
Mg	%	0.20	0.19	0.15 – 0.40
Na	%	0.07	0.07	
Zn	ppm	19	20	25 – 50
Mn	ppm	18	18	10 – 25
Cu	ppm	12	7	10 – 30
Fe	ppm	102	118	50 – 200
B	ppm	29	28	22 – 60

Table 2. Tissue sample nutrient results from Soil Basics and grower standard treatments taken on July 13. Sufficiency ranges adapted from Washington State University Extension and University of Florida Extension.

Grower standard and Soil Basics plots averaged 111 and 110.3 onions per 28ft^2 hand-dig, respectively. Yield was good, nearly 50 ton/ac (figure 7). Numerically, Soil Basics outperformed the untreated by only 1%, a difference that was not statistically confirmed.

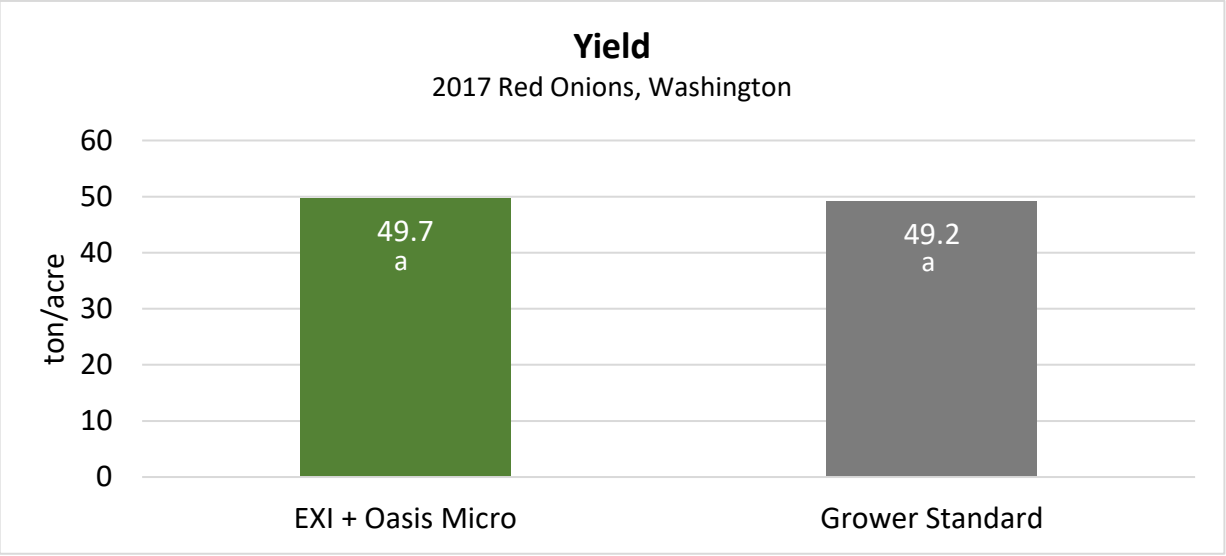


Figure 7. Average onion yield in tons per acre. Values followed by the same letter indicate no significant difference (α = 0.10).

Onion quality was acceptable (table 3). Rot percentages were low, and undersize onions remained under 5%. Statistically, Soil Basics improved onion grade, with less number 2 onions under EXI and Oasis Micro applications. Marketable number 1 percent was also higher than grower standard, and culls due to size and rot were 35% and 50% less, respectively (figure 8); however, these differences were not statistically significant.

Onion Quality				
Treatment	**Marketable Number 1**	**Number 2**	**Rot**	**Size Cull, <2.25”**
	%			
EXI + Oasis Micro	92.0a	5.01a	0.22a	2.76a
Grower Standard	88.6a	6.77b	0.44a	4.23a

Table 3. For each treatment, grade and quality metrics are shown as average percentages of onion number. Number 2 onions are those deformed or split, according to USDA grade standards. Rotted bulbs and those under 2.25 inches are also noted. Marketable number 1 percentage includes those onions with a diameter over 2.25 inches. Values followed by the same letter indicate no significant difference ($\alpha = 0.10$).

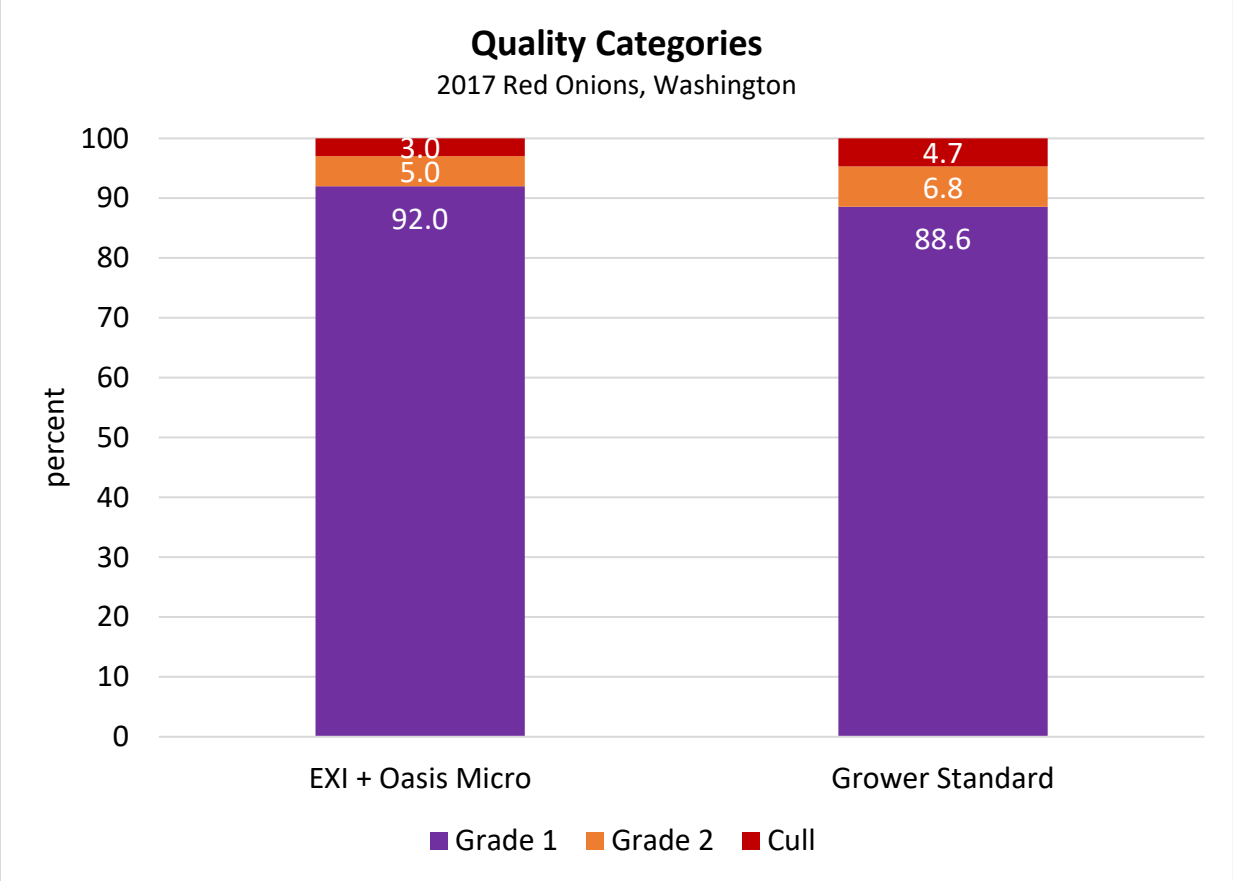


Figure 8. Average onion grades for each treatment. Grade 1, 2, and cull (rot plus undersize) percentages are shown.

Average onion diameter was 3.1 inches for both Soil Basics and grower standard. Separating the diameter values into market classes, very few colossal or super colossal onions were measured in this trial (appendix A). For both treatments, the majority of onions fell within the jumbo or medium size categories (table 4).

Soil Basics and grower standard size distribution was very similar (figure 9). Undersize percent was less under Soil Basics application, while medium, colossal, and super colossal proportions were slightly higher. None of these differences were statistically significant.

Onion Size Distribution					
Treatment	**Super Colossal >4.25”**	**Colossal 4-4.25”**	**Jumbo 3-4”**	**Medium 2.25-3”**	**Cull <2.25”**
	%				
EXI + Oasis Micro	0.2a	0.9a	66.8a	29.3a	2.8a
Grower Standard	0.0a	0.2a	67.0a	28.5a	4.2a

Table 4. Average size grade breakouts for each treatment. Values followed by the same letter indicate no significant difference (ANOVA, $\alpha = 0.10$).

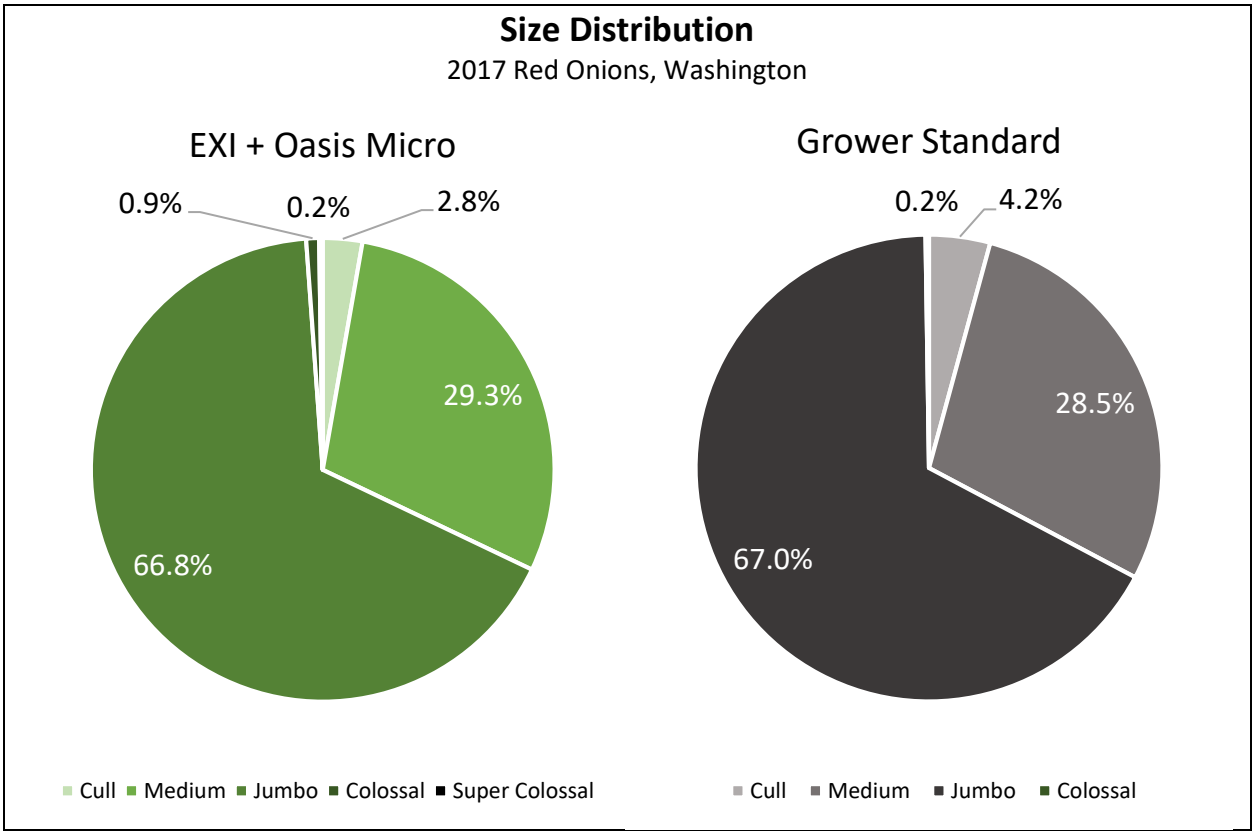


Figure 9. Average onion size breakouts for each treatment. Grades are signified by color gradation, with small culls the lightest shade and colossal/super colossal the darkest.

At an average open market price for jumbo red onions of $8 per 25-lb bag and medium red onions of $7 per 25-lb bag, plots treated with EXI and Oasis Micro resulted in a gross return of $1840 per acre (figure 10). Grower standard trailed by about $30 per acre, or 2%.

Figure 10. Average gross return per acre for each treatment. Values followed by the same letter indicate no significant difference ($\alpha = 0.10$).

Conclusions

EXI and Oasis Micro mitigated the damage caused by herbicide stress. While there were not substantially more healthy/unaffected onions, the number of severely damaged plants was diminished. Instead, the injury was more moderate, curtailed because of the nutrition and stimulus of the Soil Basics products.

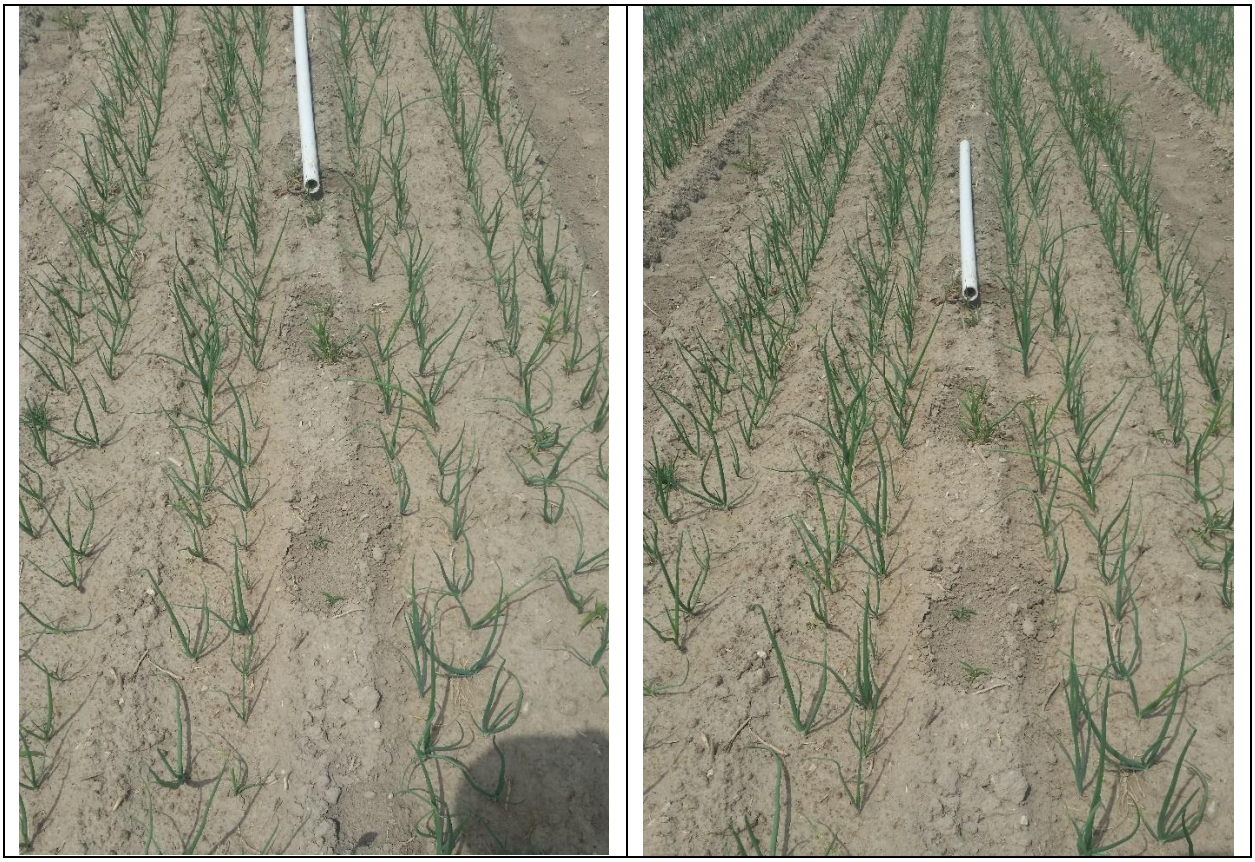
The Soil Basics program led to the highest in-season leaf copper content. Most other nutrient levels were very similar between untreated grower standard and Soil Basics, though iron was lower under Soil Basics treatment.

Yield with EXI and Oasis Micro was almost the same as grower standard. Quality was improved under Soil Basics, as these plots contained statistically fewer number 2 onions. Due to a reduced number of culls and better quality, the gross return of Soil Basics program was numerically slightly higher than the grower standard.

Photographs

The below photographs were taken June 7, at the time of herbicide injury rating.

EXI + Oasis Micro



Untreated

Each photograph below shows onions from one row (of the four rows) from one hand dig. A photograph is included from each replication.

EXI + Oasis Micro

Grower Standard




Appendix A: Data by Replicate

Trt.	*Rep.*	*Onion No. (/28 ft²)*	*Yield (lb/28ft²)*	*Yield (cwt/ac)*	*Marketable Grade 1 (%)*	*Grade 2 (%)*	*Rot (%)*	*Super Col. (%)*	*Colosssal (%)*	*Jumbo (%)*	*Medium (%)*	*Cull (%)*	*Gross Ret. ($/ac)*
EXI + Oasis Micro	1	110	60.79	934.7	87.3	7.27	0.00	0.00	0.00	60.9	33.6	5.5	1689
	2	115	67.56	1038.8	97.4	2.61	0.00	0.00	1.74	63.5	34.7	0.0	1951
	3	115	65.73	1010.7	91.3	5.22	0.87	0.00	0.87	63.5	33.0	2.6	1868
	4	101	64.71	995.0	92.1	4.95	0.00	1.00	0.99	79.2	15.8	3.0	1852
Grower Standard	1	115	63.7	979.6	87.0	8.70	0.00	0.00	0.00	62.6	33.0	4.3	1792
	2	114	63.3	973.8	88.6	4.39	1.75	0.00	0.00	68.4	26.3	5.3	1780
	3	111	64.0	984.7	88.3	6.31	0.00	0.00	0.00	64.9	29.7	5.4	1790
	4	104	64.9	998.1	90.4	7.69	0.00	0.00	0.00	72.1	25.0	1.9	1876