

EVALUATION OF ZEBBA[®] FOR ONION PRODUCTION

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Introduction

Zeba[®] marketed by United Phosphorus Inc. (King of Prussia, PA) is a cornstarch-based soil enhancement product. Zeba reportedly increases the soil water holding capacity. This trial compared plant stands and bulb yields for an untreated check treatment with three rates of soil-applied Zeba.

Materials and Methods

Onions were grown in 2018 on a Greenleaf silt loam previously planted to wheat. A soil analysis taken in the fall of 2017 showed that the top foot of soil had a pH of 8.2, 3.4% organic matter, 7 ppm nitrate-N, 3 ppm ammonium-N, 22 ppm phosphorus (P), 386 ppm potassium (K), 20 ppm sulfur (S), 3218 ppm calcium, 533 ppm magnesium (Mg), 138 ppm sodium, 4.1 ppm zinc (Zn), 3 ppm manganese (Mn), 2.2 ppm copper (Cu), 16 ppm iron, and 0.5 ppm boron (B). In the fall of 2017, the wheat stubble was shredded and the field was irrigated. The field was then disked. Based on a soil analysis, 78 lb of P/acre, 81 lb K/acre, 162 lb of S/acre, 9 lb of Mn/acre, and 1 lb of B/acre were broadcast before plowing. Also before plowing, 10 tons/acre of composted cattle manure were broadcast. The manure was estimated to supply 196 lb nitrogen (N)/acre, 156 lb P/acre, and 342 lb K/acre. The field was then moldboard plowed, and groundhogged. After ground hogging, the field was fumigated with K-Pam[®] at 15 gal/acre and bedded at 22 inches.

Seed of variety ‘Vaquero’ (Nunhems, Parma, ID) was planted on March 26 in double rows spaced 3 inches apart. Each double row was planted on beds spaced 22 inches apart. The vacuum seeder was set to drop seed every 3 inches/ft of single row.

The experimental design was a randomized complete block with four treatments and nine replicates. The field was divided into plots 4 double rows wide and 27 ft long. The treatments were an untreated check and 3 rates of Zeba SP (4, 8, and 12 lb/acre). Zeba was applied at planting to each of the four single onion rows on the middle two beds in each plot. Zeba was applied to the seed furrow after seed drop using a Gandy box applicator. The seed and then the Zeba fell into the seed furrow before the soil covered the seed.

Immediately after planting, the field received a narrow band of Lorsban[®] 15G at 3.7 oz/1000 ft of row (0.82 lb ai/acre) over the seed rows and the soil surface was rolled. Onion emergence started on April 12. On May 10, alleys 4 ft wide were cut between plots, leaving plots 23 ft long.

The field had drip tape laid at 4-inch depth between pairs of beds during planting. The drip tape had emitters spaced 12 inches apart and an emitter flow rate of 0.22 gal/min/100 ft (Toro Aqua-Traxx, Toro Co., El Cajon, CA). The distance between the tape and the center of each double row of onions was 11 inches.

Onions were irrigated automatically to maintain the soil water tension (SWT) in the onion root zone below 20 cb (Shock et al. 2000). Soil water tension was measured with eight granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co. Inc., Riverside, CA) installed at 8-inch depth in the center of the double row. Sensors had been calibrated to SWT (Shock et al. 1998). The GMS were connected to the datalogger via multiplexers (AM 16/32, Campbell Scientific, Logan, UT). The datalogger (CR1000, Campbell Scientific) read the sensors and recorded the SWT every hour. The datalogger automatically made irrigation decisions every 12 hours. The field was irrigated if the average of the eight sensors was a SWT of 20 cb or higher. The irrigations were controlled by the datalogger using a controller (SDM CD16AC, Campbell Scientific) connected to a solenoid valve. Irrigation durations were 8 hours, 19 min to apply 0.48 inch of water. The water was supplied from a well and pump that maintained a continuous and constant water pressure of 35 psi. The pressure in the drip lines was maintained at 10 psi by a pressure-regulating valve. The automated irrigation system was started on May 16 and irrigations ended on August 31.

Starting on June 8, root tissue and soil samples were taken every week from field borders (variety ‘Vaquero’) and analyzed for nutrients by Western Laboratories, Inc., Parma, Idaho (Tables 1 and 2). Nutrients were applied through the drip tape based on recommendations from Western Labs (Table 3). Urea ammonium nitrate solution (URAN) was applied through the drip tape six times from May 23 to June 25, supplying a total of 120 lb N/acre. Starting June 22, the soil solution N remained above the critical level for the rest of the season. Also starting June 22, the amount of total available soil N remained above the critical level of 60 lb N/acre for the rest of the season (Table 4, Sullivan et al. 2001). Phosphorus, K, Mg, and Cu were also applied based on the soil and tissue analyses.

Table 1. Onion root tissue nutrient content in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

| Nutrient | | 8-Jun | 15-Jun | 22-Jun | 29-Jun | 9-Jul | 23-Jul | 27-Jul | 3-Aug | 10-Aug |
|--------------------------|-------------------|-------|--------|--------|--------|-------|--------|--------|-------|--------|
| NO ₃ -N (ppm) | Sufficiency range | 8500 | 7667 | 6833 | 6000 | 5168 | 4338 | 3508 | 2678 | 1834 |
| NO ₃ -N (ppm) | | 4772 | 3668 | 4105 | 4726 | 3903 | 4644 | 3616 | 3432 | 2871 |
| P (%) | 0.32 - 0.7 | 0.52 | 0.44 | 0.34 | 0.40 | 0.44 | 0.37 | 0.28 | 0.41 | 0.35 |
| K (%) | 2.7 - 6.0 | 3.67 | 3.31 | 3.13 | 4.49 | 4.18 | 3.21 | 2.75 | 2.51 | 2.16 |
| S (%) | 0.24 - 0.85 | 1.00 | 0.94 | 0.87 | 1.21 | 0.63 | 0.60 | 0.77 | 0.81 | 0.50 |
| Ca (%) | 0.4 - 1.2 | 0.59 | 0.66 | 0.79 | 0.79 | 0.74 | 0.87 | 0.93 | 1.16 | 0.96 |
| Mg (%) | 0.3 - 0.6 | 0.33 | 0.42 | 0.47 | 0.36 | 0.32 | 0.35 | 0.43 | 0.43 | 0.36 |
| Zn (ppm) | 25 - 50 | 67 | 47 | 56 | 47 | 39 | 46 | 51 | 40 | 30 |
| Mn (ppm) | 35 - 100 | 99 | 93 | 108 | 82 | 62 | 73 | 85 | 92 | 68 |
| Cu (ppm) | 6 - 20 | 20 | 15 | 10 | 8 | 7 | 6 | 7 | 6 | 7 |
| B (ppm) | 19 - 60 | 72 | 80 | 61 | 52 | 42 | 33 | 31 | 25 | 28 |

Table 2. Weekly soil solution analyses in the onion variety trial. Data represent the amount of each plant nutrient per day that the soil can potentially supply to the crop. Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

| Nutrient | Critical level, | 8-Jun | 15-Jun | 22-Jun | 29-Jun | 9-Jul | 23-Jul | 27-Jul | 3-Aug | 10-Aug |
|----------|-----------------|-------|--------|--------|--------|-------|--------|--------|-------|--------|
| | lb/ac or g/ac | | | | | | | | | |
| N | Critical levels | 8.6 | 7.8 | 7 | 6.2 | 5.4 | 4.6 | 3.8 | 2.8 | 2 |
| N | | 2 | 2.3 | 9.7 | 8.6 | 9.7 | 8.6 | 10 | 12.6 | 10 |
| P | 0.7 lb/acre | 1.2 | 1.1 | 1.5 | 1.6 | 1.5 | 2 | 1.8 | 2.2 | 2.3 |
| K | 5 lb/acre | 8.5 | 9.1 | 9.2 | 7.9 | 6.6 | 7 | 8.2 | 6.9 | 7.4 |
| S | 1 lb/acre | 1.5 | 1 | 2.3 | 3.1 | 4.3 | 5.5 | 5.5 | 3.8 | 4.7 |
| Ca | 3 lb/acre | 4.9 | 5 | 6.1 | 4.7 | 5.5 | 4.5 | 5.5 | 5.1 | 5 |
| Mg | 2 lb/acre | 0.2 | 0.2 | 0.5 | 0.6 | 0.7 | 0.9 | 1 | 1 | 1.1 |
| Zn | 28 g/acre | 75 | 69 | 78 | 57 | 66 | 57 | 63 | 45 | 45 |
| Mn | 28 g/acre | 24 | 30 | 27 | 21 | 27 | 33 | 30 | 27 | 24 |
| Cu | 12 g/acre | 36 | 42 | 33 | 27 | 21 | 24 | 27 | 24 | 30 |
| B | 21 g/acre | 8 | 9 | 12 | 11 | 14 | 12 | 15 | 12 | 15 |

Table 3. Nutrients applied through the drip irrigation system in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

| Date | N | P | K | Mg | Cu |
|--------|-----|---------------------|----|------|-----|
| | | ----- lb/acre ----- | | | |
| 23-May | 20 | | | | |
| 1-Jun | 20 | | | | |
| 11-Jun | 20 | | | | |
| 12-Jun | 20 | | | | |
| 19-Jun | 20 | | | 2.5 | |
| 25-Jun | 20 | | | 5 | |
| 6-Jul | | | | 5 | |
| 25-Jul | | | | | 0.3 |
| 30-Jul | | 10 | | | |
| 7-Aug | | | 10 | | |
| 15-Aug | | | 10 | | |
| Total | 120 | 10 | 20 | 12.5 | 0.3 |

Table 4. Soil available N (NO₃ + NH₄) in the top foot of soil in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

| Date | Available soil N, lb/acre |
|--------|---------------------------|
| 8-Jun | 14 |
| 15-Jun | 16 |
| 22-Jun | 68 |
| 29-Jun | 60 |
| 9-Jul | 68 |
| 23-Jul | 60 |
| 27-Jul | 70 |
| 3-Aug | 88 |
| 10-Aug | 70 |

Plant stand counts were taken in the middle two double rows in each plot on April 16, April 23, and April 30.

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. For weed control, the following herbicides were broadcast: oxyfluorfen at 0.13 lb ai/acre (GoalTender[®] at 4 oz/acre), bromoxynil at 0.25 lb ai/acre (Brox[®] 2EC at 16 oz/acre), and clethodim at 0.12 lb ai/acre (Shadow[®] 3EC at 5.3 oz/acre) on May 7; pendimethalin at 0.95 lb ai/acre (Prowl[®] H₂O at 2 pt/acre) on May 17; oxyfluorfen at 0.25 lb ai/acre, bromoxynil at 0.31 lb ai/acre, and clethodim at 0.12 lb ai/acre on May 25.

For thrips control, the following insecticides were applied by ground: spirotetramat at 0.078 lb ai/acre (Movento[®] at 5 oz/acre) and azadirachtin at 0.0093 lb ai/acre (Aza-Direct[®] at 12 oz/acre) on May 21 and June 3; abamectin at 0.019 lb ai/acre (Agri-Mek[®] SC at 3.5 oz/acre) on June 11. The following insecticides were applied by air: abamectin at 0.019 lb ai/acre on June 27; spinetoram at 0.078 lb ai/acre (Radiant[®] at 10 oz/acre) on June 30 and July 7; methomyl at 0.9 lb ai/acre (Lannate[®] at 3 pt/acre) on July 14 and 21; spinetoram at 0.078 lb ai/acre on July 28 and August 5.

The onions were lifted on September 10 to field cure. Onions from the middle two rows in each plot were topped by hand and bagged on September 15. The bags were put in storage on September 21. The storage shed was ventilated, and the temperature was slowly decreased to maintain cool air temperature. Onions were graded out of storage on October 12.

During grading, all bulbs from each plot were counted. The bulbs were then separated according to quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and supercolossal (>4¼ inches). Bulb counts per 50 lb of supercolossal onions were determined for each plot of every variety by weighing and counting all supercolossal bulbs during grading. Marketable yield consisted of No.1 bulbs larger than 2¼ inches.

Treatment differences were determined using analysis of variance. Means separation was determined using a protected Fisher's least significant difference test at the 5% probability level, LSD (0.05). The least significant difference LSD (0.05) values in each table should be considered when comparisons are made between treatments for significant differences in their performance characteristics. Differences between treatments equal to or greater than the LSD value for a characteristic should exist before any treatment is considered different from any other treatment in that characteristic.

Results

The plant populations were not as high as desired because the vacuum seeder apparently failed to drop the correct amount of seed. Seed emergence was somewhat slow. There were no statistically significant differences in plant population between treatments (Table 5).

The soil water tension remained close to the target during the season (Fig. 1). Onions grew well and bulb yields were high in all treatments (Table 6). Bulb decomposition was uniformly low.

There were no statistically significant differences in onion yield or grade between treatments (Table 6).

Acknowledgements

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References

- Shock, C.C., J. Barnum, and M. Seddigh. 1998. Calibration of Watermark soil moisture sensors for irrigation management. Irrigation Association. Proceedings of the International Irrigation Show. Pages 139-146. San Diego, CA.
- Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2000. Irrigation criteria for drip-irrigated onions. *HortScience* 35:63-66.
- Sullivan, D.M., B.D. Brown, C.C. Shock, D.A. Horneck, R.G. Stevens, G.Q. Pelter, and E.B.G. Feibert. 2001. Nutrient management for sweet spanish onions in the Pacific Northwest. Pacific Northwest Extension Publication PNW 546:1-26.

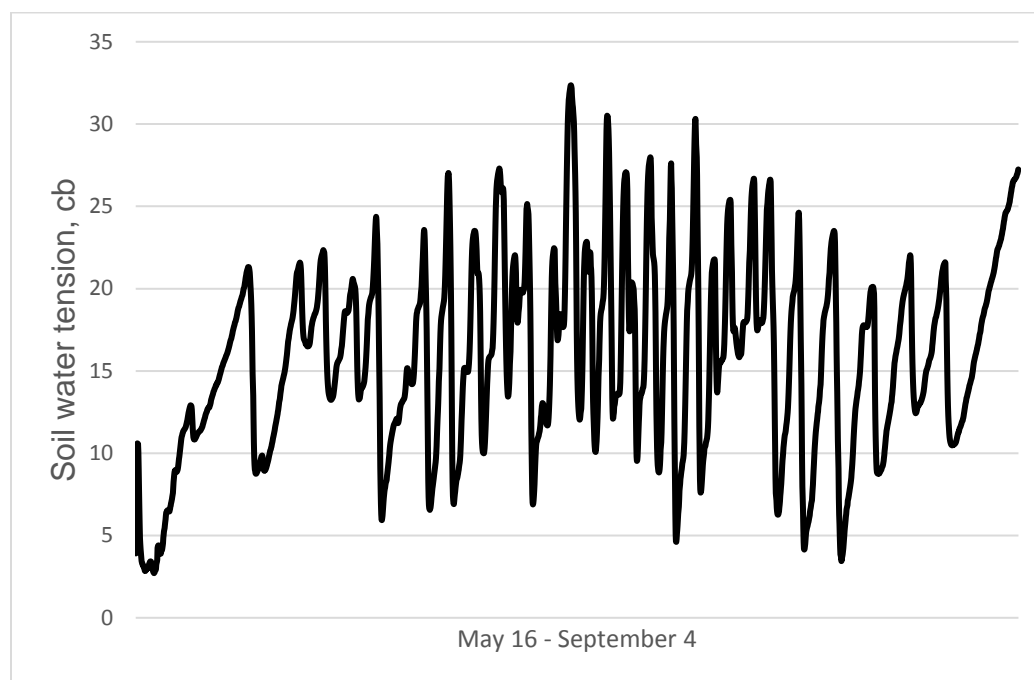


Figure 1. Soil water tension at 8-inch depth below the onion row in a corresponding check treatment. Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Table 5. Plant population in response to three Zeba[®] treatments on three dates and at harvest. Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

| Treatment | Zeba rate lb/acre | Plant population | | | |
|------------|----------------------|-------------------------|--------|--------|------------|
| | | 16-Apr | 23-Apr | 30-Apr | at harvest |
| | | ----- plants/acre ----- | | | |
| 1 | none (check) | 34,320 | 57,200 | 59,351 | 66,976 |
| 2 | 4 | 36,862 | 54,951 | 64,240 | 66,517 |
| 3 | 8 | 36,129 | 56,369 | 60,769 | 66,861 |
| 4 | 12 | 32,413 | 54,071 | 59,938 | 63,360 |
| LSD (0.05) | | NS | NS | NS | NS |

Table 6. Onion yield and grade in response to three Zeba[®] treatments. Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

| Zeba rate lb/acre | Total yield | Marketable yield by grade | | | | | | Neck rot | Plate rot | Bulb counts >4¼ in | |
|----------------------|----------------|---------------------------|--------|---------|--------|---------|--------------|-------------|-----------|--------------------------|------|
| | | Total | >4¼ in | 4-4¼ in | 3-4 in | 2¼-3 in | Small No. 2s | | | | |
| | | ----- cwt/acre ----- | | | | | | | | | |
| none (check) | 1097.1 | 1085.8 | 741.6 | 252.1 | 90.2 | 2.0 | 1.8 | 6.2 | 0.0 | 0.3 | 26.9 |
| 4 | 1075.6 | 1067.9 | 732.5 | 238.5 | 92.8 | 4.1 | 0.7 | 3.4 | 0.2 | 0.1 | 26.5 |
| 8 | 1081.7 | 1070.9 | 723.4 | 254.0 | 89.6 | 3.8 | 0.3 | 4.2 | 0.5 | 0.1 | 26.4 |
| 12 | 1052.4 | 1042.4 | 737.7 | 228.9 | 72.7 | 3.1 | 0.6 | 4.4 | 0.3 | 0.1 | 26.3 |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |