EVALUATION OF KELPAK® AND GREENFEED® IN ONION PRODUCTION

Clinton C. Shock, Erik B. G. Feibert, Alicia Rivera, and Lamont D. Saunders, Malheur Experiment Station, Oregon State University, Ontario, OR, 2015

Don Huenefeld, Caltec Ag, Inc., Modesto, CA

Introduction

Kelpak® (Caltec Ag, Inc., Modesto, CA) is a biostimulant produced from the seaweed *Ecklonia maxima*. Greenfeed® is a foliar N fertilizer formula. This trial evaluated whether Kelpak and Greenfeed could improve onion production.

Materials and Methods

Onions were grown in 2015 on a Greenleaf silt loam previously planted to wheat. A soil analysis taken in the fall of 2014 showed a pH of 7.4, 1.92% organic matter, 15 ppm nitrate-N, 5 ppm ammonium-N, 44 ppm phosphorus (P), 270 ppm potassium (K), 23 ppm sulfur (S), 3880 ppm calcium (Ca), 203 ppm magnesium (Mg), 128 ppm sodium, 3.0 ppm zinc (Zn), 5 ppm manganese (Mn), 1.5 ppm copper (Cu), 11 ppm iron (Fe), and 0.6 ppm boron (B). In the fall of 2014, the wheat stubble was shredded and the field was irrigated. The field was then disked, moldboard plowed, and groundhogged. Based on a soil analysis, 75 lb of P/acre, 200 lb of K/acre, 230 lb of S/acre, 20 lb Mg/acre, 7 lb of Mn/acre, and 1 lb of B/acre were broadcast before plowing. After plowing, the field was fumigated with K-Pam® at 15 gal/acre and bedded at 22 inches.

Seed of red onion variety 'Countach' (Nunhems Seed Co., Parma, ID) was planted on March 19 on 22-inch beds in double rows spaced 3 inches apart. Seed was planted with a vaccum seeder at 150,000 seeds/acre. Immediately after planting, the onions received a narrow band of Lorsban® 15G at 3.7 oz/1,000 ft of row (0.82 lb ai/acre), and the soil surface was rolled. Onion emergence started on April 7. On May 12, alleys 4 ft wide were cut between plots.

The experimental treatments consisted of 1) an untreated check 2) an application of Kelpak through the drip tape, 3) foliar applications of Kelpak and 4) foliar applications of Kelpak and Greenfeed (Table 1). The experimental design was a randomized complete block with four treatments and nine replicates. All treatments were started at the 3 to 4 leaf stage. The drip-injected treatment (2) had Kelpak injected through the drip tape at 1 gal/acre on May 22. The foliar treatments were started on May 21 and were applied biweekly. The experimental plots were 4 rows wide and 23 ft long.

The foliar treatments (3 and 4) were applied using a CO_2 sprayer with 4 8004 nozzles at 35 gal/acre. Kelpak was applied at 3 pt/acre for the first foliar application and at 2 pt/acre for the second and third foliar applications. Treatment 4 was the same as treatment 3, except for the addition of Greenfeed at 1 gal/acre to the last foliar application. A penetrant adjuvant (Wetcit®, Fresno, CA) was added to the spray solutions at 8 oz/100 gal of water.

Table 1. Kelpak and Greenfeed treatments applied biweekly to onions starting at the 3- to 4-leaf growth stage (May 21). Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

Treatment	Application method	Product	No. of applications
1	Check		
2	Drip injection	Kelpak	1
3	Foliar	Kelpak	3
4	Foliar	Kelpak, Greenfeed	3

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. For weed control, the following herbicides were applied: on March 30, Roundup PowerMax® at 24 oz/acre was broadcast; on May 1, GoalTender® at 0.09 lb ai/acre (4 oz/acre), Buctril® at 0.25 lb ai/acre (16 oz/acre), and Poast® at 0.25 lb ai/acre (16 oz/acre) were broadcast; on May 4, Prowl® H_2O at 0.83 lb ai/acre (2 pt/acre) was broadcast; on June 2, GoalTender at 0.09 lb ai/acre (6 oz/acre), and Buctril at 0.25 lb ai/acre (16 oz/acre), and Poast® at 0.25 lb ai/acre (16 oz/acre) were broadcast; on June 25, Poast at 0.25 lb ai/acre (16 oz/acre) was broadcast.

For thrips control, the following insecticides were applied: Movento® at 5 oz/acre on May 24 by ground application; Movento at 5 oz/acre and Aza-Direct® at 2 pt/acre on June 4 by ground application; Agri-Mek® at 3.5 oz/acre on June 11 and 18 by ground application; Radiant® at 10 oz/acre on June 25 by ground application and on July 4 by aerial application; Lannate® at 0.9 lb ai/acre on July 15 and 25 by aerial application; and Radiant at 10 oz/acre on August 8 by aerial application.

URAN at 20 lb N/acre was applied through the drip tape weekly starting May 28 totaling 100 lb N/acre. Starting on June 8, root tissue and soil solution samples from the check treatment plots were taken every week and analyzed for nutrients by Western Laboratories, Inc., Parma, Idaho (Tables 2 and 3). Nutrients were applied through the drip tape based on the analyses (Table 4).

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., 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 multiplexer, 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 at a SWT of 20 cb or higher. The irrigations were controlled by the datalogger using a controller (SDM CD16AC controller, Campbell Scientific, Logan, UT) 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 by a pump and pressure regulator 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 19. Irrigations were terminated on August 7.

Onions in each plot were evaluated for maturity and bolting on July 31. Onions were evaluated subjectively for maturity by visually rating the percentage of onions with the tops down and the percent of dry foliage.

Onions from the middle two beds in each four-bed plot were topped by hand and bagged on August 11. Onions were graded on August 14.

During grading, all bulbs from each plot were counted to determine the plant population at harvest. During grading, bulbs were separated according to quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), plate rot (bulbs infected with the fungus *Fusarium oxysporum*), and black mold (bulbs infected with the fungus *Aspergillus niger*). 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.

After grading, bulbs from each plot were rated for single centers. Twenty-five onions ranging in diameter from 3½ to 4¼ inches were rated. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the diameter of the first single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing if they were single centered or had a small multiple center.

Treatment differences in single- and multiple-center bulb ratings, maturity, bolting, bulb yield, grade, and decomposition were compared using protected analysis of variance. The plant population in each plot was treated as a covariate. Mean separations were determined using Fisher's least significant difference test at the 5% probability level, LSD (0.05).

Results

The rate of accumulation of growing degree-days (50-86°F) in 2015 was the highest since measurements began in 1993 (Fig. 1).

Root tissue and soil solution analyses conducted during the season (Tables 2 and 3), indicated that the onions required nutrient amendments during the growing season (Table 4). Root nitrates remained below the sufficient range for most of the season. However, soil solution N remained above the sufficiency range after June 12, precluding the need for additional N applications beyond the 100 lb N/acre.

There was no significant difference in bulb single centeredness, maturity, or bolting between treatments (Table 5).

Onion yields averaged 470 cwt/acre or 23.5 tons/acre (Table 6), which is within the normal range for red onions at the Malheur Experiment Station (Shock et al. 2014). No effects of Kelpak or Greenfeed were observed. There was no significant difference in any onion yield category between treatments, except for supercolossal yield (Table 6). The check treatment had slightly higher supercolossal yield than the other treatments. There was no significant difference in plant

population between treatments. None of the yield or quality variables were affected by plant population as a covariate. The low coefficients of variation for total yield and marketable yield indicate a low degree of error in the current trial (Table 6).

Acknowledgements

This project was funded by Caltec Ag, Inc., cooperating onion seed companies, Oregon State University, the Malheur County Education Service District, and was supported by Formula Grant nos. 2015-31100-06041 and 2015-31200-06041 from the USDA National Institute of Food and Agriculture.

References

Shock, C.C., J. Barnum, and M. Seddigh. 1998. Calibration of Watermark soil moisture sensors for irrigation management. Irrigation Association. Pages 139-146 in Proc. of the International Irrigation Show. 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.

Shock, C.C., E. Feibert, L. Jensen, and J. Klauzer. 2010. Successful onion irrigation scheduling, Sustainable Agriculture Techniques. Oregon State University Extension Service, Corvallis. SR 1097.

Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2014. 2014 Onion variety trials. Malheur Experiment Station Annual Report 2014, Ext/CrS 152:11-34.

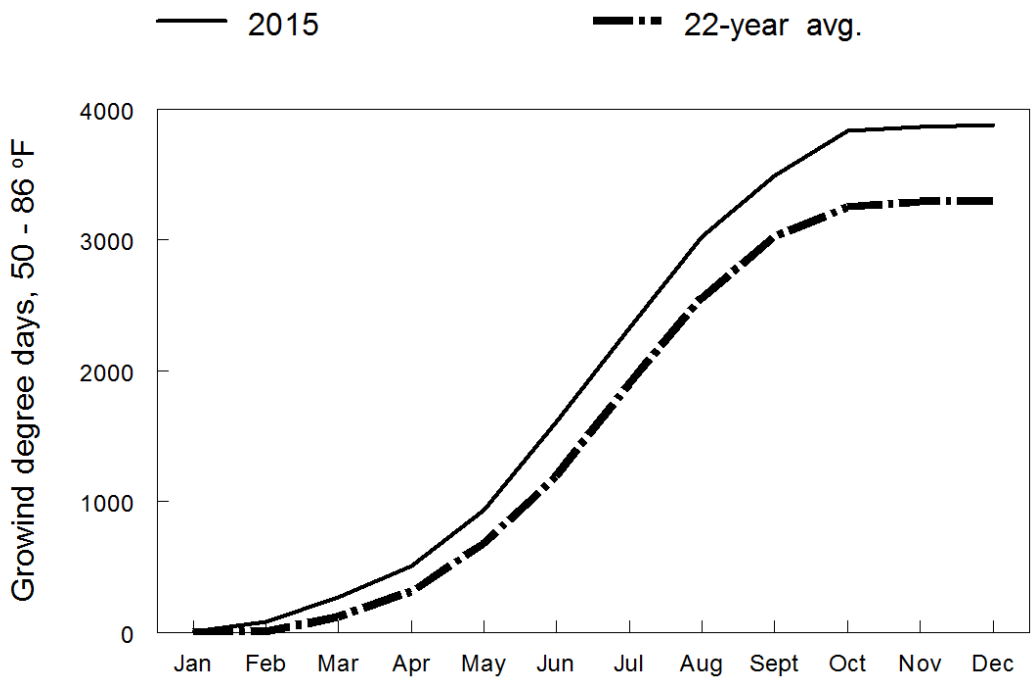

Figure 1. Cumulative growing degree-days (50-86°F) over time for 2015 and the 22-year average (1993-2014), Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

Table 2. Onion root tissue nutrient content for untreated onions in the Kelpak and Greenfeed trial, Malheur Experiment Station, Oregon State University, Ontario, OR 2015.

	Sufficiency range	8-Jun	12-Jun	19-Jun	26-Jun	6-Jul	10-Jul	20-Jul	24-Jul	31-Jul
NO_3-N (ppm)	Sufficiency range	7500	6500	5500	4500	4000	3000	2500	1250	500
NO_3-N (ppm)		5177	5004	3042	2726	2938	2359	1933	2342	2834
P (%)	0.32 - 0.7	0.7	0.7	0.6	0.5	0.4	0.4	0.4	0.3	0.2
K (%)	2.7 - 6	4.9	3.0	3.5	3.1	3.4	3.1	2.5	1.9	1.8
S (%)	0.24 - 0.85	0.4	0.3	0.5	0.6	0.6	0.6	0.7	0.8	0.9
Ca (%)	0.4 - 1.2	1.0	0.7	0.8	0.5	0.6	0.6	0.8	0.9	1.0
Mg (%)	0.3 - 0.6	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.3	0.2
Zn (ppm)	25 - 50	45	32	51	37	28	36	49	49	31
Mn (ppm)	35 - 100	21	95	195	170	136	157	155	121	118
Cu (ppm)	6 - 20	7	5	23	19	16	13	16	17	11
B (ppm)	19 - 60	43	28	52	40	38	32	30	39	21

Table 3. Weekly soil solution analyses for untreated onions in the Kelpak and Greenfeed trial. Data represent the amount of each plant nutrient per day that the soil can potentially supply to the crop. Numbers following each nutrient are the critical levels. Malheur Experiment Station, Oregon State University, Ontario, OR 2015.

Nutrient	Sufficiency range	8-Jun	12-Jun	26-Jun	6-Jul	10-Jul	20-Jul	24-Jul	31-Jul
N	Sufficiency range, lb	7.5	6	5	4.5	4	3	2	1
N		6.0	7.7	8.6	23.1	12.4	15.4	15.9	20.6
P	0.7 lb	1.4	0.8	0.6	1.4	1.1	1.2	1.0	1.1
K	8 lb	15.0	8.0	7.2	9.6	6.6	8.3	6.7	9.7
S	3 lb	3.7	2.7	1.8	5.0	5.6	3.8	4.5	5.9
Ca	3 lb	5.2	4.7	3.7	4.7	3.9	3.3	3.6	4.0
Mg	2 lb	15.2	10.1	8.6	12.9	10.2	10.3	9.1	12.0
Zn	1 oz	5.0	1.5	1.1	2.6	2.7	2.8	2.4	2.9
Mn	1 oz	0.5	0.2	0.5	0.4	0.5	0.9	0.7	0.5
Cu	0.4 oz	3.0	0.5	0.4	0.7	0.4	0.6	0.6	0.6

Table 4. Nutrients applied to onions through the drip irrigation system in the Kelpak and greenfeed trial, Malheur Experiment Station, Oregon State University, Ontario, OR 2015.

Date	N	K	Mn	S	Cu
	---------- lbs/acre ----------				
28-May	20				
2-Jun	20				
8-Jun	20				
17-Jun	20		0.5	2	0.3
24-Jun	20				
29-Jul		5.5			
3-Aug		5.5			
Total	100	11	0.5	2	0.3

Table 5. Single- and multiple-center bulb ratings, and maturity for red onion 'Countach' submitted to four treatments. Single-center ratings were taken at harvest. Maturity was measured on July 31. Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

		Multiple center			Single center		Maturity July 31	
No.	Treatment	Large	Medium	Small	Functional[a]	Bullet	Tops down	Leaf dryness
		---------- % ----------						
1	Check	7.1	10.7	52.4	82.2	29.8	73.3	43.3
2	Drip injection	4.0	8.5	59.0	87.5	28.5	74.4	47.8
3	Foliar	3.0	10.4	48.1	86.6	38.4	71.1	44.4
4	Foliar plus Greenfeed	4.0	9.3	55.6	86.7	31.1	75.6	43.3
Average		4.5	9.7	53.8	85.7	32.0	73.6	44.7
LSD (0.05)		NS	NS	NS	NS	NS	NS	NS

[a]small multiple center plus bullet single center.

Table 6. Yield and grade performance for red onion 'Countach' treated with Kelpak and Greenfeed harvested August 11 and graded on August 14, 2015, Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

			Marketable yield by grade								
No.	Treatment	Total yield	Total	4-4¼ in	3-4 in	2¼-3 in	Small	No. 2s	Total rot	Plate rot	Plant population
		---------- cwt/acre ----------							% of total yield	% by number of bulbs	plants/acre
1	Check	466.8	442.5	3.5	328.0	111.0	18.6	3.9	0.4	2.2	97,048
2	Drip injection	459.9	432.5	0.0	289.6	142.9	26.5	0.5	0.1	1.9	103,894
3	Foliar	488.9	463.3	0.0	337.6	125.7	23.0	1.4	0.2	1.9	104,466
4	Foliar plus Greenfeed	464.5	440.4	0.0	308.4	132.1	22.0	1.5	0.1	1.5	99,172
Average		470.0	444.7	0.9	315.9	127.9	22.5	1.8	0.2	1.9	101,145
Coefficient of variation %		0.1	0.1	2.4	0.2	0.2	0.3	2.3	1.7	0.4	0.1
LSD (0.05)		NS	NS	1.8	NS	NS	NS	NS	NS	NS	NS