EVALUATION OF HUMIC ACID AND OTHER NONCONVENTIONAL FERTILIZER ADDITIVES FOR ONION PRODUCTION

Erik B. G. Feibert, Clint C. Shock, and Lamont D. Saunders
Malheur Experiment Station
Oregon State University
Ontario, OR, 2000

Summary

Eleven treatments in 1999 and 13 treatments in 2000 containing single or combinations of nonconventional additives were compared with an untreated check for their effect on onion yield and quality, and for their economic efficiency. The nonconventional additives were tested at commercial rates and methods of application supplied by the manufacturers. The treatments were incorporated into standard cultural practices for onions. In both years, none of the products tested increased onion yield or quality compared to the untreated check. With minor exceptions, at the application rates used in this study, none of the products supplied sufficient amounts of plant nutrients or humic acid for an improvement in crop production to be expected.

Introduction

A nonconventional additive can be defined as (1) any nonfertilizer material applied to soil or plants that is claimed to improve crop production; or (2) a guaranteed fertilizer material that is used in an unconventional manner, such as in very small amounts. Numerous nonconventional additives are being marketed. Growers need information on onion yield and quality responses to these products and their cost effectiveness. The objective of this study was to test the most commonly used products for onion production in the Treasure Valley at commercial application rates and methods. The products tested can be included in the following descriptive categories: humic acid, Norwegian kelp (*Ascophyllum nodosum*) concentrate, biological inoculant with N-fixing bacteria, plant growth regulator (cytokinin and ammonium zinc acetate), organic fertilizer, and mineral nutrient solutions.

Methods

The trials were conducted on Owyhee silt loam with 1.4 and 1.6 percent organic matter and pH of 7.4 and 7.3 in 1999 and 2000, respectively. The fields had previously been planted to wheat. In the fall of 1998, before plowing, 20 lb N/acre, and 100 lb P_2O_5/acre were broadcast. In the fall of 1999, before plowing, 20 lb N/acre, 100 lb P_2O_5/acre, 10 lb Zn/acre as $ZnSO_4$, and 30 lb Mg/acre were broadcast. Each year, the wheat stubble was shredded, and the field was disked, irrigated, moldboard-plowed, roller-harrowed, fumigated with Telone C-17 at 20 gal/acre, and bedded. Soil chemical characteristics, determined from a composite soil sample from all check treatment plots taken in mid-May each year, are listed in Table 1.

Table 1. Soil analyses for 1999 and 2000 trials, Malheur Experiment Station, Ontario, OR.

Year	Organic matter (%)	pH	Nutrient analysis (mg/kg^{-1}) N (NO_3)	P	K	Ca	Mg	Na	Zn	Fe	Mn	Cu	S (SO_4)	B
1999	1.5	7.3	4	41	404	2,685	341	165	1.4	12	45.6	1	7	0.5
2000	1.6	6.9	19	39	526	2,080	378	240	0.8	9	3.8	0.5	21	0.6

Beds were knocked down on March 16, 1999, and on April 6, 2000. Onion seed (cv 'Vision', Petoseed, Payette, ID) was planted April 7 at 153,000 seeds/acre in double rows on beds spaced 22 inches apart. Plots were 27 ft long and four double rows wide. On May 17, 1999 and on May 4, 2000, alleys 4 ft wide were cut between plots, leaving plots 23 ft long.

The trial was managed to avoid yield reductions from weeds, pests, and diseases. Weeds were controlled with three cultivations in 1999 and two in 2000, and with low-rate herbicide applications as needed until lay-by (Table 2). After lay-by the field was hand weeded as necessary. Thrips were controlled in 1999 with four aerial applications of Warrior and Lannate (June 15, June 29, July 11, and July 25) and in 2000 with three aerial applications of Warrior and Lannate (June 9, June 21, and August 3) and one aerial application of Warrior on July 10. Microthiol Special at 8 lb ai/acre was broadcast aerially on August 4, 1999 and on August 31, 2000 for mite control.

Table 2. Herbicides and quantities applied after onion emergence, Malheur Experiment Station, Oregon State University, Ontario, OR, 2000.

1999 Date	1999 Herbicides and rate/acre	2000 Date	2000 Herbicides and rate/acre
April 30	Buctril 5 oz	May 1	Buctril 5 oz
May 10	Buctril 10 oz, Poast 24 oz	May 5	Buctril 5 oz, Poast 16 oz
May 22	Goal 5 oz, Buctril 10 oz, Poast 24 oz	May 19	Goal 5 oz, Buctril 10 oz, Poast 16 oz
June 2	Goal 5 oz, Buctril 10 oz, Poast 24 oz, Prowl 1.2 pint	May 24	Goal 5 oz, Buctril 10 oz, Poast 16 oz, Prowl 2.4 pint
June 17	Goal 5 oz, Prowl 2.4 pint	June 5	Goal 5 oz, Poast 16 oz

The experimental design was a randomized complete block with six replicates. Companies marketing products locally were invited to participate in the trial. Participating companies supplied the treatment protocols. Eight companies entered treatments in 1999 and seven companies entered treatments in 2000 (Table 3). Each treatment consisted of a single product or combinations of products. In 2000, treatments 1, 2, 3, 5, 9, 10, and 12 were the same as in 1999. Treatment 4 in 2000 was the same as in 1999 except that the granular product Agri-Plus was omitted and the liquid product Quantum-H had the application rate increased to 3 gal/acre/application. Treatment 11 in 2000 was the same as in 1999 except that two additional products were applied 3 weeks before lifting.

The product application rates and application modes are listed in Table 3. Applications in the seed furrow were made in solution just after seed drop at 23 gal/acre. Banded preplant applications were made in solution using a backpack sprayer at 20 gal/acre. Beds were raked off once before preplant banded applications were made. Foliar applications were made in solution using a backpack sprayer at 30 gal/acre. Broadcast granular applications were made with a hand-held fertilizer spreader. Sidedressed applications were made in solution to both sides of the bed at 60 gal/acre. All sidedressed products were mixed with the N fertilizer (urea-ammonium nitrate solution). The product nutrient and humic acid contents are listed in Table 4.

In 1999, all treatments were sidedressed on June 7 and on June 23 with N at 100 lb/acre as urea-ammonium nitrate solution (uran), except treatments 6 and 11. Treatment 6 (Humizyme-RX) did not receive any N fertilizer in 1999. Humizyme-RX is designed to be a complete fertilizer and was applied at a rate claimed to provide sufficient N to the onions. Treatment 11 (Kozgro) received N at 75 lb/acre the first sidedressing and at 100 lb/acre the second sidedressing. In 2000, all treatments were sidedressed with N at 100 lb/acre on May 26 and on June 21.

The trial was furrow irrigated to maintain soil water potential at 8-inch depth above -20 kPa. Soil water potential was monitored by six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA) installed in early June below the onion row at 8-inch depth. Irrigations were terminated on August 24 each year.

The onions were undercut with a rod weeder in mid-September each year to field dry. Onions from the middle two rows of every plot were topped, and bagged by hand in the field on September 28, 1999 and on September 20, 2000. The onions were placed into storage in late September each year. The storage shed was managed to maintain an air temperature of approximately 34 to 40°F.

Onions were graded out of storage on November 30 each year. Bulbs were separated according to quality: bulbs without blemishes (No. 1), split bulbs (No. 2), 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 to 3 inches), jumbo (3 to 4 inches), and colossal (>4 inches).

Onion production costs were based on data prepared by the Malheur County Extension Service. All onion production costs are the same for all treatments except (1) the product retail cost, (2) the estimated product application cost and, (3) harvest cost based on a fee per hundred weight of total yield and includes loading and hauling, bin rental and storage, and grower assessments.

In 1999, onion production costs for treatment 6 did not include N fertilizer, and production costs for treatment 11 had N fertilizer cost reduced by 12.5 percent. The treatment production costs were based on the onion production cost plus the retail cost and application cost of the products in each treatment.

Gross economic returns were calculated by crediting each marketable onion class with the average price of onions paid to the grower from the beginning of the marketing season in early August through January. Average prices were calculated for the years 1992 through

2000 from data prepared by the U.S. Department of Agriculture Agricultural Marketing Service, Idaho Falls, Idaho. Average prices reflecting adjustments for packing and shipping costs in U.S. dollars per cwt for the last 9 years were $4.05 for medium grade bulbs, $6.80 for jumbo grade bulbs, and $9.63 for colossal grade bulbs.

Treatment differences were compared using ANOVA and protected least significant differences (LSD) at the 5 percent probability level.

Results and Discussion

Plant populations averaged 134,000 and 148,000 plants per acre in 1999 and 2000, respectively (Tables 6 and 8). Total onion yields averaged 1,140 and 1,330 cwt/acre in 1999 and 2000, respectively (Tables 5 and 7).

In 1999 there was no significant difference in plant population, plant height, onion yield and quality, and profit between any of the treatments and the check, except for treatment 6 (Tables 5 and 6). Treatment 6 (Humi-Zyme-RX) resulted in significantly lower plant height, total yield, marketable yield, colossal onion yield, and profits. The lower productivity of the onions in treatment 6 could have resulted from insufficient N provided by the Humi-Zyme-RX. Humi-Zyme RX is marketed as a complete fertilizer intended to substitute for conventional fertilizer. Humi-Zyme RX plots were not fertilized with N and the Humi-Zyme RX supplied a total of 37.6 lb/acre of N compared to 200 lb/acre of N supplied by the uran in the check treatment. Based on the mid-May soil tests, the extension recommendations were for N to be applied at 300 and 250 lb/acre in 1999 and 2000, respectively (Sullivan et al., 2001).

In 2000, there was no significant difference in plant population, plant height, onion yield and quality, or profit between any of the treatments and the check (Tables 7 and 8).

With minor exceptions, at the rates tested, the products supplied insufficient amounts of nutrients and humic acid for a crop production response to be expected (Table 9).

For the products containing humic acid, the results agree with Chen and Aviad (1990) who discussed the improbability that commercial humic acids applied at rates recommended by the manufacturers would contain sufficient quantities of the active ingredients to result in an improvement in crop production. Based on concentrations of humic substances that were reported to be necessary to affect plant growth in growth chambers, Chen and Aviad (1990) suggested that a minimum of 67 lb/acre of soil-applied humic acid would be necessary to result in an improvement in crop production. Agri-Plus supplied the highest total amount of humic acid (28 lb/acre). The other humic acid-containing products supplied substantially lower amounts of humic acid. At application rates of 67 lb/acre of humic acid, the liquid products per acre would cost $248 for Humaide, $462 for Quantum-H, and $240 for RSA Humic acid. The granular Agri-Plus applied at 67 lb/acre would cost $38/acre. Our results also agree with Mcallister (1987) who discussed how even at high rates humic acid products would be incapable of significantly increasing soil organic matter and consequently improving crop production. According to calculations by Mcallister (1987), the addition of a granular humic acid (60 percent humic acid) at 300 lb/acre would only increase the soil organic matter content by 0.009 percent. Chen and Aviad (1990) also suggested 0.45 lb/acre as the minimum amount of foliar-applied humic acid to elicit an increase in crop productivity. The only foliar-applied product containing humic acid was Kozgro, which supplied a total of only 0.03 lb/acre of humic acid.

For the soil-applied products, all of the products supplied N, P, K, S, and Zn in amounts substantially lower than the range recommended for soil application to onions (Sullivan et al., 2001). The exceptions were Humi-Zyme RX, supplying sulfur at 28 lb/acre and Agri-Calcium, supplying calcium at 7.4 lb/acre. In both years the soil test level for sulfate-S did not dictate a need for sulfur fertilization. The other micronutrients (Mg, Fe, Mn, and Cu) were also supplied in amounts substantially lower than the range recommended for vegetable crops (Ells, 1993, Warncke et al., 1994). All of the foliar-applied products supplied micronutrients in amounts substantially lower than the recommended rates for foliar application to vegetable crops (Vitosh et al., 1994).

Agri-Gro was claimed to supply N-fixing bacteria and enzymes to the soil. The lack of a response from Agri-Gro application is consistent with Miller (1979) and Mcallister (1987), who discuss how improbable the long-term establishment of introduced beneficial microorganisms to the soil would be due to the huge amounts of microorganisms already present (2000 lb/acre-ft of soil of bacteria, actinomycetes, and fungi) and to the stable soil ecosystem. Introduced microorganisms generally do not survive because they are not able to out compete the native strains.

Awaken contains ammonium zinc acetate and claims to act as a plant growth regulator and improve crop vigor. The lack of a response from Awaken application is consistent with Christenson and Bricker (1976), who found a lack of response of corn grain yield to ammonium zinc acetate application.

The results of this trial suggest that the use of the nonconventional additives tested in this trial, under standard commercial agricultural practices on the soils at the Malheur Experiment Station, did not result in any crop production benefit. The low amounts of plant nutrients and humic acid supplied by the products at the rates tested cast doubt as to their value in crop production. Conventional soil or foliar-applied fertilizers for plant nutrient supplementation, or manure and compost applications for enhancing soluble humic substances, should be considered as economical alternatives. The possibility still exists that some of the products in this study or other products, applied at different rates or methods, could achieve a crop production increase. Users of non-conventional additives should carefully evaluate the effectiveness of individual products on small areas on their own farms before investing in large scale applications.

Literature Cited

Chen, Y. and T. Aviad. 1990. Effects of humic substances on plant growth. p.161-186 *In* P. MacCarthy, C.E. Clapp, R.L. Malcolm, and P.R. Bloom (eds.). Humic substances in soil and crop sciences: selected readings. Am Soc. of Agronomy and Soil Sci. Soc. of Am, Madison, WI.

Christenson, D.R. and C. Bricker. 1976. The effect of time and rate of Amoco agricultural crop additive (ACA) on yield and protein content of corn grain. *In* Compendium of research reports on use of non-traditional materials for crop production. NCR-103 Committee. Cooperative Extension Service, Iowa State University, Ames.

Ells, J.E. 1993. Vegetable fertilizer guide No. 0.509. Colorado State University Cooperative Extension, Colorado State University, Fort Collins.

Mcallister, J. 1987. A practical guide to novel soil amendments. Rodale Research Center, Rodale Press, Emmas, PA.

Miller, R.H. 1979. Ecological factors which influence the success of microbial fertilizers or activators. Developments in Industrial Microbiology 20:335-342.

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 onions in the Pacific northwest. Pacific Northwest Extension Publication 546, Oregon State University, Corvallis.

Vitosh, M.L., D.D. Warncke, and R.E. Lucas. 1994. Secondary and micronutrients for vegetables and field crops. Michigan State University Extension Bulletin E-486, Michigan State University, East Lansing.

Warncke, D.D., D.R. Christenson, L.W. Jacobs, M.L. Vitosh and B.H. Zandstra. 1994. Fertilizer recommendations for vegetable crops in Michigan. Michigan State University Extension Vegetable Bulletin 55092001, Michigan State University, East Lansing.

Table 3. Nonconventional additives, rates and application modes, Malheur Experiment Station, Ontario, OR, 1999-2000.

Treatment	Company*	Products	Rate[†](gal/acre^{-1})	Application mode
1	Ag Concepts	Jump Start 5-5-5	1.5	in seed furrow
		Jump Start 5-5-5	1	1st and 2nd sidedress
2	Ag Concepts	Agzyme	0.1	10" band preplant
		Humaide	1	10" band preplant
		Kelp Treat	0.5	10" band preplant
		Jump Start 5-5-5	1	1st and 2nd sidedress
3	Ag Concepts	Jump Start 5-5-5	1	10" band preplant
		Humaide	0.25	10" band preplant
		Kelp Treat	0.5	10" band preplant
		Agzyme	0.05	1st sidedress
		Kelp Treat	0.25	2nd sidedress
		Humaide	0.25	3rd sidedress
4	Horizon Ag Products	Agri-Plus (1999 only)	40 lb	broadcast preplant
		Quantum-H	1(1999), 3(2000)	in seed furrow, 1st and 2nd sidedress
5	RSA Microtech	RSA Humic acid	1	in seed furrow, 1st sidedress
6	RSA Microtech[‡]	High Yield	7 lb	foliar 3 times
		Expand	0.04	foliar 3 times
7	RSA Microtech[‡]	Expand	0.04	foliar 3 times
8	RSA Microtech[‡]	High Yield	7 lb	foliar 3 times
9	Dynamite Marketing[§]	Humi-Zyme RX	100	broadcast preplant
10	AgriGro1	Agrigro	0.13 (1999), 0.25 (2000)	10" band preplant
		Agrigro	0.13	seed furrow, 1st, 2nd sidedress, foliar 3X
11	AgriGro	Agrigro	0.13 (1999), 0.25 (2000)	10" band preplant
		Agrigro	0.13	seed furrow, 1st, 2nd sidedress, foliar 3X
		Agri-Calcium	3	10" band preplant
		Agri-Calcium	2	1st and 2nd sidedress
12	Huma Grow	Pop-up mix	3	in seed furrow
		Blend	0.25	1st and 2nd sidedress
		Superphos	0.5	1st and 2nd sidedress
		Sulfur	0.06	2nd foliar
		Copper	0.05	3rd foliar
		Calcium	0.09	4th foliar
		Vitol	0.25	1st and 2nd foliar
		Jackpot (2000 only)	0.25	3 weeks before lifting
		Calcium (2000 only)	0.08	3 weeks before lifting
13	UAP Northwest	Awaken	0.5	in seed furrow
14	Kozgro[§]	Kozgro	0.16	broadcast preplant
		Kozgro	0.13	1st and 2nd foliar
15	Miller Chemical[‡]	Calcium	0.5 lb	2nd foliar
		Calcium	1 lb	3rd, 4th foliar
		Cytokin	0.12	in seed furrow
		Cytokin	0.06	3rd foliar
		Cytokin	0.06	4th foliar
		Microplex	1 lb	in seed furrow, 1st foliar
		Microplex	0.5 lb	2 nd foliar
		Nutrient Express	5 lb	1st, 2nd, 3rd, 4th foliar

*Ag Concepts Corp., Boise, ID; Horizon Ag Products, Kennewick, WA; RSA Microtech, Seattle, WA; Dynamite Marketing, Meridian, ID; AgriGro, Doniphan, MO; BioHumanetics, Chandler, AZ; UAP Northwest, Caldwell, ID; Kozgro, Caldwell, ID; Miller Chemical, Hanover, PA.

[†]All rates in gal/acre^{-1} except for dry products in lb/acre^{-1}.

[‡]Treatments in 2000 only, [§]Treatments in 1999 only.

Table 4. Nonconventional additive nutrient and humic acid concentration, density, and total amount applied, Malheur Experiment Station, Ontario, OR. All concentrations were supplied by the manufacturers. Nutrients present at concentrations of less than 0.1percent were not included.

Treatment	Product	Nutrient concentration (%)												Total
		N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	Humic acid	Density (lb/gal)	product applied per acre*
1	Jump Start 5-5-5	5	5	5								0.5	9.25	3.5
2	Humaide											12	8.9	1
	Agzyme												8.6	0.09
	Kelp Treat												8.7	0.5
	Jump Start 5-5-5	5	5	5								0.5	9.25	2
3	Jump Start 5-5-5	5	5	5								0.5	9.25	1
	Humaide											12	8.9	0.5
	Agzyme												8.6	0.04
	Kelp Treat												8.7	0.75
4 (1999)	Agri-Plus											70	dry	40
	Quantum-H											6	8.5	3
4 (2000)	Quantum-H											6	8.5	9
5	RSA Humic acid											12	8.9	2
6	High Yield	15	20	20		2		0.1	1	0.1	0.15			21
	Expand								0.25	0.2	0.6		9.21	0.12
7	Expand								0.25	0.2	0.6		9.21	0.12
8	High Yield	15	20	20		2		0.1	1	0.1	0.15			21
9	Humi-Zyme RX	4	3			3							9.4	100
11	Agri-Calcium				10								11.3	6.5
12	Pop-up mix	4.3	6.3	2.1									8.87	3
	Blend	5											8.84	0.5
	Superphos		22										12.69	1
	Sulfur	8				10							10.43	0.06
	Copper					4					5		9.5	0.04
	Calcium	7			10								11.34	0.09
	Vitol	8	16	4		1							11.13	0.5
13	Awaken	18		2.5					2.7				10.25	0.5
14	Kozgro - preplant											3.1	8.4	0.16
	Kozgro - foliar											3.1	8.4	0.13
15	Microplex (seed furr.)						5.43	4	1.5	4	1.5			1
	Microplex (foliar)						5.43	4	1.5	4	1.5			1.5
	Nutrient Express	4	41	27										20
	Calcium				9.5									2.5

*All rates in gal/acre^{-1} except for dry products in lb/acre^{-1}.

Table 5. Onion yield and quality response to nonconventional additives. Malheur Experiment Station, Oregon State University, Ontario, OR, 1999.

Treatment	Total yield	Marketable yield by grade Total	>4 in	3-4 in	2¼-3 in	Nonmarketable yield Total rot	Neck rot	Plate rot	Black mold	No. 2	Small
	---- cwt/acre ----					---- % of total yield ----				-- cwt/acre --	
1- Ag Concepts 1	1,148.8	1,086.2	436.1	642.4	7.7	2.0	0.2	1.8	0.0	36.1	3.0
2- Ag Concepts 2	1,131.1	1,092.5	316.0	759.6	16.9	1.3	0.1	1.0	0.1	20.7	3.8
3- Ag Concepts 3	1,177.6	1,107.9	376.7	709.2	21.9	2.6	0.6	1.6	0.3	35.6	4.0
4- Horizon Ag-Products	1,154.4	1,091.3	372.1	707.7	11.5	2.3	0.2	1.9	0.2	35.7	1.7
5- RSA Microtech	1,165.3	1,095.8	379.6	705.0	11.1	2.5	0.9	1.4	0.2	38.8	1.4
9- Humi-Zyme-RX	957.3	905.5	173.1	695.5	36.9	1.6	0.6	1.0	0.0	34.4	2.6
10- Agri-Gro 1	1,226.6	1,174.4	400.6	763.2	10.7	1.8	0.4	1.4	0.0	28.3	1.2
11- Agri-Gro 2	1,106.4	1,032.4	369.0	656.1	7.3	2.0	0.0	1.8	0.1	50.5	1.4
12- Huma Grow	1,181.2	1,108.1	396.8	704.7	6.6	2.2	0.8	1.1	0.3	47.2	0.4
13- Awaken	1,124.9	1,076.9	385.7	680.0	11.3	1.9	1.0	0.8	0.1	24.5	1.5
14- Kozgro	1,132.4	1,068.9	320.9	730.3	17.7	1.9	0.5	1.1	0.2	40.1	2.1
16- Check	1,155.6	1,093.8	364.5	707.8	21.5	1.9	0.2	1.6	0.0	36.9	3.0
Mean	1,138.5	1,077.8	357.6	705.1	15.1	2.0	0.5	1.4	0.1	35.7	2.2
LSD (0.05)	106.8	108.2	83	NS	NS	NS	NS	NS	NS	NS	NS

Table 6. Onion plant population, plant height, maturity, and economic performance in response to non-conventional additives. Malheur Experiment Station, Oregon State University, Ontario, OR, 1999.

Treatment	Plant population	Plant height July 30	Maturity Aug. 27	Treatment cost*	Production cost	Gross returns	Profit
	plants/acre	inch	%	---- $/acre ----			
1- Ag Concepts 1	131,340	31.7	43.3	30.0	3,832.0	8,600.0	4,768.0
2- Ag Concepts 2	132,660	31.9	46.7	40.0	3,815.0	8,277.0	4,462.0
3- Ag Concepts 3	137,280	31.8	47.5	29.0	3,874.0	8,539.0	4,665.0
4- Horizon Ag-Products	130,020	31.9	46.7	34.0	3,844.0	8,443.0	4,599.0
5- RSA Microtech	123,420	31.3	45.0	8.0	3,835.0	8,495.0	4,660.0
9- Humi-Zyme-RX	138,600	29.9	42.5	166.0	3,615.0	6,546.0	2,931.0
10- Agri-Gro 1	127,380	30.8	44.2	50.0	3,968.0	9,090.0	5,122.0
11- Agri-Gro 2	132,660	31.8	40.0	82.0	3,821.0	8,045.0	4,224.0
12- Huma Grow	135,960	31.8	43.3	55.3	3,906.0	8,640.0	4,734.0
13- Awaken	136,620	32.3	45.0	9.0	3,775.0	8,384.0	4,608.0
14- Kozgro	137,940	31.4	41.7	18.0	3,789.0	8,128.0	4,339.0
16- Check	145,200	32.0	45.8		3,812.0	8,410.0	4,598.0
Mean	134,090	31.6	44.3		3,823.8	8,299.8	4,475.8
LSD (0.05)	NS	1.2	NS		160	847	702

* Includes product retail cost and application cost.

Table 7. Onion yield and quality response to nonconventional additives, Malheur Experiment Station, Oregon State University, Ontario, OR, 2000.

Treatment	Total yield	Marketable yield by grade				Nonmarketable yield					
		Total	>4 in	3-4 in	2¼-3 in	Total rot	Neck rot	Plate rot	Black mold	No. 2	Small
	---------------- cwt/acre				----------------	---- % of total yield			----	- cwt/acre -	
1- Ag Concepts 1	1,312.6	1,212.7	530.5	547.3	134.9	4.0	2.2	1.4	0.3	20.6	27.5
2- Ag Concepts 2	1,327.4	1,263.3	585.8	559.5	118.0	2.2	0.6	1.6	0.1	17.6	17.4
3- Ag Concepts 3	1,337.9	1,277.7	576.3	581.6	119.9	2.2	1.0	1.2	0.1	12.2	17.7
4- Horizon Ag. Products	1,344.3	1,263.2	621.6	533.8	107.7	3.9	1.1	2.2	0.6	13.2	15.9
5- RSA Microtech 1	1,350.0	1,286.3	641.4	542.4	102.4	2.7	1.4	1.1	0.2	12.6	13.3
6- RSA Microtech 2	1,337.8	1,214.5	498.6	582.3	133.7	6.8	3.4	1.8	1.7	15.6	14.8
7- RSA Microtech 3	1,315.7	1,238.2	554.5	546.4	137.3	3.0	1.2	1.2	0.6	21.1	16.0
8- RSA Microtech 4	1,296.4	1,228.8	510.3	583.2	135.3	3.1	2.1	0.8	0.2	8.1	17.4
10- AgirGro 1	1,305.4	1,246.3	567.0	543.3	136.0	2.1	0.3	1.5	0.2	15.0	16.9
11- AgriGro 2	1,328.5	1,263.6	597.5	538.7	127.4	2.6	0.8	1.4	0.4	15.0	14.7
12- Huma Grow	1,287.6	1,207.0	468.9	574.1	163.9	3.9	1.4	1.9	0.6	10.1	21.8
13- Awaken	1,342.3	1,228.2	560.7	559.0	108.5	6.2	2.5	2.2	1.5	9.6	21.7
15- Miller Chemical	1,368.4	1,301.2	601.6	568.3	131.4	3.0	1.7	0.7	0.5	9.5	18.1
16- Check	1,375.7	1,311.7	587.0	595.5	129.2	2.3	0.7	1.4	0.3	14.0	18.8
Mean	1,330.7	1,253.0	564.4	561.1	127.5	3.4	1.5	1.5	0.5	13.9	18.0
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 8. Onion plant population, plant height, maturity, and economic performance in response to non-conventional additives. Malheur Experiment Station, Oregon State University, Ontario, OR, 2000.

Treatment	Plant population	Plant height Aug 12	Maturity Aug 29	Treatment cost*	Production cost	Gross returns	Profit
	plants/acre	in	%		------------	$/acre	------------
1- Ag Concepts 1	144,540	34.4	65.0	30.0	4,077.0	7,987.0	3,910.3
2- Ag Concepts 2	142,560	34.2	62.5	40.0	4,108.0	8,494.0	4,385.0
3- Ag Concepts 3	149,160	34.7	65.8	29.0	4,114.0	8,534.0	4,420.0
4- Horizon Ag. Products	147,840	34.2	65.8	34.0	4,128.0	8,641.0	4,513.0
5- RSA Microtech 1	144,540	34.2	60.0	8.0	4,111.0	8,847.0	4,737.0
6- RSA Microtech 2	151,800	33.9	65.0	11.0	4,095.0	7,893.0	3,798.0
7- RSA Microtech 3	150,480	34.3	64.2	4.0	4,055.0	8,199.0	4,144.0
8- RSA Microtech 4	140,580	34.5	65.8	7.0	4,029.0	8,005.0	3,976.0
10- AgirGro 1	141,240	34.4	66.7	50.0	4,086.0	8,289.0	4,203.0
11- AgriGro 2	141,240	34.5	67.5	82.0	4,153.0	8,509.0	4,356.0
12- Huma Grow	152,460	34.7	67.5	69.0	4,079.0	7,670.0	3,592.0
13- Awaken	156,420	34.9	62.5	9.0	4,100.0	8,244.0	4,144.0
15- Miller Chemical	159,060	34.7	67.5	95.0	4,225.0	8,715.0	4,490.0
16- Check	153,120	34.4	65.0		4,141.0	8,729.0	4,589.0
Mean	148,217	34.4	65.1	36.0	4107.0	8,340.0	4,233.0
LSD (0.05)	NS	NS	NS		NS	NS	NS

*Includes product retail cost and application cost.

Table 9. Amount of nutrients supplied by nonconventional additives at rates tested, Malheur Experiment Station, Ontario, OR, 1999-2000.

		Amount of nutrient added (lb/acre^{-1})										
Treatment	Product	N	P	K	Ca	S	Mg	Fe	Zn	Mn	Cu	Humic acid
1	Jump Start 5-5-5	1.62	1.62	1.62								0.16
2	Humaide											1.07
	Agzyme											
	Kelp Treat											
	Jump Start 5-5-5	0.93	0.93	0.93								0.09
3	Jump Start 5-5-5	0.46	0.46	0.46								0.05
	Humaide											0.53
	Agzyme											
	Kelp Treat											
4 (1999)	Agri-Plus											28
	Quantum-H											1.53
4 (2000)	Quantum-H											4.59
5	RSA Humic acid											2.14
6	High Yield	3.15	4.2	4.2		0.42		0.02	0.21	0.02	0.03	
	Expand										0.01	
7	Expand										0.01	
8	High Yield	3.15	4.2	4.2		0.42		0.02	0.21	0.02	0.03	
9	Humi-Zyme RX	37.6	28.2			28.2						
11	Agri-Calcium				7.35							
12	Pop-up mix	1.13	1.67	0.55	0.01	0.01						
	Blend	0.22										
	Superphos		2.79									
	Sulfur	0.05				0.06						
	Copper					0.02					0.02	
	Calcium	0.07			0.11							
	Vitol	0.45	0.89	0.22		0.06						
13	Awaken	0.92		0.13					0.14			
14	Kozgro - preplant											0.04
	Kozgro - foliar											0.03
15	Microplex (seed furr.)						0.05	0.04	0.02	0.04	0.02	
	Microplex (foliar)						0.08	0.06	0.02	0.06	0.02	
	Nutrient Express	0.8	8.2	5.4								
	Calcium				0.24							