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Nutrient Analysis of Selected Commercial Organic Fertilizers for Greenhouse Lettuce Production

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The market for organic produce continues to expand (Thompson, 2000). Kentucky has over 30 acres of greenhouses with modified pond or tank hydroponic beds for "float" tobacco transplant production. The development of a certified organic greenhouse production system for lettuces and greens could allow Kentucky tobacco farmers to access a new market for their facilities as the tobacco market changes. In this study, commercial organic fertilizers were used to grow 'Ostinata' bibb and 'Red Sails' leaf lettuce in a pond, tank or "float" production system. Plant growth was evaluated and the fertilizer solutions were analyzed for nutrient amounts and compared to recommended standards for inorganic fertilizers (Muckle, 1993, Thompson, et al, 1998).

Materials and Methods

In this study, nine wooden hydroponic ponds (11.6 ft^2 or 1.08 m^2) or tanks were built in three rows of three on one side of a 30' x 60' (9 x 18 m) naturally ventilated sidewall plastic greenhouse. Tanks were lined with black polyethylene and filled with water to a depth of 6 inches (15 cm) to make a tank volume of approximately 35 gallons (164 L). Electric water pumps were placed in each tank to oxygenate the water; previous work demonstrated that oxygen levels would be maintained at 4-6 ppm with this procedure. Holes (35) were cut in eighteen 35" x 22" x 1 " (90 cm x 55 cm x 2.5 cm) polystyrene sheets. The holes were 1.5" (4 cm) in diameter and spaced 5" x 6" (12 x 15 cm). Lettuce plants were grown in 29 ml plastic soufflé cups (Solo Cup Company, Urbana, IL) that had holes drilled in the bottom.

Commercially available water-soluble organic fertilizers (Peaceful Valley Farm Supply, Grass Valley, CA) were compared to inorganic fertilizer (Peter's 20N-4P-16.6K, Scotts, Maryville, OH) added to the water in each tank. Algamin, .2N-0P-3.3K, (18% cold processed kelp, *Ascophyllum nodulosum* from Norway) was applied at the label rate and 3 times the label rate, approximately 1 T per gallon (4 ml L^{-1}) and 3 T per gallon (12 ml L^{-1}), respectively. EcoNutrients, .2N-.4P-.8K, (21% digested bull kelp, *Nereocystis luetkeana*, from northern California) was applied at the label rate, 8 ml L^{-1}. Omega 6N-2.6P-5K, (microbe digested organic fertilizer derived from blood meal, bone meal and sulfate of potash) was applied at the label rate and one-half the label rate, approximately 2 T per gallon (8 ml L^{-1}) and 1 T per gallon (4 ml L^{-1}), respectively.

Three crops of lettuce were grown in September, October and November of 2000. Cups were filled with a peat-based germination media (Scott's Redi-Earth, Maryville, Ohio) and placed in trays. Bibb lettuce 'Ostinata' and Grand Rapids lettuce 'Red Sails' seeds were sown in the cups and germinated at an average daily temperature of 75^{o} F (25^{o} C). Seedlings were grown for 14 days and fertigated with 150 ppm 20N-4P-16.6K inorganic fertilizer before placement in the hydroponic tanks. The plants grew under natural light conditions and the greenhouse had a heat set-point of 60^{o} F (16^{o} C) and a ventilation set-point of 76^{o} F (24^{o} C).

Plants were harvested from the tanks after 30 days and the fresh and dry weights were measured. Five water samples were taken during each crop and analyzed as standard greenhouse water samples (available nutrients) and as organic samples (total nutrients). The September crop compared the label rate of Algamin and EcoNutrients with inorganic, the October crop compared 3 times the label rate of Algamin, with the label rate of Omega and inorganic, and the November crop compared ½ label rate and the label rate of Omega with inorganic in randomized complete block experiments (Table 1).

Results and Discussion

Water soluble materials derived from algae (Algamin and EcoNutrients) had little value as an organic fertilizer for lettuce. Dry weight of lettuce grown with these materials was only 10-18% of those grown in inorganic fertilizer, depending on the cultivar (Table 1). Nitrate nitrogen and phosphorus levels were less than 1% and potassium was 5-20% of the recommended levels at the label rate for these fertilizers and 3 times the label rate (Table 2). These results are comparable to our previous unpublished trials with fish waste (fish emulsion and fish powder). However, the poor plant growth with fish waste was attributed to the high biological oxygen demand from the fertilizers that prevented root penetration into the nutrient solution for 3 or more weeks, despite moderate nutrient levels.

Dry weight of lettuce grown with a formulated organic fertilizer (Omega) was similar or lower than lettuce grown in inorganic fertilizer, depending on the cultivar (Table 1). Although dry weights were similar, head size was visually smaller with the organic fertilizer. Nitrate levels were 50%, P levels were 300% and K levels were 100-120% of recommended levels (Table 2).

Production of lettuce in this study was simplified when compared to the sophisticated practices evaluated by Thompson, et al, (1998). A commercial fertilizer was used as a control, rather than a formulated fertilizer. Plus, the inorganic fertilizer was supplemented only with additional fertilizer as the conductivity decreased, pH was not manipulated. The pH dropped dramatically throughout the study (Table 2), yet no apparent effects were noted. Additionally, the commercial fertilizer did not match recommended nutrient amounts precisely. Fresh weights in this study did not reach the commercial goal of 150 g per head (Thompson, et al, 1998), the inorganic and Omega treatments averaged approximately 110 g. The dry weights, however, were generally similar to dry weights reported by Thompson, et al (1998), but difficult to compare because of different temperatures and light levels used in these studies.

In conclusion, this study indicates that it may be possible to formulate an organic fertilizer for the hydroponic production of lettuce and greens in the greenhouse. It is unknown if state and federal agencies would certify such production practices as organic production.

Table 1. Mean shoot dry weight (g) of 'Ostinata' (O) and 'Red Sails' (RS) lettuce grown with inorganic and selected commercial organic fertilizers in 2000.

		September Crop		October Crop		November Crop	
Fertilizer	Percent of Label Rate	O	RS	O	RS	O	RS
Inorganic		3.83 a [x]	4.03 a	1.90 a	1.40 a	1.92 a	1.73 a
Omega	50					1.76 b	1.65 a
Omega	100			1.92 a	1.12 b	1.80 b	1.64 a
Algamin	100	0.76 b	1.40 b				
Algamin	300			0.15 b	0.42 b		
EcoNutrients	100	0.96 b	1.38 b				

x - Means in the same column with the same letter are not significantly different at the 0.05 level of probability according to the Least Means Square test.

Table 2. Measurements of macronutrients and pH from inorganic and selected commercial organic fertilizers used during September, October and/or November crops of lettuce in a pond culture system compared to recommended amounts (Muckle, 1993; Thompson, 1998).

	N-P-K	Percent of label rate	Weeks used	NO_3 ppm	NH_3 ppm	P ppm	K ppm	Ca ppm	Mg ppm	pH	EC dSm^{-1}
Recommended amounts				125-156	0	28-31	215-252	84-93	24-26	5.6-6.0	1.2
Inorganic	20-4-16.6		12	90	6	34	140	10 [x]	10 [x]	4.8	1.2
Omega	6-2.6-5	100	8	80	22	95	240	0	0	5.8	2.0
Omega	6-2.6-5	50	4	42	11	45	145	0	0	6.5	1.4
Algamin	.2-0-3.3	300	4	2	0	2	48	16	70	7.1	0.9
Algamin	.2-0-3.3	100	4	0	0	0.3	8	8	21	7.4	0.3
EcoNutrients	.2-.4-.8	100	4	0	0	0	10	6	4	7.5	0.1

x - Municipal water used for the nutrient solutions added a mean of 52 ppm Ca and 27 ppm Mg and a negligible amount of N, P, & K.

Literature Cited

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