Evaluating Phosphorous Fertilization and Commercial Biostimulants for Producing Cabbage

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Summary. Yield responses of 'Blue Vantage' cabbage *(Brassica oleracea* L.) to P fertilizer and two commercially available biostimulants—ROOTS and ESSENTIAL-were evaluated on soils very high in P fertility. Head yield was not increased with P fertilizer when cabbage was transplanted into soil with Mehlich-3 soil test P indexes ≥ 112 ppm (112 $mg \cdot kg^{-1}$). Neither of the biostimlants applied as a root drench at transplanting influenced head yield or plant tissue nutrient analysis.

Spring cabbage, which is planted earlier than many crops, may benefit from P fertilizer, even on soils high in P fertility. Vegetable crops grown during cool seasons are often more responsive to P fertilization than crops grown under warmer conditions (Lorenz and Vittum, 1980). Many soils used for vegetable production have high soil test P levels. More efficient use of fertilizers on such soils could improve the economic viability of cabbage production. Biostimulants maybe helpful in this regard by reducing the P fertilizer requirement.

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Biostimulants are nonnutritional products that may under some conditions reduce fertilizer use and increase yield and resistance of plants to stress (Crouch and Van Staden, 1994; Russo and Berlyn, 1990, 1992). Crop establishment may be improved with the use of biostimulants by enabling plants to withstand better the stresses of transplanting and to reduce transplant shock. A commercially available seaweed concentrate (Kelpak) has improved seedling growth of cabbage and marigold when applied as a root drench at transplanting (Aldworth and Van Staden, 1987). A commercial biostimulant called ROOTS (LISA Corp., New Haven, Corm.) consists of a mixture of humic acids, marine algal extracts, a nonhormonal reductant plant metabolite, and B vitamins. ROOTS biostimulant has increased root growth on several plant species (Berlyn and Russo, 1990). Field evaluation of ROOTS on radish and cabbage suggested that this product may increase yield of cole crops (Heckman, 1994). Further evaluation is needed, however, because these field evaluations were conducted over a single growing season, and the yield response of cabbage (13% increase with ROOTS treatment) was not statistically significant (Heckman, 1994). Another biostimulant called ESSENTIAL (Growth Products, White Plains, N.Y.) consists of humic acid, plant extracts, simple and complex sugars, kelp extract, hydrolyzed organic proteins, wetting agents, and carbohydrates. Product literature on ESSENTIAL states that it improves root growth and root systems and improves phosphate utilization by plants. The field research described here evaluated the effect of P fertilizer and ROOTS and ESSENTIAL on leaf nutrient concentrations and head yield of spring cabbage.

Materials and methods

Field experiments were conducted using cabbage transplants started in the greenhouse on 1 Mar. 1993 and 4 Mar. 1994. While in the greenhouse, the plants received a weekly application of a water-soluble 15–30–15 fertilizer. A gallon of the fertilizer solution was prepared by mixing 12 g of the 15–30–1 5 fertilizer in water and applying this amount of solution per 144 plants. The treatments listed in Table 1 were established in the field at transplanting 15 Apr. 1993 and 21

Table 1. *Cabbage yield and leaf P concentration as influenced by P fertilizer and biostimulants applied at transplanting in 1993 and 1994.*

Fertilizer P (lb/acre)	Biostimulant	Concentration (%)	Head yield 1993	t/acre 1994	Leaf P (%) 1993	Leaf P (%) 1994
0	Control	0	17.4	15.5	0.40	0.37
43	Control	0	18.1	16.5	0.40	0.39
0	ESSENTIAL	1	17.8	15.6	0.40	0.39
43	ESSENTIAL	1	17.3	15.3	0.38	0.37
0	ESSENTIAL	2	19.0	15.9	0.40	0.40
43	ESSENTIAL	2	18.0	14.3	0.41	0.40
0	ROOTS	1	20.5	15.1	0.40	0.37
43	ROOTS	1	16.7	16.5	0.39	0.40
0	ROOTS	2	19.1	15.6	0.37	0.37
43	ROOTS	2	19.1	15.7	0.40	0.40
P > F						
Treatment			0.38	0.14	0.16	0.52
Fertilizer P vs. none			0.17	0.65	0.16	0.04
ESSENTIAL vs. none			0.76	0.10	0.61	0.92
ROOTS vs. none			0.24	0.58	0.99	0.41
ESSENTIAL vs. ROOTS			0.29	0.17	0.53	0.38
CV%			12.9	7.3	8.1	7.7

Apr. 1994. Treatments with or without P fertilizer were compared in combination with two types and application rates of commercial biostimulants. The experiments were conducted using a randomized complete-block design with five replications on Freehold sandy loam (fine loamy, mixed, mesic Typic Hapludult) at the Rutgers Univ. Plant Science Research Center near Adelphia, N.J. Phosphorus application rates were 0 or 43 lb/acre (48 kg/ha) as normal superphosphate, 0–20–0.

The soils tested very high in available P. Prefertilization Mehlich-3 soil test indices for K were 178 ppm in 1993 and 274 ppm in 1994. Before transplanting, fertilizers were broadcast at 70 lb N/acre (78 kg N/ha) as NH_4NO_3, 83 lb K/acre (93 kg K/ha) as K_2SO_4, and 2 lb B/acre (2.2 kg B/ha) as $Na_2B_4O_7$ and incorporated using a disc. ROOTS and ESSENTIAL were applied as root drenches as recommended on the product labels. Cabbage transplants were transplanted at an 18-inch (0.46-m) spacing in the row, with 100 ml water added alone or with 1 % or 2% solution of biostimulant. Irrigation water was applied by overhead sprinklers as needed. Each plot consisted of three 30-ft (9.1-m) rows with row widths of 30 inches (0.76 m). Plant tissue analysis and harvest data were taken only from the center row of each plot. On 10 May 1993 and 14 May 1994, the most recently fully expanded leaf was sampled for tissue analysis from each of 10 plants per plot. The leaves were rinsed immediately with distilled water to remove soil and dust. Tissue samples were oven-dried at 158F (70C) and ground to pass a 0.02-inch (0.5-mm) sieve. Tissue analysis for N was performed with a Carlo Erba CN analyzer (Fissions Instruments, Beverly, Mass.). Analysis for P, K, Ca, Mg, B, Fe, Mn, Cu, and Zn were performed by digestion with perchloric–nitric acid, and their concentrations were determined with art inductively coupled plasma emission spectrometer (model 61 E; Thermo Jarrell Ash Corp., Franklin, Mass.). After leaf samples were taken, the cabbage was sidedressed with 70 lb N/acre (78 kg N/ha) as NH_4NO_3. Ten consecutive cabbage heads from the center row of each plot were harvested and weighed on 24 June 1993 and 27 June 1994. Data were subjected to analysis of variance. Single degree of freedom contrasts were tested for treatment effects shown for yield in Table 1 and for leaf tissue analysis.

Results and discussion

No visible signs of P deficiency were observed on the cabbage plants that did not receive P fertilizer in the field. Because the transplants were provided with P for their growth-period in the greenhouse, the rootball probably supplied some P to the crop after it was set in the field.

Applying P fertilizer did not increase head yield (Table 1) in 1993 or 1994. Cabbage leaf P concentration averaged 0.39% in 1993 and was not influenced by P fertilizer application. (Table 1). In 1994, cabbage leaf P concentration increased with P fertilizer (which averaged 0.38% P on plots without P fertilizer and 0.39% on plots with P fertilizer). Prefertilization Mehlich-3 soil test indices for the field experiments were 284 ppm in 1993 and 112 ppm in 1994. Current New Jersey recommendations for P fertilization are zero when the soil fertility rating is very high (Mehlich-3 ≥ 69 ppm) with a possible exception for early plantings in cold soil. These results support the adequacy of current P recommendations at very high soil test levels and suggest that a 0.38% P level in cabbage leaf tissue is sufficient. In tissue samples from heads of cabbage, Peck et al. (1987) found a P concentration of O .32% associated with maximum yield.

Neither of the biostimulants evaluated influenced cabbage yield (Table 1). Head size averaged 3.75 lb (1.7 kg) in 1993 and 3.09 lb (1.4 kg) in 1994 and also was not influenced by P fertilizer or biostimulant treatment. Plant tissue analysis also did not reveal any treatment differences in nutrient concentrations (data not presented). There were no visible signs that transplant shock was reduced or that field establishment was improved with the biostimulants. In contrast to previous reports (Aldworth and Van Staden, 1987; Russo and Berlyn, 1992) on the benefits of biostimulants on horticultural crops, these results do not provide any evidence for beneficial use of these biostimulants on cabbage transplants. The specific cropping situations for which biostimulants may be beneficial needs to be determined before these products can be widely recommended.

In summary, adding P to very high P testing soils is not warranted for cabbage production from transplants. New biostimulants should be evaluated with extensive field trials before their use on a large-scale.

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