Trials with Natural Growth Promoting Products©

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INTRODUCTION

Commercial nurseries are often approached by companies promoting products that enhance plant growth. These may be derived from natural products such as seaweed extracts, fish waste, humic substances, vitamins, etc. Various seaweed extracts are currently on the market and have been shown to increase root development, improve plant growth, and increase yield. Humic substances are commercially available and are reported to improve nutrient uptake and promote rooting. It is important to carefully test these products in order to assess their true value under production nursery conditions. We have tested natural growth-promoting products with varying results. This report summarizes the results of several trials with these types of products.

TRIAL 1: EFFECT OF HUMATE ON TOMATO, MUSTARD, AND LUPINE GROWTH

Potting soil, sand plus fertilizers, and sand without fertilizers were amended with 10 lb/yd^3 of two commercially available humate products. An additional set of each growing medium was not amended with humate. The potting soil was the general purpose potting soil used at Monrovia Growers, Azusa, California. The sand plus fertilizers contained the same pre-plant fertilizers used in the potting soil.

Tomato, mustard, and lupine seeds were sown into plug trays on 16 Dec. 2004. One month later, uniform seedlings were transplanted into the soil treatments in 4-inch pots. Plants were held in a propagation greenhouse at Azusa, California and watered with fortified irrigation water (nominal 50 ppm N and 75 ppm K). There were 10 plants per taxon per treatment arranged in a completely randomized design by plant species. Species were not randomized. Shoot fresh weight was determined on 28 Feb. 2005 for tomato and mustard and on 26 April 2005 for lupine.

At the end of the experiment, humates were extracted from several soil treatments and potting soil ingredients with 0.1 N NaOH followed by precipitation with concentrated sulfuric acid. The potting soil treatments were also extracted with 6 N HCl and the extract analyzed by atomic absorption spectrophotometry for Ca, Cu, Fe, K, Mg, Mn, and Zn. The extract was also analyzed for P by the ammonium molybdate colorimetric method.

The addition of humate to potting soil did not significantly improve growth of tomato, mustard, or lupine (Table 1). Humate 1 actually reduced growth of mustard. It was noted that many of the plants in the humate 1 treatment were more chlorotic than the other treatments. Analysis of the soil at the end of the experiment indicated that potting soil plus humate 1 contained 5 and 16 times the normal level of zinc and copper, respectively (Table 2). Therefore, humate 1 must have contained considerable amounts of these elements, which probably was toxic to the plants, resulting in chlorosis and reduced growth.

Table 1. Growth of tomato, mustard, and lupine in soil media amended with humates. Results are expressed as a percent of the potting soil treatment.

Treatment	tomato	mustard	lupine
Potting soil	100 a*	100 a	100 ab
Potting soil + humate 1	80 ab	66 b	113 ab
Potting soil + humate 2	88 ab	97 a	138 ab
Sand + fertilizer	32 e	53 bc	111 ab
Sand + fertilizer + humate 1	45 de	51 bc	110 ab
Sand + fertilizer + humate 2	69 bc	55 bc	141 a
Sand	57 cd	33 c	68 b
Sand + humate 1	51 cde	32 c	82 ab
Sand + humate 2	44 de	32 c	86 ab
Significance of F =	26	22	2.5
Treatment effect P > F =	< 0.0001	< 0.0001	0.016

*Values in the same column followed by the same letter are not significantly different by the Tukey-Kramer test at P = 0.05.

Table 2. Analysis of potting soil with humate addition. Soil was extracted with 6N HCl and analyzed by ammonium molybdate colorimetric method for P, and by atomic absorption spectrophotometry for all other elements. Salinity was measured on a saturated paste extract.

Treatment	pH	Salinity mmho·cm^{-1}	P	K	Ca	Mg	Fe	Mn	Zn	Cu
			(lb/yd^3)						(oz/yd^3)	
Potting soil	4.5	0.20	0.80	1.4	7.9	2.5	3.7	3.0	1.4	0.85
Potting soil + humate 1	6.1	0.75	0.90	1.6	7.4	2.3	3.7	3.8	7.1	14
Potting soil + humate 2	6.6	0.26	0.83	1.3	8.3	2.5	3.9	3.3	1.8	2.3

Plants in sand treatments generally did not grow as well as those in potting soil. Humate 2 added to sand plus fertilizer significantly improved growth of tomato, but in all other cases there was no effect of humate addition to sand.

Some of the treatments and materials used in this project were analyzed for humate (Table 3). Potting soil, bark, and compost contain considerable amount of humate even without any added humate. In comparing the humate extracted from the sand Treatments 4, 5, and 6, it can be seen that there is essentially no difference between the "blank" (Treatment 4) and humate 1 (Treatment 5). This was immediately apparent when the samples were extracted because the extracts from both of these treatments were almost colorless, whereas the extract from humate 2 (Treatment 6) was dark black in color. Humate 1 apparently had little or none of the most easily available humate fractions. The high levels of humate in typical potting mix materials and the low availability of humate 1, may explain the lack of a growth response in this trial.

Table 3. Humate analysis of soil mix or soil mix ingredients. Humate was extracted with 0.1 N NaOH followed by precipitation with concentrated sulfuric acid.

Treatment or soil mix component	Theoretical amount of humate added* (lb/yd^3)	Amount of humate analyzed (lb/yd^3)
Potting soil	0	21
Potting soil + humate 1	4.5	12
Potting soil + humate 2	0.6	28
Sand + fertilizer	0	7.4
Sand + fertilizer + humate 1	4.5	8.4
Sand + fertilizer + humate 2	0.6	19
Fir bark	--	11
Compost	--	9.4
Peat moss	--	5.1

*Humate added based on percent humate in humate product 1 and 2 as provided by manufacturer and an addition rate of 10 lb/yd^3.

TRIAL 2: SUPPRESSION OF PHYTOPHTHORA DAMPING-OFF BY HUMATE, PHOSPHITE, AND TRADITIONAL CHEMICAL FUNGICIDES

Snapdragon seeds were germinated in a flat. Inoculum was prepared by floating *Phytophthora cinnamomi* cultures in water overnight to release zoospores. On 16 Sept. 2004 seedlings were dipped in the zoospore suspension, then planted in 32-cell plug trays containing the standard potting mix used at Monrovia Growers, Azusa. The treatments listed in Table 4 were applied either by pre-mixing the product into the soil or as a drench after planting. Only one application of each product was made. There were three replicate 32-cell trays per treatment arranged in a completely randomized design. Plant mortality was recorded on 3 Nov. 2004.

Table 4. Efficacy of humate, phosphorous acid, and fungicide products on *Phytophthora* damping-off control in snapdragons.

Treatment	Disease incidence* (% seedling death)
Control	44 ab
Humate products:	
Humate product 3, 8-4-8, drenched at 2 oz/gal	28 bc
Humate product 4, 0-2-0, incorporated at 8 lb/yd^3	18 cd
Humate product 5, 1-0-0 drenched at 2 oz/gal	10 d
Humate product 6, 8-8-8, incorporated at 8 lb/yd^3	50 ab
Phosphorous acid products:	
Formula 1, drenched at 1 qt/100 gal	8.3 de
Fosphite, drenched at 2 qt/100 gal	17 d
AgriFos, drenched at 2 qt/100 gal	2.1 e
Traditional chemical fungicides:	
Stature, drenched at 6.4 oz/100 gal	3.1 e
Subdue, drenched at 1 fl oz/100 gal	1.0 e

*Treatment means followed by the same letter did not differ significantly (P = 0.05) as determined by Fisher's pairwise comparisons.

The traditional chemical fungicides and one of the phosphorous acid products had the lowest disease incidence and gave better disease control than the humate materials. Disease incidence was significantly less in two of the four humate treatments (Table 4). Humates are known to serve as a food source for soil microorganisms. Therefore these products may have stimulated the growth of soil microorganisms and thereby increased the disease suppressiveness of the soil. Alternatively, disease may have been suppressed because of more vigorous plant growth from the fertilizer value of these materials. A third possibility is that high soluble copper may have suppressed pathogen development as these products were from the same manufacturer as humate 1 in Trial 1.

TRIAL 3: EFFECT OF KELP EXTRACT ON ROOT GROWTH OF *CUPRESSUS*

One-gal *Cupressus sempervirens* 'Monshel', Tiny Tower® Italian cypress PP12933 were obtained from production stock at Monrovia Growers, Visalia, California in Oct. 2001. Plants received six kelp extract applications according to the manufacturer's instructions: Two drench applications and four foliar spray applications between 26 Oct. 2001 and 9 April 2002. The experiment was arranged in a randomized complete block design, with 30 plants per block per treatment and five replicate blocks.

Plants were evaluated about 4 weeks after the 3rd and 6th application. Three individual plant subsamples were collected from the center of each block on each evaluation date. Soil was washed-off the root ball and the root system was subjectively rated from 1 to 10 with 1 representing a weak root system with no new root growth, and 10 representing a vigorous root system with large amounts of new growth. The roots were then cut-off from the main stem, blotted dry, and weighed. The belowground portion of the crown was not included in the root fresh weight determination.

Root growth did occur during the experiment as there was a seven-fold increase in fresh root weight between January and May 2002 (Table 5). However, there was no improvement in root growth in plants treated with kelp extract compared to the control.

Table 5. Effect of kelp extract on root growth of *Cupressus sempervirens* 'Monshel', Tiny Tower® Italian cypress PP12933.

	76 days after first application		189 days after first application	
	Root rating	Root fresh weight (g/plant)	Root rating*	Root fresh weight (g/plant)
Untreated control	4.9 ns**	5.5 ns	6.1 ns	39 ns
Kelp extract	6.0 ns	6.7 ns	5.3 ns	39 ns
Significance of treatment effect	F = 1.3	F = 1.3	F = 4.6	F = 0.073
	P > F = 0.31	P > F = 0.31	P > F = 0.10	P > F = 0.80

* Roots rated from 1 to 10 with 1 representing a weak root system with no new root growth, and 10 representing a vigorous root system with large amounts of new growth.

** ns = not significant.

TRIAL 4: EFFECT OF NATURAL GROWTH-PROMOTING PRODUCTS AND IRON CHELATE ON COLOR AND ROOT GROWTH OF *GARDENIA*

Uniformly chlorotic plants of *Gardenia jasminoides* 'Veitchii' were selected from production stock at Monrovia Growers, Visalia, California and placed in 55% shade under normal fertigation (nominal 50 ppm N, 75 ppm K). Treatments listed in Table 6 were applied as a drench on 17 April, 29 April, and 22 May 2002. There were 10 individual plant replicates per treatment arranged in a completely randomized design. Plants were rated for color on 12 June 2002 on a scale of 1 to 10 with 1 representing complete chlorosis and 10 representing dark green foliage. Five randomly selected plants per treatment were evaluated for fresh root weight on 6/19/02.

Drenches of Sprint 330 iron chelate and mycorrhiza plus Sprint 330 resulted in significantly better plant color than mycorrhiza alone (Table 6). Fumigated mycorrhiza was included in the trial to determine if the potential benefit was caused by biotic or abiotic factors in the mycorrhizal formulation. There was no difference between mycorrhiza and fumigated mycorrhiza. The other natural products tested had varying effects on plant color. None of the products had color ratings equal to or better than the treatments containing iron chelate. Treatments did not affect root weight.

Table 6. Effect of natural growth-promoting products and iron chelate on color and root growth of *Gardenia jasminoides* 'Veitchii'.

Treatment	Color rating*	Fresh root weight (g/plant)
Untreated control	4.2 bc**	28 ns
Mycorrhiza + Sprint 330	5.3 ab	23 ns
Mycorrhiza	3.5 c	28 ns
Fumigated mycorrhiza	3.9 bc	25 ns
Sprint 330	6.0 a	24 ns
Humic acid	4.2 abc	26 ns
Fulvic acid	3.9 bc	22 ns
Kelp extract 1	3.9 bc	25 ns
Kelp extract 2	4.2 bc	27 ns
Biostimulant mixture	4.3 abc	25 ns
Significance of treatment effect	F = 3.9 P > F = 0.0003	F = 0.71 P > F = 0.69

* Color rated on a scale of 1 to 10 with 1 representing complete chlorosis and 10 representing dark green foliage.

**Means followed by the same letter are not significantly different at P = 0.05 by the Tukey-Kramer test. ns = not significant. ANOVA and mean separation performed on square root transformed data.

TRIAL 5: EFFECT OF NATURAL PRODUCTS ON ROOTING OF CAMELLIA CUTTINGS

Four cultivars of camellia cuttings were dipped in Dip 'N Gro and stuck in rooting medium amended with the treatments indicated in Table 7. There were four replicate flats per treatment per cultivar, each containing 56 rose pot liners. Flats were arranged in a completely randomized design with each cultivar grouped together in a separate experiment. Plants were placed under intermittent mist without bottom heat at Monrovia Growers, Visalia, California. Five liners were selected from each replicate after a majority of the cuttings had rooted and root fresh weight was determined. Most cuttings had not produced any new top growth at the time of sampling. There was some variability in the size of cuttings and therefore liners were not randomly selected for sampling, but rather plants were selected to be approximately the same size across all treatments. Obviously dead or damaged plants, or plants on the edges of the bed were not sampled.

There was no significant treatment effect (P = 0.05) on fresh root weight in three out of four cultivars (Table 7). *Camellia japonica* 'Debutante' was the only cultivar to show significant treatment differences and the control was the best.

Table 7. Effect of natural products on root weight of *Camellia* cuttings. Results are expressed as a percent of the untreated control.

	Root fresh weight				
Treatment	*Camellia* 'Winter's Fire'	*C. japonica* 'Debutante'	*C. japonica* 'Kramer's Supreme'	*C.* × *vernalis* 'Yuletide'	Average all cultivars
Control	100 a*	100 a	100 a	100 a	100
Mycorrhiza 1	96 a	67 b	54 a	37 a	63
Fumigated mycorrhiza 1		32 cd		87 a	60
Mycorrhiza 2	75 a	57 bc	75 a	102 a	77
Mycorrhiza 3		40 cd			40
Kelp extract	60 a	40 cd	91 a	45 a	59
Humic acid	63 a	25 d	170 a	88 a	87
Significance of F =	2.3	3.9	2.6	1.4	
Treatment effect P > F =	0.11	0.0092	0.077	0.31	

* Means followed by the same letter are not significantly different at P = 0.05 by the Tukey-Kramer test.

Table 8. Effect of growth-promoting products on fresh root weight of 1-gal *Camellia* cultivars. Results are expressed as a percent of the untreated control.

Treatment	*C. japonica* 'Debutante'	*C. japonica* 'Spring's Promise'	*C. japonica* 'Monke' Swan Lake™	*C. japonica* 'Kumasaka'	*C. japonica* 'Nuccio's Gem'	Average all cultivars
Control	100	100	100	100	100	100
Kelp extract 1	159	110	99	106	111	117
Kelp extract 2	167	140	81	150	126	133
Humectant	153	90	112	97	88	108
Monoammonium phosphate	92	83	80	94	79	86

TRIAL 6: EFFECT OF NATURAL GROWTH-PROMOTING PRODUCTS ON ROOT GROWTH OF ONE-GALLON *CAMELLIA*

Five camellia cultivars were selected from production stock at Monrovia Growers Azusa, California and placed in 55% shade. Plants were drenched 6 times at monthly intervals with the products indicated in Table 8. There were 10, 1-gal plants per cultivar per treatment. Treatments were not randomized. At the end of the experiment on 24 Oct. 2002, five representative plants were selected from each treatment and each cultivar and the fresh root weight was determined.

Averaged over all five cultivars, the seaweed extracts appeared to improve root growth to some degree (Table 8), but results were not consistent across all cultivars. Surprisingly, all five cultivars had lower root weights when treated with monoammonium phosphate compared to the untreated control. Phosphorus is commonly thought to promote root growth.

DISCUSSION

The results of these trials indicate limited benefit from natural growth promoting products under the cultural conditions used at a commercial nursery. Commercial nurseries strive to provide adequate water and nutrients to plants in order to promote healthy plant growth. Conditions of plant stress are avoided. Some growth-promoting products are proven in sports turf or in in-ground planting, where there is little or no organic component in the growing medium. Most container nursery soils, on the other hand, are highly organic and naturally contain high levels of humates. Although relatively high rates of humate addition were used in these trials, it may be necessary to use even higher rates in order to obtain a growth response.