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Composted Green Waste as a Container Medium Amendment for the Production of Ornamental Plants

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***Abstract.* Seed germination and crop growth characteristics were determined for *Tagetes* spp. L. 'Lemondrop', marigold; *Catharanthus roseus* Don. 'Little Pinkie', vinca; *Petunia hybrida* Vilm. 'Royalty Cherry', petunia; *Dendranthema* ×*grandiflorum* (Ramat.) Kitamura 'White Diamond', chrysanthemum; *Pittosporum tobira* Ait. 'Wheeleri', sweet mock orange; *Photinia* ×*fraseri* Dress., photinia and *Juniperus sabina* L. 'Moon Glow', juniper grown in various size containers containing blends of composted green waste (CGW) and UC Mix. Seed germination, plant height, and stem and root fresh and dry mass were lowest in unamended CGW. For most plants studied, a CGW : UC Mix blend containing at least 25% UC Mix was required for adequate growth and development. Germinating seeds and young seedlings were most adversely affected by unamended CGW. As plants grew and were transplanted into larger containers (10- and 15-cm pots, 530 and 1800 mL), they were better able to grow in media with higher CGW content.**

The use of composted plant materials as an amendment to soils is a well-established horticultural practice. Compost can be added to garden soils to increase water holding capacity and provide organic matter and it can be used as a constituent of soilless container media. Composted green waste (CGW) may be a viable material in which to grow plants or to use as an amendment to existing container media (Buchanan and Gliessman, 1991). Compost is an effective medium constituent (Purman and Gouin, 1992) and possesses some disease-suppression abilities (Boehm and Hoitink, 1992; Hoitink et al., 1991). If challenges associated with the use of CGW can be overcome (e.g., variation in physical and chemical properties, shrinkage), it may be a satisfactory container soil amendment.

Per capita, California homeowners are estimated to produce 180 kg of green waste (lawn clippings, tree/shrub prunings) per year (Statutes of California and Digests of Measures, 1989). This green waste is a significant component of the municipal waste stream that can be reused or recycled. In 1989, California passed legislation requiring every city/county to divert 25% of all solid waste from landfills through source reduction, recycling, and composting by 1 Jan. 1995 (Statutes of California and Digests of Measures, 1989). By 1 Jan. 2000, these municipalities will be required to divert 50% of their solid waste. While the legislation permits any strategy (reduction, recycling) to reduce the amount of green waste, the method of greatest interest to horticulturists is composting. The goal of this study was to assess the suitability of CGW as a growth medium and to compare the growth of various, short-term and long-term, horticultural crops in varying blends of CGW with growth in a standard medium (UC Mix).

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Materials and Methods

General procedures. Crops were chosen for this study based on their importance to the greenhouse, nursery and bedding plant industries, responsiveness to soil conditions, and cropping time. Three bedding plant species (marigold, vinca, petunia) were chosen to study seed germination and early seedling development over a relatively short period (4 to 6 weeks). Chrysanthemum was chosen to study early growth and development of rooted cuttings in various CGW : UC Mix blends. Three shrubs (photinia, pittosporum, juniper) were chosen to assess the use of CGW : UC Mix blends for growing plants in containers over the long term (6 to 8 months).

Blends of four samples of CGW (CGW from each of two composting operations at two times of the year) were made with UC Mix. CGW was obtained from operations in Sonoma County, Calif. (samples 1 and 2), and San Diego County, Calif. (samples 3 and 4); feedstock was ground municipal yard and landscape waste, with no paper, food wastes, or other materials. Samples were collected from Nov. 1993 to Apr. 1994; composting time was 2 to 3 months. All samples were stored moist in plastic bags and screened through 12-mm mesh before use. All CGW samples were evaluated for the production of bedding plants, two samples (samples 1 and 3) for chrysanthemum and one (sample 1) for woody ornamentals. CGW was blended with UC Mix [1 fine sand : 1 redwood sawdust : 1 peat (by volume)] in the following proportions: 1:0, 3:1, 1:1, 1:3, 0:1 and distributed into various sizes and types of containers as follows: 8 × 16-cell plug trays (plug size = 3 × 3 × 5 cm) for germination of marigold, petunia, and vinca; six-packs (cell size = 4 × 6 × 5.7 cm) for marigold, petunia, and vinca; 530-mL pots for marigold, petunia, and vinca; 1800-mL pots for chrysanthemum; and 3.8-L containers for *Pittosporum*, *Photinia*, and *Juniperus*.

CGW samples (50 g, three per CGW sample) were characterized using the following analyses: 1) electrical conductivity (EC, $dS{\cdot}m^{-1}$) (Rhoades, 1982); 2) cation exchange capacity [CEC, $mol(+){\cdot}kg^{-1}$] (Janitzky, 1986); 3) percent N, C, P, K, and ash (Kingston and Jassie, 1986; Rhoades, 1982); and 4) total mineral N (NH_4-N + NO_3-N, $mg{\cdot}kg^{-1}$) (Sweeney, 1989) for fresh (at collection) and aged (at planting) CGW. A controlled-environment, aerobic incubation was performed within 10 days of collection to determine short-term N mineralization/immobilization. A moist 9 soil : 1 CGW blend (w/w) was moisture-equilibrated under 25 kPa pressure then incubated at constant moisture at 30 °C for 14 days, followed by extraction in 2 N KCl. The change in mineral-N concentration over the incubation period represented net mineralization/immobilization.

The presence of phytotoxic compounds was determined through a tomato (*Lycopersicon esculentum* Mill. 'Brigade') seed bioassay. Eight grams of dry CGW and 40 mL distilled water were shaken for 2 h then filtered to remove particles; the extract was diluted 1:1 with distilled water. Seven milliliters of solution were added to a petri dish containing a filter paper blotter. Tomato seeds were added and the petri dishes incubated three days at 23 °C. A germination index (GI) was calculated by the following formula suggested by Zucconi et al. (1981):

$$GI = \frac{\%\ \text{germination in compost}}{\%\ \text{germination in distilled water}} \times \frac{\text{mean radicle length in compost}}{\text{mean radicle length in distilled water}} \times 100$$

Bulk density, water holding capacity, and air-filled porosity (AFP) were determined for selected CGW : UC Mix blends by the method of Bragg and Chalmers (1988).

Germination of bedding plants. Seeds of marigold, petunia, and vinca were placed 1 to 5 mm deep in plug trays (two seeds per cell) containing various CGW : UC Mix blends. Each plug tray was irrigated (leached) with at least two volumes of a half-strength (EC = 1.1 $dS \cdot m^{-1}$) Hoagland's solution #2 (Hoagland and Arnon, 1950) before seeds were introduced. Each species was randomly assigned to two 4 × 5 cell blocks within each plug tray (40 seeds per block, two blocks per plug tray = 80 seeds germinated for each species). Plug trays were placed under mist in a greenhouse held at 26 to 30 °C until seeds germinated. Germinated seedlings were counted and germination percentages were calculated 6, 16, and 22 days after sowing for marigold, vinca, and petunia, respectively.

Growth of bedding plants in six-packs. Seedlings resulting from germination experiments were transplanted into six-packs containing various CGW : UC Mix blends and transferred to a greenhouse for subsequent growth studies. Seedlings were transplanted into the same blend used for germination. Six-packs (four/species/CGW blend) were arranged in a randomized complete-block design on the greenhouse bench at 22 to 30 °C and irrigated daily with a half-strength Hoagland's Solution. Each bedding plant species was grown to a marketable size in the six-pack. This took 28, 42, and 43 days for marigold, petunia, and vinca, respectively. Half the plants grown in six-packs were harvested to estimate plant growth by measuring leaf area (marigold and vinca only) and top fresh and dry mass.

Growth of bedding plants in 530-mL pots. The remaining half of the plants were transplanted into 530-mL pots for subsequent growth studies. The blends used in the 530-mL pots were identical to those used in the six-packs and each plant was continued in the blend in which it had been growing. The pots were arranged in a randomized complete-block design on a greenhouse bench. Each species was grown to a marketable size. This took 21, 18, and 28 days for marigold, petunia, and vinca, respectively. All plants were harvested to estimate plant growth by counting flowers (marigold only) and obtaining leaf fresh/dry mass and flower fresh/dry mass (marigold and petunia only).

Growth of chrysanthemum. Rooted cuttings of *Dendranthema ×grandiflorum* 'White Diamond' were planted (one cutting/pot) into 1800-mL pots containing blends of CGW samples 1 and 3 with UC Mix and grown in the greenhouse. Pots were arranged on a greenhouse bench in a randomized complete-block design. After 1 week, the plants were pinched to five nodes and black-clothed (5:00 PM to 8:00 AM) to induce flowering. After 10 weeks, all plants were harvested to estimate plant growth by measuring height, stem, and flower fresh and dry mass.

Growth of woody perennials. Liners of *Pittosporum tobira* 'Wheeleri', *Photinia ×fraseri,* and *Juniperus sabina* 'Moon Glow' were transplanted into 3.8-L containers of CGW : UC Mix blends on 14 Apr. 1994. On 17 May 1994, slow-release fertilizer (15 g, Nutricote 20–7–10, Type 180; Plantco, Brayton, Ont., Canada) was applied as a topdress to each container. Plants were grown in an outdoor container nursery and automatically irrigated daily with tap water. Containers were arranged into two blocks with five replications per block. On 28 Nov. 1994, all plants were harvested to estimate plant growth by measuring top and root fresh and dry mass.

All data for all experiments were analyzed using the General Linear Model (GLM) Procedure of the SAS statistical system (SAS Institute, 1988).

Results and Discussion

Physiochemical characteristics. Physiochemical characteristics of CGW differed substantially among samples (Table 1). CGW samples 3 and 4 were higher in EC and percent ash, but lower in N, P, and K than samples 1 and 2. Macronutrient content was lower and ash content higher than is typical of more conventional agricultural composts, reflecting the substantial quantity of organic material (bark, tree trimmings, etc.) present in the municipal green waste feedstock (Chen et al., 1988). The relatively high EC in all samples mandated thorough leaching (>2X volumes of half-strength Hoagland's Solution #2) before use. Despite low C : N ratios (<12), three of four CGW samples showed net N immobilization in the controlled-environment incubation; these three samples also showed a substantial decline in mineral N content during aging, and one (sample 3) inhibited tomato germination and seedling growth in the phytotoxicity assay (germination index, Table 1). These were all indications of incomplete composting. However, the composting period (2 to 3 months) and technique (windrow, with periodic turning) was typical of CGW operations in California.

Differences also existed in AFP, water holding capacity, and bulk density of the blends (Table 2). AFP was variable, but generally low; media with AFP <10% require careful water management (Bragg and Chambers, 1988). CGW had similar (sample 2) or higher bulk density and lower water holding capacity than UC Mix. CGW sample 3 had the largest particle size (90% >0.5 mm, mass basis), while all other CGW samples and CGW : UC Mix blends had 30% or more mass in particles <0.5 mm. No media evaluated met the standard of 70% of particles in the 0.5 to 4.0 mm range suggested by Bunt (1988).

Germination of bedding plants. Germination percentage for marigold was between 84% ± 9% and 98% ± 4% (overall mean = 90%) in all media except unamended sample 4 (53% ± 18%). Germination percentage for petunia was between 53% ± 4% and 70% ± 7% (overall mean = 58%) in all media except for those in the 1:0, 3:1, 1:1 (CGW : UC Mix) blends (sample 1) and unamended samples 3 and 4. The germination percentages for those blends were 48% ± 4%, 38% ± 0%, 29% ± 1%, 40% ± 11%, and 29% ± 6%, respectively. Germination percentage for vinca was between 30% ± 16% and 60% ± 11% (overall mean = 40%). This is a relatively low germination response for vinca and may have been due to low viability of the seed used.

Growth of bedding plants in six-packs. Total leaf area and top fresh and dry mass for marigolds grown in six-packs containing blends of CGW samples 1 and 2 were not significantly different from those in UC Mix (Table 3). For CGW samples 3 and 4, marigolds grown in CGW : UC Mix ratio blends >1:1 (e.g., 3:1 and 1:0) had lower total leaf area and top fresh and dry mass (Table 3). Top fresh and dry mass of petunia plants grown in six-packs containing CGW sample 1 differed significantly in some blends. Petunias grown in unamended CGW sample 2 had lower top fresh and dry mass (Table 3). In CGW sample 3, petunias grown in media with 75% or more CGW had lower top fresh and dry mass, while in CGW sample 4 those plants grown in 50% or more CGW had lower top fresh and dry mass. Total leaf area and top fresh and dry mass of vinca plants grown in six-packs containing CGW sample 1 were not significantly different in any blends (Table 3). Vinca grown in unamended CGW sample 2 had lower total

Table 1. Physiochemical characteristics, mineral N content, and net mineralization/immobilization behavior of the four composted green waste (CGW) samples. Mineralization index and germination index values are followed by the (standard error of the mean).

CGW sample	Characteristics of CGW sample											
									Total mineral N[x]		Mineralization	Germination
	EC[z]	CEC[y]	N (%)	C (%)	C/N	P (%)	K (%)	Ash (%)	Fresh	Aged	index[w]	index[v]
1	8.3	21.5	1.40	12.4	8.9	0.31	0.73	62.4	109	328	+5.1 (1.7)	84 (16)
2	5.8	17.3	1.23	12.5	10.2	0.29	0.67	57.8	103	18	−6.3 (1.1)	96 (16)
3	12.8	13.8	0.74	8.7	11.8	0.20	0.61	63.5	54	21	−13.6 (0.3)	55 (18)
4	11.4	18.8	1.01	11.2	11.1	0.20	0.45	73.3	343	15	−8.4 (3.2)	86 (21)

[z]Electrical conductivity, $dS \cdot m^{-1}$.
[y]Cation exchange capacity, $mol(+) \cdot kg^{-1}$.
[x]NH_4-N + NO_3-N, $mg \cdot kg^{-1}$.
[w]Change in mineral content during 14-day incubation of a 10% CGW/soil blend relative to unamended soil; negative numbers indicate net immobilization.
[v]Percent seed germination × radicle length × 100, in relation to a distilled water control.

leaf area and top fresh mass. In CGW samples 3 and 4, vincas grown in CGW : UC Mix ratio blends >1:1 had lower total leaf area and top fresh mass and dry mass.

Growth of bedding plants in 530-mL pots. Leaf fresh and dry mass of marigolds grown in 530-mL pots containing CGW sample 1 differed significantly in some blends (Table 4). In CGW samples 2, 3, and 4, marigolds showed reduced growth in blends >3:1, 1:1, and 3:1, respectively. Leaf fresh and dry mass and flower dry mass of petunias grown in 530-mL pots containing CGW sample 1 were similar in all blends (Table 4). In CGW samples 2, 3, and 4, petunias showed reduced leaf fresh and dry mass in blends >3:1. Flower dry mass was reduced only in the unamended sample 4. The leaf fresh and dry mass of vincas grown in 530-mL pots were reduced in blends greater than 3:1, 3:1, 1:1, and 3:1 for samples 1, 2, 3, and 4, respectively (Table 4).

Growth of chrysanthemum in 1800-mL pots. The height and stem and flower fresh and dry mass of chrysanthemums irrigated daily with half-strength Hoagland's Solution and grown in 1800-mL pots containing CGW samples 1 and 3 were less in blends >1:1 (Table 5). Overall, chrysanthemums grown in CGW sample 1 were taller and had higher stem and flower fresh weight and dry mass.

Growth of woody perennials. There were no differences in top and root fresh and dry mass for all three woody ornamentals, *Juniperus, Photinia,* and *Pittosporum*, grown in blends of CGW sample 1 and UC Mix. Total dry mass for all five blends ranged from 31.1 to 39, 21.9 to 43.5, and 14.1 to 23.6 g for *Juniperus, Photinia,* and *Pittosporum*, respectively.

Table 2. Physical characteristics of composted green waste (CGW) and CGW : UC Mix blends. All samples were 5 cm deep.

CGW sample	Media blend CGW : UC Mix	Air-filled porosity (%)	Water holding capacity ($mL \cdot mL^{-1}$)	Bulk density ($g \cdot mL^{-1}$)	Particle distribution (%), mass basis >4 mm	0.5–4 mm	<0.5 mm
1	1:0	9.3	0.46	0.51	13	48	39
	1:1	5.0	0.55	0.47	11	42	47
2	1:0	9.9	0.51	0.39	23	45	31
	1:1	8.8	0.57	0.37	17	30	53
3	1:0	12.4	0.45	0.45	37	53	10
	1:1	7.7	0.53	0.36	20	41	38
4	1:0	3.3	0.48	0.63	13	48	39
	1:1	6.1	0.58	0.46	11	42	47
UC Mix	1:0	6.4	0.60	0.41	3	20	77

Table 3. Growth of marigold, petunia, and vinca in six-packs containing blends of four different samples of composted green waste (CGW).

		Growth characteristic[z]							
		Marigold			Petunia			Vinca	
CGW sample	Ratio of CGW:UC Mix	Total leaf area (cm^2)	Top fresh mass (g)	Top dry mass (g)	Top fresh mass (g)	Top dry mass (g)	Total leaf area (cm^2)	Top fresh mass (g)	Top dry mass (g)
1	1:0	77 a	2.9 b	0.42 a	2.4 a	0.29 a	29 a	0.7 a	0.28 a
	3:1	99 a	4.0 ab	0.48 a	6.1 a	0.45 a	30 a	1.1 a	0.22 a
	1:1	113 a	4.7 a	0.55 a	4.6 a	0.39 a	49 a	1.3 a	0.22 a
	1:3	95 a	3.7 ab	0.47 a	6.5 a	0.51 a	31 a	1.5 a	0.20 a
	0:1	95 a	3.7 ab	0.45 a	2.9 a	0.29 a	43 a	1.4 a	0.26 a
2	1:0	66 b	2.5 b	0.34 b	0.2 b	0.07 b	10 b	0.4 bc	0.16 a
	3:1	103 a	4.1 a	0.46 ab	2.5 a	0.24 a	24 ab	0.8 ab	0.17 a
	1:1	100 a	4.1 a	0.49 a	2.2 a	0.23 a	26 ab	1.2 ab	0.26 a
	1:3	103 a	4.2 a	0.49 a	3.9 a	0.46 a	41 a	1.7 a	0.31 a
	0:1	95 a	3.7 a	0.45 ab	2.9 a	0.29 a	43 a	1.4 ab	0.26 a
3	1:0	31 b	1.2 c	0.22 c	0 c	0 b	2 c	0.1 c	0.02 d
	3:1	50 b	1.9 c	0.28 bc	0.6 c	0.05 b	7 c	0.3 c	0.09 cd
	1:1	77 a	2.9 b	0.39 ab	1.4 bc	0.08 b	16 bc	0.6 bc	0.12 bc
	1:3	93 a	3.8 a	0.46 a	3.1 a	0.23 a	35 ab	1.2 ab	0.26 ab
	0:1	95 a	3.7 a	0.45 a	2.9 a	0.29 a	43 a	1.4 ab	0.26 ab
4	1:0	24 c	0.8 c	0.17 c	0.6 b	0.08 b	8 c	0.3 c	0.11 b
	3:1	58 b	2.2 b	0.3 b	1.1 b	0.15 ab	14 bc	0.5 bc	0.14 ab
	1:1	99 a	4.0 a	0.47 a	3.4 a	0.3 a	28 ab	1.0 ab	0.15 ab
	1:3	102 a	4.1 a	0.48 a	4.5 a	0.39 a	30 ab	1.2 ab	0.17 ab
	0:1	95 a	3.7 a	0.45 a	2.9 a	0.29 a	43 a	1.4 ab	0.26 a

[z]Mean separation for each CGW sample within columns by Scheffe's multiple comparison procedure at $p = 0.05$.

Conclusions

Unblended CGW, regardless of sample, was not consistently equivalent to UC Mix in terms of overall plant growth; in some cases, growth was drastically reduced in unblended CGW. If CGWs are to be used as a container medium, they will have to be blended with some other material to minimize inherent deficiencies (water holding capacity, porosity, or other characteristics) and variability among sources. As a group, germinating seeds of all three bedding plant species were most adversely affected by the CGW : UC Mix blends while the woody plants were the least affected. In general, larger plants (liners, rooted chrysanthemum cuttings, bedding plants grown in six-packs) were best able to grow in media with high CGW content.

The poor overall performance of samples 3 and 4 was likely due, in part, to incomplete composting. Compost maturity is an important characteristic of CGW (Chanyasak et al., 1983; Inbar et al., 1990). Lack of compost maturity of CGW samples 3 and 4 was suggested by decreased mineral N during aging and negative mineralization indices. Differences in the ECs among the four samples was not a factor, given the amount of leaching done before their use.

Despite the heterogeneity of the CGW samples, their use as an amendment (25% to 50%, by volume) is very promising. There was no evidence of pathogen problems and the work of others (Hoitink et al., 1991) strongly suggests that CGW may suppress common root pathogens. Viable weed seeds were present in all CGW samples, but at very low populations. The cost of producing CGW is subsidized by tipping fees paid by the generators of the waste, so the finished CGW will be very cost-effective. It is generated in urban areas, relatively near nurseries, so transport costs will also be less than for peat and timber by-products (e.g., bark). Currently, peat, at ≈\$88.00/m^3, is more than four times the cost of CGW. At ≈\$20.00/m^3, CGW could be a lower-cost alternative to peat or bark products routinely used in container media.

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Table 4. Growth of marigold, petunia, and vinca in 530-mL pots containing blends of four different samples of composted green waste (CGW).

		Growth characteristic[z]						
		Marigold		Petunia		Vinca		
CGW sample	Ratio of CGW:UC Mix	Leaf fresh mass (g)	Leaf dry mass (g)	Leaf fresh mass (g)	Leaf dry mass (g)	Flower dry mass (g)	Top fresh mass (g)	Top dry mass (g)
1	1:0	34 ab	4.7 a	39 a	13.5 a	4.5 a	21 b	3.1 c
	3:1	31 ab	4.2 a	53 a	14.8 a	4.6 a	30 ab	4.6 bc
	1:1	35 ab	5.3 a	55 a	15.1 a	4.5 a	32 ab	5.3 ab
	1:3	40 a	5.6 a	55 a	15.5 a	4.7 a	39 a	6.2 ab
	0:1	33 ab	4.8 a	35 a	13.9 a	4.4 a	42 a	6.9 a
2	1:0	25 bc	3.6 c	14 bc	11.9 b	4.2 a	15 c	1.8 c
	3:1	25 bc	3.9 bc	34 ab	13.3 ab	4.4 a	26 bc	3.8 bc
	1:1	33 ab	4.4 ab	36 ab	13.7 ab	4.1 a	32 ab	5.1 ab
	1:3	34 ab	5.0 ab	57 a	15.7 a	4.4 a	40 a	6.9 a
	0:1	33 ab	4.8 ab	35 ab	13.9 ab	4.4 a	42 a	6.9 a
3	1:0	15 c	2.0 c	5 b	11.2 b	0 b	8 c	0.9 d
	3:1	23 bc	3.1 c	26 ab	12.6 ab	4.2 a	15 bc	1.8 cd
	1:1	26 bc	3.9 bc	39 ab	13.4 ab	3.8 a	23 b	3.3 bc
	1:3	35 ab	4.9 ab	56 a	15.2 a	4.5 a	42 a	7.2 a
	0:1	33 ab	4.8 ab	35 ab	13.9 ab	4.4 a	42 a	6.9 a
4	1:0	20 c	2.4 c	6 b	11.3 b	2.1 b	9 b	0.9 c
	3:1	27 bc	3.8 bc	25 ab	12.6 ab	4.2 ab	14 b	1.8 c
	1:1	33 ab	4.6 ab	43 ab	14.3 ab	4.5 ab	31 a	4.6 b
	1:3	36 ab	5.4 ab	63 a	15.9 a	4.7 a	35 a	5.4 ab
	0:1	33 ab	4.8 ab	35 ab	13.9 ab	4.4 ab	42 a	6.9 a

[z]Mean separation for each CGW sample within columns by Scheffe's multiple comparison procedure at $\rho = 0.05$.

Table 5. Growth of chrysanthemum in 1800-mL pots containing blends of two different samples of composted green waste (CGW).

		Growth characteristic[z]				
CGW sample	Ratio of CGW:UC Mix	Ht (cm)	Stem fresh mass (g)	Stem dry mass (g)	Flower fresh mass (g)	Flower dry mass (g)
1	1:0	30 c	49 c	14.1 c	36 b	4.9 d
	3:1	32 c	65 b	16.8 b	53 a	6.9 bc
	1:1	34 b	75 ab	19.0 ab	64 a	8.4 a
	1:3	36 ab	82 a	20.9 a	63 a	8.6 a
	0:1	38 a	81 a	21.3 a	60 a	8.1 ab
3	1:0	26 c	38 c	12.5 c	27 c	3.6 d
	3:1	28 c	49 c	14.0 c	37 bc	4.8 cd
	1:1	32 b	63 b	17.0 b	43 b	5.8 c
	1:3	35 ab	78 a	20.7 a	63 a	8.5 a
	0:1	38 a	81 a	21.3 a	60 a	8.1 ab

[z]Mean separation for each CGW sample within columns by Scheffe's multiple comparison procedure at $\rho = 0.05$.

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