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Nitrogen Source and Concentration, Growing Medium, and Cultivar Affect Longevity of Potted Chrysanthemums

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Abstract. **Chrysanthemums 'Bright Golden Anne' and 'Iridon' *[Dendranthemum* ×*grandiflorum* (Ramat.) Kitamura] were grown with N concentrations of 1.3, 2.6, or 5.2 kg N/m' of water during the crop cycle from either Osmocote slow-release 14N-6.2P-11.6K or 12.4N4.4P-14.lK or Peters soluble 20N-4.4P-16.6K. Plants were moved to simulated interior rooms at flowering to evaluate effects of the treatments on longevity. 'Bright Golden Anne' longevity was not affected by fertilizer source, but 'Iridon' longevity was reduced when Peters soluble fertilizer was applied at 2.6 and 5.2 kg N/m^3 of water, whereas N concentration did not affect longevity when the slow-release Osmocote fertilizer was used. In an additional study, 'Tip', 'Copper Hostess', and 'Iridon' were grown in three soil media using 1.3, 2.6, or 5.2 kg N/m' of water using Peters soluble 20N-4.4P-16.6K fertilizer from time of planting until flowering. Longevity increased as N concentration decreased when chrysanthemums were grown in Metro Mix 350, whereas N concentration had no significant effect on chrysanthemums grown in Vergro Klay Mix or a peat-perlite-sand mix. 'Tip' showed significant in. creases in longevity as N concentration decreased.**

Fertilization concentration (Harbaugh and Waters, 1982; Scott et al., 1984), production temperature, shipping temperature (Molinar and Williams, 1977; Nell and Barrett, 1986; Staby and Kofranek, 1979), and interior irradiance level (Kraszewski and Ormrod, 1986) have been shown to affect quality and longevity of poinsettia, exacum, hibiscus, and other flowering potted plants. Exacum plants fertilized with high levels of Osmocote (7 kg·m^{-3} of a 3- to 4-month release, osmocote 14N-6.lP-11.6K or an 8- to 9-month release, Osmocote 18N-2.6P-10K) were considered high quality at flowering compared to plants fertilized at low levels (3.5 kg·m^{-3}), but plants receiving high fertilizer levels decreased in floral display after 2 weeks in simulated home conditions (23 to 26C, 1.2 to 1.5 klx from 0600 to 1800 HR from cool-white fluorescent lamps, 40% to 50% RH; Harbaugh and Waters, 1982). Similarly, poinsettia height, width, bract and foliage color, and overall plant quality increased as the level of Osmocote 14N–6. 1P-11.6K and 18N-2.6P-10K increased from 3 to 9 g/l2.5-cm pot; however, after 30 days in a simulated interior environment (21 ± lC, 15 µmol·s^{-1}·m^{-2} from cool-white fluorescent lamps, 60% ± 10% RH), plants fertilized at a rate of 9 g/12.5-cm pot lost the highest percentage of leaves, bracts, and cyathia and received the lowest plant quality rating (Scott et al., 1984). These authors also found that

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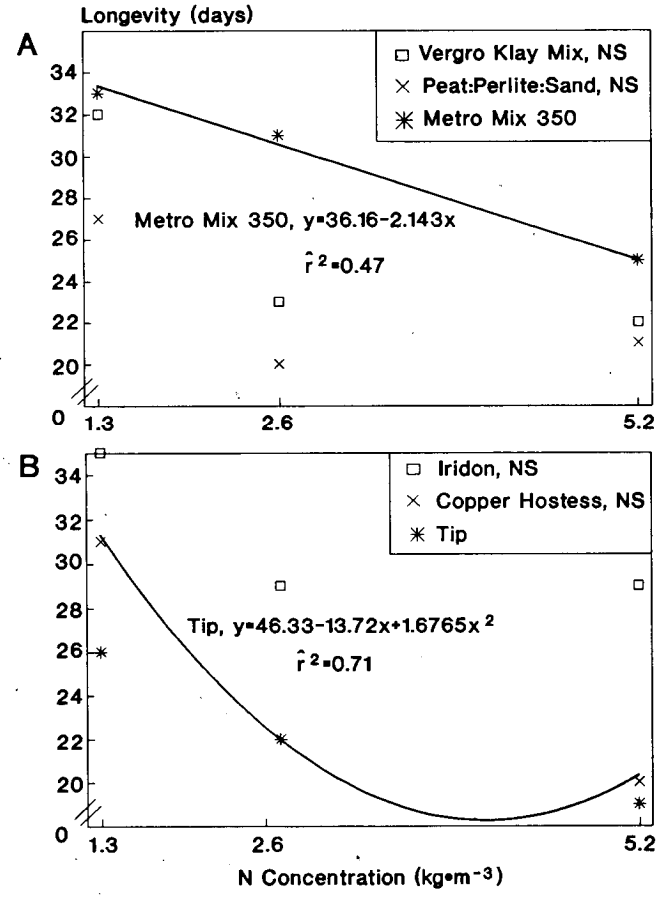

Fig. 1. Effect of N concentration on longevity of chrysanthemums in relation to medium **(A)** and cultivar **(B).** The interaction between N concentration and medium **(A)** and the interaction between N concentration and cultivar **(B)** were significant at $P = 0.05$. Regression analysis used mean values for each treatment.

Table 1. Effects of N concentration and source on 'Bright Golden Anne' chrysanthemum postharvest longevity and medium pH and conductance.

Nitrogen		Flower longevity (days)	Medium	
Source (N–P–K)[z]	Concn ($kg \cdot m^{-3}$ per crop)		pH	Conductance ($dS \cdot m^{-1}$)
14–6.2–11.6 (O)	1.3	32	6.2	0.5
12–4.4–14.1 (O)		32	5.9	0.5
20–4.4–16.6 (P)		31	6.3	0.6
14–6.2–11.6 (O)	2.6	29	5.3	1.2
12–4.4–14.1 (O)		27	5.7	0.9
20–4.4–16.6 (P)		31	5.4	1.7
14.6–6.2–11.6 (O)	5.2	29	4.6	1.3
12–4.4–14.1 (O)		30	5.1	0.7
20–4.4–16.6 (P)		29	4.7	1.8
Concn		**	**	**
Source		NS	NS	*
Concn × source		*	*	*
$HSD_{0.05}$		4	0.6	0.6
$HSD_{0.01}$		NS	NS	NS

[z]O = Omocote; P = Peters.
*,**,NSSignificant at $P = 0.05$ or 0.01 or nonsignificant, respectively.

poinsettias fertilized with 14N-6.lP-11.6K had better postharvest performance than plants fertilized with the 18N-2.6P-10K Osmocote formulation and proposed the difference was due to the faster release rate of Osmocote 14N-6.1P-11.6K than of 18N-2.6P-10K.

Longevity of potted chrysanthemums was shorter in a soiless medium than in one amended with 10% to 20% native soil (Boodley et al., 1983). The response was cultivar dependent. Since no work has been conducted to evaluate the interactions of medium, fertilizer source, and concentration on longevity of floricultural crops, we evaluated the effects of soil medium type, fertilizer source, and N concentration on the longevity of three potted chrysanthemum cultivars.

General procedures. Rooted cuttings of *Dendranthemum* × *grandiflorum* were planted, one per 12.5-cm (1. 17-liter) plastic pot and placed under a noninductive photoperiod (incandescent lamps were used from 2200 to 0200 HR) in a fiberglass, fan-and-pad-cooled greenhouse in Gainesville, Fla. Maximum irradiance levels ranged from 500 to 600 $\mu mol \cdot s^{-1} \cdot m^{-2}$ in winter to 800 to 900 $\mu mol \cdot s^{-1} \cdot m^{-2}$ in summer. Night temperature varied from 16 to 18C in winter to ≈ 25C in summer. Plants were pinched and the photoinductive period (black cloth pulled over plants at 1800 HR and removed at 0800 HR) was initiated 10 days after planting. Plants were treated with daminozide at 5,000 $mg \cdot liter^{-1}$ as a foliar spray when lateral shoots were 4.5 cm long and again 10 days later. Plants were pruned to three stems and each stem was disbudded to provide one flower per lateral shoot.

Flowering was designated in these studies when the first two rows of petals were perpendicular to the flower stem. At this time, one pot per treatment per block was used to determine medium pH, conductance of the soil solution, and leaf chlorophyll levels (expt. 3 only). Conductance was determined using the 1:2 dryweight procedure (Joiner et al., 1981), and chlorophyll levels were analyzed according to Arnon (1949).

At flowering, one plant per treatment per block was placed in simulated interior rooms to determine longevity. Each simulated interior room provided 12 $\mu mol \cdot s^{-1} \cdot m^{-2}$ of irradiance for 12 hr daily from cool-white fluorescent lames. at 20 ± lC with 50% ± 5% RH. Plants were watered from the top of the pot as needed to maintain uniform soil moisture. The flowers were judged to be no longer attractive and flower longevity was dated when the first two rows of petals turned brown and/or when 50% of the leaf margins turned brown.

Each experiment in the greenhouse was arranged in a completely randomized block design with six replications and two plants per experimental unit. In each simulated interior room, the plants were arranged in a completely randomized design. Data were subjected to analysis of variance, Tukey's HSD mean separations at $P = 0.05$ and 0.01, and regression analysis.

Production fertilizer effects on 'Bright Golden Anne'. Cuttings of 'Bright Golden Anne' chrysanthemums were planted on 6 Mar. in containers filled with Vergro Klay Mix (Verlite Co., Tampa, Fla.). At planting, a 3 × 3 factorial experiment was established using three fertilizer sources [Osmocote 14N-6.2P-11.6K (0-14), Osmocote 12N-4.4P-14.lK (0-12), and Peters soluble 20N+4.4P-16.6K (P-20)] at three N levels (1.3, 2.6, and 5.2 kg N/m^3 during the crop). Slow-release fertilizers (0-14 and 0-12) were mixed into the medium before planting. Plants treated with soluble fertilizer were watered every other day with 300 ml of solution.

Longevity of 'Bright Golden Anne' was 29 to 32 days for all fertilizer treatments, regardless of fertilizer source or concentration, except for 0-12 at 2.6 kg N/m^3 (Table 1). Even though those fertilized with 0-12 at 2.6 kg N/m^3 had the shortest longevity, the pH of their medium was higher and its

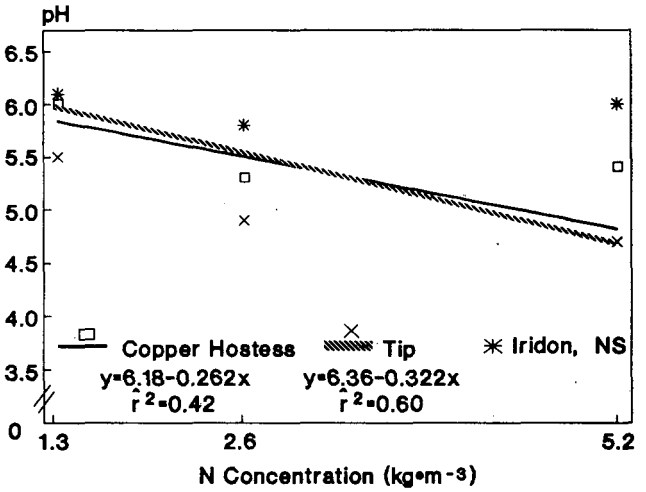

Fig. 2. Effect of N concentration and chrysanthemum cultivar on medium pH. Interaction significant at $P = 0.05$. Regression analysis of 'Iridon' was nonsignificant. Regression analysis used mean values for each treatment.

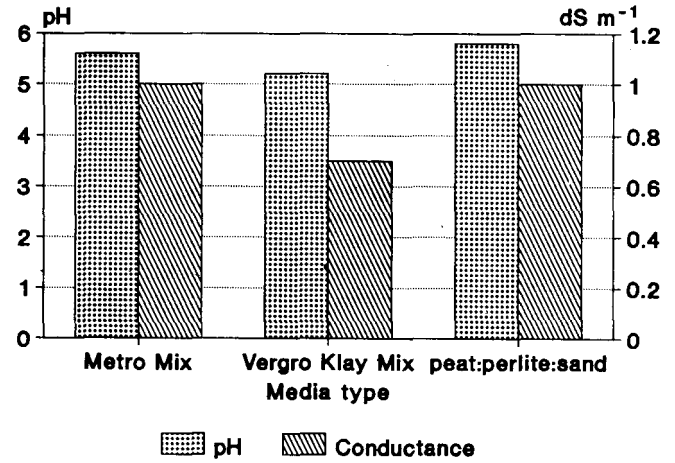

Fig. 3. Effect of medium type on pH and conductance of the soil medium for chrysanthemum cultivars Copper Hostess, Iridon, and Tip. Main effect of medium significant at $P = 0.05$ for pH and at $P = 0.01$ for conductance.

Table 2. Effects of N concentration and source on 'Iridon' chrysanthemum postharvest longevity and medium pH and conductance.

Nitrogen		Flower	Medium	
Source (N-P-K)[z]	Concn (kg·m⁻³ per crop)	longevity (days)	pH	Conductance (dS·m⁻¹)
14–6.2–11.6 (O)	1.3	38	5.1	0.6
12–4.4–14.1 (O)		37	5.0	0.7
20–4.4–16.6 (P)		34	6.6	0.5
14–6.2–11.6 (O)	2.6	35	4.6	1.0
12–4.4–14.1 (O)		35	5.2	1.0
20–4.4–16.6 (P)		30	5.4	1.5
14.6–6.2–11.6 (O)	5.2	35	4.7	1.0
12–4.4–14.1 (O)		35	5.4	0.9
20–4.4–16.6 (P)		21	4.5	2.3
Concn		**	*	**
Source		**	*	**
Concn × source		**	*	**
$HSD_{0.05}$		5	1.0	0.6
$HSD_{0.01}$		6	NS	0.7

[z]O = Osmocote; P = Peters.
*,**,Ns Significant at $P = 0.05$ or 0.01 or nonsignificant, respectively.

conductivity lower than those fertilized with 0-14 or P-20. Conductance was similar for 0-12 at any of the N concentrations tested and only a slight decrease in pH was noted at a concentration of 5.2 kg N/m³. 0-14 and P-20 both induced a significant decrease in pH, by about one pH unit per increase in N concentration, from 1.3 to 5.2 kg N/m³. Conductance was higher at 2.6 and 5.2 kg N/m³ than at 1.3 kg N/m³ for both 0-14 and P-20. The effects on conductance observed with the two controlled-release fertilizers used in this study probably were due to differences in the concentration that was released by 0-14 compared to 0-12.

Production fertilizer effects on 'Iridon'. Cuttings of 'Iridon' chrysanthemums were planted on 15 May. Treatments were the same as those described for the experiment with 'Bright Golden Anne'. Plants treated with soluble fertilizer were watered every day with 300 ml of solution.

Longevity of 'Iridon' chrysanthemums was 34 to 38 days for all treatments except those fertilized with P-20 soluble fertilizer at concentrations of 2.6 or 5.2 kg N/m³ (30 and 21 days, respectively) (Table 2). Increasing N concentrations for plants fertilized with Osmocote slow-release fertilizers 0-14 and 0-12 did not affect longevity. However, increasing N concentration did negatively affect the longevity of plants fertilized with P-20 soluble fertilizer. Effects of fertilizer source and N concentration on medium pH and conductance were similar to those observed with 'Bright Golden Anne'. Longevity was negatively correlated with conductance ($r = 0.64$). Differences in longevity and conductance may be due to the fact that P-20 soluble fertilizer was applied as a liquid solution until flowering while the slow-release fertilizers were mixed in the medium at planting and may have already been totally released before flowering. Previous results have shown that longevity of chrysanthemums grown with a liquid fertilizer program can be increased by terminating fertilizer applications ≈3 weeks before flowering (Nell et al., 1989). Thus, longevity of plants fertilized with P-20 liquid fertilizer might have been equal to plants fertilized with slow-release fertilizer if the liquid had been terminated 3 weeks before flowering.

Production media, fertilizer, and cultivar effects. A factorial experiment with three chrysanthemum cultivars ('Copper Hostess', 'Tip', and 'Iridon'), three media types, and three N levels was initiated on 13 Aug. Cuttings of chrysanthemums were planted in pots containing Vergro Klay Mix, Metro Mix 350, or a mixture of equal volumes of peat, perlite, and sand with 5.6 kg dolomite, 1.4 kg superphosphate, and 1.1 kg Perk (a micronutrient source)/m³. All plants were fertilized from planting until flowering with P-20 at concentrations of 1.3, 2.6, or 5.2 kg N/m³ during the crop cycle; 300 ml of solution was applied at every irrigation.

The three-way interaction between cultivar, N concentration, and media was not significant for any of the characteristics measured (Table 3). Longevity of all three cultivars tested decreased as N levels increased from 1.3 to 5.2 kg N/m' when grown in Metro Mix 350 (Fig. 1A). However, longevity was not affected by N concentration (data pooled over all. cultivars tested) when plants were grown in Vergro Klay Mix or the peat-perlite-sand mix. Differences in response to media type may be related to differences in

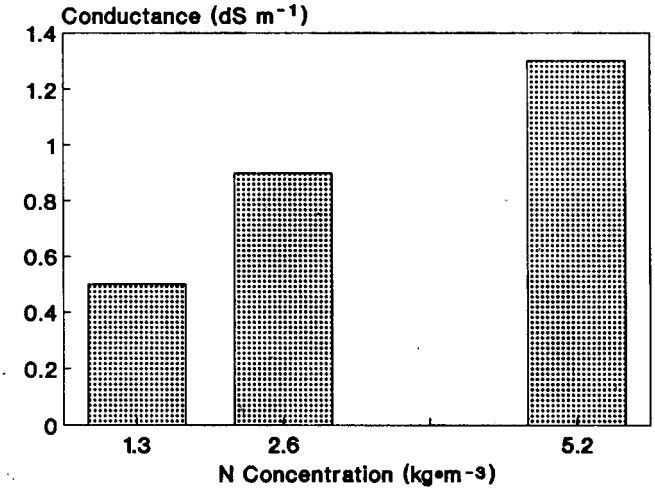

Fig. 4. Effect of N concentration on medium conductance (data were pooled for all three chrysanthemum cultivars). Effect of N concentration on medium conductance significant at $P = 0.01$.

Table 3. Effects of soil medium (Vergro Klay Mix, Metro Mix 350, or a mixture of equal volumes of peat, perlite, and sand), N concentration (1.2, 2.6 or 5.2 kg N/m^3 of liquid P-20), and cultivar (Copper Hostess, Iridon, or Tip) on flower longevity, chlorophyll, conductance, and pH.

Variable	Longevity	Chlorophyll	Conductance	pH
Cultivar	**	**	NS	**
Media	**	NS	**	*
Concn	**	NS	**	**
Cultivar × media	NS	NS	NS	NS
Media × concn	*	NS	NS	NS
Cultivar × concn	*	NS	NS	*
Cultivar × concn × media	NS	NS	NS	NS

*,**,NSSignificant at $P = 0.05$ or 0.01 or nonsignificant, respectively.

conductance as affected by the high cation exchange capacity of Vergro Klay Mix compared to the other media (J.N. Joiner and T.A. Nell, unpublished data). A decrease in longevity was observed (data pooled over all media types) as N concentration was increased from 1.3 to 2.6 kg N/m^3 for 'Tip'. How-ever, 'Copper Hostess' and 'Iridon' showed no response to N concentration alone (Fig. lB).

A significant decrease in medium pH was observed for 'Copper Hostess' and 'Tip' as N concentration increased for all media tested (Fig. 2); however, N concentration had no effect on pH in 'Iridon' grown in any of the media types.

Medium type alone had an effect on pH and conductance (Fig. 3). Vergro Klay Mix had lower conductance and pH levels than Metro Mix 350 and the peat-perlite-sand mixture. Conductance generally increased as N concentration increased (Fig. 4). Chlorophyll was only affected by cultivar. Chlorophyll levels for 'Copper Hostess', 'Iridon', and 'Tip' were 9.9, 8.9, and, 8.2 mg·liter^{-1}, respectively.

Numerous factors affect the longevity of potted chrysanthemums. Fertilization practices appear to have a significant effect on the longevity of a variety of flowering potted plants and foliage plants. Our work demonstrates the importance of the interactive effects of medium, fertilizer, and cultivar on chrysanthemum longevity. In previous work, Boodley et al. (1983) showed that longevity was affected by medium and cultivar, but plants were fertilized the same regardless of the medium. The effects of N concentration in our studies with chrysanthemum and on other crops (Harbaugh and Waters, 1982; Nell et al., 1989; Scott et al., 1984) have demonstrated the potential longevity problems that may occur with high fertilizer levels. The present studies indicate the mediating effect of the growing medium on longevity at high N concentrations. Conductance increased in all media with increased N concentration. High conductance may be the primary factor associated with decreased longevity by indirectly damaging the root system and thus limiting water uptake once plants are placed under interior conditions. Previous results have demonstrated that terminating fertilization 3 weeks before flowering increased chrysanthemum longevity, possibly due to a reduction in conductance (Nell et al,, 1989). The soil physical and chemical characteristics that contribute to increased longevity are not clear and require further investigation. These data show that there is no absolute conductance at which longevity decreases, since it depends on the growing medium. However, it appears that longevity can be extended by modifying the fertilization program to complement the medium.

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