Growth of Coreopis and *Plumbago in* Plastic and $Cu(OH)_2$-Impregnated Fiber Containers

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Summary. A study was conducted with *Coreopsis verticillata* L. 'Moonbeam' and *Plumbago auriculata* Lam. to evaluate the growth of these perennial plants in 2.6-liter (#1) black plastic containers (BPCs) compared to plants grown in fiber containers with $Cu(OH)_2$(FCs+) impregnated into the container walls. *Coreopsis* root and shoot dry weight was unaffected by container type, whereas *Plumbago* root and shoot dry weight was greater (2.2x and 1.6x, respectively) for plants grown in FCs+ compared to BPCs. The root : shoot ratio of *Plumbago* increased 30% when plants were grown in FCs+ compared to BPCs. Root circling was effectively controlled for both species grown in the FCs+. FCs remained in salable condition for the duration of the study. In contrast to untreated FCs, FCs+ will have to be removed at transplanting to allow for normal root development.

With current concerns regarding recycling plastic containers, using biodegradable containers in nurseries and garden centers is increasing (Roberts, 1993). Some advantages of biodegradable fiber containers are increased insulation against heat and cold, increased porosity for better root development, and that the containers are plantable and compostable. The primary limitation in the use of fiber containers has been their lack of longevity, which may only be 2 months in the southeastern United States (J. Ruter, unpublished data).

Using copper-containing compounds to extend container longevity and improve root development is limited (Appleton, 1993; Struve et al., 1987) because the manufacturing technology is new, and $Cu(OH)_2$ has only recently received EPA approval. Copper-containing materials prevent root circling in containers, inhibit root elongation, increase root branching, and may influence the root : shoot ratio of woody and herbaceous species (Arnold and Struve, 1989; Beeson and Newton, 1992; Krieg and Witte, 1993; Struve and Rhodus, 1990; Struve et al., 1994).

Spin Out (Griffin Corp., Valdosta, Ga.) is a new root growth regulator, containing 100 g $Cu(OH)_2$/liter in latex paint, which has effectively reduced root circling on several container-grown landscape plants (Beeson and Newton, 1992; Krieg and Witte, 1993; Struve and Rhodus, 1990; Struve et al., 1994). This study compared the growth of two perennial landscape plants that typically develop good (coreopsis) or poor (cape plumbago) root systems in blackplastic containers to plants grown in $Cu(OH)_2$-impregnated fiber containers.

Materials and methods

The experiment was conducted outdoors under full sun at Wight Nurseries in Cairo, Ga. Uniform liners (9 cm high) of *Coreopsis verticillata* 'Moonbeam' and *Plumbago auriculata* were transplanted into containers on June 23, 1992. Black plastic containers (BPCs) had a height of 16 cm, atop width of 16 cm, a bottom width of 13 cm, and a volume of 2.6 liters. The fiber containers (FCs) (height = 18 cm, top width = 18 cm, bottom width = 14 cm. volume = 3.6 liters) were manufactured by Keiding, Inc. (Milwaukee). FCs+ were impregnated with about 3000 $\mu g \cdot g^{-1}$ $Cu(OH)_2$ within the container walls as determined by inductively coupled plasma emission spectroscopy.

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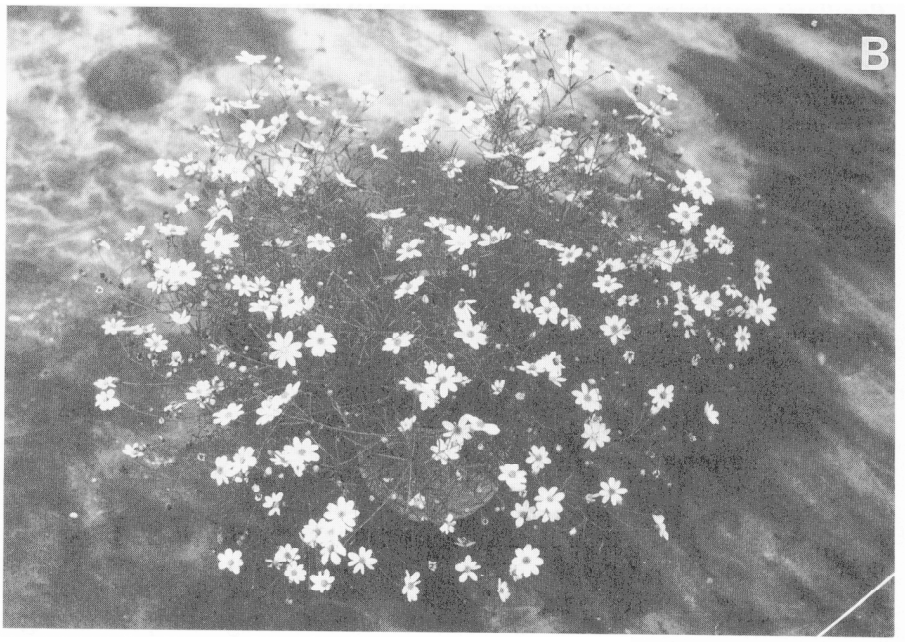

Fig. 1. Coreopsis verticillata *'Moonbeam 'grown in black plastic (A)* and *$Cu(OH)_2$-impregnated fiber containers (B). Note differences in foliage density.*

Containers of each type were filled with 2.6 1 of medium consisting of milled pine bark and sand (19:1 by volume). Overhead fertigation (1.3 cm) with 125 mg N/liter from 12.5N–1.4P–8.0K (+ micronutrients, Big Bend Agri-Supply, Cairo, Ga.) was applied daily. The experiment design was randomized complete blocks with eight single-plant replicates.

The Coreopsis were harvested on 21 Aug. 1992 because plants required pruning to remain marketable. *Plumbago* was harvested on 22 Sept. 1992. Measurements at the termination of the study included- growth index [(height + width 1 + width 2 (perpendicular to width 1))/3] and shoot and root dry weight. Data for all growth parameters were evaluated by analysis of variance using SAS (SAS Inst., Cary, N.C.). Means were compared by LSD.

Results and discussion

Container type had no effect on height, shoot dry weight, root dry weight, total biomass or root : shoot ratio of Coreopsis (data not shown). However, the growth indices for BPC Coreopsis were 21% larger than FC+ plants (data not shown). The increased growth indices for BPC plants with no differences in shoot dry weight can be explained by sparse and open BPC foliage compared to FC+ plants (Fig. 1).

All growth parameters except growth index were influenced by container type for *Plumbago* (Table 1). For height, root dry weight, and root : shoot ratio, plants grown in FCs+ were greater compared to BPCs. Root dryweight of *Plumbago* grown in FCs+ was 123% greater than in BPCs. Shoot dry weight and total biomass increased by 59% and 74% in FCs+, respectively, compared to BPCs. Root: shoot ratio increased 30% for *Plumbago* grown in FCs+ compared to BPCs (Table 1).

No root circling was observed for both species grown in FCs+. Root circling was noticed for both species grown in BPCs. Removal of plants from FCs+ was easy since root growth was inhibited by $Cu(OH)_2$.

FCs are broken down by bacteria and other microorganisms in potting media and soil (Jim Gehl, personal communication). The $Cu(OH)_2$ in the walls of the FCs+ may have decreased microbial activity thereby increasing the longevity of the FCs+. With FCs+, plants need to be removed from the

Table 1. *Effects of* container designs on the *shoot and root growtb of* Plumbago auriculata.

Container design[z]	Ht (cm)	Growth index[y]	Shoot dry wt (g)	Root dry wt (g)	Plant biomass (g)	Root : shoot ratio
BPC	32.5	38.1	21.5	6.7	28.2	0.32
FC+	42.9	45.2	34.1	15.0	49.1	0.45
Pr > F[x]	*	NS	*	**	*	**
LSD	9.2		11.5	3.2	14.4	0.07

[z]*Container design: black plastic container (BPC), fiber container+ $Cu(OH)_2$(FC+).*
[y]*Growth index. [(height + width 1 + width 2)/3].*
[x]*NS,*,**Nonsignificant or significant at* P 0.05 *or 0.01, respectively. Mean separation by LSD (n = 8).*

container at planting so normal root development and landscape establishment occurs. In this respect, FCs+ are a disadvantage compared to traditional fiber containers, which are plantable.

Plumbago was more responsive to container design than *Coreopsis.* While *Coreopsis* grown in FCs had smaller growth indices compared to those grown in BPCs, this was an advantage since plants in the FCs were more compact with the same shoot dry weight, and thus increased salability. Root : shoot ratio of *Plumbago* increased for plants in FCs+ due to an increase in root dry weight. Prevention of root circling is an added benefit when using FCs+. Results of this research indicate that FCs treated with $Cu(OH)_2$ have the potential to produce higher-quality plants with improved root systems when used on short-term crops such as perennials.

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