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Cotton Gin Trash Compost as Growing Medium Ingredient for the Production of Pot Ornamentals

Kompostierte Abfallprodukte aus Entkörnungsbetrieben als Bestandteil von Substraten für die Zimmerpflanzenkultur

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Summary

Rooted cuttings of *Euphorbia pulcherrima* cv. 'Peterstar white', *Codiaeum variegatum* var. *pictum*, *Syngonium podophyllum* and *Ficus benjamina* were grown for 6 to 10 months depending on the species in media containing cotton gin trash compost, peat and perlite in various ratios, and their vegetative growth, root growth and flowering where appropriate was determined. As control was used the medium 1 peat : 1 perlite (by volume).

Replacement of 60% of the peat of the control by CGC induced one-week earlier bract colouring and flowering and a small reduction of plant height in *E. pulcherrima*, while in *C. variegatum* var. *pictum* foliage development was similar to the control and in *S. podophyllum* was increased. In *F. benjamina*, although plant height and number and length of lateral shoots were similar in all media tested, the foliage fresh weight was reduced in media with CGC, and this was attributed to the decrease in stem diameter measured.

There was an indication that CGC reduced dry weight of the roots in all species, but this reduction was found statistically significant in *E. pulcherrima* and *F. benjamina*; in the latter the main roots were observed to be much thinner in CGC media.

Zusammenfassung

Bewurzelte Stecklinge von *Euphorbia pulcherrima* cv. 'Peterstar white', *Codiaeum variegatum* var. *pictum*, *Syngonium podophyllum* und *Ficus benjamina* wurden je nach Art in einem Zeitraum von 6 bis 10 Monaten in kompostierten Abfallprodukten der Entkörnungsbetriebe (CGC), Torf (T) und Perlite (P) kultiviert und das Wachstum, die Entwicklung des Wurzelsystems und für *E. pulcherrima* zusätzlich das Blühen untersucht. Als Kontrollsubstrat wurde ein Gemisch aus Torf:Perlite (1:1 per Volumen) verwendet.

Ein Ersatz des Torfs um 60% durch kompostierte Bestandteile führte bei *E. pulcherrima* zu einer um eine Woche früheren Färbung der Tragblätter und Beginn der Blüte sowie zu einer geringen Reduktion der Pflanzenhöhe. Außerdem wurde festgestellt, daß dieser Ersatz im Vergleich zu den Kontrollpflanzen bei *C. variegatum* keinen Einfluß auf die Laubentwicklung hatte, während bei *S. podophyllum* eine Steigerung des Wachstums stattfand.

Obwohl bei *F. benjamina* sowohl die Pflanzenhöhe, als auch die Anzahl und die Länge der Seitensprosse bei allen untersuchten Substraten ähnlich waren, war das Blatt-Frischgewicht bei Substraten mit CGC geringer, was auf den geringeren Durchmesser des Hauptsprosses zurückzuführen ist.

Es wurde festgestellt, daß das Trockengewicht der Wurzeln bei allen Pflanzenarten in Substraten mit CGC kleiner war; dieser Verringerung war bei *E. pulcherrima* und *F. benjamina* statistisch signifikant, wobei bei letzterer die Zentralwurzeln in diesen Substraten sehr viel dünner waren als bei den Kontrollpflanzen.

Introduction

Large quantities of cotton gin trash is produced annually that has to be disposed in a friendly to the environment way. Compost made of this waste material has been tested as soil amendment in the field on greenbean culture (HILEMAN and MORELOCK 1982), in pot mixes with soil on tomato culture (PESSARAKLI and TUCKER 1984), and in a pot mix with peat and vermiculite on a number of house plants (PARNELL et al. 1980) with promising results.

Most of the pot ornamentals are grown in soilless substrates that usually contain peat moss. Peat is widely preferred, for all its high price, because of its high water-holding and cation exchange capacity and its high porosity. Cotton gin trash compost (CGC) has all the above characteristics, as well, as a remarkable suppressive effect on the soil fungus *Rhizoctonia solani* (BALIS et al. 1994). At the maturity it was found to contain 86.8 NH_4-N, 37.6 NO_3-N, 61200 Ca, 14900 Mg, 24100 K, 5600 Na and 4500 P, ppm over dry weight, or 7 NH_4-N, 5.3 NO_3-N, 424 Ca, 269.7 Mg, 3235 K, 225 Na and 30 P, ppm in 1:3 volume water extract (BALIS et al. 1994). However CGC has the problem of high pH and electrical conductance (EC) that makes it toxic to the plants if used in high ratios in the growing mix (BALIS et al. 1994, TSATIRIS et al. 1998).

Target of the present study was to determine the amount of peat that could be replaced by CGC, in the commonly used in pot ornamentals commercial culture 1 peat:1 perlite (by volume) medium. Physical and chemical properties of the media tested were also defined. The flowering pot plant *Euphorbia pulcherrima* (Poinsettia) and three foliage pot plants *Codiaeum variegatum* var. *pictum* (Croton), *Syngonium podophyllum* (Goose foot plant) and *Ficus benjamina* (Weeping fig), which are all species of high commercial value, were employed as test plants.

Materials and Methods

Having as control the medium 1 peat:1 perlite (by volume), two media with peat moss (T), CGC and perlite (P) were tested, that were 1T:1CGC:2P and 1T:1.5CGC:2.5P (by volume). The pH of the 1T:1CGC:1P and 1T:1.5CGC:2.5P media was found 5.9 and 6.3, respectively; and the pH of the 1T:1P one was adjusted to 5.6 by lime stone. The peat used was sphagnum moss peat with pH 3.4–3.7 by HIGHMOOR, and the perlite by PERLOFLOR. The CGC[3] was made as described by BALIS et al. (1994).

Rooted terminal cuttings of *Euphorbia pulcherrima* cv. 'Peterstar white', *Codiaeum variegatum* var. *pictum*, *Syngonium podophyllum* and *Ficus benjamina* were obtained from a commercial source and potted in 14 cm black plastic pots (one plant per pot) in the three growing media, on 15 July 1999. One week later and up to the end of the experiment the plants were fed weekly with the water-soluble fertilizer 20N-19P-19K (2 g/l), except *E. pulcherrima* in which fertilization stopped when colour appeared in the bracts (1st week of November). The plants were grown in a heated glasshouse and were irrigated to insure adequate leaching from the pot, with frequency depending on weather conditions, plant species and plant age; plants never showed any symptoms of water stress. All experiments were terminated in February 2000.

From transplanting to the end of the experiments the length of the main shoot (plant height) from pot rim to the upper visible node (in all species), as well, as the number and length of lateral shoots developed (in all species except *C. variegatum* var. *pictum*) and the number of leaves (in *C. variegatum var. pictum and S. podophyllum*) were recorded monthly. In *E. pulcherrima* was also recorded the number of bracts on 22 November and end of February, the node where the 1st bract was initiated (counted from plant base), as well, as the date of bract colouring (50% of the treatment plants showed colour in the bracts) and the date of flowering (50% of the treatment plants showed anthers in one or two cyathia). At the end of each experiment the fresh weight of the foliage (from plant base), except in *E. pulcherrima*, and the dry weight of the roots was measured. In each treatment 12 plants of each plant species were used. For fresh and dry weight measurements 11 plants per treatment of each plant species were used, except in *E. pulcherrima* where seven plants were used.

The physical characteristics of the growing media were determined by Richards's apparatus (RICHARDS 1949), in three replicates per medium saturated for 48h. Measurements of the pH and the electrical conductance (EC) of the media were done in 1:2.5 and 1:1.5 volume water extracts, respectively, at the beginning and at the end of the experiments; the values presented are average of the four experiments.

In all experiments the completely randomized design was used. The significance of the results was tested by analysis of variance (*F* test) at P 0.05 and the treatments means were compared by the Tukey-Kramer HSD at $P = 0.05$.

Results and Discussion

Replacement of 50% or 60% of peat by CGC in the growing medium of *E. pulcherrima* induced a small reduction of the plant height (Tab. 1). Height of *E. pulcherrima* was previously found to be affected by medium composition (FONTENO et al. 1981, SANDERSON and DRANE 1988). The cultivar Gutbier V-14 Glory grew slightly shorter in media amended with composted cotton burrs (WANG and BLESSINGTON 1990). In media with CGC the first bract was formed two nodes lower on the stem (Tab. 1), indicating that the decrease in plant height was due to a decrease in nodes number and not in internodal spaces length. Plants in all media developed the same number of bracts, but plants grown in media with CGC showed pigmentation in the bracts and flowered one week earlier than those in the control (1st and 2d week of November for bract pigmentation and 1st and 2d week of December for flowering, respectively). Similar effects of compost on bract colouring and flowering of *E. pulcherrima* were obtained by WANG and BLESSINGTON (1990).

The decrease of plant height, with the promotion of early colouring and flowering simultaneously, could be particularly interesting for the production practice of *E. pulcherrima*, as could contribute on the one hand to the reduction of the plant growth retardants, that are routinely employed for height control in commercial cultures of this species, and on the other hand to the decrease of the culture period, and these both could lead to a reduced production cost.

On the contrary to the effect of CGC on plant height of *E. pulcherrima*, in *S. podophyllum* there was an indication that plant height was increased, by partitioning of CGC in the growing medium (Tab. 2), while in *C. variegatum* var. *pictum* and *F. benjamina* was at the same level of the control (Tab. 3, 4). The fresh weight of the foliage was increased in *S. podophyllum* (Tab. 3), while it was decreased in *F. benjamina* (Tab. 4). In the later, the

Tab. 1. Effect of growing medium containing cotton gin trash compost (CGC), peat (T) and perlite (P) on vegetative growth, flowering and root dry weight of *E. pulcherrima*. Mean separation in columns by Tukey-Kramer's HSD at p = 0.05.
Einfluß von Substraten mit kompostierten Abfallprodukten aus Entkörnungsbetrieben (CGC), Torf (T) und Perlite (P) auf das Pflanzenwachstum, das Blühen und das Trockengewicht der Wurzeln von E. pulcherrima. Mittelwertsvergleiche innerhalb der Spalten mit Tukey-Kramer's HSD bei p = 0.05.

Growing medium (ratio by volume)	Plant ht (cm)	Bract number	1st bract node	Root dry wt (g)
1T:1P	100 b	9.8 a	45 b	4.65 b
1T:1CGC:1P	89 a	9.6 a	43 a	3.44 a
1T:1.5CGC:2.5P	91 a	10.8 a	43 a	4.08 ab

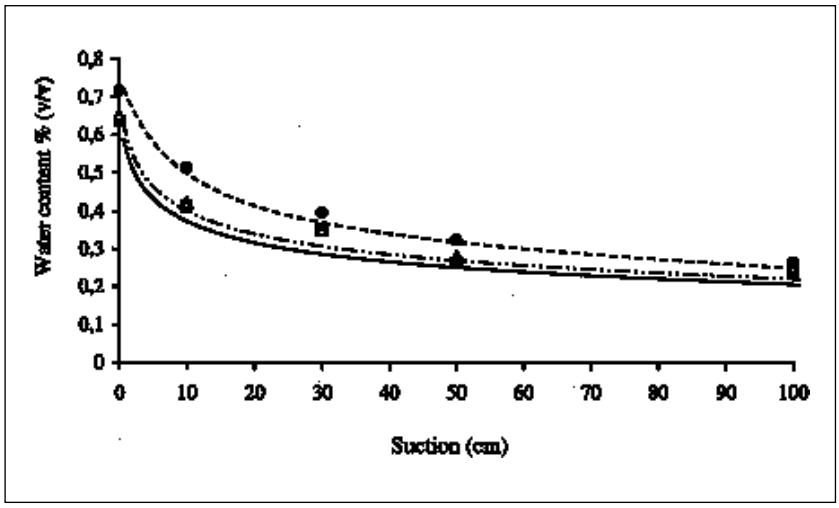


Fig. 1. Water content curves of media containing cotton gin trash compost (CGC), peat (T) and perlite (P) at the suctions shown.
Wasserhaltevermögen der Substrate mit kompostierten Abfallprodukten (CGC), Torf (T) und Perlite (P), bei den angegebenen Saugdrucken.
1T : 1P,
1T : 1CGC : 1P,
1T : 1.5CGC : 2.5P

Tab. 2. Effect of growing medium containing cotton gin trash compost (CGC), peat (T) and perlite (P) on vegetative growth and root dry weight of *C. variegatum* var. *pictum*. Mean separation in columns by Tukey-Kramer's HSD at p=0.05.
Einfluß von Substraten mit kompostierten Abfallprodukten aus Entkörnungsbetrieben (CGC), Torf (T) und Perlite (P) auf das Pflanzenwachstum und das Trockengewicht der Wurzeln von C. variegatum var. pictum. Mittelwertsvergleiche innerhalb der Spalten mit Tukey-Kramer's HSD bei p=0.05.

Growing medium (ratio by volume)	Plant ht (cm)	Leaf number	Foliage fresh wt (g)	Root dry wt (g)
1T : 1P	18 a	24.5 a	118.37 a	4.13 a
1T : 1CGC:1P	20 a	25.0 a	127.81 a	3.40 a
1T : 1.5CGC : 2.5P	19 a	26.5 a	127.47 a	3.48 a

Tab. 3. Effect of growing medium containing cotton gin trash compost (CGC), peat (T) and perlite (P) on vegetative growth and root dry weight of *S. podophyllum*. Mean separation in columns by Tukey-Kramer's HSD at p = 0.05.
Einfluß von Substraten mit kompostierten Abfallprodukten aus Entkörnungsbetrieben (CGC), Torf (T) und Perlite (P) auf das Pflanzenwachstum und das Trockengewicht der Wurzeln von S. podophyllum. Mittelwertsvergleiche innerhalb der Spalten mit Tukey-Kramer's HSD bei p = 0.05.

Growing medium (ratio by volume)	Plant ht (cm)	Leaf number	Foliage fresh wt (g)	Root dry wt (g)
1T:1P	26 a	27.8 a	79.62 a	7.56 a
1T:1CGC:1P	29 ab	29.6 a	88.35 a	7.11 a
1T:1.5CGC:2.5P	33 b	31.0 a	103.46 b	6.27 a

main stem diameter was smaller in media with CGC (Tab. 4). This difference in stem thickness was obvious and could be the reason for the reduced foliage weight measured in plants grown in CGC media.

There was an indication that replacement of part of peat be CGC induced a reduction in dry weight of the roots in all species tested (Tab. 1, 2, 3, 4) but the effect was significant only in *E. pulcherrima* and *F. benjamina*. The root system of all species was more compact in media with compost, while the characteristic thickening of the main roots of *F. benjamina* was strongly prevented in CGC media, resembling the prevention of thickening of the main stem in this species. The reduction in root system volume in media with CGC could be due to the reduced total porosity that these media were found to have in comparison to the control (about 64% v/v in CGC media and 72% v/v in the control). CGC seemed to have higher number of small pores compared to peat, as media with CGC held initially less water than the control, while at 100 cm suction they held water similar to the control (Fig. 1). This might had induced some stress of anaerobic conditions in the roots.

The media with CGC had high EC at the beginning of the culture period (7.7 and 10.1 mS/cm the 1P:1CGC:1P and 1P:1.5CGC:2.5P medium, respectively) compared to the control (0.6 mS/cm), but at the end of the culture period all three media had similar EC (1.2, 1.4, and 1.5 mS/cm, respectively). The tremendous reduction of the EC in CGC media during the culture period indicated that the compost had high content of soluble salts. Similar behavior of EC in potting media with compost has been previously reported

Tab. 4. Effect of growing medium containing cotton gin trash compost (CGC), peat (T) and perlite (P) on vegetative growth and root dry weight of *F. benjamina*. Mean separation in columns by Tukey-Kramer's HSD at p = 0.05.
Einfluß von Substraten mit kompostierten Abfallprodukten aus Entkörnungsbetrieben (CGC), Torf (T) und Perlite (P) auf das Pflanzenwachstum und das Trockengewicht der Wurzeln von F. benjamina. Mittelwertsvergleiche innerhalb der Spalten mit Tukey-Kramer's HSD bei p = 0.05.

Growing medium (ratio by volume) (cm)	Plant ht	Lateral shoot number	Lateral shoot length (cm)	Stem diameter (mm)	Foliage fresh wt (g)	Root dry wt (g)
1T:1P	74 a	20 a	14 a	10.5 b	121.60 b	12.54 b
1T:1CGC:1P	74 a	19 a	15 a	9.2 a	105.78 a	6.45 a
1T:1.5CGC:2.5P	73 a	21 a	13 a	9.3 a	94.36 a	6.46 a

(SIMINIS and MANIOS 1990, WANG and BLESSINGTON 1990). The lack of symptoms on the plant foliage due to the high EC could be attributed to the balanced combination of cations in the mature CGC and the water saturation leaching, as well, as to the low level of Na ions of the compost (BALIS et al. 1994, PASTERNAK 1987), and to the relatively fast reduction of the EC, as the EC of the CGC dropped from 22.6 mS/cm to 2.45 mS/cm after seven applications of 150 ml water per pot, every second day; similarly the EC of the 1P:1CGC:1P and 1P:1.5CGC:2.5P media dropped to 0.77 and 0.79 mS/cm respectively (in pots without plants and fertilization).

As a conclusion, cotton gin trash compost can replace up to 60% (by volume) of peat in a peat-perlite medium with positive effects on the growth of *E. pulcherrima*, *C. variegatum* var. *pictum* and *S. podophyllum*, and with no major problems in *F. benjamina*, adding to the effort of reduction of the production cost, and contributing to the disposal of this agricultural industry waste in a friendly to the environment way.

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