The effect of polyethylene terephtalate (PET) or cellulose polymer (CP) as substrate components on the growth and quality of container and bedding plants

Dr. Claudio C. Pasian
Department of Horticulture and crop Science
The Ohio State University
Columbus, OH 43210

Objective 1

To conduct suitability studies for using PET and CP as components of soilless mixes used in floriculture. This is being achieved by evaluating the quality of several crops grown in substrates containing different substrates prepared with different proportions of PET and CP.

Materials and methods

Experiment I. (Chrysanthemum)

One rooted cutting of the pot chrysanthemum cultivar Coral Charm was planted in a 6 inch diameter standard plastic container using different substrates (treatments):

100% Commercial Mix / 0% PET
50% Commercial Mix / 50% PET
25% Commercial Mix / 75% PET
12% Commercial Mix / 88% PET
0% Commercial Mix / 100% PET

Two commercial mixes were used: MetroMix 360 (MM360) and Fafard 3-B (F3B).

There were 6 replications (plants) per treatment. Plants were randomly distributed on a bench in one of the greenhouse sections of our Department in Columbus, OH. The chrysanthemums were fertigated using a concentration of 200 ppm N of a 20-10-20 Peters water soluble fertilizer. Plants were induced to flower by natural photoperiod (short autumn days).

Experiment II. (geranium and coleous)

Geraniums and coleous rooted cuttings were separately planted, one per 4.5 inches plastic container using different substrates (treatments):

1) 100% Peat/Perlite Mix / 0% PET
2) 75% Peat/Perlite Mix / 25% PET
3) 50% Peat/Perlite Mix / 50% PET
4) 25% Peat/Perlite Mix / 75% PET
5) 0% Peat/Perlite Mix / 100% PET
6) Fafard 3-B commercial Mix

The percent of the different mix components are expressed by volume. The peat/perlite mix was prepared in our greenhouse with the objective of testing a substrate without a fertilizer charge (the fertilizer added to the mix by the manufacturer).

There were 6 replications (plants) per treatment. Plants were randomly distributed on a bench in one of the greenhouse sections of our Department in Columbus, OH. The geranium and coleous were fertigated using a concentration of 150 ppm N of a 15-5-15 Cal Mag Peters water soluble fertilizer.

In addition to visual observations of plants, the following variables were measured:

Chrysanthemums: Dry Weight, Leaf Area, Plant Height

Coleous and Geraniums: Leaf Area, Dry Weight, Consumer Preference

Consumer preference was determined by organizing the plants by treatment and asking a group of 17 Master Gardener volunteers to evaluate them based on their appeal using a scale from 1 to 5 where 1 = “do not like” and 5 = “like it a lot”.

At the end of the experiment, plants were moved into a lab and leaves were individually separated from the plant’s stems. Each leaf was put in a LiCor 3100C Area Meter which added the area of each leaf to yield the total plant leaf area. The leafless stems of each individual plant were then cut at the soil surface and put in a paper bag along with the leaves of each plant. The bag was then located in a drying oven at 75 C for 3 days. After that time, the weight of dry leaves and stems was measured. Plant height was obtained by measuring the distance between the soil surface and the upper most part of the plant.

<u>Experiment III</u>. (begonias)

Begonia rooted cuttings of the cultivar Bayou Rose were separately planted, one per 4.5 inches plastic container using different substrates (treatments):

1) 100% Coconut Coir / 0% PET
2) 75% Coconut Coir / 25% PET
3) 50% Coconut Coir / 50% PET
4) 25% Coconut Coir / 75% PET
5) 0% Coconut Coir / 100% PET
6) 100% Coconut Coir / 0% CP
7) 75% Coconut Coir / 25% CP
8) 50% Coconut Coir / 50% CP
9) 25% Coconut Coir / 75% CP
10) 0% Coconut Coir / 100% CP
11) Fafard 3-B commercial Mix

There were 6 replications (plants) per treatment. Plants were randomly distributed on a bench in one of the greenhouse sections of our Department in Columbus, OH. The begonia plants were fertigated using a concentration of 150 ppm N of a 20-10-20 Peters water soluble fertilizer.

In addition to visual observations of plants, the following variables were measured: Dry Weight and Leaf Area. These two variables were measured using the same methodology described in Experiment I and II.

Statistical analysis

Each variable measured in these experiments as a response PET or CP concentration were analyzed using the general linear model procedure in SAS (SAS Institute, Cary, NC). Mean comparisons by LSD were used to compare PET or CP amended substrates with the standard soilless mixes used as a comparison.

Results

Pest and Disease Problems: No pests or diseases were noted on the geraniums and coleous. Some root rot was noticed on mums and treated with the fungicide Subdue.

<u>*Chrysanthemum*</u>

Plant Growth (Dry Weight, Leaf Area, and Height)

There were no (statistically) significant differences in chrysanthemum dry weight between the MetroMix 360 (MM360) and the Fafard 3-B (F3-B) mixes, without PET (Fig 1). No significant differences in dry weight were found among plants grown in 0, and 50% PET mixes. Plants grown at 88% PET were slightly lighter (smaller) than the other treatments except 100% PET (Fig 1). The difference in size between plants grown in 100% PET and the other treatments seemed to be even larger when plants were younger although measurements were not taken at that stage.

The trend in diminishing dry weight with increasing PET percent (by volume) was significant. It is surprising the large effect of a 12% MM360 or F3-B substrate can have on plant size when mixed with PET. It can be speculated that this is due to the low water retention of PET.

While no consumer evaluations were obtained for mums, it was clear to me that the quality of plants grown in 100% PET was inferior making them un-salable.

A similar picture was obtained when Leaf Areas were analyzed (Fig 2). There were no significant differences in chrysanthemum leaf areas between plants grown in MM360 and F3-B mixes with PET at 50, 75, and 88%. Plants grown in mixes with 88% PET had the smallest leaf areas except the 100% PET which had very reduced leaf areas. These differences can also be attributed to the low water retention of PET.

Only the height of plants grown in 100% PET was significantly different from that of other treatments (Fig 3).

Geranium

No significant differences in geranium dry weight were found between plants grown in Peat/Perlite and Fafard 3-B mixes without PET (Fig 4, Table 4). Larger plants were obtained when 25% by volume of PET was added to the Peat/Perlite mix. Increasing PET in the mix from 25 to 100% reduced dry weight of geranium plants. Plants grown in 100% PET were the smallest.

No significant differences were found between leaf area of plants grown at 0 % or any of the PET mixes. Only plants grown in 100 % PET had leaf areas significantly smaller (Fig 5). For an unidentifiable reason, there was a large variability in plant size in the 50 and 100% PET treatments.

Coleous

Coleous dry weight response to different percentages of PET in the Peat/Perlite mix was not very different from the one observed with geraniums (Fig 6). As with geranium and chrysanthemum, the 25% PET addition to the substrate produced plants that were larger than plants in MM360 and F3B mixes. The difference between 0 and 100% PET was not (statistically) significant.

No significant differences in coleous leaf area as a function of PET percent were found (Fig 7). As with dry weight, there were no significant differences in leaf area among plants grown in 0 or 100% PET. Plants grown in 25% PET were larger than plants grown in 100% PET.

Consumer preference

Consumers did not indicate any difference in their preferences between geranium grown at any percent PET addition except the 100% PET (Fig 8). A similar situation was found with coleous. Plants grown in 0, 25, 50, and 75 % PET were more attractive to consumers than plants grown in 100% PET.

Visual observations

No symptoms of phytotoxicity were observed in leaves, flowers or stems of plants grown with PET either 100% or as an amendment in different proportions. Pictures of plants are presented in Figures 10 – 13.

Roots of plants grown in mixes having 0, 50 and 75% PET were well distributed in the substrate. On the other hand, roots of plants grown in 100% PET had the roots concentrated only in the lower 1/3 to ¼ of the substrate (Figures 14, 15, and 16).

Begonias

Increasing PET concentrations in the coconut coir mixes increased dry weight and leaf area of ‘Bayou Rose’ begonias (Fig 17 and 18). On the other hand, adding CP to the coir mix had no effect on plant dry weight or leaf area (Fig 17 and 18). No significant differences in dry weight were found when adding 75%

PET or growing in plants in 100% PET (Fig 17). The fact that begonia plants grown in 100 PET did so well is surprising because in all previous experiments this treatment produced the least growth. The 75% PET growing mix produced plants that were heavier and with larger leaf areas than the controls (Fig 17 and 18).

Objective 2

To evaluate the viability of using PET as rooting substrate for floriculture crops.

Only preliminary experiments have been conducted for objective 2. Un-rooted cuttings of calibrachoa, geranium, and sweet potato vine were harvested from mature plants and inserted in cubes of PET or Oasis rooting substrate. The cubes were then located on a mist bench. The mist was intermittent and timer controlled: 8 seconds on, 8 minutes off. The mist was off during the night. Observations on rooting were made.

Results

An important problem was noted in this experiment: the PET rooting cubes were made of too low fiber density and were not able to support heavy cuttings such as geraniums. Eventually, all cuttings rooted but its quality was not acceptable. Newer, denser cubes will be available soon and more experiments will be conducted.

Objective 3

To evaluate the viability of using PET as a substrate for growing bedding plants without a container.

Only preliminary experiments have been conducted for objective 3. PET was mixed with common glue and given a cylindrical shape by placing the wet material on a metallic cylinder used as a mold or inside the cells of large plug trays. After 4 days the PET was removed and left to dry on a bench. When dry, rutted cuttings were stuck in the material which was placed on a flat tray on a bench. Plants were fertigated as needed.

Results

At this point, no satisfactory “glue” has been found to bind the PET fibers and keep them in the shape of a container. Experiments with CP will be underway soon.

General Discussion

Based on these results, PET can be used as a component for soilless substrates as long as it is utilized between 25 and 75% by volume. Different plants will respond differently as indicated by the geraniums and coleous results. Before generalization of these results, more experiments using different species and cultivars are recommended.

Data from these experiments were collected on mature plants. It is quite possible that more clear (marked) differences can be found if measurements are taken on younger plants.

When PET is used at a rate of 25% by volume, some plants performed better (dry weight and leaf area) than when grown in the commercial mixes used for comparison.

Growing plants in 100% PET should be avoided despite the fact that begonia plants performed very well in such a substrate. However, this specific experiment was conducted during the winter when evapotranspiration demands are usually low. This experiment will be repeated during the summer.

PET is too fibrous and as a result, mixing it with other components is difficult. Furthermore, the resulting mix is not “flowable” so the mechanical filling of containers is impossible. Experiments with “flowable” PET and CP will be conducted as soon as these new materials become available.

PET has the potential to be used as a rooting medium for cuttings if it can be given the form (shape) of a plug or liner.

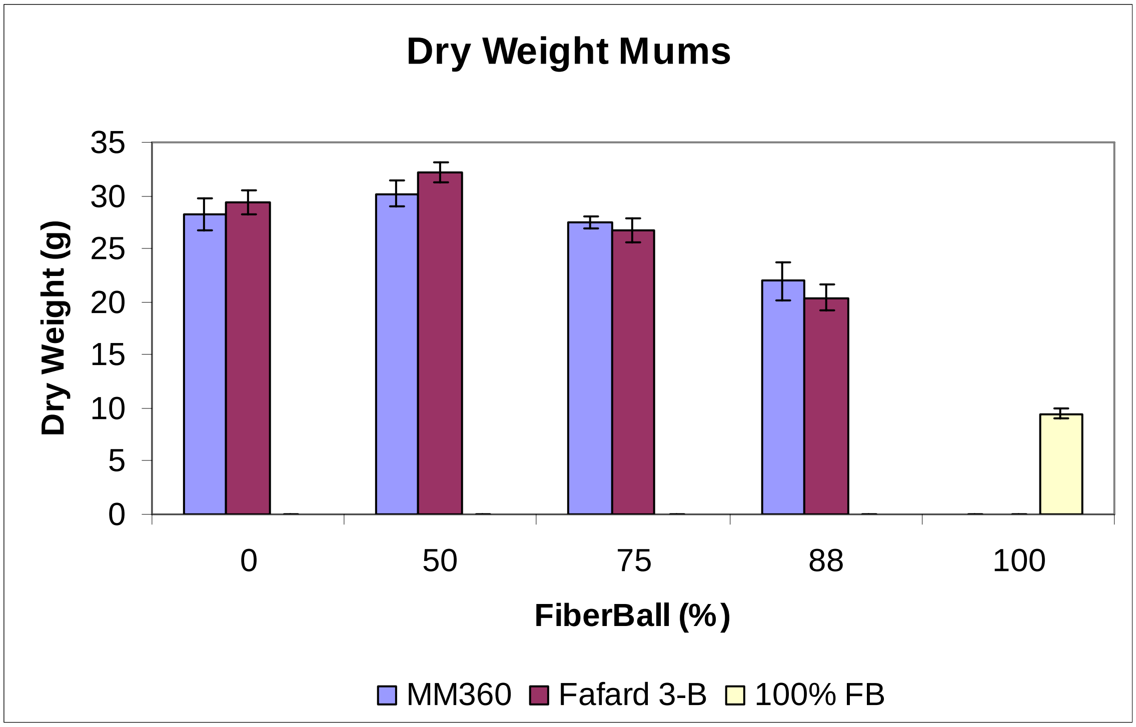


Figure 1. Dry weight (grams) of chrysanthemum plants grown in two commercial mixes: Metro Mix 360 (MM 360) or Fafard 3-B and different proportions of PET (from 0% to 100%). Error bars represent the Standard Error of the mean.

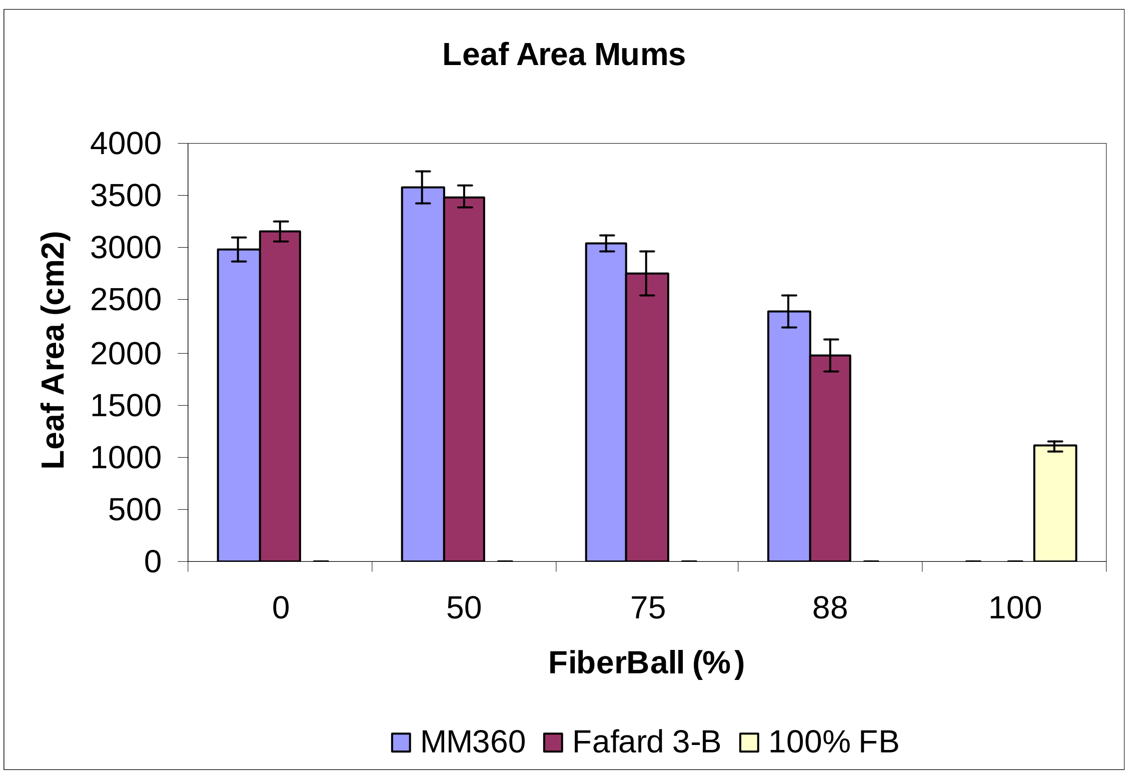


Figure 2. Leaf Area (cm^2) of chrysanthemum plants ± Standard Error grown in two commercial mixes: Metro Mix 360 (MM 360) or Fafard 3-B and different proportions of PET (from 0% to 100%). Error bars represent the Standard Error of the mean.

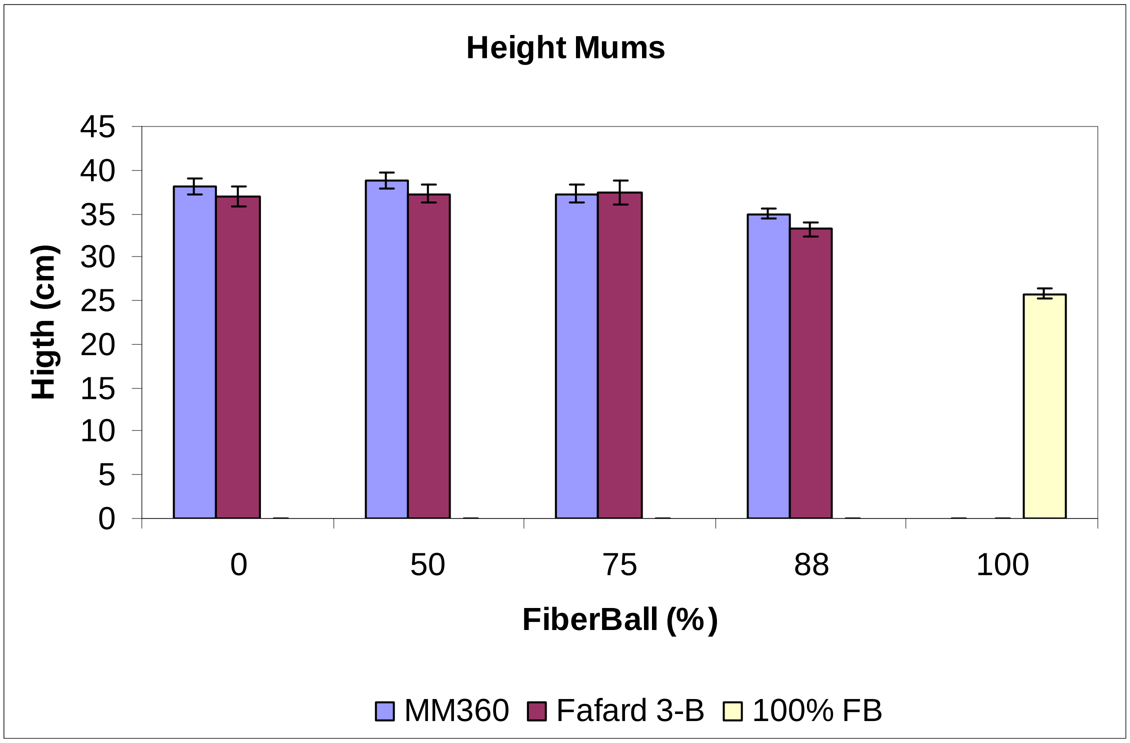


Figure 3. Plant Height (cm) of chrysanthemum plants grown in two commercial mixes: Metro Mix 360 (MM 360) or Fafard 3-B and different proportions of PET (from 0% to 100%). Error bars represent the Standard Error of the mean.

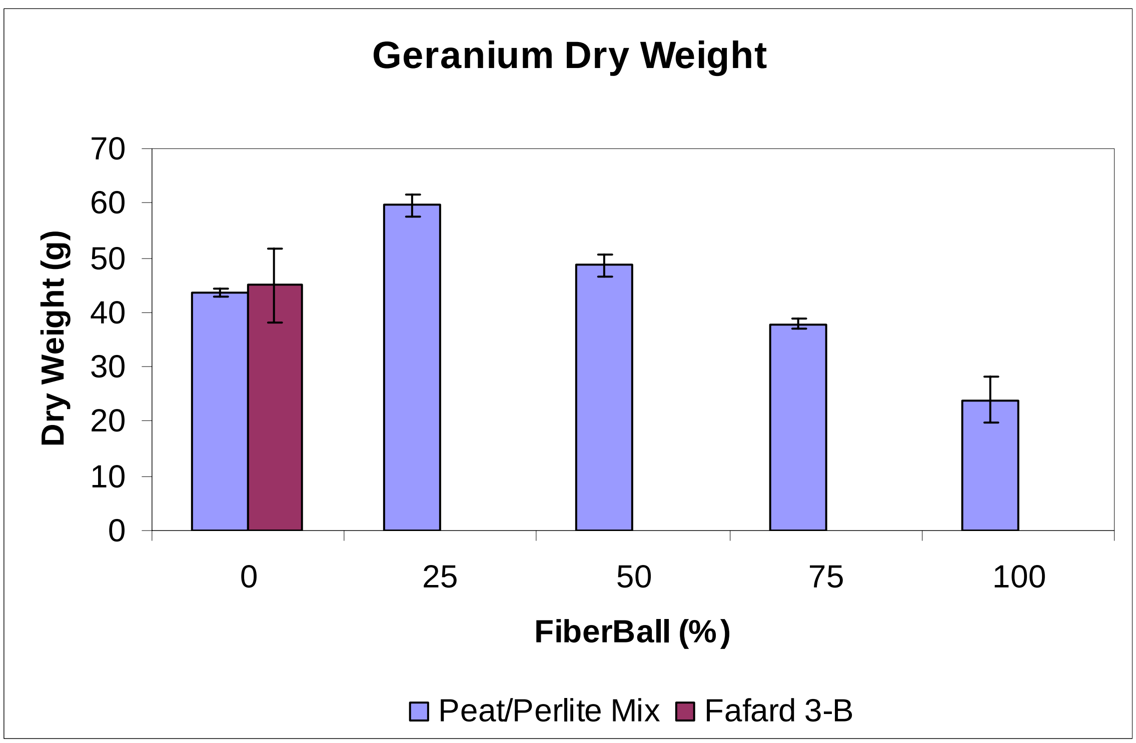


Figure 4. Dry Weight (grams) of geranium plants grown in a Peat/Perlite mix with different proportions of PET (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.

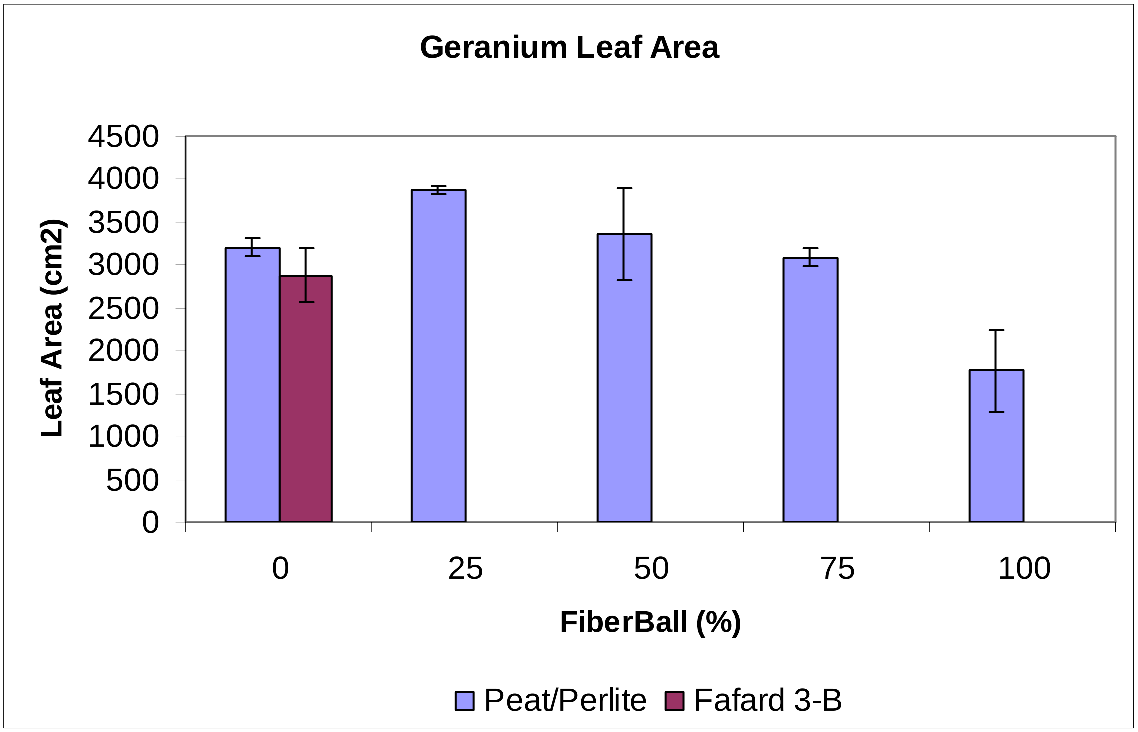


Figure 5. Leaf Area (cm^2) of geranium plants grown in a Peat/Perlite mix with different proportions of PET (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.

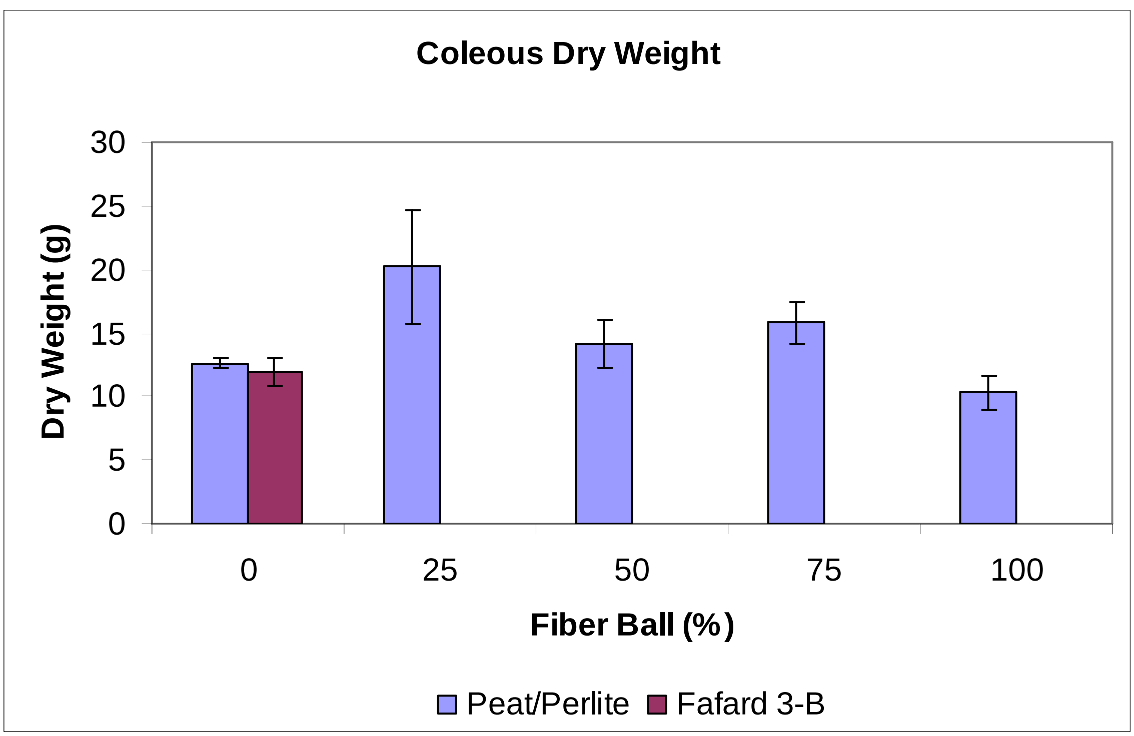


Figure 6. Dry Weight (grams) of coleous plants grown in a Peat/Perlite mix with different proportions of PET (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.

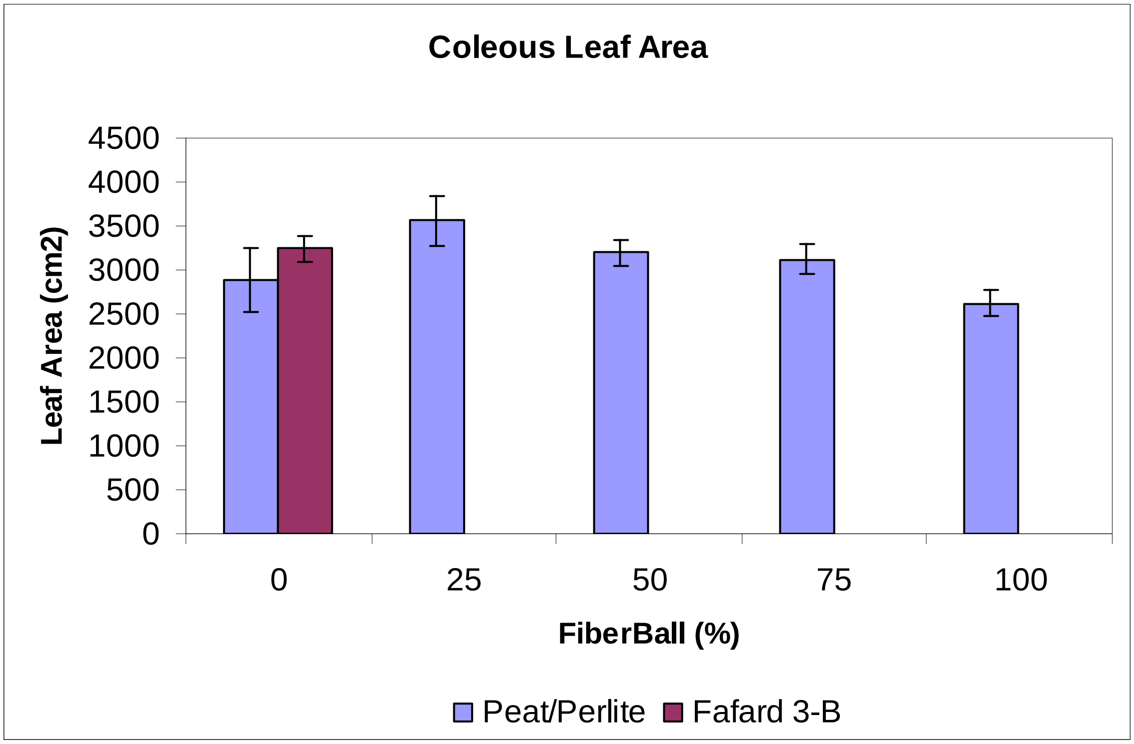


Figure 7. Leaf Area (cm2) of coleous plants grown in a Peat/Perlite mix with different proportions of PET (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.

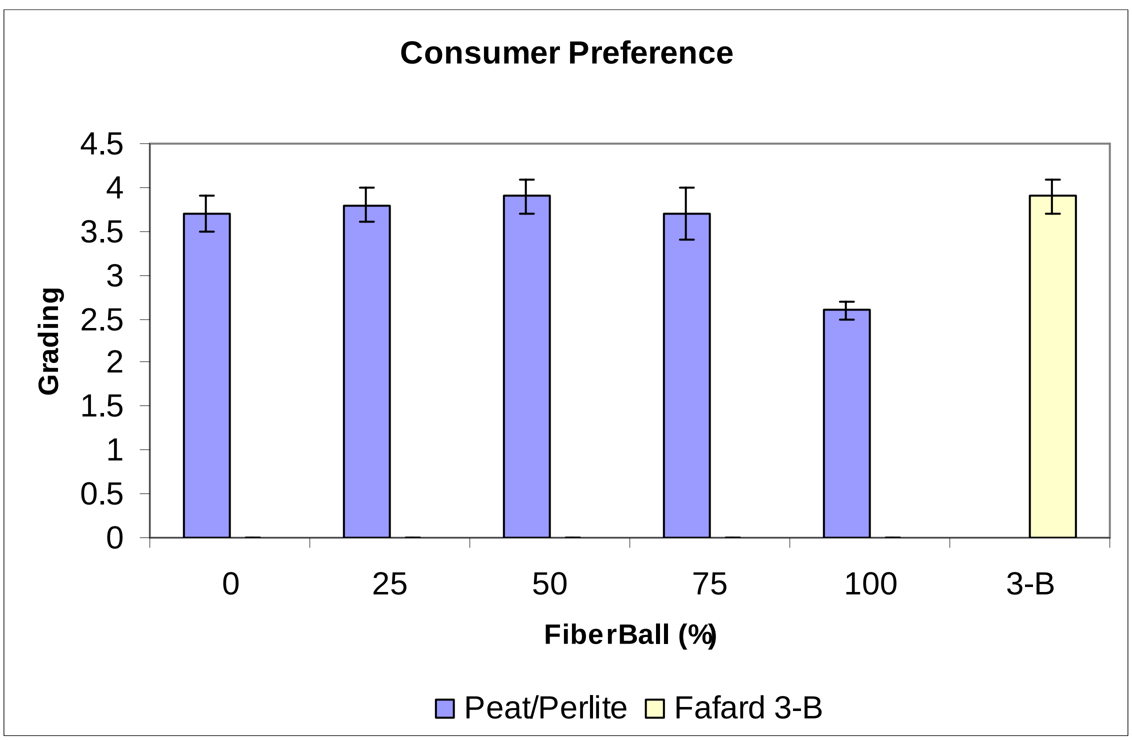


Figure 8. Consumer Preference for geranium plants grown in a Peat/Perlite mix with different proportions of PET (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.

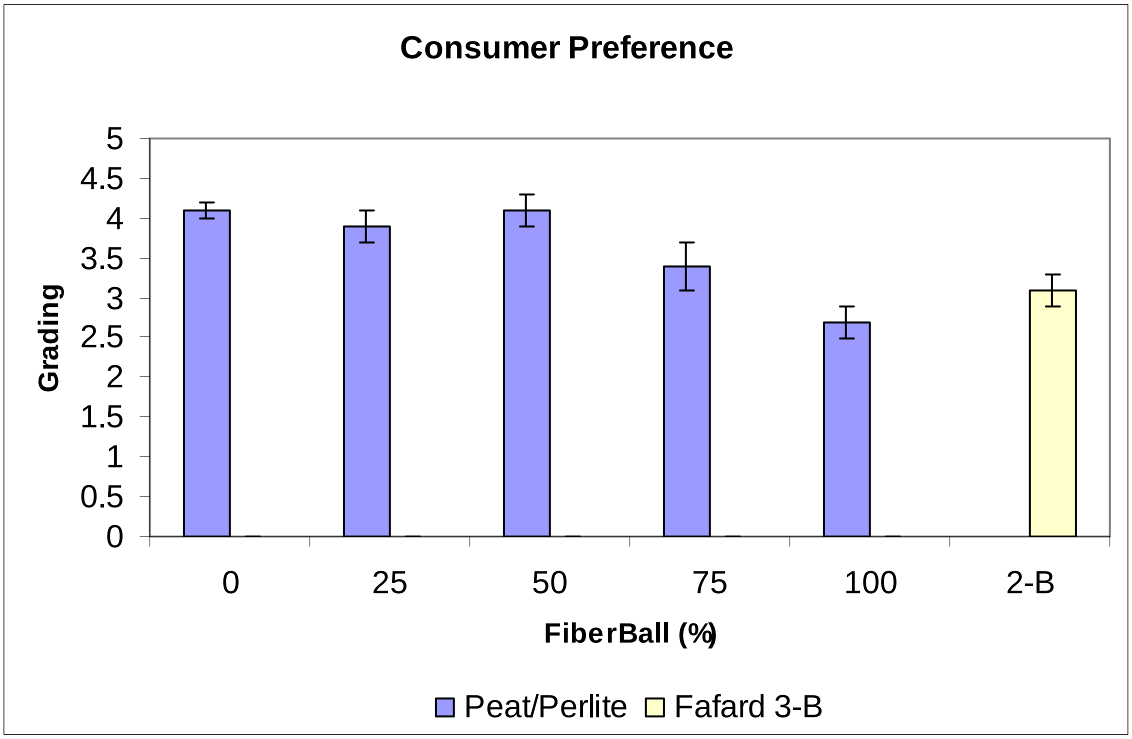


Figure 9. Consumer Preference for coleous plants grown in a Peat/Perlite mix with different proportions of PET (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.

0% FB - 100% Peat/Perlite

Fafard 3-B

25% FB – 75% Peat/Perlite

50% FB – 50% Peat/Perlite

75% FB – 25% Peat Perlite

100 FB – 0% Peat/Perlite

Figure 10. A representative coleous plant from each treatment.

Fafard 3-B

0% FB - 100% Peat/Perlite

25% FB – 75% Peat/Perlite

50% FB – 50% Peat/Perlite

75% FB – 25% Peat Perlite

100% FB – 0% Peat/Perlite

Figure 11. A representative coleous plant from each treatment.

Figure 12. From Left to right: 100% PET – 0% MM360; 88% PET – 12% MM360, 75% PET – 25% MM360, 50% PET – 50% MM360, and 0% PET – 100% MM360.

Figure 13. From Left to right: 100% PET – 0% 3-B; 88% PET – 12% 3-B, 75% PET – 25% 3-B, 50% PET – 50% 3-B, and 0% PET – 100% - 3-B.

Figure 14. Location of the chrysanthemum roots in the 100 PET substrate. Note how roots can be found only at the bottom.

Figure 15. In a substrate composed 100% by MM360, the roots occupy almost all the substrate profile.

Figure 16. A 12% MM360 helps the distribution of roots in the substrate profile.

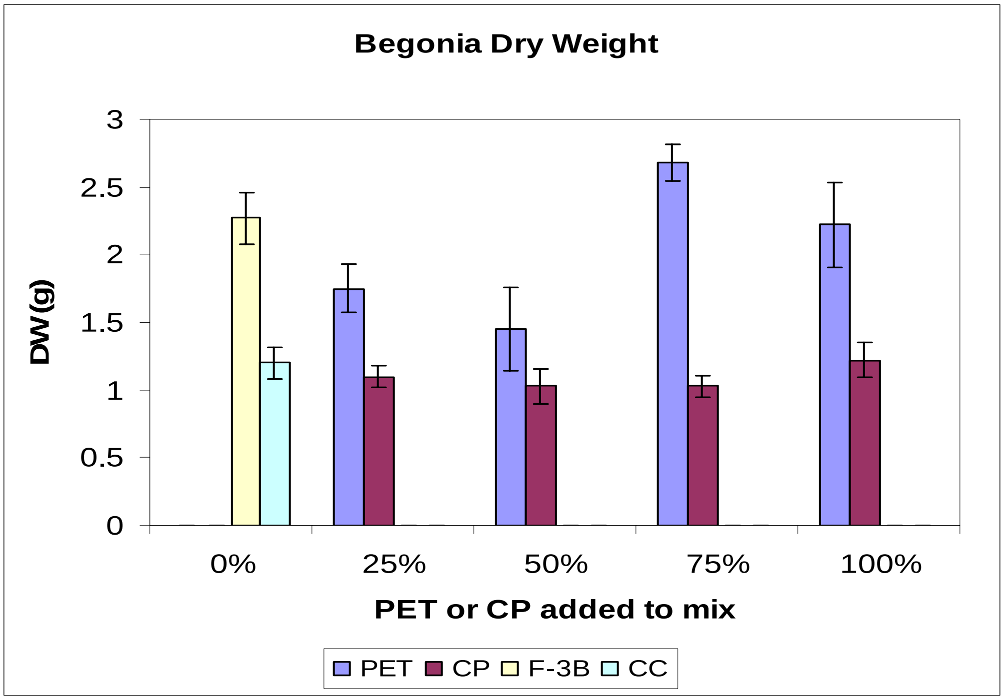
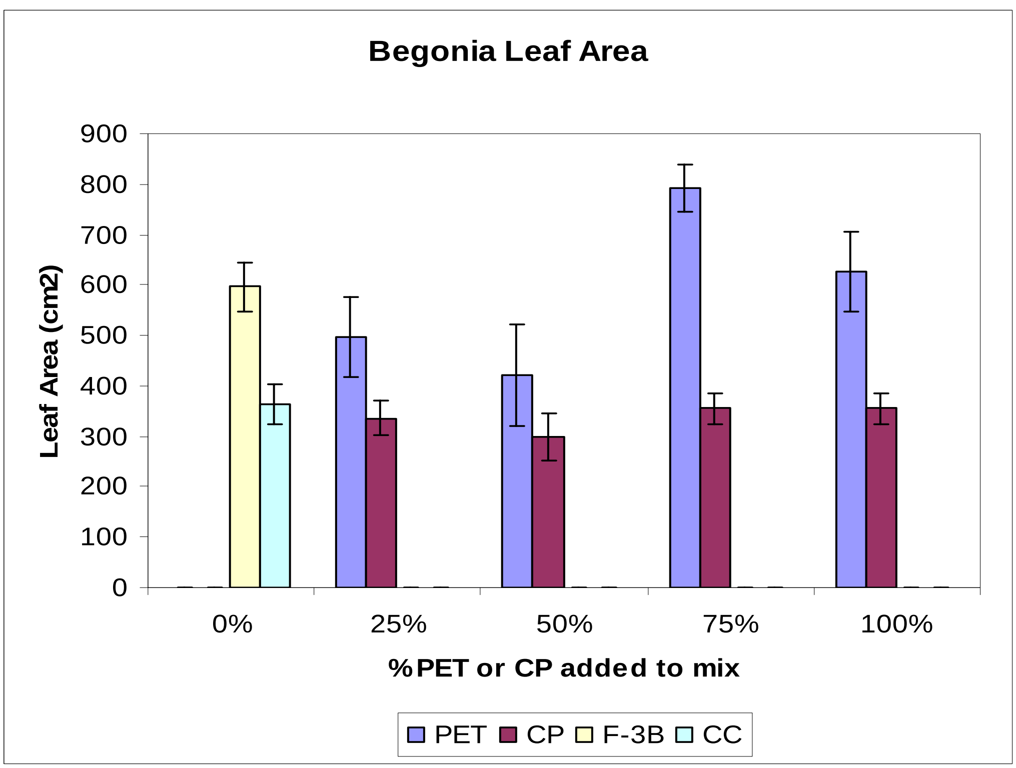


Figure 17. Dry Weight (grams) of coleous plants grown in coconut coir with different proportions of PET or CP (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.



Fiure 18. Leaf Area (cm2) of begonia plants grown in coconut coir mix with different proportions of PET or CP (from 0% to 100%) or in a commercial mix: Fafard 3-B. Error bars represent the Standard Error of the mean.

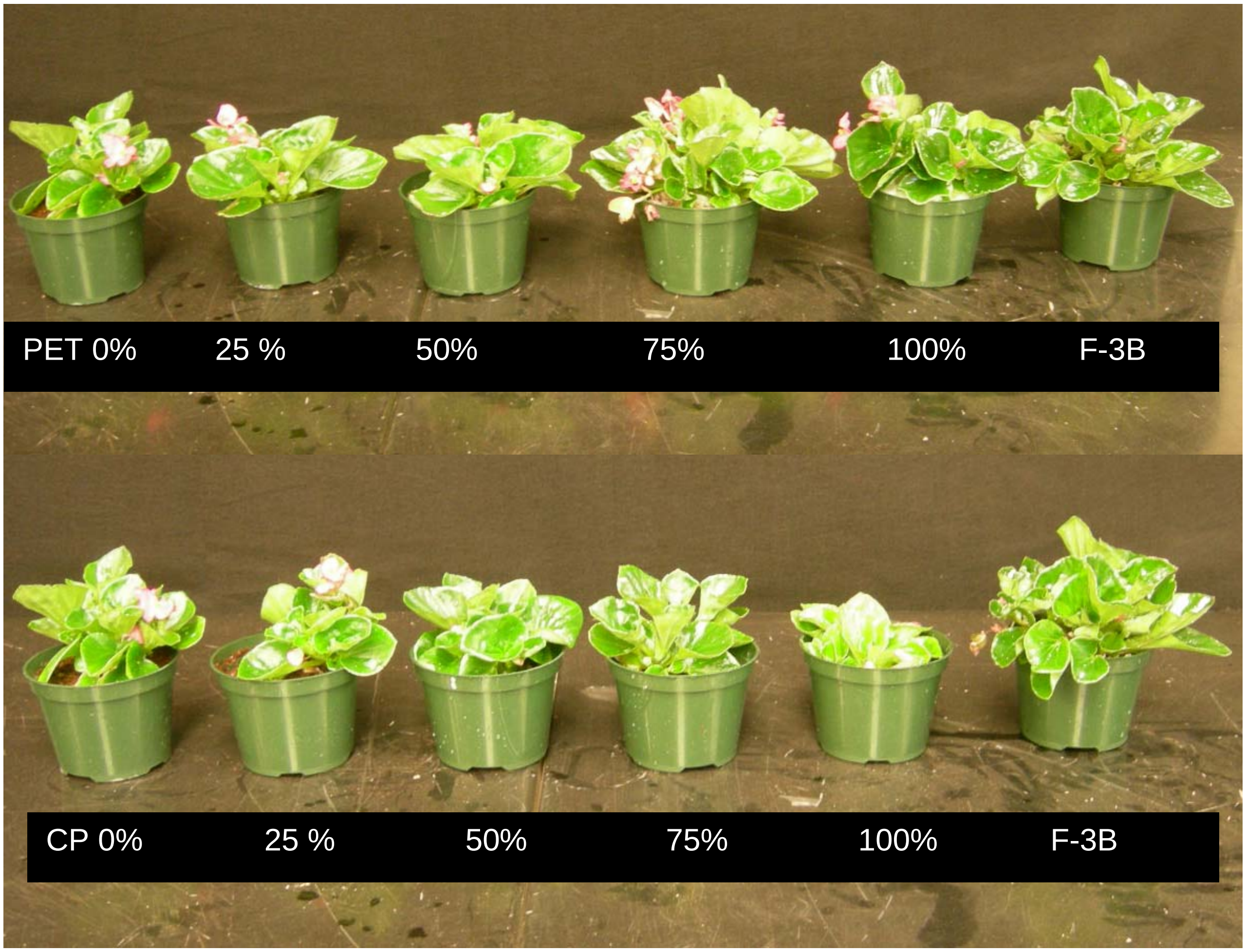


Figure 19. Begonia plants grown in a coconut PET mix (top) and coconut CP mix (bottom).