# Space and Time Efficiency of Different Cutting Types and Transplanting Strategies

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Callused cuttings are an alternative to unrooted cuttings (URCs) for vegetative propagation. Callused cuttings have potential to increase profitability by reducing the crop time. They are also more resistant to dehydration during propagation, resulting in less shrinkage than URCs. Labor, which is an increasing challenge for our industry, can potentially be saved by direct transplant into the final container, and by-passing a rooted liner stage.

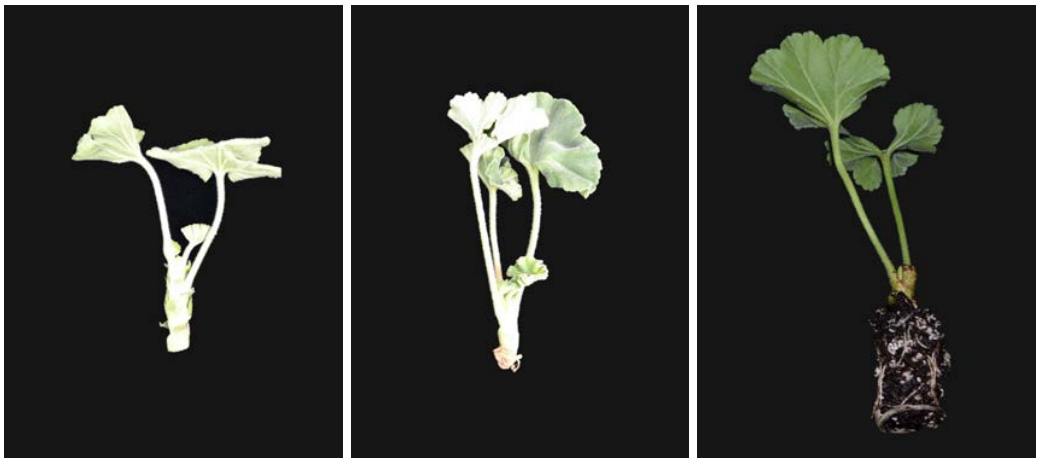
However, there is limited research on the effect of callusing on production time and shrinkage for bedding plants. This information is needed in order to support decisions on when it is most profitable to use unrooted cuttings, callused cuttings, or liners (Figure 1).

In this article, we discuss an experiment run at the University of Florida over two years, collecting information about production time and shrinkage. We investigated two scenarios:

(1) **Liner stage:** Production time and rooting losses (shrinkage) to produce a rooted liner from either unrooted cuttings (URCs) or callused cuttings.

(2) **Finished stage:** Production time and shrinkage to produce a 4-in finished flowering plant from direct transplant of either unrooted cuttings (URCs) or callused cuttings, or transplant of a rooted liner.

**Figure 1. Examples of an unrooted cutting (URC, left), callused cutting (middle), and rooted liner (right) for Pelargonium**



The experiment was carried out at the University of Florida from March to June 2015 and from February to May 2016. A complete list of species and cultivars can be seen in Table 1.

**Table 1. Species and Cultivars in the Trial**

| Species | Cultivar | Year 1 | Year 2 |
|---|---|---|---|
| Bracteantha | Dreamtime Pink | Y | |
| Bracteantha | Dreamtime Red | Y | |
| Bracteantha | Dreamtime Yellow | Y | Y |
| Osteospermum | Serenity Lavender | Y | |
| Osteospermum | Serenity Pink | Y | |
| Osteospermum | Serenity White | | Y |
| Osteospermum | Summertime | Y | |
| Pelargonium | Survivor Dark Red | Y | Y |
| Scaevola | Bondi Blue | Y | Y |
| Scaevola | Scala Blue | | Y |
| Scaevola | Scalora | Y | |
| Scaevola | White | Y | |
| Scaevola | Scalora Topaz Pink | Y | |

Two types of cuttings (callused and unrooted) were received for all varieties. Cuttings were produced in Central America from two suppliers. All species arrived in good conditions and were transplanted within 24 hours using two different sticking strategies: 12 cuttings per type (callused or URC) and variety were directly transplanted into 4-inch (10cm) diameter containers, and 84 cuttings per type per variety were transplanted in 25mm liners (Ellepot brand paper-wrapped pots in propagation trays) for Bracteantha, Scaevola and Osteospermum or 30 mm liners for Pelargonium. Each 84-count tray was cut into four 21-plant sections so that partial trays could be randomly located on the benches. Replicate containers were organized in four blocks (bench areas), with varieties and cutting types randomly located within each block. During propagation, trays and 4-in pots were separated to allow different mist regimes. Liners and finished pots were filled with a 70% peat/ 30% perlite substrate.

The layout of the experiment is shown in Figure 2, with propagation and finished zones. After misting and acclimation in the propagation zone, cuttings were moved to the finishing zone (picture in the right) and spaced at 9-in between pot centers until plants were at a shippable stage. For all URCs except Pelargonium, rooting hormone was applied at 0.1% IBA. Immediately after transplant, Capsil surfactant at 0.3 cc/liter was sprayed on top of the cuttings.

All combinations of cutting type and transplant strategy were tested in a factorial design with replicated trays and pots. For this article, we will focus on

(1) Producing a rooted liner to stage 5 (shown in Figures 3 and 4) from either (a) URC or (b) callused cutting, and

(2) Producing a finished flowering plant (as defined in Table 3) from direct transplanted (a) URC or (b) callused cutting, or (c) from a rooted liner.

**Figure 2: Left (A): Propagation area used to transplant cuttings into liners or direct transplant into 4-in pots, and right (B) Finishing environment for rooted 4-in pots**


Three different growing zones were conditioned: misting, acclimation and growing. Temperature and light conditions for these zones can be seen in Table 2.

**Table 2. Growing conditions in the two greenhouse zones**

| | Year 1 | Year 2 |
|---|---|---|
| Liner Propagation Zone | | |
| Daily air temperature (ºC) | 25.4±2.8 | 23.1±1.6 |
| Daily light integral ($mol \cdot m^{-2} \cdot d^{-1}$) | 9.6±1.4 | 6.7±2.3 |
| Finishing Zone | | |
| Daily air temperature (ºC) | 24.3±3.9 | 21.1±6.9 |
| Daily light integral ($mol \cdot m^{-2} \cdot d^{-1}$) | 22.1±6.7 | 17.8±6.4 |

Callused cuttings in liners were hydrated under mist and then moved off mist in less than 12 hours. These plants remained in the liner propagation zone until transplant into 4-in pots. Unrooted cuttings in liners were removed from mist as soon as they had callus, and also remained in the propagation zone until transplant into 4-in pots. Direct transplant cuttings were similarly started under mist, and moved to the finishing zone when roots were to the edge of the 4-in pot. Rooted liners that were transplanted into 4-in pots were grown without mist in the finished plant zone.

Decisions for moving cuttings and transplanting liners were based on observations taken three times per week. When 80% of liner cuttings had roots to the edge (stage 2), they were moved from propagation to finishing zones. When 90% of liner cuttings were at stage 5, they were transplanted to 10-cm-diameter containers (Figure 3).

**Figure 3. Liner rooting scale (an index value of 0 indicates no roots to edge of cell). Stage 5 (circled) was considered a transplantable liner.**

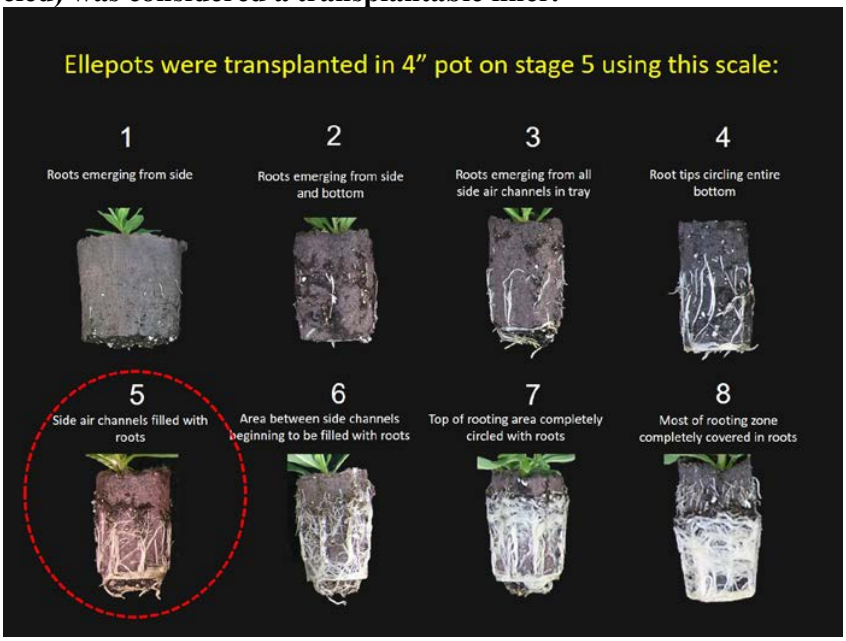



**Figure 4. Liner ready to be transplanted, with side channels from the tray filled with roots (stage 5 in Figure 3).**

**Table 3. Standards used to define a finished 4-in-diameter potted plant**

| Species | Size and Flowering | Representative photo |
|---|---|---|
| **Bracteantha** | Height 9-11”<br>Soil surface covered in foliage<br>Three or more blooms showing color, at least one open |  |
| **Osteospermum** | Height- 8-10”<br>Soil surface covered in foliage<br>Three or more blooms, at least one open | |
| **Scaevola** | Height 7-9”<br>Width 7-9”, foliage past edge of pot with at least three branches<br>At least three open flowers | |
| **Pelargonium** | Height 9-11”<br>Soil surface covered in foliage<br>At least one Inflorescence with at least three open florets | |

## RESULTS

Our trial results are separated into the two production stages (producing a liner, followed by producing a finished plant).

(1) Liner Stage from either URCs or callused cuttings

For the liner stage, all callused cuttings produced a transplant liner more quickly than from a URC. The average reduction time using callused cuttings was seven days. However, there were no differences in finished time between callused cuttings or URC for Scaevola Bondi Blue and Scaevola Scala Blue. We observed limited Scaevola callusing on some received cuttings and conclude that if there is inadequate callusing, there may be no difference between a callused cutting and an URC.

**Table 4. Effect of cutting type on production time and shrinkage when producing a rooted liner. Values in parenthesis the difference in days saved by using a callused cutting compared with a URC. Shrinkage refers to any cutting that did not produce a horticulturally acceptable rooted liner.**

| | | Days to produce a rooted liner | | Shrinkage (loss %) | |
|---|---|---|---|---|---|
| | | URC | Callused | URC | Callused |
| Year 1 | Bracteantha Dreamtime Pink | 36 | 23 (-13) | 25% | 0% |
| Year 1 | Bracteantha Dreamtime Red | 35 | 24 (-11) | 10% | 0% |
| Year 1 | Bracteantha Dreamtime Yellow | 29 | 19 (-10) | 10% | 0% |
| Year 1 | Osteospermum Serenity Lavender | 28 | 21 (-7) | 0% | 0% |
| Year 1 | Osteospermum Serenity Pink | 32 | 20 (-12) | 2% | 0% |
| Year 1 | Osteospermum Summertime | 26 | 20 (-6) | 1% | 0% |
| Year 1 | Pelargonium Survivor Dark Red | 30 | 20 (-10) | 0% | 0% |
| Year 1 | Scaevola Bondi Blue | 28 | 26 (-2) | 0% | 0% |
| Year 1 | Scaevola Scalora | 33 | 30 (-3) | 11% | 0% |
| Year 1 | Scaevola White | 31 | 26 (-5) | 4% | 0% |
| Year 1 | Scaevola Scalora Topaz Pink | 27 | 20 (-7) | 2% | 0% |
| Year 2 | Bracteantha Dreamtime Yellow | 32 | 25 (-7) | 4% | 1% |
| Year 2 | Osteospermum Serenity White | 46 | 32 (-14) | 2% | 4% |
| Year 2 | Scaevola Bondi Blue | 32 | 32 (0) | 1% | 4% |
| Year 2 | Scaevola Scala Blue | 40 | 40 (0) | 0% | 0% |
| Year 2 | Pelargonium Survivor Dark Red | 47 | 40 (-7) | 1% | 2% |
| | **Average** | **32** | **25 (-7)** | **5%** | **1%** |

In 2015, shrinkage was notably lower in callused cuttings compared to URCs. One reason for this can be that the experiment was carried out later in the spring season in 2015 compared with 2016, so cuttings were harvested at the end of the season and propagation temperatures were higher (Table 2). We noted that quality of received cuttings was higher in 2016, when shrinkage was close to zero.

(2) Finished plant stage from URC, callused cutting, or liner

Growers are currently weighing their options and realizing the convenience of using callused cuttings or pre-rooted cuttings to reduce labor in the transplant process and optimize the use of space in greenhouses.

For this trial, although the time to obtain a finished plant was reduced in all cases when using callused cuttings (with the exception of Osteospermum Summertime), the time was still 2 to 5 weeks longer compared to a transplanted liner.

**Table 5. Days from transplanting into a 4-in pot until plants develop into a shippable flowering plant [Order by year and species. Add bottom row averages]**

| | | Liner | URC Direct stick | Callused direct stick | Liner | URC | Callused |
|---|---|---|---|---|---|---|---|
| Year 1 | Bracteantha Dreamtime Pink | 36 | 66 (29) | 51 (15) | 0% | 25% | 0% |
| Year 1 | Bracteantha Dreamtime Red | 27 | 57 (30) | 49 (22) | 0% | 0% | 0% |
| Year 1 | Bracteantha Dreamtime Yellow | 31 | 59 (28) | 50 (19) | 0% | 25% | 0% |
| Year 1 | Osteospermum Serenity Lavender | 47 | 68 (22) | 64 (17) | 0% | 8% | 0% |
| Year 1 | Osteospermum Serenity Pink | 45 | 73 (27) | 68 (23) | 0% | 25% | 0% |
| Year 1 | Osteospermum Summertime | 54 | 68 (14) | 70 (16) | 0% | 17% | 0% |
| Year 1 | Pelargonium Survivor Dark Red | 33 | 60 (26) | 50 (17) | 0% | 0% | 0% |
| Year 1 | Scaevola Bondi Blue | 34 | 60 (27) | 60 (26) | 0% | 17% | 8% |
| Year 1 | Scaevola Scalora | 31 | 71 (40) | 60 (30) | 0% | 8% | 0% |
| Year 1 | Scaevola White | 29 | 61 (32) | 53 (24) | 0% | 17% | 0% |
| Year 1 | Scaevola Scalora Topaz Pink | 31 | 57 (26) | 47 (17) | 0% | 0% | 0% |
| Year 2 | Bracteantha Dreamtime Yellow | 42 | 77 (35) | 69 (27) | 0% | 0% | 0% |
| Year 2 | Osteospermum Serenity White | 41 | 76 (35) | 67 (26) | 0% | 50% | 0% |
| Year 2 | Scaevola Bondi Blue | 27 | 67 (40) | 66 (39) | 0% | 0% | 0% |
| Year 2 | Scaevola Scala Blue | 35 | 68 (33) | 67 (32) | 0% | 0% | 0% |
| Year 2 | Pelargonium Survivor Dark Red | 38 | 72 (34) | 72 (34) | 0% | 0% | 0% |
| | **Average** | **36** | **66 (29)** | **60 (23)** | **0%** | **12%** | **1%** |

## CONCLUSIONS

There was a clear benefit of using callused cutting compared with a URC when producing a liner. Shrinkage was lower in callused cutting along with average reduction time which proves to have many benefits with space and time efficiency. Since our results showed no difference between the Scaevola Bondi Blue and Scaevola Scala Blue, further testing would be needed to see if this was just a result of the shipments received or if these species truly show no difference between cutting types.

Callused cuttings also produced a finished flowering plant more quickly than URCs, and with less shrinkage. However, production time of a finished flowering plant from callused cuttings averaged 3 weeks longer than transplanted liners.

We recommend that you test callused cuttings in your own greenhouse conditions to evaluate rooting time and efficiency. Trial more than one shipment from your cutting supplier to evaluate the consistency of rooting. In the next article, we evaluate the profitability of different types of plant material, considering the price to purchase URC, callused cutting, or rooted liner compared with their production time and shrinkage.

## ACKNOWLEDGEMENTS

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