

# Effect of Planting Hole Size and Amendments on Growth and Establishment of *Acacia farnesiana*

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## Abstract

The objective of this project was to determine whether the size of planting holes and the addition of organic material in the backfill is beneficial for plant establishment and growth during the early years. *Acacia farnesiana* were transplanted from containers into a permanent landscape using four methods: large planting hole with or without amendments or a small planting hole with or without amendments. The study was repeated on two sites. Three years following transplanting, plant growth such as height and caliper were not affected by the planting hole size or amendments, but differed significantly between sites. Plants that received more irrigation and were planted in a less rocky soil had greater caliper and were taller than those supplied with less irrigation and planted on a more rocky soil. Visual observations one and three years after transplanting indicate that trees that were amended with compost in the backfill had the highest incidence of leaning trunks and sinking crowns (20% of trees in study or 37% of those receiving amendments) while of those trees that were not amended only one tree (3%) was leaning three years after transplanting. Hole size at transplanting had no significant effect on leaning or sinking three years after transplanting. These results confirm earlier research across the country that 33% to 50% organic amendment in backfill compared to native soil at transplanting is not beneficial for native trees, but increases the risk of leaning or sinking.

## Introduction

Guidelines for transplanting trees and shrubs have been revised more than ten years ago. The major changes compared to previous recommendations address the size and proportions of the planting hole and amendments in the backfill. Current transplanting guidelines recommend tilling an area three to five times the diameter of the root ball and no deeper than the root ball. A hole should be dug in the center of the tilled area that is only slightly wider and no deeper than the root ball. Circling roots on the outside of the root ball should be cut. The root ball is then placed on undisturbed soil and unamended soil is used for the backfill. The top of the root ball should be level with or slightly above the soil surface.

Although the above guidelines relating to planting hole dimensions and amendments are accepted throughout the country, some nurseries and landscape companies still follow the older practice of digging a planting hole deeper than the root ball and of using organic amendments in the backfill. Research has shown that the root system of trees and shrubs is relatively shallow and wide because of the availability of oxygen and water close to the surface. Roots extend from one and a half time to four times the distance from the trunk to the drip line and are mostly located in

the top 0.6 m of soil. Although deep roots can be found in certain desert species, the root system of most trees and shrubs is shallow and is primarily determined by the properties of the soil in which they grow. The purpose of loosening the soil in a wide planting hole is to minimize resistance that growing roots encounter in compacted soil and to ensure that oxygen and water are readily available in the root zone. The purpose of planting a root ball on undisturbed soil is to prevent the root collar from sinking below the surface when loosened soil settles.

Organic amendments increase the water holding capacity of sandy soils, increase aeration of clay soils, and decrease the potential for compaction. In general, organic amendments decompose to humus and disappear within a short period of time. The shrinking root ball of plants growing in organic media in containers is a common sight. More than 30 studies conducted on a wide variety of soil types found that in most cases organic amendments in the backfill reduced root and shoot growth. Several reasons can cause this reduction in growth. When backfill is amended with organic material, decomposition occurs, the plant settles and the root collar will sink below the soil surface. Adding amendments to the soil creates an additional interface between the organic potting media and the mineral soil. Roots may stay within the amended soil and grow not into the native soil, creating a root bound plant within the amended soil. Incompletely decomposed organic material may require nitrogen for further decomposition and may compete with plant roots for minerals, thereby resulting in reduced growth.

Although the evidence of previous research suggests that large wide planting holes and no amendments in the backfill were most beneficial to plant establishment and growth after transplanting, the majority of research has been conducted in mesic climates. A study was initiated in the semi-arid Southwest using a common landscape to determine whether the size of planting holes and the addition of organic material in the backfill is beneficial for plant establishment and growth during the early years.

## Materials and Methods

*Acacia farnesiana* were transplanted from 15 gal. containers using one of the following four treatments. The planting hole sizes was either a small hole that could accommodate the rootball, dug to a depth of the rootball, and slightly wider at the top, or a planting hole three to five times the width and the same depth of the rootball. Dimensions of the transplanted rootballs were 0.36 m in diameter and height. The general size of the small hole was 0.52 m wide and 0.36 m deep. Large holes were 1.37 m to 1.52 m wide and 0.36 m deep. The unamended backfill treatment consisted of soil from the planting hole. Amended backfill treatments consisted of 50% compost (1.9 cm screened) and 50% soil for the small planting hole, and 33% compost and 66% soil for the large planting hole.

| <u>Treatment</u> | <u>Planting hole size</u> | <u>Backfill</u> |
|------------------|---------------------------|-----------------|
| 1.               | Small                     | amended         |
| 2.               | Small                     | unamended       |
| 3.               | Large                     | amended         |
| 4.               | Large                     | unamended       |

The project is located in southeast Tucson and is part of a streetscape that was installed in 2001. The west planting consists of eight replications of each treatment and has better soil quality with fewer rocks than the east planting, which replicates each treatment with eight trees as well. Plants for the west and east planting were transplanted at the beginning of June and in mid July 2001. Drip irrigation with two emitters per tree was installed. Lower branches of experimental trees were pruned back to a length of 15 to 30 cm and double leaders or damaged branches were removed in fall 2001 and summer 2002.

Plant height and stem caliper at 20, 70, and 120 cm above the soil line were measured in August 2001, and caliper measurements were taken again in February 2002 and August 2002. Caliper was measured at three levels above the ground to determine growth and taper. Taper was calculated by subtracting the upper caliper at 120 cm from the lower caliper at 20 cm and dividing it by the distance between the two measurements. Final height and caliper measurements were taken in October 2004. All data were subjected to analysis of variance. Observations at each measurement date also included general health and appearance of trees, for example if foliage was sparse, trees were leaning, or root collars were sunken.

## Results and Discussion

### *Tree Growth 2001-2002*

Plant height in August 2001 was greater for trees from the west planting with an average height of 2.2 m compared to trees from the east planting at 1.7 m. This difference may result from trees in the west planting being planted earlier and being provided with irrigation, while plants for the east planting were held six weeks longer in the 15-gal. containers. We are not certain what level of irrigation the trees in containers received during this holding period when evaporative demand was high and daytime temperatures exceeded 38°C.

In August 2001, calipers at all three levels were greater for trees at the west planting compared to trees at the east planting (Table 1), most likely because plants at the east part of the project were held for six weeks in containers. Caliper growth increased more for trees at the west planting compared to the ones at the east planting, such that the difference in caliper between the two planting sites increased over the next 12 months (Table 1). The lower caliper from trees at the west planting increased 226% from August 2001 to August 2002, while those at the east planting increased significantly less at 173% during that same time period. Caliper at 70 cm height increased 218% on average for all trees without significant differences between treatments, while the caliper at 120 cm height increased significantly more at the east planting with 326% versus 257% at the west planting.

Taper was greater for trees from the east planting than the west planting in August 2001 (Table 1). All trees developed good taper during the first growing season and by August 2002 no differences between sites or other treatments were found. Plant growth during the first 12 to 14 months after transplanting was affected only by planting location, while planting hole size and amendments had no significant effect on growth.

### *Tree Growth 2004*

Location remained the strongest influence that affected tree growth three years after transplanting. Caliper and taper of trees planted in the west planting were approximately 45% greater than for trees planted in the east planting (Table 1). In October 2004, average plant height in the west planting was 4.3 m, significantly greater than the average tree height of 3.0 m in the east planting. Planting hole size and amendment had no effect on plant growth. Irrigation delivery and water availability and probably to a smaller extent soil quality appear to be the main factors resulting in significantly less growth of trees in the east planting.

### *Visual observations 2001-2002*

Sparse foliage was observed on some trees in the east and west planting. Many of those trees were planted on an upward slope and it is likely that less water is emitted for those plants which are also smaller than other trees planted on flat terrain or in the west planting. Another possibility is that some water from the drip emitters may run down the slope instead of infiltrating the root zone.

Ten trees in the west planting were leaning at angles of 15° to 80° from a vertical position in August 2002, and on 11 trees the root collar had sunk 6 to 9 cm below the original grade (Table 2). Observations indicate that trees planted in the large planting hole and amended with compost in the backfill had the highest incidence of leaning and sinking. Some of the trees were only sunk, some were only leaning, and some were sunk and leaning at various angles. Seven of those trees needed to be re-staked to remain functional in a public landscape. No leaning trunks and no sinking of the root collar more than 2.5 cm was observed on trees in the east planting, which may in part result from their slower growth during the first year.

### *Visual Observations 2004*

Trees in the west planting continued to grow more rapidly than in the east planting and leaning at angles of 15° to 40° from a vertical position was observed on ten trees, nine of which were amended with compost at transplanting (Table 2). One of the trees where the trunk had been almost horizontal in August 2002 was cut back to the ground. Twelve new branches had originated from this stump and have grown into a multi-trunk shrub by October 2004.

As the trees were growing larger, lack of irrigation became more evident. Smaller leaves and less foliage were noticeable on trees receiving less irrigation compared to those supplied with sufficient amounts of irrigation. Six trees in the west planting and 13 trees in the east planting had canopies with sparse foliage.

Sunken root collars were not as frequently observed three years after transplanting than within one year after transplanting. The root collar of only four trees in the west planting were obviously approximately 10 cm too deep, and according to our records sunken crowns were noted for those same trees in August 2002. Some of the other trees where sunken crowns were observed in 2002 did not show any changes in grade around the base of the tree, but may still be too low. No leaning trees or sunken crowns were observed for trees growing in the east planting. Our observations confirm earlier research across the country that organic amendment in backfill is not beneficial for trees.

When trees were installed in 2001 the planting specifications had called for single trunk *Acacia farnesiana* which were delivered from the nursery. By October 2004, 25% of the trees in the study developed into multi-trunk trees within 50 cm above the soil, which is a more natural form for this species. Nine multi-trunk trees were observed in the east planting and seven multi-trunk trees were counted in the west planting.

## Conclusions

- Holding plants for six weeks in containers and delaying planting of the east part of the project during the hottest summer months resulted in smaller plants being planted and less growth in caliper during the first year.
- Different soil conditions and different irrigation amounts supplied to trees had the greatest influence on growth, whereas planting hole size and amendment treatment combinations did not affect growth for three years following transplanting. Less irrigation resulted in less height and caliper growth of acacias.
- Visual observations one and three years after transplanting indicate that trees that were amended with compost in the backfill had the highest incidence of leaning trunks and sinking crowns (20% of trees in study or 37% of those receiving amendments) while of those trees that were not amended only one tree (3%) was leaning three years after transplanting. Hole size at transplanting had no significant effect on leaning or sinking three years after transplanting. ***These results confirm earlier research across the country that 33% to 50% organic amendment in backfill compared to native soil at transplanting is not beneficial for native trees, but increases the risk of leaning or sinking. Long term health of trees that are affected in this manner may be compromised.***

Table 1. Caliper of *Acacia farnesiana* trees planted in June and July of 2001 in small or large planting holes with or without amendments in two planting locations. Means are the average of 32 plants and include the planting hole and amendment treatments.

| <i>Planting location</i> | <i>Caliper (mm) above ground at</i> |              |              | <i>Taper (mm/cm)</i> |
|--------------------------|-------------------------------------|--------------|--------------|----------------------|
|                          | <i>20 cm</i>                        | <i>70 cm</i> | <i>120cm</i> |                      |
| <i>August 2001</i>       |                                     |              |              |                      |
| West                     | 16.9 a*                             | 14.2 a       | 11.1 a       | 0.058 b              |
| East                     | 14.8 b                              | 10.8 b       | 5.8 b        | 0.090 a              |
| <i>February 2002</i>     |                                     |              |              |                      |
| West                     | 31.4 a                              | 27.6 a       | 22.3 a       | 0.09 a               |
| East                     | 23.8 b                              | 20.5 b       | 12.8 b       | 0.11 a               |
| <i>August 2002</i>       |                                     |              |              |                      |
| West                     | 55.2 a                              | 45.9 a       | 38.8 a       | 0.16 a               |
| East                     | 39.6 b                              | 32.8 b       | 22.4 b       | 0.17 a               |
| <i>October 2004</i>      |                                     |              |              |                      |
| West                     | 103.4 a                             | 88.8 a       | 70.5 a       | 0.64 a               |
| East                     | 59.2 b                              | 47.7 b       | 34.5 b       | 0.36 b               |

\* Means within a column followed by different letters are significantly different at P<0.05.

Table 2. Number of trees where the plant crown sunk about 2-3'' (6-9 cm) below the original grade and number of plants leaning at angles of 10° to 40° from a vertical position at the west planting in August 2002.

| <i>Plant hole size</i> | <i>Amendment</i> | <i>August 2002</i> |                | <i>October 2004</i> |                |
|------------------------|------------------|--------------------|----------------|---------------------|----------------|
|                        |                  | <i>Crown sunk</i>  | <i>Leaning</i> | <i>Crown sunk</i>   | <i>Leaning</i> |
| Large                  | +                | 6                  | 4              | 2                   | 5              |
| Large                  | -                | 3                  | 2              | 0                   | 1              |
| Small                  | +                | 2                  | 3              | 1                   | 4              |
| Small                  | -                | 0                  | 1              | 0                   | 0              |