Soil Amendments at Planting[1]

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Abstract

The growth response of 10 difficult to establish landscape shrubs and trees was evaluated in a series of 4 backfill experiments utilizing hole sizes, organic amendments, mulch, and/or drip irrigation. Growth responses varied among species, but no consistent, positive responses were derived from traditional backfill amendments.

Index words: nursery crops, landscape plants, plant establishment, planting techniques, amended backfill

Introduction

For several hundred years organic matter has been routinely added to planting holes of landscape shrubs and trees. This practice was based on the apparent logic of creating a favorable root environment of improved soil structure, aeration, and water holding capacity, thus enhancing plant establishment and subsequent growth. During recent years considerable research has been generated concerning the "five dollar planting hole" in response to data presented by Pellet (4) and Whitcomb, *et al.* (5). These data questioned the value of adding organic amendments to the backfill of landscape plants. Subsequent research was reported from 4 locations in the southeastern U.S. (1, 2, 3, 6) which largely substantiated earlier findings. Tests in these locations involved container media, organic amendments, and colloidal amendments. They represented varying soil types, planting sites, and climates.

Since 1975, 4 major backfill experiments with difficult to transplant shrubs and trees have been undertaken at this location: (1) 4 species in an exceptionally good textured Cecil clay topsoil, (2) 4 species in compacted Cecil clay subsoil, (3) *Rhododendron* 'English Roseum' in compacted Cecil clay subsoil, and (4) 4 trees in a heterogeneous, infertile, compacted clay subsoil planting site. The latter 3 test sites represent typical planting sites in the Georgia piedmont where organic amendments would be of greatest benefit.

Materials and Methods

All 4 tests were planted during fall months with sites limed to increase the pH to 6.0. The experimental design was a randomized complete block with a minimum of 6 plants per treatment. Planting holes were dug with a tractor mounted power auger and glazing of planting holes was corrected by scoring with shovels. Agriform tablets were added to planting holes according to manufacturer's recommendations. Backfill amendments were mixed on v/v basis with a tractor mounted concrete mixer. Aged wood chips were used as mulch and were maintained at 5 cm (2 in) depth for the duration of the tests. Plants were watered by hand immediately after planting and subsequent irrigation for the 3 shrub tests was provided by overhead impact sprinklers. The fertility program consisted of spring and fall applications of 10N-4.3P-8.3K (10-10-10) sufficient to maintain a medium range of major nutrients. Weed control consisted of a spring and fall application of paraquat and a summer application of glyphosate. Top growth of plants was measured annually by calculating a growth index of height + width / 2. At the termination of Tests 1 and 2, tops were harvested and fresh weight recorded. Roots were dug, washed, air dried, and weighed.

Test 1: Plant materials used were *Juniperus conferta*-Shore juniper, *Ilex crenata* 'Helleri,' *Cornus florida* white seedling, and *Rhododendron obtusum* 'Hinodegiri.' Plants of evergreen species were #1 container size and dogwood seedlings were 46-61 cm (18-24 in) grade. Backfill amendments were: 1) 33 percent peat; 2) 33 percent composted pine bark; and 3) 100 percent Metro Mix 500. Native clay served as the control. Two hole sizes were prepared for each species and amendments. Thirty-one cm (12 in) and 61 cm (24 in) diameter holes were dug to a depth of 61 cm (24 in).

Test 2: Hole size was eliminated as a variable and 46 cm (18 in) planting holes were dug to a depth of 61 cm (24 in). One-third composted pine bark was the soil backfill amendment. Planting treatments were: 1) clay backfill with roots not disturbed; 2) clay backfill with roots disturbed; 3) bark amended backfill with roots undisturbed; and 4) bark amended backfill with root disturbance. Root disturbance was accomplished by 4 vertical knife slits 2.5 cm (1 in) deep on root balls. Four species were used: *Juniperus conferta, Ilex crenata* 'Convexa,' *Rhododendron obtusum* 'Hinodegiri,' and *Cornus florida* white seedling. Plants were #1 container size except dogwood. Disturbed root treatments were 46-61 cm (18-24 in) BR nursery seedlings and non-disturbed root treatment plants were similar size plants grown in #2 containers.

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Table 1. Effect of hole size on plant and root growth of 4 woody nursery crops.[z]

Species	Hole size	Growth Index 12 mo.	Growth Index 24 mo.	Top weight	Root weight
Juniper	31 cm	N.S.[y]		*	N.S.
	61 cm		*		
Holly	31 cm				
	61 cm	*[x]	*	*	*
Dogwood	31 cm	N.S.	N.S.	N.S.	
	61 cm				*
Azalea	31 cm			N.S.	N.S.
	61 cm	*	*		

[z]Test 1, 1975-1977.

[y]Not significant at the 5% level.

[x]Mean separation within columns significant at the 5% level using Duncan's Multiple Range Test.

Test 3: Number 2 container size plants of *Rhododendron* 'English Roseum' were planted in 46 cm (18 in) holes dug 61 cm (24 in) deep. Three planting treatments consisted of: 1) native clay; 2) clay amended with 33 percent pine bark; and 3) clay amended with pine bark and raised 10 cm (4 in) above original soil level.

Test 4: The planting site was heterogeneous, compacted clay subsoil which typifies many planting sites in the Georgia piedmont. Fifteen cm (6 in) pilot holes were dug to a depth of 1 m (3 ft) for the 61 x 61 cm (2 x 2 ft) planting holes. Planting treatments were: 1) native clay; 2) clay amended with 33 percent pine bark; 3) clay mulched with wood chips; and 4) clay amended with 33 percent pine bark and wood chip mulch. Drip irrigation was installed in split plots, resulting in 8 treatments. Irrometers were placed in root zones of irrigated plants and soil moisture levels were maintained at 30-50 cb. Non-irrigated treatments received supplemental irrigation during periods of extreme moisture stress to insure survival. Plant materials used were sugar maple *(Acer saccharum)* 1.8 m (6 ft) BR, southern magnolia *(Magnolia grandiflora)* 1.2 m (4 ft) B&B, white dogwood *(Cornus florida)* 1.5 m (5 ft) B&B, and white dogwood 1.5 (5 ft) BR. When differences in trunk calipers became evident during the third growing season growth index calculations were changed to height x width x caliper.

Results and Discussion

Growth response to soil amendments and planting treatments varied by species in all 4 tests. In Test 1, the growth index of dogwood was not significantly affected by increased hole size, while Shore juniper, Helleri holly, and Hinodegiri azalea growth was significantly greater when planted in larger holes. Top weight of Shore juniper was significantly greater in smaller holes while the opposite was true for Helleri holly. Dogwood and Hinodegiri azalea top weight did not respond to increased hole size. Root weights of Shore juniper and Hinodegiri azalea were not significantly affected by increased hole size, but Helleri holly and dogwood root systems were signicantly larger in bigger holes. Table 2 shows plant growth responses to the 4 planting hole treatments. After 2 years, the growth measurements of Shore juniper were greatest in amended backfills. After 24 months, soil amendments did not significantly affect top growth measurements and root weight of Helleri holly, but Metro Mix gave greater top weight. Dogwood growth was not significantly affected by soil amendments, but both top and root weights were greatest in Metro Mix and peat amendments. Rhododendron 'Hinodegiri' top growth and top weights were not affected by amended planting holes. Amendments resulted in significantly smaller root systems. This has probably been a common experience, since the Ameri-

Table 2. Effect of soil amendments on plant and root growth of 4 woody nursery crops.[z]

Species	Treatment	Growth Index (cm) 12 mo.	Growth Index (cm) 24 mo.	Top weight (kg)	(Root weight (kg)
Juniper	Metro Mix	105 a[y]	170 a	21.8 a	2.4 a
	1/3 Peat	105 a	168 a	20.0 ab	2.0 b
	1/3 Bark	100 ab	163 bc	19.5 b	1.7 c
	Clay	98 b	158 c	18.6 b	1.7 c
Holly	Clay	39.8 a	49.8 a	1.0 c	1.3 a
	1/3 Peat	39.3 ab	51.8 a	1.5 b	1.4 a
	1/3 Bark	37.3 b	49.8 a	1.1 c	1.1 a[x]
	Metro Mix	37.0 b	52.8 a	1.7 a	1.3 a[x]
Dogwood	Metro Mix	128 a	168 a	3.7 ab	1.8 a
	1/3 Peat	128 a	160 a	3.9 a	1.2 b
	Clay	123 b	160 a	3.0 c	1.0 c
	1/3 Bark	118 b	163 a	3.4 bc	1.2 b
Azalea	Clay	42 a	48 a	.16 a	.55 a
	Metro Mix	40 ab	47 a	.18 a	.37 b
	1/3 Bark	39 ab	46 a	.15 a	.21 c
	1/3 Peat	38 b	47 a	.16 a	.19 c

[z]Test 1, 1975-1977.

[y]Mean separation within columns followed by the same letter or letters are not significantly different at the 5% level using Duncan's Multiple Range Test.

[x]Severe root knot infestation

Table 3. Effects of amended backfill and root disturbance on top and root growth of 4 woody nursery crops.[z]

Plant	Treatment	Growth Index (cm) 12 Mo	24 Mo	36 Mo	Top Wt (kg)[w]	Root Wt (kg)
Azalea	Clay — no disturbance	45 a[y]	57 a	65 a	0.8 b	0.5 a
	Clay — root disturbance	46 a	61 a	71 a	1.1 a	0.6 a
	Amended — no disturbance	43 a	52 a	60 a	0.5 c	0.5 a
	Amended — root disturbance	39 a	48 a	57 a	0.5 c	0.5 a
Holly	Clay — no disturbance	82 a	98 a	120 a	3.4 a	3.0 a
	Clay — root disturbance	80 a	95 a	116 a	3.2 a	2.2 b
	Amended — no disturbance	80 a	100 a	123 a	3.6 a	3.0 a
	Amended — root disturbance	79 a	98 a	122 a	3.0 a	2.2 b
Juniper	Clay — no disturbance	78 a	115 a	144 a	18.9 a	1.7 a
	Clay — root disturbance	74 a	113 a	123 a	15.0 b	1.4 ab
	Amended — no disturbance	76 a	114 a	135 a	12.9 b	1.2 b
	Amended — root disturbance	74 a	106 a	133 a	13.0 b	1.4 b
Dogwood	Clay — no disturbance	72 a	x	x	x	x
	Clay — root disturbance	74 a	204 a	250 a	5.6 a	3.2 a
	Amended — no disturbance	36 x	195 a	252 a	4.9 a	3.3 a
	Amended — root disturbance	67 a	193 a	242 a	5.5 a	3.4 a

[z]Test 2, 1977-1981.

[y]Mean separation within columns followed by the same letter or letters are not significantly different at the 5% level using Duncan's Multiple Range Test.

[x]Denotes winter injured plants.

[w]Data expressed in air dry weight.

can Rhododendron Society recently deleted amended backfill from its planting recommendations.

In Test 2 (Table 3) Hinodegiri azalea showed similar growth responses to those in Test 1. Growth indices of the other 3 species followed suit. Plant growth response within the 4 species were similar for all measurement dates. Root disturbance did not significantly increase top growth of the various species. Top weights of holly and dogwood did not respond to planting treatments. Native clay without root disturbance gave a significantly higher top weight of Shore juniper. Root disturbance resulted in a significantly lower root weight of Convexa holly.

Table 4 presents the results of Test 3. As in the 2 previous tests with another rhododendron species, the growth of 'English Roseum' was not affected by the transplanting methods. These data largely agree with other rhododendron backfill tests (3, 6).

Results of Test 4 involving landscape trees are presented in Table 5. Again, plant materials responded differently to the various treatments. Magnolia growth after 2 years was influenced greatest by the mulch + irrigation treatment and least by soil amendment alone. After 3 years, amended + irrigation gave the greatest growth. After 2 years the B&B dogwood plants showed no significant response to any treatment, but after 3 years the treatments consisting of (1) mulch, amendment, and irrigation and (2) amendment + irrigation were significantly higher than other treatments. The 2 treatments of mulch and native clay produced larger plants of bare root dogwood. After 3 years the amended + irrigated plants were significantly larger. The growth of sugar maple also varied by years. Mulched plants were largest after 2 years, but mulched + amended + irrigated plants were larger after 3 years. This test is being continued to determine possible longevity effects of the treatments.

The data collected in this series of experiments point out the variable reactions of plant species to soil treatments. Thus, no consistent positive response was derived from amended backfill. In Tests 1 and 2, examination of the root systems revealed that the majority of roots were confined to the original planting hole. The interface of amended soil and undisturbed soil undoubtedly has a deleterious effect on root growth and soil water movement. Soil moisture data collected from Test 4 (data not shown) indicate that amended mulched treatments do not significantly increase moisture retention when compared to mulching alone. Conversely, amended and mulched soils can amplify aeration problems caused by overwatering or excessive rainfall. Soil microflora probably play a very important role in the amended planting hole saga. Current emphasis on mycorrhizal research will undoubtedly yield some enlightening data.

Table 4. Growth response of *Rhododendron* 'English Roseum' to planting techniques.[z]

Treatment	Growth Index (cm) 2 Years	4 Years	6 Years
Clay	104	104	136
Amended	108	122	144
Amended, Raised	109	118	141
	N.S.[y]	N.S.	N.S.

[z]Test 3, 1977-1983

[y]Mean separation within columns not significant at the 5% level using Duncan's Multiple Range Test.

Table 5. Effects of mulch, backfill amendment, and drip irrigation on growth of 4 landscape trees.[z]

Treatment	Magnolia Growth Index		B&B Dogwood Growth Index		BR Dogwood Growth Index		Sugar Maple Growth Index	
	2 yr[y]	3 yr[x]	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr
Mulch + amended + irrigated	43 ab[w]	204 abc	53 a	195 ab	58 ab	235 b	50 bc	163 a
Mulch + amended	46 ab	205 abc	51 a	157 bc	——	——	51 ab	103 bcde
Mulch + irrigated	49 a	171 bcd	54 a	136 c	50 c	138 cd	46 cd	91 cde
Mulch	46 ab	163 cd	55 a	122 c	65 a	167 c	55 a	132 ab
Amended + irrigated	46 ab	253 a	51 a	210 a	58 ab	291 a	50 bc	126 abc
Amended	39 b	55 e	53 a	125 c	49 c	110 d	45 d	71 de
Irrigated	44 ab	216 ab	54 a	146 bc	56 bc	238 b	45 d	67 e
Native clay	41 b	150 d	50 a	145 bc	63 ab	117 d	51 ab	111 bcd

[z]Test 4, 1979-1982.

[y]Growth measured by height + width / 2.

[x]Growth measured by height x width x caliper.

[w]Mean separation within columns followed by the same letter or letters are not significantly different at the 5% level using Duncan's Multiple Range Test.

In the final analysis, economics must be applied to decision making in landscaping practices. Since amended backfill is a considerable budget item for landscape contractors, all recent research data indicate that this practice is not economically sound. The emerging "five dollar planting hole" is large, mulched, well drained, and sufficiently fertile.

Significance to the Nursery Industry

Amending the backfill of planting holes for shrubs and trees is a considerable budget item for landscape business firms. Amended soil is either batch mixed on site or bulk mixed and hauled to the planting site. This involves a considerable investment in materials, equipment, and labor. For more than a decade, research data have not shown a consistent, positive growth response among common landscape plant materials to amended backfills. From the landscape nurseryman's or contractor's point of view, primary emphasis should be placed on preparing a large planting hole with adequate drainage, fertility, and mulch in order to achieve a more economical, living landscape.

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Erratum

In the paper "Resistance of Several Members of the Cupressaceae to Cypress Tip Miner, Argyresthia cupressella" by C.S. Koehler and W.S. Moore (J. Environ. Hort. 1(4):87-88. 1983), the regression points in Figure 1 and caption appear below.

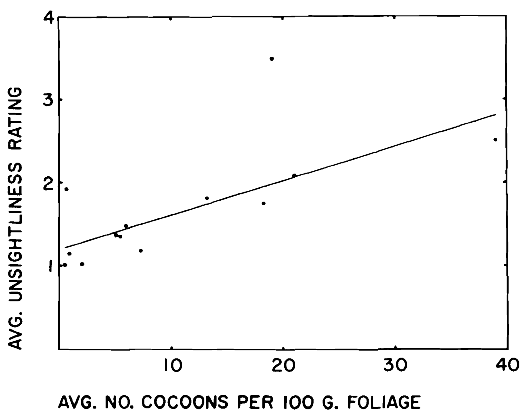

Fig. 1. Linear regression of unsightliness in selected Cupressaceae on numbers of cocoons of cypress tip miner. Y = 1.20 + 0.041 X.