Effects of Seed Handling, Pre-germination and Planting Positions on Tree Seedling Root and Stem Development[1]

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Abstract

Distortions of stem and root systems are sometimes noted with woody landscape plants propagated from seed. While position of the seed during stratification appears to produce no adverse effect, a change in seed orientation during pre-germination and/or transplanting can influence the subsequent development of these stem and root systems, frequently resulting in distorted seedlings unacceptable for commercial or research use.

Index Words: *Quercus robur*, *Quercus shumardi*, *Quercus acutissima*, *Carya illinoensis*, cold stratification, embryo, tree seedling quality

Introduction

Many woody landscape plants are propagated from seed, however, little has been reported about the effects of seed orientation during storage, pre-germination or planting on seedling quality. During years of seedling production at the Oklahoma State University Research Nursery, distortions of stem and/or root systems of seed propagated trees have been observed. Among the trees showing the greatest degree of distortion were Chinese pistache (*Pistacia chinensis*), pecan (*Carya illinoensis*), lacebark elm (*Ulmus parvifolia*), and several oak (*Quercus*), and maple (*Acer*) species. Species showing severe distortions were generally those whose seed were pre-germinated due to limited seed quantity or poor germination.

Stem and/or root distortions were observed not only in seedlings, but in trees one or more years old. Frequently the distortions resulted in trees of poor or unacceptable quality.

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Little previous research is available on this subject. While the effect of sowing position on germination rate has been reported (1, 4), the authors did not study the effect of seed position on seedling stem and/or root development.

Marlangeon (2) concluded that for hardy orange (*Poncirus trifoliata*), sowing position of seeds had no effect, although his data showed three to four times more stem distortion in seeds sown in an inverted position (radicle pointing up) as compared to those sown in the normal upright (radicle pointing down) or in a horizontal position. In later work with English oak, (*Quercus robur*), Marlangeon (3) concluded that stratification position geotropically sensitizes the embryo, giving it the direction that it will initially follow. He noted that this sensitization may or may not effect ultimate seedling growth depending upon positional changes between stratification and planting.

The objectives of this study were to use other landscape and nursery species to expand upon the seed position findings of Marlangeon (3) and to attempt to determine if an embryo can be geotropically sensitized to such an extent that undesirable and/or detrimental seedling stem/root distortion results.

Materials and Methods

Four experiments were conducted from November, 1982, thru April, 1985. Seeds of pecan and all oak species used were collected locally. Seeds requiring stratification or those receiving a pre-germination treatment were placed in plastic flats containing moist sphagnum moss peat. Immediately following completion of stratification treatments, all seeds were transplanted into bottomless plastic containers 6 × 6 × 8 cm in depth (2.3 × 2.3 × 3 in) in a medium of peat and perlite (1:1 by vol).

All treatments, depending upon the particular experiment, were replicated 6 to 18 times in randomized block designs. Treatments were evaluated using a visual rating scale from 1 to 10 (1 represented extreme distortion of stem and/or root, while 10 represented no distortion). All seedlings were approximately 15 to 20 cm (6 to 8 in) in height when evaluated.

Experiment 1. English oak (*Quercus robur*) seeds, which require no stratification, were direct seeded in bottomless plastic containers in 3 basic positions: normal (radicle end down), horizontal and inverted (radicle end up). Separate evaluations of the 3 positions were made for seeds with no radicle emergence and with radicle tips visible.

Experiment 2. On November 8, pre-germination of English oak began in the 3 positions described in Exp. 1. On November 20 and 29, sets of pre-germinated seeds with radicles visible but not extending beyond the seed coats were planted into 4 position combinations: normal (radicle end down); horizontal (seed on side); horizontal rotated (seed rotated 180 degrees from pre-germination position when transplanted); and inverted (radicle end up). Pre-germination positions by planting positions gave 10 possible combinations.

Experiment 3. Stratification of shumard oak (*Q. shumardi*) seeds began on November 8, 1982, in the 3 basic positions described in Exp. 1. On February 10, 1983, 1 seed lot was removed from cold storage and planted in the 10 planting positions as described in Exp. 2. A second seed lot was planted on February 16, by which time radicles had emerged approximately 3 cm (1.24 in).

Experiment 4. Seeds of shumard oak and 'Western' pecan were stratified horizontally, then transplanted to the same horizontal position or to the horizontal rotated position on April 10 (seeds not swollen), April 20 (seeds swollen) and April 30, 1985 (radicles visible, but not more than 1 mm beyond seed coats).

Results and Discussion

Experiment 1. With both no radicle emergence and with radicle tips visible, the inverted (radicle end up) position yielded the greatest number of distorted seedlings (Table 1.). This agrees with Marlangeon (3). There was a trend, though not significant, toward less seedling distortion for the horizontal compared to the normal direct seeding position.

Experiment 2. Planting position had a striking effect on seedling development. A significantly greater amount of distortion occurred when seeds from any pre-germination position were inverted at transplanting time (Table 2). The least amount of distortion occurred when the same normal

Table 1. Effect of direct-seeded position on stem/root development of English oak with or without radicle emergence at planting.

Radicle development	Planting position[x]	Mean-visual grade[z]
No emergence	normal	5.3 ab[y]
	horizontal	7.3 b
	inverted	4.4 a
Visible	normal	5.3 ab
	horizontal	7.3 b
	inverted	2.9 a

[z]1 = extreme distortion of stem and/or root; 10 = no distortion.

[y]Means followed by the same letter or letters are not significantly different at the 5% level using a protected LSD test ($LSD_{0.05}$ = 2.7).

[x]Normal = radicle end down; Horizontal = seed on side; Inverted = radicle end up.

Table 2. Effects of seed pre-germination and transplanting positions on stem/root development of English oak.

Pre-germination position	Planting position[x]	Mean visual grade[z]
Normal	normal	5.4 bc[y]
	horizontal	4.7 b
	inverted	1.8 a
Horizontal	normal	4.6 b
	horizontal	6.6 c
	inverted	2.3 a
	horizontal rotated	4.8 b
Inverted	normal	5.2 bc
	horizontal	5.0 bc
	inverted	2.3 a

[z]1 = extreme distortion of stem and/or root; 10 = no distortion.

[y]Means followed by the same letter or letters are not significantly different at the 1% level using a protected LSD test ($LSD_{0.01}$ = 1.8).

[x]Normal = radicle end down; Horizontal = seed on side; Inverted = radicle end up; Horizontal rotated = seed rotated 180 degrees from pre-germination position when transplanted.

or horizontal pre-germination positions were maintained as transplant positions.

Experiment 3. Planting date, position and the date/position interaction were all significant (Table 3). On the February 10 planting date, differences in stem and/or root development were small.

By the February 16 planting date, radicle emergence had progressed enough to cause permanent stem and/or root distortion in all position combinations except inverted/inverted.

Experiment 4. Prior to radical emergence, rotating seeds following stratification had no adverse effect on stem and/or root development even if the seeds were swollen (Table 4). However, once the radicles became visible, even if they did not extend beyond the seed coats more than 1 mm swollen (approximately 1/16 in), seedling development was adversely affected (Figure 1). The length of emerging radicles, not the number of days per se, is the critical factor in determining whether stem and root distortions occur.

Table 3. Effects of seed position and date on stem/root development of stratified shumard oak.

Stratification position	Planting position^w	Mean visual grade^z Date 1^v	Date 2
Normal	normal	9.0 a^y,ab^x	2.8 b,cd
	horizontal	8.7 a,abc	2.2 b,de
	inverted	6.3 a,c	2.3 b,de
Horizontal	normal	8.1 a,bcd	1.9 b,de
	horizontal	9.0 a,ab	4.9 b,b
	inverted	6.3 a,e	3.6 b,c
	horizontal rotated	9.1 a,ab	1.4 b,e
Inverted	normal	7.9 a,cd	1.9 b,de
	horizontal	9.6 a,a	1.9 b,de
	inverted	7.2 a,de	6.3 b,a

^{z}1 = extreme distortion of stem and/or root; 10 = no distortion.

^{y}Means in a row followed by the same letter or letters are not significantly different at the 1% level using a protected LSD test ($LSD_{0.01}$ = 0.5).

^{x}Means in a column followed by the same letter or letters are not significantly different at the 1% level using a protected LSD test ($LSD_{0.01}$ = 1.0).

^{w}Normal = radicle end down; Horizontal = seed on side; Inverted = radicle end up; Horizontal rotated = seed rotated 180 degrees from pre-germinated position when transplanted.

^{v}Date 1 = no radicle emergence; Date 2 = radicle emergence.

Table 4. Effect of seed rotation during transplanting on stem/root development.

Date/seed condition	Seed rotation^y	Mean visual grade^z Shumard Oak	Pecan
4-10-85	−	9.7 a^x	9.8 a
(not swollen)	+	9.4 a	9.7 a
4-20-85	−	9.4 a	9.8 a
(swollen)	+	9.6 a	9.6 a
4-30-85	−	9.6 a	9.7 a
(radicle visible)	+	1.3 b	1.7 b

^{z}1 = extreme distortion of stem and/or root; 10 = no distortion.

^{y}− = horizontal stratification position to same horizontal transplant position; + = horizontal stratification position to 180 degrees rotated horizontal transplant position.

^{x}Means followed by the same letter are not significantly different at the 1% level using a protected LSD test ($LSD_{0.01}$ = 1.1).

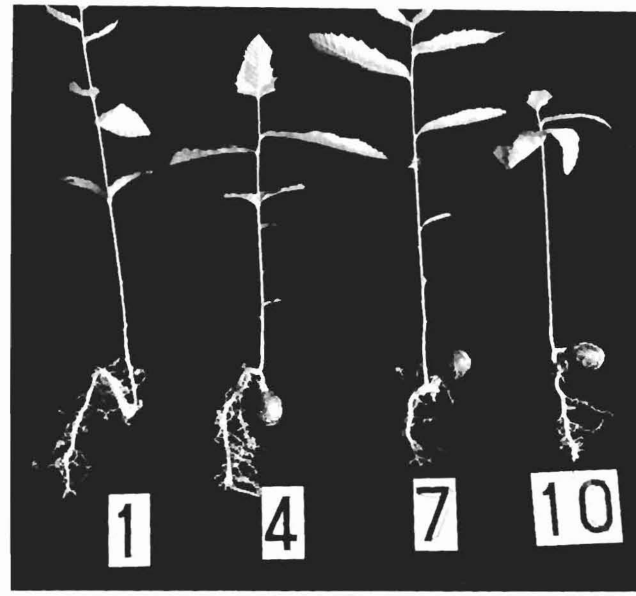

Fig. 1 Grading scale used to evaluate root/shoot distortion of sawtooth oak (*Quercus acutissima*). Left: Rating 1 (horizontal/horizontal rotated) shows adversely affected root/shoot quality resulting from rotating a seed 180° after the tip of the radicle was visible. Right: Rating 10 (horizontal/horizontal) shows no adverse quality when germination position is maintained when the seed is moved.

These experiments show that seed orientation during germination can have a major effect on stem and/or root development. There appear to be positions or position combinations that minimize seedling distortion not only for seeds that are direct planted, but also for those requiring pre-germination due to low viability, expensive seed or a desire to reduce labor needed to thin seedlings.

Stratification position had no adverse effect on seedling stem and/or root development of the oaks or pecans. It would appear that perception of the geotropic (gravitropic) stimulus by the radicle either does not occur during the stratification period, or is not strong enough to prevent reversal at planting time.

For pre-germinated seeds, careful handling is required to minimize stem and/or root distortion. If the tip of the radicle is visible, either the position during pre-germination must be maintained at planting time, or transplanting must be done at seed swell. Germination within a seedlot is rarely uniform, and these experiments show that a few days of additional radicle emergence prior to permanent planting can increase stem and root distortions.

It should not be difficult for the industry to incorporate this information into its seed handling techniques. Seed lots being pre-germinated can be checked daily for seed swell, and all seeds showing swelling transplanted at that time. If daily monitoring is impractical and all seeds must be planted at one time, maintenance of seed orientation at transplanting should not be difficult.

Significance to the Nursery Industry

While seed position during cold stratification does not appear to have any adverse effect on seedling stem or root development, pre-germination position can. Change of seed position during radicle emergence can result in distortions of stems and roots.

The pre-germination stage at which seeds of different tree species become geotropically sensitized may vary. Observations of these various position effects should be made for all species being grown in order to improve seed handling techniques and to minimize or eliminate unnecessary stem and root distortions that may result in unusable or unsalable trees. Because distortions may be hard to see in trees that produce small seedlings, growers may need to look for stem and/or root distortions on older trees and relate their observations to their seed handling techniques.

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Effects of Wounding, IBA and Basal Trimming on Rooting of Boxwood Cuttings[1]

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Abstract

Wounding, indole butyric acid (IBA) and trimming of cuttings to a basal node were evaluated for their effects on rooting of *Buxus sempervirens* L. (American boxwood), *B. sempervirens* L. 'Suffruticosa' (English boxwood), *B. microphylla* var. *koreana* Nakai. (Korean boxwood), and B. microphylla var. *japonica* (Müll. Agr.) Rehd. and Wils. (Japanese boxwood) cuttings. Rooting of all cultivars was improved by a 5 second dip in a 0.4% aqueous solution of the potassium salt of IBA. Wounding the basal end of the cuttings only improved rooting for Korean and Japanese boxwoods. However, the combination of wounding and IBA dip gave the best results for all cultivars. Trimming the cuttings to a basal node was beneficial only to Korean boxwoods.

Index words: propagation, *Buxus sempervirens*, *Buxus microphylla*, indole-3-butyric acid

Introduction

American and English boxwoods are valued in the landscape throughout the southeastern and eastern coastal regions of the United States. The more rapidly growing Korean and Japanese boxwoods are often used although they are not as finely textured.

The boxwoods are commonly propagated by cuttings taken at any time of the year (1), however, success and speed of rooting varies with the season (4). Rooting studies on Jojoba (*Simmondsia chinensis* (Link) C.K. Scheid.) (Buxaceae) indicated a positive response to the combination of stem wounding and IBA treatment (3). The possibility of similar treatment effects on boxwood cuttings was investigated in the following study.

Materials and methods

Terminal cuttings of Korean and Japanese boxwoods were collected in late June. Terminal cuttings of English and American boxwoods were collected in early July. The basal ends of the cuttings were cut either just below a node (nodal cutting) or above a node (internodal cutting). The cuttings were trimmed to 9–10 cm (3.5–4 in) and the leaves were stripped from the basal 4 cm (1.5 in) of each cutting. Two cm (0.78 in) of the base of half of the cuttings were wounded by a single incision through the cortex with the point of a scalpel. Both wounded and unwounded cuttings were treated with either a 0.4% solution of the potassium salt of IBA (United States Biochemical Corp.) or left untreated. Treatment was by dipping the basal 2 cm (0.78 in) of the cuttings into the solution for 5 seconds and allowing the cuttings to air dry 15 minutes. All cuttings were stuck 4 cm (1.63 in) in 52 cm × 40 cm (20.5 in × 15.5 in) plastic flats containing moist peat and perlite (1:1 by vol.). Flats were placed on raised outdoor mist benches covered with 47% shade cloth under natural sunlight. Cuttings were misted 5 seconds every 5 minutes from 6:30 AM to 6:30 PM. A randomized complete block design was used of 5 replications with 10 cuttings per treatment. The *B. microphylla* cuttings were evaluated after 12 weeks and the *B. sempervirens* cuttings were evaluated after 28 weeks. Measurements included number and length of rooted cuttings per treatment. Data

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