Effects of Chilling and Stratification on Nut Germination of Northern and Southern Pecan Cultivars[1]

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Abstract. **Stratification (moist-cold) at 0 - 2°C for 8-12 weeks promoted earliness and uniformity of germination of nuts of 4 cultivars of pecan (*Carya illinoensis* Wang. K. Koch). Of three northern cultivars used, two had a greater seed stratification requirement than a southern cultivar, whereas the third was similar. Chilling (dry-cold) was much less effective than stratification in promoting earliness and uniformity of germination. The use of stratification by pecan nurserymen should result in larger and more uniform stands of pecan seedlings.**

The pecan is asexually propagated by budding or grafting desired cultivars onto seedling rootstocks. Nurserymen use open-pollinated seed of named cultivars and native seedlings for rootstock purposes (1). Pecan nuts are assumed to have no well-defined rest period, and will germinate at any time after harvest (1). In fact, preharvest sprouting in the shuck (or germination on the tree) is common for several cultivars. Others have indicated that as long as the seed nuts are handled carefully and not allowed to dry out or become rancid, they can be planted with assurance of good germination at any time from harvest until late winter or early spring (3, 5). Most pecan nurserymen, therefore, store their seed nuts in large burlap sacks in unheated buildings. In the spring the nuts are soaked for 2 or 3 days in water before planting.

In a study on breeding to develop pecan seedling rootstocks, Madden (4) found that nuts of 'Major' and 'Peruque', regardless of the pollen parent, did not germinate readily or uniformly when given the same treatment as nuts of southern origin. We have also observed that when nurserymen in the South plant nuts of northern origin, they get only 30 to 40% germination, and germination is spread over a long period of time.

After 15 years' study of germination and seedling growth, Bailey and Woodroof (2) concluded that optimum conditions for germination and uniformity of growth were stratification at 0°C at high humidity and a substrate pH of 6.8. Sparks, et al. (6) found that stratification at 7°C increased uniformity, early germination and final percentage of germination as the length of stratification time increased (up to 10 weeks). They concluded that for maximum enhancement the stratification period should exceed 10 weeks.

The following study was conducted to determine the germination requirements of nuts of northern pecan cultivars as compared to a southern cultivar. Nuts of 'Giles' (Kansas seedling), 'Major' (Kentucky seedling), 'Peruque' (Missouri seedling), and 'Riverside' (Texas seedling) were used. All nuts were harvested at Brownwood, Texas, and matured in the same environment. Treatments consisted of stratification in peat moss in plastic bags at 0 - 2°C for 0, 2, 4, 6, 8, 10, and 12 weeks and chilling in plastic bags at the same temperature and time periods. Controls consisted of nuts soaked for 3 days and planted, the common procedure used by nurserymen. Twenty-five nuts of each cultivar were used for each treatment. All nuts were planted in a mixture of equal parts of peat moss, sand, and perlite in a greenhouse at 27°C. The controls were planted Dec. 12, 1970. Nuts receiving stratification and chilling were planted at 2 week intervals beginning Dec. 24, 1970. The nuts were planted 2 inches deep in 5 nut plots with 5 replications. Germinated seedlings were counted at the time of initial emergence and at 3- to 6-day intervals until all seedlings had emerged.

Nuts in the control required up to 160 days from planting to reach 50% germination (Table 2). Nuts of 'Major' and 'Peruque' were very slow to reach 50% germination until they had received at least 8 weeks of stratification (Table 2). This would indicate that nuts of some pecan cultivars may have a rest period and stratification is necessary to satisfy a requirement for germination.

We have observed other cultivars originating in the Northeastern area which react similarly to the 'Major' and 'Peruque' controls when handled in a like manner. No southern cultivars observed have exhibited such prolonged germination.

The response of 'Giles' was similar to that of 'Riverside'. Even though 'Giles' is a northern type nut, its area of origin is completely different from the other northern cultivars studied.

Promptness of germination was increased in all 4 cultivars as

Table 1. Effect of cultivar, soaking, dry cold storage, and stratification on the days to initial germination.

	Days to initial germination						
	3-day	Weeks of storage					
Cultivar	soak	2	4	6	8	10	12
		Stratified					
Giles	25	25	22	20	19	19	14
Major	39	30	29	20	26	19	16
Peruque	27	40	22	22	26	19	16
Riverside	21	33	22	22	19	19	16
		Dry cold storage					
Giles		35	29	33	33	26	20
Major		49	36	40	54	30	36
Peruque		32	47	40	40	30	36
Riverside		32	42	47	40	28	26

Table 2. Effect of cultivar, soaking, dry cold storage, and stratification on the days to 50% germination.

	Days to 50% germination						
	3-day	Weeks of storage					
Cultivar	soak	2	4	6	8	10	12
		Stratified					
Giles	37	45	29	28	26	19	16
Major	160	146	135	121	54	23	20
Peruque	107	146	135	68	48	23	26
Riverside	47	45	61	28	26	23	20
		Dry cold storage					
Giles		55	54	47	42	40	20
Major		166	135	121	75	61	97
Peruque		148	135	121	156	54	79
Riverside		60	54	54	48	44	79

Table 3. Effect of cultivar, soaking, dry cold storage, and stratification on the days to final germination.

	Days to final germination						
	3-day	Weeks of storage					
Cultivar	soak	2	4	6	8	10	12
		Stratified					
Giles	160	146	135	139	44	26	26
Major	195	181	184	170	125	50	47
Peruque	195	181	153	170	64	50	47
Riverside	111	146	186	68	64	40	36
		Dry cold storage					
Giles		183	135	170	125	47	40
Major		183	170	170	156	142	128
Peruque		183	170	170	156	142	128
Riverside		148	153	121	79	93	97

Table 4. Effect of cultivar, soaking, dry cold storage, and stratification on final germination percentage.

	Final germination percentage						
	3-day	Weeks of storage					
Cultivar	soak	2	4	6	8	10	12
		Stratified					
Giles	96	100	96	100	80	80	92
Major	88	96	96	84	96	92	92
Peruque	88	80	92	88	88	96	80
Riverside	100	100	100	92	96	100	100
		Dry cold storage					
Giles		92	92	100	100	100	100
Major		92	92	92	88	84	88
Peruque		84	76	88	48	84	80
Riverside		92	96	100	100	96	100

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stratification time was increased up to the 12 weeks maximum used (Table 2, 3). Chilling showed the same general trend but was not as effective at the same time intervals. Stratification decreased time to initial germination slightly (Table 1) but showed no influence on final percentage of germination (Table 4) because of the long period of time allowed for germination. Under field conditions germination percentage could be affected.

These data indicate that seed of northern origin can be successfully grown as nursery stock in the South if given a stratification treatment for 10-12 weeks. Stratification of seed of all cultivars should result in greater uniformity, a better stand of seedlings, and larger seedling size at the end of the growing season as a result of promptness in germination.

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Growth Regulators Increase Yield and Reduce Length of Harvest of Highbush Blueberries[1]

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Abstract. **Applications of potassium gibberellate (KGA_3) combined with 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) or 2,4,5-trichlorophenoxypropionic acid (2,4,5-TP) increased fruit set, reduced the number of aborted berries, increased yield, and shortened length of harvest period when applied at full bloom to 'Dixi' blueberry plants (*Vaccinium corymbosum* L.). Compared with untreated 'Jersey' blueberry plants, succinic acid-2,2-dimethylhydrazide (SADH) applied 2 weeks before full bloom reduced yield in comparison to SADH applied 2 weeks after full bloom but had no effect on fruit size or time of harvest.**

Poor pollination and non-uniform fruit development of blueberries in western Washington often results in uneven maturity and a long harvest period. Treatments that would stimulate fruit set and berry growth may shorten the harvest period and aid in mechanical harvest.

Gibberellic acid derivatives used to stimulate parthenocarpy in *Vaccinium* (2, 3, 5, 6, 7) generally cause production of smaller fruit and longer maturation periods (6). Combinations of SADH and GA_3 aided mechanical harvest of tomatoes by controlling and concentrating fruit set (1).

Trials were designed to find a method to control and concentrate fruit set and shorten the harvest period of blueberries. Growth regulators (Table 1) were applied at full bloom to tagged canes on 8-year-old 'Dixi' blueberry plants replicated 5 times in randomized complete blocks. Naphthalene acetamide (NAD), naphthalene acetic acid (NAA), 2,4,5-T and 2,4,5-TP were first dissolved in 10% polyethylene glycol 600 in ethanol then added to water. The wetting agent X-77 at 0.1% was added to all treatments. Canes with approx the same size and the same no. of buds were selected. SADH at 2500 mg/liter was applied to tagged branches on 8-year-old 'Jersey' plants either 2 weeks before full bloom, full bloom, or 2 weeks after full bloom and replicated 5 times in randomized complete blocks.

Berries were harvested every 7 to 10 days, weighed, and yields per 100 flowers calculated from total no. of flowers and total wt. Harvest dates were based on the time when full color developed. Bushes were observed at regular intervals for signs of foliar and fruit phytotoxicity. Soluble solids were determined in a refractometer.

Fruit yield was increased by all treatments except the GA_3 and NAA combination and mono(dimethylcocoamine)succinate (TD-692) (Table 1). The principal effects from the treatments were in reducing the no. of aborted berries that failed to mature and increasing the initial fruit set.

No difference in soluble solids or berry size or weight was found (Table 1) except from the KGA_3-NAA treatment which reduced berry size due to the phytotoxicity of NAA (3).

KGA_3-2,4,5-T and KGA_3-2,4,5-TP shortened the harvest period without decreasing yield or size of berries (Table 1). The 2,4,5-T and 2,4,5-TP appeared to partially counteract the effect of GA_3 (6), and as reported for SADH and GA_3 (1) controlled and concentrated fruit set and maturation.

Harvest of KGA_3-2,4,5-T and KGA_3-2,4,5-TP treated berries and the control started July 17. KGA_3-2,4,5-T and KGA_3-2,4,5-TP treated plants were last picked on Sept. 4, and the control on Sept. 23. This rapid rate of development would reduce harvest labor and facilitate mechanical harvest. KGA_3 combinations had no adverse effect on growth.

SADH applied 2 weeks before full bloom significantly reduced fruit set. Yield was reduced by SADH applied at full bloom or 2 weeks before full bloom in comparison to SADH applied 2 weeks after full bloom (Table 2). No differences were found in soluble solids.

No effect of SADH was found on rate of maturation, size of berries, or damage to blossoms, fruit, or leaves. Vegetative growth was somewhat depressed but color, shape, and size of leaves was normal. Hapitan et al. (4) depressed vegetative growth with SADH

Table 1. Effects of growth regulators on fruit set and development of 'Dixi' blueberries.

Growth regulator	Concentration (mg/liter)	Fruit set (%)	Fruit aborted (%)	Yield per 100 blossoms (g)	Soluble solids (%)	Harvest period (days)	Wt/100 berries (g)
ABA[z]	5	90ab[y]	18b	62.1ab	12.6	68a	85a
KGA_3+NAD	500+100	96a	12b	67.4a	12.7	68a	77a
KGA_3+2,4,5-T	500+ 3	90ab	6b	63.0ab	13.4	49b	75ba
KGA_3+2,4,5-TP	500+ 20	87ab	13b	61.4ab	12.7	49b	79a
KGA_3+NAA	500+250	88ab	10b	39.4c	11.9	36c	50b
TD-692	480	76bc	37a	44.0bc	12.4	68a	94a
Control	–	66c	33a	38.4c	12.7	68a	85a

[z]ABA = abscisic acid, KGA_3 = potassium gibberellate, NAD = napthaleneacetamide, NAA = naphthalene acetic acid, 2,4,5-T = 2,4,5-trichlorophenoxyacetic acid, 2,4,5-TP = 2,4,5-trichlorophenoxypropionic acid and TD-692 = mono(dimethylcocoamine)succinate.

[y]Mean separation in columns by Duncan's multiple range test, 5% level.

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