Defoliation Response of Woody Seedlings to Endothall/Ethephon[1]

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Abstract. **Six species of seedling trees were foliar-treated in greenhouse experiments with 7-oxabicyclo(2,2,1)heptane-2,3-dicarboxylic acid (endothall) mixed with (2-chloroethyl)phosphonic acid (ethephon). A range of 75 to 100% abscission was obtained within 14 days with little or no damage except on Chinese elm (*Ulmus parvifolia* Jacq.).**

The results of this investigation should be of interest to nurserymen and investigators such as those cited by Larsen (6) who are concerned with defoliation of deciduous nursery fruit or ornamental trees to permit early digging for storage or shipment. Also, such individuals as plant pathologists and entomologists may find the chemicals useful for simulating defoliation of actively growing woody plants for experimental purposes.

A promising chemical abscissor, which defoliated bean plants (*Phaseolus vulgaris* L. cv. Red Kidney) in a controlled environment chamber, is composed of endothall and ethephon (1). Ethephon is thought to be absorbed by the plant as a weak aliphatic acid which breaks down at cytoplasmic pH (2). Endothall causes mild injury to the leaf followed by endogenous ethylene production (4, 5). This study was designed to determine the dose range of a mixture of endothall and ethephon which will induce abscission of actively growing woody nursery seedlings.

Seedlings of pin oak (*Quercus palustris* Muenchh.), white oak (*Quercus alba* L.), Chinese elm, white ash (*Fraxinus americana* L.), and black locust (*Robinia pseudoacacia* L.) approx 30 cm tall were planted in 1-liter pots in January in the greenhouse in soil (2:1:1 Loam:sand:peat moss), pruned to 15 cm, and thinned to a single new shoot to obtain uniform plants. Live oak (*Quercus virginiana* Mill.) was grown from seed in the greenhouse under similar conditions 15 months prior to treatment. The live oak seedlings available limited the possible treatments. A preliminary experiment with black locust indicated that it was responsive to ethephon alone; therefore, endothall was omitted. Control plants were not sprayed. The pH of spray mixtures containing ethephon was 2.0 ± 0.5. Foliage was sprayed to runoff with the various mixtures of endothall-ethephon in water and 1% Tween 20 (= 0.1% polyoxyethylene sorbitan). Preliminary research with white ash indicated that 1% Tween 20 was the optimum concn of surfactant to use with endothall/ethephon. Applications were made in April in a spray chamber with a DeVilbiss (No. 163) atomizer at 281 g/cm^2 (4 psi). Temp and relative humidity of the greenhouse were 25 ± 5°C and 60 ± 10% respectively. Complete counts of attached leaves were made before treatment and at intervals following treatment. Dead leaves still attached after treatment were included in the count. Leaf counts were transformed to % defoliation. Damage in the form of shoot tip dieback and necrosis was estimated visually, 1 month after treatment (0 = no damage; 10 = 100% damage). One tree was used per treatment which was replicated 3 – 4 × in randomized blocks.

Defoliation and damage varied with species and chemical dose. The highest defoliation of pin oak was 96% without damage with a combination of 600 ppm endothall and 600 ppm ethephon (Table 1). White oak defoliation reached 91% with slight damage to the shoot tips from 1,200/600 ppm endothall/ethephon mixture (Table 1). The majority of pin oak leaves died and remained attached as a result of high levels of endothall and ethephon. They appeared to be injured too severely for abscission to occur. No shoot damage occurred to live oak at maximum defoliation (86%) with 1,200/2,400 ppm endothall/ethephon mixture (Table 1). Resistance to damage of live oak could have been due to its degree of maturity even though it appeared to be actively growing at the time of treatment. The shoots of the deciduous species were only 3 months old and more succulent compared to portions of the live oak shoots which were at least 14 months old. The highest defoliation for Chinese elm ranged from 72 to 87% from the high levels of endothall/ethephon, but damage to the shoots was excessive. The maximum defoliation with the least variation and only slight damage for white ash was 92% with a combination of 1,200/2,400 ppm endothall/ethephon mixture. Black locust was 94% defoliated without damage from 2,400 ppm ethephon (Table 2).

Defoliation of all species was rapid with the majority of leaves dropping within 7 days after treatment, and most of the shoot damage which occurred

Table 1. Defoliation of oak, elm, and ash seedlings 2 weeks after treatment with endothall/ethephon and shoot damage after 1 month.

Endothall (ppm)	Defoliation (%) Ethephon (ppm) 0	600	2,400	9,600
	Pin oak			
0	0 g[z] (0)[y]	0 g (0)	4 f (0)	11 ef (0)
600	20 de (1)	96 a (0)	88 ab (0)	91 a (1)
1,200	75 ab (1)	42 c (1)	60 bc (1)	40 c (2)
2,400	41 c (1)	41 c (1)	35 cd (2)	41 c (4)
	White oak			
0	0 i (0)	0 i (0)	14 f (1)	7 g (0)
600	46 d (1)	16 f (0)	64 c (1)	24 e (5)
1,200	84 a (1)	91 a (1)	68 bc (1)	3 h (6)
2,400	77 ab (3)	53 d (1)	81 a (1)	51 d (3)
	Live oak			
0	0 f (0)	2 f (0)	18 de (0)	–
600	13 e (0)	31 cd (0)	52 bc (0)	–
1,200	17 de (0)	75 ab (0)	86 a (0)	–
	Chinese elm			
0	0 f (0)	8 e (1)	7 e (0)	74 ab (3)
600	30 d (1)	14 e (1)	48 c (2)	78 a (3)
1,200	44 cd (2)	38 cd (1)	72 ab (2)	87 a (3)
2,400	29 d (4)	56 bd (4)	81 a (3)	85 a (4)
	White ash			
0	0 h (0)	6 g (0)	4 gh (1)	18 f (1)
600	50 cde(0)	70 abc(0)	52 cde(0)	33 ef (1)
1,200	36 de (1)	83 ab (1)	92 a (1)	44 cde(1)
2,400	60 bcd(1)	64 abc(1)	48 cde(1)	84 ab (2)

[z]Mean separation, within species, by Duncan's multiple range test, 5% level.
[y]Values in parentheses are damage ratings (0 = no damage; 10 = 100% damage).

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Table 2. Defoliation of black locust seedlings 2 weeks after treatment with ethephon and shoot damage after 1 month.

Ethephon (ppm)	Defoliation[z] (%)	Damage[y] rating
0	0 d	0
300	24 c	0
600	53 b	0
1,200	79 ab	0
2,400	94 a	0

[z]Mean separation by Duncan's multiple range test, 1% level.

[y]Rating (0 = no damage; 10 = 100% damage).

was to the succulent tips from the high levels of endothall/ethephon. Refoliation of the undamaged shoots of Chinese elm, white ash, live oak, and black locust took place within 1 month after treatment and white oak and pin oak refoliated within 2 months. As was noted by Davis et al. (1) on bean, it appeared that levels of endothall and ethephon which caused slight leaf injury were more effective chemical abscissors. This mild injury to the leaf probably facilitated the penetration of sublethal quantities of both chemicals (3).

Research is in progress on ornamental nursery stock in the field to determine defoliation responses during different stages of growth including the period prior to natural abscission.

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Parthenocarpy—A Factor Contributing to the Production of Blank Pistachios[1]

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Abstract. **During a 4-year period, 'Kerman' pistachio trees (*Pistacia vera*) produced an average of 26% blank nuts. Production of blanks by individual trees remained relatively constant from year to year and was not associated with yield or position of the trees in relation to pollinators. Blank production was also found to be a characteristic of *P. atlantica* Desf. and *P. chinensis* Bunge. Results demonstrated that production of blanks, at least in 'Kerman', is partly the result of parthenocarpy.**

The production of blank (empty, except for the funiculus) pistachio nuts is an important problem wherever the crop is produced (4). The scant literature on the subject, however, contains little more than vague speculation as to the underlying cause of this phenomenon. Grundwag and Fahn (3) in Israel tried to clarify the situation through an embryological study; but they merely described instances of degeneration of megaspore mother cells, megaspores, and embryo sacs, all of which normally result in flower abscission. In addition, they found a few flowers on some trees, and all flowers on other trees, to be devoid of megaspore mother cells and embryo sacs. However, they did not indicate whether blank pistachios were produced on trees in which all flowers lacked embryo sacs, nor did they imply that parthenocarpy might be involved in the production of blanks.

In the study described here, blank production in 'Kerman' (1), currently the only female pistachio being planted commercially in California, was compared to that in other cultivars and species. Also, the possible involvement of parthenocarpy in blank production was studied.

In 1961, seedling rootstocks of *P. atlantica* at the Wolfskill Experimental Orchards, Winters, California were budded to 'Peters' (staminate) and 'Kerman' (pistillate) cultivars in a ratio of 1:6 trees, respectively. Individual yield records of 24 'Kerman' trees have been maintained since they began bearing in 1969. The average percentage of blank nuts was determined from three 100-nut samples per tree. The variation among samples from individual trees generally did not exceed 4%.

The 4-year average blank production per individual tree varied from a low of 14.7% to a high of 38.7% (Table 1). With the exception of tree 1-11 in 1972, the individual trees consistently produced relatively high or relatively low percentages of blanks each year. Average blank production varied from a low of 20.3% in 1970 to a high of 31.7% in 1972. The seriousness of the problem is indicated by the fact that blank production of all trees averaged 26.2% for the 4-year period.

The degree of blank production was not associated with yield of the individual tree (Table 1). For example, average yield of tree 2-8 was almost twice that of 1-11; yet there was a difference of only 1% in blank production between the trees. Likewise, tree 3-5 yielded 3 times more than 1-9, with only 0.5% difference in blank production. Although similar average yields of all trees occurred in 1970 and 1972, the greatest extremes in blank production also occurred, 20.3 and 31.7%, respectively.

Position with respect to the prevailing wind and proximity to staminate trees, both of which would have an effect on degree of pollination, are factors that might also be related to the production of blanks. However, neither seems to be operative in this instance. For example, tree 2-6 was more favorably situated for pollination than was 2-8. Yet, 2-6 produced the highest average percentage of blanks of all trees in the orchard, whereas 2-8 was third lowest in this respect. Because of these findings, and because yield and blank production do not seem to be related, it is tentatively concluded that variation in blank production from tree to tree is a rootstock effect.

Table 1. Blank production, by count, and yield of in-shell 'Kerman' pistachios. The data are for the 5 out of 24 trees that produced the least, and for the 5 that produced the greatest, percentages of blanks during the 4-year period.

Row and tree	Blanks (%)					Yield (kg)				
number	1969	1970	1971	1972	Avg	1969	1970	1971	1972	Avg
4–13	19	10	10	20	14.7	6.3	3.1	14.7	3.4	6.8
4–12	13	18	14	18	15.7	7.5	17.5	12.5	15.8	13.3
2–8	22	13	20	24	19.7	13.2	14.4	23.9	20.8	18.0
1–11	13	19	18	33	20.7	7.9	7.5	15.0	9.1	9.8
2–2	23	19	21	22	21.2	5.0	12.1	6.1	10.7	8.4
2–10	20	23	27	44	28.5	5.8	7.5	8.0	3.7	6.2
3–1	34	29	31	39	33.2	6.8	8.7	10.6	10.3	9.1
3–5	46	25	29	39	34.7	7.1	10.8	8.6	11.7	9.5
1–9	55	24	30	32	35.2	1.0	4.0	3.2	3.4	2.9
2–6	49	23	37	46	38.7	5.5	8.3	13.1	10.2	9.2
Avg	29.4	20.3	23.7	31.7	26.2	6.6	9.3	11.5	9.9	9.3

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