Table 1. Elemental concentration of leaflets and leaflet Zn/Fe ratio of normal and mouse-ear pecan trees of 4 cultivars.

Leaf condition	Schley	Desirable	Mohawk	Wichita	Mean
		Ca (%)[z]			
Normal	1.85a	0.94a	1.90a	1.31a	1.50a
Mouse-ear	1.19a	1.12a	1.43a	2.44b	1.55a
		Mg (%)			
Normal	0.80b	0.55a	0.51a	0.47a	0.58a
Mouse-ear	0.55a	0.59a	0.49a	0.83b	0.61a
		Mn (ppm)			
Normal	440a	283a	577b	305a	401a
Mouse-ear	227a	224a	289a	525a	319a
		Cu (ppm)			
Normal	10.8b	4.0a	13.9b	7.1a	9.0b
Mouse-ear	5.7a	5.1a	6.8a	7.1a	6.2a
		Zn (ppm)			
Normal	205a	84a	167a	79a	134a
Mouse-ear	223a	114a	82a	247b	166a
		Al (ppm)			
Normal	532a	519a	1092b	546a	672b
Mouse-ear	501a	425a	593a	542a	515a
		Cr (ppm)			
Normal	2.87b	2.18a	3.98b	2.77a	2.95a
Mouse-ear	2.45a	2.44b	2.79a	3.39b	2.77a
		Pb (ppm)			
Normal	25.0b	17.7a	36.2b	24.9a	26.0a
Mouse-ear	19.5a	21.6b	26.4a	31.7b	24.8a
		Cd (ppm)			
Normal	1.41a	0.94a	2.18b	1.37a	1.47a
Mouse-ear	1.06a	1.18b	1.46a	1.87a	1.39a
		Zn/Fe ratio			
Normal	3.00a	1.90a	2.83b	1.30a	2.26a
Mouse-ear	4.11a	2.22a	1.21a	3.38b	2.73a

[z]Means are based on dry wt of leaflet tissue. Mean separation by General Linear Models procedure 5% level. Coefficients of variability (%) were: K=22, Ca=29, Mg=21, Fe=16, Mn=38, B=32, Cu=29, Zn=37, Na=32, Al=24, Si=30, Co=115, Cr=7, Ni=14, Pb=9, Cd=14 and Zn/Fe ratio=36.

at 500°C and analyzed for P, K, Ca, Mg, Fe, Mn, B, Cu, Zn, Na, Si, Al, Co, Cr, Ni, Pb and Cd by emission spectroscopy (4). Data were analyzed by the General Linear Models procedure (1).

There was no significant association between mouse-ear symptoms and leaflet P, K, Fe, B, Na, Si, Co or Ni. There were cultivar-symptom interactions for leaflet Ca, Mg, Mn, Cu, Zn, Al, Cr, Pb, Cd and for the leaflet Zn/Fe ratio (Table 1). Normal 'Schley' leaflets were high in Ca, Mg, Mn, Cu, Cr, Pb and Cd compared with mouse-eared 'Schley', but differences for Ca, Mn and Cd were not significant at the 5% level. Normal 'Desirable' leaflets were lower in Cr, Pb and Cd than mouse-eared leaflets. 'Mohawk' was similar to 'Schley' for most elements except Zn. Normal 'Wichita' leaflets were lower in Ca, Mg, Zn, Cr, and Pb than mouse-eared leaflets. High Zn/Fe ratio favored mouse-eared leaflets except for 'Mohawk', which was just the opposite. Normal leaflets were higher in Cu and Al than mouse-eared leaflets when the means for mouse-ear vs normal leaflets over all varieties are compared, but even then there were significant variety by symptom interactions.

There was some confounding of the location and cultivar effects, however, 'Schley' and 'Desirable' usually reacted differently at the same location.

The coefficient of variability (CV) was large for most elements, reflecting the usual large tree to tree differences in mineral concentration and the high CV's obtained with emission spectroscopy. Differences between means had to be large for significance.

Weight of each element/leaflet was calculated to determine if results would be different from concentration data. These data (not shown) revealed normal leaflets contained more of each element analyzed than mouse-eared leaflets, perhaps due to larger size of normal vs mouse-eared leaflets.

The data agree with that of Gallaher and Jones (2) that mouse-eared leaflets contain a higher concentration of Ca, Mn, Zn, and Mg than normal leaflets of some cultivars on some locations, but the opposite might occur if cultivar or location changes. No leaflet sample contained less than 100 ppm Mn suggested as a possible threshhold by Gammon and Sharpe (3).

The cause of mouse-ear, apparently results in differences in elemental concentration of leaflets that are inconsistent over different cultivars or locations.

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The Effects of Defoliation and Pruning on Flower Bud Initiation and Differentiation in 'Chico' Walnut (*Juglans regia* L.)[1]

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Additional index words. etiolation, pruning stimulus,

Abstract. **Heading back of 2nd flush growth to basal buds on vigorous young trees at different times of the year indicated that buds were converted from a vegetative to a reproductive state within 4 weeks after they were formed at the shoot apex. Defoliation or defoliation plus etiolation of 7 terminal nodes in July did not deter the buds at these nodes from differentiating pistillate flowers for the next season. Pruning greatly accelerated the differentiation processes.**

With long-lived perennial fruit species, inherent growth, bearing habits, mature tree size, and cultural practices are important considerations in pruning and training of young trees. When economi-

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cally favorable characteristics are bred into new cultivars, traditional cultural practices need to be re-examined to take advantage of the genetic modifications. In 'Chico', 'Vina', 'Pedro', and 'Tehama', precocious 'Payne'-type English walnuts introduced by the late E.F. Serr, over 80% of the lateral buds are fruitful. In older cultivars, only the terminal bud bears pistillate flowers.

The growth habit of a young walnut tree just coming into bearing is somewhat unique in that the vigorous shoots exhibit 2 flushes of growth per season. The first flush arising from a mixed bud is determinate, having 4 to 9 nodes and terminating with 1 or 2 pistillate flowers. After this phase is completed with flowers pollinated and fruits set, a bud subapical to the peduncle will elongate and grow, giving rise to the second flush. This growth is indeterminate, reaching 2 to 3 m before the onset of cool weather. The periods when the buds on the 2nd flush growths are physiologically conditioned to initiate flowers and when morphological differentiation becomes evident are yet unknown. Of physiological and horticultural interest is whether the basal 6 to 8 buds on the second flush growth, which are located in axils of scales and strap-like appendages rather than normal compound leaves, are fruitful or not.

Lin et al. (3) reported that when the subapical bud does not develop a second flush, as is usual in older mature trees, a floral apex is normally differentiated in early June. This differentiation is first manifest by the flattening of the dome, the apical meristem, followed by the appearance of the involucre primordium shortly thereafter. The time of appearance of the sepal primordia varied from July to the following March depending on the cultivar. Other researchers have reported that the conversion from a vegetative bud to a reproductive one in English walnut occurs at different times. This conversion in 'Sorrento', an unnamed German cultivar, and 'Concord', occurred in August (5), October (2), and February (4), respectively. The variation could be attributed to the cultivar and geographical location but also to the interpretation of the primodial bud morphology. Lin et al. (3) considered the flattening of the dome as first evidence of floral differentiation while others may have waited until the sepal or pistil primordia became noticeable.

Since the 2nd flush growth is indeterminate, this study was undertaken to determine how soon these basal buds and those following become converted to reproductive apices after their formation at the shoot apex. These questions are pertinent in formulating a pruning and training system for these highly fruitful cultivars to maintain vigor, sustain high yield, and to control tree size.

Fig. 1. Mixed buds with pistillate flowers (within rings) arising from basal nodes of second flush growths which were headed back in Aug and photographed in Sept. Note the lack of leaves at these basal nodes and the shrivelled nut. Nuts on young trees often shrivel when the second flush in very vigorous.

Fig. 2. Fruitful first flush growths arising from basal nodes of second flush growth which grew the previous summer and was headed back in Mar. The arrow points to the sub-apical bud which will give rise to the second flush.

Whether the basal buds are fruitful or not was answered by heading back several 2nd flush growths on 6 trees to these whorls of buds in late June, August or the following March, just prior to bud break. Thirty to 50% of shoots which grew from these basal buds in response to the heading in June were fruitful mixed buds. When the treatment was repeated on June 28, 1978, 8 of 11 shoots (72%) headed back sent forth a total of 25 lateral buds of which 15 (60%) bore 1 or 2 pistillate flowers by July 31. Buds which grew in response to the August 1976, or March 1977, pruning were over 90% fruitful (Fig. 1, 2).

The finding from the June pruning indicates that these basal buds on 2nd flush growth were stimulated to flower within 4 weeks after being formed at the shoot apex. If their development normally follows that of buds on the 1st flush growth, that is, of not having pistil primordia appearing until February-March of the following year, their differentiation processes were greatly accelerated in response to some pruning stimulus. These basal buds are located at nodes devoid of normal compound leaves. Assuming that the presence of leaves is essential for flower initiation, we conclude that the causal factors, whether hormones (1) and/or assimilates, must be translocated.

Having established that normally dormant basal buds of 2nd flush growth are fruitful and that they can be forced to grow by pruning, it appears that light to moderate heading of long shoots during the dormant season will not materially reduce yield. The invigorating effect of pruning should result in larger and better quality nuts.

Based on an *a priori* assumption that leaves are necessary for flower bud initiation, immature leaves were removed from 7 most distal nodes, to assess how early these lateral buds on the 2nd flush growth were induced to flower. Fifteen shoots were defoliated in July, 1975, and 19 in July, 1976. In 1976, 17 additional shoots were defoliated and wrapped with aluminum foil. The purpose of the foil was to eliminate the possibility that a pigment system in the green stem could initiate the flowering process. At the time of defoliation, the smallest leaves were 2 to 5 cm in length while those at the 7th node were about 3/4 full size and still pale and thin. The foil was removed during the winter long after other leaves on the same limbs had fallen. As control, 7 fully expanded mature leaves were removed from 5 shoots.

Examination of defoliated shoots in the following spring disclosed that a relatively high percentage of buds which grew were fruitful (Table 1, Fig. 3). Of particular interest is that buds which were very young at the time of defoliation were induced to flower. If, instead of defoliating, the apices had been pinched, these distal buds would normally have developed into vegetative shoots. Hence, it seems that while some principle related to apical domi-

Table 1. Distribution of fruitful (+), unfruitful (−), and dormant (o) buds at 7 defoliated or defoliated plus etiolated nodes[z], compared to the control[y].

Node no.	Defoliated 1975			Defoliated 1976			Etiolated 1976			Control 1976		
	+	−	o	+	−	o	+	−	o	+	−	o
1	5	3	7	8	0	11	6	0	11	4	0	1
2	8	2	5	13	0	6	7	0	10	5	0	0
3	7	4	5	12	0	7	6	1	10	4	0	1
4	10	1	4	16	1	1	10	0	7	4	0	1
5	13	0	2	13	1	3	8	0	9	4	0	1
6	12	1	2	15	0	2	10	0	7	2	0	5
7	8	0	7	15	1	3	9	1	7	3	0	1
%+[x]	85			97			96			100		
%o[w]			25			26			51			23

[z]Young leaves were removed from shoot apex. Etiolation was accomplished by wrapping the shoot portion with aluminum foil. (1 = distal, 7 = proximal node).

[y]Mature fully expanded leaves were removed.

[x]Based on buds which grew the following spring.

[w]Based on total no. of buds, including those which grew immediately following defoliation or that differentiated catkins.

Fig. 3. Shoots bearing nuts (within rings) arising from portion of 1-year-old wood (between arrows) which was defoliated and etiolated the previous summer.

nance was inhibiting budbreak, these buds began to differentiate floral parts and eventually became fruitful. Since the partially defoliated shoots resumed growth after a short lag period following defoliation, it is not certain whether the flower initiating substances originated from leaves above or below the defoliated zone. Nodes 1 to 3 defoliated in 1975 were less fruitful than nodes 4 to 7 but this trend did not hold for similarly treated shoots in 1976. More buds kept under foil failed to grow compared to those exposed (Table 1). Subsequently, these dormant buds and weak shoots from both treatments abscised. While the percentage of dormant buds on control shoots was nearly equal to the percentage on shoots where young leaves were removed, none abscised. Hence, the age of the buds when the leaves were removed and light exposure had a distinct effect on bud vitality. These findings reinforce our idea that some judicious annual dormant pruning to encourage second flush growth may be advantageous on these fruitful cultivars.

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Susceptibility of 25 Citrus Rootstocks to the Citrus Nematode[1]

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Abstract. **No significant difference in root or top weight of 25 citrus rootstock seedlings grown in the greenhouse for 15 months was attributable to infestation of the citrus nematode, *Tylenchulus semipenetrans* (Cobb). Many nematodes were found on the roots of most of the cultivars tested regardless of nematode biotype, with the exception of trifoliate orange and some hybrids where one parent was trifoliate orange.**

The citrus nematode exists in all citrus-growing areas of the world and in some instances can be one of the limiting factors in fruit production (9). Baines et al. (1) and Du Charme (8) found that all common species of citrus were susceptible to *T. semipenetrans* but that trifoliate orange (*Poncirus trifoliata* (L.) Raf.) possessed a high degree of resistance. Cameron et al. (6, 7) explored the possibility of hybridizing citrus species with trifoliate orange to produce nematode-resistant hybrids which could be used as rootstocks for citrus. Several such hybrids produced progeny which showed a reduction in infestation of *T. semipenetrans* when compared to citrus rootstocks now in use. Baines et al. (3) reported the existence of 4 biotypes of *T. semipenetrans* that differed from one another in their host preference for different citrus species.

Bitters et al. (4, 5) carried out long-term screening trials to find citrus rootstocks tolerant to tristeza virus.

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