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Xenia and Metaxenia in Pistachio¹

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Abstract. Pollen from 5 different sources did not alter fruit size or time of maturity of 'Kerman' pistachio (*Pistacia vera* L.). Degree of shell (endocarp) dehiscence was modified with some pollen sources but was found to be related directly to kernel development rather than to type of pollen. Thus, there were no manifestations of metaxenia. Xenia, as exhibited by reduced kernel length and dry weight, did occur, however, following the use of *P. atlantica* and hybrid pollen.

The pistachio, *Pistacia vera*, is one of few plants in which xenia and metaxenia have been observed (8, 9, 12). Peebles and Hope (8), working with the 'Red Aleppo' and 'Trabonella' cultivars as seed parents, reported delayed maturity, increased fruit length, and increased shell (endocarp) splitting, depending upon the pollen applied. Whitehouse et al. (12), working with the 'Sfax', 'Bronte', 'Red Aleppo', and 'Trabonella' cultivars as seed parents, also found certain kinds of pollen to bring about delayed maturity. Pollen of *P. vera* produced more nuts with split shells and nuts with larger kernels than pollen of 4 other *Pistacia* species. Pontikis (9), on the other hand, working with an unspecified Greek cultivar, noted hastening of maturity and increased kernel weight, depending upon pollen source. Thus, these studies have indicated that both the seed and the tissues composing the fruit may be modified by the pollinizer, responses defined by Swingle (11) as xenia and metaxenia, respectively.

Interspecific hybridization readily occurs among the various species of *Pistacia*, e.g. *P. vera*, *P. atlantica*, *P. terebinthus*, *P. Palaestina*, *P. integerrima*, *P. chinensis*, etc. (5, 8, 12). The fact that most species bloom ahead of *P. vera* enables the collection, preparation and storage of their pollen for use later in pollinating the pistachio.

The pistachio is dioecious and staminate trees are strategically located among pistillate trees in the orchard to provide pollen at the time pistillate flowers are receptive. The apetalous flowers do not attract insects and pollen dispersal is by wind. The degree to which pollination occurs, therefore, is dependent upon prevailing weather conditions. Research is being conducted toward the collection and storage of pollen for use in supplementing natural pollination. Also being explored is the possibility of developing a completely controlled artificial pollination procedure, in which pollen would be collected from staminate trees (not necessarily only those growing within the orchard), stored, and applied mechanically with dusting or spraying equipment. Such a procedure could eliminate use of valuable orchard space by staminate trees that serve only as sources of pollen. Should these procedures prove to be practical, it would be desirable to know the xenia and metaxenia responses, if any, of 'Kerman' (currently the only pistillate cultivar being grown commercially in California) to the various types of pollen available. This paper presents the results of an initial study to determine the response of 'Kerman' to 5 different pollen sources.

Male inflorescences were collected prior to dehiscence in late March from a *P. atlantica* and a hybrid (*P. vera* × *P. atlantica*) tree in a commercial orchard at Elk Grove. The inflorescences, as well as those collected later from 'Aegina B', 'Ask', and 'Peters' (all *P. vera*) trees at Winters, were spread on paper at 22°C in the laboratory. The next day the pollen was separated from the inflorescences by screening and

stored in glass vials stoppered with cotton plugs in a freezer at -15°C. Previous study had indicated the value of low temperature for preserving *Pistacia* pollen viability (4).

Five 9-year-old 'Kerman' trees growing at the Wolfskill Experimental Orchards, Winters, were selected on the basis of their relatively large numbers of inflorescence buds. Twelve branches, each supporting 3-5 inflorescence buds, were selected on each tree. On April 3, before anthesis, these branches were enclosed in bags made of tightly woven, white cotton gabardine, material that had proven satisfactory in walnut breeding operations (10). The bags were eventually removed from the branches on April 24, several days after anthesis of the last 'Kerman' flowers and when pollen had ceased shedding primarily from 'Peters' trees in the vicinity.

Each of the 5 different kinds of pollen was applied to the inflorescences on 2 branches on each of the 5 trees. Pollen application was made in the early, windless mornings of April 13, 16, 18, and 20. Flowers were pollinated by daubing them with the cotton plugs covered with pollen. Two of the bagged branches on each tree served as unpollinated controls. Bags on these branches were removed briefly and replaced each morning that pollen was applied to the test flowers.

Average number of flowers per inflorescence was determined by counting the number of flowers in each of 25 inflorescences picked at random from the 5 experimental trees. The number of nuts harvested per cluster was used in determining the approximate percentage of fruit set resulting from a particular kind of pollen.

Nuts were harvested at maturity, as judged by the time at which the hull separated easily from the shell (3). Length and cheek diameter of each fruit were measured with a vernier caliper and, after hull removal in a hulling machine, the nuts were dried in a dehydrator. Length and cheek diameter measurements of the kernels were made, as well as dry weight determinations.

Less than 1% of the flowers on 4 bagged but unpollinated branches set fruits, all of which were parthenocarpic.

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Table 1. Effect of pollen source on fruit set, fruit size, kernel size, shell dehiscence, and production of blanks in 'Kerman' pistachio.

Pollen source	Fruit set (%)	Whole fruit		Filled nuts with split shells (%)	Blanks (%)	Kernel		
		Length (mm)	Cheek diam (mm)			Length (mm)	Cheek diam (mm)	Dry wt (g)
Peters	5.0	27.1	17.4	53.8 a ^z	28.3 a	20.1 a	12.2	.73 a
Ask	6.1	27.0	17.4	52.2 ab	28.6 a	20.0 a	12.3	.76 a
Aegina B	4.2	26.8	17.0	42.4 abc	36.6 a	20.2 a	12.0	.73 a
Hybrid	3.4	27.0	16.9	37.9 abc	55.6 b	19.8 b	11.8	.73 a
<i>P. atlantica</i>	3.6	26.8	16.8	19.9 c	65.7 b	19.2 b	11.7	.64 b
	NS	NS	NS	*	**	*	NS	**

^zMean separation in columns by Duncan's multiple range test, 5% (*), 1% (**), or not significant (NS).

No fruit set occurred on the remaining bagged control branches. There were no significant differences among percentages of fruit set resulting from hand pollination with the different pollen sources (Table 1). This would indicate that all sources of pollen were of similar viability and of equal compatibility with 'Kerman'.

Time of nut maturity was not altered by any of the pollen sources. Peebles and Hope (8) and Whitehouse et al. (12) reported a metaxenia response of several cultivars as shown by delay in nut maturity following the use of pollen from *Pistacia* species other than *vera*. Maturity of dates (*Phoenix dactylifera*) had been shown previously to be affected by type of pollen (11). It was thought at first that a delay in maturity of 'Kerman' pistachios had occurred following pollination with the hybrid and *P. atlantica* pollen. This, however, was found not to be the case. The hulls of blank nuts, those in which there are no kernels due mainly to embryo abortion (1, 2), do not go through the sequence of changes in appearance and texture characteristic of nuts with kernels and, therefore, appear immature. The high percentages of blank nuts produced with the hybrid and *P. atlantica* pollen gave an initial false impression regarding maturity. Nuts with kernels resulting from those cross-pollinations, however, matured at the same time as nuts produced with *P. vera* pollen. Length and diameters of whole fruits produced by the various cross-pollinations were not significantly different from each other (Table 1). Thus, from the standpoints of time of maturity and fruit size, there were no metaxenia effects resulting from the use of different kinds of pollen.

An apparent metaxenia effect occurred with regard to shell dehiscence; nuts resulting from pollination and fertilization with 'Peters' and 'Ask' pollen had significantly greater percentages of split shells than nuts resulting from *P. atlantica* pollen (Table 1). However, the degree of shell splitting of nuts produced by all pollen sources was inversely related to blank nut production, the smaller the percentage of blanks the greater was the percentage of filled nuts with split shells ($r = 0.96$). Thus, it would appear that shell splitting is related directly to kernel development rather than to type of pollen that brings about fertilization. This is supported by comparing the data for kernel size with that for the percentage of filled nuts with split shells (Table 1). The trends of these data, in general, also indicate that the smaller the kernel the lower is the percentage of nuts with split shells. Nevo et al. (7) presented several lines of evidence indicating that the source of pollen does not influence the structure of the endocarp nor its dehiscence but it does affect size of the kernel. The data for kernel length and dry weight show clearly that xenia did occur in the cases of hybrid and *P. atlantica* pollen and support the conclusions of Nevo.

McKay and Crane (6), in a study of the effect of different pollen sources on fruits of chestnut (*Castanea crenata* and *C. mollissima*), found that size of nuts produced was always in the direction of the size of nuts characteristic of the pollen parent. Pollen from a cultivar that produced relatively small nuts when applied to a cultivar normally producing large nuts brought about a reduction in size of nuts and

vice-versa. The pistachio responded somewhat similarly. *P. vera* cultivars characteristically produce fruits much larger than those produced by other *Pistacia* species. Also, *P. vera* is the only *Pistacia* species in which the endocarp dehisces. While none of the various pollen sources altered overall fruit size, endocarp dehiscence, percent blanks, and length and dry weight of kernels were all adversely affected in fruits resulting from cross-pollination with hybrid and *P. atlantica* pollen. The use of pollen in artificial pollination from a source other than *P. vera*, therefore, would seem undesirable.

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