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Self and Cross-Pollination Affect Fruit Quality of Iranian Pomegranate 'Malas-e-Yazdi'

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ABSTRACT

The present study was done to find the effect of self and cross-pollination on pomegranate fruit yield and quality. Treatments were 'Bihasteh Ravar' (♂) × 'Malas-e-Yazdi' (♀): [BM]; 'Kambar Najaf Abad' (♂) × 'Malas-e-Yazdi' (♀): [KM]; 'Sangan Khash' (♂) × 'Malas-e-Yazdi' (♀) :[SM]; and 'Malas-e-Yazdi' (♂) × 'Malas-e-Yazdi' (♀) :[MM]. Data showed that pollen source influenced all traits related to fruit quality with the exception of aril color and taste. The best pollen source for 'Malas-e-Yazdi' was 'Bihasteh Ravar' that reduced peel thickness, but increased juice volume and TSS/TA ratio. So, it is concluded that cultivation of at least two pomegranate cultivars in an orchard is useful to achieve more yield and better fruit quality.

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INTRODUCTION

The pomegranate (*Punica granatum* L.), a popular fruit and ornamental of Mediterranean peoples for centuries, is a native from Iran to the Himalayas. It belongs to the Punicaceae and produces deliciously edible fruits. The fruit has round shape with a prominent attached calyx and a hard leathery skin [2].

The pomegranate is andro-monoecious, developing male (A type-unfertile) and perfect (B type-fertile) flowers on each tree, being self-pollinated, self and cross-pollinated, highly cross-pollinated or often cross-pollinated [5]. There were many reports on desirable characteristics of hybridized progenies regarding to fruit quality [8,10]; high productivity [7]; frost resistance [6] and so on. Hybridization between 'Mollar de Elche' and other foreign varieties was done to obtain darker skin and early ripening [3]. Derin and Eti [4] stated that cross-pollination significantly influence fruit set of pomegranate. Softness or seedlessness or absence of hard cover in seed is a desirable economic trait that improves the market and consumption qualities of fruits.

Thus, the main aim of this study was to investigate the effect of self and cross-pollination on fruit quality of commercially hard-seeded pomegranate Malas-e-Yazdi. The second aim was to evaluate compatibility and/or incompatibility of these Iranian pomegranates to introduce the best pollinizer (s) for Malas-e-Yazdi.

MATERIALS AND METHODS

Plant materials, Emasculation and Treatments:

The experiment was conducted on 25 years-old trees at Agriculture and Natural Resources Research Center of Yazd Province, Yazd, Iran during 2010 to 2012 growing seasons. Iranian pomegranate cultivars including 'Bihasteh Ravar', 'Kambar Najaf Abad', 'Sangan Khash' and 'Malas-e-Yazdi' were chosen as male parents that the first-three are non-commercial, but have soft-seeded fruits, and 'Malas-e-Yazdi' was selected as female parent, which has been introduced as a commercial cultivar, but has hard-seeded fruits (Table 1).

Conventional farm management including irrigation, fertilization and training was done during the experimental periods. Emasculation was done at April 10, 2010 on some flowers of 'Malas Yazdi', and then isolated immediately. Prepared pollen of male cultivars mentioned above were used for fertilization of flowers, consequently isolation was done in order to take confidence about close pollination and sufficient fruit set [9]. Self or cross-pollination included (male × female):

'Bihasteh Ravar' (♂) × 'Malas-e- Yazdi' (♀) :[BM]
'Kambar Najaf Abad' (♂) × 'Malas-e-Yazdi' (♀) :[KM]
'Sangan Khash' (♂) × 'Malas-e-Yazdi' (♀) :[SM]

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'Malas-e-Yazdi' (♂) × 'Malas-e-Yazdi' (♀) :[MM]

Table 1: Some characteristics of selected Iranian pomegranate cultivars.

Cultivars	Yield	Peel color	Fruit size	Vigor	Taste
Sangan Khash	Medium	Pale-red	Medium	High	Sweet
Kambar Najaf Abad	Medium	Pale-red	Medium	High	Sweet
Bihasteh Ravar	Low	Pink	Small	Medium	Sour
Malas-e-Yazdi	High	Rich-red	Large	Medium	Sour-sweet

Table 2: Effects of self and cross-pollination on fruit decay, cracking, sun burn and total yield.

Treatment	Fruit decay (%)	Fruit Cracking (%)	Sun burn (%)	Total yield (Kg/Tree)
B × M	75.00a	50.00b	75.00a	15.30a
K × M	75.00a	75.00a	50.00b	15.10a
S × M	73.00a	75.00a	50.00b	14.50a
M × M	50.00b	25.00c	75.00a	10.50b

Within each column, same letter indicates no significant difference between treatments at 5% levels of LSD.

Table 3: Effects of self and cross-pollination on some peel and seed characteristics of pomegranate.

	Peel		Seed	
Treatment	Color	Thickness (mm)	Length (mm)	Diameter (mm)
B × M	Pink	2.00c	5.10b	2.01b
K × M	Pink	6.00a	6.20ab	2.13ab
S × M	Pink	6.00a	6.70ab	2.61a
M × M	Rich-red	3.50b	7.01a	2.78a

Within each column, same letter indicates no significant difference between treatments at 5% levels of LSD.

Table 4: Effects of self and cross-pollination on some aril and juice characteristics of pomegranate.

	Aril			Juice				
	Color	Length	Diameter	Volume	TSS	TA	TSS/TA	Taste
Treatment		(mm)	(mm)	(ml)	(%)	(mg/100g Fruit F.W.)		
B × M	Pink	10.70a	6.40b	100.00a	15.80d	0.52d	30.38a	Sweet
K × M	Pink	9.50b	7.40a	55.00c	16.20c	0.84c	19.28b	Sweet
S × M	Pink	9.40b	6.60b	55.00c	17.42b	1.03b	16.90c	Sour
M × M	Rich-red	10.90a	7.80a	70.00b	18.10a	1.16a	15.60c	Sour-sweet

Within each column, same letter indicates no significant difference between treatments at 5% levels of LSD.

Table 5: Evaluation of compatibility and incompatibility of mentioned cultivars via seed germination and consequent characteristics.

Treatment	Germination (%)	Leaf emergence time	Leaf area (cm)	Flowering (days after leaf emergence)	Fruit setting (days after flowering)	Leaf abscission (days after emergence)
B × M	83.32a	Mar, 26	97.00a	24.00a	16.00a	239.00a
K × M	86.98a	Feb, 7	90.00b	15.00b	16.00a	234.00a
S × M	93.22a	Feb, 6	99.00a	19.00a	18.00a	232.00a
M × M	43.36c	Mar, 26	82.00c	14.00b	12.00b	238.00a

Within each column, same letter indicates no significant difference between treatments at 5% levels of LSD.

Measurement:

After seven months, the yielded fruits, which resulted from hand pollination, were harvested and some qualitative characteristics were evaluated. About fruit quality, sun burn scald (SBS), fruit cracking (FC), fruit decay (FD), fruit juice content (FJ), total soluble solids (TSS), total acidity (TA) and TSS/TA ratio, rind and seed color, rind thickness, dimension of aril and seed were evaluated on 100 harvested fruits in each treatment. Sun burn scald was assessed considering the appearance of fruit skin and data showed as percent. Fruit cracking and decay were determined using the harvested fruits and data showed in percent. The juice content of fruit was evaluated in a sample including 100 g of fruit in each replication and data showed as ml $100g^{-1}$ fruit fresh weight. Total soluble solid contents were accounted by refractometer and showed as percent. Total acidity was determined by titration method using 0.1 N of NaOH, and results were expressed as mg citric acid in 100 g fruit fresh weight [1].

Then, some samples of seeds in each treatment were separated from pulp and prepared, then planted on special rows in winter to receive essential amount of chilling and germinate in future season. After germination, the canopy growth area, time of leaf appearance, and the time of leaf abscission were recorded.

Statistical Analysis:

The experiment was arranged in Randomized Complete Block Design (RCBD) with 4 treatments and 10 replications, each replication consisted of 10 trees. For evaluation of characteristic, 100 fruit were used. Means were compared using least significant difference (LSD) tests at 5% level.

RESULTS AND DISCUSSION

Pollen source influenced all qualitative traits of pomegranate with the exception of aril color and taste that unaffected. Cross pollination increased fruit decay, and the lowest rate was observed in M × M. It seems that all

other pollens are effective in decay development (Table 2). The lowest cracking also observed in M × M pollination (Table 2). Data showed that both 'Kambar Najaf Abad' and 'Sangan Khash' are effective in fruit cracking, however, significantly reduced sun burn disorder (Table 2). The highest total yield was observed in B × M, S × M and K × M pollinations that may be resulted from larger seeds or arils, higher fruit set and development or larger peel content (Table 2). Increment of total yield was in agreement with findings of Derin and Eti (2001) and may be resulted from cross-pollination.

Pollen source affected peel color, as data shown, this variable changed from rich-red into pale red in 'Malas-e-Yazdi' (Table 3). The highest thickness of peel was obtained in K × M and S × M treatments that may be related to higher yield (Table 3).

The highest seed length and diameter were shown in B × M, K × M and S × M treatments (Table 3). Aril color and taste unaffected by different pollen sources (Table 4), however, the lowest aril length and juice volume were resulted from K × M and S × M (Table 4). A positive correlation was observed between aril length and juice volume and also peel thickness and juice content. The highest TSS and TA were shown in M × M and pollen source decreased these variables (Table 4). The best marketable index (TSS/TA ratio) was resulted from B × M pollination and self-pollination reduced this variable (Table 4).

Compatibility and incompatibility evaluated via seed germination percentage. Data showed that self-pollination significantly reduced this variable and the highest rate was obtained from S × M (Table 5). There was a positive correlation between total yield and seed germination percentage. It is suggested that more viable embryo and seeds are the cause of the higher yield. Regarding to breeding aspects, pollen source affected vegetative growth and development of pomegranate (Table 5). 'Kambar Najaf Abad', 'Sangan Khash' delayed leaf emergence of plant that is good for chilling injury reduction. The highest leaf area and also the later flowering were observed in B × M and S × M treatments, which may useful to find late flowering cultivars (Table 5).

Moreover, fruit setting was delayed in treatments other than M × M that needs longer growing season for fruit growth and development or may improve harvesting period to find or develop its market (Table 5). Leaf abscission unaffected by parental genetic (Table 5). Regarding to data presented here, it is concluded that pollen source strongly affects fruit yield and quality of pomegranate and the best pollinizer for 'Malas-e-Yazdi' is 'Bihasteh Ravar', because of lower thickness in peel, more juice volume, higher TSS/TA and high productivity.

Conclusion:

In the light of this experiment it can be concluded that: Although hybridization led to the best results, however, it was a time-consuming method. It is advised that to find a better method to reduce the experimental period. Finally, it is concluded that cultivation of more than one pomegranate cultivar is necessary for commercial orchards to achieve the better yield and quality. There are more than 760 cultivars in Iran that needs to find all pollinizers and pollen receptive for future industrial development of pomegranate.

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