

Effect of Self, Open and Cross Pollination on Fruit Characteristics of Some Plum Cultivars

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Abstract: This investigation was performed during 2005 and 2006 seasons on three plum cultivars Hollywood, Golden Japanese and Santa Rosa trees grown in loamy soil at Sendyon village, Kalubia governorate, Egypt. The present study was carried out to determine the effects of different types of pollination on fruit physical and chemical characteristics. Data showed that cross pollination of Santa Rosa cv. with Golden Japanese cv. gave the heaviest and largest fruits, followed by Golden Japanese cv. cross pollination with Santa Rosa cv. during the two studied seasons. Also Santa Rosa cv. under cross pollination with Golden Japanese pollen grains yielded fruits with higher dimensions than with self pollination. In case of fruit shape index and firmness, results showed some differences regarding the pollination type and generally cross, open pollination had fruits of round shape, meanwhile fruits resulted from self pollination tended to be oblong shape. Cross pollination of Santa Rosa cv. with Hollywood pollen grains recorded the highest fruit firmness, meanwhile Hollywood cv. with self pollination recorded the lowest firmness during the two studied seasons. Total soluble solids (TSS %), TSS/acid as well as total sugars % were increased at cross pollination of Hollywood cv. with Santa Rosa cv. during the two seasons of study.

Key words: Cultivars · fruit characteristics · Plum · pollination

INTRODUCTION

Plums (*prunus salicina*) are occupying an important share in the total fruit production of Egypt. Plum fruit are mainly marketed as fresh consumption as well as for drying. Also using for canning freezing, Jam and Jelly products [1].

The total area of plum in Egypt reached about 2960 feddans which produced 17148 tons with an average yield of 5.79 tons/fed. according to the census of Egyptian Ministry of agriculture [2].

The majority of plum cultivars are self incompatible and failed to give satisfactory yield in the absence of suitable pollinizers. In addition, cross and open pollination of different plum cultivars resulted in significant increases in fruit set, large and more uniform crops than self pollination. Therefore, to ensure maximum fruit production from plum orchards it is necessary plant cultivars with sufficient overlap in bloom, to permit adequate cross pollination, is necessary.

The effect of pollination on apple fruit weight and size were found by El-Wakee *et al.* [3], Arafat *et al.* [4]

and Stino *et al.* [5]. Fruit shape index Miller [6] Khalil [7] and Stino [5], Tss Larry *et al.* [8] El-Sherbini [9] and Stino *et al.* [5], Firmness Arafat *et al.* [4] and Stino *et al.* [5], Acidity, El-Sherbini [9], church and Williams [10] and Stino *et al.* [5] has been studied.

Moreover, the effect of different pollination treatments has been studied in different fruit trees species, such as apricot Burgos *et al.* [11], almond Ahmed *et al.* [12], Ortega *et al.* [13] and on olive Essa [14], Hassan [15], Atawia [16] Milany *et al.* [17] and El-Agamy *et al.* [18].

The main objective of the present investigation was to study the relationship of pollination regime in the studied cultivars on plum fruit characteristics.

MATERIALS AND METHODS

This investigation was performed during 2005 and 2006 seasons on 13 years old trees of three plum cultivars namely, Hollywood, Golden Japanese and Santa Rosa trees were grown in loamy soil at Sendyon village, Kalubia governorate Egypt. These trees were cultivated

at 5×5 M apart under basin irrigation system. Trees were similar in their vigor and subjected to the same horticultural practices. The trees were randomly selected from each cultivar in each replicate tree 40 shoots were labbled and divided randomly into 4 groups (each of 10 shoots) and examined for either self, open and cross pollination. Three replicate trees were chosen for each cultivar and one tree per replicate to study the pollination treatments.

Pollination studies: In each season of the study and on each cultivar four pollination treatments were made as follows:

- Self pollination (bagging only),
- Open pollination,
- Cross pollination by the other selected cultivars (Hollywood, Golden Japanese and Santa Rosa).

For self pollination (bagging only) flowers were covered with pergamine bags prior to flower opening. This was done before flower opening for about 3-4 days to 15 days after full bloom. In open pollination the flowers were left under the natural conditions of the orchard. Meanwhile, cross pollination of each cultivar was done when flowers were at balloon stage were hand emasculated; covered with pergamine bags till reached the stage of anthesis and then pollen grains of the two male parents applied to the stigma of emasculated flowers.

Fruit physical characteristics: Sample of 20 mature fruits were taken from each replicate tree of each pollination type and the following characteristics were determined:

- Average fruit weight (g),
- Average fruit volume (cm³),
- Specific gravity (gm cm⁻³),
- Average fruit length and diameter (cm),
- Fruit shape index (L/D),
- Fruit firmness was determined as (Lb/inch²) by using taylor pressure tester 5/16 inch plunger.

Fruit chemical characteristics:

- Total soluble solids Tss % of fruit juice was measured by using a, Hand Refractometer,
- Fruit acidity, the percentage of total acidity in fruit juice was determined as malic acid according to A.O.A.C. [19],
- Total soluble solids/acid ratio,

- Total soluble sugars, was determined according to smith [20] in methanolic extract using the phenol sulphoric acid methods and the percentage was calculated on dry weight basis.

Statistical analysis: A completely randomized block design was used and the obtained data were subjected to analysis of variance and Duncan's multiple range test used to differentiate means Duncans [21].

RESULTS AND DISCUSSION

Fruit physical and chemical characteristics

1 - Physical characteristics

Fruit weight, volume and specific gravity: Results in Table 1 show that the values of fruit weight and volume of three plum cultivars Hollywood, Golden Japanese and Santa Rosa under different pollination treatments (self, open and cross) during 2005 and 2006 seasons. It is evident that, Santa Rosa under cross pollination with Golden Japanese gave the heaviest and largest fruits followed by Golden Japanese cross pollination with Santa Rosa, during the two successive seasons.

Concerning specific gravity data presented in Table 1 showed that specific gravity was not significantly affected by different pollination treatment in the first season. Meanwhile in the second one Santa Rosa open pollination recorded the highest specific gravity while Hollywood cross with Santa Rosa pollen grain recorded the lowest specific gravity.

These results are agreement with those obtained by El-Wakeel *et al.* [3] on apple, Stino *et al.* [5] on apple and Kilany *et al.* [17] on olive.

Fruit length and width: The present data in Table 2 indicated that, cross pollination of Santa Rosa cv. with Golden Japanese pollen grains yielded fruits with higher dimensions as compared with self pollination.

The above results goes in line with those obtained by Essa [14], Hassan [15], Atawia [16], El-Kilany *et al.* [17] on olive they demonstrated that fruit diamension were significantly affected by different pollination treatments.

Fruit shape index and firmness: Data presented in Table 3 showed that fruit shape index were affected by different pollination types and generally cross and open pollination had round fruit shape, meanwhile those fruits resulted in from self pollination tended to be oblong shape.

Table 1: Effect of self, open and cross-pollination on fruit weight, volume and specific gravity of some plum cultivars in 2005 and 2006 seasons

Cultivars	Treatments	Fruit weight (g)		Fruit volume (cm ³)		Specific gravity	
		2005	2006	2005	2006	2005	2006
Hollywood	Self Pollination	32.00f	34.03f	31.67h	33.50g	1.07a	1.01b
	Open Pollination	37.17gh	39.33e	36.10g	38.70ef	1.00a	1.01b
	Cross with Golden Japanese	44.57de	46.40cd	42.57ef	44.17cd	1.47a	1.05ab
	Cross with Santa Rosa	44.90de	45.33d	44.23de	45.67bc	1.01a	0.99b
Golden Japanese	Self Pollination	40.43fg	39.20e	39.67f	38.27ef	1.01a	1.02ab
	Open Pollination	45.77cde	47.67bcd	45.00cde	46.00bc	1.01a	1.03ab
	Cross with Hollywood	47.83bcd	49.63bc	46.97bcd	48.00abc	1.01a	1.03ab
	Cross with Santa Rosa	50.20ab	51.50ab	49.20ab	49.50ab	1.01a	1.03ab
Santa Rosa	Self Pollination	36.37h	37.87e	35.90g	36.33fg	1.00a	1.03ab
	Open Pollination	43.20ef	44.83d	40.33f	41.33de	1.02a	1.07a
	Cross with Hollywood	48.80bc	51.27ab	48.10abc	49.27ab	1.01a	1.04ab
	Cross with Golden Japanese	53.10a	54.13a	51.17a	51.67a	1.03a	1.04ab

Table 2: Effect of self, open and cross-pollination on fruit length and width of some plum cultivars in the 2005 and 2006 seasons

Cultivars	Treatments	Fruit length (cm)		Fruit width (cm)	
		2005	2006	2005	2006
Hollywood	Self Pollination	3.76bcd	3.86c	3.56e	3.70d
	Open Pollination	3.93abcd	4.06bc	3.96cd	4.03bc
	Cross with Golden Japanese	4.03abcd	4.10bc	4.16abcd	4.23ab
	Cross with Santa Rosa	4.06abcd	4.26ab	4.13abcd	4.23ab
Golden Japanese	Self Pollination	3.70cd	3.90c	4.13abcd	4.26ab
	Open Pollination	3.96abcd	4.16abc	4.26abc	4.36a
	Cross with Hollywood	4.13abc	4.30ab	4.26abc	4.40a
	Cross with Santa Rosa	4.06abcd	4.16abc	4.33ab	4.43a
Santa Rosa	Self Pollination	3.63d	4.03bc	3.83de	3.93cd
	Open Pollination	4.13abc	4.16abc	4.03bcd	4.23ab
	Cross with Hollywood	4.20ab	4.30ab	4.30abc	4.26ab
	Cross with Golden Japanese	4.33a	4.43a	4.43a	4.50a

Table 3: Effect of self, open and cross-pollination on fruit shape index and firmness of some plum cultivars in the 2005 and 2006 seasons

Cultivars	Treatments	Fruit shape index		Fruit firmness Ib/inh ²	
		2005	2006	2005	2006
Hollywood	Self Pollination	1.05a	1.04a	10.17f	10.20h
	Open Pollination	0.98ab	1.00ab	10.20f	10.33gh
	Cross with Golden Japanese	0.96bc	0.96abc	10.47ef	10.50efg
	Cross with Santa Rosa	0.95bc	1.00ab	11.50ab	11.57a
Golden Japanese	Self Pollination	0.89c	0.91c	10.20f	10.40fg
	Open Pollination	0.92bc	0.94bc	10.57de	10.57def
	Cross with Hollywood	0.95bc	0.97abc	10.70de	10.80c
	Cross with Santa Rosa	0.93bc	0.93bc	11.17bc	11.30b
Santa Rosa	Self Pollination	0.94bc	1.02ab	10.90cd	10.70cd
	Open Pollination	0.98ab	0.98abc	10.63de	10.60de
	Cross with Hollywood	0.97abc	1.00ab	11.57a	11.60a
	Cross with Golden Japanese	0.97abc	0.98abc	11.47ab	11.47b

Table 4: Effect of self, open and cross-pollination on TSS% and Acidity of some plum cultivars in the 2005 and 2006 seasons

Cultivars	Treatments	TSS %		Acidity %	
		2005	2006	2005	2006
Hollywood	Self Pollination	13.53c	13.80b	1.00bc	1.03ab
	Open Pollination	13.93abc	14.33a	0.86cd	0.96b
	Cross with Golden Japanese	14.23ab	14.53a	0.90cd	0.86c
	Cross with Santa Rosa	13.87abc	14.63a	0.76d	0.83cd
Golden Japanese	Self Pollination	11.83e	12.43d	1.13ab	1.03ab
	Open Pollination	12.00de	12.93c	1.20a	1.00ab
	Cross with Hollywood	12.50d	12.67cd	1.13ab	1.06a
	Cross with Santa Rosa	12.50d	14.47a	1.10ab	1.03ab
Santa Rosa	Self Pollination	14.47a	13.80b	0.83d	0.76d
	Open Pollination	13.67bc	13.93b	0.76d	0.83cd
	Cross with Hollywood	13.73bc	14.33a	0.80d	0.83cd
	Cross with Golden Japanese	14.07abc	14.67a	0.90cd	0.86c

Table 5: Effect of self, open and cross-pollination TSS/acid ratio and Total sugars of some plum cultivars in the 2005 and 2006 seasons

Cultivars	Treatments	TSS/acid ratio		Total sugars %	
		2005	2006	2005	2006
Hollywood	Self Pollination	13.60e	13.37c	8.63de	8.83def
	Open Pollination	17.16bcd	14.87b	9.20bc	9.20d
	Cross with Golden Japanese	15.27de	16.83a	9.96a	10.13ab
	Cross with Santa Rosa	18.17a	17.63a	10.30a	10.40a
Golden Japanese	Self Pollination	10.50f	12.03d	8.60de	8.66ef
	Open Pollination	10.03f	12.93cd	8.33e	8.46f
	Cross with Hollywood	11.03f	11.90d	8.76d	8.93de
	Cross with Santa Rosa	11.40f	14.03bc	9.96a	10.17ab
Santa Rosa	Self Pollination	17.40abc	18.07a	8.93cd	9.60c
	Open Pollination	17.90ab	16.77a	9.43b	9.96bc
	Cross with Hollywood	17.20abc	17.23a	10.20a	10.27ab
	Cross with Golden Japanese	15.77cd	16.97a	8.78d	8.60ef

Regarding fruit firmness data presented in the same table cleated that fruit firmness was significantly affected with different pollination treatments.

Santa Rosa cv. Cross with Hollywood pollen grains recorded the highest fruit firmness meanwhile Hollywood under self pollination recorded the lowest fruit firmness during two successive seasons. The above results agree with those obtained with Miller [6] and Khalil [7], Arafat *et al.* [4] and Stino *et al.* [5].

2 - Chemical characteristics

Total Soluble Solids (TSS %) and acidity: Data in Table 4 revealed that, Santa Rosa plum fruit under self pollination recorded the highest Juice TSS % in the first season, meanwhile in the second one Santa Rosa plum fruit cross with golden Japanese recorded the highest TSS %. On the other hand self pollination Golden Japanese plum fruit recorded the lowest fruit

TSS % during both seasons, respectively.

As for total acidity % of fruit Juice, data presented in Table 4 revealed that, Santa Rosa fruit Juice under self and open pollination recorded the significantly lowest fruit Juice acidity % during the first and second seasons, respectively.

TSS/acid ratio and total sugars %: Data in Table 5 indicted that Hollywood fruit which cross pollinated with Santa Rosa gave the highest percentage of TSS/acid ratio during the first season. Meanwhile, Santa Rosa self pollinated recorded the highest range in this respect during the second season.

Concerning total sugars data in Table 5 showed that, Santa Rosa pollens induced higher total sugars values when used as a pollinizer for Hollywood cultivar during both season, respectively. On the other hand, open pollination in golden Japanese induced the lower

percentage of total sugars in first and second seasons, respectively.

Similar results were reported by El-Sherbini [9], church and Williams [10], Stino *et al.* [5] and El-Agamy *et al.* [18]. TSS, acidity and total sugar were affected with different pollination treatments.

Generally, it can be concluded from the obtained results, study, that cross and open pollination were more effective and resulted in an improved fruit physical and chemical characteristics while self pollination ranked later in this respect.

REFERENCES

1. Crisosto, C.H., 1994. Stone fruits maturity indices: A descriptive review. *Postharvest. News Info.*, 5: 65-68.
2. Ministry of Agric, A.R.E., 2005. Acreage and total production of Agric. Crops in A.R.E. *Bull. Agric. Econ and statistics (In Arabic)*.
3. El-Wakeel, A.T., A.R. El-Shekh and A.F. El-Solimon, 1974. Certain quality of leconte pear fruits in relation to seedless. *Agric. Res. Rev.*, 59: 1.
4. Arafat, A.M., N.S. Guirguis and M.M. Yehia, 1994. Effect of open and cross pollination on fruit set and fruit quality of Anna apple. *Annals Agric. Sci. Moshtohor*, 32: 2083.
5. Stino, R.G., E.S. Hegazy, T.A. Yehia and A.A. Hegazy, 2001. Bearing potential, fruit growth and quality of Anna apples in relation to bud position and pollination regimes. *Egypt. J. Hort.*, 28: 291-303.
6. Miller, S.S., 1979. Effect of promalin on physical characteristics of delicious apples grown in two geographic location. *J. Am. Soc. Hort. Sci.*, 104: 857.
7. Kalil, B.M., 1989. Studies on compatibility of some apple cultivars grown in Egypt. M.Sc. thesis, Fac. Agric., Cairo Univ., Egypt.
8. Larry, K., H.K. Hig and S.A. Hale, 1977. Association between soluble solids/acid content and days from full bloom of Golden delicious apple fruit. *J. Am. Soc. Hort. Sci.*, 102: 429.
9. El-Sherbini, N.R., 1982. Physiological and histological studies on fertilization, setting and fruit quality of apple. Ph.D. thesis, Fac. Agric., Cairo, Univ.
10. Church, R.M. and R.R. Williams, 1983. Comparison of the compatibility and meta xenia effect of several dessert apple and ornamental Malus cultivars with Cox's orange pippin. *J. Hort. Sci.*, 58: 343.
11. Burgos, L.L., T. Berenguer and J. Egea, 1993. Self and cross compatibility among apricot cultivars. *Hort. Sci.*, 28: 148-150.
12. Ahmed Oukabli, A. Lansari, D.L. Wallali, A. Abou Salim, J. Egea and N. Michaux, 2000. Self and cross pollination effects on pollen tube growth and fertilization in self compatible almond (*Prunus dulicus*) Tuono. *J. of Hort. Sci. Biotechol.*, 75: 739-749.
13. Ortega, E., J. Egea and F. Dicenta, 2004. Effective pollination period in Almond cultivars. *Hort. Sci.*, 39: 19-22.
14. Eassa, K.B., 1993. Effect of cross pollination on fruiting of some olive varieties. M.Sc. Thesis, Fac. of Agric. Moshtohor, Zagazig Univ., Egypt.
15. Hassan, S.A., 1996. Studies on floral biology, pollination and fruiting of some olive cultivars. M.Sc., Thesis, Fac. of Agric, Cairo Univ. Egypt.
16. Atawia, A.A.R., 1997. Pollination effect and cytological analysis of Picual olive and some pollinator cultivars. *Annals of Agric. Sci., Moshtohor*, 35: 1633-1644.
17. Kilany Omaira, A., T.A. Yehia, M.S. Abou Rayya and H.S. Hassan, 2002. Morphological and physiological studies on flowering, pollination and fruiting of Picual olive trees. II effect of selfopen, cross pollination on fruit set, drop and fruit characteristics. *J. Agric. Sci. Mansoura Univ.*, 27: 493-501.
18. El-Agamy, S.Z., T.K. El-Mahdy, F.A. Khalil and B. Abd El-Sabour, 2003. Studies on flowering and fruit set of some olive cultivars under Assiut Environments. a. The effect of mating system on chemical characteristics of fruits. *Assiut. J. of Agric. Sci.*, 34: 99-120.
19. A.O.A.C., 1985. Official Methods of analysis. Association of official analytical chemists Washington DC., pp: 490-510.
20. Smith, F., A.M. Gilles, K.J. Haniltum and A.P. Gedeas, 1956. Colourimetric methods for determination of sugar and related substances. *Ann. Chem.*, 28: 350.
21. Duncan, D.B.C., 1955. Multiple range and multiple (F) test *Biometrics*, 11: 1-42.