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Effect of pollen source on some fruit characteristics of exotic pear (*Pyrus communis* L.) cv. carmen and abate Fetel

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Abstract

A research experiment was conducted on two fruit bearing exotic cultivars “Carmen” and “Abate Fetel” of pear (*Pyrus communis* L.). The treatments included self, open and cross pollination of these two maternal parents with seven pollinizers viz., “William Bartlett”, “Fertility”, “Clapp’s Favourite”, “Chinese Sandy Pear”, “Max Red Bartlett”, “Kings Pear” and “Beurre de Amanalis”. The design of experiment was RCBD with three replications and the number of treatment combinations were 18. Pollen source affected the fruit colour significantly, wherein the highest value of red colour based on ‘a’ value was recorded with the pollen of “Max Red Bartlett” in the combination ‘Carmen × Max Red Bartlett’ (a=25.81) whereas, it was lowest with the pollen of “Kings Pear” (a=-16.63) in the combination ‘Abate Fetel × Kings Pear’, fruit shape, pedicle length and number of lenticles remain unaffected with the pollinizers used, however, sensory characteristics varied significantly with the pollinizers used.

Keywords: Pollen, characteristics, pear, *Pyrus communis* L.

Introduction

Pear (*Pyrus communis* L.) belongs to family Rosaceae, sub-family Pomoideae, order Rosales and genus *Pyrus*. The cultivated pear is an economically important fruit tree species of genus *Pyrus* in which often gametophytic self-incompatibility occurs. Therefore, this species need to be pollinated by cross-compatible cultivars that bloom in the same time. Selection of appropriate pollinizers for pear cultivars is very important to produce commercial yield. Pollination stimulates the development of ovary and the surrounding tissue leading to the formation of fruit (Callan and Lombard, 1978) [2]. Pollination is therefore an important biologic factor in pear culture, and pollen viability and germination are two fundamental cues, indicating the productive potential of the cultivar. Pollen source besides improving the fruit set and retention, have strong impact on physical and biochemical quality of fruit as reported in some fruit crops like date (Al-Obeed and Abdul-Rehman, 2002) [1] through plant hormones produced by seeds. This phenomenon by which a characteristic of pollen parents is expressed in maternal tissues outside the embryo and endosperm is called as metaxenia and it might be included in xenia. The effects of the phenomenon was proved at different species for qualitative characteristics, like color (*Castanea*, *Citrus*, *Diospyros*, *Malus*, *Pyrus*, *Rubus*, *Vitis*), shape (apple, pear, grape), sugar content (apple, peach, corn), other internal chemicals (sunflower, olive, bean). The aim of this investigation was to determine the effect of pollen source on some of the quality characteristics of exotic pear cultivars Carmen and Abate Fetel.

Materials and Methods

Full bearing exotic pear cultivars under high density planting, uniform in age were selected for experimentation in Experimental Farm of Division of Fruit Science Sher-e-Kashmir University of Agricultural Science & Technology of Kashmir, Shalimar, Srinagar, Jammu & Kashmir during 2017. The soil was moderately deep, having medium fertility status. The trees were spaced at 3 m × 3m laid in square system of planting on Quince C rootstock which received uniform cultural practices during the study. Pollination was conducted under three different modes viz., self-pollination, open pollination and hand cross pollination. The pear cultivars used as female parents were Carmen (M₁) and Abate Fetel (M₂) while as source of pollen used as male parents were William Bartlett (P₁), Fertility (P₂), Clapp’s Favourite (P₃), Chinese Sandy Pear (P₄), Max Red Bartlett (P₅), Kings Pear (P₆), Beurre de Amanalis (P₇), Abate and Carmen (P₈) and open source (P₉).

Fruit shape of the representative samples from each treatment combination was observed according to International Union for the Protection of New Varieties (UPOV 2004-2005) pear descriptor. The colour of the representative fruit samples from each treatment combination was observed under Hunter colour Lab. (A60-1014-593). The pedicel length of each random sample was measured with the help of digital vernier caliper in millimeters and then converted into centimeter. Pedicel length was averaged and statistically analyzed. The number of lenticels was counted in each representative sample with the help of magnifying glass. These observations were recorded when the lenticels were prominent. The number of lenticels were averaged and statistically analyzed. Sensory quality attributes such as fruit texture, flavour, taste and overall acceptability of each sample of pear fruits were evaluated by 5 panelists. The samples for organoleptic evaluation were presented to the panelists in coded form and then requested to note their sensory responses on the basis of texture, flavour, taste and overall acceptability on 5 point sensory evaluation scale.

5	:	Excellent
4	:	Very good
3	:	Good
2	:	Fair
1	:	Poor

Result and discussion

The fruit shape was observed visually by comparing the fruits of different cross combinations with that of UPOV pear descriptor (2004-2005) and observations were penned down in Table 1. The observations clearly reveal that although maternal parents showed clear difference in terms of fruit shape as the position of maximum diameter in “Carmen” was clearly towards the calyx and profile was concave whereas, in “Abate Fetel” position of maximum diameter was slightly towards the calyx with straight profile, however, pollen source did not effect the fruit shape to considerable extent in any of the treatment combination. Fruit shape is largely dependent on the formation of seeds within the pericarp of the fruit, pome fruits that develop as a full complement of seeds are more symmetrical than those with fewer seeds (Ryugo, 1988) [12]. Nakagawa *et al.*, 1968 proposed that seed development leads to greater extension of locules and ovary, affects the cell division and extension of outer sections of locules. The reason for this is probably due to hormones such as gibberellin and cytokinins. The auxins synthesized by the seeds not only increase accumulating organic substances in the fruit but also induce the cytokinins (Soltesz, 1997) [14]. The cultivars which develop regular and symmetrical fruits contain good number of seeds hence, seeds play an important role in shaping of fruits. The fruit shape obtained in present investigation was identical in all the combinations, which may be attributed to the fact that none of the fruits contained less than five number of seeds in all the treatment combination moreover, seed number was sufficient to contribute to pear shape. These findings also corroborate the results of Sharifani (1997) [13] who reported that five to six seeds is sufficient to give high proportion of nicely shaped fruits in pear..

The L, a, b colour space (also referred to as CIELAB) is presently one of the most popular spaces for measuring object colour and is widely used in virtually all fields. In this space, ‘L’ indicates lightness and ‘a’ and ‘b’ are the chromaticity coordinates; ‘a’ and ‘b’ indicate colour directions, +a is the red direction, -a is the green direction, +b is the yellow

direction, and -b is the blue direction. Perusal of the data recorded with respect to fruit colour under hand cross pollination and open pollination of both the pear cultivars under study is penned down in (Table 2). Fruit over colour is determined on the basis of value of ‘a’, the highest value of ‘a’ (a=25.81) in cultivar “Carmen” was obtained for ‘Carmen x Max Red Bartlett’ combination whereas, the lowest value of ‘a’ (a=16.83) was obtained in ‘Carmen x Kings Pear’ combination, which was lower than that obtained from open pollination (a=21.63), while as for “Abate Fetel” as female parent the value of ‘a’ was negative under all the combinations. Lightness of colour ‘L’ value in cultivar “Carmen” was highest (34.79) in ‘Carmen x William Bartlett’ combination and also in “Abate Fetel” fruit colour lightness was highest (51.93) in ‘Abate Fetel x William Bartlett’ combination. The ‘b’ value for cultivar “Carmen” was highest (24.28) in ‘Carmen x William Bartlett’ combination and for cultivar Abate Fetel the highest value of ‘b’(43.33) was obtained in ‘Abate Fetel x William Bartlett’ combination. Lancaster (1992) [7] reported that fruit skin colour is determined by carotenoids, chlorophyll and anthocyanin. The red blush in fruits is due to the presence of two anthocyanin pigments, cyanidin 3-galactoside and cyanidin 3-arabinoside, in hypodermal layers of the skin (Dussi *et al.*, 1995) [3]. Steyn *et al.* (2004) [15] reported that during the development of pear fruit there is change in activity of phenylalanine ammonia-lyase (PAL) and Uridine diphosphate galactose (UDPGalactose), flavonoid -3 o-glycosyl transferase (UFGT). Also, he reported that red and blushed pear cultivars attained maximum redness and highest anthocyanin concentrations in immature fruit and colour tends to fade towards harvest and this fading of red colour was attributed to the high day temperatures and light which lead to anthocyanin degradation and hence colour fading towards maturity. The variations in the value of L, a, b in different treatment combinations in the present investigation may be ascribed to metaxenic effect of pollen source on the maternal tissues, the genes of the parent transfer to embryo which may affect the embryo and endosperm physiology and such changes in turn affect the pericarp appearance, however, transposons do not jump directly to maternal tissues. These results are similar to those found by Militaru *et al.* (2015) [9] who reported fruit skin colour parameters showed significant differences between the fruits obtained by different cross combinations in apple. Levin (1994) [8] also stated that occasionally metaxenia is observed such that there are several seeds of other colours within an individual fruit of pomegranate. Gharaghani *et al.* (2017) [4] also reported metaxenic effect of pollen source on fruit peel colour in pomegranate.

It is evident from the data pertaining to pedicel length (Table 3) that highest mean pedicel length (2.80 cm) was observed with pollinizer “William Bartlett” followed by pedicel length of 2.73 cm with “Chinese Sandy Pear” irrespective of the varieties of pear used in study. The lowest pedicel length of 2.61 cm was recorded when “Clapp’s Favourite” was used as pollen source. However, the pollinizers did not show any significant effect on pedicel length, but pedicel length varied significantly between the cultivars i.e. “Carmen” and “Abate Fetel”. The highest pedicel length (3.04 cm) was observed in cv. “Carmen” while as pedicel length to the tune of 2.35 cm was found in “Abate Fetel”.

The data recorded for presence of lenticels (Table 4) clearly indicate that highest mean number of lenticels (26.78) were observed with pollinizer “Fertility” followed by (26.77) with

“Clapp’s Favourite” irrespective of the varieties of pear used in study. The lowest number of lenticels 26.21 were recorded when “Kings Pear” was used as pollen source. The data depicts that pollinizers did not show any significant effect on presence of lenticels, however, presence of lenticels varied significantly between the cultivars i.e. “Carmen” and “Abate Fétel”. The highest number of lenticels (27.49) were observed in “Abate Fétel” while as number of lenticels to the tune of 25.54 were found in “Carmen”.

Score for sensory evaluation (texture, flavour, taste and overall acceptability) varied from 3.01 to 4.23 for cv. “Carmen” and for cv. “Abate Fétel” score varied from 2.84 to 4.00 under different treatment combinations (Table 5). The highest score (3.92) for texture was noticed in ‘Carmen x William Bartlett’ combination and lowest (2.84) in ‘Abate

Fétel x Kings pear’. Score for flavour was rated highest (4.02) in ‘Carmen x Fertility’ and lowest (2.92) in ‘Abate Fétel x Kings Pear’, for taste highest score (4.23) was given to ‘Abate Fétel x Fertility’ combination and lowest (2.91) ‘Carmen x Kings Pear’. Overall acceptability was highest (3.96) in ‘Carmen x Fertility’ and minimum (2.92) in ‘Abate Fétel x Kings Pear’ combination. Paillard (1990) [11] stated that “taste is directly linked to certain constituents present in variable amounts” and further suggested that the acid and sugar contents of apples can give a good indication of flavour. Hulme and Rhodes (1971) [5] consider the taste of pome fruits including apples is principally based on sugar/acid balance. Similar variations in organoleptic rating of apple using different pollinizers was reported by Javid (2015) [6].

Table 1: Effect of pollen source on fruit shape (based on UPOV descriptor 2004-2005) in different cultivars of pear

Maternal parents (M)	Pollen Source (P)								
	P1: William Bartlett	P2: Fertility	P3: Clapp’s Favourite	P4: Chinese Sandy Pear	P5: Max Red Bartlett	P6: Kings Pear	P7: Beurre de Amanalis	P8: Self Pollination	P9: Open Pollination
M₁: Carmen									
Position of maximum diameter	Clearly towards calyx	Clearly towards calyx	Clearly towards calyx	Clearly towards calyx	Clearly towards calyx	Clearly towards calyx	-	-	Clearly towards calyx
Profile	Concave	Concave	Concave	Concave	Concave	Concave	-	-	Concave
M₂: Abate Fétel									
Position of maximum diameter	Slightly towards the calyx	Slightly towards the calyx	Slightly towards the calyx	Slightly towards the calyx	Slightly towards the calyx	Slightly towards the calyx	-	-	Slightly towards the calyx
Profile	Straight	Straight	Straight	Straight	Straight	Straight	-	-	Straight

Table 2: Effect of pollen source on fruit colour (L* a* b*) in different cultivars of pear

Maternal parents (M)	Pollen source (P)									Mean
	P1: William Bartlett	P2: Fertility	P3: Clapp’s Favourite	P4: Chinese Sandy Pear	P5: Max Red Bartlett	P6: Kings Pear	P7: Beurre de Amanalis	P8: Self Pollination	P9: Open Pollination	
M₁: Carmen										
L	34.79	32.53	29.58	31.60	27.54	30.53	-	-	33.85	31.48
a	20.42	19.16	23.08	17.67	25.81	16.83	-	-	21.63	20.65
b	24.28	22.79	19.57	21.56	18.80	20.59	-	-	22.89	21.49
M₂: Abate Fétel										
L	51.93	49.12	40.70	46.04	39.34	45.85	*	*	50.67	46.23
a	-14.67	-15.30	-16.10	-15.53	-16.30	-16.63	-	-	-14.90	-15.98
b	43.33	40.73	38.03	39.06	34.37	37.20	-	-	42.13	39.26

C.D ($p \leq 0.05$)

		L	a	b
Maternal parent (M)	:	0.35	0.26	0.48
Pollen source (P)	:	0.65	0.50	0.90
M x P	:	0.93	0.70	1.26

Table 3: Effect of pollen source on pedicel length (cm) in different cultivars of pear

Maternal parents (M)	Pollen source (P)									Mean
	P1: William Bartlett	P2: Fertility	P3: Clapp’s Favourite	P4: Chinese Sandy Pear	P5: Max Red Bartlett	P6: Kings Pear	P7: Beurre de Amanalis	P8: Self Pollination	P9: Open Pollination	
M ₁ : Carmen	3.10	3.07	3.04	3.02	3.06	3.00	-	-	3.03	3.04
M ₂ : Abate Fétel	2.51	2.21	2.20	2.45	2.39	2.38	-	-	2.34	2.35
Mean	2.80	2.63	2.61	2.73	2.72	2.69	-	-	2.68	2.69

C.D ($p \leq 0.05$)

Maternal parent (M)	:	0.32
Pollen source (P)	:	NS
M x P	:	NS

Table 4: Effect of pollen source on presence of lenticels (No. cm⁻²) in different cultivars of pear

Maternal parents (M)	Pollen source (P)									Mean
	P1: William Bartlett	P2: Fertility	P3: Clapp’s Favourite	P4: Chinese Sandy Pear	P5: Max Red Bartlett	P6: Kings Pear	P7: Beurre de Amanalis	P8: Self Pollination	P9: Open Pollination	
M ₁ : Carmen	25.21	25.55	25.99	25.88	25.10	25.33	-	-	25.66	25.54
M ₂ : Abate Fétel	27.44	27.99	27.55	27.21	27.77	27.10	-	-	27.33	27.49

Mean	26.32	26.78	26.77	26.55	26.44	26.21	-	-	26.49	26.51
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C.D ($p \leq 0.05$)

Maternal parent (M) : 0.92

Pollen source (P) : NS

M \times P : NS**Table 5:** Effect of pollen source on organoleptic rating (score) in different cultivars of pear

Maternal parents (M)	Pollen source (P)									Mean
	P ₁ : William Bartlett	P ₂ : Fertility	P ₃ : Clapp's Favourite	P ₄ : Chinese Sandy Pear	P ₅ : Max Red Bartlett	P ₆ : Kings Pear	P ₇ : Beurre de Amanalis	P ₈ : Self Pollination	P ₉ : Open Pollination	
M₁: Carmen										
Texture	3.92	3.73	3.21	3.43	3.83	3.13	-	-	3.61	3.52
Flavour	3.91	4.02	3.14	3.26	3.81	3.01	-	-	3.63	3.51
Taste	3.90	4.12	3.82	3.53	4.00	2.91	-	-	3.00	3.61
Overall acceptability	3.91	3.96	3.39	3.40	3.88	3.01	-	-	3.41	3.56
M₂: Abate Fetel										
Texture	3.52	3.36	3.01	3.16	3.62	2.84	-	-	3.43	3.30
Flavour	3.51	3.45	3.02	3.13	3.63	2.92	-	-	3.46	3.30
Taste	4.00	4.23	3.66	3.20	3.94	3.00	-	-	3.48	3.64
Overall acceptability	3.67	3.68	3.23	3.16	3.73	2.92	-	-	3.45	3.40

C.D ($p \leq 0.05$)

Texture Flavour Taste Over all acceptability

Maternal parent (M) : 0.95 0.90 0.11 0.17

Pollen source (P) : 0.18 0.17 0.21 0.32

M \times P : NS NS NS NS

Conclusion

Pollen source affected the fruit colour and organoleptics of both the cultivars to a considerable extent, however, fruit shape, pedicel length and number of lenticles remain unaffected.

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