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Studies on the Compatibility Among Some Annona Cultivars as Pollinators and Their Effects on Fruit Set and Fruit Quality

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POLLINATION studies in Annona were conducted during 2007 & 2008 seasons in the Horticulture Research Institute. Pollen grains of Balady sp., Abd ElRazik and Finny cultivars were used to introduce different combinations of hybridization. Testing of pollen fertility revealed that Balady sp. has the highest percentage of fertile pollen. Moreover, using of Balady as a pollen parent had almost increased the initial percent of setting and fruiting of Abd ElRazik and Finny cultivars. Although the source of pollen parent affected both fruit length and fruit diameter, no clear trend could be observed during the two studied seasons. However, using of Balady pollen produced the best fruits with respect to fruit and pulp weight. However, the fruit contained the highest number of seeds. Concerning the T.S.S/acidity ratio, fruits resulted from using Abd ElRazik pollen parent revealed the highest ratio with all of the studied cultivars.

The genus Annona belongs to the family Annonaceae. It includes more than 60 species mostly of tropical American origin (Kojima, 2004). The Annona is one of the rare fruits which has become wanted for its desirable fruits (Armstrong *et al.*, 1997). Effective pollination of subtropical Annona is carried out by transfering pollens from the flower to the receptive stigma of female flower. In most subtropical countries, pollination is performed almost exclusively by large insects, especially beetles and large flies. Caging subtropical Annona without pollinators usually results in no, or only a few fruits (Degani *et al.*, 2003). Dichogamy is one of the major causes for the lack of open pollination which always results in a low yield. Furthermore, the short receptivity period of stigmas after anthesis (2-3hours) (Bonaventure, 1999) restricted the chance of pollination. In fact, the Annona fruits have different performances and quality. Therfore, the aim of the present investigation was firstly to improve the performance and fruit quality of *A. Atemoya* cultivars so as to enter successfully the race of competition with the other fruit crops, secondly to determine the most suitable source of pollen grains for pollination of Balady, Abd ElRazik and Finny to each other, and thirdly to have the possibility for collecting seeds with new genetic characteristics resulting from cross pollination for breeding programs.

Material and Methods

This investigation was carried out during two succesive seasons: 2007 & 2008 on Balady, Abd ElRazik and Finny cultivars grown in a loamy sand soil in

the Horticulture Research Institute, Giza Governorate. The tested pollination types were, hand-self pollination and interspecific cross pollination using pollens of the abovementioned cultivars. For each treatment, about 30 flowers, in three replicates, on three trees were used. These treatments were conducted through the last week of May, June, July and August to determine the effect of pollination date on fruit set, fruiting and fruit quality. For hand cross pollination, pollen grains were obtained from starting to open flowers, at the next day (8a.m.), pollens were directly applied to just starting to open flowers in which stigmas were sticky and receptive. The percentage of fruit set was calculated 10 days after pollination and went on at biweekly intervals up to fruit maturity.

Pollen fertility was tested by using 2, 3, 5-triphenyl tetrazolium chloride (TTC), staining solution, 1 part (10%TTC): 10 parts sucrose solution according to the methods described by (Oberle and Watson, 1953).

For studying the possible effect of pollen source on fruit quality, samples of six fruits from each replicate were picked at maturity stage and held at room temperature until ripening. Fruits were examined for the following aspects: fruit weight (gm), fruit length (cm), fruit diameter (cm), pulp weight (gm), Peel weight (gm), seeds weight (gm), seed number, T.S.S and percentage of acidity expressed as citric acid (A.O.A.C.,1975).

Data analysis

The experiment included in this study followed a complete randomized design in factorial design. Data analysis were performed by MSTAT-C (1990) computer statistical analysis program.The obtained data were subjected to analysis of variance (ANOVA) according to Senedecor and Cochran (1980).

Results and Discussion

Flowering date, number of flowers per shoots and pollen fertility in some Annona cultivars

As shown in Table 1 flowering date was affected by the cultivar, *e.g.*, Balady and Finny flowered in mid May in the first season, meanwhile, Balady flowered in the first week of May in the second season. However, Abd El Razik flowered in the last week of May in the first season and in the mid of May in the second one. The flowering period expanded to the end of August for all the tested cultivars except for Finny which recorded end of flowering date in the last of July in the first season and mid of August in the second season. Balady and Finny were earlier by two weeks than that of Abd ElRazik cultivar in the first season, however, Balady was the earliest cultivar in the second season.Moreover, Balady was continued flowering till the first of september in the second season.

Concerning, the flower number, it is clear that flowering density increased with the advance of the flowering period to reach its maximum then decreased gradually till the end of the flowering period. Balady sp. recorded the highest

average number of flowers/shoot (6.4 & 6.9) followed by Abd ElRazik (5.3 & 4.4) and finaly Finny (3.5 & 3.6) in both seasons of the study, respectively. Testing of pollen fertility (Table 2) revealed that Balady had the highest percentage of fertile pollens in both of the studied seasons. On the other hand, Abd El Razik cultivar showed a lower percent of fertile pollens (86.5%) than Finny (89.2%) in the first season, while, the vice versa was observed in the second season. Although there were differences in the percentage of pollen fertility, these differences were statistically insignificant. Thakur and Singh (1965) reported that germination of pollen in artificial media was a satisfactory measure of pollen viability while, the stianability test was entirly uneffective and unreliable method because the stainability depends not on viability but on the contents of the pollen.

TABLE 1. Average number of flowers/shoot in some Annona cultivars during 2007 and 2008 seasons.

Date	Season 2007			Season 2008		
	Balady	Abd ElRazik	Finny	Balady	Abd ElRazik	Finny
StMay	-	-	-	3.1	-	-
^{Mid}May	8.2	-	3.1	5.6	2.1	1.3
^{Last}May	10.3	10.1	6.1	10.1	8.2	5.4
StJune	12.4	15.1	9.2	14.3	10.1	7.2
^{Mid}June	12.1	11.2	10.1	12.3	9.1	8.1
^{Last}June	10.1	10.1	8.1	11.8	8.2	8.4
StJuly	8.1	6.1	3.1	9.1	6.0	7.1
^{Mid}July	8.0	5.1	2.9	9.3	5.2	3.1
^{Last}July	7.1	6.1	2.5	7.5	4.0	3.0
StAugust	4.0	2.3	-	3.2	2.5	1.8
^{Mid}August	2.1	2.0	-	2.4	2.0	1.1
^{Last}August	1.1	1.0	-	1.0	-	-
Mean	6.4	5.3	3.5	6.9	4.4	3.6
L.S.D 5%	1.0	1.11	1.01	1.50	1.15	1.01

TABLE 2. Percentage of fertile pollens in some Annona cultivars during 2007 and 2008 seasons.

Cultivars	2007	2008
Balady	90.3	88.1
Abd El Razik	86.5	87.4
Finny	89.2	86.1
L.S.D 5%	N.S	N.S

Initial percent of fruit set as affected by type and date of pollination

The highest percentage of setting was observed during July for all of different type crosses in both seasons of the study (Table 3). Using of Balady as a pollen parent had almost increased the initial percent of setting of both Abd ElRazik and Finny, except the cases of using Abd ElRazik X Abd ElRazik in August of

the first season and Finny as a pollinator for both of itself in July and Balady in August of the second season. The highest percent of pollen fertility of Balady may play a role in this respect. On the other hand, the initial fruit set was found to increase during July in comparison with the date of June and August, this might be correlated with the number of formed flowers before or during the pollination in July. Moreover, using of Abd ElRazik as a pollinator for Balady revealed a high initial percent of fruit set as compared to Finny as a pollinator for Balady. Initial fruit set was less in case of using Abd El Razik as pollinator for Finny than of using Finny as pollinator for itself, and the vice versa was truc when Finny was used as a pollinator for Abd ElRazik. This might be reflect a different degree of compatibility. It is obvious that using Balady cultivar as a pollen parent and Abd ElRazik & Finny as female parents detected the best setting percent regardless of the pollination date. In this respect, Azzouni *et al.* (1982) concluded that a tendency toward dichogamy is shown in Cherimata and Abd ElRazik cultivars.

TABLE 3. Initial percent of fruit set of Balady sp., Abd El Razik and Finny cultivars as affected by date of pollination during 2007 and 2008 seasons.

Type of pollination	Season 2007			Season 2008		
	June	July	August	June	July	August
Baladyx Balady	76.0	78.1	37.0	73.8	77.9	33.3
Baladyx Abd El Razik	69.2	71.1	33.2	67.3	66.8	30.9
Balady x Finny	63.2	68.3	28.9	65.1	60.1	35.2
Abd El Razikx Abd El Razik	65.9	69.4	38.9	69.1	71.3	34.5
Abd El Razikx Balady	70.1	74.1	33.0	75.1	78.1	35.7
Abd El Razik x Finny	61.8	67.0	26.7	65.4	70.1	30.1
Finny x Finny	63.8	72.3	21.9	60.1	70.5	20.6
Finny x Balady	70.4	75.8	26.3	66.1	70.2	24.8
Finny x Abd El Razik	61.8	69.7	21.4	63.1	67.5	18.7
L.S.D 5%		15.01			13.10	

Effect of pollen source on fruit retention percent

Using of Balady as a pollinator for Abd ElRazik and Finny cultivars resulted in the highest percentage of fruit retention as compared to pollination by Abd ElRazik and Finny (Table 4). Moreover, using Finny cultivar as a pollinator and Abd ElRazik cultivar as a female recorded a fruit retention percent higher than that of using Abd ElRazik as a pollinator for itself. On the other hand, pollination of Finny female by Abd El Razik pollinator, revealed also a higher percent of fruit retention than that of using Finny as a pollinator for itself.

It is worth mentioning that the initial setting was in contrast to the fruit retention percent for pollination between the Finny and Abd ElRazik cultivars. This could be attributed to that the compatibility between Abd ElRazik and

Finny cultivars is higher than self compatibility. However, using of Finny cultivar as a pollinator for Balady cultivar recorded a higher fruit retention percent than that of using Abd ElRazik as a pollinator for Balady female sp. Rokba *et al.*,(1982) reported that there was high fruit set with all species and varities, using *A. Squamosa* pollen, however, it was low with pollen of *A. Senegalensis*. Furthermore, Othman and Aisha (1995) cited that self pollination of each of Abd ElRazik and Beni Mazar varities increased fruit set followed by Cherimata pollen on the same varities.

TABLE 4. Effect of pollen source on fruit retention percent during 2007 and 2008 seasons.

Type of pollination	Season 2007			Season 2008		
	Balady	Abd El Razik	Finny	Balady	Abd El Razik	Finny
Balady	37.5	28.2	35.0	32.1	29.1	30.1
Abd El Razik	38.2	22.4	31.8	38.0	31.1	34.4
Finny	35.0	31.8	29.7	38.2	34.4	25.1
L.S.D 5 %	8.11			10.15		

Effect of different types of crosses on physical and chemical characteristics of fruit

The phenomenon of direct influence of the male parent pollen on fruit characteristics of Balady, Abd ElRazik and Finny which is called Metaxenia was proved in the present study as described by Kahn *et al.* (1994). Although, the source of pollen parent had its effect on both fruit length and fruit diameter, there is no clear trend of them in both of the studied seasons (Tables 5 & 6). However, fruit shape index was the most reliable indicator for studying the effect of pollen parent on fruit shape, *e.g.*, using of Balady pollen decreased the fruit shape idex of Abd ElRazik, Finny and Balady itself (Fig.1) in the first season and also in the second one except for the Finny cultivar which increased its fruit shape index in comparison with using of Abd ElRazik and Finny pollen. Furthermore, using of Abd ElRazik and Finny pollen (Fig.2 & 3) with Balady cultivar resulted in a slight difference in this parameter.

On the other hand, cross pollination of both Finny and Abd ElRazik flowers with Balady pollen produced the best fruits with respect to fruit and pulp weight, while, the fruits contained the highest number of seeds in both seasons. Meanwhile, the effect of both Abd ElRazik and Finny pollen on Balady fruit and pulp weight revealed slight differences as compared with the use of Balady pollen. Moreover, using of Finny pollen as a parent resulted in the least seed number per fruit of both Balady and Abd ElRazik cultivars. These results were in accordance with Bonaventure L. (1999).

TABLE 5. Effect of different pollinators of Annona on physical and chemical fruit characteristics during 2007 season.

Type of pollination	Fruit length (cm)	Fruit diameter (cm)	Fruit shape index	Fruit weight gm	Peel weight gm	Pulp weight gm	Seeds weight gm	No. of seeds	T.S.S %	Acidity %	T.S.S/ Acidity ratio
Baladyx Balady	6.9	5.8	1.19	113.7	32.4	81.3	14.5	28.4	15.7	0.23	68.26
Baladyx Abd El Razik	7.7	5.9	1.30	138.5	28.9	109.6	13.9	24.1	16.1	0.30	53.66
Balady x Finny	7.8	6.2	1.26	142.6	30.1	112.5	13.5	19.2	15.1	0.22	68.64
Abd El Razikx Abd El Razik	6.8	6.4	1.06	148.9	39.5	109.4	14.3	15.3	15.2	0.30	50.66
Abd El Razikx Balady	7.1	6.8	1.04	159.1	47.8	111.3	15.7	19.6	14.5	0.25	58.0
Abd El Razik x Finny	6.8	6.2	1.10	125.6	35.2	90.4	12.1	15.1	14.3	0.25	57.2
Finny x Finny	6.6	5.3	1.20	170.3	25.4	144.9	13.6	18.7	12.8	0.20	64.0
Finny x Balady	6.4	5.9	1.17	188.1	33.5	154.6	15.9	23.4	12.1	0.21	57.6
Finny x Abd El Razik	6.3	5.1	1.24	186.9	29.1	157.8	14.8	20.1	13.0	0.25	52.0
L.S.D 5%	0.531	0.80	0.15	20.41	8.23	16.67	N.s	6.24	1.01	0.019	

TABLE 6. Effect of different pollinators of Annona on physical and chemical fruit characteristics during 2008 season.

Type of pollination	Fruit length (cm)	Fruit diameter (cm)	Fruit shape index	Fruit weight gm	Peel weight gm	Pulp weight gm	Seeds weight gm	No. of seeds	T.S.S %	Acidity %	T.S.S/ Acidity ratio
Baladyx Balady	6.9	6.9	1.00	131.7	57.2	74.50	15.2	25.2	15.3	0.23	66.52
Baladyx Abd El Razik	6.6	6.3	1.50	153.4	41.3	112.1	14.1	23.8	15.9	0.27	58.88
Balady x Finny	6.5	6.1	1.07	151.5	34.2	117.3	12.9	21.3	15.2	0.25	60.80
Abd El Razikx Abd El Razik	6.7	6.2	1.08	159.8	24.5	135.3	13.8	18.1	15.5	0.30	51.66
Abd El Razikx Balady	6.9	6.5	1.06	225.7	52.8	172.9	16.2	16.4	15.1	0.24	62.92
Abd El Razik x Finny	6.9	6.3	1.09	171.3	23.1	148.2	11.7	15.1	14.1	0.25	56.40
Finny x Finny	6.3	5.1	1.20	174.5	32.6	141.9	13.1	17.4	12.2	0.22	55.45
Finny x Balady	6.8	5.1	1.33	190.2	33.4	156.8	15.1	16.1	12.8	0.23	55.65
Finny x Abd El Razik	6.9	5.2	1.33	161.3	31.1	130.2	13.5	18.9	14.8	0.25	59.20
L.S.D. 5 %	0.67	0.91	0.001	22.5	6.9	15.09	N.S	4.81	0.041	0.011	

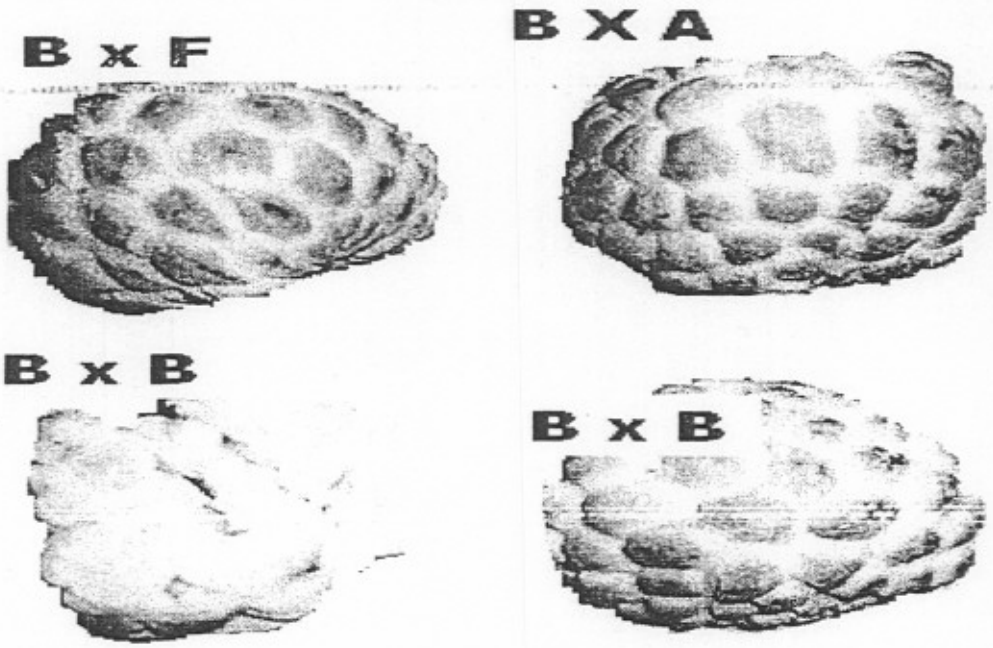

Fig.1. Effect of Balady pollen on fruit characteristics of Finny and Abd El Razik cultivars.
A: Abd El Razik , B: Balady and F: Finny.

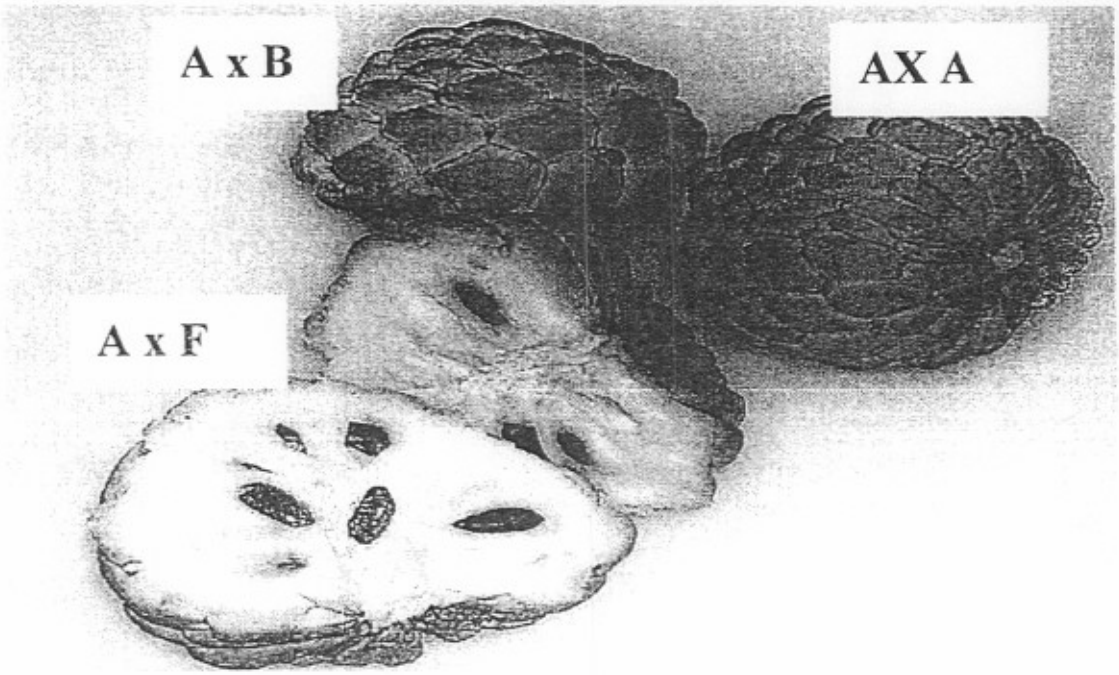

Fig. 2. Effect of Abd El Razik pollen on fruit characteristics of Finny and Balady cultivars.
A: Abd El Razik , B: Balady and F: Finny.

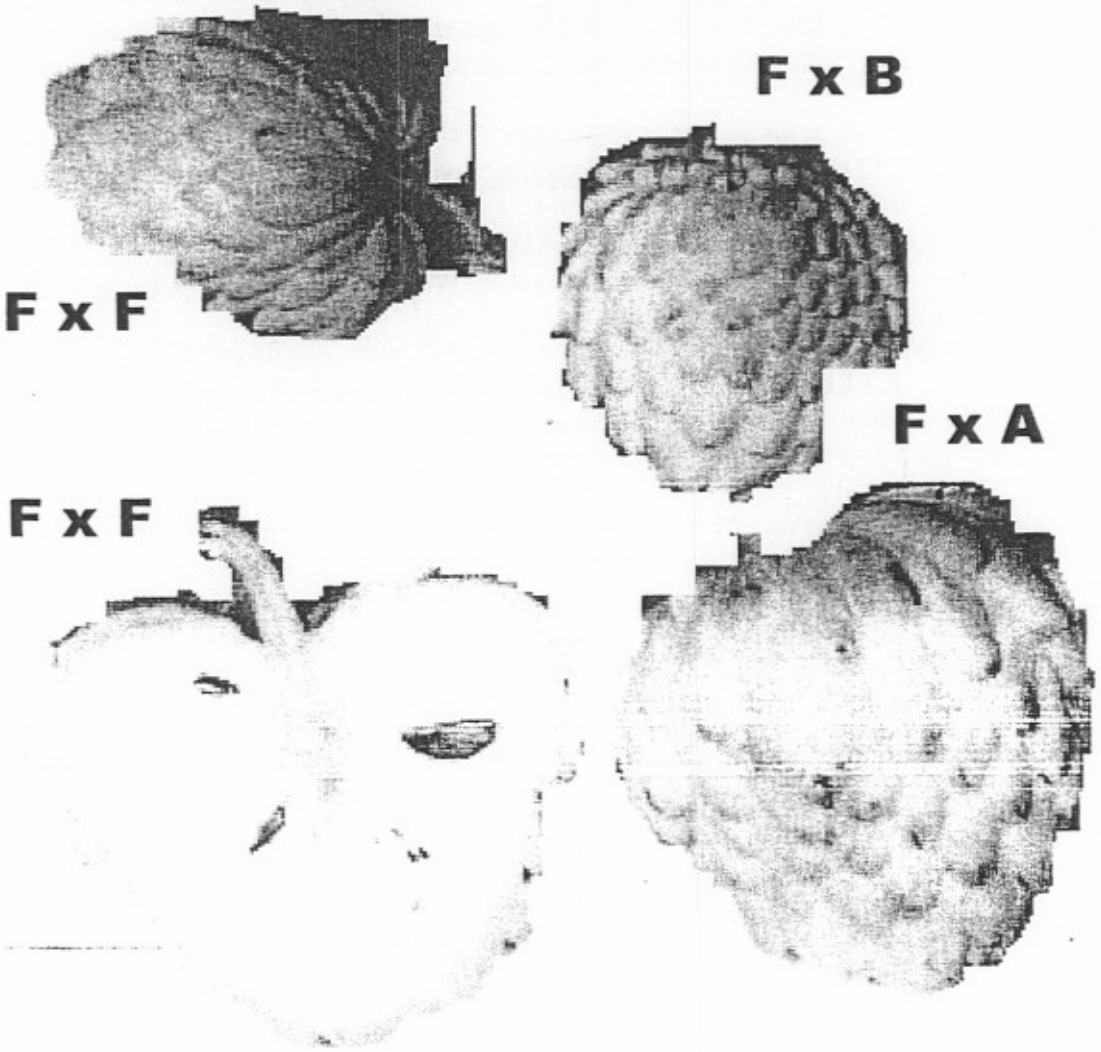

Fig. 3. Effect of Finny pollen on fruit characteristics of Abd El Razik and Balady cultivars.
A: Abd El Razik , B: Balady and F: Finny.

As shown in (Tables 5 & 6) using of Abd ElRazik pollen recorded the highest percentage of T.S.S and acidity of Finny, Balady and Abd ElRazik fruits in both seasons of the study. While, Balady pollen recorded a high percentage of T.S.S with Abd ElRazik and Balady fruits as compared to using Finny pollen. Concerning the T.S.S/ acidity ratio, fruits resulted from using Abd ElRazik as a pollen parent revealed the highest ratio in all the studied cultivars.

It was generally noticed that fruit character showed different responses to pollination treatments even when the pollen parent was used as a pollinator for itself. Crane and Lowrance (1965) stated that the effect of pollen may be positive or negative.Rokba *et al*., (1982) found that fruit weight in Annonas as influenced by different pollinators and did not follow a definite trend. George and Nessem (1986) suggested that growth rate of fruit is controlled endogenously.

George *et al.* (2006) developed hybrids with red skin colour and pink internal flesh. Red skin colour may be carried by either a single or double recessive gene. Fruit symmetry, flesh recovery and flavor characteristics of some crosses are excellent.

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دراسات على مدى توافق بعض اصناف القشطة كملقحات لبعضها البعض و تاثيرها على نسبة العقد و صفات الثمار

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اجريت هذه الدراسة بمعهد بحوث البساتين على التلقيح فى القشطة خلال عامى ٢٠٠٧ و ٢٠٠٨ . و قد استخدمت ثلاث طرز من حبوب اللقاح من اصناف البلدى و عبد الرازق و الفينى لعمل التهجينات المختلفة بينهم.

اوضح اختبار حيوية حبوب اللقاح ان صنف البلدى قد سجل اعلى حيوية لحبوب اللقاح. بالاضافة الى ان استخدام حبوب لقاح الصنف البلدى كأب كان غالبا ما يزيد من نسبة العقد و الاثمار.ومن ناحية اخرى فإن استخدام حبوب لقاح صنف عبد الرازق مع الفينى اعطى نسبة اثمار اعلى من استخدام حبوب لقاح الفينى مع نفسه. كما ان استخدام الفينى كملقح للبلدى رفع من نسبة الاثمار عنه عند استخدام عبد الرازق كملقح للبلدى.

على الرغم من ان مصدر حبوب اللقاح كان له اثره على كل من طول و قطر الثمار الا انه لم يكن هناك اتجاه واضح لهذا التاثيرعلى هاتين الصفتين خلال موسمى الدراسة. فى حين ان استخدام الصنف البلدى كاب ادى الى زيادة وزن الثمار واللحم و البذور فى كل الاصناف المدروسة.

من ناحية اخرى كانت النسبة بين المواد الصلبة الذائبة و الحموضة عالية فى الثمار الناتجة من التهجين باستخدام صنف عبد الرازق كأب مع كل الاصناف المدروسة. فى حين ان حبوب لقاح البلدى ادت الى زيادة نسبة المواد الصلبة الذائبة الكلية فى عبد الرازق مقارنة باستخدام لقاح الفينى مع عبد الرازق.

عموماً فان استخدام حبوب لقاح البلدى قد ادى الى تحسين صفات الثمار الا انه قد تسبب فى نفس الوقت فى زيادة عدد البذور بالثمرة. فى حين ان لقاح الفينى ادى الى نقص فى عدد البذور مقارنة الصنف البلدى.