

**THE PERFORMANCE OF SOLO AND SUNSET
PAPAYA CULTIVARS UNDER THE
ENVIRONMENT OF EGYPT
A: VEGETATIVE GROWTH AND FRUIT
COMPOSITION DURING THE
DEVELOPMENTAL STAGES**

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Abstract: The performance of two known cultivars of papaya i.e., Solo and Sunset under the environments of Giza, Egypt were studied. Such studies are included vegetative growth and characteristics of developing fruits.

Results indicated that Solo plant was much taller which had more leaves number per plant than Sunset one during both seasons of study. Most of plant height increases occurred during the period from February to May then slight increases were observed from September to December. Leaves area in Sunset cv were significantly higher than those of Solo cv. Leaf area increased during the period from Feb. to May then no remarkable changes in leaves area were noticed during the period from May to December.

Fruit weight and size increased slightly until fruit age of 60 days in both cvs then gradual increases occurred until the age of 120 days of anthesis. The final swell started until the fruit ripening; 150 and 160 days for Sunset and Solo cultivars, respectively. Papaya fruit growth under the environment of Egypt followed the familiar pattern of double sigmoid type of growth curve. Fruit weight, size and

pulp (%) were significantly higher in Solo cv compared to Sunset cv in both seasons.

Total soluble solids percentage was low (less than 5%) until 120 days of anthesis, followed by a sudden sharp increase until the fruit reached the harvesting stage in the two cultivars.

The titerable acidity of papaya fruits was high at the early stages of growth followed by a gradual decrease until the fruit reached its lowest acidity content at the harvesting stage in Solo and Sunset cvs.

There was a high initial value of ascorbic acid content at the early stages of fruit development declining pattern then took place until fruit aged 60 days, followed by gradual increases until reaching its maximum value at the harvesting stage in the two cultivars.

TSS and acidity were found to be significantly higher in Sunset cv compared to Solo cv. Ascorbic acid content was also statistically higher in Solo cv.

It could be concluded that these two cultivars strongly confirm the recommendation of planting them due to their good performance under Giza environments.

Key words: Papaya, Vegetative growth, fruit composition, developmental stages.

Received on: 30/3/2009

Accepted for publication on: 16/5/2009

Referees: Prof. Dr. A. El-fattah M. El-Salhy

Prof. Dr. Said A. Bakr

Introduction

Papaya is the preferred common name for "*Carica papaya* L.". The plant is usually dioecious, with either male or female flowers. However, trees with hermaphrodite flower also occur (Samson, 1992)

Papaya fruit is usually cylindrical on hermaphrodite trees and more round on female trees. In Egypt, papayas still not a popular fruit crop although it grows successfully under Egypt environment. The papaya trees are planted in scattered sites in Aswan governorate, El-Kanater (Kalubia), at universities, research Institutes, orchards and in some special home gardens. Papaya is a minor fruit crop in Egypt with great potentiality as an export fruit crop. (Abd El-Kareem, 1996). World production of papaya was to be 6,504,369 thousand metric tons. Brazil, Thailand, Nigeria, India, Mexico and Indonesia are the leading producers of papaya (FAO, 2004).

Papaya plant vegetative growth is influenced by several factors including genetics, planting distance, fertilization, environment and sex (Yadava *et al.*, 1990 and Abdel-Kareem, 1996).

The pattern of fruit development in papaya followed the double sigmoid type of growth curve. The fruit growth period lasting 130 days with a 14 days lag period. The papaya fruit takes 145 to 165 days from the date of flowering to attain eating ripe stage depending on the

climate and cultivar (Selvaraj *et al.*, 1982b; Ghanta, 1994 and Desai and Wagh, 1995).

The objective of this work was to study the performance of two known cultivars of papaya i.e., Solo and Sunset under the environments of Giza, Egypt.

Materials and Methods

This study was conducted in the Horticulture Research Institute Orchard at Giza and in the laboratory of Horticulture Department at the Faculty of Agriculture, Assiut University for two successive seasons of 1996 and 1997 on Solo and Sunset papaya cultivars. Ten healthy female trees from each Solo and Sunset cultivars were randomly selected for this investigation. The selected trees were three years old which planted at 2x2 meters apart and grown in loamy sand soil and subjected to the same horticultural practices.

Vegetative Growth:

The following vegetative growth criteria, i.e. plant height, leaf number and its area were recorded at monthly intervals. The 7th leaf from the epical growing point was used to determine the leaf area monthly. Leaf area was estimated using leaf-dry weights given by the equation $Y = 267.10 X$, where Y is the leaf area (cm²) and X is the leaf dry weight (g) Alyelaagbe and Fawusi (1988).

Fruit Development:

Fully opened female flowers (of May flowering) allowed to get open pollinated were tagged at regular intervals. Samples (10 fruits; one fruit from each tree, at random) were taken at 15 days interval up to maturity. Growth fruit curve was prepared by plotting the average weight of fruit against its age.

Physical characteristics:

Average fruit weights (g) and pulp weight % were recorded as well as average fruit size was measured.

Chemical constituents of fruit at harvest:

1. Percentage total soluble solids (TSS) in papaya pulp were estimated by a hand refractometer.
2. Acidity was determined in pulp juice by NaOH titration according to A.O.A.C. (1975) and calculated as citric acid/100 g fruit (according to Selvaraj *et al.*, 1982a).
3. Vitamin "C" content was estimated as milligrams ascorbic acid per 100 grams pulp which was determined by direct titration method using 2,6-dichlorophenol indophenol as outlined in A.O.A.C. method (1975).

The complete randomized block design with ten replicates, one trees per each was used to determine variance between cultivars. The data was calculated and means were separated for statistical

significance at 5% and 1% levels (Gomez and Gomez, 1984).

Result and Discussion

Vegetative growth:

Data in Table (1) showed that Solo plant was much taller than Sunset one during both seasons of study. Most of plant height increases occurred during the period from February to May. In Solo plants, the increases in plant height were 27.3 and 22.3 cm during the first and second seasons, respectively while they were 23.4 and 21.2 cm in Sunset cultivar in both seasons.

Data in Table (2) cleared that averages of leaves number per plant were significantly higher in Solo than in Sunset during both seasons. The higher rates of increase in leaves formation were occurred during the period from February to May, then no remarkable changes in leaves formation were found during the period from May to September. Leaves defoliation was found to occur within September to February.

Data in Table (3) revealed that leaf area in Sunset cv were significantly higher than those of Solo cv. during both seasons. Leaf area increased during the period from Feb. to May then no remarkable changes in leaves area were observed during the period from May to December. This pattern of leaves area was found in both cvs during the two studied seasons. These results are in

Table (1): Plant height (cm) of Solo and Sunset papaya cultivars during 1996 and 1997 seasons.

Seasons	Cultivar	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1996	Solo	185.0	190.0	197.0	199.1	202.0	205.1	208.0	210.3	211.2	212.3	212.3
	Sunset	167.2	171.3	176.2	178.4	180.8	183.2	185.3	187.4	189.3	190.4	190.6
	Significance	**	**	**	**	**	**	**	**	**	**	**
1997	Solo	212.6	215.7	220.8	223.5	225.9	228.8	231.4	233.5	234.5	234.9	234.9
	Sunset	190.6	193.5	197.5	200.2	202.5	205.1	207.5	209.6	210.8	211.7	211.8
	Significance	**	**	**	**	**	**	**	**	**	**	**

N.S., *, ** Non Significant, Significant at $P \leq 0.05$ or 0.01 , respectively.

Table (2): Total No. of produced leaves/plant of Solo and Sunset papaya cultivars during 1996 and 1997 seasons.

Seasons	Cultivar	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1996	Solo	19.2	40.3	56.0	62.0	60.8	61.0	58.0	59.0	53.6	45.2	27.0
	Sunset	15.2	35.6	49.2	51.1	49.2	47.1	45.9	48.9	45.1	36.8	21.1
	Significance	**	*	*	**	**	**	**	**	**	**	**
1997	Solo	17.8	42.6	57.4	60.1	61.6	61.3	60.4	60.5	56.6	47.6	26.8
	Sunset	16.0	37.0	51.0	52.0	52.6	51.5	51.2	50.0	47.7	40.2	24.0
	Significance	**	**	**	**	**	**	**	**	**	**	**

N.S., *, ** Non Significant, Significant at $P \leq 0.05$ or 0.01 , respectively.

agreement with those found by Abd El-Kareem (1996)

Fruit growth and development:

Fig (1 and 2) clearly illustrated that increases in fruit weight as well as fruit size of both cultivars were at same rate during the first phase of fruit growth (60 days), then slightly higher rate of increase in Solo cv could be observed compared to Sunset cv (phase II; 60-120 in Solo cv and from 60-105 days in Sunset cv.) while a more pronounced increase was occurred at the final phase of fruit growth (phase III; 120-160 in Solo cv and from 105-150 days in Sunset cv). It also could be observed that most of the differences between the two cvs were noticed after 75 days from anthesis until fruit ripening. Moreover, it could be noticed that the increase in final weight and size of Solo cv compared to Sunset occurred mainly at the final swell stage. So, it could be concluded that papaya fruit growth under the environment of Giza followed the familiar pattern of double sigmoid type of growth curve in Solo and Sunset cvs.

These results are in agreement with those found by Selvaraj *et al.* (1982b), Ghanta (1994) and Desai and Wagh (1995) who reported that papaya fruit has the double sigmoid curve. On the other hand, Zaki (1971) showed undefined double sigmoid curve but rather gradual increases.

Data in Table (4) showed that there was a gradual increase in pulp weight % during the first period of fruit growth followed by much higher increase during phase II. then gradual decrease was noticed up to harvesting stage (135 and 120 days from anthesis for Solo and Sunset cvs, respectively). These results are slightly in agreement with Selvaraj *et al.* (1982b) who found that the pulp percentage increased with increased fruit age increase.

Also, data in Table (4) declared that total soluble solids percentage was low (less than 5%) until 120 days after anthesis followed by a sudden sharp increase until the fruit reached the harvesting stage in the two cultivars during the two seasons. It also can be noticed that both cultivars have almost the same rate of TSS increases until fruits age of 135 days then Sunset fruit was found to have much more pronounced higher rate of increases in TSS content until harvesting. These results are in agreement with Ghanta (1994) who concluded that total soluble solids percentage was low until about 120 days after anthesis of Ranchi cv.

Data in Table (5) cleared that the titratable acidity of papaya fruits was high at the early stages of growth followed by a gradual decrease until the fruit reached its lowest acidity content at harvesting stage in Solo and Sunset cvs in both seasons. The pattern of development of acidity as shown in

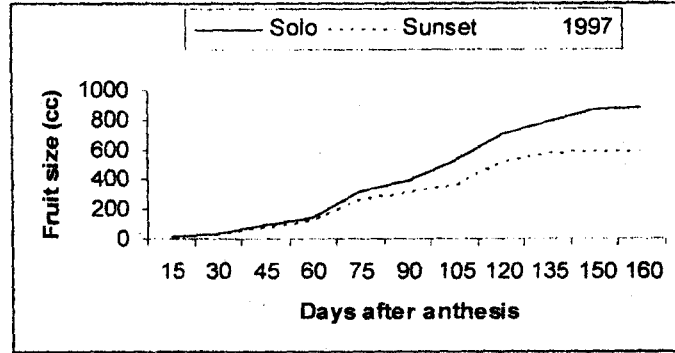
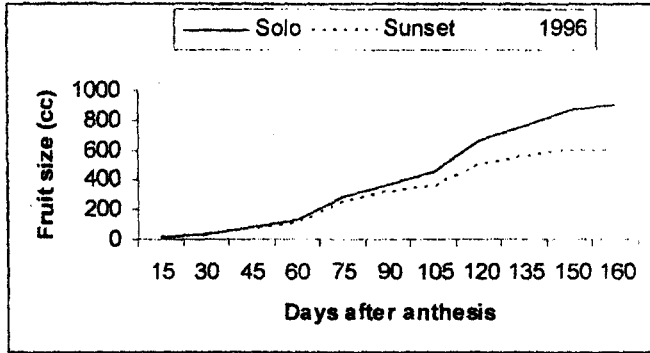
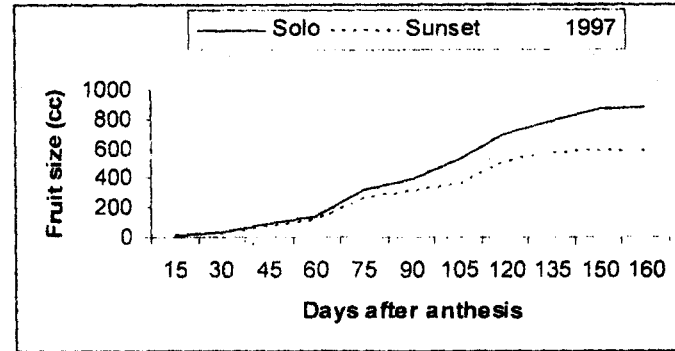
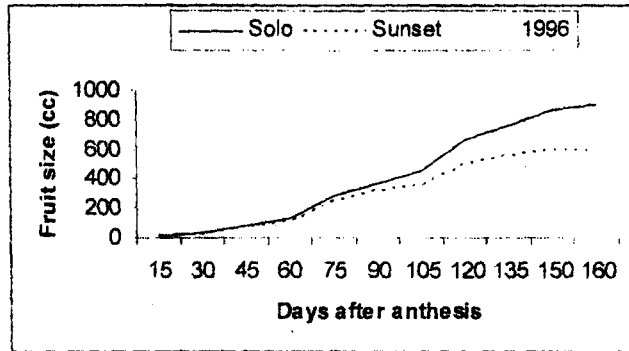


Fig (1): Changes in fruit weight (g) of Solo and Sunset papaya during 1996 and 1997 seasons.



Fig(2):Changes in fruit size (cc) of Solo and Sunset papaya during 1996 and 1997 seasons.

Table (3): Leaf area (cm²) of Solo and Sunset papaya cultivars during 1996 and 1997 seasons

Seasons	Cultivar	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1996	Solo	438.58	623.55	840.33	844.13	853.79	849.76	846.94	852.15	848.48	849.89	848.29
	Sunset	466.36	676.56	861.00	882.76	900.21	903.46	905.37	899.06	896.65	892.38	886.50
	Significance	**	**	**	**	**	**	**	**	**	**	**
1997	Solo	421.49	630.62	849.91	850.61	855.25	852.85	859.53	861.67	857.12	855.79	856.86
	Sunset	454.38	673.52	867.02	889.38	892.65	894.79	898.52	894.79	892.65	896.12	891.31
	Significance	**	**	**	**	**	**	**	**	**	**	**

N.S., *, ** Non Significant, Significant at P ≤ 0.05 or 0.01, respectively.

Table (4): Changes in pulp (%) and total soluble solids (%) of Solo and Sunset papaya during 1996 and 1997 seasons.

Days after anthesis	Pulp (%)						Total soluble solids (%)					
	1996			1997			1996			1997		
	Solo	Sunset	Significant	Solo	Sunset	Significant	Solo	Sunset	Significant	Solo	Sunset	Significant
15	84.4	83.7	*	84.1	83.4	*	3.4	4.0	**	3.52	4.0	**
30	85.9	84.5	**	86.2	84.8	**	3.6	4.2	**	3.7	4.2	**
45	86.65	85.7	**	87.1	85.8	**	3.75	4.2	**	3.84	4.34	**
60	87.3	86.4	**	87.8	86.8	**	3.8	4.4	**	3.92	4.5	**
75	89.0	88.1	**	89.4	88.4	**	4.0	4.52	**	4.12	4.6	**
90	89.1	88.4	*	89.5	88.6	**	4.2	4.6	**	4.32	4.74	**
105	89.5	88.8	*	89.7	88.9	**	4.32	4.8	**	4.4	4.94	**
120	89.6	89.5	NS	90.1	89.2	**	5.8	6.8	**	5.74	7.0	**
135	89.85	87.7	**	90.0	88.2	**	8.6	12.0	**	8.8	12.2	**
150	87.95	85.42	**	88.0	85.57	**	10.8	14.4	**	10.56	14.5	**
160	86.28	85.42	**	86.37	85.57	**	12.5	14.4	**	12.52	14.5	**

N.S., *, ** Non Significant, Significant at P ≤ 0.05 or 0.01, respectively.

Table (5): Changes in acidity (%) and ascorbic acid (mg/100g) of Solo and Sunset papaya during 1996 and 1997 seasons.

Days after anthesis	Acidity (%)						Ascorbic acid (mg/100g)					
	1996			1997			1996			1997		
	Solo	Sunset	Signi- ficant	Solo	Sunset	Signi- ficant	Solo	Sunset	Signi- ficant	Solo	Sunset	Signi- ficant
15	0.81	0.83	**	0.81	0.83	**	44.2	38.4	**	42.8	40.0	**
30	0.80	0.82	**	0.81	0.83	**	32.6	27.5	**	30.8	28.2	**
45	0.80	0.81	*	0.80	0.82	**	22.4	18.2	**	20.6	18.0	**
60	0.79	0.80	*	0.79	0.81	**	18.75	13.5	**	16.4	14.0	**
75	0.77	0.78	*	0.78	0.79	*	22.5	18.6	**	20.8	16.8	**
90	0.75	0.76	*	0.76	0.77	*	24.0	22.0	**	22.4	20.6	**
105	0.73	0.74	*	0.73	0.75	**	24.6	22.5	**	24.6	22.0	**
120	0.70	0.72	**	0.70	0.72	**	25.4	28.6	**	27.5	27.5	NS
135	0.67	0.69	**	0.67	0.69	**	33.5	37.0	**	32.1	38.5	**
150	0.66	0.67	*	0.65	0.67	**	44.0	46.54	**	42.0	47.76	**
160	0.64	0.67	**	0.63	0.67	**	53.59	46.54	**	51.49	47.76	**

N.S., *, ** Non Significant, Significant at $P \leq 0.05$ or 0.01 , respectively.

this study is in line with what was found by Zaki (1971), Selvaraj *et al.* (1982a) and Ghanta (1994). They reported that titratable acidity of papaya fruits was high at the early stage of growth followed by a gradual decrease until the fruit reached the harvesting stage.

Data in Table (5) indicated that there was a high initial value of ascorbic acid content at the early stages of fruit development. A declining pattern then took place until fruit age of 60 days followed by gradual increases until reaching its maximum value at the harvesting stage in the two cultivars during both seasons. The pattern of development of ascorbic acid content as shown in this study is in line with what was found by Zaki (1971), Selvaraj *et al.* (1982a) and Ghanta (1994).

From the obtained results, it could be concluded that the papaya fruit of Sunset and Solo cvs. took 150 to 160 days from anthesis to fruit ripening. The fruit development followed the double sigmoid type of growth curve. In addition, these two cultivars can be recommended for planting in Giza, Egypt for such good performance.

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تقييم صنفى الباباظ " سولو وصن ست " تحت الظروف البيئية لمصر

أ - النمو الخضري وخصائص الثمار أثناء مراحل النمو

سمير زكى العجمى* ، رافت أحمد على مصطفى* ، ميخائيل بطرس

بسطوروس** ، ايهاب سعد بشرى توفيق**

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** معهد بحوث البساتين - الجيزة

يعتبر الباباظ من محاصيل الفاكهة الثانوية ذات الأهمية القصوى كمحصول تصديرى. لذا كان هدف الدراسة هو تقييم صنفى الباباظ سولو وصن ست تحت ظروف منطقة الجيزة - مصر حيث تضمن التقييم النمو الخضري وصفات الثمار ومنحنى نموها .

وقد أظهرت النتائج :

- كانت نباتات الصنف سولو الأطول ساقا والأكثر أوراقا مقارنة بالصنف صن ست .
 - كان معدل الزيادة في طول النباتات خلال الفترة من فبراير حتى مايو أكبر مقارنة بالفترة من سبتمبر إلى ديسمبر .
 - تزداد مساحة الأوراق خلال الفترة من فبراير حتى مايو وقد كانت مساحة الورقة في الصنف صن ست أكبر منها في الصنف سولو .
 - كان معدل الزيادة في وزن وحجم الثمار قليل حتى 60 يوم تلاها زيادة تدريجية حتى 120 يوم من التزهير يعقبها مرحلة الإمتلاء النهائى حتى 150 ، 160 يوم لكل من صنفى صن ست وسولو على التوالى . وعليه فإن ثمار الباباظ تسلك منحنى النمو ذو الدورين تحت ظروف البيئة المصرية .
 - كان وزن وحجم الثمرة ونسبة اللب أعلى في الصنف سولو مقارنة بثمار صن ست .
 - كانت نسبة المواد الصلبة الذائبة أقل من 5% حتى 120 يوم من التزهير يلى ذلك زيادة حادة حتى مرحلة النضج .
 - كانت نسبة الحموضة مرتفعة في المرحلة الأولى يلى ذلك نقص حتى النضج .
 - حدثت زيادة في محتوى فيتامين C في المرحلة الأولى ثم نقص حتى عمر 60 يوم ثم زيادة تدريجية لتصل إلى أعلى محتوى عند النضج .
 - تحتوى ثمار الصنف صن ست على نسبة أعلى من المواد الصلبة الذائبة والحموضة وأقل محتوى من فيتامين C مقارنة بمحتوى ثمار الصنف سولو .
- لذا يمكن التوصية بزراعة صنفى الباباظ سولو وصن ست تحت الظروف البيئية لمحافظة الجيزة بنجاح حيث أن الصفات الطبيعية والكيميائية لثمارها على مستوى عال من الجودة