

Vegetative Growth Cycles of Some Mango Cultivars in Relation to Flowering and Fruiting

A.E.A. Shaban

Department of Pomology, Faculty of Agriculture, Cairo University, Giza, Egypt

Abstract: This experiment was carried out during the years 2006, 2007 and 2008 on four mango cultivars namely Ewais, Sediek, Zebda and Keitt. The experiment was designed to evaluate the three vegetative growth cycles of spring, summer and autumn of these cultivars in relation to flowering and fruiting. Results indicated that, the trees in "off" year produced higher percentage of vegetative growth cycles than those in "on" year and the main growth cycle was emerged in the summer this was noticed with all tested cultivars. Vegetative growth cycles emerged in "off" year was higher in shoot length, number of leaves and leaf area than those emerged in "on" year. Summer growth cycle recorded the highest significant shoot length, number of leaves and leaf area compared to spring and autumn growth cycles. Generally, the three growth cycles differed in shoot length, number of leaves and leaf area according to bearing habit and cultivars. Summer growth cycle gave the highest flowering percentage followed by spring cycle then autumn cycle which recorded the lowest values. Percentage of perfect flowers and panicle length was significantly higher in "on" year than "off" year. The highest percentage of perfect flowers and panicle length was detected in summer growth cycle followed by spring and autumn cycles. Pollen germination percentage was significantly higher in "on" year than "off" year. Summer growth cycle recorded the highest pollen germination followed by spring and autumn growth cycles. Keitt and Zebda cultivars recorded higher pollen germination than Sediek cultivar. On the other hand, the lowest pollen germination was achieved with Ewais cultivar. Panicles emerged in "on" year has significant higher number of fruits at harvest than those emerged in "off" year. Number of fruits per panicle at harvest varied significantly between the three growth cycles where, the highest value was recorded with summer followed by spring and autumn cycles. The trees in "off" year produced higher fruit weight than in "on" year. The maximum fruit weight was presented on summer growth cycle followed by spring growth cycle, while the minimum fruit weight was found on the autumn growth cycle. There were no significant differences in fruit TSS and acidity among the three vegetative growth cycles.

Key words: Mango % Vegetative growth cycles % Flowering % Fruiting

INTRODUCTION

Mango is one of the most important fruits grown in Egypt, there are many cultivars such as Ewais, Sediek, Zebda and Keitt etc.... Growth of mango is not continuous but it occurs as intermittent, short lasting flushes of shoots from apical or lateral buds. Vegetative growth occurs up to three or four times per year on individual stems, depending upon cultivars and growth conditions. Terminal inflorescences or panicles are initiated in dormant apical buds on stems that developed vegetative from lateral buds following the previous flowering seasons [1]. The pattern of the growth flushes of mango are affected by various factors such as

cultivars, age of the trees and crop load in the previous season. A positive relationship between fruiting behavior of shoots in the preceding season and its vegetative growth in the subsequent season has also been established, that is, shoots that carried fruit to maturity produced less vegetative growth and smaller number of shoots than those which failed to flower or had shed the flowers. Biennial bearing mango cultivars produced little growth during the fruiting period and also after harvest, shoots emerging during this period don't flower in the next spring. On the other hand, shoots emerging in the beginning of spring will differentiate in the coming spring [2]. Previous researches indicated variation in vegetative growth of various mango cultivars grown under Egypt

conditions [3-7]. So studying the different vegetative growth cycles may help the mango growers to know the most important vegetative growth cycle for bearing regulation the vegetative growth, bearing fruits and increasing yield also in this case the growers can use all methods for inducing trees to produce their vegetative growth cycles in the time which help to maximize income.

There for this experiment was designed to compare the three vegetative growth cycles of spring, summer and autumn in "on" and "off" years of Ewais, Sediek, Zebda and Keitt mango cultivars in relation to flowering and fruiting.

MATERIALS AND METHODS

This experiment was carried out during the years 2006, 2007 and 2008 on four mango cultivars namely Ewais, Sediek, Zebda and Keitt. The experiment was designed to evaluate the three vegetative growth cycles of spring, summer and autumn of these cultivars in relation to flowering and fruiting. The trees were about ten years old, grown in a private orchard located at Elwadi El-Faregh region; Alexandria desert road six of October governorate, the trees planted in sandy soil at 5X5 meter apart under drip irrigation system and received the similar and regular horticultural practices. The experiment was arranged in completely randomized block design with three replicates, one tree per each replicate. Six trees from each cultivar of equal age and growth were selected in spring of 2006 and 2007 at the time of full bloom and divided into two groups the first group was in "on" year and the second in "off" year according to the intensity of flowering in the spring of 2006 and 2007 seasons. On each tree fifty uniform terminal shoots from the growth of the previous season were selected randomly all over the tree sides and tagged for recording the following observations during 2006 and 2007 seasons:

Percentage of vegetative growth of spring cycle (flushes emerged during March, April and May), summer cycle (flushes emerged during June, July and August) and autumn cycle (flushes emerged during September and October) were determined by using the following equation:

$$\text{Percentage of vegetative growth} = \frac{\text{Number of emerged flushes per vegetative growth cycle}}{\text{Total number of tagged shoots}} \times 100$$

Shoot length (cm), number of leaves and leaf area (cm²) of the three vegetative growth cycles were measured at the end of the season in December 2006 and 2007.

The vegetative growth which emerged in 2006 season was followed for their flowering characteristics in 2007 season. Also, the vegetative growth which emerged in 2007 season was followed for their flowering characteristics in 2008 season as follows:

At full bloom stage in April 2007 and 2008 flowering percentage of the three vegetative growth cycles which emerged in 2006 and 2007 seasons was determined by the following equation:

$$\text{Flowering percentage} = \frac{\text{Number of flowered shoots for each growth cycle}}{\text{Number of emerged shoots for each growth cycle}} \times 100$$

Also, panicle length (cm) was measured and percentage of perfect flowers was determined by using the following equation:

$$\text{Percentage of perfect flowers} = \frac{\text{Number of perfect flowers per panicle}}{\text{Total number of flowers per panicle}} \times 100$$

Ten panicles were taken from each replicate at full bloom stage (2007 and 2008 seasons), for pollen germination percentage determination by using hanging drop technique as described by Stanley and Linskens [8].

Number of fruits per panicle was counted at harvest (Third week of July for Sediek, first week of August for Ewais, last week of August for Zebda and third week of October for Keitt during 2007 and 2008 seasons) also, nine fruits were taken randomly from each replicate for determination of fruit weight (g), fruit total soluble solids (TSS%) by using hand refractometer and fruit acidity (%) as citric acid content according to A.O.A.C [9]. Data were tabulated and statistically analyzed according to Snedecor and Cochran [10] and mean values were compared by Duncan's multiple range test at 5% [11].

RESULTS AND DISCUSSION

Vegetative Growth Percentage: Data in Table 1 indicated that the vegetative growth percentage was significantly higher in "off" year than in "on" year. Regardless of cultivars and bearing habit, the highest vegetative growth percentage was produced during the summer cycle followed by spring and autumn cycles. In "on" year the main vegetative growth cycle was emerged in summer followed by autumn and spring. Meanwhile, in "off" year vegetative growth percentage in spring was significantly higher than in autumn. Vegetative growth percentage in autumn was the highest in Ewais and Sediek cultivars in "on" year, this may be due to early harvesting of these cultivars and this may help to increase the vegetative

growth cycles percentage in autumn after harvest. Meanwhile, the late cultivars Keitt and Zebda produced the lowest vegetative growth cycles percentage during autumn in "on" year because of bearing fruits till the end of autumn which prevent producing new flushes. Zebda and Keitt cultivars produced the highest vegetative growth percentage in summer cycle in "on" and "off" years, respectively. The lowest vegetative growth percentage was observed with Keitt cultivar in autumn and spring cycles for both "on" and "off" years. In general, vegetative growth percentage varied between the three growth cycles and the summer cycle was the most important in this regard. Also, the growth of three cycles was depending on bearing habit rather than on the cultivars. These results are in agreement with those reported by Hussein *et al.* [11] and Elmasry [12] where they recorded three vegetative growth cycles i.e. spring, summer and autumn for different mango cultivars under Egypt conditions and the main cycle was the summer growth cycle. Also, Boshra [7] detected a variation between mango cultivars Ewais, Keitt, Sediek and Tommy Atkins in percentage of vegetative flushes for spring, summer and autumn growth cycles.

Morphological Characteristics of Vegetative Growth Cycles: Data presented in Tables 2,3 and 4 show the shoot length, number of leaves and leaf area of spring, summer and autumn growth cycles of Ewais, Sediek, Zebda and Keitt mango cultivars.

Vegetative growth cycles emerged in "off" year was higher in shoot length than those emerged in "on" year and the differences were significant in both seasons (Table, 2). Regardless of bearing habit, summer growth cycle recorded the highest significant shoot length comparing to spring and autumn growth cycles. Shoot length of the three vegetative growth cycles was varied according to cultivars where, the highest values were found with Ewais cultivar. Meanwhile, the lowest values were recorded with Keitt cultivar and the shoot length of growth cycles for the rest cultivars was in between, this was noticed in both "on" and "off" years. Shoot length of summer growth cycle reached the maximum values in Ewais cultivar and the minimum values were found with Keitt cultivar. The same trend was noticed with spring and autumn growth cycles in both seasons. Generally, the three growth cycles differed in their shoot length according to bearing habit and cultivars.

Regarding number of leaves, the growth cycles emerged in "off" year produced higher number of leaves than those emerged in "on" year (Table, 3). Summer growth cycle has recorded the highest number of leaves

followed by autumn and spring cycles in both "on" and "off" years. Regardless of growth cycles Ewais cultivar produced the highest significant number of leaves per shoot followed by Zebda and sediek cultivars. Meanwhile, Keitt cultivar produced the lowest number. Interaction between bearing habit, cultivars and growth cycles cleared that, the highest number of leaves was recorded with summer growth cycle for Ewais cultivar. On the other hand, the lowest number of leaves was detected on spring and autumn growth cycles of Keitt cultivars in both seasons.

Concerning leaf area the highest values were observed with summer growth cycle followed by autumn then spring growth cycle and the differences were significant in both seasons (Table, 4). Growth cycles in "off" year recorded significant higher leaf area than those in "on" year. Keitt cultivar produced the maximum leaf area followed by Ewais and Zebda then Sediek cultivar which recorded the lowest significant values in both seasons. Interaction indicated that the maximum leaf area was detected in summer growth cycle for both Keitt and Ewais cultivars. On the other hand the minimum leaf area was recorded with spring growth cycle for both Sediek and Zebda cultivars. From the above mentioned results it could be concluded that the summer growth cycle proved to be the most important as it recorded higher shoot length, number of leaves and leaf area than spring or autumn growth cycles for all tested cultivars. These results are in harmony with those obtained by Ragab *et al.* [6], Das *et al.* [13], Sharma *et al.* [14] and Hammam [15].

Flowering in Relation to Vegetative Growth Cycles: Data presented in Tables 5,6,7 and 8 show the flowering percentage, panicle length, perfect flowers percentage and pollen germination percentage of spring, summer and autumn growth cycles for Ewais, Sediek, Zebda and Keitt mango cultivars.

Concerning flowering percentage, it was significantly higher in "on" year than "off" year (Table, 5). Summer growth cycle gave the highest flowering percentage followed by spring cycle then autumn cycle which recorded the lowest percentage; this was noticed for all tested cultivars in both "on" and "off" years. Flowering percentage varied between cultivars where the highest values were recorded with Keitt cultivar in "on" year and Ewais cultivar in "off" year. Meanwhile, the lowest value was detected with Zebda cultivar in "off" year for both seasons. Interaction indicated that the highest flowering percentage was observed with summer growth cycle of Keitt cultivar in "on" year and summer growth cycle of

Table 1: Vegetative growth (%) of some mango cultivars in the "on" and "off" years during 2006 and 2007 seasons

Bearing Habit	Cultivars	2006 season				2007 season			
		Spring	Summer	Autumn	Mean	Spring	Summer	Autumn	Mean
On year	Ewais	3.2 i	17.0 ef	9.0 gh	9.73 bc	4.0 ij	19.0 f	10.0 gh	11.0 b
	Sediek	2.9 i	21.0 de	12.0 fg	11.97 b	2.8 j	19.0 f	11.0 g	10.93 b
	Zebda	2.3 i	22.0 de	3.0 i	9.10 bc	2.6 j	23.0 e	4.0 ij	9.86 bc
	Keitt	2.0 i	20.0 de	1.2 i	7.73 c	2.4 j	22.0 ef	1.8 j	8.73 c
	Mean	2.6 e	20.0 c	6.3 c	9.63 b	2.9 e	20.7 c	6.7 d	10.13 b
Off year	Ewais	25.0 cd	55.0 ab	6.0 hi	28.66 a	22.0 ef	58.0 b	8.0 gh	29.33 a
	Sediek	29.0 c	50.0 b	9.0 gh	29.44 a	27.0 d	54.0 c	8.0 gh	29.66 a
	Zebda	25.0 cd	52.0 b	6.0 hi	27.66 a	24.0 de	60.0 ab	7.6 h	30.53 a
	Keitt	25.0 cd	59.0 a	5.0 hi	29.66 a	21.0 ef	62.0 a	7.0 hi	30.0 a
	Mean	26.0 b	54.0 a	6.5 d	28.86 a	23.5 b	58.5 a	7.6 d	29.86 a
Mean		14.34 b	37.00 a	6.40 c		13.23 b	39.63 a	7.17 c	

Values followed by the same letter(s) are not significantly different at 5% level

Table 2: Shoot length (cm) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2006 and 2007 seasons.

Bearing Habit	Cultivars	2006 season				2007 season			
		Spring	Summer	Autumn	Mean	Spring	Summer	Autumn	Mean
On year	Ewais	14.4 f-j	19.5 bcd	17.8 b-g	17.23 bc	14.6 g-j	20.1 cde	18.2 def	17.63 b
	Sediek	14.2 f-j	15.3 e-i	13.1 h-k	14.2 d	12.0 jk	13.3 j	11.6 jk	12.3 d
	Zebda	16.0 d-h	18.0 b-f	18.0 b-f	17.33 b	16.4 f-i	17.6 efg	17.3 efg	17.14 b
	Keitt	11.3 jk	13.5 h-k	9.8 k	11.53 e	10.0 k	12.0 jk	10.2 k	10.73 d
	Mean	13.9 d	16.5 bc	14.6 cd	15.07 b	13.2 d	15.7 c	14.3 cd	14.45 b
Off year	Ewais	19.5 bcd	25.2 a	16.6 c-h	20.4 a	22.0 bc	25.6 a	16.9 fgh	21.5 a
	Sediek	14.3 f-j	18.6 bic	12.0 ijk	14.96 cd	14.6 g-j	18.1 def	11.6 jk	14.76 c
	Zebda	18.6 b-e	21.5 ab	20.0 bc	20.03 a	19.0 c-f	23.0 ab	18.0 ef	20.11 a
	Keitt	14.0 g-i	19.8 bcd	11.6 ijk	15.13 cd	13.6 ij	21.2 bcd	14.0 hij	16.26bc
	Mean	16.6 b	21.2 a	15bcd	17.64 a	17.3 b	21.9 a	15.1 c	18.16 a
Mean		15.2 b	18.9 a	14.8 b		15.2 b	18.9 a	14.7 b	

Values followed by the same letter(s) are not significantly different at 5% level

Table 3: Number of leaves of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2006 and 2007 seasons.

Bearing Habit	Cultivars	2006 season				2007 season			
		Spring	Summer	Autumn	Mean	Spring	Summer	Autumn	Mean
On year	Ewais	11.5 e-i	16.8 a	16 ab	14.76 a	14-cde	17 ab	14.6 cd	15.2 a
	Sediek	11.2 f-i	12.2 d-g	11 f-i	11.46 c	10.6 fgh	11 fg	10.6 fgh	10.73 c
	Zebda	12.0 d-h	14.2 bcd	14.0 b-e	13.40 ab	12.2 ef	11.2 fg	12.6 def	12 b
	Keitt	8.2 j	9.6 hij	8.2 j	8.66 d	8.6 hi	9.2 ghi	8.6 hi 8.6 hi	8.8 d
	Mean	10.7 d	13.2 ab	12.3 bc	12.07 a	11.3 b	12.1 b	11.6 b	11.68 b
Off year	Ewais	14.8 abc	14.9 abc	12.6c-f	14.1 abc	15.6 bc	18.3 a	13.5 cde	15.8 a
	Sediek	12 d-h	14 b-e	12.1 d-h	12.7 bc	12.6 def	14.8 c	11 fg	12.8 b
	Zebda	10.8 f-i	16.2 ab	11 f-i	12.66bc	12.2 ef	15.3 bc	12 ef	13.16 b
	Keitt	9.9 g-j	10.5 f-j	9.2 ij	9.86 d	8.4 i	11.2 fg	10.5 f-i	10.03 c
	Mean	11.8cd	13.9 a	11.2 cd	12.34 a	12.2 b	14.9 a	11.7 b	12.95 a
Mean	11.3 b	13.5 a	11.7 b	11.7 b	13.5 a	11.6 b			

Values followed by the same letter(s) are not significantly different at 5% level

Table 4: Leaf area (cm²) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2006 and 2007 seasons

Bearing Habit	Cultivars	2006 season				2007 season			
		spring	Summer	autumn	mean	spring	summer	autumn	mean
On year	Ewais	26.2 j-m	33.9 gh	29.2 ijk	29.73 d	26.6 hij	37.6 ef	28.1 ghi	30.77 d
	Sediek	22.2 mn	28.7 ijk	24.0 lmn	24.96 e	23.0 j	30.0 gh	25.9 ij	26.32 e
	Zebda	20.1 n	29.2 ijk	25.8 klm	25.03 e	23.2 j	31.2 g	26.5 hij	26.96 e
	Keitt	49.2 e	67.2 c	52.1 de	56.16 b	40.0 de	65.0 b	58.0 c	54.36 b
	Mean	29.3 f	39.7 c	32.7 e	33.99 b	28.2 d	40.9 b	34.6 c	34.6 b
Off year	Ewais	31.5 hi	45.0 f	33.6 gh	36.7 c	34.9 f	42.2 d	38.1 ef	38.43 c
	Sediek	26.9 jkl	36.2 g	30.2 hij	31.1 d	25.9 ij	35.8 f	30.0 gh	30.59 d
	Zebda	28.8 ijk	43.3 f	32.2 ghi	34.76 c	28.7 ghi	35.5 f	30.1 gh	31.43 d
	Keitt	53.7 d	80.0 a	73.4 b	69.13 a	54.5 c	76.5 a	65.8 b	65.6 a
	Mean	35.2 d	51.1 a	42.3 b	42.91 a	36.0 c	47.5 a	41.0 b	41.51 a
Mean		55.3 b	59.4 a	36.5 c		55.9 b	59.8 a	35.6 c	

Values followed by the same letter(s) are not significantly different at 5% level

Ewais in "off" year. On the other hand, the lowest flowering percentage in "on" year was detected with autumn growth cycle of Zebda cultivar in the first season and Sediek cultivar in the second one. Concerning "off" year the autumn growth cycle of Zebda cultivar recorded the lowest values in both seasons. Generally, the four tested cultivars bear flowers on the three vegetative growth cycles and the summer cycle came in the first followed by spring then autumn cycle.

In addition, panicle length of all tested cultivars produced significant longer panicle in "on" year than those in "off" year (Table, 6). Summer growth cycle bore the longest panicle followed by spring and autumn growth cycles, this was noticed for "on" and "off" year trees. Keitt cultivar produced the longest panicle followed by Ewais and Sediek. In the contrary, Zebda cultivar has recorded the shortest panicle in "on" and "off" years. Interaction indicated that the longest panicle was observed with Keitt and Ewais cultivars on summer growth cycle in "on" and "off" years. Meanwhile, the shortest panicle was found with autumn growth cycle of Zebda cultivar.

Regarding percentage of perfect flowers, the highest values were detected in panicles that emerged in summer growth cycle followed by spring then autumn cycle which recorded the lowest values in this respect (Table, 7). Percentage of perfect flowers was significantly higher in panicle produced in "on" year than those produced in "off" year. Percentage of perfect flowers varied among the tested cultivars, since the highest percentage was recorded with Keitt followed by Sediek and Zebda. Meanwhile, the lowest percentage was found with Ewais cultivar. Panicles of Keitt cultivar recorded the highest

percentage of perfect flowers in summer growth cycle for both "on" and "off" years. On the other hand, the lowest percentage of perfect flowers was detected in autumn growth cycle of Ewais cultivar in "on" and "off" years.

In addition, pollen germination data in Table (8) show that the pollen germination was significantly higher in "on" year than "off" year. Summer growth cycle recorded the highest pollen germination followed by spring then autumn growth cycle which gave the lowest values, this was noticed for both "on" and "off" years. Keitt and Zebda cultivars recorded higher pollen germination than Sediek cultivar. On the other hand, the lowest pollen germination was achieved with Ewais cultivar. Summer growth cycle of Keitt and Zebda exhibited the highest pollen germination percentage in "on" and "off" years.

Meanwhile, the lowest pollen germination was found with autumn growth cycle of Ewais cultivar. The above mentioned results concerning the differences between the tested mango cultivars and vegetative growth cycles on their flowering characteristics are in general agreed with the results reported by Pandey [2], Hussein *et al.* [3], Ragab *et al.* [6] and Galila and Elmasry [16].

Fruiting and Fruit Properties in Relation to Vegetative Growth Cycles: Concerning number of fruits per panicle at harvest, data in Table 9 indicated that, panicles emerged in "on" year has a significant higher number of fruits at harvest than those emerged in "off" year. Number of fruits per panicle varied significantly between the three growth cycles, where the highest value was recorded with summer one followed by spring and autumn cycle which recorded the lowest values, this was noted in both

Table 5: Flowering (%) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	spring	summer	autumn	mean
On year	Ewais	92.6 c	97.6 ab	67.3 d	85.83 a	93.3 ab	94.3 ab	64.3 c	83.97 a
	Sediek	93.6 c	96.3 abc	64.3 de	84.73 ab	92.6 b	95.6 ab	52.3 e	80.17 b
	Zebda	94.6 bc	97.6 ab	58.6 f	83.6 b	95.3 ab	96.3 ab	59.8 d	83.8 a
	Keitt	98.3 ab	98.6 a	63.3 e	86.7 a	96.3 ab	97.6 a	61.3 cd	85.0 a
	Mean	94.7 b	97.5 a	63.3 c	85.22 a	94.3 a	95.9 a	59.4 b	83.24 a
Off year	Ewais	21.6 h	28.3 g	12.3 kl	20.73 c	23.0 g	30.3 f	14.3 ijk	22.55 c
	Sediek	16.3 ij	25.6 g	10.3 lm	17.4 d	18.6 ghi	27.6 f	12.6 jk	19.60 d
	Zebda	10.8 lm	13.3 jkl	8.3 m	10.8 f	12.3 jk	16.6 hig	10.0 k	12.97 f
	Keitt	15.3 ijk	18.3 hi	8.3 m	13.97 e	16.3 hij	20.3 gh	10.6 k	15.73 e
	Mean	16.0 e	21.3 d	9.8 f	15.74 b	17.5 d	23.7 c	11.8 e	17.72 b
Mean	55.38 b	59.45 a	36.59 c		55.96 b	59.83 a	35.65 c		

Values followed by the same letter(s) are not significantly different at 5% level

Table 6: Panicle length (cm) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	spring	summer	autumn	mean
On year	Ewais	31.0 cde	33.0 bcd	30.0 def	31.33 b	32.0 abc	32.1 abc	30.2 bcd	31.43 a
	Sediek	26.1 g-j	27.2 f-i	25.2 h-k	26.16 c	25.0 ef	27.3 de	24.5 ef	25.6 c
	Zebda	19.0 l	19.2 l	18.0 lm	18.76 d	18.8 gh	25.4 ef	17.7 h	20.6 d
	Keitt	33.5 bc	38.0 a	32.2 bcd	34.56 a	33.2 ab	35.0 a	31.2 bc	33.13 a
	Mean	27.4 b	29.3 a	26.6 b	27.70 a	27.2 b	29.1 a	25.9 bc	27.7 a
Off year	Ewais	25.0 jkl	28.0 f-i	23.3 kl	25.44 c	24.1 ef	29.2 cd	22.1 fg	25.13 c
	Sediek	24.0 kl	26.3 h-k	23.0 l	24.43 c	24.8 ef	25.5 ef	22.0 fg	24.1 c
	Zebda	15.0 no	16.3 o-n	14.2 o	15.16 e	13.8 i	15.6 hi	12.2 i	13.86 e
	Keitt	31.2 cde	34.0 b	29.1 e-h	31.54 b	29.3 cd	30.1 bcd	27.6 de	29.0 b
	Mean	23.8 c	26.2 b	22.4 c	24.15 b	23.0 d	25.1 c	20.9 e	23.02 b
Mean	25.6 b	27.8 a	24.3 b	25.13 b	27.53 a	23.44 c			

Values followed by the same letter(s) are not significantly different at 5% level

Table 7: Perfect flowers percentage of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	spring	summer	autumn	mean
On year	Ewais	23.8 i-l	26.3 ghi	22.5 kl	24.22 ef	25.1 efg	26.2 efg	24.1 gh	25.13de
	Sediek	29.3 ef	31.2 de	27.4 fg	29.3 c	26.8 ef	30.0 d	25.6 efg	27.46 c
	Zebda	26.6 f-i	27.2 fgh	25.0 g-l	26.29 d	25.5 efg	27.1 e	25.1 efg	25.9 de
	Keitt	35.2 b	38.6 a	34.2 bc	36.00 a	36.1 b	39.2 a	33.4 c	36.23 a
	Mean	28.6 b	30.8 a	27.2 c	28.92 a	28.3 b	30.6 a	27.0 bc	28.6 a
Off year	Ewais	22.3 l	24.5 h-l	23.2 jkl	23.33 f	21.2 i	22.1 hi	20.6 i	21.3 f
	Sediek	25.2 g-h	26.1 ghi	24.8 g-l	25.36 de	26.7 efg	27.2 e	26.1 efg	26.66cd
	Zebda	25.9 g-j	25.4 i-l	24.0 i-l	25.11 de	25.0 efg	25.3 efg	24.2 fgh	24.83 e
	Keitt	32.2 cd	33.2 bcd	31.6 cde	32.36 b	33.4 c	34.2 bc	31.6 cd	33.03 b
	Mean	26.4 c	27.3 c	25.9 c	26.54 b	26.5 cd	27.1 bc	25.6 d	26.45 b
Mean	27.54 b	29.06 a	25.60 b		27.48 b	28.91 a	26.34 c		

Values followed by the same letter(s) are not significantly different at 5% level

Table 8: Pollen germination (%) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	spring	summer	autumn	mean
On year	Ewais	47.2 fgh	50.6 def	45.6 ghi	47.82 b	45.3 h	52.2 ef	43.1 h	46.86 e
	Sediek	51.3 def	53.1 de	44.9 hi	49.79 b	52.2 ef	58.1 cd	50.2 fg	53.5 c
	Zebda	66.7 b	70.2 ab	51.3 def	62.76 a	57.6 cd	63.2 b	53.4 e	58.06 b
	Keitt	65.4 b	72.5 a	51.2 def	63.03 a	59.4 c	71.3 a	53.6 e	61.43 a
	Mean	57.6 b	61.6 a	48.2 c	55.85 a	53.6 b	61.2 a	50.0 c	54.97 a
Off year	Ewais	36.1 kl	41.8 ij	32.8 l	36.93 c	31.6 l	38.2 ij	30.1 l	33.3 h
	Sediek	37.6 jkl	44.1 hi	34.4 kl	38.70 c	39.3 i	49.1 g	35.3 k	41.23 g
	Zebda	48.4 e-h	55.2 cd	38.6 jk	47.4 b	40.5 i	56.2 d	36.2 jk	44.3 f
	Keitt	50.2 d-g	58.0 c	41.2 ij	49.9 b	44.2 h	57.4 cd	43.6 h	48.4 d
	Mean	43.1 d	49.8 c	36.6 e	43.23 b	38.9 d	50.22 c	36.3 e	41.80 b
Mean	50.38 b	55.72 a	42.51 c		46.26 b	55.71 a	43.19 c		

Values followed by the same letter(s) are not significantly different at 5% level

Table 9: Number of fruits per panicle at harvest of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	Spring	summer	autumn	mean
On year	Ewais	0.31 hi	0.51 f	0.27 hij	0.36 d	0.31 hi	0.56 ef	0.29 ij	0.38 e
	Sediek	0.33 h	0.36 gh	0.31 hi	0.33 d	0.35 hi	0.38 h	0.29 ij	0.34 f
	Zebda	1.2 b	1.4 a	0.82 c	1.14 a	1.10 b	1.30 a	0.92 c	1.10 a
	Keitt	0.88 c	1.20 b	0.75 cd	0.94 b	0.90 c	1.15 b	0.71 d	0.92 b
	Mean	0.68 b	0.86 a	0.53 c	0.69 a	0.66 b	0.84 a	0.55 c	0.68 a
Off year	Ewais	0.25 hij	0.33 h	0.15 j	0.24 e	0.21 k	0.36 hi	0.18 k	0.25 g
	Sediek	0.24 hij	0.28 hij	0.19 ij	0.23 e	0.22 jk	0.29 ij	0.20 k	0.23 g
	Zebda	0.48 fg	0.65 de	0.36 gh	0.49 c	0.50 fg	0.62 e	0.31 hi	0.47 c
	Keitt	0.48 fg	0.54 ef	0.32 hi	0.44 c	0.47 g	0.52 fg	0.30 i	0.43 d
	Mean	0.36 e	0.45 d	0.25 f	0.35 b	0.35 e	0.44 d	0.24 f	0.34 b
Mean		0.52 b	0.63 a	0.39 c		0.50 b	0.64 a	0.40 c	

Values followed by the same letter(s) are not significantly different at 5% level

Table 10: Fruit weight (g) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	Spring	summer	autumn	mean
On year	Ewais	220 kl	239 j	215 c	224.7 g	224 no	236 n	210 p	223.3 g
	Sediek	386 f	436 cd	359 h	393.7 d	415 h	434 g	413 hi	420.7 c
	Zebda	328 i	338 i	333 i	333 f	368 j	405 hi	371 j	381.4 d
	Keitt	482 a	494 a	401 e	459 b	450 f	485 ab	432 g	455.6 b
	Mean	354 d	376.8 b	327 e	352.6 b	364.3 d	390 b	356.5 e	370.3 b
Off year	Ewais	230 jk	240 j	225 kl	231.7 g	228 no	250 m	218 op	232 f
	Sediek	430 d	460 b	438 cd	442.6 c	453 ef	482 bc	465 de	466.6 a
	Zebda	382 fg	405 e	371 gh	386 e	345 k	400 i	324.7 l	356.6 e
	Keitt	465 b	490 a	446 c	467 a	471 cd	498 a	452 ef	473.7 a
	Mean	376.8 b	398.8 a	370.0 c	381.0 a	374.3 c	407.5 a	364.9 d	382.2 a
Mean		365.4 b	387.8 a	348.5 c		369.3 b	398.8 a	360.7 c	

Values followed by the same letter(s) are not significantly different at 5% level

Table 11: Fruit TSS (%) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	Spring	summer	autumn	mean
On year	Ewais	9.0 a	9.0 a	9.0 a	9.0 ab	9.1 a	9.2 a	9.0 a	9.1 a
	Sediek	8.8 a	8.9 a	8.6 a	8.7 ab	8.8 a	8.8 a	8.8 a	8.8 a
	Zebda	8.3 a	8.3 a	8.2 a	8.26 ab	8.6 a	8.6 a	8.6 a	8.6 a
	Keitt	8.2 a	8.2 a	8.0 a	8.13 b	8.2 a	8.4 a	8.2 a	8.26 a
	Mean	8.5 a	8.6 a	8.4 a	8.56 a	8.6 a	8.7 a	8.6 a	8.69 a
Off year	Ewais	9.2 a	9.0 a	9.0 a	9.06 a	9.1 a	9.1 a	9.0 a	9.06 a
	Sediek	8.8 a	9.0 a	8.6 a	8.8 ab	9.0 a	9.0 a	8.8 a	8.93 a
	Zebda	8.4 a	8.5 a	8.4 a	8.43 ab	8.6 a	8.6 a	8.5 a	8.56 a
	Keitt	8.4 a	8.4 a	8.2 a	8.33 ab	8.4 a	8.4 a	8.4 a	8.4 a
	Mean	8.70 a	8.72 a	8.55 a	8.65 a	8.77 a	8.77 a	8.67 a	8.73 a
Mean		8.70 a	8.63 a	8.50 a		8.72 a	8.77 a	8.66 a	

Values followed by the same letter(s) are not significantly different at 5% level

Table 12: Fruit acidity (%) of spring, summer and autumn growth cycles of some mango cultivars in "on" and "off" years during 2007 and 2008 seasons

Bearing Habit	Cultivars	2007 season				2008 season			
		spring	summer	autumn	mean	Spring	summer	autumn	mean
On year	Ewais	1.8 d	1.8 d	1.9 cd	1.83 d	1.8 e	1.9 e	1.9 e	1.88 c
	Sediek	2.1 bcd	2.2 a-d	2.1 bcd	2.13 bcd	2.2 b-e	2.0 de	2.1 cde	2.1 c
	Zebda	2.4 a-d	2.4 a-d	2.4 a-d	2.4 ab	2.5 abc	2.4 a-d	2.4 a-d	2.43 b
	Keitt	2.5 abc	2.4 a-d	2.5 abc	2.46 ab	2.6 ab	2.6 ab	2.6 ab	2.6 ab
	Mean	2.2 a	2.2 a	2.22 a	2.2 b	2.27 ab	2.22 b	2.25 b	2.24 b
Off year	Ewais	2.1 bcd	2.0 bcd	2.0 bcd	2.03 cd	2.2 b-e	2.1 cde	2.0 de	2.1 c
	Sediek	2.4 a-d	2.5 abc	2.5 abc	2.46 bc	2.4 a-d	2.3 b-e	2.4 a-d	2.36 b
	Zebda	2.6 ab	2.6 ab	2.6 ab	2.6 ab	2.5 abc	2.5 abc	2.5 abc	2.5 ab
	Keitt	2.8 a	2.6 ab	2.8 a	2.73 a	2.8 a	2.6 ab	2.8 a	2.73 a
	Mean	2.47 a	2.42 a	2.47 a	2.45 a	2.47 a	2.37 ab	2.42 ab	2.42 a
Mean		2.33 a	2.27 a	2.29 a		2.38 a	2.30 a	2.33 a	

Values followed by the same letter(s) are not significantly different at 5% level

seasons. Panicles of Zebda bore the highest number of fruits at harvest. Meanwhile, the lowest number was detected with panicles of Sediek. Summer growth cycle of Zebda and Keitt cultivars bore the highest significant number of fruits per panicle in both "on" and "off" years. On other hand, autumn growth cycle of Ewais has the lowest number of fruits per panicle at harvest. In general, summer growth cycle has recorded the highest number of fruits per panicle at harvest. This may be due to producing the highest shoot length, number of leaves, leaf area and panicle length on this cycle compared to both spring and autumn growth cycles.

Regarding fruit weight, data in Table 10 clearly show that the trees in "off" year produced of fruit higher weight than those in "on" year. The maximum fruit weight was presented in the fruits picked from summer cycle followed by spring cycle, while the minimum fruit weight was found on autumn growth cycle. Fruit weight significantly varied between cultivars, where the highest fruit weight was observed with Keitt followed by Sediek and Zebda. On the other hand, the lowest fruit weight was achieved with Ewais cultivar. Interaction indicated that the highest fruit weight was recorded with summer growth cycle of Keitt and the lowest values were found with fruits harvested from autumn growth cycle of Ewais cultivar. In general, cultivars variations were more effective than growth cycles or bearing habit. No significant differences were detected among vegetative growth cycles in relation to fruit TSS. The differences in fruit TSS were insignificant between "on" and "off" years (Table, 11). Fruit TSS varied between cultivars with insignificant differences. Fruits of Ewais cultivar recorded higher TSS than the other tested

cultivars. Contrary, Keitt cultivar recorded the lowest values of fruit TSS, this was noticed in both seasons of study.

Concerning fruit acidity obtained, data in Table 12 showed a higher fruit acidity in "off" year than "on" year. Regardless of cultivars, there were no significant differences among the three growth cycles in relation to fruit acidity. Keitt cultivar recorded the highest fruit acidity meanwhile; the lowest fruit acidity was detected with Ewais cultivar. From the above mentioned results it could be concluded that the number of fruits per panicle at harvest and fruit weight were significantly varied between vegetative growth cycles and cultivars. Meanwhile, fruit TSS and acidity were of no effect in relation to vegetative growth cycles.

In this concern, several investigators detected variation in number of fruits per panicle at harvest, fruits weight, fruit TSS and fruit acidity in relation to mango cultivars. Sayamal and Mishra [17] on various mango cultivars, Shaban [18] on Zebda cultivar, Hassan *et al.* [19] on Tommy Atkins, Keitt and Sediek cultivars and Khattab *et al.* [20] on Ewais and Sediek cultivars.

In conclusion, all mango cultivars under this investigation bear the flowers and fruits on the three vegetative growth cycles of summer, spring and autumn in descending order. The summer growth cycle was the most important as it recorded higher shoot length, number of leaves, leaf area, flowering percentage, panicle length, percentage of perfect flowers, number of fruits per panicle at harvest and fruit weight than spring and autumn growth cycles. So, further studies are necessary to induce summer growth cycle for mango trees especially in "on" year this may be help in regulation bearing in mango.

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