J. Agric. Sci. Mansoura Univ., 30 (8): 4485 - 4496, 2005

PRODUCTION OF NEW TOMATO HYBRIDS UNDER EGYPTIAN CONDITIONS

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ABSTRACT

This study was conducted to estimate the degree of heterosis and inbreeding depression for different traits, in the F_1 and F_2 generations. Six crosses of tomato cultivars (*Lycopersicon esculentum* Mill.) were evaluated. In summer growing season of 2000 all genotypes were planted at two locations. The combined data over both locations indicated the presence of significant heterosis versus the mid-parents and the better-parent for most studied traits.

The cross Lin 73 X Strain-B showed the highest heterotic effect for total yield as number and weight of fruits/plant. The heterosis values over mid-parent were 59.29 and 80.78% for total fruit number/plant and total fruit weight/plant, respectively. While, the values of heterosis over the better-parent were: 51.45 and 76.15% for total fruit number/plant and total fruit weight/plant, respectively. The results also revealed that the heterotic effects for total yield (number and weight of fruits/plants) were due to genes have an over-dominance type of inheritance. The obtained values of inbreeding depressions ranged from 38.76% for early fruit number/plant to 36.27% for early fruit weight/plant. Estimates of heritability in broad sense ranged from 11% for plant height to 79% for total fruit weight.

INTRODUCTION

Filling the gap between food supply and the by increasing population requires increasing agricultural production from the already limited agricultural area. For a popular vegetable crop like tomato (*Lycopersicon esculentum* Mill.), the production of first generation hybrids offers a reliable solution to this problem. Also, tomato hybrids are currently dominated tomato cultivation world-wide including Egypt.

Several studies were conducted on heterosis of vegetative growth such as plant height and number of branches/plant in different crosses (Ahmed and Petrescu, 1983; Mahmoud and Gad El-Hak, 1988; Abd-El-Rahim, 1989; Brahma *et al.*, 1991; Dod *et al.*, 1992; Singh and Singh, 1993; Guirgis *et al.*, 1994; Abd-Allah, 1995; Hegazi *et al.*, 1995; El-Sharkawy *et al.*, 1997; Yossef, 1997; Amin *et al.*, 2001 and Ramadan 2001). Heterosis over mid-parents ranged between –17.64 and 8.55% to 18.75 and 21.05% for plant height and number of branches, respectively. Whereas, these values were –51 and 5.1% to 6.69 and 13.79% when compared with better parent, respectively.

The manifestation of heterosis in early yield were reported by (Ivanyuk and Antsugal 1989; Desouki *et al.*, 1989-b; Suresh Kumar *et al.*, 1995; Hegazi *et al.*, 1995 and Bhanan 1998). Heterosis over the better parent ranged form 4.23% (Luk'Yan's 1980) to 62.5% (Hegazi *et al.*, 1995).

Nuez and Tarrega, (1981); Singh and Singh, (1993) and Youssef, (1997), studied heterosis for earliness of flowering. They concluded that most hybrids gave negative and positive values of heterosis over the better parent.

The fact that Most hybrids showed positive heterosis for fruit number/plant and total yield over the better parent was confirmed by Hegazi *et al.* (1995); Youssef (1997); Salib (1999); Amin *et al.* (2001) and Ramadan (2001). They found that heterosis was present for fruit number/plant and total yield. In this respect, El-Sharkawy *et al.* (1997) obtained heterosis values from the mid-parents for fruit number/plant and total fruit weight/plant with mean values at 33.2 and 37.6%, respectively. Whereas, these values were 15.6 and 31.2% when compared with better parent, respectively.

Concerning inbreeding depression, Zanata, 1994; El-Sharkawy *et al.*, 1997; Amin *et al.*, 2001 and Ramadan, 2001 obtained inbreeding depression values ranged between 14.76 and 4.03 (Abd El-Rahim 1989) to 7.6 and 11.83% (El-Sharkawy *et al.*, 1997), for plant height and number of banches/plant, respectively.

Zanata (1994) found that inbreeding depression was highly significant for total yield. Similarly, Singh *et al.* (1995) concluded that the hybrids with high heterosis for fruit number had high inbreeding depression. El-Sharkawy *et al.* (1997) found that all F_2 generation individuals decreased than their F_1 hybrids for these traits. Therefore, inbreeding depression was 21.5 and 22.4 for fruit number/ plant and total fruit weight, respectively. In addition, Amin *et al.*, (2001) found that all F_2 genotypes were decreased than their F_1 hybrid for number of fruit/plant and total yield/plant and inbreeding depression values were 29.23 and 21.46 for these traits, respectively.

Salib (1999) found that heritability estimates in broad and narrow sense for plant height were (95.59 – 77.79) and (82.4 – 52.14), respectively. However, these estimated values for number of branches/plant were (99.88 – 98.99) and (88.13 – 56.77), respectively. Amin *et al.* (2001) reported that heritability estimates in broad and narrow sense for plant height and number of branches/plant were (94.59 – 3.61) and (95.29 and 62.61) for these traits, respectively.

Several authors among them Metwally *et al.*, 1990; Reddy and Reddy 1992; Zanata 1994; Salib 1999 and Ramadan 2001 reported that, heritability in broad sense for earliness traits were high and ranged from (90.74 – 94.02) and (77.98 – 94.43) for early fruit number (EFN) and early fruit weight Kg/plant (EFW), respectively. Found Ramadan (2001) that, broad sense heritability estimate was high for total yield as number and weight/plant and ranged from (80.95 – 91.69) and (79.57 – 86.09) for total fruit number (TNF) and total fruit weight (TWF), respectively.

MATERIALS AND METHODS

1- Genetic materials:

The genetic materials used in the present investigation included five genetically different varieties. All varieties belong, to the species *Lycopersicon esculentum*, Mill. These varieties were: Campbell 1327, Strain B, Lin 73, Homestead 24 F and Floradata.

On October 15th 1998 seeds were sown in seedling trays. The trays were protected under controlled conditions in Fiberglass green house at Kaha

Experimental Station, Kaliobia Governorate. Transplanting took place 45 days after sowing. Seedlings were transplanted in the Fiberglass green house (9 X 60 m., 3 m. high).

All varieties were crossed in all possible combinations excluding reciprocals to obtain 10 single crosses. During the 1998 late summer planting, preliminary evaluation for the parents and their hybrids was made to choose the best hybrids with respect to earliness and good fruit quality. These chosen crosses were as follows:-

Cross (1) Campbell 1327 X Floradata
Cross (2) Campbell 1327 X Lin. 73
Cross (3) Campbell 1327 X Homestead 24 F
Cross (4) Campbell 1327 X Strain-B
Cross (5) Lin 73 X Strain-B
Cross (6) Lin 73 X Homestead 24 F

Seeds of the chosen F_1 hybrids and their parents were sowen on 10th August 1999 and transplanted after 30 days from seed sowing under fiberglass green house at Kaha Experimental station. Some flowers from each parent and F_1 plants were selfed in order to increase seeds from parental genotypes as well as to produce F_2 generations seed. The crosses between these parental verieties were done again in the same manner to increase F_1 seeds. The 17 genotypes (6F_1's, 6F_2 + 5 parent varieties), were evaluated in summer growing season of 2000 at two locations i.e. Baramon Experimental Farm of Horticultural Research Institute, Mansoura and Kaha Experimental Station, Kaliobia Governorate. The field experiment was arandomized complete blocks design with three replications. Each block/replicate consisted of 17 plots, which included five parents, 6F_1's and 6F_2 generations. Plot size was two rows for each parent as well as each F_1 hybrids and four rows for each F_2 generation. Each row was 5 meter long and 1 meter width, plants were spaced at 35 cm. on side ridges. All agricultural practices were applied at each location in the proper time as recommended for tomatoes production.

Data were recorded on individual plants, which were labeled for different populations for each cross on the following characters:- Plant height Cm (PH), Number of branches/plant (NB/P), Early fruit number/plant (EFN), Early fruit weight/plant (EFW), Total fruit number (TFN) and Total fruit weight/plant Kg (T.F.W).

Statistical Analysis:

1- Heterosis:

The amounts of heterosis were determined as the percentage deviation of the F_1 hybrids mean over the average of its two parents or above its better parent. Therefore, the values of heterosis could be estimated as follows:

a) Heterosis over the mid-parents:

$$H(M.P)\,\% = \frac{\overline{F}_1 - M.P}{M.P} \times 100$$

b) Heterosis over the better parent:

$$H\ (H.P)\ \% = \frac{\overline{F}_1 - B.P}{B.P} \times 100$$

2- Inbreeding depression:

It was measured as a percentage deviation of F_2 generations than their corresponding F_1 hybrids from the following equation:

$$I.D. = \frac{\overline{F}_1 - \overline{F}_2}{\overline{F}_1} \times 100$$

The difference between any two means was tested for significance using the least significant difference value (LSD) at both 5% and 1% levels of probability, which would be obtained as follows:

$$LSD\ (5\%) = t_{0.05},\ E.df\ X\ Sd^{-}$$

$$LSD\ (1\%) = t_{0.01},\ E.df\ X\ Sd^{-}$$

$$Sd^{-} = \sqrt{\frac{EM.S.}{r}\left(\frac{n_1 + n_2}{n_1 \cdot n_2}\right)}$$

Where:

E.df: is the number of error degree of freedom.

E.M.S: is error mean square.

r: is the number of replications.

n_1 : is the number of genotypes in the first mean.

n_2 : is the number of genotypes in the second mean.

3- Heritability:

Heritability valuesin broad sense was calculated using the formula outlined by Allard (1960) and Falconer (1981).

4- The phenotypic coefficient of variance (PCV) and the genotypic coefficient of variance (GCV) were calculated according to the methods of Kumar *et al.*, 1985:

$$GCV = \frac{\sigma g}{\bar{X}} \times 100$$

$$PCV = \frac{\sigma P}{\bar{X}} \times 100$$

Where: σ g and σ P are the genotypic and phenotypic standard deviation, and $\bar{X}$ is the mean of the characters under consideration.

5- The expected genetic gain:

The expected genetic gain resulting from selection in a character (G.s.) was computed by the formula reported by Allard (1960) as follows:

$$G_s = K\ \sigma_p \left(\frac{\sigma_g^2}{\sigma_p^2}\right) = K\ \sigma_{ph}\ h^2$$

where: K: is constant equal

σ_p^2: is phenotypic variance

σ_g^2: is genotypic variance

RESULTS AND DISCUSSION

Due to difference in the performances of genotypes over different locations, it could be more worthy to discuss the results obtained from the combined data over both locations.

The combined analysis of variance over both locations is presented in Table 1.

The F-tests of the mean squares of genotypes were highly significant for all traits except for early fruit number. While, the interactions of genotypes by locations showed that their mean squares were significant or highly significant for all traits except for early fruit weight. These significant variations suggested the existence of some sort of variabilities between genotypes and locations.

Table 1: The combined analysis of variance over both locations for all studied traits.

Source of variance	d.F.	Traits					
		PH	N.B/P	EFN	EFW	TFN	TFW
Location	1	6771.48**	338.17**	9.54	0.06	16.14	0.31*
Reps. withers location	4	20.41	6.17	2.56	0.03	5.09	0.04
Genotypes (A)	16	385.59**	6.29**	35.12	0.34**	153.85**	1.23**
Location x genotypes (LA)	16	296.92**	4.80**	4.92*	0.03	12.36**	0.07*
Error	64	26.26	1.07	2.41	0.03	4.03	0.03

*, ** Significant at 5% and 1% levels, respectively.

The mean performances of genotypes:

The means of five parents, their F_1's and F_2 generations were obtained from the combined over two locations and the obtained results are presented in Table 2.

The means showed that, there was no specific parent, which was superior or inferior for all studied traits. Although, the variety Strain-B was the lowest parent for plant height, it was the earlier parent, the highest in the number of branches/plant and total fruit number with the mean values of 60.75, 12.78, 11.9 and 21.23, respectively. While, the Lin-73 was the highest parent for plant height, with the mean values of 84.42 Cm. However, the highest one for total yield as fruit weight and earlier yield as early fruit weight was the variety Campbell 1327 but it was the lowest parent for number of branches/plant, with the mean values of 1.94 Kg, 1.21 Kg and 10.15, respectively. On the other hand, the variety Homestead 24 F was the latest parent for early yield as number and fruit weight/plant and lowest one for total yield as number and weight/plant. The results indicated that, the crosses, which involved at least one of the highest parent with respect to any one of studied traits, had the highest mean values for these traits. For instance, the 5^{th} cross (Lin-73 X Strain-B) was the highest hybrid for plant height, number of branches/plant and total yield as number and fruit weight /plant with mean values 85.43, 14.59 and (32.15 and 3.23 Kg), respectively. In general, the F_1 hybrids showed superiority over their high parent for total yield as number and weight/plant, indicating the prevalence of heterotic effects.

Table(2): Mean performances of the five parents and their F_1's and F_2's for earliness traits, data are combined over the two locations.

Traits	PH				B/P				E.F.N				E.F.W Kg				TFN				TFW			
Crosses	P_1	P_2	F_1	F_2	P_1	P_2	F_1	F_2	P_1	P_2	F_1	F_2	P_1	P_2	F_1	F_2	P_1	P_2	F_1	F_2	P_1	P_2	F_1	F_2
1	65.35	69.77	69.25	84.86*	10.15	11.37	12.37	12.06	11.78	10.30	12.93	11.00	1.21*	0.97	1.43	1.04	20.17	20.26	22.55	19.63	1.94*	1.72	2.47	1.99
2	65.35	84.42	79.06	80.92	10.15	11.31	12.24	11.68	11.78	10.40	13.10	10.90	1.21	1.01	1.60*	1.02	20.17	19.14	24.03	19.50	1.94	1.74	2.74	1.85
3	65.35	76.50	72.00	74.50	10.15	10.95	11.68	11.60	11.78	9.43	11.17	15.50	1.21	0.87	1.21	1.25	20.17	18.86	21.53	27.53	1.94	1.54	2.18	2.17
4	65.35	60.75	65.50	64.78	10.15	11.90	11.93	12.18	11.78	12.78	17.77*	17.13	1.21	1.08	1.57*	1.46	20.17	21.23*	30.67	32.07	1.94	1.83	2.66	2.55
5	84.42	60.75	85.43*	81.08	11.31	11.90	14.59*	12.83*	10.40	12.78	11.40	10.94	1.01	1.08	1.18	0.91	19.14	21.23	32.15*	31.50	1.74	1.83	3.23*	2.60
6	76.50	84.42	75.98	84.03	10.95	11.31	10.23	10.89	9.43	10.40	14.13	14.25	0.87	1.01	1.53	1.07	18.86	19.14	24.27	29.86	1.54	1.74	2.55	2.09

This finding may explain the reduction existed in most F_2 generation than their corresponding F_1 hybrids. In addition, the 2nd and 4th crosses which involved the earlier parents (Campbell 1327 and Strain-B were the earlier crosses with respect to early fruit weight.

These findings reflected the presence of transgressive segregation and indicating the role by additive and additive by additive epistaces in the inheritance of these traits with respect to the previous crosses. However, the remaining crosses indicated the role of non-additive gene action in the inheritance of these traits.

Data in Table 3 showed positive heterotic expression over mid-parental values for plant height and number of branches/plant in the F_1 hybrids of all crosses except the 6th cross. But it was only highly significant in the 5th cross for plant height and three out of six crosses showed significant or highly significant positive heterotic effects over mid-parent for number of branches/plant.

Two out of six crosses exhibited positive heterosis over-better parent for plant height but it was in significant, while all crosses except the 6th cross showed positive heterotic effects over-better parent for number of branches/plant. These results are in agreement with the findings obtained by Yossef, 1997 and Amin, 2001.

Table 3 Heterosis (%) over mid-parent and better-parent for all studied traits, data are combined over the two locations.

Traits / Crosses	Ketorosis	PH	NB/P	E.F.N.	E.F.W Kg	T.F.N.	T.F.W. Kg
1	H. M.P%	2.5	14.93*	17.12	31.65**	11.57	35.15**
	H. H.P%	-0.03	8.81	9.76	18.72	11.32	27.53**
2	H. M.P%	5.57	14.09*	18.12	44.72**	22.29**	48.88**
	H. H.P%	-6.35*	8.27	11.21	32.73**	19.17*	41.13**
3	H. M.P%	1.51	10.75	5.28	16.02	10.35	25.20**
	H. H.P%	-5.88*	6.71	-5.18	-0.08	6.77	12.42
4	H. M.P%	3.88	8.24	44.71**	37.03**	48.17**	40.99**
	H. H.P%	0.23	0.28	39.05**	29.99**	44.46**	37.06**
5	H. M.P%	17.68**	25.73**	-1.64	12.73	59.29**	80.78**
	H. H.P%	1.19	22.56**	-10.80	8.77	51.45**	76.15**
6	H. M.P%	-5.6	-8.07	42.58**	62.32**	27.79**	55.27**
	H. H.P%	-9.99*	-9.51	35.86*	51.44**	26.81**	46.61**

The same data showed that heterosis over the mid-parent had desirable positive values for all crosses for early fruit number/plant and early fruit weight/plant, respectively. While, Two and four crosses from six showed highly significant positive heterotic effects over mid-parent for early fruit number/plant and early fruit weight/plant, respectively. With respect to heterosis over high-parent, four and five crosses from six gave positive with insignificant, significant or highly significant values ranged between 9.76 to 39.05 and 8.77 to 51.44 for early fruit number/plant and early fruit weight/plant, respectively. These results are in agreement with the findings obtained by several authors among them Yossef, 1997.

Regarding heterosis over mid-parent, positive and significant or highly significant values for total yield (as number and weight) in all crosses were recorded. The values of heterosis over mid-parents ranged from 10.35 in the 3rd cross to 59.29 in the 5th cross for total fruit number/plant, while, it ranged from 25.2 in the 3rd cross to 80.78 in the 5th cross for total fruit weight/plant.

All crosses showed positive heterotic effect over better-parent for total yield as number and weight/plant. It ranged from 6.77 in the 3rd cross to 51.45 in the 5th cross and from 12.42 in the 3rd cross to 76.15 in the 5th cross for total fruit number and total fruit weight/plant, respectively. The 5th cross (Lin-73 X Strain-B) showed the highest heterotic effect for total yield as number and weight/plant. The results also revealed that the heterotic effects for total yield (number and weight/plant) were due to over-dominance. These results are in agreement with the findings obtained by Ramadan 2001.

The inbreeding depression is presented in Table 4 where the reduction of F_2 generation due to inbreeding depression was observed in four and two crosses for plant height and number of branches/plant, respectively. This results indicated the role of dominant gene action in the inheritance of these characters. On the other hand, inbreeding depression was absent in (1st, 2nd, 3rd and 6th), (4th and 6th) crosses for plant height and number of branches/plant, respectively. This result is in agreement with results of several authors among them Amin *et al.* (2001) and Ramadan (2001).

Four from six crosses showed positive inbreeding depression for early fruit number. On the other hand, two crosses showed negative values of inbreeding depression for this trait. However all crosses except for the 3rd cross showed positive values significant or highly significant for early fruit weight/plant. The positive values of inbreeding depression means that the F_1 is earlier than their F_2.

Table 4 Inbreeding depression for all studied traits, data are combined over two locations.

Traits / Crosses	PH	NB/P	E.F.N.	E.F.W Kg	T.F.N.	T.F.W. Kg
1	-21.67**	2.47	14.93	27.22**	12.96	19.48**
2	-2.34	4.59	16.79	36.27**	18.86**	32.58**
3	-3.47	0.74	-38.76**	-3.57	-27.86**	0.37
4	1.09	-2.03	3.60	7.14	-4.56	4.10
5	5.09	12.07*	4.04	22.92*	2.02	19.49**
6	-10.58*	-6.40	-0.85	29.7**	-23.05**	17.78**

Three from six crosses showed positive inbreeding depression for total fruit number, but, only one (2nd cross) was positive and highly significant. On the other hand, the remaining crosses showed negative inbreeding depression for this trait. However, all crosses showed positive values of inbreeding depression ranged between 0.37 – 32.58 for total fruit weight/plant, while, four crosses from that were positive and highly significant. The positive values of inbreeding depression means that the F_1 out yielded their F_2 generation. On the other hand, the negative values of inbreeding depression means that F_2 generation out yielded their F_1 hybrid. This finding may be due to transgressive segregation in the advanced generations. These results were in accordance with results obtained by (Zanata 1994; Singh *et al.*, 1995; El-Sharkawy *et al.*, 1997 and Ramadan, 2001).

The estimates of genotypic variance (σ^2_g), Phenotypic (σ^2_p), phenotypic variance coefficient, genotypic variance coefficient, hertability (Hb^2) and genetic gain are given in Table 5. It can be concluded that the phenotypic variability observed in most characters is influenced more by genetic factors than non-genetic. This is due to the fact that estimate of genotypic variance is higher than that of the error. Most traits such as early fruit number, early fruit weight, total fruit number and total fruit weight have high PVC values. The genotypic variance coefficient (GVC) for these traits appeared to be close to their corresponding estimates of PVC. Also, it showed the same trend as PVC and ranged from 17.75 in early fruit number to 19.89 in total fruit number. This finding was an evidence about the presence and importance of genetic variance on the expression of these characters. So that, the estimated values of broad sense heritabilities for this traits were high and ranged from 0.61 in early fruit number to 0.79 in total fruit weight. In general, the higher estimates of heritabilities indicated that epigenetic factors play a minor role in the expression of this traits. Similar results obtained by Zanata, 1994 and Salib, 1999. Direct selection for vegetative growth (plant height and number of branches/plant) has a limited scope for further improvement as indicated by its low values of heritability, GVC and genetic gain. The values of expected genetic gain depend on selection density of 5% superior plant of F_2 generation in order to improve these traits ranged from 0.31 in early fruit weight to 8.86 in total fruit number. These results indicated that there is a potential for total yields improvement indirectly through total fruit number selections.

Table (5): Estimates of genotypic variance (σ^2_g), phenotypic (σ^2_p), phenotypic variance coefficient, genotypic variance coefficient, heritability (Hb^2) and genetic advance, data are combined over two locations.

Traits	σ^2_g	σ^2_p	PVC	GVC	Hb^2	GA
PH	14.78	131.26	15.29	5.13	0.11	2.60
NB/P	0.25	2.56	13.61	4.25	0.098	0.32
E.F.N	5.03	8.28	22.79	17.75	0.61	3.62
E.F.W	0.05	0.05	23.3	19.00	0.67	0.31
TFN	23.58	30.39	22.59	19.89	0.78	8.86
TFW	0.19	0.24	21.86	19.57	0.79	0.80

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إنتـــاج هجـــن طماطـــم جـــديـــدة فى الظروف المصرية

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تهدف هذه الدراسة إلى تقدير قوة الهجين والانخفاض الناتج عن التربية الدخلية فى صفات النمـــو الخضرى والتبكير والمحصول الكلى فى الجيلين الأول والثانى للهجن الستة الناتجة من تهجين خمسة أصناف من الطماطم التابعة للجنس (.*Lycopersicon esculentum* Mill)٠

قيمت هذه التراكيب الوراثية المختلفة والتى شملت (خمسة أباء والجيل الأول والجيل الثـــانى) فـــى الموسم الصيفى لعام ٢٠٠٠ فى موقعين مختلفين (المنصورة وقها)٠ وتشير النتائج المتحصل عليهـــا مـــن الموقعين أن قوة الهجين منسوبة إلى أفضل الأباء وكذلك منسوبة إلى متوسط الأبوين كانت معنوية فى معظم الصفات المدروسة٠

أظهر الهجين (73 X Strain-B) أعلى قـــوة هيجـــن بالنسبة للمحصول الكلـــى (كعـــدد ووزن ثمار)، وكانت قيمة قوة الهجين منسوبة إلى متوسط الأبوين ٢٩ر٥٩ و ٧٨ر٨٠ لعدد الثمار ووزن الثمـــار على التوالى٠ بينما كانت قوة الهجين منسوبة إلى أفضل الأباء ٤٥ر٥١ و١٥ر٧٦ بالنسبة لعـــدد الثمـــار ووزن الثمار على التوالى٠ كما تعزى قوة الهجين الحادثة فى المحصول الكلى (لعدد ووزن ثمار) إلى سيادة فائقة٠

كما تراوحت قيم الانخفاض الناتج عن التربة الداخلية ما بين ٧٦ر٣٨ للمحصول المبكر كعدد ثمار إلى ٢٧ر٣٦ للمحصول المبكر كوزن ثمار٠

تراوحت قيم معامل التوريث فى المدى الواسع ما بين ١١ر٠ فى طول النبات إلى ٧٩ر٠ فـــى المحصـــول الكلى كوزن ثمار٠