RESULTS AND DISCUSSION

4- RESULTS AND DISCSSION

4-1- First experiment.

***Effect of plant density, fertilization source and their interaction on vegetative growth, bulb yield and its quality.**

4-1-1- Vegetative growth characteristics.

Data presented in Tables (1 and 2) show the effect of plant density and fertilization as well as their interaction on vegetative growth characteristics of onion plant.

a- Effect of plant density.

Regarding the effect of planting density, data in Table (1) show that all the studied growth parameters were not significantly affected due to the differences in number of ridges per unit area (6, 5, 3 ridges / plot), i.e., transplanting on 25, 20 or 15 cm apart between rows on ridges according to the number of ridges /plot, respectively. However, the highest values for plant length were recorded in the closest transplanting i.e., growing the plant in six rows on ridge 90 cm a part (18 rows /plot) on the other hand, the highest values for number of leaves, fresh weight of leaves and bulb as well as whole plant, neck and bulb

Table (1): Effect of plant density and source of fertilization on vegetative growth characteristics of onion plants.

Season	2001/2002									
Treatments	Plant length (cm)	Leave length (cm)	Leaves number /plant	Leaves weight (g)	Bulb weight (g)	Whole plant weight (g)	Bulb height (cm)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio
1*	69.2	53.7	7.0	88.2	41.0	129.2	15.5	1.37	2.79	0.49
2**	61.4	50.0	7.0	80.2	44.1	124.3	11.9	1.44	3.00	0.48
3***	65.4	57.3	7.2	72.0	35.9	107.9	8.1	1.23	2.72	0.45
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Town refuse	62.8	51.4	6.9	78.8	39.8	118.6	11.4	1.35	2.88	0.46
Compost	58.8	47.6	6.9	52.8	29.1	81.9	11.2	1.18	2.45	0.48
FYM	60.9	49.4	6.7	66.7	36.1	102.8	11.5	1.26	2.67	0.47
Chicken	72.5	60.3	7.6	106.6	50.9	157.5	12.2	1.50	3.16	0.47
90+30+24	71.7	59.8	7.1	97.7	45.7	143.4	11.9	1.44	3.03	0.47
L.S.D. at 0.05	**8.59**	n.s.	n.s.	**11.8**	**10.7**	**38.8**	n.s.	**0.19**	**0.35**	n.s.
	2002/2003									
1*	72.9	59.0	7.4	44.3	66.1	110.4	13.9	1.62	3.21	0.50
2**	78.7	64.3	7.5	42.6	59.6	102.2	14.4	1.75	3.15	0.55
3***	78.7	60.8	7.6	37.0	59.0	96.0	17.9	1.69	3.07	0.55
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Town refuse	75.3	60.4	7.5	41.5	57.1	98.6	14.9	1.63	3.17	0.51
Compost	74.8	60.1	7.4	40.6	55.6	96.2	14.7	1.69	3.12	0.54
FYM	73.8	59.0	7.4	42.5	58.2	100.7	14.8	1.72	3.13	0.54
Chicken	79.0	64.6	7.7	43.8	73.8	117.6	14.4	1.74	3.22	0.56
90+30+24	77.5	62.8	7.5	38.1	63.3	101.4	14.7	1.65	3.06	0.53
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

*** Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.**

**** Transplanting at 10 cm apart on both sides of 60 cm in width i.e., 20 cm between rows.**

*****Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.**

diameter were obtained in case of widest planting, i.e., growing the plants in two rows on ridges 50 cm apart (12 rows/plot). Obtained results are true during both seasons of growth. In this respect, **Muostafa (1979), Mc-Geary (1985)** and **Vasets-Kii** and **Ostroverkhov (1986),** reported that growth rate of onion plants varied greatly according to the number of plants per unit area. Moreover, **El-Habbasha *et al.* (1984), Koriem *et al.* (1990), El-Sheekh *et al.* (1994), El-Gamili (1996), Fatma (1997)** and **Naik** and **Hosamani 2003)** reported similar results on plant growth aspects under different planting densities.

b-Effect of fertilization.

Concerning the effect of fertilization, obtained data in Table (1) show that the vegetative growth parameters of onion plants expressed as plant length, average number of tubular leaves per plant, length of tubular leaves, weight of leaves and bulb as well as whole plant weight, bulb and neck diameter and bulbing ratio were affected as a result of organic fertilizers application compared with NPK fertilization (control treatment) during both seasons of study. In this respect, such effects reached the level of 0.05 significancy in case of plant length, weight of leaves and bulb per plant as well as the total weight of plant and bulb and neck diameter during the first season of study only. In

addition, no significant differences were noticed in all recorded vegetative growth characters during the second season. However, the highest values in all studied growth parameters were recorded in case of plants received chicken manure at a rate of 4 tons /fed. followed by those received the recommended dose of NPK fertilizers (90 kg N + 30 kg P_2O_5 + 24 kg K_2O /fed.). Obtained results are true during both seasons of study. In this respect, the enhancing effect of chicken manure on growth rates of onion plants my be due to the highest nutrients content of chicken manure and its faster decomposition compared with the other used organic manures and consequently increased the concentration of macro and micro nutrients in the solution of the soil at roots zone which in turne increased the plant growth aspects during the first stage of vegetative growth after transplanting. Obtained results are in agreement with those of **Abo-El-Hamed (1984)**, **Haggag *et al.* (1986)**, **Khalil *et al.* (1988-b)**, **Koriem and Farag (1990-a)**, **Hanna-Alla *et al.* (1991-a)**, **El-Gizawy *et al.* (1993)**, **El-Sheekh *et al.* (1994)**, **El-Gamili** and **Abd El-Hadi (1996)**, **Fatma(1997)**, **El-Sheekh** and **Hegazy (1998)**, **Deho *et al.* (2002)**, **Singh** and **Singh (2002)** and **Naik** and **Hosamani (2003)** all working on mineral fertilizers., **Khalaf** and **Taha (1988)**, **Foly (1999)** and **El-Zohery (2004)** on garlic, **Ekbladh (1995)**, **Singh *et al.* (1997)**, **El-Sheekh** and

Hegazy (1998), **Mohamed** and **Gamie, (1999)**, **Shadia (2000) and Khalil *et al.* (2002)** on onion, reported that there were a differences in vegetative growth of such plants due to the different used levels and sources of organic fertilizers. Moreover, **El-Sheekh** and **Hegazy (1998), Foly (1999), Mohamed** and **Gamie (1999)** and **Khalil *et al.*(2002)** indicated that chicken manure supplies onion plants with suitable rates of NPK and in proper time and increased plant growth parameters compared with other used organic manures and inorganic fertilizers treatments.

c- Effect of the interaction.

As for the effect of the interaction between plant density and fertilization on studied vegetative growth parameters of onion plants, data in Table (2) reveal that no significant differences can be noticed in all the studied growth parameters due to the interaction during both seasons of these experiments. Obtained results are in agreement with those reported by **Koriem** and **Farage(1990-a)** and **El-Sheekh *et al.* (1994).** On the other hand, **Fatma (1997)** and **Naik** and **Hosamani (2003)** reported significant increases in plant growth parameter (plant length, number of leaves, plant fresh and dry weight of whole

Table (2): Effect of the interaction between plant density and source of fertilization on vegetative growth characteristics of onion plants.

Season		2001/2002									
Treatments		Plant length (cm)	Leave length (cm)	Leaves number /plant	Leaves weight (g)	Bulb weight (g)	Whole plant weight (g)	Bulb height (cm)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio
1*	Town refuse	66.8	55.3	6.8	77.9	38.3	116.2	11.3	1.29	2.69	0.47
	Compost	61.2	49.8	6.8	59.1	28.2	87.3	11.4	1.15	2.35	0.48
	FYM	67.4	55.7	6.7	80.3	38.7	119.0	11.7	1.39	2.73	0.50
	Chicken	75.7	62.6	7.5	111.3	56.5	167.8	13.1	1.61	3.18	0.50
	90+30+24	74.7	63.3	7.1	112.6	43.2	155.8	11.4	1.43	3.0	0.47
2**	Town refuse	55.6	45.4	7.0	94.0	46.5	140.5	10.2	1.51	3.20	0.47
	Compost	55.2	43.6	7.0	56.7	32.5	89.2	11.6	1.34	2.63	0.50
	FYM	54.5	43.7	6.6	66.1	42.7	108.8	10.8	1.36	2.95	0.46
	Chicken	67.9	56.2	7.6	117.0	53.3	170.3	11.7	1.55	3.30	0.46
	90+30+24	74.0	61.3	6.6	67.5	45.3	112.8	12.7	1.44	2.94	0.48
3***	Town refuse	66.0	53..5	7.0	58.5	34.5	93.0	12.5	1.24	2.75	0.45
	Compost	60.0	49.4	6.9	42.8	26.5	69.3	10.6	1.06	2.37	0.44
	FYM	66.8	48.4	6.7	53.9	26.8	80.7	18.4	1.02	2.33	0.43
	Chicken	73.8	62.0	7.6	91.7	43.0	134.7	11.8	1.35	2.99	0.45
	90+30+24	66.3	54.8	7.6	113.1	48.5	161.6	11.5	1.46	3.14	0.46
L.S.D. at 0.05		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
		2002/2003									
1*	Town refuse	72.3	58.5	7.6	42.2	60.8	103.0	13.8	1.56	3.06	0.50
	Compost	71.5	57.3	7.2	40.8	58.6	99.4	14.2	1.65	3.17	0.52
	FYM	68.4	54.8	6.9	43.6	68.0	111.6	13.6	1.50	3.37	0.44
	Chicken	77.4	63.5	7.9	48.3	67.8	116.1	13.9	1.72	3.07	0.56
	90+30+24	74.9	60.9	7.4	37.7	75.3	113.0	14.0	1.65	3.36	0.49
2**	Town refuse	78.3	63.2	7.5	42.5	55.5	98.0	15.1	1.68	3.24	0.51
	Compost	78.4	64.2	7.4	40.8	55.8	96.6	14.2	1.67	3.11	0.53
	FYM	78.9	64.0	7.7	43.6	62.7	106.3	14.9	1.84	3.10	0.59
	Chicken	80.8	67.0	7.3	48.3	66.0	114.3	13.8	1.70	3.38	0.50
	90+30+24	77.3	63.1	7.6	37.7	58.0	95.7	14.2	1.88	2.91	0.64
3***	Town refuse	78.3	59.6	7.4	39.7	55.0	94.7	18.7	1.64	3.21	0.51
	Compost	78.4	58.7	7.6	37.9	52.2	90.1	19.7	1.76	3.07	0.57
	FYM	78.9	58.2	7.5	33.9	44.1	78.0	20.7	1.81	3.93	0.46
	Chicken	80.8	63.4	8.0	49.2	87.4	126.6	17.4	1.81	3.20	0.56
	90+30+24	77.3	64.3	7.4	35.0	56.5	91.5	13.0	1.43	2.92	0.48
L.S.D. at 0.05		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

* Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.

** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.

***Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.

plant) due to the combined effect of plant density via fertilization treatments.

4-1-2- Yield and its components.

Data presented in Tables (3 and 4) show the effect of plant density and fertilization as well as their combination on total bulbs yield and its components expressed as average bulb weight, single bulbs yield, culls bulb weight and culls ratio during both seasons of study.

a- Effect of plant density.

Data presented in Table (3) show the effect of plant density on total yield of bulbs, yield of single bulbs, weight and percentage of culls as well as average weight of bulb. Such data indicate that there were significant differences among the tested planting densities in all the studied yield parameters. In this respect, the medium plant density, i.e., growing the plants in three rows per ridge 60 cm width gave the highest values of total bulb yield, yield of single bulbs and the average weight of bulb compared with growing the plants in two rows per ridge 50 cm width and growing plants in six rows per ridge 90 cm width. On the other hand, the lowest values were obtained as a result of transplanting six rows per ridge 90 cm width. In addition, the highest percentage and weight of culls bulbs were recorded in

Table (3): Effect of plant density and source of fertilization on bulb yield and its components of onion plants.

Season	2001/2002				
Treatments	Average bulb weight (g)	Single bulb weight ton/fed.	Culls bulb weight ton/fed.	Total yield ton /fed.	Culls (%)
1*	85.6	15.940	3.510	19.450	10.83
2**	86.2	17.620	3.220	20.840	9.38
3***	74.8	15.130	2.560	17.690	8.70
L.S.D. at 0.05	**1.6**	**0.660**	**0.370**	**0.750**	**0.85**
Town refuse	82.2	15.430	3.210	18.640	10.30
Compost	73.7	14.430	2.730	17.160	9.48
FYM	79.8	15.730	2.950	18.680	9.49
Chicken	83.5	17.560	2.950	20.510	8.66
90+30+24	91.8	17.890	3.640	21.530	10.25
L.S.D. at 0.05	**5.1**	**0.590**	**0.290**	**0.780**	**0.81**
	2002/2003				
1*	78.2	15.900	3.300	19.200	10.57
2**	85.4	19.900	3.350	23.250	8.75
3***	78.2	16.030	3.420	19.450	10.74
L.S.D. at 0.05	**n.s.**	**1.090**	**n.s.**	**0.910**	**1.01**
Town refuse	75.0	15.910	3.290	19.200	10.37
Compost	78.6	16.560	3.450	20.010	10.60
FYM	67.9	14.170	3.390	17.560	11.84
Chicken	86.6	20.350	3.010	23.360	8.23
90+30+24	94.8	19.400	3.640	23.040	9.06
L.S.D. at 0.05	**8.2**	**1.300**	**n.s.**	**1.520**	**1.21**

*** Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.**

**** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.**

*****Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.**

case of wide spacing, i.e., growing the plants in two rows per ridge 50 cm wide. In this respect, such increments in total bulb yield and its parameters failed to reaches the level of 0.5 % significancy in case of weight of culls and average weight of bulb during the second season of study. From the above-mentioned results, it could be concluded that the superiority of the medium plant density (planting three rows/ ridge 60 cm wide) on both total and single bulb yield may be attributed to the less competition between plants and the well utilization of nutrients in the soil as well as to encouragement of the capacity of plants in bulbing metabolites, which in turne resulted in more accumulation of stored food in onion bulbs which increased the total produced yield. Obtained results are conformed by those reported by **Hassan** and **Ayoub (1978), Omran** and **Awad (1979), Koriem *et al.* (1990), El-Sheekh *et al.* (1994), Badr *et al.* (1995), Fatma *et al.* (1995), El-Gamili (1996), Koriem *et al.* (1996), Fatma (1997), Oukal (1999)** and **Naik** and **Hosamani (2003)** all working on onion where they found that total bulb yield and its components were affected by the tested plant densities either as plant spacing, number of rows per ridge or number of plants per unit area.

b- Effect of fertilization.

Data on the effect of fertilization on total and single bulb yield, weight and percentage of culls bulbs as well as average weight of bulb are presented in Table (3), Such data indicate that there were differences in total produced bulbs yield and its parameters, i.e., weight of single bulbs, weight and percentage of culls as well as average weight of single bulb among the used organic fertilizers as well as the recommended rate of mineral fertilizer during both seasons of study. In this concern, fertilizing onion plants with mineral fertilizers (NPK) at a rate of 90 kg N + 30 kg P_2O_5 + 24 kg K_2O /fed. during the plant growth or addition of chicken manure at 4 tons /fed. during soil preparation produced the highest total and single bulb yield and the largest average single bulb weight compared with other used organic fertilizers. In addition, no significant differences can be noticed between the used levels of mineral fertilizers and the used amount of chicken manure in all forementioned yield traits during both seasons of growth. On the other hand, the lowest values in total yield and single bulb were recorded by application of compost at a rate of 5 tons /fed. during the first season, and using FYM at rate of 14 tons/fed. during the second season, respectively. However, the highest values for weight of culls were recorded in case of using mineral fertilizer at a

recommended dose during the first season only, whereas, the highest percentage for culls was resulted due to the using town refuse at a rate of 8 tons /fed. during the first season and FYM at 14 tons/ fed. during the second season. In this regard, the superiority of chicken manure and mineral fertilizer in total and weight of single bulbs yield as well as average weight of single bulb may be due to such treatments supplied the plant with higher amounts and readily for absorption from NPK nutrients during the first stage of growth which consequently affected most metabolic process of plant and in turne increased the vegetative growth parameters of plant (Tables, 1 and 2). Hence, it increased the produced yield. In this respect, **Haggag *et al.* (1986)**, **Khalil *et al.* (1988-b)**, **Hanna-Alla *et al.* (1991-a&b)**, **El-Gizawy *et al.* (1993)**, **El-Sheekh *et al.* (1994)**, **Badr *et al.* (1995)**, **El-Gamili** and **Abd El-Hadi (1996)**, **El-Sheekh** and **Hegazy (1998)**, **Abd El-Latif (1999)**, **Oukal (1999)** and **El-Moshileh (2001)** reported similar results in case of using mineral fertilizers (NPK) either in a single form or in combination and **Khalaf** and **Taha (1988)** on garlic and **El-Sheekh** and **Hegazy (1998)**, **Shadia (2000)** and **Khalil *et al.* (2002)** on onion using organic fertilizers. They reported that using organic manure had positive effect on total bulb yield and its components. In this regard, **El-Sheekh** and **Hegazy (1998)** and **Khalil *et al.* (2002)**

found that addition of chicken manure increased total and marketable bulb yield as well as average bulb weight but did not affect culls weight in comparison with other used organic fertilizers.

c- Effect of the interaction.

As for the effect of the interaction between planting density and fertilization, data presented in Table (4) show that the total produced bulbs yield, yield of single bulbs as well as weight and percentage of cull bulbs were significantly affected. In this respect, the maximum total and single bulbs yield were obtained in case of growing plants in three rows on ridges 60 cm in width and fertilized with either mineral fertilizer at the recommended dose during the growing seasons or chicken manure at 4 tons per fed. In addition, the highest values for average weight of bulb were obtained in case of the lowest plant density (2 rows /ridge 50 cm in width) combined with mineral fertilizer at the recommended dose. On the contrary, the lowest values for culls weight and its percentage were recorded in case of medium plant density (3 row/ ridge 60 cm in width) combined with using chicken manure at 4 tons/fed. Moreover, using town refuse, FYM or mineral fertilizers at the widest planting distance (2 rows per ridge 50 cm width) reflected the highest values for

Table (4): Effect of the interaction between plant density and source of fertilization on bulb yield and its components of onion plants.

Season		2001/2002				
Treatments		Average bulb weight (g)	Single bulb weight ton/fed.	Culls bulb weight ton/fed.	Total yield ton /fed.	Culls (%)
1*	Town refuse	82.8	15.190	4.200	19.390	12.96
	Compost	82.3	15.490	3.000	18.490	9.73
	FYM	79.6	15.300	3.430	18.730	11.09
	Chicken	77.6	16.600	3.160	19.760	9.61
	90+30+24	105.5	17.100	3.730	20.830	10.77
2**	Town refuse	92.8	18.000	3.040	21.040	8.65
	Compost	70.2	14.100	3.400	17.500	11.64
	FYM	91.6	18.100	3.100	21.200	8.78
	Chicken	86.6	19.200	2.890	22.090	7.88
	90+30+24	90.1	18.700	3.700	22.400	9.96
3***	Town refuse	70.9	13.090	2.400	15.490	9.29
	Compost	68.7	13.690	1.800	15.490	7.06
	FYM	68.3	13.800	2.320	16.120	8.62
	Chicken	83.5	16.900	2.800	19.700	8.49
	90+30+24	91.8	17.830	3.490	21.320	10.25
L.S.D. at 0.05		**8.8**	**1.020**	**0.510**	**1.350**	**1.41**
		2002/203				
1*	Town refuse	63.3	13.33	3.16	16.490	11.48
	Compost	64.5	13.15	3.60	16.750	12.90
	FYM	69.3	13.54	3.10	16.640	11.19
	Chicken	94.2	19.35	3.01	22.360	8.10
	90+30+24	99.7	20.15	3.66	23.810	9.18
2**	Town refuse	87.9	18.78	3.52	22.30	9.43
	Compost	87.7	20.22	3.25	23.470	8.33
	FYM	78.2	17.52	3.46	20.980	9.91
	Chicken	80.1	21.41	2.94	24.350	7.54
	90+30+24	92.9	21.55	3.58	25.130	8.54
3***	Town refuse	73.8	15.60	3.19	18.790	10.20
	Compost	83.4	16.33	3.49	19.820	10.59
	FYM	56.3	11.47	3.61	15.080	14.43
	Chicken	85.5	17.45	3.10	20.550	9.04
	90+30+24	91.8	19.33	3.67	23.000	9.46
L.S.D. at 0.05		**14.2**	**2.26**	**n.s.**	**2.640**	**2.10**

* Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.

** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.

***Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.

weight and percentage of culls. Obtained results agree with those reported by **El-Sheekh *et al.* (1994), Badr *et al.* (1995), Fatma (1997)** and **Oukal (1999).**

4-1-3- Bulb quality.

a- Physical bulb quality.

Data presented in Tables (5 and 6) show the effect of plant density, fertilization source and their interaction on physical quality of produced bulbs expressed as bulb diameter, firmness, total soluble solids and the dry matter percentage of bulbs.

a-1- Effect of plant density.

Such data in Table (5) show that there were no significant differences can be noticed among the studied plant densities in all measured bulb characters, i.e., bulb diameter, firmness, total soluble solids and dry matter percentage. Obtained results were true during both seasons of study. However, we can noticed that transplanting onion seedlings in sex rows per ridge 90 cm wide, i.e., the distance between rows 15 cm reflected the highest values in bulb firmness, TSS and dry matter % during the first season and TSS and dry matter % during both seasons of study. On the other hand, growing onion plants in two rows /ridge 50 cm width

Table (5): Effect of plant density and source of fertilization on bulb quality of onion bulbs.

Season	2001/2002				2002/2003			
Treatments	Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	Dry matter (%)	Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	Dry matter (%)
1*	6.39	15.07	13.49	17.72	6.55	14.38	11.89	17.26
2**	6.34	15.07	13.51	17.73	6.52	14.73	12.11	17.66
3***	6.29	15.28	13.52	18.13	6.43	14.75	12.18	17.66
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Town refuse	6.18	13.63	13.21	17.55	6.37	13.64	11.54	17.10
Compost	6.36	15.62	13.69	17.99	6.58	14.93	12.17	17.66
FYM	6.30	14.68	13.38	17.83	6.45	14.55	12.01	17.22
Chicken	6.36	15.30	13.51	17.99	6.49	14.75	12.08	17.44
NPK	6.44	16.47	13.73	18.10	6.61	15.25	12.49	17.88
L.S.D. at 0.05	n.s.	0.50	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

* Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.

** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.

***Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.

reflected the highest values of bulb diameters. Obtained results may be due to that higher plant density increased the competition between plants on water and consequently decreased the amounts of water absorbed by plant which in turne increased bulb firmness and TSS content as well as the dry matter % of produced bulbs. In this respect. **Mostafa (1979)**, **Omran** and **Awad (1979)**, **Farag (1986)**, **Koriem *et al.* (1990-b)**, **El-Sheekh *et al.* (1994)** and **Oukal (1999)** reported that higher bulb dry weight, dry matter percentage, total soluble solids and bulb diameter were obtained with wider spacing (7-10 cm).

a-2- Effect of fertilization.

Concerning the effect of fertilization on physical bulb quality for the produced bulbs, the same data in Table (5) reveal that irrespective of bulb firmness, which was significantly affected due to fertilization treatments during the first season only, there were no significant differences can be noticed among the tested fertilizer treatments in all the studied physical bulb characters. Obtained results are similar during both seasons of study. In addition, fertilizing bulb plants with organic fertilizer as compost at rate of 5 tons /fed. reflected the lowest values for bulb firmness, TSS and dry matter percentage during both seasons of study. On the other hand, the highest values in such

characters were obtained in case of fertilizing onion plants with mineral fertilizer at the recommended dose (90 kg N + 30 kg P_2O_5 + 24 kg K_2O /fed.). In this regard, **El-Sheekh** and **Hegazy (1998)** and **Shadia (2000)** reported that organic manure application had positive effect on dry weight and diameter of bulbs when compared with the check treatment. In addition, town refuse treatments (10 and 20 ton /fed.) in the first and by application of FYM at 20 ton /fed. in the second one surpassed other studied treatments.

a-3- Effect of the interaction.

As for the effect of the interaction between plant density and fertilization treatments on physical bulb quality expressed as bulb diameter, bulb firmness, TSS content as well as dry matter percentage. Data in Table (6) indicate that the above mentioned bulb quality parameters were not significantly affected due to the interaction between the studied treatments. Such results are true during both seasons of growth. Moreover, the highest bulb diameter was obtained as a result of using the recommended dose of mineral fertilizer in case of the lowest plant density (planting two rows on both sides of ridge 60 cm apart), while the highest values of bulb firmness, TSS content and dry matter % were obtained in case of using organic fertilizer as compost and

Table (6): Effect of the interaction between plant density and source of fertilization on bulb quality of onion bulbs.

Season		2001/2002				2002/2003			
Treatments		Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	Dry matter (%)	Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	Dry matter (%)
1*	Town refuse	6.26	13.63	13.62	17.33	6.43	13.46	11.40	17.33
	Compost	6.46	15.90	14.13	18.33	6.63	14.66	11.93	17.00
	FYM	6.33	14.80	13.06	17.66	6.50	14.46	11.86	17.00
	Chicken	6.43	15.00	13.40	17.66	6.53	14.60	11.86	17.33
	NPK	6.48	16.03	13.60	17.66	6.70	14.73	12.40	17.66
2**	Town refuse	6.13	13.46	13.03	17.66	6.40	13.60	11.70	16.66
	Compost	6.43	15.80	13.60	17.33	6.60	15.00	12.20	18.00
	FYM	6.36	14.46	13.60	17.33	6.46	14.66	12.03	17.33
	Chicken	6.36	14.96	13.53	18.00	6.56	14.86	12.13	17.66
	NPK	6.46	16.70	13.80	18.33	6.60	15.56	12.53	17.66
3***	Town refuse	6.16	13.80	13.36	17.66	6.30	13.86	11.53	17.33
	Compost	6.36	15.16	13.36	18.33	6.53	15.10	12.40	18.00
	FYM	6.23	14.80	13.50	18.00	6.40	14.53	12.16	17.33
	Chicken	6.30	15.96	13.60	18.33	6.40	14.80	12.26	17.33
	NPK	6.40	16.70	13.80	18.33	6.53	15.46	12.56	18.33
L.S.D. at 0.05		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

* Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.

** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.

***Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.

the highest plant density. Obtained results are in agreement with those reported by **Tashkhodzhaev (1985)**, **Jana** and **Jahangir (1990)**, **Pimpini *et al.* (1992) and Singh *et al.* (1997)** who recorded that applying organic manure combined with mineral fertilizers on onion gave the highest value of bulb diameter, bulb size and total soluble solids percentage.

4-1-3-b-Chemical composition of onion bulbs.

Data presented in Tables (7 and 8) show the effect of plant density, fertilization and their interaction on chemical composition of onion bulbs expressed as total nitrogen, phosphorus and potassium content.

a-Effect of plant density.

Data in Table (7) show clearly that there were no significant differences in the concentration of all assayed macro elements, i.e., total nitrogen, phosphorus and potassium in bulbs due to the different studied plant densities during both seasons of growth. However, planting two rows per ridge 50 cm apart reflected the highest values for N, P and K concentration of bulbs during the two seasons of study compared with planting three rows per ridge 60 cm apart and six rows per ridge 90 cm wide. In this

Table (7): Effect of plant density and source of fertilization on N, P and K percentage of onion bulbs.

Season	2001/2002			2002/2003		
treatments	N	P	K	N	P	K
1*	3.07	0.29	2.47	2.27	0.27	1.19
2**	3.00	0.28	2.37	2.23	0.24	1.18
3***	2.93	0.28	2.41	2.23	0.24	1.17
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Town refuse	3.06	0.29	2.29	2.13	0.25	1.14
Compost	2.87	0.27	2.18	2.17	0.26	1.24
FYM	2.83	0.28	2.32	2.36	0.25	1.22
Chicken	3.02	0.28	2.70	2.37	0.23	1.12
90+30+24	3.27	0.29	2.62	2.18	0.25	1.18
L.S.D. at 0.05	n.s.	n.s.	0.19	n.s.	n.s.	0.03

* Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.

** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.

***Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.

respect, the highest concentration of N, P and K in case of low plant density may be due to the lowest competition between plants on N, P and K uptake and the more opportunity for plants to absorb higher amounts of such nutrients from the soil. In this regard, **Badr *et al.* (1995)** reported that there were significant increases in the concentration of nitrogen while phosphorus was not affected with increasing plant density. On the other hand, K concentration was increased with lower plant density. In addition, **El-Gamili (1996)** indicated that there were no marked effects for different plant populations on the content of N, P and K in bulbs tissues.

b- Effect of fertilization

As for the effect of fertilization on total nitrogen, phosphorus and potassium content of onion bulbs, the same data in Table, (7) indicate that irrespective of potassium concentration which was significantly affected

due to the application of different fertilizers sources, total nitrogen and phosphorus concentration were not significantly affected due to the application of different organic manure sources or the recommended dose of NPK fertilizers. Obtained results were true during both seasons of study. Moreover, the highest potassium concentration was noticed in case of bulbs

produced as a result of using chicken manure at a rate of 4 tons /fed. and or the mineral fertilizer at the recommended dose during the first season and application of compost organic manure at a rate of 5 tons/fed. during the second season of study. However, **Khalil *et al.* (1988-b)**, **Amado** and **Teixeira(1992)**, **Patel *et al.*(1992)**, **Badr *et al.* (1995) Farghali** and **Zeid (1995)**, **El-Gamili** and **Abd El-Hadi (1996)** and **Oukal (1999)** all working on onion and **Abo-Sedera *et al.* (1991)** on garlic reported that total nitrogen, phosphorus and potassium content were increased with increasing NPK fertilizer levels. Moreover, **Khalaf** and **Taha (1988)** on garlic, **Abd-El-Moez *et al.* (1997)** and **Khalil *et al.* (2002)** on onion found that application of different organic manure sources positively affected bulbs content from N, P and K nutrients.

c- Effect of interaction.

Regarding the effect of the interaction between planting density and different fertilization treatments, data in Table (8) indicate that nitrogen concentration during the second season and potassium during the two seasons of growth were significantly affected due to the interaction while phosphorus concentration was not affected. In this connection, the highest N, P or K concentrations were recorded in case of all combinations where

Table (8): Effect of the interaction between plant density and source of fertilization on N, P and K percentage of onion bulbs.

Season		2001/2002			2002/2003		
Treatments		N	P	K	N	P	K
1*	Town refuse	3.33	0.31	2.33	2.13	0.28	1.15
	Compost	2.90	0.28	2.33	2.23	0.28	1.31
	FYM	2.70	0.28	2.20	2.33	0.25	1.18
	Chicken	3.03	0.29	2.70	2.43	0.27	1.16
	90+30+24	3.40	0.29	2.83	2.23	0.26	1.19
2**	Town refuse	3.00	0.29	2.13	2.13	0.24	1.17
	Compost	3.83	0.27	2.03	2.10	0.27	1.17
	FYM	2.90	0.29	2.43	2.53	0.26	1.30
	Chicken	3.20	0.29	2.80	2.30	0.21	1.11
	90+30+24	3.10	0.28	2.50	2.10	0.25	1.15
3***	Town refuse	2.90	0.29	2.43	2.13	0.25	1.11
	Compost	2.90	0.28	2.20	2.20	0.25	1.25
	FYM	2.90	0.29	2.33	2.23	0.26	1.20
	Chicken	2.83	0.28	2.60	2.40	0.22	1.10
	90+30+24	2.93	0.30	2.53	2.23	0.26	1.20
L.S.D. at 0.05		n.s.	n.s.	0.20	0.20	n.s.	0.07

* Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.

** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.

***Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.

the highest concentration was not the same at one combination at both seasons. In this regard, **Fatma (1997)** indicated that total nitrogen and potassium content of onion bulbs were increased while phosphorus content was not affected due to the interaction. However, the highest total nitrogen and potassium content was connected with the widest planting

spacing (2 rows /ridge 50 cm in width) and the highest level of NPK fertilizer (190 kg N + 96 kg P_2O_5 + 161 kg K_2O/fed.).

4-1-4- Storageability.

Data presented in Tables (9 and 10) show the effect of plant density, fertilization source and their interaction on total weight loss percentage of bulbs during the storage periods.

a-Effect of plant density.

The data in Table (9) show clearly that there were no significant differences in weight loss percentage percentage of bulbs during the storage period (7 months) were noticed among the studied plant densities in both seasons of study. In this respect, planting onion plants at a rate of six rows on ridge 90 cm wide gave the lowest values of total weight loss percentage percentage along the storage period during the two seasons of study compared with planting two rows on both sides of ridge 50

Table (9): Effect of plant density and source of fertilization on percentage of total weight loss of onion bulbs.

Season	2001/2002							
Treatments	Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1*	2.41	3.96	4.20	4.24	5.59	6.16	11.15	5.38
2**	2.26	3.28	3.61	4.15	5.26	5.37	11.10	5.00
3***	2.15	3.05	3.46	3.52	4.48	4.82	10.08	4.50
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
Town refuse	2.95	3.91	4.14	4.45	5.67	6.67	5.87	4.80
Compost	2.05	3.06	3.58	3.64	4.69	5.08	4.54	3.80
FYM	2.34	3.10	3.93	4.09	5.12	5.24	5.02	8.10
Chicken	2.08	3.19	4.10	4.30	5.60	5.34	5.04	4.23
90+30+24	1.93	2.63	3.04	3.37	4.49	4.92	4.24	3.51
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
	2002/2003							
1*	4.36	4.98	4.76	4.26	9.11	7.82	10.87	6.59
2**	4.35	4.66	4.64	4.02	9.06	7.67	10.86	6.46
3***	4.22	4.07	4.62	3.80	7.88	7.40	9.86	5.97
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Town refuse	4.50	4.43	5.01	4.18	8.89	8.18	6.68	5.98
Compost	4.28	4.58	4.48	3.52	8.66	7.15	6.12	5.54
FYM	4.34	4.76	4.52	3.98	8.68	7.97	6.40	5.80
Chicken	4.38	4.85	4.69	4.07	8.82	7.99	6.51	5.90
90+30+24	4.06	3.70	4.46	3.36	8.37	6.88	3.83	4.95
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	

*** Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.**

**** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.**

*****Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.**

cm width or three rows on ridge 60 cm width. Obtained results are connected with bulb quality at harvest time where the narrow spacing of transplanting i.e., transplanting 6 rows on ridge 90 cm width resulted in bulbs with higher percentage of TSS, dry matter and firmness. Therefore, it exhibited the lowest values of weight loss percentagees during the storage. In this regard, **Moustafa (1979), El-Sheekh (1990), El-Sheekh *et al.*(1994)** reported that weight loss percentage percentage of onion bulbs was markedly affected by different plant distances. Moreover, **Oukal (1999)** pointed out that increasing the spacing between plants from 5 up to 10 cm between transplants caused an increase in total weight loss percentage of bulbs during the storage.

b-<u>Effect of fertilization.</u>

The same data in Table (9) reveal that application of organic fertilizers either in a form of town refuse, compost, farmyard manure, or chicken manure and or mineral fertilizer at the recommended dose had no significant effect on total weight loss percentage percentage of bulbs during the storage period (7 months). Obtained results are true during both seasons of study. In addition, the lowest values for weight loss percentage percentage during the different months of storage were obtained

in case of using mineral fertilizers at the rate of 90 kg N + 30 kg P_2O_5 + 24 kg K_2O /fed. Such results may be due to the rate of macro-elements in mineral fertilizers increasing the percentage of TSS and dry matter % as well as bulb firmness at harvesting as shown in (Table, 11) which in turne affected bulbs storability. Such results are in agreement with those reported by **El-Aweel (1976), D'yachenko(1981)** and **El-Kafoury (1986)**. On the other hand, **Petkov *et al.* (1976), El-Sheekh *et al.* (1998)** and **Oukal (1999)** concluded that application of relatively high rate of NPK fertilizers improved the keeping quality of onion bulb. In this respect, **El-Sheekh** and **Hegazy (1998)** studied the effect of chicken manure and farmyard manure at a rate of 10, 15 and 20 m3 /fed. for each on storability of onion bulbs for cv. Giza 20. They found that organic fertilizers did not affect the total weight loss percentage during the storage period (5 months).

c- <u>Effect of the interaction.</u>

As for the effect of the interaction between the plant density and fertilization treatments on total weight loss percentage of onion bulbs during the storage. Data recorded in Table (10) show that except the total weight loss percentage during the last month of storage period (December) in the second season of study, which was significantly affected due to the interaction, no

Table (10): Effect of the interaction between plant density and source of fertilization on percentage of total weight loss of onion bulbs.

Season		2001/2002							
Treatments		Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1*	Town refuse	3.08	3.97	4.87	5.91	5.87	7.85	14.85	6.62
	Compost	1.80	3.06	3.42	3.43	5.72	5.74	10.96	4.87
	FYM	2.53	3.90	4.73	3.34	5.09	5.48	10.36	5.06
	Chicken	2.34	3.38	3.80	4.48	5.85	5.45	10.59	5.12
	90+30+24	2.32	1.67	4.20	4.08	4.46	6.30	9.16	4.59
2**	Town refuse	3.05	4.14	4.56	4.04	6.22	5.96	13.10	5.86
	Compost	2.20	2.87	4.09	4.02	4.72	5.86	7.37	4.44
	FYM	1.99	2.42	3.31	4.29	5.72	5.50	10.71	4.84
	Chicken	2.25	3.59	3.53	4.82	6.24	4.91	15.40	5.82
	90+30+24	1.81	3.42	2.58	3.58	3.42	4.62	8.94	4.05
3***	Town refuse	3.13	3.64	2.99	3.42	4.94	6.22	12.23	5.22
	Compost	2.17	3.25	3.24	3.48	3.63	3.65	9.12	4.07
	FYM	2.51	3.00	3.75	4.66	4.55	4.75	12.95	5.16
	Chicken	1.66	2.60	4.99	3.60	3.71	5.68	6.20	4.06
	90+30+24	1.68	2.80	2.34	2.46	5.59	3.84	9.94	4.09
L.S.D. at 0.05		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
		2002/2003							
1*	Town refuse	4.64	6.43	5.01	3.98	7.99	7.35	8.46	6.26
	Compost	3.88	5.04	5.42	4.16	10.29	7.26	9.50	6.50
	FYM	3.82	4.37	4.07	4.84	7.03	8.52	10.91	6.22
	Chicken	4.70	5.25	4.81	4.13	11.86	9.20	12.35	7.47
	90+30+24	4.64	3.82	4.51	4.21	8.38	6.80	8.06	5.77
2**	Town refuse	4.81	4.03	4.76	4.08	9.14	10.41	12.41	7.09
	Compost	3.34	4.50	4.13	3.45	9.83	6.03	8.85	5.73
	FYM	4.91	6.16	4.76	3.60	11.37	8.65	10.95	7.20
	Chicken	4.41	5.62	4.44	4.17	6.77	6.70	12.66	6.39
	90+30+24	4.28	3.03	5.14	4.79	8.21	6.56	9.44	5.92
3***	Town refuse	4.05	4.43	5.27	4.50	9.55	6.78	8.46	6.14
	Compost	4.71	4.22	3.91	2.95	5.88	8.16	9.50	5.61
	FYM	4.31	3.77	4.75	3.52	7.64	6.74	10.91	5.94
	Chicken	4.04	3.68	4.83	3.91	7.83	8.07	12.35	6.38
	90+30+24	4.02	4.26	4.35	4.16	8.52	7.28	8.06	5.80
L.S.D. at 0.05		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	4.71	

* Transplanting at 10 cm apart on both sides of ridges 50 cm in width i.e., 25 cm between rows.

** Transplanting at 10 cm apart on both sides of ridges 60 cm in width i.e., 20 cm between rows.

***Transplanting at 10 cm apart on ridges 90 cm in width i.e., 15 cm between rows.

significant differences can be noticed in weight loss percentage of onion bulbs during the different months of storage. In addition, the total weight loss percentage of onion bulbs was gradually increased with prolonging the storage period during the two seasons of study. In this regard, **El-Sheekh *et al.* (1994)** pointed out that there was no significant differences regarding the combination between the two factors of study i.e., plant density and nitrogen fertilizer level among total weight loss percentage of onion bulbs during storage period. In this concern, they found that growing transplants of onion cv. Giza 20 in four rows on ridge of 90 cm in width and applying nitrogen fertilizer at 150 kg N/fed. produced bulbs with better keeping quality.

4-2- Second experiment.

** Effect of cultivar, seedlings age and their interaction on vegetative growth, bulb yield and its quality.

4-2-1- Vegetative growth characteristics.

Data presented in Tables (11 and 12) show the effect of cultivars and seedlings age as well as their interaction on vegetative growth parameters during 2001\2002 and 2002\2003 growth seasons.

a- Effect of cultivar.

Data in Table (11) show clearly that vegetative growth aspects expressed as leaf, bulb and whole plant length, fresh weight of leaves and bulb as well as whole plant, neck and bulb diameter as well as bulbing ratio were in most cases significantly affected by the studied cultivars during both seasons of study. In this respect, cv. Behairy Red reflected the highest values in all the studied growth parameters compared with cvs. Giza 20 and Giza 6-Mohasin during the two seasons of growth. On the other hand, the lowest values were obtained in case of cv. Giza 6-Mohasein. However, such differences did not reach the level of significancy in case of average bulb length and weight during the first season and leaves length, bulb length and neck diameter as well as bulbing ratio during the second season of study, respectively. Such results are in agreement with those reported by **El-Shafie *et al.* (1971), Ahmed *et al.* (1977), Omran** and **Awad (1979), Mondal *et al.*(1986), Miccolis, (1987), Khalil *et al.* (1988), Attar** and **Korla (1991), Salazar *et al.* (1995)** and **Abd El-Latif (1999)**. In this respect, **Abd El-Latif (1999)** reported that cvs. Giza 20 and composite gave the highest values for all studied vegetative growth parameters expressed as plant height, blades length, bulb length, plant fresh weight, blades

Table (11): Effect of cultivars and seedling age on vegetative growth characteristics of onion plants.

Season	2001/2002									
Treatments	Plant length (cm)	Leave length (cm)	Leaves number /plant	Bulb weight (g)	Leaves weight (g)	Whole plant weight (g)	Bulb height (cm)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio
Giza 20	71.7	58.2	6.9	56.4	54.2	110.6	13.5	1.3	4.2	0.33
Giza 6-M.	67.1	54.1	6.7	56.7	52.5	109.1	13.0	1.3	3.8	0.36
Behairy Red	74.3	62.1	7.2	56.9	55.6	112.6	12.2	1.4	4.4	0.31
L.S.D. at 0.05	**1.5**	**0.85**	**0.2**	**n.s.**	**0.7**	**2.3**	**n.s.**	**0.02**	**0.4**	**0.02**
45 day	65.9	54.41	6.4	50.0	41.1	91.1	11.4	1.3	3.6	0.35
60 day	70.6	58.1	6.9	50.1	57.8	108.0	12.4	1.3	4.0	0.34
75 day	76.7	61.8	7.6	69.9	63.4	133.3	14.8	1.4	4.9	0.31
L.S.D. at 0.05	**1.0**	**0.8**	**0.2**	**2.01**	**2.4**	**2.1**	**1.3**	**0.05**	**0.81**	**0.061**
	2002/2003									
Giza 20	67.0	54.9	7.4	47.3	60.6	108.0	12.0	1.3	2.5	0.55
Giza 6-M.	64.8	53.6	7.1	40.9	59.3	103.0	11.2	1.2	2.3	0.54
Behairy Red	68.9	56.3	7.6	48.3	62.2	110.4	12.5	1.4	2.3	0.52
L.S.D. at 0.05	**0.7**	**n.s.**	**0.02**	**1.9**	**0.7**	**1.6**	**n.s.**	**n.s.**	**0.13**	**n.s.**
45 day	53.9	44.6	6.4	33.6	46.9	80.5	9.3	1.0	1.6	0.62
60 day	70.8	58.0	7.5	47.6	60.6	108.2	12.9	1.3	2.0	0.56
75 day	75.9	62.2	8.2	58.3	74.5	132.8	13.6	1.5	3.5	0.42
L.S.D. at 0.05	**1.4**	**2.2**	**0.13**	**1.6**	**1.0**	**1.3**	**2.6**	**0.1**	**0.2**	**0.01**

weight, bulb weight and number of leaves per plant compared with cv. Giza 6-Mohassen.

b- Effect of seedlings age.

The same data in Table (11) indicate that average leaf, bulb and whole plant length, bulb and whole plant weight, neck and bulb diameter as well as bulbing ratio were significantly affected by seedling age at transplanting time during both seasons of growth. In this regard, the highest values in all the studied growth aspects were noticed in case of using transplants of 75 days old compared with 45 and 60 days old transplants during the two seasons of the experiment. Such increments in the studied growth parameters with increasing the age of transplants may be due to that the large transplants have more roots and foliage parts that enable it to grow and establishment quickly and in turn increased their vegetative growth rate than small age one. Obtained results are not similar to those reported by **Herison *et al.* (1993), Sharma (1998)** and **Singh** and **Chaure (1999).** They reported that the optimum seedling age in terms of leaf length, number of leaves per plant and bulb weight were 6 weeks old compared with 5 and 7 weeks old.

c- Effect of the interaction.

As for the effect of the interaction between the studied cultivars and the age of seedling at transplanting time, data in Table (12) show clearly that all the measured growth parameters were affected due to the interaction. In this respect, such differences reached the level of significancy in case of leaf, bulbs and whole plant length as well as bulbing ratio during the first season and average bulb weight and fresh weight of plant during the second season of study. In this regard, the highest values in such growth aspects were obtained as a result of using 75 days old transplants in case of cv. Behairy Red during the two growing seasons.

4-2-2- Bulb yield and its components.

Data presented in Tables (13 and 14) show the effect of cultivar, seedlings age and their interaction on total bulbs yield and its components expressed as average bulb weight, yield of single bulbs, cull bulbs yield as well as total yield of produced bulbs per feddan during both seasons of study.

a-Effect of cultivar.

Data in Table (13) show clearly that there were significant differences in total produced bulb yield and its

Table (12): Effect of the interaction between cultivars and seedling age on vegetative growth characteristics of onion plants.

Season		2001/2002									
Treatments		Plant length (cm)	Leave length (cm)	Leaves number /plant	Bulb weight (g)	Leaves weight (g)	Whole plant weight (g)	Bulb length (cm)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio
Cv.	Day										
Giza 20	45	66.4	52.7	6.5	49.5	41.1	90.6	13.7	1.3	3.5	0.36
	60	71.5	58.0	6.8	49.9	58.0	108.0	13.4	1.3	4.0	0.34
	75	77.4	64.0	7.5	69.8	63.5	133.2	13.4	1.4	5.1	0.29
Giza 6-M	45	63.0	52.6	6.2	49.9	39.5	89.4	10.3	1.4	3.5	0.35
	60	67.0	54.0	6.6	51.0	56.2	107.2	13.0	1.2	3.6	0.37
	75	71.5	55.7	7.5	69.1	61.7	131.0	15.9	1.4	4.2	0.37
Behairy Red	45	68.8	58.1	6.6	50.7	42.5	93.2	10.3	1.4	3.7	0.34
	60	73.3	62.3	7.1	49.5	59.3	108.0	11.0	1.3	4.2	0.31
	75	81.2	66.0	7.8	70.7	65.1	135.8	15.3	1.4	5.3	0.29
L.S.D. at 0.05		1.8	1.3	n.s.	n.s.	n.s.	n.s.	2.33	n.s.	n.s.	0.003
		2002/2003									
Giza 20	45	54.1	44.3	6.4	33.3	46.9	80.3	9.8	1.0	1.6	0.65
	60	70.5	58.3	7.5	49.4	60.8	110.1	12.2	1.4	2.4	0.57
	75	76.5	62.2	8.3	59.3	74.0	133.3	14.3	1.5	3.4	0.43
Giza 6-M	45	52.1	43.4	6.2	33.6	45.4	78.9	8.7	1.0	1.5	0.64
	60	69.0	56.3	7.2	43.5	59.7	103.2	12.9	1.2	2.2	0.56
	75	73.0	61.0	8.0	54.8	72.8	127.6	12.0	1.4	3.2	0.42
Behairy Red	45	55.4	46.1	6.6	33.9	48.5	82.4	9.4	1.1	1.8	0.59
	60	72.9	59.3	7.8	50.1	61.4	111.4	13.5	1.4	1.5	0.55
	75	78.3	63.4	8.4	60.8	76.7	137.5	14.7	1.6	3.8	0.43
L.S.D. at 0.05		n.s.	n.s.	n.s.	2.8	n.s.	2.2	n.s.	n.s.	n.s.	n.s.

Table (13): Effect of cultivars and seedling age on yield and its components of onion plants.

Season	2001/2002				2002/2003			
Treatments	Bulb weight (g)	Single bulb weight (ton/fed.	Culls bulb weight (ton/fed.)	Total yield (ton /fed.)	Bulb weight (g)	Single bulb weight (ton/fed.)	Culls bulb weight (ton/fed.)	Total yield (ton /fed.)
Giza 20	70.21	13.380	0.880	14.260	76.34	10.650	1.100	11.750
Giza 6-M.	67.43	11.540	1.300	12.840	70.83	10.590	1.288	11.880
Behairy Red	87.40	15.340	2.600	17.940	75.48	11.420	1.460	12.880
L.S.D. at 0.05	**12.03**	**1.470**	**0.530**	**1.104**	**1.14**	**0.54**	**0.210**	**0.544**
45 day	73.47	12.360	1.620	13.980	54.89	8.420	0.140	8.560
60 day	74.00	13.590	1.100	14.690	81.37	11.380	1.860	13.240
75 day	79.15	14.280	2.060	16.340	88.79	12.850	1.850	14.700
L.S.D. at 0.05	**n.s.**	**0.850**	**n.s.**	**0.552**	**0.69**	**0.220**	**0.240**	**0.336**

constituents expressed as average bulb weight, yield of single and cull bulbs per feddan among the studied onion cultivars during both seasons of study. In this respect, cv. Behairy Red recorded the highest values in all studied yield parameters followed by cvs. Giza 20 and Giza 6-Mohasein. Such superiority of Behairy Red in produced total and single bulb are connected with its superiority in vegetative growth Table (11) which consequently reflected on the produced yield. Moreover, cv. Giza 20 reflected the lowest culls yield in both seasons of study. Obtained results were true during both seasons of the experiments. Such differences in yield and its components among the studied cultivars may be attributed to the potential of genetic differences among such genotypes. In this regard, **Omran** and **Awad (1979)**, **Lisbao *et al.* (1986)**, **Lopes (1987)**, **Khalil *et al.* (1988-b)**, **Gabal *et al.* (1989)**, **Koriem** and **Farag (1990-b)**, **Hanna-Alla *et al.* (1991-b)**, **Jitendra *et al.* (1992)**, **El-Kafoury *et al.* (1996)**, **Abd El-Latif (1999)** and **Mohanty** and **Prusti (2002)** all working on onion indicated that there were significant differences among the studied cultivars in total and marketable yields, doubling and bolting bulbs percentage as well as average bulb weight.

b- Effect of seedlings age.

The same data in Table (13) indicate that average bulb weight, single culls and total bulbs yield /fed. were affected with seedlings age at transplanting time during the two seasons of study. In this regard, such yield parameters were significantly increased with increasing the age of used seedlings from 45, 60 to 75 days. In this respect, using seedlings 75 days old reflected an increase about 15.5, 52.6 and 9.96, 12.93 % over 45 and 60 days old seedlings in case of single bulb and 16.9, 71.50 and 11.3, 10.90 in case of the total bulbs yield /fed., respectively during the two season of growth. Moreover, the increasing percentage due to using 60 days old seedlings over 45 days old ones reached about 5.1 and 35.1 % in case of single bulbs and 5.1 and 54.8 in case of total yield during the first and second seasons of study, respectively. From such results, it could be concluded that the most suitable age for onion seedlings to produce higher yield either as total or marketable (single bulbs) was 75 days old. In this connection, **Koriem** and **Farage (1990-a), Mohanty *et al.* (1990), Herison *et al.* (1993) Oladiran** and **Sangodele (1996), Sharma (1998)** and **Singh** and **Chaure (1999)** recorded similar results.

c-Effect of the interaction

Data recorded in Table (14) declared that there were differences in average bulb weight, single and cull bulbs yield as well as total bulbs yield due to the effect of the interaction between the tested cultivars and the age of seedlings at transplanting time. In this regard, the highest values in all the studied yield traits were recorded in case of cv. Behairy Red when its seedlings were transplanted at 75 days age during both seasons of growth compared with other used cultivars at different tested ages. Differences reached the level of 0.5 significancy in all yield parameters during the second season and total produced yield only during the first season. In this regard, **Oladiran** and **Sangodele (1996),** reported that when seedlings of cvs. Ex Gayanawa, Ex-Dala, D-77 and Composite 4 were transplanted into the field at the age of 4, 6 and 8 weeks, Ex Gayanawa, Ex-Dala and D-77 produced the highest yield when seedlings were transplanted at 6 week, but for Composite 4, the best results were obtained when seedlings were transplanted at 4 weeks old.

4-2-3- Bulb quality.

Data in Tables (15 and 16) show the effect of cultivars and seedlings age as well as their interaction on bulb quality

Table (14): Effect of the interaction between cultivars and seedling age on yield and its components of onion plants.

Season		2001/2002				2002/2003			
Treatments		Bulb weight (g)	Single bulb weight (ton/fed.	Culls bulb weight (ton/fed.)	Total yield (ton /fed.)	Bulb weight (g)	Single bulb weight (ton/fed.)	Culls bulb weight (ton/fed.)	Total yield (ton /fed.)
Varity	Age (days)								
Giza 20	45	64.76	13.010	0.450	13.460	55.43	8.260	0.050	8.310
	60	67.71	13.410	0.650	14.060	83.36	10.260	2.560	12.820
	75	78.17	13.730	1.680	15.410	90.23	12.960	0.690	13.650
Giza 6-M.	45	66.50	10.370	1.730	12.100	52.43	8.980	0.070	9.050
	60	68.21	11.600	1.380	12.980	75.60	10.800	2.340	13.140
	75	67.53	12.660	0.800	13.460	84.46	12.000	1.460	13.460
Behairy Red	45	89.15	13.700	2.690	16.390	56.83	7.570	0.300	7.870
	60	86.09	15.780	1.400	17.180	85.16	13.090	0.690	13.780
	75	91.72	16.450	3.730	20.180	91.71	13.620	3.410	17.030
L.S.D. at 0.05		n.s.	n.s.	n.s.	0.960	1.20	0.384	0.42	0.592

for produced bulbs i.e., bulb diameter, bulb firmness and TSS content as well as dry matter percentage during the two seasons of this experiment.

a- Effect of cultivar.

Data in Table (15) show that average bulb diameter and firmness as well as TSS content and dry matter percentage were differed among the tested cultivars. In this regard, the highest bulb diameter were obtained in case of cv. Behairy Red. On the other hand, cv. Giza 20 exhibited the highest values for bulb firmness, TSS content and dry matter % compared with other used cultivars. Such differences failed to reach the level of significancy in case of dry matter % during the first season and bulb diameter and dry matter % during the second season of this study only. The superiority of cv. Behairy Red in average bulb diameter was connected with the highest vegetative growth parameters (Tables, 11 and 12), while the highest firmness of bulbs in case of Giza 20 is related to the highest TSS and dry matter percentage of produced bulbs. In this respect, **Khalil *et al.* (1988-b), Koriem** and **Farag (1990-b), Hanna-Alla *et al.* (1991-b) and Abd El-Latif (1999)** reported that differences among the studied onion cultivars in measured bulb quality were clearer.

Table (15): Effect of cultivars and seedling age on bulb quality of onion plants.

Season	2001/2002				2002/2003			
Treatments	Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	DM (%)	Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	DM (%)
Giza 20	6.24	17.35	13.58	15.88	6.38	16.15	12.58	15.66
Giza 6-M	6.12	14.43	12.07	15.33	6.13	11.80	12.09	15.44
Behairy Red	6.51	15.78	12.63	15.33	6.26	15.09	12.17	15.55
L.S.D. at 0.05	**0.21**	**1.97**	**0.46**	**n.s.**	**n.s.**	**1.49**	**0.29**	**n.s.**
45 day	6.31	15.82	12.60	15.22	6.21	14.22	12.13	15.33
60 day	6.29	15.82	12.80	15.55	6.25	14.33	12.29	15.44
75 day	6.26	15.92	12.87	15.77	6.31	14.50	12.42	15.88
L.S.D. at 0.05	**n.s.**	**n.s.**	**n.s.**	**n.s.**	**n.s.**	**n.s.**	**n.s.**	**n.s.**

b- Effect of seedlings age.

Concerning the effect of seedling age on bulb quality, such data in Table (15) refer that no significant differences were noticed for all studied bulb parameters during both seasons of growth. However, the highest values in such bulb traits were noticed in case of using 75 days old seedling at transplanting compared with young and medium age seedlings. Moreover, **Mohanty *et al.*(1990), Herison *et al*(1993)** and **Oladiran** and **Sangodele (1996)** reported that average bulb diameter, TSS and dry matter percentage were positively affected with increasing the age of seedlings at transplanting time.

c- Effect of the interaction.

As for the effect of the interaction, results in Table (16) reveal that no significant differences can be noticed in case of all studied bulb quality traits except the average bulb firmness during the first season of study. In this regard, the highest bulb firmness were obtained as a result of using the oldest seedlings age (75 days) in case of cvs. Behairy Red and Giza 20, respectively.

Table (16): Effect of the interaction between cultivars and seedling age on bulb quality of onion plants.

Season		2001/2002				2001/2002			
Treatments		Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	DM (%)	Bulb diameter (cm)	Firmness (kg/cm^2)	TSS (%)	DM (%)
Varity	Age (days)								
Giza 20	45	6.20	17.36	13.36	15.66	6.33	16.03	12.43	15.33
	60	6.23	17.23	13.70	16.00	6.40	16.10	12.66	15.66
	75	6.30	17.46	13.70	16.00	6.43	16.33	12.66	16.00
Giza 6-M.	45	6.10	15.80	11.96	15.00	6.10	11.73	11.90	15.33
	60	6.13	15.80	12.06	15.33	6.13	11.73	12.13	15.33
	75	6.13	15.76	12.20	15.66	6.16	11.96	12.26	15.66
Behairy Red	45	6.50	14.50	12.50	15.00	6.20	14.90	12.06	15.33
	60	6.50	14.43	12.66	15.33	6.23	15.16	12.10	15.33
	75	6.53	14.36	12.73	15.66	6.36	15.23	12.36	16.00
L.S.D. at 0.05		n.s.	0.17	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

4-2-4 Storability of onion bulbs.

Data recorded in Tables (17 and 18) show the effect of tested cultivars, seedlings age and their interaction on total weight loss percentage of onion bulbs during the storage periods (7 months) in both seasons of study.

a- Effect of cultivars.

The same data in Table (17) indicate that there were differences among the studied cultivars in total weight loss percentage of onion during the different months of storage periods in both seasons of study. In this respect, such differences in weight loss percentage reached the level of 0.05 significancy during the second and last months of storage in the first season and the second month and the last four months of storage in the second season. In addition, cv. Giza 20 followed by Behairy Red recorded the lowest values of weight loss percentage during the different months of storage in two seasons of study. The lowest value of total loss in case of cv. Giza 20 may be due to the higher content of bulbs from dry matter and TSS percentage Table (15) and consequently reduced the amounts of water loss during the storage. Such results are confirmed with those reported by **Kheraba (1979), El-Shafie** and **Warid (1979), El-Kafoury (1986), Khalil *et al.* (1988-b), Bednarz** and **Kadams (1989)** and

Table (17): Effect of cultivars and seedling age on total weight loss percentage of onion bulbs.

Season	2001/2002							
Treatments	Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Giza 20	3.31	4.15	5.40	9.59	13.64	12.86	28.45	11.12
Giza 6-M	3.52	5.89	6.99	12.07	14.96	14.05	31.89	12.44
Behairy Red	3.33	4.46	6.25	11.96	17.07	19.31	33.24	14.08
L.S.D. at 0.05	n.s.	1.25	n.s.	n.s.	n.s.	n.s.	2.01	
45 day	3.10	4.41	5.79	9.23	11.93	13.08	23.97	10.23
60 day	3.43	4.86	6.07	11.80	16.27	16.09	34.20	13.39
75 day	4.62	5.94	6.78	14.48	17.48	17.06	35.41	14.41
L.S.D. at 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	1.98	
	2002/2003							
Giza 20	4.66	3.26	4.61	9.91	16.15	12.18	10.57	8.54
Giza 6-M	5.55	4.29	6.66	16.11	17.68	13.54	11.47	9.51
Behairy Red	5.12	3.70	4.91	10.51	18.77	14.40	12.98	11.19
L.S.D. at 0.05	n.s.	n.s.	1.38	3.95	0.61	1.94	n.s.	
45 day	4.50	2.92	5.09	9.40	15.99	11.97	19.39	10.00
60 day	5.04	3.75	5.40	12.51	18.04	12.72	27.54	12.14
75 day	5.79	4.58	5.69	14.62	18.62	15.42	28.58	13.21
L.S.D. at 0.05	0.97	n.s.	n.s.	n.s.	0.40	2.29	1.53	

Warid *et al.* (1996). In addition **El-Aweel *et al.* (2000)** they reported that an acceptable storability was shown by Giza 20, Giza 6-Mohasein and Nucleus 961 under Sultanate of Oman.

b-Effect of seedlings age.

Data in Table (17) pointed out that the total weight loss percentage in stored bulbs was affected by the age of seedlings at transplanting time during both seasons of study. In this regard, using small seedlings (45 days old at transplanting) recorded the lowest weight loss percentage along the period of storage compared with other tested seedlings ages, i.e., 60 and 75 days old. In addition, such differences reached the level of significancy during the last month of storage in the first seasons and the last three-months in the second one. Moreover, such results may be due to the highest TSS in produced bulbs in case of 45 days old seedlings. (Table, 15).

c- Effect of the interaction.

Concerning the effect of the interaction between the tested genotypes and the age of seedlings at transplanting on weight loss percentage during the storage period, data in Table (18) prove that there were differences in total weight loss percentage of produced bulbs during the different months of storage due to

Table (18): Effect of the interaction between cultivars and seedling age on total weight loss personage of onion bulbs.

Season		2001/2002							
Treatments		Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Varity	Age (days)								
Giza 20	45	3.11	3.77	4.89	7.55	12.09	11.80	25.43	10.86
	60	3.28	4.43	5.60	7.60	14.58	11.82	34.20	11.73
	75	3.55	4.26	5.72	13.64	14.26	14.96	25.73	10.81
Giza 6-M	45	3.09	5.13	5.41	8.74	9.85	17.17	22.43	9.89
	60	3.66	5.68	7.04	12.07	18.12	12.87	33.46	13.37
	75	3.82	5.97	8.53	21.27	16.32	12.12	39.80	13.89
Red	45	3.11	4.34	5.45	5.32	13.85	10.27	24.06	9.95
	60	3.37	4.47	6.23	15.94	15.53	23.58	34.96	14.64
	75	3.51	4.59	7.07	14.62	21.69	24.10	40.70	17.01
L.S.D. at 0.05		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	3.44	
		2002/2003							
Giza 20	45	3.81	2.34	3.88	8.80	15.16	8.79	16.33	8.46
	60	4.85	3.14	5.39	10.97	16.50	13.16	32.90	12.42
	75	5.33	4.31	4.58	9.97	16.97	14.59	25.16	11.84
Giza 6-M	45	4.88	3.54	6.32	10.46	16.20	11.40	20.16	10.22
	60	5.19	4.23	6.75	15.77	18.23	14.50	24.03	11.55
	75	6.58	5.10	6.91	22.10	18.61	14.73	31.23	12.62
Behairy Red	45	4.81	2.90	5.08	8.94	16.63	15.74	21.40	1.28
	60	5.09	3.88	4.06	10.80	19.40	10.51	25.70	12.47
	75	5.46	4.34	5.59	11.80	20.30	16.96	29.36	15.20
L.S.D. at 0.05		n.s.	n.s.	n.s.	n.s.	0.69	3.12	2.65	

the interaction between the studied treatments. In this regard, such differences reached the level of significancy only in the last month of storage during the first season and the last three months of storage during the second season. In addition, the lowest values of weight loss percentage were obtained due to using seedlings of 45 days old in case of cv. Giza 20 in both seasons of study. Moreover, the same data indicate that the value of total weight loss percentage during storage was steadily increased with increasing the period of storage since the lowest values of total weight loss percentage were recorded during the first and second month of storage.