Zagazig Journal of Agricultural Research
www.zu.edu.eg/agr/journals

BULBING RATIO AND DRY WEIGHT OF ONION PLANT GROWN IN SANDY SOIL AS AFFECTED BY PLANTING DATE, PLANTING DISTANCE AND POTASSIUM FERTILIZER RATE

Samar A. Bardisi*, E.A. El-Ghamriny, A.A. Gad and Dalia A.S. Nawar

Hort. Dept., Fac. Agric., Zagazig Univ., Egypt

ABSTRACT

This work was carried out during winter seasons of 2010/2011 and 2011/2012 at El-Khattara Experimental Farm, Fac. Agric., Zagazig University, to study the effect of planting date, plant spacing and potassium levels on bulbing ratio and dry weight of onion grown in sandy soil. At 130 days after transplanting (DAP), early transplanting of onion (30th November) gave high values of neck diameter and total dry weigh /plant, whereas delaying transplanting gave the highest value of bulbing ratio, also plant spacing at 11 or 15 cm increased total dry weight /plant. In general, the interaction treatments among planting date on 30th November, planting densities at 11 or 15 cm and 80 or 120 K_2O/fad., recorded high values of neck diameter, bulb diameter and total dry weight/plant compared to other treatments at 110 and 130 DAP in both seasons. Also, bulbing ratio increased with delaying transplanting (30th December) under 11 or 15 cm planting distances and K_2O at 80 or 120 kg/fad.).

Key words: Onion, *Allium cepa* L., planting date, planting distance, potassium rate, bulbing ratio and dry weight.

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family *Amaryllidaceae* (*Alliaceae*). It is one of the most important commercial vegetable crops and is widely grown in almost all the countries of the world. In addition to its medicinal value, it contains carbohydrates, protein, vitamin A, thiamine, riboflavin, niacin and ascorbic acid (Yahaya *et al.*, 2010).

The total cultivated area of onion in Egypt was about 147,684 and 152,935 fad., during 2010 and 2011 seasons which produced 2,208,080 and 2,304,210 tons with average of 14.951 and 15.066 ton/fad., respectively (FAOSTAT, 2011).

It is well documented that onion plants require short days and cooler temperatures in the early stages of crop establishment to enhance vigorous vegetative growth prior to the onset of warm temperature and longer days later in the growing seasons which promote bulbing (Jones and Mann, 1963).

Under Egyptian conditions, early transplanting of onion in December resulted in marked increase in vegetative growth compared to delaying transplanting to February (Mostafa, 1979; El-Hindi *et al.*, 1981; Farrag, 1983; Leilah *et al.*, 2003).

With respect to plant spacing, the plants grown under wider spacing received more nutrients, light and moisture around each plant surrounding compared to plants of closer spacing which is probably the cause of better performance growth of individual onion in wider spacing choice (Khan *et al.*, 2003).

Lower planting density significantly increased bulb diameter of onion and dry weight/ plant, but gradually decreased the bulbing ratio (Dawar *et al.*, 2007 and Abd El-Wahed, 2008).

Respecting potassium fertilizing, potassium plays a vital role in enhancing starch formation, which consequently resulted in increasing

* **Corresponding author: Tel.** : +201004959529
E-mail address: summer_scents88@yahoo.com

weight and diameter of bulb. As well, the increment in dry matter accumulation in the bulb may be attributed to more synthesis and translocation of photosynthates from the leaves to the bulb and also due to the availability of more nutrients from the soil. Similarly, higher rate of photosynthesis due to higher dose of potassium enhanced the vegetative growth and accumulated more food (Dilruba *et al.,* 2006 on onion). Both neck and bulb diameter, bulbing ratio as well as dry weight/plant of onion were significantly increased with increasing potassium rate (Mahmoud, 1999; El-Beheidi *et al.*, 2004; Abd El –Al *et al.*, 2005; El-Bassiouny, 2006).

Therefore, the aim of this study was to determine the suitable planting date, plant distance and potassium fertilization rate of onion to obtain maximum bulbing ratio and dry weight under sandy soil conditions.

MATERIALS AND METHODS

This work was carried out during winter seasons of 2010/2011 and 2011/2012 at El-Khattara Experimental Farm, Fac. Agric., Zagazig University, to study the effect of planting date ,plant distance and potassium levels on growth and bulbing ratio of onion grown in sandy soil.

The soil physical and chemical properties of the used experimental site is sandy in texture for the two seasons. It had 0.06 and 0.05% organic matter, 8.09 and 7.88 pH, 2.28 and 2.33 dS/m for EC, 0.10 and 0.12% total N, 14.16 and 15.18 ppm available N, 13.00 and 13.73 ppm available P and 60.14 and 63.01 ppm available K in the 1st and 2nd seasons, respectively.

This experiment included 27 treatments which were the combinations among three planting dates (30th Nov., 15th Dec. and 30th Dec.), three plant spacings (7, 11 and 15 cm) and three levels of potassium fertilization(40,80 and 120 kg K_2O/fad.).

Seeds were sown in nursery bed on 15th Oct., 1st Nov. and 15th Nov. in both seasons, then transplants of nearly 45 days old were transplanted in the permanent field.

These treatments were arranged as split split-plot in a randomized complete block design with three replicates. Planting dates were randomly arranged in the main plots, plant spacings were randomly distributed in the sub plots and potassium levels were randomly arranged in the sub sub- plots.

Potassium sulphate (48-52% K_2O) was used as a source of potassium and was added as soil application at five times; *i.e.* 30, 45, 60, 75 and 90 days after transplanting. All experimental units received equal amounts of FYM at 30 m^3/ fad., during soil preparation as well as 100 kg N and 50 kg P_2O_5/faddan. The source of N and P_2O_5 were ammonium sulphate (20.5% N) and phosphoric acid (85% P_2O_5). The amount of phosphoric acid and ammonium sulphate were splitted into five equal portions and added through irrigation water (fertigation) at the same time of potassium application. Drip irrigation system was used. Behairy onion cultivar was used in this experiment. That cultivar was improved and introduced by Prof. Dr. A. A. Gad during the period from 1999 to 2009. The other normal agricultural treatments for growing onion plants were practiced

Data Recorded

Three Samples of five plants from each experimental unit were randomly taken after 90,110 and 130 days from transplanting and the following data were recorded:

Neck diameter (cm) and bulb diameter (cm) were recorded. Bulbing ratio was calculated according to the formula of Mann (1952).

Bulbing ratio=Bulbing diameter /Neck diameter.

The different plant parts; *i.e.,* roots, leaves and bulbs were oven dried at 70°C till constant weight and the total dry weight / plant (roots+ bulb +leaves) (g) were recorded

Statistical Analysis

Statistical analysis was conducted for all collected data. The analysis of variance was calculated according to Snedecor and Cochran (1980), means separation was done according to LSD at 0.05 level.

RESULTS AND DISCUSSION

Effect of Planting Date

Data in Table 1 show that planting date had significant effect on neck diameter, bulb diameter, bulbing ratio and total dry weight/plant, except bulb diameter at 110 and 130 days after transplanting (DAP) and bulbing ratio at 90 DAP in the 1st season only.

Early transplanting of onion (30th November) gave high values of neck diameter and total dry weight/ plant at 110 and 130 DAP in both seasons, followed by transplanting on 15th December.

Also the same data indicated that neck diameter of onion was decreased with increasing age of onion plants from 110 to 130 days (16 to 19 weeks), except at 30th November in 1st season, whereas bulb diameter was increased.

As for bulbing ratio, data in Table 1 show that maximum bulbing ratio was noticed with delaying transplanting (30th December) at all three sampling dates, except at 90 DAP in the 1st season. It could be concluded that there was a progressive bulb development with the advancement of age of onion plant towards maturity. However, the increment in bulbing ratio observed at the later stage of growth may be a result, at least to some extent of tabular blades shriveling which reduced neck diameter. Thus, causing the ratio to increase even after swelling of sheath bases and bladeless leaves.

The decreases in total dry weight/ plant were about 34.4 and 40.2% for planting date on 15th December and 46 and 52.8% for planting on 30th December less than planting date on 30th November at 130 DAP in the 1st and 2nd seasons, respectively.

It is well documented that onion plants require short days and cooler temperatures in the early stages of crop establishment to enhance vigours vegetative growth prior to the onset of warm temperature and longer days later in the growing seasons which promote bulbing (Jones and Mann, 1963).

The significant of higher growth of onion in November could be due to moderated climatic conditions than in December (being relatively cool) month. The decreased growth period due to delaying transplanting date may be ascribed to the fact that late transplanted plants did not get sufficient time for growth before bulbing starts.

On the other hand, the latest planting date showed the lowest growth parameters values that may be due to the short period allowed for growth, which confirms the findings of Gonzalez *et al.* (1997).

Under Egypt conditions, early transplanting of onion in December resulted in marked increase in vegetative growth compared to delaying transplanting to February (Mostafa, 1979; El-Hindi *et al.*, 1981; Farrag, 1983; Leilah *et al.*, 2003).

Effect of Planting Distance

The obtained results in Table 2 indicate that planting distances had no significant effect on neck diameter, bulb diameter, bulbing ratio and total dry weight, except bulb diameter at 110 DAP in the 2nd season and at 130 DAP in the 1st season and total dry weight at 110 DAP in the 2nd season and at 130 DAP in both seasons.

Total dry weight of onion/plant at 130 DAP was significantly increased with increasing plant spacing within seedlings of onion from 7 cm to 11 or 15 cm in both seasons. The increases in total dry weight were about 25.4 and 15.5% for plant spacing at 11cm and 17.2 and 13.5% for plant spacing at 15 cm over the plant spacing at 7 cm in the 1st and 2nd seasons, respectively.

From the above mentioned results it could be concluded that, the plants grown under wider spaces received more nutrients, light and moisture around each plant surrounding compared to plants in closer spaces which is probably the cause of better performance of total dry weight of individual onion in wider space.

Similar results were also obtained with those reported by Abd El-Wahed (2008) on onion plant who found that bulb diameter as well as dry weight of onion plant were increased with increasing planting distance.

The above mentioned results contradicted with those reported by Dawar *et al.* (2007). They indicated that lower planting density significantly increased number of leaves /plant and bulb diameter of onion.

Table 1. Effect of planting dates on neck and bulb diameter, bulbing ratio and total dry weight of onion plant during 2010/2011 and 2011/2012 seasons under sandy soil conditions

Characters / Treatments	Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight /plant(g)		
	Days after transplanting											
	90	110	130	90	110	130	90	110	130	90	110	130
Planting date	**2010/2011 season**											
30th Nov	1.07	2.25	2.65	1.49	3.18	4.31	1.39	1.41	1.63	2.59	8.96	12.01
15th Dec.	0.98	2.06	2.03	1.43	3.35	4.25	1.46	1.63	2.09	1.99	6.98	7.89
30th Dec.	1.79	1.70	1.37	2.53	3.37	3.92	1.41	1.98	2.86	4.79	5.66	6.49
LSD at 0.05 level	**0.34**	**0.38**	**0.20**	**0.34**	**NS**	**NS**	**NS**	**0.11**	**0.21**	**1.20**	**2.16**	**3.44**
	2011/2012 season											
30th Nov	2.06	2.31	1.86	2.74	5.32	5.77	1.33	2.30	3.10	7.03	15.10	15.01
15th Dec.	1.98	1.71	1.32	4.03	5.06	5.16	2.04	2.96	3.91	8.87	11.83	8.98
30th Dec.	1.53	1.06	0.63	3.67	3.96	4.34	2.40	3.74	6.89	5.97	5.57	7.07
LSD at 0.05 level	**0.27**	**0.22**	**0.18**	**0.51**	**0.95**	**0.62**	**0.53**	**0.76**	**1.79**	**1.48**	**4.40**	**3.99**

NS= Not significant at 0.05 level of probability

Table 2. Effect of planting distances on neck and bulb diameter, bulbing ratio and total dry weight of onion plant during 2010/2011 and 2011/2012 seasons under sandy soil conditions

Characters / Treatments	Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight /plant (g)		
	Days after transplanting											
	90	110	130	90	110	130	90	110	130	90	110	130
Planting distance (cm)	**2010/2011 season**											
7	1.19	1.95	1.92	1.72	3.12	3.95	1.45	1.60	2.06	2.91	6.59	7.70
11	1.29	2.05	2.09	1.82	3.44	4.37	1.41	1.68	2.09	3.24	7.49	9.66
15	1.35	2.02	2.04	1.92	3.33	4.16	1.42	1.65	2.04	3.21	7.51	9.03
LSD at 0.05 level	**NS**	**NS**	**NS**	**NS**	**NS**	**0.27**	**NS**	**NS**	**NS**	**NS**	**NS**	**1.28**
	2011/2012 season											
7	1.89	1.68	1.239	3.48	4.56	4.91	1.91	2.90	4.82	7.08	10.15	9.44
11	1.78	1.63	1.290	3.45	4.76	5.23	1.99	2.97	4.77	7.04	10.21	10.91
15	1.91	1.76	1.294	3.51	5.02	5.13	1.88	3.10	4.86	7.76	12.15	10.72
LSD at 0.05 level	**NS**	**NS**	**NS**	**NS**	**0.38**	**NS**	**NS**	**NS**	**NS**	**NS**	**1.65**	**1.16**

NS= Not significant at 0.05 level of probability

Effect of K_2O Rates

Fertilization of onion with K_2O at different rates (40, 80 and 120 kg/fad.) did not reflect any significant effect on both neck and bulb diameter, bulbing ratio and total dry weight at the three sampling dates in both seasons under the conditions of this experiment (Table 3).

These results did not coincide with those reported by Mahmoud (1999); El -Beheidi *et al.* (2004); Abd El-Al *et al.* (2005) and El-Bassiouny (2006) on onion. They found that both neck and bulb diameter and bulbing ratio as well as total dry weight /plant were significantly increased with increasing potassium rates.

Effect of Interaction Between Planting Dates and Planting Distances

It can be seen from the data presented in Table 4 that the interaction between planting date and planting distance had significant effect on both neck and bulb diameter, bulbing ratio and total dry weight /plant at 90,110 and 130 DAP in both seasons, except bulb diameter at 110 DAP in the 1st season only.

As for both neck and bulb diameter, data in Table 4 indicate that, the interaction between planting date on 30th November and plant distance at 7 , 11 and 15 cm significantly increased both neck and bulb diameter at 110 and 130 DAP compared to other treatments in both seasons, except bulb diameter at 110 DAPin the 1st season .

Bulbing ratio increased with increasing plant age and with delaying transplanting under different planting distances. Maximum bulb diameter was recorded with the interactions between planting date on 30th November and planting distances at 11 or 15 cm at 110 and 130 DAP in both seasons. At 130 DAP, bulbing ratio was increased by the interaction between planting date on 30th December and planting distances at 7, 11 or 15 cm in both seasons.

Transplanting of onion on 30th November at wider spaces (11 or 15 cm) recorded maximum total dry weight /plant, followed by transplanting on 30th November at narrow spacing (7 cm) at 130 DAP in both seasons. These increases in total dry weight at 130 DAT were about 31.7 and 23.0% for the interaction between planting date on 30thNovember and plant spacing at 11cm as well as 23.1 and 16.5% for the interaction between planting date on 30th November and plant spacing at 15 cm over the interaction between planting date on 30th November and plant spacing at 7 cm in the 1st and 2nd seasons, respectively.

Effect of the Interaction Between Planting Dates and K_2O Rates

The interaction between planting date and K_2O rate reflected a significant effect on both neck and bulb diameter, bulbing ratio and total dry weight/ plant, except bulb diameter at 110 and 130 DAP, bulbing ratio at 90 DAP and total dry weight at 110 DAP in the 1st season (Table 5).

As for neck and bulb diameter, the interaction between planting dates on 30th November and K_2O rates (40, 80 or 120 kg /fad.) recorded maximum values of both neck and bulb diameter at 110 and 130 DAP in both seasons.

Bulbing ratio was increased with increasing plant age and with delaying transplanting under different K_2O levels in both seasons. Maximum bulb diameters were recorded at both early transplanting (30th November) and at mid transplanting (15th December) with different rates of K_2O (40, 80 and 120 kg/fad.) in both seasons. At 110 and 130 DAP, bulbing ratio increased with the interactions between late planting date (30th December) and K_2O at 40, 80 or 120 kg/faddan.

In general, the interaction between planting on 15th December and K_2O at 120kg/fad., gave the highest value of total dry weight /plant at 130 DAP in both seasons.

The increments in plant growth may be attributed to that potassium is the major limit big nutrient in onion production where it plays an important role in maintenance of cell water potential because it regulates opening and closing of stomata. Also, potassium facilitates water uptake by roots and reduces transpiration loss from plants, although it is known to stimulate translocation of metabolites from foliage to bulb that consequently led to increase bulb size and dry weight and also resistance to frost, drought and diseases. Adequate supply of K is also necessary for nitrogen utilization by onion crop.

Table 3. Effect of potassium fertilizer rates on neck and bulb diameter, bulbing ratio and total dry weight / plant of onion plant during 2010/2011 and 2011/2012 seasons under sandy soil conditions

Characters / Treatments	Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight/plant (g)		
	Days after transplanting											
	90	110	130	90	110	130	90	110	130	90	110	130
K_2O (kg/fad.)	2010/2011 season											
40	1.26	1.99	2.02	1.79	3.28	4.05	1.42	1.65	2.00	2.93	7.25	8.10
80	1.29	2.01	1.97	1.85	3.24	4.15	1.43	1.61	2.11	3.30	6.94	8.98
120	1.29	2.03	2.07	1.82	3.37	4.28	1.41	1.66	2.07	3.14	7.41	9.30
LSD at 0.05 level	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	2011/2012 season											
40	1.95	1.75	1.28	3.50	4.69	5.08	1.79	2.68	3.97	7.20	10.59	10.13
80	1.84	1.69	1.26	3.46	4.87	5.12	1.88	2.88	4.06	7.47	11.49	10.78
120	1.79	1.64	1.27	3.48	4.78	5.08	1.94	2.91	4.00	7.21	10.42	10.15
LSD at 0.05 level	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Not significant at 0.05 level of probability

Table 4. Effect of interaction between planting dates and planting distances on neck and bulb diameter, bulbing ratio and total dry weight of onion plant during 2010/2011 and 2011/2012 seasons under sandy soil conditions

Treatments / Characters		Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight/plant (g)		
		Days after transplanting											
		90	110	130	90	110	130	90	110	130	90	110	130
Planting date	Planting distance (cm)	2010/2011 season											
30th Nov.	7	1.06	2.15	2.46	1.48	2.97	3.97	1.40	1.38	1.61	2.39	7.81	10.15
	11	1.03	2.27	2.74	1.44	3.26	4.50	1.40	1.44	1.64	2.32	9.44	13.37
	15	1.13	2.33	2.74	1.54	3.30	4.45	1.36	1.42	1.62	3.06	9.61	12.50
15th Dec.	7	0.94	2.07	2.02	1.38	3.36	4.27	1.47	1.62	2.11	1.91	7.20	7.58
	11	1.00	2.15	2.13	1.45	3.53	4.50	1.45	1.64	2.11	2.12	7.05	8.48
	15	0.99	1.97	1.94	1.47	3.15	3.99	1.48	1.60	2.06	1.93	6.68	7.61
30th Dec.	7	1.58	1.64	1.30	2.28	3.03	3.61	1.44	1.85	2.78	4.42	4.75	5.36
	11	1.84	1.73	1.38	2.57	3.54	4.10	1.40	2.05	2.97	5.29	5.99	7.12
	15	1.94	1.74	1.44	2.74	3.55	4.04	1.41	2.04	2.81	4.65	6.25	7.00
LSD at 0.05 level		**0.20**	**0.36**	**0.31**	**0.37**	NS	**0.46**	**0.06**	**0.24**	**0.10**	**1.14**	**2.36**	**2.23**
		2011/2012 season											
30th Nov.	7	2.12	2.29	1.83	2.58	5.12	5.39	1.22	2.24	2.95	6.28	14.50	13.26
	11	1.96	2.20	1.90	2.74	5.31	5.99	1.40	2.41	3.15	7.03	14.06	16.31
	15	2.11	2.43	1.85	2.91	5.54	5.94	1.38	2.28	3.21	7.79	16.73	15.46
15th Dec.	7	2.02	1.72	1.30	4.41	4.83	4.98	2.19	2.81	3.83	9.39	11.01	7.96
	11	1.93	1.73	1.31	3.85	5.02	5.29	2.00	2.90	4.04	8.19	11.10	9.50
	15	2.00	1.67	1.36	3.82	5.33	5.21	1.91	3.19	3.83	9.05	13.39	9.48
30th Dec.	7	1.53	1.03	0.58	3.46	3.72	4.36	2.26	3.61	7.52	5.57	4.94	7.10
	11	1.46	0.97	0.65	3.75	3.97	4.41	2.57	4.09	6.78	5.90	5.46	6.90
	15	1.61	1.19	0.66	3.799	4.19	4.25	2.36	3.52	6.44	6.44	6.32	7.21
LSD at 0.05 level		**0.29**	**0.26**	**0.14**	**0.50**	**0.67**	**0.50**	**0.17**	**0.27**	**0.61**	**1.66**	**2.86**	**2.07**

NS= Not significant at 0.05 level of probability

Table 5. Effect of interaction between planting dates and potassium fertilizer rates on neck and bulb diameter, bulbing ratio and total dry weight of onion plant during 2010/2011 and 2011/2012 seasons under sandy soil conditions

Characters / Treatments		Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight/plant (g)		
		Days after transplanting											
		90	110	130	90	110	130	90	110	130	90	110	130
Planting date	**K_2O rate (kg/fad.)**	**2010/2011 season**											
30th Nov.	**40**	1.09	2.23	2.63	1.51	3.20	4.15	1.39	1.43	1.58	2.54	6.42	6.65
	80	1.05	2.23	2.59	1.43	3.09	4.30	1.36	1.39	1.66	2.85	6.33	8.07
	120	1.08	2.28	2.71	1.52	3.24	4.47	1.41	1.42	1.65	3.34	7.01	8.37
15th Dec.	**40**	0.98	2.08	2.02	1.45	3.41	4.07	1.48	1.64	2.01	3.42	7.40	9.28
	80	0.94	2.01	1.96	1.38	3.14	4.37	1.47	1.56	2.23	3.33	7.16	9.57
	120	1.01	2.10	2.10	1.48	3.49	4.32	1.47	1.66	2.06	2.98	7.92	10.12
30th Dec.	**40**	1.70	1.65	1.39	2.39	3.25	3.93	1.41	1.97	2.83	2.84	7.93	8.36
	80	1.90	1.77	1.35	2.74	3.48	3.78	1.44	1.97	2.80	3.72	7.32	9.32
	120	1.77	1.69	1.39	2.46	3.39	4.04	1.39	2.01	2.91	3.08	7.30	9.42
LSD at 0.05 level		**0.15**	**0.20**	**0.22**	**0.20**	**NS**	**NS**	**NS**	**0.13**	**0.18**	**0.71**	**NS**	**2.93**
		2011/2012 season											
30th Nov.	**40**	2.31	2.34	1.90	2.76	5.35	5.63	1.19	2.29	2.96	6.98	9.87	9.69
	80	1.96	2.33	1.83	2.74	5.33	5.94	1.40	2.29	3.25	6.78	11.13	10.15
	120	1.91	2.24	1.84	2.73	5.29	5.76	1.43	2.36	3.13	7.47	9.46	8.48
15th Dec.	**40**	1.97	1.79	1.36	4.07	4.76	5.21	2.07	2.66	3.83	7.40	9.85	9.95
	80	2.06	1.70	1.34	4.13	5.24	5.11	2.00	3.08	3.81	7.14	10.76	10.77
	120	1.92	1.62	1.27	3.88	5.18	5.15	2.02	3.20	4.06	6.58	10.00	11.99
30th Dec.	**40**	1.57	1.11	0.57	3.66	3.98	4.40	2.33	3.59	7.72	7.20	12.06	10.76
	80	1.50	1.03	0.62	3.51	4.04	4.30	2.34	3.92	6.94	8.48	12.57	11.41
	120	1.53	1.04	0.70	3.84	3.86	4.33	2.51	3.71	6.19	7.59	11.81	9.97
LSD at 0.05 level		**0.36**	**0.28**	**018**	**0.46**	**0.45**	**0.40**	**0.29**	**0.46**	**1.07**	**1.61**	**2.25**	**2.03**

NS= Not significant at 0.05 level of probability

Effect of Interaction Between Planting Distances and K_2O Rates

The interaction between planting distances and K_2O rates reflected a significant effect on neck diameter at 90 DAP in the 1st season, bulb diameter at 130 DAP in the 2nd season, bulbing ratio at 90 DAP in the 2nd season and at 130 DAP in both seasons and total dry weight at 90, 110 and 130 DAP in both seasons (Table 6).

Transplanting of onion at narrow spacing (7 cm) and fertilizing with 40, 80 or 120 kg /fad., significantly increased total dry weight at 110 and 130 DAP in both seasons compared to other interaction treatments.

Under narrow spacing (7cm), total dry weight /plant was increased with increasing K_2O rates from 40 up to 120 K_2O kg /fad., and the increases in total dry weight at 130 DAP were about 19.5 and 7.4% for the interaction between transplanting at 7 cm and K_2O at 80 kg /fad., over the interaction between transplanting at 7 cm and K_2O at 40kg/fad., in the 1st and 2nd seasons, respectively.

From the foregoing results, it could be concluded that the promoting effect of K_2O on dry weight may be due to that amongst three major nutrients (N,P and K), it is considered to be taken up in large amounts than N and P by crops. According to Kanwar (1985) K acts as a chemical traffic policeman regulating the management of the other nutrients in the plant system. Potassium (K) is one of the most important elements in plant nutrition. All living organisms required it in large amounts for normal plant growth and development.

Table 6. Effect of interaction between planting distances and potassium fertilizer rates on neck and bulb diameter, bulbing ratio and total dry weight of onion plant during 2010/2011 and 2011/2012 seasons under sandy soil conditions

Characters / Treatments		Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight/plant (g)		
		Days after transplanting											
		90	110	130	90	110	130	90	110	130	90	110	130
Planting distance (cm)	**K_2O rate (kg/fad.)**	**2010/2011 season**											
7	40	1.20	1.88	1.90	1.72	3.12	3.71	1.43	1.66	1.95	2.60	9.00	10.52
	80	1.11	1.97	1.88	1.63	3.02	3.98	1.47	1.53	2.12	2.69	8.82	12.58
	120	1.26	2.01	1.98	1.80	3.22	4.16	1.43	1.60	2.10	2.47	9.05	12.91
11	40	1.30	2.11	2.08	1.84	3.50	4.34	1.42	1.66	2.09	2.05	7.11	7.24
	80	1.34	2.02	2.02	1.87	3.22	4.25	1.40	1.59	2.10	1.78	6.39	8.40
	120	1.23	2.01	2.17	1.75	3.61	4.50	1.42	1.80	2.07	2.13	7.43	8.03
15	40	1.27	1.97	2.07	1.80	3.23	4.10	1.42	1.64	1.98	4.14	5.64	6.54
	80	1.43	2.02	2.00	2.05	3.47	4.21	1.43	1.72	2.11	5.42	5.61	5.97
	120	1.36	2.05	2.06	1.91	3.30	4.16	1.40	1.61	2.02	4.81	5.75	6.97
LSD at 0.05 level		**NS**	**NS**	**NS**	**0.22**	**NS**	**NS**	**NS**	**0.13**	**NS**	**0.71**	**1.61**	**2.93**
		2011/2012 season											
7	40	2.16	1.76	1.18	3.46	4.45	4.88	1.60	2.53	4.14	6.83	15.46	14.76
	80	1.71	1.69	1.28	3.29	4.68	4.98	1.92	2.77	3.89	7.38	15.48	15.86
	120	1.80	1.59	1.25	3.71	4.54	4.86	2.06	2.86	3.89	6.89	14.35	14.41
11	40	1.83	1.66	1.32	3.48	4.56	5.11	1.90	2.75	3.87	8.98	10.58	8.66
	80	1.76	1.63	1.18	3.39	4.86	5.08	1.93	2.98	4.31	9.08	13.04	9.39
	120	1.76	1.61	1.36	3.48	4.88	5.50	1.98	3.03	4.04	8.56	11.88	8.89
15	40	1.86	1.83	1.33	3.55	5.08	5.25	1.91	2.78	3.95	5.78	5.74	6.99
	80	2.06	1.75	1.34	3.70	5.08	5.28	1.80	2.90	3.94	5.93	5.93	7.08
	120	1.80	1.71	1.20	3.27	4.91	4.86	1.82	2.87	4.05	6.20	5.05	7.15
LSD at 0.05 level		**NS**	**NS**	**NS**	**NS**	**NS**	**0.40**	**0.29**	**0.46**	**NS**	**1.61**	**2.25**	**2.03**

NS= Not significant at 0.05 level of probability

This was attributed to the role of K in biochemical pathways in plants. Potassium increased the photosynthetic rates of crop leaves, CO_2 assimilation and facilitates carbon movement (Sangakkara *et al.*, 2000). Potassium had favorable effects on metabolism of nucleic acids, proteins, vitamins and growth substances (Bisson *et al.*, 1994; Bednarz and Oosterhuis, 1999). Furthermore, K has an important role in the translocation of phtotsynthates from sources to skins (Cakmak *et al.*, 1994).

The stimulatory effects of potassium fertilization on plant growth was previously demonstrated by some investigators (Ayub *et al.*, 1999; Gerendas *et al.*, 2008; Abbadi *et al.*, 2008; Christin *et al.*, 2009).

On the other hand, reduction in potassium supplementation for plant induced reduction in plant growth due to the fact that in K-deficient plants, soluble carbohydrates and nitrogen compounds are accumulated, and starch content is decreased. These changes were due to the fact that many enzymes involved in carbohydrate metabolism require high concentrations of potassium. Potassium ions were also involved in the activation of protein-pump ATPases, photosynthesis osmoregulation, cell expansion, and stomatal movement (Horst, 1995).

Effect of Triple Interaction Among Planting Dates, Planting Distances and K_2O Rates

It can be seen from data presented in Tables 7 and 8 that the triple interaction among planting dates, planting distances and K_2O rates had significant effect on neck diameter, bulb diameter, bulbing ratio and total dry weight at 90, 110 and 130 DAP in both seasons.

In general, the interactions among planting date on 30th November, planting densities at 11 or 15 cm and 80 or 120kg K_2O /fad., recorded the highest values of both neck and bulb diameter compared to other triple interaction treatments 130 DAP in both seasons.

Table 7. Effect of triple interaction among planting dates, planting distances and potassium fertilizer rates on neck and bulb diameter, bulbing ratio and total dry weight of onion plant during 2010/2011 season under sandy soil conditions

Characters / Treatments			Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight / plant(g)		
			Days after transplanting											
			90	110	130	90	110	130	90	110	130	90	110	130
Planting date	Planting distance (cm)	K_2O rate (kg/fad.)	2010/2011 season											
30th Nov.	7	40	1.06	2.04	2.59	1.46	2.96	3.86	1.38	1.45	1.49	2.33	7.62	8.91
		80	0.97	2.11	2.32	1.36	2.88	3.88	1.40	1.36	1.67	2.16	7.38	10.60
		120	1.14	2.29	2.46	1.64	3.08	4.18	1.43	1.34	1.70	2.68	8.44	10.94
	11	40	1.09	2.38	2.63	1.60	3.39	4.38	1.46	1.42	1.67	2.70	9.56	11.60
		80	0.96	2.34	2.75	1.30	3.19	4.66	1.35	1.36	1.69	1.87	9.92	15.20
		120	1.04	2.08	2.86	1.44	3.20	4.47	1.38	1.54	1.56	2.38	8.86	13.31
	15	40	1.12	2.27	2.68	1.49	3.24	4.22	1.33	1.43	1.57	2.78	9.83	11.05
		80	1.22	2.25	2.71	1.64	3.21	4.36	1.34	1.43	1.61	4.04	9.16	11.96
		120	1.05	2.48	2.82	1.49	3.46	4.78	1.41	1.40	1.70	2.35	9.85	14.49
15th Dec.	7	40	0.91	2.01	1.87	1.40	3.29	3.87	1.53	1.64	2.07	1.84	6.77	6.38
		80	0.93	2.02	2.00	1.37	3.15	4.49	1.47	1.56	2.25	1.82	6.89	7.98
		120	1.00	2.19	2.18	1.38	3.63	4.46	1.38	1.66	2.05	2.08	7.94	8.38
	11	40	1.10	2.26	2.16	1.49	3.83	4.44	1.35	1.69	2.06	2.62	7.10	8.32
		80	0.94	2.00	2.02	1.38	3.00	4.33	1.46	1.50	2.14	1.81	5.99	8.04
		120	0.97	2.19	2.22	1.48	3.76	4.72	1.52	1.72	2.13	1.92	8.06	9.08
	15	40	0.94	1.97	2.05	1.47	3.10	3.90	1.56	1.57	1.90	1.69	7.45	7.02
		80	0.94	2.02	1.85	1.38	3.27	4.29	1.46	1.62	2.32	1.71	6.30	9.18
		120	1.08	1.94	1.92	1.57	3.08	3.78	1.45	1.59	1.97	2.39	6.29	6.62
30th Dec.	7	40	1.65	1.58	1.25	2.31	3.10	3.40	1.40	1.96	2.72	3.44	4.88	4.68
		80	1.44	1.80	1.33	2.17	3.04	3.58	1.50	1.69	2.69	4.56	4.73	5.62
		120	1.65	1.55	1.31	2.37	2.94	3.86	1.43	1.90	2.95	5.28	4.66	5.78
	11	40	1.70	1.70	1.45	2.44	3.29	4.20	1.43	1.94	2.90	4.92	5.54	7.94
		80	2.12	1.72	1.28	2.93	3.48	3.77	1.38	2.02	2.95	6.31	5.59	5.47
		120	1.70	1.77	1.43	2.34	3.86	4.32	1.37	2.18	3.02	4.65	6.84	7.97
	15	40	1.74	1.67	1.47	2.43	3.35	4.19	1.39	2.01	2.85	4.04	6.50	7.01
		80	1.06	1.81	1.44	3.14	3.94	4.00	2.96	2.18	2.78	5.40	6.50	6.82
		120	0.97	1.74	1.43	2.67	3.37	3.94	2.75	1.94	2.76	4.52	5.75	7.16
LSD at 0.05 level			**0.26**	**0.35**	**0.39**	**0.38**	**0.60**	**0.88**	**0.18**	**0.28**	**0.30**	**1.24**	**2.79**	**5.08**

Table 8. Effect of triple interaction among planting dates, planting distances and potassium fertilizer rates on neck and bulb diameter, bulbing ratio and total dry weight of onion plant during 2011/2012 season under sandy soil conditions

Treatments			Characters	Neck diameter (cm)			Bulb diameter (cm)			Bulbing ratio			Total dry weight/plant (g)		
				Days after transplanting											
				90	110	130	90	110	130	90	110	130	90	110	130
Planting date	Planting distance(cm)	K_2O rate (kg/fad.)		2011/2012 season											
30th Nov.	7	40		2.92	2.30	1.82	2.76	5.19	5.25	0.95	2.26	2.88	6.84	14.93	13.90
		80		1.63	2.42	1.81	2.30	5.27	5.64	1.41	2.18	3.12	5.41	15.47	14.66
		120		1.82	2.15	1.85	2.68	4.90	5.30	1.47	2.28	2.86	6.58	13.10	11.21
	11	40		1.96	2.16	1.92	2.76	5.10	5.66	1.41	2.36	2.95	6.80	14.00	16.15
		80		2.02	2.22	1.89	2.84	5.24	6.17	1.41	2.36	3.26	8.16	14.40	16.49
		120		1.89	2.22	1.88	2.63	5.58	6.16	1.39	2.51	3.28	6.14	13.78	16.30
	15	40		2.06	2.58	1.98	2.76	5.76	5.98	1.34	2.23	3.02	6.86	17.44	14.22
		80		2.24	2.36	1.80	3.08	5.49	6.02	1.38	2.33	3.34	8.58	16.58	16.44
		120		2.02	2.36	1.78	2.89	5.39	5.82	1.43	2.28	3.27	7.94	16.16	15.72
15th Dec.	7	40		1.90	1.88	1.14	4.14	4.37	4.92	2.18	2.32	4.32	8.40	9.30	7.34
		80		2.06	1.66	1.51	4.59	5.08	5.10	2.23	3.06	3.38	10.10	12.98	9.71
		120		2.10	1.62	1.26	4.50	5.04	4.90	2.14	3.11	3.89	9.67	10.75	6.83
	11	40		2.02	1.77	1.52	3.89	4.74	5.31	1.93	2.68	3.49	9.63	10.26	7.84
		80		1.90	1.80	1.12	3.58	5.06	4.74	1.88	2.81	4.23	7.04	11.50	8.66
		120		1.87	1.62	1.30	4.10	5.26	5.82	2.19	3.25	4.48	7.89	11.56	12.01
	15	40		1.99	1.72	1.42	4.18	5.17	5.40	2.10	3.01	3.80	8.90	12.20	10.80
		80		2.24	1.64	1.38	4.24	5.59	5.50	1.89	3.41	3.99	10.12	14.66	9.81
		120		1.78	1.64	1.27	3.06	5.24	4.73	1.72	3.20	3.72	8.12	13.33	7.82
30th Dec.	7	40		1.68	1.10	0.57	3.46	3.80	4.48	2.06	3.45	7.86	5.70	5.37	7.82
		80		1.44	0.99	0.51	2.97	3.68	4.22	2.06	3.72	8.27	4.84	4.93	6.08
		120		1.48	1.00	0.65	3.95	3.68	4.40	2.67	3.68	6.77	6.18	4.54	7.42
	11	40		1.52	1.05	0.53	3.79	3.83	4.36	2.49	3.65	8.23	5.78	5.30	5.87
		80		1.35	0.86	0.54	3.76	4.28	4.35	2.79	4.98	8.06	6.22	6.40	7.18
		120		1.51	1.00	0.89	3.70	3.80	4.54	2.45	3.80	5.10	5.70	4.67	7.66
	15	40		1.53	1.18	0.60	3.72	4.31	4.38	2.43	3.65	7.30	5.86	6.56	7.28
		80		1.70	1.25	0.83	3.80	4.18	4.33	2.24	3.34	5.22	6.74	6.46	7.99
		120		1.61	1.14	0.56	3.87	4.10	4.05	2.40	3.60	7.23	6.72	5.94	6.37
LSD at 0.05 level				**0.63**	**049**	**0.32**	**0.80**	**0.79**	**0.70**	**0.50**	**0.80**	**1.84**	**2.79**	**3.90**	**3.52**

As for bulb diameter and bulbing ratio, in general, they were increased with increasing plant age, whereas neck diameter in most cases was decreased in both seasons. Also, bulbing ratio increased with delaying date (30th December) under planting distances at 11 or 15 cm and K_2O at 80 or 120 kg/faddan at 110 and 130 DAPwith few exceptions.

The interaction among planting date (30 November), planting spacing at 11 cm and K_2O at 80 kg/fad., recorded the maximum values of total dry weight/plant. These results may be due to that the interaction among 30th November and 11 or 15 cm and 80 or 120 kg K_2O/fad., had stimulative effect on plant growth and this in turn increased total dry weight /plant.

REFERENCES

Abbadi, J., J. Gerendás and B. Sattelmacher (2008). Effects of potassium supply on growth and yield of safflower as compared to sunflower . J. Plant Nutr. and Soil Sci., 171 : 273-280.

Abd El-Al, F.S., M.R. Shafeek, A.A. Ahmed and A.M. Shaheen (2005). Response of growth and yield of onion plants to potassium fertilizer and humic acid. J. Agric. Sci., Mansoura Univ., 30 (1): 315-326.

Abd El-Wahed, A.M.M. (2008). Evaluation of growth characters, productivity, quality and storability of some onion (*Allium cepa* L.) cultivars planted at different densities under Al-Akhdar conditions. M.Sc. Thesis, Hort. Dept., Fac. Agric., Omar Al-Mokhtar University, Libia.

Ayub, M., A. Tanveer, M.Z. Amin, M.S. Sharar and A. Pervaiz (1999). Effect of different levels of potash on yield and oil content of spring sunflower. Pakistan J. Biol. Sci., 2 (3): 801-803.

Bednarz, C.W. and D.M. Oosterhuis (1999). Physiological changes associated with potassium deficiency in cotton. J. Plant Nutr., 22 : 303-313.

Bisson, P., M. Cretenet and E. Jallas (1994). Nitrogen, phosphorus and potassium availability in the soil-physiology of the assimilation and use of these nutrients by the plant. Challenging the future proceedings of the world cotton Res., Conf.-1 Brishane Australia, Feb.14-17, Ed. Constable G.A. and N.W. Forrester, CSLRO, Melbourne, 115-124.

Cakmak, I., C. Hengeler and H. Marschner (1994). Partitioning of shoot and root dry matter and carbohydrates in bean plants suffering from phosphorus, potassium and magnesium deficiency. J. Expt. Bot., 45: 1245-1250.

Christin, H., P. Petty, K. Ouertani, S. Burgado, C. Lawrence and M.A. Kassem (2009). Influence of iron, potassium, magnesium, and nitrogen deficiencies on the growth and development of sorghum (*Sorghum bicolor* L.) and sunflower (*Helianthus annuus* L.) seedlings. J. Biotech. Res., 1 (3): 64-71.

Dawar, N.M., F.K. Wazir, M.V. Dawar and S.H. Dawar (2007). Effect of planting density on growth and yield of onion varieties under climatic conditions of Peshawar Sarhad. J. Agric., 23 (4): 912-917.

Dilruba, S., M.M. Alam, M.A. Rahman and M.F. Hasan (2006). Influence of nitrogen and potassium on yield contributing bulb traits of onion. Inter. J. Agric. Res., 1 (1): 85-90.

El-Bassiouny, A.M. (2006). Effect of potassium fertilization on growth, yield and quality of onion plants. J. Appl. Sci. Res., 2 (10):780-785.

El-Beheidi, M.A., M.A.I. Khalil, H.E. Arisha and S.Kh.A. Ibrahim (2004). Onion crop response to nitrogen and potassium fertigation and soil application. Zagazig J. Agric. Res., 31 (5): 2123-2138.

El-Hindi, M.H., M.M. El-Gamal, A.T. El-Kassaby and A.K. Mostafa (1981). Response of Behairy onion (*Allium cepa* L.) to different dates of transplanting and different rates of nitrogen fertilization. J. Agric. Sci., Mansoura Univ., 6 (1): 15-30.

FAOSTAT (2011). Food Agriculture Organization of the United Nations.

Farrag, M.M. (1983). Growth regulator and plant density in onion production. Ph. D. Thesis, Fac. Agric., El-Minia Univ.

Gerendás, J., J. Abbadi and B. Sattelmacher (2008). Potassium efficiency of safflower

(*Carthamus tinctorius* L.) and sunflower (*Helianthus annuus* L.). J. Plant Nutr. and Soil Sci., 171:431-439.

Gonzalez, M.A., J.L. Burba and C.R. Galnarini (1979). Effect of sowing date on the production of three storage varieties of onions in the eight region of Chile. Acta Horticultura, 433:549-554.

Horst, M. (1995). Introduction, definition and classification of mineral nutrients. In: mineral nutrition of Higher plants. 2nd (ed.) academic Press, San Diego, CA. Chap., 1 : 1-5.

Jones, H.A. and L.K. Mann (1963). Onion and their allies. Interscience publishers, Inc. New York

Khan, M.A., M.K. Hasan, M.A.J. Miah, M.M. Alam and A.S.H. Hasan (2003). Effect of plant spacing on the growth and yield of different varieties of onion. Pakistan J. Biol. Sci., 6 (18): 1582-1585.

Kanwar, J.S. (1985). Inaugural address. In soil testing, plant analysis and fertilizer evaluation for K, Pot. Res. Inst. India, Res. Series, 4:3-8.

Leilah, A.A., S.A. El-Kalla, A.K. Mostafa and M.M. Afifi (2003). Performance of some local Egyptian onion strains under different planting dates. Scientific J. King Faisal Univ. (Basic and Appl. Sci.), 4 (1): 119-136.

Mahmoud, A.R. (1999). Effect of some agricultural treatments on productivity and quality of onion. Ph. D. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Mann, L.K. (1952). Anatomy of garlic bulb and factors affecting bulb development. Hilgardia, 21: 195 - 228

Mostafa, A.K. (1979). Studies on the inter-relationship between some cultural practices and the yield of Behairy onion. M.Sc. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Sangakkara, U.R., M. Frehner and J. Nosberger (2000). Effect of soil moisture and potassium fertilizer on shoot water potential, photosynthesis and partitioning. J. Agron. Crop Sci., 185:201-207.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 7th ed., Iowa State University Press, Iowa, USA., ISBN-10: 0-81381560-6, 507.

Yahaya, Y., U.A. Birnin Yauri and B.U. Bagudo (2010). Study of nutrient content variation in bulb and stalk of onion (*Allium cepa* L,) cultivated in Aliero, Kebbi Stat., Nigeria. Nigerian J. Basic and Appl. Sci., 18 (1): 83-89.

تأثير ميعاد الزراعة وكثافة الزراعة ومعدل السماد البوتاسى على معدل التبصيل والوزن الجاف لنبات البصل المنزرع فى أرض رملية

سمر عبد الله برديسى - المتولى عبد السميع الغمرينى - عبد المنعم عامر جاد - داليا أحمد سامى نوار

قسم البساتين- كلية الزراعة- جامعة الزقازيق- مصر

أجرى هذا العمل خلال شتاء موسمى ٢٠١٠/٢٠١١، ٢٠١١/٢٠١٢ فى مزرعة التجارب الزراعية بالخطارة التابعة لكلية الزراعة – جامعة الزقازيق وذلك لدراسة تأثير ميعاد الزراعة وكثافة الزراعة ومعدل السماد البوتاسى على معدل التبصيل والوزن الجاف لنبات البصل المنزرع فى أرض رملية، وقد أعطى شتل البصل المبكر فى ٣٠ نوفمبر أعلى قيم لقطر عنق البصلة والوزن الجاف الكلى للنبات بعد ١٣٠ يوماً من الشتل، بينما أعطى شتل البصل المتأخر فى ٣٠ ديسمبر أعلى معدل تبصيل، كما أدى زراعة البصل على مسافة ١١ أو ١٥ سم إلى زيادة الوزن الجاف الكلي للنبات، وعموماً، فقد سجلت معاملة التفاعل الثلاثى بزراعة نبات البصل مبكراً فى ٣٠ نوفمبر على مسافة ١١ أو ١٥ سم بين النباتات، والتسميد بمعدل ٨٠ أو ١٢٠ كجم بو٢أ / فدان أعلى القيم لقطر العنق ، وقطر البصلة، والوزن الجاف الكلى للنبات مقارنة ببـاقى المعاملات الأخرى عند ١١٠ و ١٣٠ يوماً من الزراعة فى كلا الموسمين، أيضاً فقد ازداد معدل التبصيل عند الزراعة المبكرة فى ٣٠ نوفمبر تحت مسافات الزراعة الواسعة ١١ أو ١٥ سم بين النباتات والتسميد بمعدل ٨٠ أو ١٢٠ كجم بو٢أ /فدان.

المحكمـــون :

١- أ.د. سـعيد عبـدالله شحـاتـه أستـاذ الخضر – كليـة الزراعـة - جامعـة القاهرة.

٢- أ.د. حامد محمد الهادى عريشـه أستـاذ الخضر – كليـة الزراعـة - جامعة الزقازيق.