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CROP-WATER RELATIONS AND YIELD OF ONION AS AFFECTED BY RIDGE WIDTH AND IRRIGATION INTERVAL

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ABSTRACT: *Two field experiments were conducted at Tamiea Res. Station, Fayoum Governorate, Egypt, during 2010/2011 and 2011/2012 seasons, to study the effect of ridge width treatments, i.e. 50 , 75 and 100 cm (beds) and irrigation interval treatments e.g. irrigation every 21 , 28 and 35 days on yield, yield components and some crop-water relations of onion crop (Giza 20 cv.). The experimental treatments were assessed in a strip- plot design with four replicates. The main obtained results were as follows:*

1. Ridge width, irrigation interval treatments and their interaction significantly affected dry bulbs yield and its components in both seasons, except dry bulb diameter in first season.

2. The highest averages of plant height, leaf No. plant^{-1}, bulb weight, bulb diameter and dry bulbs yield, in the two successive seasons, were detected from transplanting onion on ridges of 50 cm width and irrigation at 21 days interval. On the contrary, transplanting on beds (100 cm width) and irrigation at 35 days interval gave the lowest averages of dry bulbs yield and all of yield components in the two seasons.

3. Seasonal evapotranspiration (ET_C), as a function of the interaction of the adopted treatments were 35.97 and 37.92 cm in 2010/2011 and 2011/2012 seasons, respectively. The highest ET_C values, i.e. 41.07 and 43.05 cm were recorded from transplanting onion on ridges of 50 cm width and irrigation every 21 days in 2010/2011 and 2011/2012 seasons, respectively. Transplanting on beds and irrigation at 35 days interval gave the lowest ET_C values which comprised 30.62 and 31.94 cm in the two successive seasons.

4. The crop coefficient (K_C) values (estimated for the highest yield treatment) were 0.46, 0.64, 0.75, 1.04, 0.68 and 0.48 (average of the two seasons) during Dec., Jan., Feb., March, April and May, respectively.

5. The highest water use efficiency values (9.41 and 9.47 kg dry bulbs m^{-3} water consumed) were observed from transplanting onion on ridges of 50 cm width and irrigation every 21 days in 2010/2011 and 2011/2012 seasons, respectively. In order to manage the limited water resources efficiently and to obtain reasonable figures for water productivity, it is advisable to irrigate onion every 21 days and transplanting on ridges of 75 cm under Fayoum Governorate circumstances.

Key words: *Onion yield, yield components, ridge width, irrigation interval, onion crop- water relations, water use efficiency*

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops grown in Egypt, not only for local consumption but also for exportation. The crop production of onion is affected by many factors such as varieties, fertilization requirements, agricultural practices and irrigation management. Ridge width and hill spacing are two factors effecting bulbs diameter, size and weight. In this respect, Geremew Awas *et al.* (2010), revealed that, bulb diameter, bulb weight and onion crop yield were significantly affected by decreasing row spacing. In this sense, with different crops under furrow irrigation, yield and crop water use were influenced due to ridge width e.g. Musick *et al.* (1985) reported that consumptive use of corn planted on 0.75 m furrows width was higher than those planted on 1.5 m width. Tawadros and Abd El-Aziz (1992) pointed out that increasing ridge width caused a reduction in cotton and corn water consumption; Salib *et al.* (1998) found that increasing ridge width from 0.7 to 1.4 m (beds) significantly decreased sunflower yield and yield components, whereas seasonal ET_C was reduced; .Ashry *et al.* (2008) found that increasing ridge width to be 120 cm significantly decreased grain sorghum yield, yield components and seasonal ET_c, while water use efficiency (WUE) was increased, comparable with 60 cm ridge width.

Regarding water use of onion crop, Doorenbos *et al*. (1979) reported that, the optimum onion yield required 350 – 550 mm water and water use efficiency is 8-10 kg/m^3. The author added that, the crop coefficient (K_C) values were 0.4- 0.6, 0.7 – 0.8, 0.95 – 1.1, 0.85 – 0.90 and 0.75 – 0.80 for transplanting, crop development, mid-season, late season and harvest stages, respectively. Moreover, Saha *et al.* (1997), Govila *et al.* (1998), Koriem *et al.* (1999) indicated that the greater the amount of irrigation water applied, the higher the yield obtained. Abu-Awwad (1999) showed that ET and transpiration of onion increased by increasing irrigation water applied. Pelter *et al.*(2004) found that soil water stress at both 3 and 7 leaf stages reduced onion yield by 26% than the control. Morsy and Abd El-Latif (2012) stated that, plant height, leaves N°. plant^{-1}, bulb diameter, bulb weight, dry matter% and total yield of onion (Giza 20 cv) were significantly increased as irrigation events increased and the highest water consumptive use (1331.3 m^3 fed^{-1}) resulted from applying 5 irrigations, while WUE tended to decrease.

The present trials aiming at determining the extent to which yield, yield components and water use efficiency for onion crop was influenced due to ridge width and irrigation interval under Fayoum Governorate circumstances.

MATERIALS AND METHODS

Two field experiments were carried out during two growing seasons of 2010/2011 and 2011/2012 at Tameia research station – Fayoum Governorate, Egypt to study the effect of ridge width treatments i.e. 50, 75 and100 cm(beds) and irrigation at 21, 28 and 35 days intervals and their interaction on onion yield, yield components and some crop -water relations. The treatments were assessed in the split-plot design with four replicates. The plot area was 21.0 m^2 (3.0 ×7.0 m). Calcium super phosphate (15.5% P_2O_5) was added at the rate of 300 kgfed^{-1} during seed - bed preparation with 150 kg potassium sulphate (45% K_20). Nitrogen fertilization (ammonium nitrate 33.5 N%) at the rate of 120 kg N fed.$^{-1}$ added in two equal doses (before the 1st and 2nd irrigations). Onion seedlings (Giza 20 cv) were transplanted in hills 10 cm apart on both sides of the ridge. Beds were transplanted on both sides and in the middle as well. The onion seedlings were transplanted on December 6th and harvesting was executed on May7th in the two successive seasons. The experimental plots were isolated by allays (1.5 m in width) to avoid the lateral movement of irrigation water. Some soil physical and chemical properties were determined according to Klute (1986) and Page *et al.* (1982) and data are presented in Table 1. The averages of weather factors for Fayoum governorate during the onion crop growing seasons are recorded in Table 2, and some soil water constants are illustrated in Table 3. Irrigation treatments started at 3rd irrigation and date of irrigation and irrigation counts, under different treatments in both seasons, are listed in Table 4.

At harvesting time, the following data were collected under each sub-plot :-

I. Yield and yield components:

1- Plant height (cm)
2- Leaf N° plant^{-1}
3- Dry bulb weight (g)
4- Dry bulb diameter (cm) and
5- Dry bulbs yield (ton fed^{-1}).

Yield and yield components data were subjected to the statistical analysis according to Snedecor and Cochran (1980) and the means were compared using L.S.D. test at 5% significance level.

II. Crop - water relationships:

1-Seasonal consumptive use (ET_c)

Crop water consumptive use (ET_c), was determined via soil samples taken from each sub-plot, in 15cm increment system to 60cm depth of soil profile, just before and after 48 hours each irrigation, as well as at harvesting time. The ET_C between each two successive irrigations was calculated according to the following equation:-

Table 1: Particle size distribution and some chemical analyses of the experimental site at 2010/ 2011 and 2011/2012 seasons (average of two seasons)

<table>
<tr><td colspan="8">Particle size distribution</td><td colspan="3">Organic matter (%)</td><td colspan="4">CaCo3 (%)</td></tr>
<tr><td>Sand (%)</td><td>Silt (%)</td><td colspan="2">Clay (%)</td><td colspan="4">Textural class</td><td colspan="3" rowspan="2">1.49</td><td colspan="4" rowspan="2">6.21</td></tr>
<tr><td>41.02</td><td>19.76</td><td colspan="2">39.22</td><td colspan="4">Clay loam</td></tr>
<tr><td colspan="4">Soluble cations (meq/L)</td><td colspan="4">Soluble anions (meq/L)</td><td>EC (dS/m)</td><td>p^H(soil paste)</td><td>CEC(meq/ 100gm soil)</td><td colspan="4">Exchangeable Cations (meq/100 gm soil)</td></tr>
<tr><td>Ca^{++}</td><td>Mg^{+}</td><td>Na^{+}</td><td>K^{+}</td><td>Cl^{-}</td><td>HCO_3^{-}</td><td>CO_3^{--}</td><td>SO_4^{--}</td><td rowspan="2">5.48</td><td rowspan="2">8.39</td><td rowspan="2">39.17</td><td>Ca^{++}</td><td>Mg^{++}</td><td>K^{+}</td><td>Na+</td></tr>
<tr><td>9.32</td><td>6.91</td><td>33.19</td><td>0.61</td><td>25.19</td><td>4.15</td><td>-</td><td>20.69</td><td>19.31</td><td>12.11</td><td>1.32</td><td>6.19</td></tr>
</table>

Table 2: The monthly averages of weather factors for Fayoum Governorate during 2010/2011 and 2011/2012 seasons

Month	season	Temperature C°			Relative Humidity %	Wind Speed (m sec^{-1})	Class A pan evaporation (mm day^{-1})
		Max.	Min.	Mean			
December	2010	21.9	7.6	14.80	53	1.18	1.8
	2011	21.5	12.6	19.60	52	1.16	2.8
January	2011	24.4	8.2	16.30	48	1.65	2.5
	2012	23.6	7.7	15.51	46	1.66	2.6
February	2011	27.5	11.4	19.50	50	3.13	4.3
	2012	27.0	10.8	18.4	51	2.15	4.4
March	2011	31.8	14.3	23.00	46	2.43	5.9
	2012	25.4	11.8	19.60	52	2.42	5.8
April	2011	28.5	11.7	21.10	47	2.42	4.9
	2012	29.1	13.6	21.30	48	2.49	5.6
May	2011	32.8	17.4	25.1	44	2.78	6.4
	2012	34.1	18.3	26.2	45	2.76	6.7

Table 3: Soil moisture constants for the experimental field during 2010/2011 and 2011/2012 seasons (average of the two seasons)

Soil depth (cm)	Field capacity (%,wt/wt)	Wilting point (%wt/wt)	Bulk density (gcm^{-3})	Available moisture (%wt/wt)
00 -15	44.72	21.75	1.53	22.97
15 -30	41.32	19.32	1.42	22.00
30 - 45	37.21	18.41	1.29	18.80
45 - 60	35.29	17.67	1.31	17.62

TABLE 4

Cu (ET_c) = {(Q_2-Q_1) / 100} × Bd ×D (Israelsen and Hansen, 1962).......where

Cu = Crop water consumptive use (cm).

Q_2= Soil moisture percentage by weight 48 hours after irrigation.

Q_1= Soil moisture percentage by weight just before irrigation.

Bd = Soil bulk density (gcm^{-3}).

D = Soil layer depth (cm).

2. Daily ET_C rate ($mmday^{-1}$)

Calculated from the ET_C between each two successive irrigations divided by the number of days.

3. Reference evapotranspiration (ET_0)

Estimated as mm/day using the monthly averages of weather factors of Fayoum governorate and the procedures of the FAO-Penman Monteith equation (Allen *et al.* 1998).

4. Crop Coefficient (K_C)

The crop coefficient was calculated as follows:

$K_C = ET_C / ET_0$ .... Where:

ET_C = Actual crop evapotranspiration (mm day^{-1}) and ET_0 = Reference evapotranspiration (mm day^{-1}).

5-Water use efficiency (WUE)

The water use efficiency as kg onion bulb yield/ m^3 water consumed was calculated for different treatments as described by Vites (1965):

WUE (kg $m^{-3)}$ = onion bulb yield (kg fed^{-1}) / Seasonal ET_C (m^3 fed^{-1})

RESULTS AND DISCUSSION

I - Yield and yield components:

Data in Table (5) reveal that ridge width significantly effected onion yield and it's components in both seasons. Transplanting onion on 50 cm ridge width gave the highest averages of plant height, leaf No. $plant^{-1}$, bulb weight, bulb diameter and dry bulb yield fed. $^{-1}$ in the two seasons. Transplanting onion on 75 cm ridge width significantly decreased plant height, leaf No. $plant^{-1}$, bulb weight, bulb diameter and dry bulb yield fed. $^{-1}$in 2010/2011 season by 12.26, 16.58, 8.60, 10.29 and 12.90%, respectively, and in 2011/2012 season by 14.33, 6.35%, 7.56, 11.51 and 12.50%, respectively, as compared with transplanting on 50 cm ridge width. Moreover, transplanting on wide ridges (100 cm) significantly reduced the plant height, leaf No. $plant^{-1}$, bulb weight, bulb diameter and dry bulb yield fed.$^{-1}$ in 2010/2011 season by 19.08, 41.34, 14.50, 22.24 and 28.89%, respectively, and by 22.57, 30.88, 14.02, 24.10 and 25.79% in 2011/2012. These results may be due to that inadequate irrigation water was applied under wide ridges (beds), which in turn restricted the onion plant growth and yield. Several research trials proved the potency of bed- furrow irrigation system to reduce the water that applied to the field (Taleghani et al 2004; Buttar et al. 2006; Harms and Konschuh, 2010). The obtained results are in consistent with those found by Salib *et al.* (1998), Ashry *et al.* (2008) and Geremew Awas *et. al.* (2010).

Regarding the effect of irrigation interval treatments, data in Table (5) show that onion yield and its components were significantly affected by irrigation treatments in both seasons. Irrigation onion every 21 days gave the highest averages of yield and its components, while, irrigation at every 35 days gave the lowest ones in both seasons. Increasing the available soil moisture depletion by increasing the irrigation intervals from 21 days to 35 days significantly decreased the plant height, leaf No. $plant^{-1}$, bulb weight, bulb diameter and dry bulb yield fed. $^{-1}$ in first season by 15.19%, 27.94%, 21.97%, 18.89% and 25.45%, respectively, and by 18.31%, 25.27%, 20.58%, 16.26% and by 25.26%, in the second season, respectively. It could be concluded that increasing irrigation intervals more than 21 days significantly decreased onion yield and its components. These results may by referred to that increasing irrigation intervals will reduced the available soil moisture in the root zone, which in turn reduced vegetative growth of bulbs and dry matter accumulation during bulbs formation, as well as reducing nutrients absorption from soil. The obtained results are in accordance to those reported by Doorenbos *et al.* (1979), Saha *et al.* (1997), Govila *et al.* (1998), Koriem *et al.* (1998), Abu-Awwad (1999), Pelter *et al.* (2004) and Morsy and Abd El-Latif (2012).

Table 5: Effect of ridge width, irrigation intervals treatments and their interaction on yield components and yield of onion crop 2010/2011 and 2011/2012 seasons.

Ridge width*	Irrigation Interval (days)	2010/2011 season					2011/2012 season				
		Plant Height (cm)	Leaf No./plant	Dry bulb weight(g)	Dry bulb Diameter (cm)	Dry bulbs Yield ($tfed^{-1}$)	Plant Height(cm)	Leaf No./plant	Dry bulb weight (g)	Dry bulb Diameter (cm)	Dry bulbs Yield ($tfed^{-1}$)
R_1	21	68.8	11.3	100.2	6.01	16.24	69.30	10.2	102.6	6.12	17.13
	28	65.1	9.20	85.3	5.4	14.48	64.40	8.8	86.9	5.61	15.01
	35	61.1	8.10	78.7	4.9	12.98	60.50	7.9	80.2	4.96	13.47
Mean		65.0	9.53	88.07	5.44	14.57	64.7	8.97	89.9	5.56	15.20
R_2	21	62.2	9.61	89.8	5.32	14.85	61.8	9.7	91.4	5.26	15.12
	28	55.7	7.93	81.2	4.91	12.81	53.9	8.4	83.6	5.00	13.42
	35	53.2	6.32	70.5	4.4	10.41	50.60	7.1	74.3	4.51	11.36
Mean		57.03	7.95	80.5	4.88	12.69	55.43	8.4	83.1	4.92	13.30
R_3	21	58.6	6.14	84.6	4.74	12.18	57.20	7.3	85.8	4.66	13.24
	28	52.8	5.56	76.3	4.11	10.02	50.40	5.9	78.3	4.03	11.42
	35	46.4	5.07	64.9	3.83	8.88	42.80	5.3	67.7	3.96	9.17
Mean		52.6	5.59	75.3	4.23	10.36	50.10	6.2	77.3	4.22	11.28
Irrigation interval mean											
21 days		63.20	9.02	91.53	5.36	14.42	62.77	9.07	93.27	5.35	15.16
28 days		57.87	7.56	80.93	4.81	11.64	56.23	7.7	82.93	4.88	13.28
35 days		53.57	6.50	71.37	4.38	10.76	51.3	6.77	74.07	4.48	11.33
LSD, 05%											
R		1.71	1.03	4.12	0.32	0.16	1.73	1.07	5.60	0.37	0.24
Irrigation interval		1.68	1.11	2.94	0.15	0.21	1.66	1.18	5.41	0.12	0.14
R x Irrigation interval		1.82	1.09	2.85	N.S	0.37	1.90	2.01	4.11	0.20	0.24

*R_1, R_2 and R_3 referred to 50, 75 and 100 cm ridge width, respectively.

Data in Table (5) indicate that yield and its components were significantly affected due to interaction of ridge width and irrigation intervals treatments except bulb diameter in first season. The highest averages of the plant height, leaf No. $plant^{-1}$, bulb weight, bulb diameter and dry bulb yield fed^{-1} were detected from transplanting on 50 cm ridge width and irrigation at 21 days interval in both seasons. On the other hand, the lowest averages of yield and its components resulted from transplanted on wide ridges (beds, 100 cm width) as interacted with irrigation at 35 days interval in both seasons.

II - Crop water relations

1. Seasonal evapotranspiration (ET_C)

The results in Table (6) show that seasonal ET_C values as affected by ridge width and irrigation intervals interaction were 35.97 and 37.82 cm in 2010/2011 and 2011/2012 seasons, respectively. Transplanting onion seedlings on ridges of 50 width gave the highest ET_C values, i.e. 38.89 and 40.67 cm in the two successive seasons, whereas, the lowest ET_C values, i.e. 34.06 and 34.94 cm resulted from transplanting on ridges of 100 cm width (beds) in the two successive seasons. It is obvious that increasing ridge width from 50 to 75 or 100 cm, reduced ET of onion crop by 7.1% and 14.8%, respectively, in 2010/2011 season and by 7.48% and 16.4%, respectively, in 2011/2012 season. Such findings may be attributed to less irrigation water applied under both 75 and 100cm ridge width treatments, comparable with 50 cm one, which may be attributed to lower canopy transpiration and less soil surface evaporation rates.. The reductions in ET_C ,under ridges wider than 50 cm, are in the same line with those indicated by Musick *et al.* (1985), Tawadros and Abd El-Aziz (1992), Salib *et al.* (1998) and Ashry *et al.* (2008). Higher both transpiration rate from plants canopy and evaporative demands from soil surface under higher available soil moisture are responsible for higher ET_C values. Such findings are in accordance with those reported by Doorenbos *et al.* (1979), Abu-Awwad (1999), Ashry *et al.* (2008) and Morsy and Abd El-Latif (2012).

Data in Table (6) indicate that transplanting on 50 cm ridge width and irrigation every 21 days interaction gave the highest values of ET_C which comprised 41.07 and 43.05 cm in the first and second seasons, respectively. Nevertheless, the lowest ET_C values, i.e. 30.62 and 31.94 cm in the two successive were detected under transplanting on wide ridges of 100 cm (beds) as interacted with irrigation at 35 days interval.

2. Reference evapotranspiration (ET_0)

Reference evapotranspiration rate (ET_0, mm day^{-1}) during 2010/2011 and 2011/2012 growing seasons was estimated according to FAO Penman- Monteith method via the meteorological data of Fayoum Governorate, Table (7). The data indicated that the ET_0 rate were started with low values during Dec. and Jan., thereafter, it increased from Feb. to May. These results are attributed to the variation in weather factors from one month to another. Allen *et al.* (1998) reported that the reference ET values are depending mainly on the prevailing evaporative power i.e. air temperature, solar radiation, air relative humidity and wind speed.

Table 6: Effect of ridge width and irrigation intervals treatments and their interaction on seasonal consumptive use of onion crop (ET_C) in cm.

Ridge width*	2010/2011 season				2011/2012 season			
	Irrigation interval(days)			Mean	Irrigation interval(days)			Mean
	21	28	35		21	28	35	
R_1	41.07	39.91	36.87	38.89	43.05	41.21	37.74	40.67
R_2	39.06	36.40	33.47	36.31	40.67	37.84	35.02	37.84
R_3	37.64	33.91	30.62	34.06	38.32	34.55	31.94	34.94
Mean	38.68	36.74	33.65	35.97	40.68	37.87	34.90	37.82

*R_1, R_2 and R_3 referred to 50, 75 and 100 cm ridge width, respectively.

8. Crop coefficient (K_C)

The crop coefficient (K_C) is a function of ET_C and ET_0 values, whereas the crop cover percentage affects the daily ET_C and consequently the K_C values. The K_C values in this investigation were estimated from the ET_C in mm day^{-1} and during the months from onion transplanting to harvesting for the treatment which gave the highest yield and highest seasonal ET, i.e. transplanting onion on ridges of 50 cm width and irrigation every 21 days in both seasons. The results recorded in Table (7) indicate that the K_C values of onion crop started with low values during Dec. and Jan. months (seedling growth period), then increased during Feb., as the vegetative growth increased. The K_C values reached its maximum values (1.03 and 1.04) during March, as the bulbs completed its formation (rapid growth in size and weight), thereafter the K_C values tended to decrease again during April and reached low values on May (as the leaves of the plants dried until harvest). These results are in harmony with those mentioned by Doorenbos *et al.* (1979).

4-Water Use Efficiency (WUE)

Results in Table (8) reveal that the mean values of WUE, as a function of ridge width and irrigation interval treatments were 8.10 and 8.29 kg dry bulbs m^{-3} water consumed in the two successive seasons. Transplanting onion on ridges of 50 cm width gave the highest WUE values, i.e. 8.71 and 8.85 kg dry bulbs m^{-3} water consumed in 2010/2011 and 2011/2012 seasons, respectively. The lowest WUE values, i.e. 7.47 and 7.68 kg dry bulbs m^{-3} water consumed in the two successive seasons were observed from transplanting onion on wide ridges of 100 cm width (beds). These results may be due to that transplanting on ridges of 50 cm width gave the highest bulbs yield and the highest ET_C, but transplanting on wide ridges of 100 cm width decreased bulb yield by 40.64% and 34.75% in both seasons, while the ET_C values decreased by 14.18% and 16.40% in the same two seasons (Tables, 5 and 6). These results are in the same trend with that found by Ashry *et al.* (2008) who reported that planting grain sorghum on wide ridges (120 cm) reduced grain yield by 7.4%, whereas seasonal ET_C was decreased by 3.4% only.

Data in Table (8) show that irrigating onion every 21 days gave the highest WUE averages, i.e. 8.82 and 8.88 kg dry bulbs m-3 water consumed in 2010/2011 and 2011/2012 seasons, respectively. However, the lowest values, i.e. 7.30 and 7.65 kg dry bulbs m-3 water consumed in the two successive seasons were detected from 35 days irrigation intervals. Irrigation onion every 28 days decreased WUE values by 7.81% and 6.47% in both seasons, respectively, than irrigation every 21 days. These results may referred to the reduction in bulbs yield fed-1 and the reduction in ETC values for irrigation every 28 and 35 days, compared with 21 days irrigation. These results are in agreement with those reported by Doorenbose *et al.* (1979), Saha *et al.* (1997), Koriem *et al.* (1998), Abu-Awwad (1999), Ashry *et al.* (2008) and Morsy and Abd El-Latif (2012).

Table (7): Crop coefficient values (K_C) under ridge width of 50 cm and irrigation every 21 days as the interaction resulted in the highest onion yield, in 2010/2011 and 2011/2012 seasons

Month	2010/2011 season			2011/2012 season		
	ET_0 (mm day-^{1})	ET_C (mm day-^{1})	K_C	ET_0 (mm day-^{1})	ET_C (mm day-^{1})	K_C
December	2.14	0.96	0.45	2.10	0.97	0.46
January	2.19	1.38	0.63	2.80	1.93	0.65
February	3.21	2.38	0.74	3.52	2.85	0.76
March	4.51	4.56	1.03	4.50	4.64	1.04
April	5.30	3.29	0.67	5.43	3.69	0.68
May	6.80	3.08	0.45	6.60	3.31	0.50

Table 8: Effect of ridge width, irrigation intervals and their interaction on water use efficiency (kg dry bulbs m^{-3} water consumed) in 2010/2011 and 2011/2012 seasons

Ridge width*	2010/2011 season				2011/2012 season			
	irrigation intervals(days)			Mean	irrigation intervals(days)			Mean
	21	28	35		21	28	35	
R_1	9.41	8.86	7.87	8.71	9.47	8.74	8.35	8.85
R_2	8.83	8.38	7.13	8.11	8.79	8.44	7.76	8.33
R_3	8.21	7.31	6.90	7.47	8.37	7.83	6.84	7.68
Mean	8.82	8.18	7.30	8.10	8.88	8.34	7.65	8.29

*R_1, R_2 and R_3 referred to the treatments of (50, 75 and 100 cm) ridge width.

The results in Table (8) reveal that transplanting onion on ridges of 50 cm width and irrigation every 21 days gave the highest productivity of water unit, i.e. 9.41 and 9.47 kg dry bulbs m^{-3} water consumed in 2010/2011 and 2011/2012 seasons, respectively. Whereas, transplanting on wide ridges (beds) and irrigation every 28 days gave the lowest values of water unit productivity, i.e. 6.90 and 6.84 kg dry bulbs m^{-3} water consumed in the two successive seasons.

On conclusion, data reveal that irrigating onion crop every 28 days resulted in lower WUE values comprised 7.26 and 6.08% less than those under irrigating every 21 days, respectively, in 2010/2011 and 2011/2012 seasons. So, on managing the limited irrigation water resources efficiently, its advisable to irrigate the onion crop (transplanted on 75 cm ridge in width, every 21days in order to achieve reasonable water productivity value and to conserve the irrigation water as well.

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العلاقات المائية ومحصول البصل تحت معاملات عرض الخط وفترات الري

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أجريت تجربتان حقليتان بمحطة البحوث الزراعية بطامية – محافظة الفيوم – مصر خلال موسمي الزراعة ٢٠١١/٢٠١٠ ، ٢٠١٢/٢٠١١ لدراسة تأثيرات معاملات عرض الخط وهي : شتل البصل علي خط بعرض R_1: ٥٠ سم ، R_2: ٧٥ سم ، R_3: ١٠٠ سم (مصاطب) ومعاملات فترات الري وهي : الري كل I_1: ٢١ يوم ، I_2:

٢٨ يوم ، I_3: ٣٥ يوم علي المحصول ومكوناته وبعض العلاقات المائية لمحصول البصل صنف جيزة ٢٠. وتوافقت المعاملات التجريبية في تصميم الشرائح المتعامدة في اربع مكررات وكانت أهم النتائج المتحصل عليها كما يلي:-

١- أثرت معاملات عرض الخط وفترات الري والفاعل بينهما علي محصول البصل الجاف ومكوناته في كلا الموسمين ماعدا قطر البصلة في الموسم الاول لم يكن الفرق معنوي.

٢- كانت أعلي متوسطات لأرتفاع النبات، عدد الاوراق علي النبات، وزن البصلة، قطر البصلة ومحصول الابصال للفدان (١٦,٢٤ ، ١٧,١٣ طن فدان$^{-1}$) في كلا الموسمين المتعاقبين وقد نتجت من شتل البصل علي خطوط بعرض ٥٠ سم والري كل ٢١ يوم ، بينما الزراعة علي مصاطب والري كل ٣٥ يوم أعطي أقل المتوسطات لمحصول البصل الجاف (١٠,٣٦ ،١١,٢٨ طن فدان$^{-1}$) وكل مكونات المحصول في الموسمين علي الترتيب.

٣- كان متوسط الاستهلاك المائي متأثرا بالتفاعل بين معاملات عرض الخط وفترات الري هو ٣٥,٩٧ ، ٣٧,٩٢ سم في ٢٠١١/٢٠١٠ ،٢٠١٢/٢٠١١ علي الترتيب. وكانت أعلي قيم للاستهلاك المائي وهي ٤١,٠٧ ، ٤٣,٠٥ سم قد سجلت من شتل البصل علي خطوط بعرض ٥٠ سم والري كل ٢١ يوم في ٢٠١١/٢٠١٠ ،٢٠١٢/٢٠١١ علي الترتيب. بينما أدي الشتل علي مصاطب (خطوط عرض ١٠٠ سم) والري كل ٣٥ يوم للحصول علي أقل متوسطات للاستهلاك المائي وهي ٣٠,٦٢ ، ٣١,٩٤ سم في الموسمين المتعاقبين.

٤- كان معامل المحصول (K_C) والمقدر من المعاملة التي أعطت أعلي محصول أبصال وأعلي استهلاك مائي وهو ٠,٤٦ ، ٠,٦٤، ٠,٧٥، ١,٠٤، ٠,٦٨، ٠,٤٨ (متوسط الموسمين) وذلك خلال ديسمبر، يناير، فبراير، مارس، ابريل، مايو علي الترتيب.

٥- كانت أعلي كفاءة استهلاك مائي وهي ٩,٤١، ٩,٤٧ كجم بصل جاف م$^{-3}$ ماء مستهلك قد نتجت من شتل البصل علي خطوط بعرض ٥٠سم والري كل ٢١ يوم في ٢٠١١/٢٠١٠، ٢٠١٢/٢٠١١ علي الترتيب . ومن النتائج المتحصل عليها فمن المناسب ري البصل كل ٢١ يوم والشتل علي خطوط بعرض ٧٥سم وذلك في حالة محدودية مصادر المياه للحصول علي كفاءة إستهلاك مناسبة من الماء المتوفر.

Table 4: Dates and irrigation number of onion as affected by ridge width* and irrigation interval treatments in 2010/2011 and 2011/2012 seasons

Irrigation event	2010/2011 season									2011/2012 season								
	R_1			R_2			R_3			R_1			R_2			R_3		
	Irrigation interval(days)			Irrigation interval(days)			Irrigation interval(days)			Irrigation interval(days)			Irrigation interval(days)			Irrigation interval(days)		
	21	28	35	21	28	35	21	28	35	21	28	35	21	28	35	21	28	35
	Date			Date			Date			Date			Date			Date		
Transplanting	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12
1st irrigation	27/12	27/12	27/12	27/12	27/12	27/12	27/12	27/12	27/12	26/12	26/12	26/12	26/12	26/12	26/12	26/12	26/12	26/12
2nd irrigation	17/1	24/1	31/1	17/1	24/1	31/1	17/1	24/1	31/1	17/1	24/1	31/1	17/1	24/1	31/1	17/1	24/1	31/1
3rd irrigation	7/2	21/2	7/3	7/2	21/2	7/3	7/2	21/2	7/3	7/2	21/2	7/3	7/2	21/2	7/3	7/2	21/2	7/3
4th irrigation	28/2	21/3	11/4	28/2	21/3	11/4	28/2	21/3	11/4	28/2	21/3	11/4	28/2	21/3	11/4	28/2	21/3	11/4
5th irrigation	21/3	18/4	-	21/3	18/4	-	21/3	18/4	-	21/3	18/4	-	21/3	18/4	-	21/3	18/4	-
6th irrigation	11/4	-	-	11/4	-	-	11/4	-	-	11/4	-	-	11/4	-	-	11/4	-	-
Harvesting	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5
Irrigation count	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5

*R_1, R_2 and R_3 referred to 50, 75 and 100 cm ridge width, respectively