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APPROACHING TO DETERMINE THE OPTIMUM ONION CULTIVAR AND WATER MANAGEMENT IN NEWLY RECLAIMED SANDY SOIL CONDITION "EL-BOSTAN REGION"

BY

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ABSTRACT

Two field experiments were carried out over two growing seasons from 2004 to 2006 in National Research Center Experimental farm "El-Bostan region", to investigate the response of three onion cultivars (*Giza 20, El-Behairy and Supper X F1 hybrid*), vegetative growth, yield, storage ability and water use efficiency (WUE) to three irrigation rates under drip irrigation in newly reclaimed, sandy soil condition

The results revealed that the best growth of onion plants were obtained with the irrigation rate of (75- 90% of Class A Pan evaporation equation "CAP") over the two seasons in all investigated cultivars. Concerning bulb yield, quality and yield after storage, the best results were recorded with the 90 % CAP treatment. While, the highest values of bulb TSS, DM%, WUE and bulb storage ability recorded by all investigated cultivars were obtained from the lowest irrigation rate (60%) over the two seasons.

Meanwhile, *Super X Hybrid* was the superior on vegetative growth, total yield, WUE and marketable yield before storage, its cured bulb recorded the lowest TSS & DM % and tended to sprout rapidly during the fifth month in the storage. On contrary, *Giza 20* cultivar bulbs recorded the highest values of TSS content & DM over all investigated cultivars. Meanwhile, *El-Behairy* cultivar was the best among all investigated cultivars, regarding to bulb storage ability.

Generally, it could be concluded that regarding to irrigation rate, the optimal irrigation treatment for best yielding and storage ability of onion for *El-Bostan* region, might be 75% of CAP rate, during the first two months after transplanting then, turn to90% of CAP rate, during the rest of growing season.

Regarding to cultivars, *El-Behairy* cultivar seemed to be the recommended cultivar for *El-Bostan* region, since it was more diseases tolerant, yielding and storage than *Giza 20* cultivar, and recorded better bulb TSS and DM percentage in comparison with *Super X Hybrid.*

Thus, there are some efforts are needed to breed or introduce new onion cultivar can compete *Super X Hybrid* in diseases tolerant, earliness and yielding

ability, and also, compete *Giza 20* cultivar regarding to bulb TSS, DM and skin color "bronzed yellow", which became the favorable for both local consumer and exporting markets.

Key Words: Onion, cultivars, irrigation rates,, WUE, storage ability

INTRODUCTION

Onion is considered one of the most important vegetable crops in Egypt. It is almost, becomes in third order among vegetable crops as for total cultivated area after tomatoes and potatoes. Also, onion is one of the most important exportable crops in Egypt. Moreover the average Egyptian annual consumption from onion is about 12.5 kg/person, which mean that the total Egyptian consumption around million tons/year. So, the cultivated area of onion was increased from 1968 to 2004 by about 235% (Agric. Econ. Inst. 2004).

Onion cultivars diversity in Egypt is very narrow. Whereas, only 4 cultivars are using in almost onion cultivated areas. *Shandawill* cultivar is mainly cultivated in Upper Egypt region. While, middle Egypt region onion cultivated area mainly cultivated by *Giza 6* and *Giza 20* cultivars. *Giza 20* cultivar is also cultivated in south and middle Delta region *in competition with El-Behairy* cultivar which dominate the onion cultivated area in north Delta region and its surround reclaimed areas (Nat. Progr. Onion Researchs 2004 and Agric. Econ. Inst. 2004). Meanwhile, Those mentioned cultivars are good enough regarding to their adaptability for local condition and bulb quality requested by consumer, they show a susceptible for some soil born, and storage diseases, which greatly affect growth, yield, bulb quality and storage ability. Some of those mentioned diseases severely infect onion cultivated area, and storage such as white rot & pink rot in the field, soft rot and black neck rot in the storage. Because of sever damage by those mentioned diseases a lot of discussion and researches were carried out and suggested the sever infection due to cultivar susceptibility in combination with water management and crop rotation (El-Behairy 1978, Hassan 1987 and Abd-Alla 1992). Moreover, all Egyptian onion cultivars are intermediate day length cultivars, so Glala *et al.* (2006) suggested that cultivation of short day cultivar which have a tolerant to the obvious diseases such as *Super X Hybrid* may overcome those problems and increasing the exporting windows, where its maturing will be earlier than all local cultivars. They also reported that *Super X Hybrid* dominant the local onion cultivars regarding to diseases tolerant, early maturity and total yield,

Abd-Alla (1992), Glala (1997) and Glala *et al.* (2006) reported that good irrigation practices improve onion yield, quality and storage ability, whereas, either deficit or excess irrigation water reduces onion yield and inferiors bulb quality and storage ability.

As it is well known, using estimating models in calculating ET crop and drip irrigation system are the best ways to increase the productivity of both area unit and cubic meter of irrigation water specially in sandy soil of new reclaimed

regions, whereas irrigation water and costs are the most important limitation factor more than other agriculture practices (Doorenbos *et al.*, 1984, Doorenbos *et al.;* 1986, Glala 1997, Al-Jamal *et al.*, 1999 and Glala *et al.* (2006)). In recent time, increasing the exporting windows, saving irrigation water and increasing water use efficiency (WUE) are national targets in order to increase the vertical and horizontal expansion.

The present investigation aims, therefore, to find the optimum irrigation rates for onion in one of the horizontal expansion region "El-Bostan" Moreover, these trials are going to study the possibility of depending on the newly introduced onion hybrid "*Super X*" to decrease diseases control costs and increase early yielding ability in relation to the effect of the irrigation rate on growth, yield, quality and storage ability of onion bulb, in comparison with the two local cultivars mainly used around the study region "*Giza20* and *El-Behairy*".

MATERIALS AND METHODS

This investigation was carried out over two seasons (2004-2005 and 2005-2006) in sandy soil of new reclaimed area in National Research Center Experimental farm "El-Bostan region" to investigate the response of three onion cultivars (*Giza 20, El-Behairy and Supper X F1 hybrid*), vegetative growth, yield, storage ability and water use efficiency (WUE) to three irrigation rates (60, 75 and 90% of Class A Pan evaporation equation "CAP") as recommended by Glala (1997) and Glala *et al.* (2006) under drip irrigation in newly reclaimed, sandy soil condition.

During the first week of December, ten-weeks old onion seedlings of each cultivar were transplanted, with 7-10 cm between each two plants on the row which has 6 edges. The apart between each two rows is 150 cm. The plot area was 90 m^2 containing 2 rows. A split plots design with four replicates was adapted; where three irrigation rates were occupied the main plots and the three cultivars were in sub plots. Irrigation treatments were started after plant establishment in the field "14 days after transplanting" with consideration of crop coefficient as mentioned by Al-Jamal *et al.* (1999), redaction factor for drip irrigation system and leaching requirements as recommended by Doorenbos *et al.* (1984) and Doorenbos *et al.* (1986). Total seasonal amount of irrigation water "M^3/Fadden [4200 m^2]" was 1211.449, 1524.312 and 1817.174 M^3 for low, medium and high irrigation rates, respectively.

Leaf area index, plant fresh and dry weight were recorded after 70 days from transplanting "the beginning of bulb formation stage".

At the second week of May 12.6 m^2 from each replicate were harvested, weighted to determine the fresh yield and then calculated as "Ton / Fadden". The yield samples were cured in a shady place for three weeks and weighted to determine the cured yield. The dry canopy was removed and the bulbs of each sample were weighted to obtain the bulb yield. Marketable yield also was recorded after discarding of the doubles, thick neck, immature and skin cracking

bulbs. Total soluble solid (TSS) and dry matter percentage was determined in the marketable bulbs, as indication for bulb quality response. To investigate the effect of the three irrigation rates on bulb storage ability, samples of marketable bulbs were stored in a shady place from the end of June until the end of November in both seasons. The stored bulbs were sorted monthly to remove out the sprouted and rotted "decayed" bulbs. The healthy bulbs at the end of November were weighted and considered yield after storage. Moreover the water use efficiency (WUE) was calculated as mentioned by Abd-Alla (1992), Glala (1997) and Glala *et al.* (2006), to determine net bulb income yield per cubic-meter of irrigation water (Kg/M^3).

Data were subject to statistical analysis of ANOVA, and the entries means were compared according to Least significant differences (LSD) comparative methods, as reported by (Gomez and Gomez, 1984). All statistical process was processed by SAS computer program.

RESULTS AND DISCUSSION

1. Vegetative growth characters:

Data presented in Figs. (1-3) presented onion vegetative growth " Leaf area index, plant fresh and dry weight" 70 days after transplanting of three onion cultivars (*Giza-20, El-Behairy* and *supper X F_1 hybrid*) receiving three different irrigation treatments (60, 75 and 90% of Class A Pan evaporation equation).

As for leaf area index (LAI), Fig:(1) revealed that it was highly significant affected with both cultivars& irrigation rates and their interaction. Regarding cultivars, *supper X F1* hybrids plants recorded the highest LAI value, followed by *El-Behairy* and then *Giza-20* cultivar plants. On other hand, onion plants irrigated by highest irrigation rates "90 %CAP" recorded the highest LAI value followed by medium and lowest irrigation rate, respectively. There was no significant difference between the high and medium irrigation rate regarding to LAI values. The interaction between the onion cultivars and irrigation rates was statistically very high significant effective on LAI value. The highest LAI value was obtained from the plant of *supper X F1* hybrid irrigated by high irrigation rate followed by the plant of *El-Behairy* with high irrigation rate and *supper X F1* plants with the medium irrigation rate. The plants of *Giza-20* irrigated with high irrigation rate and *El-Behairy* plants irrigated by medium irrigation rate came in the third significant level.

On contrary, the lowest LAI value was obtained from *supper X F1* plant irrigated with low irrigation rate preceded by *Giza-20 plants* irrigated with high irrigation rate, in both two seasons.

Regarding total plant fresh and dry weights as presented in Fig.(2 & 3), showed the same trend of LAI with high significant response to cultivars, irrigation rates and their interaction.

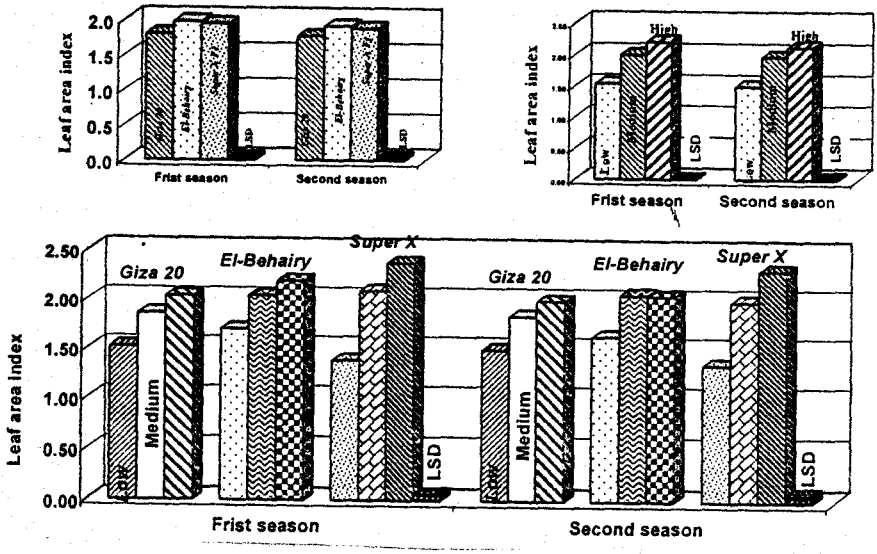

Fig. (1): Response of onion leaf area index to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first and second seasons, respectively.

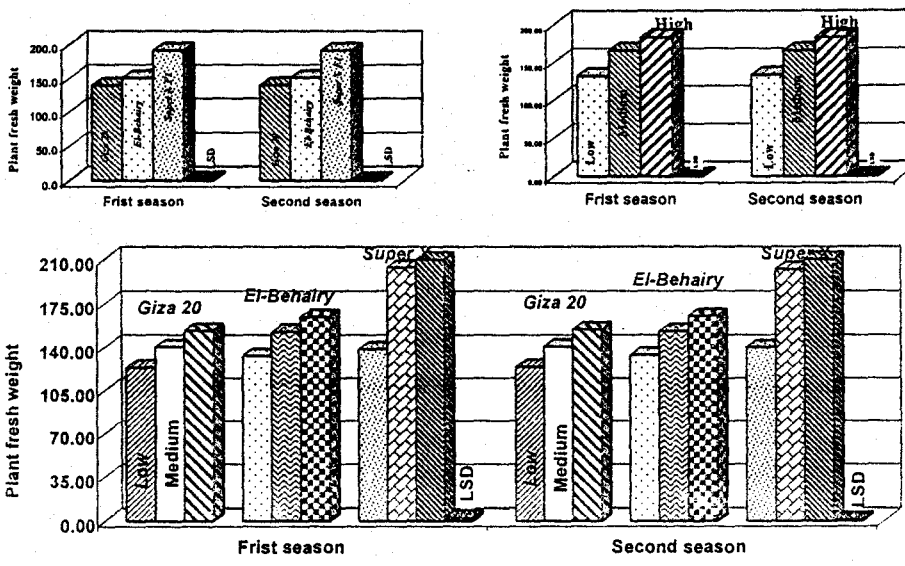

Fig. (2): Response of onion plant fresh weight (g) to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first and second seasons, respectively.

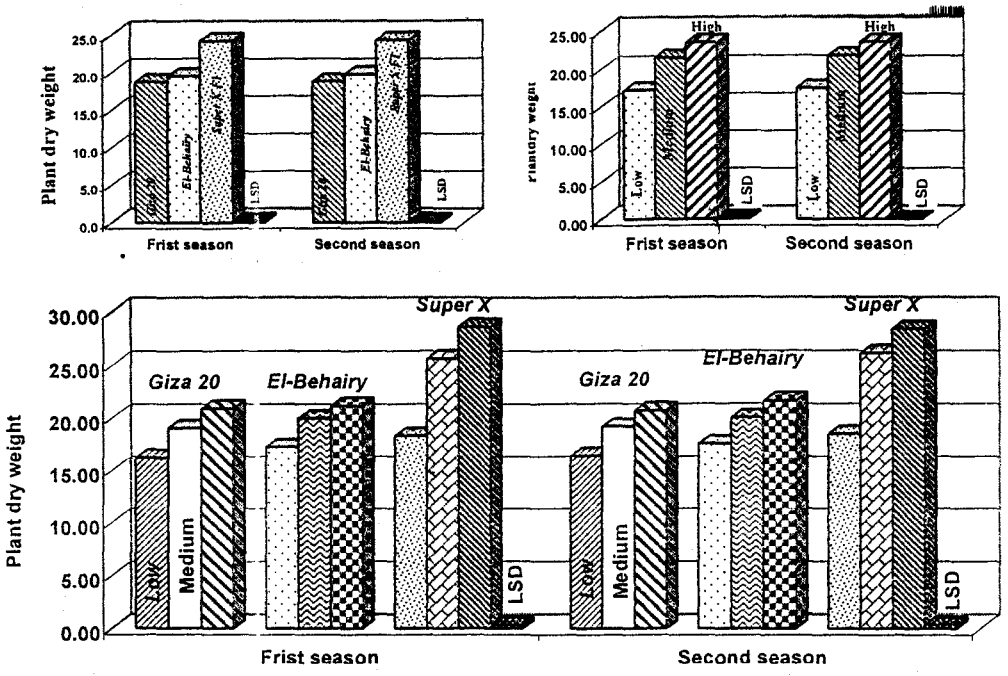

Fig. (3): Response of onion plant dry weight (g) to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first and second seasons, respectively.

On contrary, the calculated dry matter "DM%" percent took the opposite trend, where, the plant of *Giza-20* recorded the highest DM% value (13.36%) followed by *El-Behairy* plants (12.91%) and lastly *supper X F1 hybrid* plants (12.68%). Dry matter % was decreased by increasing irrigation rates in both investigation growing seasons.

Theses results were in agreement with those found by El-Behairy (1978) El-Tabbakh *et al.* (1979), Caraballo *et al.* (1986), Battilani and Lanzoni (1987), Abd-Alla (1992), Galbiatti *et al.* (1992), Thabet *et al.* (1994), Glala (1997 and Glala *et al.* (2006).

Doorenbos *et al.* (1986)., Glala (1997), Glala *et al.* (2006) motioned that onion plant showed no response to inconsequential irrigation rate during the first two months after transplanting. Which illustrate non significant differences found between high irrigation rate (90% of CAP) and the medium rate (75% of CAP). Meanwhile, there were highly significant differences between both high and medium rate compared with the lowest irrigation rate (60% of CAP) in both investigation seasons, for the investigated growth characters. Consequently, the suggestion of reducing the irrigation rate during this period to be 75% of CAP, then increasing it up to 90% would not effect onion growth and yield significantly, and save about 2.5-3 % of seasonal water consumption and irrigation water.

2. Yield and yield components.

Onion yield and its components (bulb yield, marketable yield before and after storage) were calculated as ton per feddan (4200 m^2). The obtained results are illustrated in Figs. (4-6), showed clearly that *Supper X F1 hybrid* resulted in higher onion yield components in both seasons, followed by *El-Behairy* and then *Giza-20* cultivar. The marketable yield after storage for six months showed an exception, since, the highest value was recorded by *El-Behairy* because the *Supper X F1 hybrid* bulbs tended to sprout very rapid from the beginning of the fifth month in the storage, so that the largest percent (48.7 % in the first season and 47.45 % in the second season) of discarded bulbs during storage were obtained from *Supper X F1 hybrid*, mainly according to bulb sprouting. Comparing with 21.78 & 21.97 % for *Giza-20* bulbs and 19.98 & 21.09% for *El-Behairy* bulbs in the first and second seasons, respectively.

The discarded bulbs from *Giza-20* were mainly because of soft rot especially those treated with high irrigation rate. Meanwhile, those discarded from *El-Behairy* were mainly because of black neck rot which was also increased by increasing irrigation rate.

Yield and yield components were positively and significantly influenced by increasing water application from 60 to 90% of CAP during the two growing seasons. Whereas, the highest total bulb yield, marketable yield before and after storage were recorded with the highest irrigation treatment (90% of CAP), followed by the medium irrigation treatment of 75%, while, the lowest values of yield and its components were obtained with the lowest amount of irrigation water treatment of 60% of CAP.

Marketable bulb yield after storage (Fig. 6), the best results were obtained from the high and medium irrigation rate without any significant differences in both investigation years, where the highest percent of discarded bulb during storage (33.81 & 35.67 % in first and second year respectively)were recorded from the high irrigation rate treatments.

Interaction effect between the two studied factors (cultivars and irrigation treatments), could be notice that *Supper X F1 hybrid* which irrigated with highest water regime (90% of CAP) adamantly resulted in the highest values of onion yield and its components compared to all interaction treatments during both seasons. On the other hand, *Giza-20* cultivar insistently produced the lowest values of bulb yield and marketable yield before storage, when it was irrigated with the lowest water regime (60% of CAP) during the two growing seasons. As for marketable yield after storage the lowest value was obtained from the combination of *Supper X F1 hybrid* irrigated with the lowest irrigation rate preceded by *Giza-20* with the same irrigation rate. Meanwhile the highest marketable yield after storage was recorded by treatments of *El-Behairy* irrigated with both high and medium irrigation rate, followed by *Giza20* irrigated with both high and medium irrigation rate. That was true in both two year.

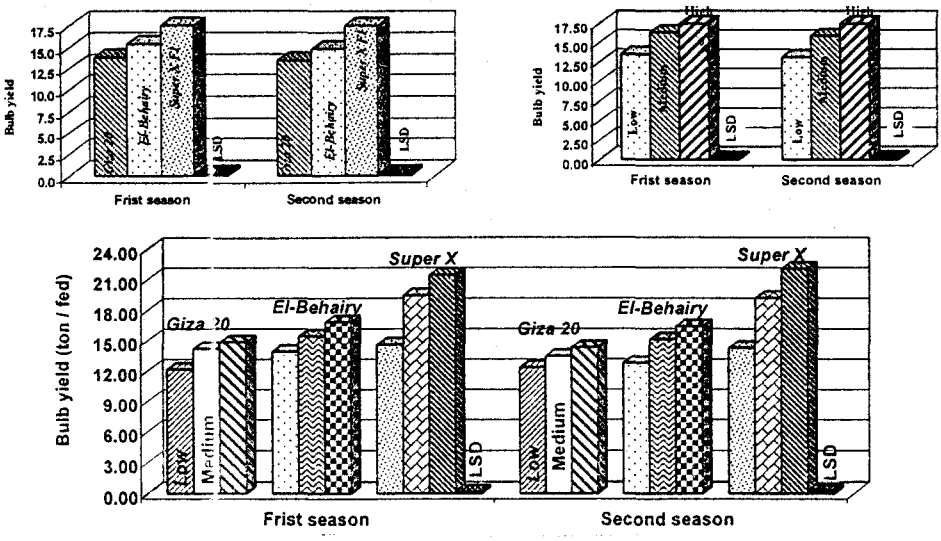

Fig. (4): Response of onion total bulb yield to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first and second seasons, respectively.

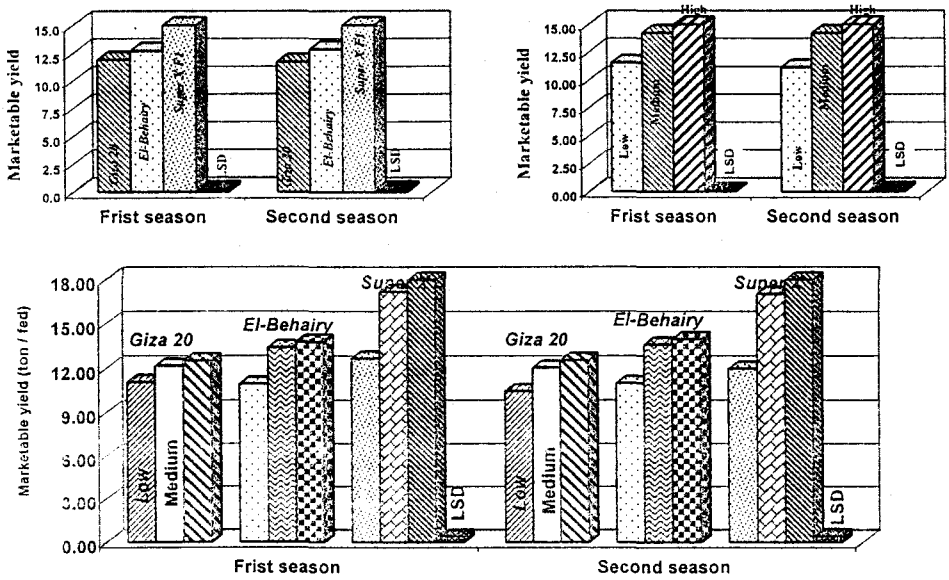

Fig. (5): Response of onion marketable yield to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first and second seasons, respectively.

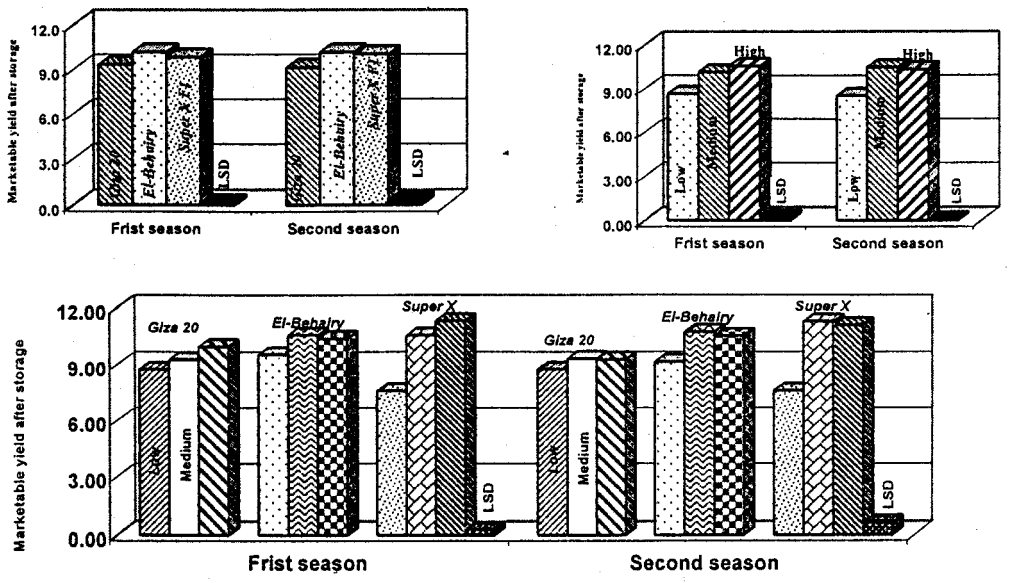

Fig. (6): Response of onion marketable yield after storage to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first (1) and second season (2) respectively.

These results are going well with those mentioned by El-Behairy (1978), Barnoczki (1982), Hassan (1984), Hegde (1985), Goyal *et al.* (1985), Galbiatti and Castellane (1987), Singh *et al.* (1987), Palled *et al.* (1988), Chung (1989), Dhian *et al.* (1991), Abd-Alla (1992), Shock *et al.* (1995), Glala (1997), Neeraja *et al.* (2001), Neeraja and Reddy (2003) and Glala *et al.* (2006).

3- Water Use Efficiency (WUE).

Water use efficiency in Fig. (7) show a similar trend of yield components as for response to cultivar, but its response to irrigation rates took a contrary trend in comparison with yield response trends. The highest water use efficiency "WUE" was obtained from the plots received the lowest amount of irrigation water. WUE was gradually decreased by increasing irrigation rates, in both growing seasons.

Concerning water use efficiency (WUE), the highest values (11.178 &13.127 Kg bulbs/M^3 irrigation water) were obtained from *Supper X F1 hybrid* irrigated by the medium irrigation rate, in the first and second seasons, respectively. On the other hand, the lowest WUE values (8.169 & 8.144) were recorded by *Giza-20* when irrigated with the highest irrigation rate in the first and second seasons, respectively.

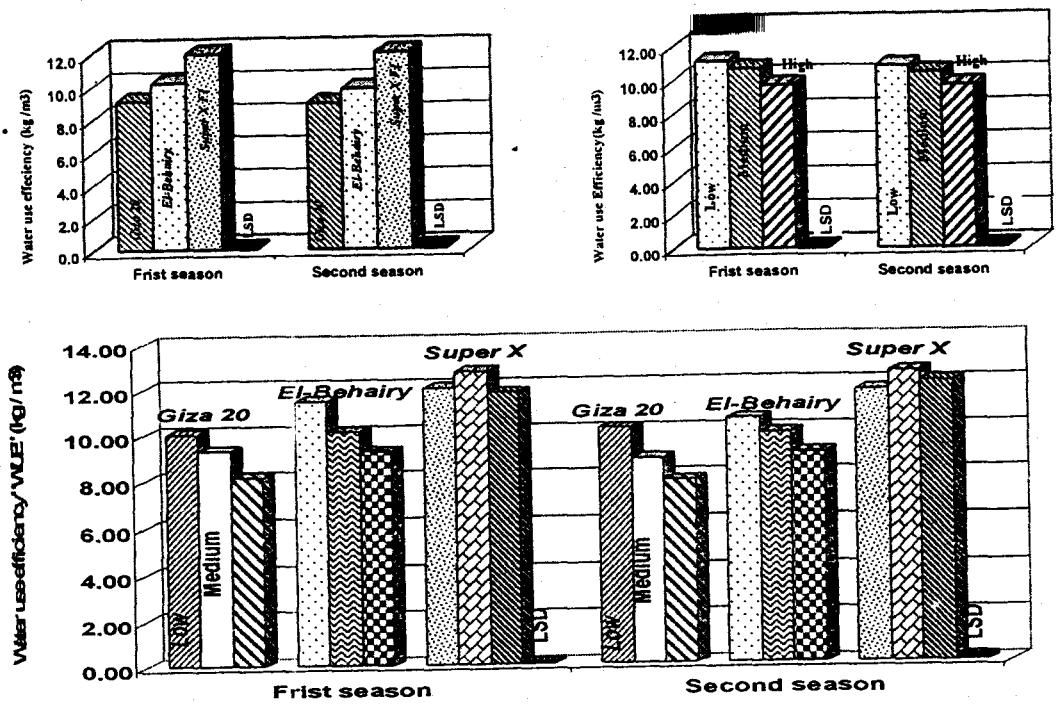

Fig. (7): Response of onion water use efficiency (WUE) to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first and second seasons, respectively

The results of water use efficiency are matched with those obtained by Hegde (1986), Hegde (1988), Palled *et al.* (1988), Abd-Alla (1992), Abu-Awwad (1994), Martin *et al.* (1994), Glala (1997), Abu-Awwad (1999), Al-Jamal *et al.* (1999), Koriem *et al.* (1999), Mohamed and Gamie (2000), Al-Jamal *et al.* (2001) and Glala *et al.* (2006.

4. Bulb Quality.

Total soluble solids (TSS) and dry matter content (DM%) of marketable onion were determined as indicator for bulb quality and its response to onion cultivars and irrigation rates. Data of bulb TSS and DM% are shown in Fig. (8&9). The results revealed that the highest TSS and DM% values were significantly obtained with *Giza20* bulbs followed by *El-Behiary* and then *Super X hybrid* bulbs in both two seasons.

As for total soluble solids (TSS %) and dry matter content (DM%) response to irrigation rates, they were significantly responded to irrigation rates. Being highest TSS and DM% values with low irrigation rate followed by medium irrigation rates.

The highest TSS and DM% were obtained with the treatment of Giza20 with low irrigation rate, however, the lowest values of them were found when Super X hybrid irrigated with high irrigation rate. Differences of TSS and DM% were highly significant in both two season.

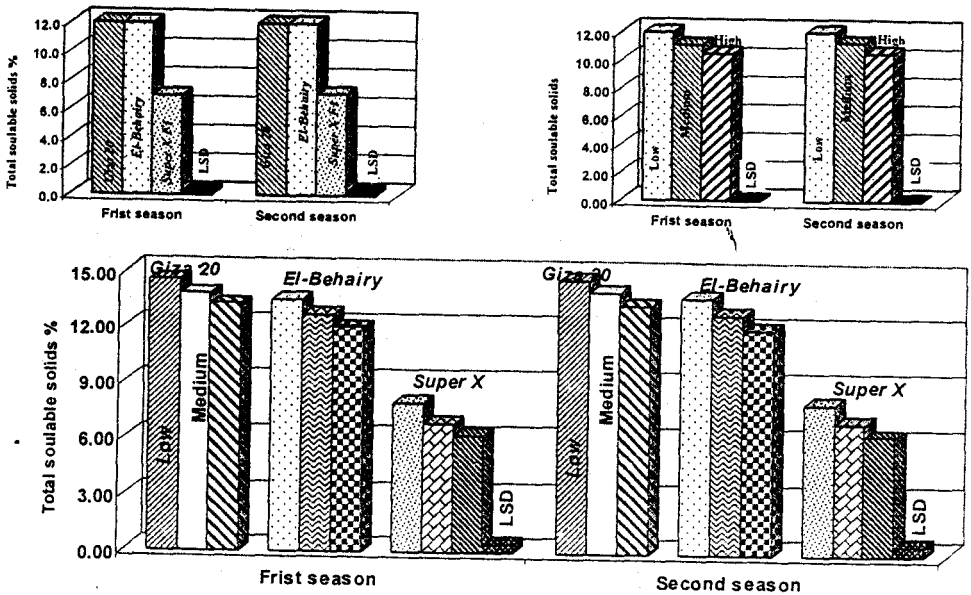

Fig. (8): Response of onion bulb Total soluble solids (TSS %) to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first (1) and second season (2) respectively

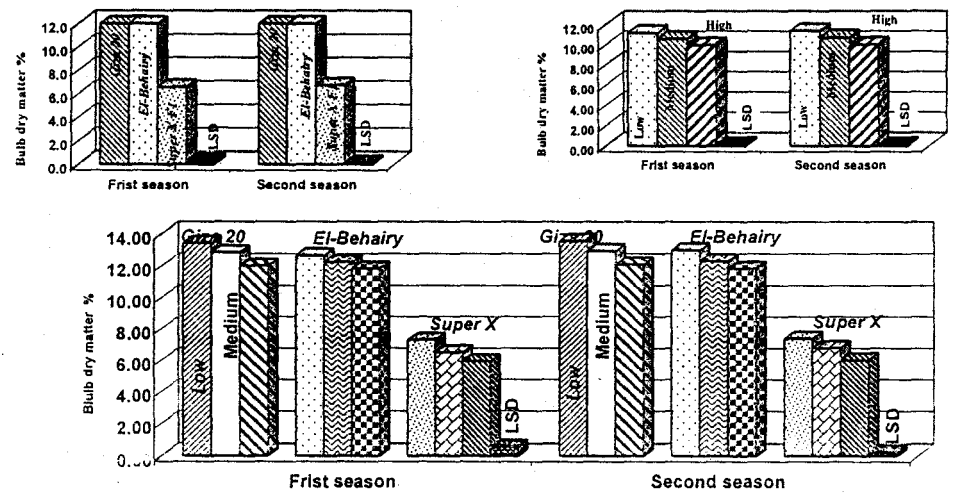

Fig. (9): Response of onion bulb dry matter % to cultivars "top left", irrigation rates "top right" and their interaction "bottom" after 70 days from transplanting in first and second seasons, respectively

The results of TSS and DM% matched with those mentioned by Martin *et al.* (1994), Glala (1997), Abu-Awwad (1999) and Al-Jamal *et al.* (1999)

CONCLUSIONS

Generally, it could be concluded that regarding irrigation rate, the optimal irrigation treatment for best yielding and storage ability of onion for *El-Bostan* region, might be 75% of CAP rate, during the first two months after transplanting, and then, turn to90% of CAP rate, during the rest of growing season.

Regarding to cultivars, *El-Behairy* cultivar seemed to be the recommended cultivar for *El-Bostan* region, where it was more diseases tolerant, yielding and storage ability in comparison with *Giza 20* cultivar, and recorded better bulb TSS and DM percentage in comparison with *Super X Hybrid.*

Consequently, some efforts are needed to breed or introduce new onion cultivar which can compete with *Super X Hybrid* in diseases tolerant, earliness and yielding ability, and also, compete with *Giza 20* cultivar regarding to bulb TSS, DM and skin color "bronzed yellow", which became the favorable for both local consumer and exporting markets.

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نحو تحديد أنسب أصناف البصل و معدلات الري بالتنقيط في الأراضى الرملية حديثة الإستصلاح بمنطقة البستان

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أجريت التجارب الحقلية علي مدى موسمين زراعيين (٢٠٠٤ – ٢٠٠٥ ، ٢٠٠٥ – ٢٠٠٦) في مزرعة المركز القومى للبحوث بمنطقة البستان بمحافظة البحيرة لدراسة استجابة ٣ أصناف بصل (جيزة٢٠ – البحيري – هجين سوبر اكس) لتأثير ٣ معدلات للري (٦٠، ٧٥ و ٩٠%) من معدل البخر نتح المحسوب بواسطة معادلة حوض البخر Class A pan من حيث النمو والإنتاجية والقدرة التخزينية للأبصال وكفاءة استخدام ماء الرى وجودة الأبصال.

سجلت بيانات النمو الخضري (مساحة الأوراق، وزن النبات الطازج والجاف) بعد ٧٠ يوما من الشتل (في بداية مرحلة تكوين الأبصال). وفي مرحلة الحصاد أخذت عينات المحصول و أجري لها العلاج التجفيفي لمدة ٣ أسابيع ثم تم تسجيل محصول الأبصال فقط (بدون عروش) مع حساب كفاءة استخدام ماء الرى (كجم أبصال / م^3 ماء رى)، و قدر محصول الأبصال القابل للتسويق (بعد استبعاد المزدوجة والمقشورة وسميكة العنق وغير تامة النضج) وقياس نسبة المواد الصلبة الذائبة و نسبة المادة الجافة فى الأبصال القابلة للتسويق ، كما تم تخزين المحصول القابل للتسويق لمدة ٦ شهور لتقدير قدرة الأبصال علي التخزين.

أظهرت النتائج أن النباتات المروية بمعدل الرى المتوسط و المرتفع(٧٥ – ٩٠% من معدل حوض البخر) كانت أفضل نموا بالمقارنة بتلك المروية بالمعدل المنخفض في جميع الأصناف خلال عامى الدراسة. فى حين تفوقت معاملة الرى بالمعدل المرتفع فى المحصول الكلى والقابل للتسويق . فقد تفوقت معاملة الرى بالمعدل المنخفض فى نسبة المواد الصلبة الذائبة و نسبة المادة الجافة فى الأبصال وكفاءة استخدام الماء والقدرة التخزينية للأبصال. كما أثبت النتائج وجود تأثير عالى المعنوية لكل من الأصناف ومعدلات الرى والتفاعل بينهما على معظم الصفات المدروسة فى كلا عامى الدراسة. فقد كان نمو نباتات هجين سوبر اكس المروية بمعدل ٩٠% من قيمة البخر نتح المحسوب بواسطة معادلةClass A pan هو الأفضل على الإطلاق بين جميع المعاملات تحت الدراسة خلال موسمى الزراعة. وعلى العكس فان نباتات صنف جيزة ٢٠ المروية بالمعدل المنخفض كانت الأقل نموا خلال موسمى الزراعة. وقد أخذت بيانات المحصول الكلى والقابل للتسويق نفس اتجاه النمو الخضرى حيث زادت بزيادة معدل الرى. فى حين سجلت معاملة هجين سوبر إكس بمعدل الرى المنخفض أعلى قيمة لكفاءة استخدام الماء. أما بالنسبة لمحتوى الأبصال من المواد الصلبة الذائبة و نسبة المادة الجافة والقدرة التخزينية فقد تفوق الصنف جيزة ٢٠ المروى بمعدل الرى المنخفض على جميع المعاملات تحت الدراسة فى حين سجلت أقل القيم عند رى هجين سوبر إكس بمعدل الرى المرتفع فى كلا عامى الدراسة.

على الرغم من أن النتائج أظهرت تفوق هجين سوبر اكس بالنسبة للمحصول الكلى و القابل للتسويق وكفاءة استخدام مياه الرى على باقى الأصناف تحت الدراسة فى حين سجلت أقل بيانات للمحصول ومكوناته فى صنف جيزة ٢٠. فقد سجلت أبصال هجين سوبر اكس أقل القيم فى نسبة المواد الصلبة الذائبة و نسبة المادة الجافة واتجهت للتزريع بمعدلات مرتفعة وسريعة للتزريع أثناء الشهر الخامس من بداية التخزين. وعلى العكس فإن أبصال صنف جيزة ٢٠ سجلت أعلى قيم نسبة المواد الصلبة الذائبة و نسبة المادة الجافة فى الأبصال. فى حين كانت أبصال صنف البحيرى هى الأكثر تحملا للتخزين. وعموما فإن نتائج الدراسة تؤيد التوصيات الآتية:

١. ينصح برى زراعات البصل المروية بالتنقيط بمنطقة البستان بمعدل ٧٥ % من معدل حوض البخر Class A pan خلال الشهر الأول والثانى بعد الشتل ثم الرى بمعدل ٩٠ % من معدل حوض البخرClass A pan حتى قرب نهاية الموسم.
٢-صنف البصل البحيرى هو الأنسب لمنطقة البستان حيث كان أكثر تحملا للأمراض وأعلى محصولا وتحملا للتخزين مقارنة بصنف جيزة ٢٠ كما سجلت أبصاله قيم

أعلى لنسبة المواد الصلبة الذائبة و نسبة المادة الجافة مقارنة بأبصال هجين سوبر إكس.

٣- مازال هناك حاجة ماسة لتربية أو استيراد صنف جديد من البصل قادر على منافسة هجين سوبر إكس فى التبكير وتحمل الأمراض ويماثل صنف جيزة ٢٠ من حيث نسبة المواد الصلبة الذائبة و نسبة المادة الجافة فى الأبصال ولون القشرة (الأصفر البرونزى) الأكثر قبولا فى الأسواق المحلية والأسواق التصديرية.