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RESPONSE OF JERIOSALEM ARTICHOKE TO CUT OFF IRRIGATION BEFORE HARVEST AND FERTILIZATION WITH Ca, Mg and B

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ABSTRACT

T*his investigation was carried out to determine the effect of cut off irrigation i.e., 4 and 7 weeks before harvest and fertilization with calcium nitrate (CN) at 100 kg/fed., magnesium sulphate (MS) at 5 kg/fed. and boric acid (BA) at 1 kg /fed., as well as, their combinations on yield and its components (marketable and unmarketable yields), tuber quality (chemical constituents) and tubers storability of Jerusalem artichoke (Helianthus tuberosus, L.), cv. Fusaeu. The experiment was conducted during summer seasons of 2014 and 2015 on clay loam soil at Kaha Vegetables Research Farm, Horticulture Research Institute, Agriculture Research Centre. The obtained results showed that cut off irrigation for short period (4 weeks before harvest) significantly increased the average tuber weight, average yield/plant, marketable, unmarketable and total yield/fed. However, the cut of irrigation for long period (7 weeks before harvest) produced the highest dry matter percentage of tubers and the lowest values of unmarketable yield. Moreover, the application of each of CN, MS and BA enhanced the total yield and its components, whereas, the combination between the three nutrients produced the best results, compared to each of them alone.*

The interaction between the long period of cut off irrigation (7 weeks before harvest) and applying CN + MS+ BA together resulted in the lowest weight loss and decay percentage of tubers during storage period and the highest inulin, total carbohydrates, Ca and Mg contents of the tubers.

Conclusively, *from these results it can be concluded that the cut off irrigation for a short period (4 weeks before harvest) exist beneficial effect in pre-harvest performance of Jerusalem artichoke plants, but cut of irrigation for a long period (7 weeks before harvest) was effective in post-harvest. The maximum average tuber weight, total, marketable, and unmarketable yields were obtained from the cut off irrigation for short period, while, the highest dry matter percentage of tubers and the lowest values of unmarketable yield were achieved by cutting of irrigation for a long period. Application of Ca + Mg + B together gave beneficial effect*

on the most tubers characteristics, marketable and total yields, as well as, reduces the percentages of weight loss and decay in tubers during storage period.

Key words: Jerusalem artichoke, Cut off irrigation, Ca, Mg, B, Yield components, Marketable yield, Unmarketable yield, Storability, Weight loss, Decay.

INTRODUCTION

Jerusalem artichoke (*Helianthus tuberosus, L.*) is an economically important plant with advantages of low input cultivation, high crop yield and wide adaptation to climatic and soil conditions. In addition, functional foods derived from Jerusalem artichoke tubers, the leaves also have important applications. Jerusalem artichoke leaves are traditionally used as a folk medicine for the treatment of bone fractures, skin wounds, swelling and pain (Talipova, 2001 and Baba *et al.*, 2005). A number of valuable bioactive compounds of medicinal significance have been isolated from the aerial parts of plants, demonstrating antifungal, antioxidant, anticancer activities and other medicinal effects (Baba *et al.*, 2005; Pan *et al.*, 2009; Yuan *et al*., 2012 and Chen *et al.*, 2013).

Jerusalem artichoke tubers are exposed to rapid deterioration after the short period of storage and the tubers can be kept only for several weeks or few months according to the temperature and humidity of the store conditions. However, the weight loss, decay and low nutritional value are the most distinctive features of the tubers (Danilcenko *et al*., 2008). These troubles in storage can result from the fact that lack of tubers corky surface layer, similar to that found on potatoes tubers, which could reduce transpiration, but Jerusalem artichoke tubers have a thin, easily damaged surface that permits rapid water (Modler *et al.*, 1993 and Saengthongpinit, and Sajjaanantakul, 2005). Other reason which can cause rot and rapid weight loss is the high moisture content in the tubers with a decrease in dry matter percentage.

Time of cut off irrigation before harvest may be valuable to protect tubers from the rots and reduce the weight loss, as well as increase the dry matter content and improve the total yield of Jerusalem artichoke tubers. Multiple studies have investigated the effect of cut-off irrigation before harvest. The lowest sprouting, decay, total losses and physiological weight loss in storage occurred when the onion bulbs were harvested 12 days after the last irrigation (Bhonde *et al.*, 1996). Moreover, Nabi (2011) found that large onion bulbs were given by 7 days with holding last irrigation pre-harvest, while small and medium size bulbs were produced by 28 and 21 days with holding last irrigation before harvest time, respectively. Contra result was obtained on sugar beet, while, Sohrabi and Heidari (2008) found that, increasing the length of cut

off irrigation period from 10 to 40 days before harvest times decreased roots yield and increased sugar content.

Fertilization has substantial effect on growth of Jerusalem artichoke plants and subsequently on yield and tubers quality during storage. In addition, type of fertilizers, applying methods, rates and forms of fertilizers, also play an important role in determining the quality of harvested tubers. The application of mineral fertilizers to the potato crop accelerated plant growth and increased tubers yield (Harris, 1992; Trehan and Sharma, 2003 and White *et al*., 2005). It is evident that, applying boron with combination of Mg, S and Zn gave the highest number of tubers/plant and the highest tuber weight of potato (Bari *et al*., 2001). Applying, magnesium increased tubers yield of potato by 18 and 31%, when Mg was applied at 5 and 10 kg/ha, respectively (Talukder *et al*., 2009). Moreover, on potato plants, the mixture foliar spraying of calcium nitrate at 2% + Potassium sulphate at 2% or Magnesium sulphate at 1.5% + Potassium nitrate at 2% gave the highest percentage of largest tubers size and the highest yield per plant and per fed. (El-Zohiri and Asfour, 2009). Also, foliar application of potato plants by boron at 1.0 kg/ha, caused significant effects on tuber weight per plant with 60% and 59.4%, number of tubers per plant with 21.87% and 22.97%, average tuber weight with 33% and 31%, in both growing seasons, respectively, as compared with the control (Marie and Toma, 2011). Increasing calcium content of potato tubers can prevents calcium related disorders and reduces post-harvest losses (Bangerth, 1979).

Therefore, the aim of this study was to determine the effect of cut off irrigation before the harvest, fertilization with calcium nitrate, magnesium sulphate and boric acid and their combinations on the total yield and its components (marketable and unmarketable yields), tuber quality (chemical constituents), as well as, changes in some quality parameters of Jerusalem artichoke (*Helianthus tuberosus, L.*), *cv*. Fusaeu tubers during storage.

MATERIALS AND METHODS

Site description

This investigation was carried out at Kaha Vegetables Research Farm, Horticulture Research Institute, Agriculture Research Centre during the summer seasons of 2014 and 2015, under clay loam soil using Fusaeu cultivar of Jerusalem artichoke (*Helianthus tuberosus, L.*) to investigate the effect of cut off irrigation before the harvest, i.e., 4 and 7 weeks before harvest and fertilization with calcium nitrate (CN) at 100 kg/fed., magnesium sulphate (MS) at 5 kg/fed. and boric acid (BA) at 1 kg/fed. either each of them alone or in a mixture and their interactions on yield, quality and storability of tubers. A soil sample was collected from the experimental field at the beginning of the experiment.

Physical and chemical properties of the experimental soil were determined according to the methods described by Jakson (1970) are presented in Table a.

Experimental design

This experiment included 14 treatments, which were the combinations between two cut off irrigation, *i.e*., 4 and 7 weeks before the harvest and 7 fertilization treatments. Experiment design was a split plot in a randomized

Table a: The physical and chemical properties of the experimental soil*.

Physical properties	**Season**		**Chemical properties**		**Season**	
	2014	**2015**			**2014**	**2015**
Clay (%)	61.12	60.45	pH (1: 2.5 suspension)		**7.63**	**7.25**
Silt (%)	19.89	21.18	**Available** (p.p.m.)	**N**	99.74	101.11
Sand (%)	18.99	18.37		**P**	5.78	6.95
Texture class	**Clay loam**			**K**	212.98	214.22

*****Soil samples were taken from 25 cm soil surface.

complete block design with three replicates, where the cut off irrigation treatments were distributed in the main plot and fertilization treatments allocated in sub plots. Each experimental plot included five ridges 3.5 m length and 70 cm width with an area about 12.25 m^2, one ridge was left without planting as a guard ridge between plots to prevent fertilizers movements from any plot to adjacent one**.**

Planting technique

Jerusalem artichoke seed tubers Fusaeu cultivar were obtained from Horticulture Research Institute, Agriculture Research Centre, Ministry of Agriculture, Dokki Giza. Tubers were planted on 15^{th} and 18^{th} of April in 2014 and 2015 seasons respectively, on the top of the ridges in hills 60 cm apart and 5 cm depth. Tubers were irrigated directly after planting, then three weeks later, and at intervals of every 10 to 15 days according to the temperature and plant requirements.

The treatments

A- Cut off irrigation periods

1- Cut off irrigation at 4 weeks before harvest.
2- Cut off irrigation at 7 weeks before harvest.

B- Fertilization treatments

1- Calcium nitrate (CN) at 100 kg/fed.
2- Magnesium sulphate (MS) at 5 kg/fed.
3- Boric acid (BA) at 1 kg/fed.
4- CN + MS. 5- CN + BA.
6- MS + BA. 7- CN + MS + BA.

All the quantities of fertilizers were divided into three equal portions and added at three times 30, 60 and 90 days after planting. In addition, Agricultural practices took place whenever it was necessary according to the recommendation of Ministry of Agriculture.

Data Recorded

a. Yield components

At harvest times, 180 and 200 days after planting all tubers of each experimental plot were harvested after removal of plant foliage above ground surface, then ten plants from each experimental plot were randomly chosen and the tubers were cleaned from the soil and the following data were recorded:

1- Average number of tubers/plant.
2- Average tuber weight (g): Yield of the chosen plants were weighted and counted then, average tuber weight was computed.
3- Dry matter percentage of tubers: a sample of 100 g from fresh weight of tubers were taken from each experimental plot and dried in an electric oven to constant weight at 70 ^{o}C and the dry matter percentage was calculated.

b- Marketable, unmarketable and total yield

1- Average yield (kg/plant).
2- Total tubers yield: Total tubers yield per plot was weighted and converted into tons/fed.
3- Marketable yield (tons/fed.), which included all tubers weighting >50 gm in weight.
4- Unmarketable yield (tons/fed.), which included all tubers weighting <50 gm in weight.

c. *Storability of Tubers*

At harvesting times, 180 and 200 days after planting the tubers of every experimental plot were taken and cured placing the tubers for about 2 weeks in the shady place at 25$\pm$ 5^{o}C and 60 -70 % relative humidity. Samples of cured tubers (Two kilograms of marketable yield) were taken randomly from each experimental plot, put in plastic box and stored for 90 days at normal room temperature 25$\pm$ 5^{o}C and 60 - 75% RH. The percentage of

weight loss and decay of stored tubers were recorded after 30, 60 and 90 days from storage in both seasons according to Youssef (2007), as follows:

1. Weight loss (%): The stored tubers were calculated according to the following formula:

$$\textbf{Weight loss}\ (\%) = \frac{Initial\ weight\ of\ sampling - Weight\ of\ sampling\ dates}{Initial\ weight\ of\ sampli\square g} \textbf{ x 100}$$

2. Decay (%): Decayed tuber were removed and counted. They included all spoiled tuber resulting from fungal or bacterial infections. The percentage of decayed tubers was calculated in relation to the total number of tubers according to the following formula:

$$\textbf{Decay}\ (\%) = \frac{Number\ of\ decayed\ tubers}{Total\ number\ of\ tubers} \textbf{ x 100}$$

d. Chemical Constituents

In the digested dry matter of tubers, Ca, Mg and B were determined using atomic absorption spectrophotometer according to A.O.A.C. (1990). Carbohydrates were assayed in tubers calorimetrically using the methods described by Dubois *et al. (*1956). Tuber concentration of inulin was determinate according to (Winton and Winton, 1985).

Statistical analysis

Obtained data during the two seasons were subjected to proper statistical analysis of variance as a split plots design according to Snedecor and Cochran (1989). Means separation was done according to L.S.D. at 5% level of probability.

RESULTS AND DISRUPTIONS

a. Yield Components

1- Effect of cut off irrigation periods

Data illustrated in Table 1 show that the number of tubers/plant, average tuber weight and dry matter percentage significantly affected due to cut off irrigation periods before harvest. In this regard, the maximum values in all previously mentioned yield components were achieved in the cut off irrigation for a long period (7 weeks before harvest) except the average tuber weight, which was increased with reducing the cut off irrigation period (4 weeks before the harvest). The possible reason could be the increase in duration of water stress between last irrigation and harvest time was affected on the quantity of moisture inside the tubers. In this connection, Sohrabi and Heidari (2008) reported similar findings on sugar beet yield, which increased with decreasing the length of cut off irrigation period before harvest to 10 days. Nabi (2011) on

Table 1: Effect of cut off irrigation periods and fertilization treatments on yield components of Jerusalem artichoke.

Treatments	Tubers number/plant		Average tuber weight (g)		Tuber DM (%)	
Cut off irrigation periods	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
4 weeks before harvest	88.9	93.5	101.6	115.4	21.31	23.37
7 weeks before harvest	89.8	95.1	97.8	112.1	23.91	25.99
L.S.D at 0.05 level	**N.S.**	**N.S.**	**0.6**	**0.5**	**0.52**	**0.43**
Fertilization						
Control	61.2	69.2	86.5	100.9	20.59	22.67
CN	76.3	78.7	89.3	102.9	23.02	24.93
MS	87.8	93.8	95.8	110.5	22.96	25.06
BA	79.5	81.0	91.9	105.1	22.49	24.55
CN + MS	106.7	112.0	114.3	130.8	22.63	24.70
CN + BA	96.3	103.3	101.4	113.7	23.04	25.24
CN + MS + BA	117.7	122.3	118.5	132.5	23.53	25.61
L.S.D. at 0.05 level	**5.8**	**4.9**	**1.9**	**1.7**	**0.45**	**0.40**

CN: Calcium nitrate at 100 kg/fed., MS: Magnesium sulphate at 5 kg/fed., BA: Boric acid at 1 kg/fed., N.S.: Not significant at 0.05 level probability.

onion found that, large bulbs were given by 7 days with holding last irrigation before harvest, while minimum large size bulbs were produced by 28 and 21 days with holding last irrigation before harvest, respectively. Contra results were obtained in case of small bulbs.

2- Effect of fertilization treatments

Yield components responses by the fertilizer treatments have been shown in Table 1, such data reveal that the highest number of tubers/plant, average tuber weight and dry matter percentage of tubers were recorded with the mixture of calcium nitrate (CN) + magnesium sulphate (MS) + boric acid (BA) treatment, flowed by CN + MS treatment in case of number of tubers/plant and average tuber weight and CN + BA in case of dry matter percentage during both seasons, respectively compared to the other tested treatments. Moreover, using CN, BA and MS in a single form significantly increased all studied yield parameters compared to the control treatment during the two seasons of plant growth. On the other hand, the lowest number of tubers/plant, average tuber weight and dry matter percentage were obtained in untreated control. The positive effect of Ca, Mg and B and its combinations treatments on Jerusalem artichoke tubers yield components could be interpreted by multiple physiological functions to each element. Whereas, Bari *et al*. (2001) found that the combination between B, Mg, S and Zn gave the highest number of tubers/plant and the high potato tuber weight. In addition, Magnesium increased tuber yield of potato by18 and 31% when magnesium was applied at

5 and 10 kg/ha, respectively (Talukder *et al*., 2009). Marie and Toma (2011) reported that, foliar application of boron with 1 kg/ha caused significant effects on tuber weight per plant with 60 and 59.4%, number of tubers per plant with 21.87 and 22.97%, average tuber weight with 33 and 31%, in both growing season, respectively, as compared with control.

3- Effect of the interaction

As for the interaction effect, it is obvious from data in Table 2 that cutting off irrigation in a short period pre-harvest combined with the mixture of CN + MS + BA significantly increased all yield components except the dry matter percentage of tubers, which recorded the highest result when the period of cut off irrigation to harvest was (7 weeks) combined with the fertilization by the mixture containing CN + MS + BA. This result might be due the decreasing in water content of the soil due to increasing the day's number from the last irrigation until the harvest date. These results were in conformity with those reported by Sohrabi and Heidari (2008) on sugar beet and Nabi (2011) on onion.

Table 2: Effect of the interaction between cut off irrigation periods and fertilization treatments on yield components of Jerusalem artichoke**.**

Treatments		**Tubers number/plant**		**Average tuber weight** (g)		**Tuber DM (%)**	
Cut off irrigation periods	**Fertilization**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
4 weeks before harvest	Control	54.0	65.7	88.2	102.6	18.66	20.92
	CN	73.3	75.0	91.1	104.6	22.29	24.08
	MS	85.3	95.3	98.2	111.5	21.91	23.98
	BA	73.7	74.6	93.9	107.4	21.75	23.87
	CN + MS	113.7	113.7	116.2	131.8	20.58	22.66
	CN + BA	99.0	104.6	103.6	115.7	21.85	23.99
	CN + MS+ BA	123.3	125.7	119.9	134.1	22.09	24.09
7 weeks before harvest	Control	68.3	72.6	84.8	99.2	22.52	24.43
	CN	79.1	82.2	87.6	101.2	23.74	25.77
	MS	90.3	92.3	93.5	109.5	23.99	26.13
	BA	85.3	87.3	89.9	102.7	23.23	25.23
	CN + MS	99.7	110.3	112.4	129.8	24.67	26.74
	CN + BA	93.6	102.0	99.6	111.7	24.22	26.51
	CN + MS+ BA	112.0	119.0	116.9	130.9	24.96	27.14
L.S.D. at 0.05 level		**8.2**	**6.9**	**2.6**	**2.4**	**0.64**	**0.57**

CN: Calcium nitrate at 100 kg/fed., MS: Magnesium sulphate at 5 kg/fed., BA: Boric acid at 1 kg/fed.

b. Total Yield and Its Quality

1- Effect of cut off irrigation periods

Data in Table 3 indicated that increasing the period of cut off irrigation from 4 to 7 weeks before harvest significantly decreased the average yield/plant, marketable and total yield/fed. in both seasons. The reduction in average yield/plant was 9.86 and 10.99%, marketable yield decreased by 0.51 and 0.80% and in total yield/fed. 1.33 and 1.58%, in the first and second season, respectively. On the other hand, unmarketable yield was increased with decreasing the cut off irrigation period from 7 to 4 weeks before harvest. This result may be due to the small tubers to grow. Sohrabi and Heidar (2008) obtained the same trend on sugar beet and Nabi (2011) on onion, they found that, sugar beet roots and onion bulbs yields were increased as the harvest was delayed and the length of the cut off period was decreased.

2- Effect of fertilization treatments

Data presented in Table 3 show clearly that application of CN, MS and or BA to Jerusalem artichoke plants three times during the growing season reflected positive effect on average yield/plant and, marketable yield in both seasons, compared with the control. The effect of different nutrient elements on tubers yield were in the order of Ca + Mg + B > Ca + Mg > Ca + B. Such results indicated that the combined application of nutrients Ca + Mg + B gave the best yield/plant, marketable and total yield/*fed.*, as well as, decreasing unmarketable yield than all other applications. The yield increases were in agreement with the findings of Bari *et al*. (2001) who found that, the treatment receiving Zn, B, S and Mg together gave the highest tuber yield (30.90 tons/ha), but the lowest yield (25.40 tons/ha) was obtained in control treatment. El-Zohiri and Asfour (2009) who reported that foliar spraying of the mixture of CN at 2% + Potassium sulphate 2% or MS at 1.5% + Potassium nitrate 2% gave the highest yield/plant and per fed. of the largest tubers. Similarly, Harris (1992); Trehan and Sharma (2003) and White *et al*. (2005) reported that the application of mineral fertilizers to the potato crop accelerates plant growth and increases tubers yield.

3- Effect of the interaction

Results presented in Table 4 indicated that increasing the cut off irrigation period pre-harvest (7 weeks), reduced the tubers fresh weight/plant, marketable and total yield/fed. in both seasons of study, while unmarketable yield was increased with shortage the period between the final irrigation to harvest time. However, cut off irrigation for 4 weeks before harvest combined with the treatment which, received Ca + Mg + B together

reflected the highest results in all yield characters, where the cut off irrigation for 7 weeks pre-harvest combined with the same fertilizers significantly decreased tubers fresh weight/plant, marketable and total yield/fed. These results may be due to the decreasing in soil moisture with increasing the period between the final irrigation up to the harvest time, which may allow curing the tubers under the ground before the harvest.

d. Storability of Tubers

1- ***Effect of cut off irrigation period***

Data presented in Tables 5 show that weight loss and decay percentages were significantly increased with increasing the storage period up to the end of storage in both cut off irrigation periods *i.e*., 4 and 7 weeks after the final irrigation in the first and second season. However, the weight loss was less in the tubers, which produced under cutting off irrigation for 7 weeks pre-harvest time, compared with the short period of cut off irrigation. This result may be due to the increasing in tubers dry matter percentage, as shown in Table 1. This result was in harmony with that reported by, El-Zohiri and Asfour (2009) on potato, who found that, the percentage of weight loss for all treatments was increased with increasing the storage period up to 90 days.

2- ***Effect of fertilization treatments***

Results recorded in Table 6 revealed that the weight loss and decay percentages of tubers significantly decreased due to application of Ca, Mg and or B, compared with untreated control. In this regard, application of 100 kg CN, 5 kg MS and 1 kg BA/fed. solo or as a combination produced the lowest weight loss and decay (%) during the storage period (90 days), followed by the treatment which received 100 kg CN + 5 kg MS/fed. together. Whereas, the control treatment recorded the highest weight loss and decay (%) in both seasons of this study. Such results may be due to the integrate role of Ca, Mg and B in plant. Both calcium and magnesium play integral role in the quality of stored tubers. Calcium is a key component of cell walls, helping to build a strong structure and ensuring cell stability. Boron is an important element present in the cell wall. Here, it acts as cement between pectin, providing cohesive strength for cell tissues. Therefore, B affects tubers storage quality characteristics. Boron also affects calcium absorption, so its supplies are important to ensure balanced calcium and magnesium has been associated with the cell wall and resistance to several tuber pastes and pathogens. Several physiology disorders, which developed in potato tubers during prolonged storage, which have been found to be associated with calcium deficiency. Increasing the calcium content of

potato tubers can prevent these calcium-related disorders and reduced post-harvest losses (Bangerth, 1979). Improved tubers yield and storage quality is associated with increasing tubers calcium content (Spillman, 2003).

3- *Effect of the interaction*

According to the effect of the interaction between the cut off irrigation (4 and 7 weeks before harvest) and application of Ca, Mg and B at the rates of 100 kg CN, 5 kg MS and 1 kg BA/fed. separately or in combinations on weight loss and decay percentages of Jerusalem artichoke tubers stored under room temperature, it is obvious from such data in Table 6 that the interaction between the cutting off irrigation for long period (7 weeks of the harvest time) and application of Ca + Mg + B significantly decreased the weight loss and decay of tubers followed in ascending order by using the treatment which received Ca + Mg. while the highest values were recorded by the interaction between the cut off irrigation for 4 weeks of the last irrigation to harvest with the untreated control treatment, followed in a descending order by Ca application separately.

d. Chemical constituents

1- Effect of cut off irrigation period

Data illustrated in Table 7 show that inulin, carbohydrates, Ca, Mg and B contents of tubers were significantly affected because of cut off irrigation periods before harvest. Cutting of irrigation for 7 weeks before harvest significantly increased in chemical constituents of Jerusalem artichoke tubers expressed as inulin, Ca, Mg and B in both seasons of study. However, there were no significant differences between the two cuttings off irrigation on total carbohydrate % in both seasons of this study.

2- *Effect of fertilization treatments*

Data presented in Table 7 reveal that application of Ca, Mg and B each separately or in a combination with other one enhanced inulin, total carbohydrates, and Ca, as well as Mg contents of tubers. However, application of BA separately, significantly increased B content of the tubers. However, the boron content was higher in the untreated control, compared with the treatments of Ca alone or Ca + B together. This result may be due to the competitive between Ca and B.

3- *Effect of the interaction*

Data presented in Table 8 show clearly that the interaction between the cut off irrigation before harvest and the treatments, which fertilized with 100 kg CN, 5 kg MG and 1 kg BA/fed. applied as solo or in combination tended to increase inulin, total carbohydrates, Ca and Mg contents in both

seasons of study, as compared with the control treatment. Whereas, within the two cuttings off irrigation the combined application of Ca + Mg + B has a better result than the solo application**.** Moreover, cut off Irrigation for 7 weeks pre-harvest combined with the fertilizer treatment, which containing Ca + Mg + B together produced the highest values of all chemical constituents of tubers. While, the lowest results were obtained due to applied of the first cut off irrigation combined with the untreated control.

Conclusively, from these results it can be concluded that the cut off irrigation for a short period (4 weeks before harvest) exist beneficial effect in pre-harvest performance of Jerusalem artichoke plants, but cut of irrigation for a long period (7 weeks before harvest) was effective in post-harvest. The maximum average tuber weight, total, marketable, and unmarketable yields were obtained from the cut off irrigation for short period, while, the highest dry matter percentage of tubers and the lowest values of unmarketable yield were achieved by cutting of irrigation for a long period. Application of Ca + Mg + B together gave beneficial effect on the most tubers characteristics, marketable and total yields, as well as, reduces the percentages of weight loss and decay in tubers during storage period.

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إستجابة الطرطوفة لفترات منع الري قبل الحصاد، والتسميد بالكالسيوم والماغنسيوم والبورون

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أجريت هذه التجربة بهدف دراسة تأثير فترة وقف الرى، والتسميد بنترات الكالسيوم (١٠٠ كجم)، وسلفات الماغنسيوم (٥ كجم)، وحمض البوريك (١ كجم) / فدان، وكذلك تأثير التفاعل الثنائي بينهما على المحصول الكلي، ومكوناته (المحصول القابل، وغير القابل للتسويق)، وجودة الدرنات (الصفات الكيميائية)، وكذلك القدرة التخزينية لدرنات نباتات الطرطوفة صنف فيوزوا. لذلك أقيمت تجربة حقلية خلال موسم الزراعة الصيفي لعامى ٢٠١٤، ٢٠١٥، تحت ظروف مزرعة محطة قها التابعة لمعهد بحوث البساتين- مركز البحوث الزراعية.

أوضحت النتائج المتحصل عليها، أن حصاد درنات الطرطوفة بعد ٤ أسابيع من وقف الرى سجل زيادة معنوية لمتوسط وزن الدرنة، ومحصول النبات من الدرنات، وكذلك المحصول الكلي، ومكوناته (المحصول القابل، وغير القابل للتسويق) للفدان، بينما نتج عند حصاد الدرنات بعد ٧ أسابيع من وقف الرى أعلى القيم في محتوى الدرنات من المادة الجافة، وإنخفض المحصول غير القابل للتسويق للفدان. أما التسميد بنترات الكالسيوم (١٠٠ كجم/فدان)، وسلفات الماغنسيوم (٥ كجم/فدان)، وحمض البوريك (١ كجم/ فدان) زاد من إنتاجية الفدان لدرنات الطرطوفة. بينما سجل التفاعل بين عاملى الدراسة (فترة وقف الرى، والتسميد بالعناصر الثلاث معا) أعلى قيما للصفات المدروسة، مقارنة بالنباتات غير المعاملة. حيث سجل التفاعل بين مدة وقف الرى لفترة ٧ أسابيع مع التسميد بمخلوط العناصر الثلاثة أقل القيم من نسبتي الفقد في الوزن، والتلف (التدهور) في درنات الطرطوفة خلال فترة التخزين، بالإضافة إلى إرتفاع محتوى درنات النباتات من الأنيولين، الكربوهيدرات، والكالسيوم والماغنسيوم.

التوصية: بناء على ذلك، يمكن الحصول على أعلى محصول قابل للتسويق من درنات الطرطوفة صنف فيوزوا، وصفات جودة عالية، مع زيادة القابلية للدرنات على التخزين، مع ارتفاع القيمة الغذائية لهذه الدرنات عن طريق وقف الرى لمدة ٧ أسابيع في حقول النباتات المسمدة بنترات الكالسيوم (١٠٠ كجم/فدان)، وسلفات الماغنسيوم (٥ كجم)، وحمض البوريك (١ كجم/ فدان).