Assiut J. Agric. Sci., (48) No. (2) 2017 (167-176) *ISSN: 1110-0486*
Website: http://www.aun.edu.eg/faculty_agriculture *E-mail: ajas@aun.edu.eg*

Seed Chilling Enhances Head Earliness and Yield of Artichoke (*Cynara scolymus* L.) under Assiut Conditions

S.Y. Attallah

Department of Vegetable Crops, Faculty of Agriculture, Assiut University Assiut, Egypt

Received on: 2/2/2017 **Accepted for publication on:** 21/2/2017

Abstract

Subjection of seeds to a chilling pretreatment has been reported to enhance crop yield particularly earliness in number of vegetable crops including seed-grown (annual) globe artichoke. Therefore, the current study was carried out to assess the impact of seed chilling pretreatment on the production of seed-propagated globe artichoke in two cultivars (EL-Balady and Chinese) under Assiut conditions. Four seed pretreatments were utilized. These were seeds imbibed in water for 24 h and subjected to chilling at 4-5 ^{0}C for 0 (positive control), 10 and 15 d, in addition to untreated seeds (negative control). These seed pretreatments were scheduled so as to be simultaneously ready at the time of sowing. A field experiment was carried out to test these treatments during 2014/2015 and 2015/2016 winter seasons at the Experimental Farm of Faculty of Agriculture, Assiut University, Assiut, Egypt. Data revealed an influential effect for seed chilling on growth, earliness and yield of artichoke. Comparing to plants of both control treatments, imbibed seeds which were subjected to chilling at 4-5˚C for 15 d gave the greatest reduction in number of days to form heads and highest early head yield. Average head weight, number of heads/plant and head diameter and height were increased while total yield was elevated. This pre-sowing seed chilling treatments increased yield by 22.5% and 40.3% relative to positive and negative controls, respectively, on average. The reduction in the number of days to develop harvestable inflorescences ranged from 21 d to 23 d comparing with the positive and negative controls, respectively, on average. Apparently, seed chilling pretreatment may be usefully applied to overcome the delay in head formation, due to insufficient natural chilling under Assiut conditions, while elevating total head yield and expanding production season.

Keywords: *cultivars, flower head, pre-sowing treatments, yield components, yield quality, vernalization.*

Introduction

Artichoke is a vegetable that cultivated for fresh undeveloped flower head (Sałata *et al*. 2012). Globe artichoke is a large immature flower bud rich in medicinal substances. It is considered one of the most important vegetable crops in the countries bordering the Mediterranean basin including Egypt. The world production of globe artichoke increased from 1205 to 1290 million tons from 1999 to 2000 (Behr, 2001). In Egypt a renewed attention is given to promote globe artichoke production (Mohamed *et al*., 2002a; Mohamed *et al*., 2002b) to satisfy the increased demands of local consumption and for exportation as well. High quality artichoke buds and early production of flower heads during December to February is important for successful production and exportation of this crop.

The early harvest period from December to February for globe artichoke in Egypt is economically interesting because in most European countries there is no production during these months, except in southern Italy and Spain, but they are also a big consumer for globe artichoke. The earlier the harvest the higher the prices of the globe artichoke in the market. In Egypt the highest market prices are obtained from December to February also. Literature demonstrates that artichoke seeds are able to germinate over a wide range of temperatures (3-4 to 35-39 °C) and exhibit neither photoperiodic sensitivity nor dormancy. In this connection, Schrader *et al*. (1992) reported that significant yield increases were achieved when artichoke was propagated by seed. Globe artichoke plants are biennial when grown from seeds (Hill, 1993). This 2-year cycle requires milder winters than they do happen in Connecticut, but it has been shown that the growth cycle can be shortened to 5-6 months by seed vernalization (moistened chilled seeds) or by GA_3 application to young plants. These techniques enabled satisfactory flower bud production on plants grown as annuals. The most suitable temperature for vernalization ranged from 2^0C to 7^0 C (Harwood and Markarian 1968).

Vernalization has been induced in globe artichokes by stratifying seed (Gerakis *et al*., 1969; Hill and Maynard, 1989). Vernalization is metabolic process that causes plant to change from a vegetative stage to reproductive stage. This change may be initiated by subjecting seed to a cool moist treatment. Induced vernalization is done after soaking seeds in tap water at room temperature to soften the seed coat then refrigerated. Application of pre-sowing seed chilling has been reported to enhance fruit crop productivity of pumpkin *(Cucurbita spp*) (Hussein *et al.,* 2010) and earliness and curd yield of cauliflower (Mohamed *et al.,* 2014). From the crop production point of view, seed chilling is considered simple and environmental friendly treatment plus it adds no substantial production cost. Therefore, the aim of this research work was to assess pre-sowing imbibed seed chilling treatments as affecting the production of seed-propagated (annual) artichoke under Assiut conditions.

Materials and Methods

This study was carried out at the Experimental Farm of Faculty of Agriculture, Assiut University, Assiut, Egypt, during 2014/2015 and 2015/2016 winter seasons. Seeds of two globe artichoke cultivars (EL-Balady and Chinese) were subjected to low temperatures before sowing into the field on 22 and 28 September for the first and second seasons, respectively.

Plant material and experimental procedure

Seeds of EL-Balady and Chinese cultivars imbibed in water for 24 h were subjected to chilling at 4-5 ^{0}C for 0 (positive control), 10 and 15 d in addition to untreated seeds (negative control). These seed treatments were scheduled so as to be simultaneously ready at the time of sowing. The experiment was conducted using randomized complete-block design with three replications. Each experimental plot consisted of three rows. Each row was 3.5 meters long and 1 m wide. The seeds of cv El-Balady were produced locally while the seeds of Chiness cv were obtained from Flower-Goddess Agriculture Company.Within row planting distance was 75 cm. Each replicate consisted of eight treatments, i.e. the combinations of four pre-sowing seed chilling treatments and two cultivars.

Fertilizer applications comprised 45 kg P_2O_5/ha (calcium superphosphate 15.5 % P_2O_5), 60 kg N/ha (ammonium sulphate 20.5 % N) and 65 kg K_2O/ha (potassium sulfate 49 % K_2O). Calcium superphosphate was soil-incorporated two weeks before transplanting. Ammonium sulfate was side dressed in 5 doses; first dose was 40 days after planting, second at the heading stage, third before the first harvest and fourth and fifth ones after the first harvest. Other agricultural practices of irrigation, pest control…, etc, were applied as recommended for globe artichoke production (Hasan, 1991). Harvesting of artichoke floral heads was done successively as they developed up to early May.

Measurements

Number of days lapsed to form inflorescence head, main shoot height (cm), stem base diameter (cm), number of branches per plant and number of leaves per plant were determined for the mature plants. Random samples of five flower heads were taken from each plot at the mid-harvest season to determine the head diameter (cm), head height (cm) and the head weight (g). Head yield of first three harvests was considered as an estimate of early yield. It was recorded as weight of heads / plant and was expressed as ton/feddan. Total head yield (ton/feddan) was the sum of head weight per plant overall harvests. It was also expressed as head yield /fed.

Statistical process

The obtained data were statistically analyzed following the procedure of the analysis of variance (Snedecor and Cochran, 1980). Data of each season, separately, were subjected to analysis of variance then the homogeneity of error variances was tested. As the homogeneity of error variances was verified, the two seasons combined data were used in combined analysis of variance. Means of the treatments were compared using the Duncan's Multiple Range Test (DMRT) at 0.05 probability level.

Results and Discussion

The analysis of variance (Tables 1, 2 and 3) shows significant influence for the studied treatments on all crop parameters. These treatment effects did not manifest significant interaction with the year effect. However, the data were presented for each separate year for further clarity. Mean comparisons in the current study obviously show that subjection of seeds imbibed for 24 h to low temperature (4-5°C) resulted in significantly enhanced artichoke productivity (Tables 1, 2 and 3). Generally, longer period of subjection time (15 d) to chilling demonstrated more influential effect in most yield key traits, especially earliness.

Regarding main vegetative characteristics of the Chinese cv, the number of leaves/plant was low for plants of both control treatments (seeds imbibed only or untreated) comparing with those which received chilling pretreatment for the seeds (Table 1). Imbibed seeds of El-Balady cv that were subjected to low temperature (4-5˚C) for 15 d gave significantly greater number of leaves only in the first year. Seed chilling produced plants having taller main shoot in the Chinese cv in both years than control treatments. The values for main shoot height in El-Balady cv were comparable among different treatment in the first year and lacking sharp differences in the second year. Shoot diameter at the bottom displayed a significant augmentation in both years for the plants propagated by seeds chilled for 15d, except in the Chinese cv in the second year. Plants raised from seeds chilled prior to planting had greater number of branches/plant at the end of season in both cvs and years than plants derived from untreated seeds (negative control) or seeds imbibed only (positive control). Number of branches/plant at the end of season was larger for positive control plants as compared with negative control plants. In both cvs and years, the number of branches/plant at the end of season exhibited elevation when seeds were chilled for 15 d prior to planting as compared with chilling for 10 d.

Imbibed seeds subjected to low temperature (4-5˚C) for 10 or 15 days resulted in significantly decreased number of days to form heads in comparison to either control treatments (Table 2). There were no difference between the plants derived from seeds imbibed only (positive control) and those from untreated seeds (negative control). Fifteen days of pre-sowing seed subjection to chilling gave plants forming earlier heads than subjection for ten days. For cv El-Balady compared with the control, the reduction in the number of days was 24 d in the first year and 23 d in the second year when the plants were raised from seeds received chilling for 15 days. The reductions in the number of days for cv Chinese were 19 d and 21 d in the first and the second year, respectively. Rather similar behavior was displayed by the early yield of heads (Table 2). Seed chilling pretreatment led to producing higher early head yield than either control treatments. Plants derived from seeds imbibed only (positive control) showed greater values for early yield than those from untreated seeds (negative control), except in the second year for the Chinese cv. The chilling for 15 d was superior to 10 d in this regard. For cv El-Balady, the increase in the early yield was 10.5% in the first year and 17.2 in the second year, relative to the positive control, when the plants were raised from seeds received chilling for 15 days. The increases in the early yield for Chinese cv were 4.5% and 9.5% in the first and the second year, respectively.

Total head yield exhibited comparable response to early head yield as affected by the period of time of subjection to seeds pretreatment (Table 2). Pre-sowing seed chilling treatment produced higher head yield than either control treatments. Plants derived from seeds imbibed only (positive control) showed greater values for total head yield than those from untreated seeds (negative control). Chilling for 15 d surpass chilling for 10 d in this regard. For cv El-Balady, the increase in the total head yield was 24.6% in the first year and 26% in the second year, relative to positive control treatment, when the plants were raised from seeds received chilling for 15 days. The increases in the total head yield for Chinese cv were 25% and 21% in the first and the second year, respectively. Number of heads significantly increased as a result of subjecting the seeds to the low temperature. There was no difference in the number of heads between subjection for 10 d and 15 d concerning El-Balady cv in both years and for the Chinese cv in the second year. The Chinese cv, however, produced significantly larger number of heads in the first year when seeds were subjected to chilling for 15 d. Plants derived from seeds imbibed only (positive control) showed greater number of head than those from untreated seeds (negative control).

Plants raised from seeds imbibed for 24 h and subjected to low temperature (4-5° C) gave significantly greater height for head than either control treatments (Table 3). This was alike for head diameter and head weight in both cultivars and years. Longer time (15 d) of subjection to the low temperature exhibited increases over shorter one regarding height for head, head diameter and head weight. Plants derived from seeds imbibed only (positive control) showed greater values for head height, diameter and weight than those from untreated seeds (negative control).

The depicted results here imply for a quantitative nature of response of the artichoke to seed chilling pretreatments. Accordingly, plants derived from untreated seeds formed heads while plants from vernalized seeds showed enhanced response for head development including earliness and yield (Hussein *et al*., 2010; Mohamed *et al.,* 2014). The longer period of time (15 d) of seed subjection to the low temperature revealed an improved response reflected in reduced number of days to develop heads and elevated early and total head yield. In the present study, it was further observed that seeds imbibed for 24 h prior to planting (positive control) had an enhanced effect on earliness, yield and head characteristics in comparison to untreated seeds (negative control). Pre-planting imbibitions of the seeds can provide sufficient seed hydration. Thus plants may develop better and faster reaching the receptive stage to low-temperature early. Vernalization treatments may enhance endogenous gibberellic acid activity which can stimulate plant growth when acting at early vegetative stage (Hussein *et al.,* 2010). Thus additional stimulation using seed vernalization beside seed hydration is provided for the plants accelerating their growth to reach the receptive stage to low-temperature for head initiation early (Rangarajan *et al*., 2000). Studies of exogenous applications of gibberellic acid to globe artichoke revealed that it can substitute chilling requirement of artichoke and consequently enhance earliness of head formation (Mauromicale, *et al*., 2000). Further, it is suggested that exposure of seeds to low temperature may induce antioxidants which may lead to greater efficiency in chloroplast to manufacture photosynthetic assimilates (Devlin and Witham 1983).

Conclusion

We deduce that seeds imbibition for 24 h then exposing them to low temperature (4-5°C) for 15 days can greatly enhance head production of artichoke in form of earliness while elevating head yield and improving head characteristics. Beside these production advantages, the seed pre-sowing chilling treatment is considered technically simple, environmental-friendly and can be achieved at no appreciable additional production cost.

Literature Cited

Behr, Hans-Christoph. 2001. ZMP-Marktbelanz, Gemüse 2001, Deutschland Europäsche Union Weltmarkt. ZMP Zentrale Markt- und Preisberichtstelle GmbH, Bonn. P 233.

Devlin, R.M and F.H. Witham.1983. Plant physiology. Forth edition. Willard Grant press, Boston.

Gerakis, P.A., D. Markarian, and S. Honma. 1969. Vernalization of globe artichoke, *Cynara scolymus* L. J. Amer. Soc. Hort Sci. 94:254–258.

Harwood R.R., D. Markarian. 1968. Annual culture of globe artichoke (*Cynara scolymus* L.). I. Preliminary report. Proc. Amer. Soc. Hort. Sci. 92: 400–409.

Hasan, A. A. 1991. Production of vegetable crops.1st ed., Published by Arab House for Publishing and Distribution, Cairo, Egypt. (in Arabic).

Hill, D.E. 1993. Annual culture of globe artichokes, mulching and planting date trials 1989-1992. Bulletin Connecticut Agricultural Experiment Station 911: 1-8.

Hill, D.E and A.A. Maynard. 1989. Globe artichoke trials 1987–1988. Conn. Agr. Expt. Sta. (May) 867:3–9.

Hussein, H.A., M. F. Mohamed, E.M.A. Butt and M.S.S. Abdel-Rahman. 2010. Pre-sowing seed chilling treatment enhances fruit crop productivity of pumpkin *(Cucurbita spp*). Assiut J. Agric. Sci. 41:424-433 (special issue, The 4th conf. Junior Scientists, Faculty Agric, Assiut University, April 27th, 2010.

Mauromicale, G., A. Ierna, V. Cavallaro. 2000. Effects of vernalization and gibberellic acid on floral induction and harvest time of seed-grown artichoke. IV International Congress on Artichoke, October 17-21.

Mohamed, E.A.A., M.F. Mohamed, E.F. El-Sayed and A.G. Haridy. 2014. Curd yield of cauliflower derived from chilled and hydroprimed seeds. Assiut J. Agric. Sci. 45 (2):104-112.

Mohamed, M. F., A. K. Metwally and S. H. Ali. 2002b. Narrow spacing enhances head yield of the artichoke. Assiut J. Agric. Sci. 33 (4):105-115.

Mohamed F,M., A.K. Metwally and S. H. Ali. 2002a. Stand and yield performance of transplant-, off-shoot- and Stump- Propagated Artichoke. Proc. The Third Sci. Conf. Agric. Sci. p. 429-439, Oct. 20-22, Assiut Univ.

Rangarajan A., B.A. Ingall, V.C. Zeppelin. 2000. Vernalization strategies to enhance production of annual globe artichoke. Hort. Technol.10 (3):585-588.

Sałata A., R. Gruszecki, J. Dyduch. 2012. Morphological and qualitative characterization of globe artichoke (*Cynara scolymus* L.) cultivars 'Symphony' and 'Madrigal' on depending of the heads growth. Acta Sci. Pol., Hort. Cultus 11 (5): 67–80.

Schrader, W.L., K.S. Mayberry, D.W. Cudney. 1992. Paving the way to a better artichoke. California Agriculture 46 (4): 28-29.

Snedecor, C.W. and W.G. Cochran. 1980. Statistical methods. 6th ed. Iowa Univ. Press, Ames, Iowa, U.S.A.

Table 1. Influence of pre-sowing seed treatments on growth characters of artichoke crop in 2014- 2015 and 2015-2016 seasons, respectively [1]

Cultivars	Seed pre-treatments	No. of leaves/plant	Main shoot height (cm)	Shoot diameter at bottom (cm)	No. of branches/plant at the end of the season
2014-2015					
EL-Balady	Imbibed 24h/chilled 15 d	69.0 c	79.0 bc	4.9 c	4.0 e
	Imbibed 24h/chilled 10 d	66.3 bc	78.7 b	4.2 b	3.7 d
	Imbibed 24h	64.0 b	77.7 b	4.2 b	3.3 c
	untreated seed	63.7 b	76.3 b	3.9 ab	3.0 b
Chinese	Imbibed 24h/chilled 15 d	69.3 c	83.3c	4.2 b	4.0 e
	Imbibed 24h/chilled 10 d	66.7 bc	80.0 bc	3.7 a	3.3 c
	Imbibed 24h	57.7 a	58.3 a	3.5 a	3.0 b
	untreated seed	54.0 a	56.3 a	3.6 a	2.7 a
2015-2016					
EL-Balady	Imbibed 24h/chilled 15 d	69.3 bc	81.0 d	5.5 f	4.3 e
	Imbibed 24h/chilled 10 d	68.3bc	80.0 cd	4.5 e	4.0 d
	Imbibed 24h	65.0 b	78.0 bc	4.5 d	3.3 c
	untreated seed	65.0 b	76.7 b	4.3 cd	3.0 b
Chinese	Imbibed 24h/chilled 15 d	70.0 c	82.3 d	4.0 bc	4.0 d
	Imbibed 24h/chilled 10 d	68.0 b	81.7 d	3.9 ab	3.3 c
	Imbibed 24h	57.0 a	61.7 a	3.6 a	3.0 b
	untreated seed	54.0 a	60.3 a	3.8 ab	2.7 a

Source of variation	d.f	Mean Square			
Year	1	8.33	27.00	0.653	0.086
Rep (within year)	4	0.281	60.00	0.0014	0.073
Treat	7	193.522 **	557.035 **	1.711 **	1.714 **
Treat × year	7	1.239 ns	4.00 ns	0.049 ns	0.035 ns
Error	28	2.119	4.6905	0.047	0.190

[1]means within column followed by the same letter(s) are not significantly different at 0.05 level of probability.

Table 2. Influence of pre-sowing seed treatments on yield characters of artichoke crop in 2014- 2015 and 2015-2016 seasons, respectively [1]

Cultivars	Seed pre-treatments	No .of days to form Heads	No. of heads/plant	Early yield (ton/fed)	Total yield (ton/fed)
2014/ 2015					
EL-Balady	Imbibed 24h/chilled 15 d	81.66 a	13.0 e	2.145 d	9.046 g
	Imbibed 24h/chilled 10 d	92.66 b	13.0 e	2.106 c	8.891 f
	Imbibed 24h	105.00 cd	11.3 c	1.972 b	7.252 c
	untreated seed	106.33 d	10.0 b	1.927 a	6.137 a
Chinese	Imbibed 24h/chilled 15 d	84.00 a	12.0 d	2.296 g	8.695 e
	Imbibed 24h/chilled 10 d	91.66 b	11.6 c	2.273 f	8.284 d
	Imbibed 24h	103.00 c	11.0 c	2.209 e	7.197 c
	untreated seed	105.00 cd	9.3 a	2.126 d	6.575 b
2015/2016					
EL-Balady	Imbibed 24h/chilled 15 d	80.00 a	13.6 d	2.078 d	9.150 f
	Imbibed 24h/chilled 10 d	92.33 d	13.0 d	2.036 c	8.860 e
	Imbibed 24h	103.33 e	11.6 c	1.999 b	7.309 c
	untreated seed	104.33 ef	11.3 b	1.932 a	6.295 a
Chinese	Imbibed 24h/chilled 15 d	83.33 b	12.0 c	2.337 g	8.646 e
	Imbibed 24h/chilled 10 d	90.33 c	11.6 c	2.292 f	8.139 d
	Imbibed 24h	104.00 ef	10.6 b	2.088 d	7.116 b
	untreated seed	105.33 f	9.3 a	2.133 e	6.483 a
Source of variation	**d.f**	**Mean Square**			
Year	1	7.5216	0.75	4.281×10^{-3}	0.0768
Rep (within year)	4	3.791	0.0112	2.725×10^{-3}	0.0389
Treat	7	611.187 **	10.03 **	0.1068 **	1.695 **
Treat × year	7	1.711 ns	0.417 ns	3.55×10^{-3} ns	0.048 ns
Error	28	2.238	0.214	6.924×10^{-3}	0.114

(1) means within column followed by the same letter(s) are not signify
(2) cantly different at 0.05 level of probability.

Table 3. Influence of pre-sowing seed treatments on head characteristics of artichoke crop in 2014- 2015 and 2015-2016 seasons, respectively [(1)]

Cultivars	Seed pre-treatments	Head height (cm)	Head Diameter (cm)	Head weight (g)
2014-2015				
EL-Balady	Imbibed 24h/chilled 15 d	13.5 f	5.8 g	173.90 ef
	Imbibed 24h/chilled 10 d	13.3 e	5.6 f	171.00 e
	Imbibed 24h	12.9 d	5.5 e	156.10 b
	untreated seed	12.4 c	5.4 d	152.60 a
Chinese	Imbibed 24h/chilled 15 d	12.5 c	5.3 c	181.20 g
	Imbibed 24h/chilled 10 d	12.3 b	5.2 b	175.40 f
	Imbibed 24h	12.1 a	5.1 a	165.80 d
	untreated seed	12.1 a	5.1 a	159.70 c
2015-2016				
EL-Balady	Imbibed 24h/chilled 15 d	13.5 g	5.8 h	173.52 f
	Imbibed 24h/chilled 10 d	13.2 f	5.6 g	170.4 e
	Imbibed 24h	12.9 e	5.5 f	157.36 b
	untreated seed	12.5 d	5.4 e	152.86 a
Chinese	Imbibed 24h/chilled 15 d	12.4 c	5.3 d	181.50 g
	Imbibed 24h/chilled 10 d	12.2 b	5.2 c	176.53 f
	Imbibed 24h	12.0 a	5.0 b	168.63 d
	untreated seed	12.0 a	4.9 a	161.20 c

Source of variation	**d.f**	**Mean Square**		
Year	1	0.0199	9.041×10^{-4}	6.9339
Rep (within year)	4	3.787×10^{-3}	6.875×10^{-5}	2.1787
Treat	7	1.765 **	0.5046 **	596.008 **
Treat × year	7	7.857×10^{-3} ns	6.6128×10^{-4} ns	1.858 ns
Error	28	0.4056	1.992×10^{-3}	3.710

[(1)]means within column followed by the same letter(s) are not significantly different at 0.05 level of probability.

معاملات تبريد البذور قبل الزراعة تحسن المحصول والتبكير فى الخرشوف تحت ظروف اسيوط

شرين يعقوب عطاالله

قسم الخضر– كلية الزراعة – جامعة اسيوط – ٧١٥٢٦ اسيوط

الملخص

اجريت هذة الدراسة بمزرعة التجارب البحثية – كلية الزراعة – جامعة اسيوط وذلك خلال عامى ٢٠١٥/٢٠١٤ ، ٢٠١٦/٢٠١٥ واستخدم فيها صنفين من الخرشوف (البلدى، الصينى).

وتم دراسة تأثير ٤ معاملات لاعداد البذور قبل الزراعة، وكانت هذة المعاملات كالتالى: بذور شربت بالماء لمدة ٢٤ ساعة ثم عرضت للتبريد على درجة حرارة ٤–٥ م لمدة ١٠ او١٥ يوم ، وبذور شربت بالماء لمدة ٢٤ ساعة فقط (الكنترول الايجابى) ، وبذورغير معاملة (الكنترول سلبى).هذة المعاملات نظمت بحيث تكون جاهزة للزراعة سويا فى ذاك الوقت. وقد اشارت النتائج الى ان النباتات الناتجة من بذور تشربت الماء لمدة ٢٤ ساعة وبردت على درجة حرارة ٤–٥ م لمدة ١٥ يوم كانت الافضل ، فهى الاكثر فى عدد الاوراق ووزن النورة (الرأس) والاعلى فى المحصول ، وتراوحت الزيادة فى المحصول لهذة المعاملة ما بين حوالى ٢٢،٥–٤٠،٣ % مقارنة بالكنترول الايجابى والسلبى على التوالى. كما سجلت هذة المعاملة تبكيرا فى تكوين النورات بحوالى ٢١ – ٢٣ يوم مقارنة بالكنترول الايجابى والسلبى على التوالى، وتلى هذة المعاملة تلك التى شربت بذورها بالماء ٢٤ ساعة وبردت على درجة حرارة ٤–٥ م لمدة ١٠ ايام ، ثم معاملة البذور التى شربت بالماء ٢٤ ساعة فقط ثم معاملة البذور الجافة. ومع وجود مشكلة في انتاج الخرشوف في وقت مناسب وقصر موسم الانتاج بأسيوط ، فان هذه الدراسة تقدم معاملة تبريد البذور كطريقة سهلة ومتناغمة مع الحفاظ على البيئة لتطوير انتاج الخرشوف باستخدام البذرة وبما يحقق التبكير على وجه الخصوص مع اعطاء محصول اعلى.