Curd Yield of Cauliflower Derived from Chilled and Hydroprimed Seeds

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Abstract:

This study was carried out at the Experimental Farm of the Faculty of Agriculture, Assiut University, Assiut, Egypt, during 2012 and 2013. Two cultivar accessions of the local cauliflower "El-Soultani" were used. Six pre-sowing seed treatments were tested. These included: 1) seeds imbibed in tap water for 6 h and subjected to chilling at 4-5°C for 10 or 15 d, 2) seeds imbibed in tap water for 6 h, air dried and stored for 10 or 15 d, 3) seeds merely imbibed in tap water for 6 h and 4) untreated seeds. These seed treatments were scheduled so as to be simultaneously sown. The results revealed that the highest curd weight total yield were produced by plants derived from seeds imbibed in tap water for 6 h and subjected to chilling at 4-5°C for 15 d. The increase in total crud yield for this treatment ranged from 73.9 to 77.3% relative to control treatment (untreated). The visible curd initiation for this treatment was also earlier by 7 d, on average. It is concluded that considerable cauliflower crop enhancement can be achieved by this simple and environment friendly treatment at low added production cost. Second to this treatment was the seeds imbibed in tap water for 6 h and subjected to chilling at 4-5°C for 10 d. The seeds imbibed in tap water for 6 h, air dried and stored for 10 d came in the third order.

Keywords: *Brassica oleracea var botrytis*, crop improvement, environment friendly treatment, seed pretreatments.

Introduction:

Maximizing crop yield and quality are the ultimate goals of every plant production program. Seed preparation is an initial important practice that has an appreciable impact on vegetable production (Hassan, 1988). There are many seed pretreatments that have been widely utilized depending on the crop species and the purpose.

Concerning cauliflower, it has a chilling requirement to initiate curds (flower buds) (Booij and Struik, 1990) and the plants respond to the low temperature after ending a certain juvenile growth phase. The inductive temperature, the duration necessary for thermo-induction and the juvenile growth phase vary among cultivars (Fujime, 1988). Accordingly cultivars are classified into early, medium and late cultivars. El-Soultani local cv is considered to have a low chilling requirements and, therefore, is regarded as a summer cultivar type (Hassan, 1991). Crop improvement due to seed chilling pretreatment (Metwally, 2003, Mostafa, 2006 and Abdel-Rahman, 2011) and seed pretreated with water (hydropriming) or solution of inorganic or organic salts (osmopriming) before sowing (Strogonov, 1964, Rehman *et al*, 1998, Babaeva *et al*, 1999, Change–Zheng *et al*, 2002) have been reported. However, we are unaware of previous study of these pretreatments as affecting curd initiation and yield of cauliflower.

During priming, some pre-germination physiological and biochemical incidences occur for a duration that is insufficient for germination to overpass a certain critical limit (Bradford, 1986). The proper end of the hydration treatment is before losing of the desiccation tolerance. The primed seeds can then be dried and sown when ready. There are four common methods utilized for priming seeds. These are hydropriming, osmopriming, solid-matrix priming, and drum priming. Primed seeds usually germinate more rapidly than unprimed seeds. Over the last two decades, the seed priming approach has been extensively used to enhance the rate and uniformity of field germination and emergence in many important crops plants grown under both stress and non stress conditions. Seed priming as technique is adopted to improve the rate and synchrony of seed germination. The disadvantage of seed priming is the difficulty to store the seeds in some cases, as they may need cool storage temperatures. However, in most cases, seed can be primed overnight, surface-dried, and sown the next day. The primary objective of this study was to access the effects of pre-sowing seed chilling and hydropriming on crud initiation and yield of cauliflower.

Materials and Methods:

This study was carried out at the Experimental Farm of the Faculty of Agriculture, Assiut University, Assiut, Egypt, during 2012 and 2013. Two cultivar accessions of the local cauliflower "El-Soultani" were obtained from seed retailers. Six pre-sowing seed treatments were tested. These included: 1) seeds imbibed in tap water for 6 h and subjected to chilling at 4-5^{o}C for 10 or 15 d, 2) seeds imbibed in tap water for 6 h, subjected to slow progressive air drying and stored at room temperature for 10 or 15 d, 3) seeds merely imbibed in tap water for 6 h (positive control) and 4) untreated seeds (negative control). Seeds were kept wet during the entire time of subjection to chilling. These seed treatments were scheduled so as to be simultaneously sown. Seeds used in the whole course of this study were from the same seed lot.

Seeds of both cultivars were sown separately in 209 whole trays filled with peat moss. Two seeds were sown in each hole of the trays, then thoroughly irrigated and subsequently watered whenever needed. After 45 d, one seedling was transplanted per hill in row spaced 50 cm apart on August, 13 in 2012 and on August, 21 in 2013. Transplanting was on northern side of 70 m wide and 3 m long ridges. Land preparation and all cultural practice were done as recommended for production of cauliflower (Hassan, 1991). The experiment was factorial (2 X 6) in randomized complete-blocks with four replicates. Each plot was 10.5 m^2.

The following parameters were obtained: 1) number of days to form visible curd, 2) number of leaves per plant at the time of showing visible curd, 3) total yield (ton/feddan), 4) average weight of curd (kg) and 5) curd diameter (cm). Data of this study were subjected to analysis of variance according to Gomez and Gomez (1984). Means were compared using Duncan's Multiple Range Test (DMRT) at 0.05 probability level

Results and Discussion:

Significant differences due to seed pretreatments were detected (Tables 1, 2 and 3) for all the studied traits and showed appreciable interaction with cultivars. In addition, the factorial treatments of cultivars and seed pretreatments exhibited a significant interaction with years. Accordingly, data for the effect of seed pretreatments were presented in the current study for each of the two cvs and years, separately. As shown in Table (1 A and B), the least number of days to visible curd but the larger number of leaves per plant developing visible curd were consistently shown by the plants derived from seeds imbibed for 6 h and subjected to chilling at 4-5^{o}C and for 15 d. In this regard, the pretreatment of seeds chilling for 10 d was mostly the second in both traits. The plants derived from seeds imbibed for 6 h, air dried and stored for 10 d followed those plants of the two chilling pretreatments. Otherwise, inconsistent results were exhibited in the two year of the study by the other treatments. .

Apparently, total curds yield was the highest for those plants that were raised from seeds imbibed for 6 h and subjected to chilling at 4-5^{o}C for 15 d (Table 2A). This seed chilling pretreatment gave plants producing also the curds of the greatest weight (Table 2B). Plants derived from seeds imbibed for 6 h and subjected to chilling at 4-5^{o}C for 10 d had the second highest total curds yield and the second greatest curd weight. An opposite results was shown for curd diameter (Table 3) where plants from seeds imbibed for 6 h and subjected to chilling at 4-5^{o}C for 10 d had curds of larger diameter than those plants raised from seeds subjected to chilling for 15 d. This sustains our observation for a more compact curds produced a result of seeds subjection to chilling at 4-5^{o}C for 15 d. Among the other seed pretreatments, the most consistent results for higher cured total yield and both weight and diameter of the curds were for the seeds imbibed for 6 h, air dried and stored for 10 d. This pretreatment was shown to come next after the two seed chilling ones but with a noticeable reduction (ranged from 27.6 % to 46.5%) for total curd yield relative to seed chilling for 15 d. The remaining three seed pretreatments demonstrated a slight differences and inconsistent results in the different years concerning their effect on the total curd yield and both the curd weight and diameter. In the entire course of this study, the two cv accessions seemed to similarly respond to the studied pretreatments but inconsistent in the two years, except for earliness.

As shown here, seeds imbibed for 6 h, air dried and stored for 10 d were superior to those seeds stored for 15 d. Thus one disadvantage of priming that may be confronted is the seed deterioration during a prolonged storage unless kept in cool temperatures. There is a limit for each plant species as to when the line between priming and pre-germination is crossed. Proper treatment for pre-sowing seed hydration allows some of the early germination processes to take place and should be stopped before the embryo desiccation tolerance is lost.

The effects of chilling treatment on gibberellins activity and the spreads of curd initiation in cauliflower were investigated by Wurr*, et al*. (1981). It was shown that exposure to low temperature may increase gibberellins activity in the plant apices and the spread of curd initiation when applied at a stage receptive to low-temperature treatment. The receptive phase of growth is a cultivar-dependent. As shown by Fernández, *et al*. (1997), the applications of gibberellins advances curd initiation only under sub-optimal conditions of vernalization. Analysis of protein electrophoresis revealed a specific band appeared only in seed chilling treatment in studied pumpkin cvs suggesting that a specific polypeptide may be involved in the mechanism(s) of seed chilling response (Abdel-Rahman, 2011). Besides their effect on mitotic division, gibberellins signal starch hydrolysis providing simple sugar forms for seed embryo through inducing synthesis of enzyme α-amylase. Pre-sowing seed chilling treatment, therefore, may enhance germination and plant growth. Additionally, exposure of seeds to low temperature may induce antioxidants generating resistance to unfavorable stress conditions (Abdel-Rahman, 2011). This can lead to greater efficiency of chloroplasts to manufacture photosynthetic assimilates resulting in enhancing plant growth and crop yield. The superiority of chilling the wet seeds over seeds that were merely imbibed, air dried and stored is reasonable since the former treatment collectively had the advantage of the hydration in hydropriming and the favorable stimulation of the factors induced by subjection to low temperature.

This study proposes use of seeds imbibed for 6 h and subjected wet to chilling at 4-5^{o}C for 15 d in production of cauliflower to produce early and high curd yield. The treatment is technically simple, environment-friendly and can be achieved at no appreciable additional production cost. Pre-sowing seed chilling treatments may increase curd yield by up to 75.6%, average of the years, relative to the traditionally utilization of untreated seeds.

Table (1): Number of days to develop visible curd (A) and number of leaves per plant at the time of developing visible curds (B) for two accessions of cauliflower cv. El-Soultani grown during 2012 and 2013 when derived from seeds received different pre-sowing treatments [(a)].

Seed Pretreatments (A) \ Cultivars (B)	(cv1)	(cv2)	Mean
(A) Number of days to visible curd [(b)]			
2012			
Untreated	78.0 a	74.5 a	76.3
Imbibed for 6 h	74.0 b	70.0 b	72.0
Imbibed for 6 h+ chilled at 4-5°C for 10 d	69.3 c	65.0 c	67.1
Imbibed for 6 h+ chilled at 4-5°C for 15 d	68.5 d	63.0 d	65.8
imbibed for 6 h + air dried and stored for 10 d	77.8 a	74.0 a	75.9
imbibed for 6 h + air dried and stored for 15 d	77.3 a	74.3 a	75.8
Mean	74.1	70.1	72.1
$LSD_{0.05}$	**A: 0.2 B: 0.7 AB: 1.0 [(c)]**		
2013			
Untreated	76.0 a	72.8 a	74.4
Imbibed for 6 h	74.0 b	68.0 b	71.0
Imbibed for 6 h+ chilled at 4-5°C for 10 d	68.8 c	62.3 c	65.5
Imbibed for 6 h+ chilled at 4-5°C for 15 d	68.0 c	60.3 d	64.1
imbibed for 6 h + air dried and stored for 10 d	76.8 a	72.3 a	74.5
imbibed for 6 h + air dried and stored for 15 d	76.0 a	72.0 a	74.0
Mean	73.3	67.9	70.6
$LSD_{0.05}$	**A: 0.4 B: 0.9 AB: 1.3[(c)]**		
(B) Number of leaves per plant at the time of developing visible curds [(b)]			
2012			
Untreated	16.3 d	15.5 e	15.9
Imbibed for 6 h	17.5 c	17.3 d	17.4
Imbibed for 6 h+ chilled at 4-5°C for 10 d	25.5 b	24.8 b	25.1
Imbibed for 6 h+ chilled at 4-5°C for 15 d	27.5 a	27.5 a	27.5
imbibed for 6 h + air dried and stored for 10 d	17.8 c	20.5 c	19.1
imbibed for 6 h + air dried and stored for 15 d	17.0 c	17.5 d	17.3
Mean	20.3	20.5	20.4
$LSD_{0.05}$	**A: .2 B: .8 AB: 1.1[(c)]**		
2013			
Untreated	15.3 d	16.5 e	15.9
Imbibed for 6 h	17.3 c	17.3 d	17.3
Imbibed for 6 h+ chilled at 4-5°C for 10 d	25.5 b	24.5 b	25.0
Imbibed for 6 h+ chilled at 4-5°C for 15 d	27.8 a	27.5 a	27.6
imbibed for 6 h + air dried and stored for 10 d	17.8c	20.8 c	19.3
imbibed for 6 h + air dried and stored for 15 d	17.8 c	16.8 e	17.3
Mean	20.2	20.5	20.4
$LSD_{0.05}$	**A: .3 B: .8 AB: 1.2[(c)]**		

[(a)] variance of cultivar x seed treatments x year interaction was significant.

[(b)] means within column followed by the same letter(s) are not significantly different at 0.05 probability level using Duncan' Multiple Range Test (DMRT).

[(c)] to compare of cultivars received same seed treatment.

Table (2): Total crud yield (A) and average crud weight (B) for two accessions of cauliflower cv. El-Soultani grown during 2012 and 2013 when derived from seeds received different pre-sowing treatments [(a)].

Seed Pretreatments (A) / Cultivars (B)	(El-Soultani 1)	(El-Soultani 2)	Mean
(A) Total Crud Yield (ton/feddan) [(b)]			
2012			
Untreated	9.150 d	9.585 e	9.368
Imbibed for 6 h	9.579 d	10.683 d	10.131
Imbibed for 6 h+ chilled at 4-5°C for 10 d	13.197 b	15.474 b	14.336
Imbibed for 6 h+ chilled at 4-5°C for 15 d	16.215 a	17.148 a	16.682
imbibed for 6 h + air dried and stored for 10 d	11.244 c	14.193 c	12.719
imbibed for 6 h + air dried and stored for 15 d	9.516 d	11.235 d	10.376
Mean	11.484	13.053	12.268
$LSD_{0.05}$	**A: .133, B: 726, AB: .027 [(c)]**		
2013			
Untreated	9.495 d	9.615 d	9.555
Imbibed for 6 h	9.837 d	10.656 c	10.247
Imbibed for 6 h+ chilled at 4-5°C for 10 d	13.125 b	13.650 b	13.388
Imbibed for 6 h+ chilled at 4-5°C for 15 d	16.518 a	17.085 a	16.802
imbibed for 6 h + air dried and stored for 10 d	11.283 c	13.350 b	12.317
imbibed for 6 h + air dried and stored for 15 d	9.195 e	11.049 c	10.122
Mean	11.576	12.568	12.072
$LSD_{0.05}$	**A: .188 B: 532 AB: .752 [(c)]**		
(B) Average Crud Weight (kg) [(b)]			
2012			
Untreated	0.763 d	0.799 e	0.781
Imbibed for 6 h	0.798 d	0.890 d	0.844
Imbibed for 6 h+ chilled at 4-5°C for 10 d	1.100 b	1.290 b	1.195
Imbibed for 6 h+ chilled at 4-5°C for 15 d	1.351 a	1.429 a	1.390
imbibed for 6 h + air dried and stored for 10 d	0.937 c	1.183 c	1.060
imbibed for 6 h + air dried and stored for 15 d	0.793 d	0.936 d	0.865
Mean	0.957	1.088	1.022
$LSD_{0.05}$	**A: .011 B: .061 AB: .086 [(c)]**		
2013			
Untreated	0.791 d	0.801 d	0.796
Imbibed for 6 h	0.820 d	0.888 c	0.854
Imbibed for 6 h+ chilled at 4-5°C for 10 d	1.094 b	1.138 b	1.116
Imbibed for 6 h+ chilled at 4-5°C for 15 d	1.377 a	1.424 a	1.400
imbibed for 6 h + air dried and stored for 10 d	0.940 c	1.113 b	1.026
imbibed for 6 h + air dried and stored for 15 d	0.766 d	0.921 c	0.844
Mean	0.965	1.047	1.006
$LSD_{0.05}$	**A: .016 B: .044 AB: .063 [(c)]**		

[(a)] variance of cultivar x seed treatments x year interaction was significant.

[(b)] Means within column followed by the same letter(s) are not significantly different at 0.05 probability level using Duncan' Multiple Range Test (DMRT).

[(c)] to compare of cultivars received same seed treatment.

Table (3): Curd diameter for two accessions of cauliflower cv. El-Soultani grown during 2012 and 2013 when derived from seeds received different pre-sowing treatments [(a)].

Seed Treatments (A) / Cultivars (B)	(cv1)	(cv2)	Mean
Curd diameter (cm) [(b)]			
2012			
Untreated	21.0 e	24.4 e	22.7
Imbibed for 6 h	28.1 d	27.9 d	28.0
Imbibed for 6 h+ chilled at 4-5^{o}C for 10 d	37.0 a	38.1 a	37.6
Imbibed for 6 h+ chilled at 4-5^{o}C for 15 d	31.0 b	35.0 b	33.0
imbibed for 6 h + air dried and stored for 10 d	29.4 c	30.1 c	29.7
imbibed for 6 h + air dried and stored for 15 d	27.5 d	27.4 d	27.4
Mean	29.0	30.5	29.7
$LSD_{0.05}$ [(b)]	**A: 0.5 B: 1.2 AB: 1.7 [(c)]**		
2013			
Untreated	19.3 f	21.5 f	20.4
Imbibed for 6 h	22.9 e	25.9 e	24.4
Imbibed for 6 h+ chilled at 4-5^{o}C for 10 d	37.4 a	38.0 a	37.7
Imbibed for 6 h+ chilled at 4-5^{o}C for 15 d	34.1 b	35.2 b	34.7
imbibed for 6 h + air dried and stored for 10 d	28.4 c	30.6 c	29.5
imbibed for 6 h + air dried and stored for 15 d	25.9 d	28.0 d	27.0
Mean	28.0	29.9	29.0
$LSD_{0.05}$	**A: 0.8 B: 0.7 AB: 1.0 [(c)]**		

(a) variance of cultivar x seed treatments x year interaction was significant.
(b) Means within column followed by the same letter(s) are not significantly different at 0.05 probability level using Duncan' Multiple Range Test (DMRT).
(c) to compare of cultivars received same seed treatment.

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محصول اقراص القنبيط الناتج من البذور المرطبة والمبرده قبل الزراعه

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الملخص:

أجريت هذه الدراسة في المزرعة البحثية لكلية الزراعة، جامعة أسيوط، خلال عامي ٢٠١٢ و٢٠١٣، وأستخدم فيها سلالتين قنبيط من الصنف السلطاني. ودرس تأثير ٦ معاملات لإعداد البذور قبل الزراعة، وكانت هذه المعاملات كالتالي: ١- بذور شربت بالماء لمدة ٦ ساعات ثم عرضت للتبريد علي درجة حرارة ٤-٥ درجة مئوية لمدة ١٠ أو ١٥ يوم. ٢- بذور شربت بالماء لمدة ٦ ساعات ثم جففت تجفيف هوائي بطيء متدرج وخزنت لمدة ١٠ أو ١٥ يوم. ٣- بذور شربت بالماء فقط لمدة ٦ ساعات. ٤- بذور غير معاملة. هذه المعاملات قد نظمت بحيث تكون جاهزة للزراعة سوياً في ذات الوقت. وقد أشارت النتائج إلي أن أعلي محصول أقراص كان من النباتات الناتجة من البذور التي تشربت الماء لمدة ٦ ساعات وبردت علي درجة حرارة ٤-٥ درجة مئوية لمدة ١٥ يوم. وتراوحت الزيادة في المحصول هذه المعاملة ما بين ٧٣,٩ – ٧٧,٣% مقارنة بالبذور الغير معاملة. كما سجلت هذه المعاملة تبكيراً في تكوين الأقراصً بحوالي ٧ أيام. وقد أستنتج من هذه الدراسة أن القنبيط يمكن تحقيق زيادة محصولية ملحوظة به بهذه المعاملة البسيطة، صديقة البيئة، والتي لا تضيف تكلفة تذكر في الإنتاج، وقد تلي هذه المعاملة في التفوق معاملة تشرب البذور بالماء لمدة ٦ ساعات وتعريضها للتبريد لمدة ١٠ أيام. في المرتبة التالية معاملة تشرب البذور لمدة ٦ ساعات وتجفيفها تدريجياً وتخزينها لمدة ١٠ أيام.