A COMPARATIVE STUDY BETWEEN GARLIC EXTRACT AND HYDROGEN CYANAMIDE ON FLOWERING, FRUIT SET AND PRODUCTIVITY OF GRAPES

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This experiment was carried out during 2016 and 2017 seasons on Flame Seedless grapevines grown at El-Khatatba district, in Menofia Governorate, Egypt. Climate is one of the important factors that control grape production, in warm-winter regions, where the need of intervention of chemical means to break bud rest becomes a dominant factor for maintaining economic production of table grapes. However, the problem is more acute when farmers want to grow on organic table grapes in the absence of environmentally friendly natural bud break promoters. This study aimed to evaluate the effect of a garlic extract in comparison to the conventional use of hydrogen cyanamide in promoting bud break and their effects on cluster quality of Flame Seedless grapevines, aiming to invade the markets earlier to maximize the benefits for the producers and to avoid the negative effects of high summer temperature on the vine clusters quality if harvested late. Moreover, this study is a trail to examine to how extent garlic extract (which contains GA_3 like substance) can substitute the declination of chilling hours. Five treatments of foliar application [tap water (control); hydrogen cyanamide (H_2CN_2) 3 and 5%, garlic extract (GE) 3 and 5%] were applied to the vines on three times [the first (D_1), mid (D_2) and the end (D_3) of December]. The obtained results revealed that all treatments were very effective in stimulating vegetative growth, bud burst %, yield, physical and chemical characteristics of the fruits. Generally, D_2 was better than the other two times of spraying in all parameters. Vines that had been sprayed with 5% GE on D_2 were the best for early harvest time as compared with the two other times. In addition, this treatment increased bud burst, leaves number per new shoot, leaf area and chlorophyll content, cluster weight, yield, the average weight and volume of 100 berries, cluster number, cluster length, cluster width, berry length and diameter, total soluble solid, total sugar, while decreased total acidity. In addition,

vines that had been sprayed with 5% GE on D_2 gave early blooming (decreasing the time from spraying to blooming).

Keywords: grapevine, garlic extract, hydrogen cyanamide, dormancy

Grapes (*Vitis vinefera*, L.) is considered as one of the most important deciduous fruit crops in the world. In Egypt, grapes rank the second fruit crop after citrus and have a special economic value for local consumption and export, because of its nice taste, high nutritional value and excellent flavor. Seedless grapes are attracting a great interest for their better eating quality and their high economic return.

Climate is one of the factors that control grape production (Fraga et al, 2014). It is affecting the suitability of certain grape varieties to a particular region (Fraga et al., 2015 and Gladstones, 2016). Analyses of historic climatic changes indicate that the land surface temperature increased by about 1.06◦C over a period of more than 100 years (IPCC, 2014 a and b). To overcome the dormancy and start a new cycle of vegetation, without delay and within uniformity to the shoots, they need to be exposed to a cold period, variable according to each cultivar (Ben Mohamed et al., 2010). Hawerroth et al. (2013) claim that the dormancy is one of the main factors that influence the production of temperate fruit trees in tropical regions. Therefore, the use of chemicals to overcome dormancy is a key factor of higher production in these regions (Botelho and Müller, 2007 a and b). In vines, which are one of the main temperate climate fruit trees in the world, the necessary period of cold climate to the uniformity of budding and overcome dormancy can range from 50 to 400 hours, at the temperature of 7ºC (Vasconcelos et al., 2007).

Grapevines are suffering from inadequate winter chilling exhibit that delaying and erratic bud break and decrease shoot and cluster counts per vine, in addition to poor uniformity of fruit development (Lavee et al., 1984 and Wicks et al., 1984). Fruit yield and quality are reduced as a result of warm autumns and winters, that causing insufficient chilling for normal bud break (Wicks et al., 1984). To overcome this problem, many investigations have been conducted to interrupt dormancy in grapevines artificially with synthetic chemicals (Lin and Wang, 1985; Nir et al., 1988; Zelleke and Kliewer, 1989 and Dookoozlian and Wiliams, 1995). The use of natural products in horticultural practices is becoming as the main target for many fruit crop producers, where the world market has been growing rapidly in recent years for organic fruit production (Dimitri and Oberholtzer, 2006). Moreover, many investigators used natural extracts to substitute some of chilling requirements aiming to accelerate bud breaking (El-Desouky et al., 1998 and Wanas et al., 1998).

Hydrogen cyanamide (H_2CN_2) (Dormex, BASF) is the most effective synthetic brands used for bud breaking in grapevine orchards (Zelleke and Kliewer, 1989). It is leads to early bud breaking and vigorous vegetative growth. Despite these attributes, H_2CN_2 is not accepted by organic protocols for grape production, because H_2CN_2 is a product considered as toxic, negatively impacting the health of the producer and the environment. Thus, it is necessary to find an environmentally friendly and suitable for organic table grape production as safer bud break promoters (Arispuro et al., 2008).

Garlic (*Allium sativum* L.) is native to central Asia, the Mediterranean region as well as Asia, Africa and Europe. It was known to ancient Egyptians, and has been used for both culinary and medicinal purposes since their time (Harris et al., 2001). Jullyanna et al. (2016) stated that natural garlic extract has a principal action in dormancy breaking of grapevine. Thus, this natural product may be a potential substitute for synthetic growth regulators. Garlic extract contains enzymes, B vitamins, proteins, minerals, saponins, flavonoids, sulphur and allyl group (H_2CHCH_2), mainly diallyl disulfide. Furthermore, a phytoalexin (allixin) has been found (Pandya et al., 2011). Kubota et al. (1999) stated that the active substances in garlic cloves is about 1-3% of sulfur compounds are responsible for breaking bud dormancy in grapevine and their effects varied among the concentration and the duration of exposure**.** In addition, El-Desouky et al. (1998) and Wanas et al. (1998) found that the natural extract of garlic cloves, which contains many growth materials and essential requirements for vegetative and reproductive growth and rich in phytohormones and vitamins, improved growth, sex expression, yield and quality of squash plant. Moreover, Botelho and Müller (2007 a and b), who evaluated using garlic extract (GE) on apple trees and table grapes, Abd El-Razek et al. (2011) on Canino' apricot trees grown under warm winter conditions found that those fruit trees greatly responded to spraying garlic extract by improving productivity and fruit quality. In addition, Chowdhury et al. (2007) found that extracts from garlic improved number of fruits, TSS and yield of mango trees. In addition, Abd El-Razek et al. (2013) found that spraying GE combined with GA_3 at 100 ppm is recommended to improve productivity and fruit quality of 'Le Conte' pear trees grown under warm winter conditions in Egypt. Mostafa and El-Yazal (2013) reported that GE enhanced date of floral bud break and increased percentage of bud break, fruit set, total number of fruits and fruit yield per tree of "Anna" apple trees. Oliveira et al. (2009) observed that GE initiated the break dormancy of the pear buds, they adding that treatment with 5% GE presented similar results to those obtained with 0.52% H_2CN_2. Leonel et al. (2015) reported that fig tree cultivars that sprayed with GE at 3% gave the highest production as compared with 2% H_2CN_2. Similar results were reported in previous studies, which stated that extracts prepared from fresh garlic improved productivity and fruit

quality when applied to grapevine, apple and peach (Serag El-Deen, 2002; Botelho et al., 2007 and Ahmed et al., 2009). Kim and Kim (1999) studied the effect of GE on bud break and flowering of "Daebong" grapes. They observed that all treatments hastened bud break and was very effective on hastening flowering than untreated grapevines. Kim and Kim (2000) mentioned that treating Campbell Early grapevine buds with GE and its ethanol and ethyl ether extracts was effective in increasing percentage of bud break. Shaddad (2010) recorded that application of GE (15%) and onion extract at 5% significantly enhanced percentage of bud burst and fruiting bud percentage of "Superior" grapevines. Botelho et al. (2010) reported that the GE showed a great potential for bud break in organic production, by improving the sprouting percentage, number of clusters, accelerating the beginning of sprouting and reducing the cycle between pruning and harvest in grape.

The objective of this study was to evaluate the effect of a natural GE in comparison to the conventional use of H_2CN_2 in promoting bud break and their effects on cluster quality of Flame Seedless grapevines, under the studying zone conditions. Aiming to substitute the organic treatments instead of chemical treatments, in addition to invade the markets earlier to maximize the benefits for the producers. Moreover, this study is a trail to examine how to extent GE (which contains GA_3 and GA_3 like substance) to improve early bud breaking and avoid the negative effects of high summer temperature on the vine clusters quality if harvested late.

MATERIALS AND METHODS

This study was conducted during the two successive seasons; 2016 and 2017 in private vineyards at El Khatatba, El Menofia Governorate, Egypt. The experiment included 135 vines arranged in factorial design. Five treatments of foliar application [tap water (control); H_2CN_2 (3 and 5%), GE (3 and 5%) were applied to the vines on three times [the first (D_1), mid (D_2) and the end (D_3) of December]. Each treatment was represented by three replicates (3 vines/replicate). The selected vines were 7-years old, planted in sandy soil (Table 1) at 1.5x3 meters under drip irrigation system (Table 2). The vines trained according to the double cordon system. Pruning was carried out at the end week of November by leaving 45-55 buds per vine (20 fruiting spurs of 2-3 buds/spur). It is noticeable that most of grape producers at El Khatatba area spray H_2CN_2 as a bud rest barker agent on first of January to harvest their fruits generally on first-mind of July.

Table (1). Some physical and chemical properties of the soil experimental orchard.

Particle size distribution (%)			Soil texture	EC (ds/m)	pH	Soluble cation (meq/L)				Soluble Anions (meq/L)			
Sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{++}	K^{+}	CO^{--}_3	HCO^{-}_3	Cl^{-}	SO^{--}_4
91.72	6.15	2.13	Sandy	1.99	7.87	6.65	3.40	9.18	0.57	--	3.85	8.30	7.85

Table (2). Irrigation water analysis.

Characters	pH	EC (ds/m)	Soluble cation (meq/L)				Soluble Anions (meq/L)			
			Ca^{++}	Mg^{++}	Na^{++}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{-}
Value	7.46	1.33	3.00	3.70	6.30	0.32	0.50	2.42	6.40	4.00

The 3 and 5% garlic aqueous extract were prepared by blending 30 and 50 g of fresh mature cloves, respectively, in one liter of distilled water, frozen and thawed two times, and then filtered and diluted by distilled water to one liter (El-Desouky et al., 1998). Some chemical constituents of garlic cloves are shown in table (3).

Table (3). Some chemical constituents of garlic cloves according to Arid Land Agricultural Research Unit.

Components	Concentration
GA_3	1.633 mg/l00 g F.W.
IAA	Trace amount
ABA	Trace amount
Ca	1.363%
Mg	1.230%
$S0_4$	0.181%
Mn	94.4 ppm
Zn	66.5 ppm

The following parameters were measured:

Buds burst (%): the percentage of bud burst was calculated according to Bessies (1990).

Time length for blooming: period in days beginning from spraying date to full bloom date.

Number of leaves per shoot: leaves developed on the new shoots were counted at Veraison stage.

Leaf Area (cm^2): was determined by using the leaf area meter CL203.
Total chlorophyll content: was measured in fresh leaves in the third leaf from the base at the end of July in field using Minolta meter SPAD-502.
Harvesting date: harvesting of each treatment begins on the date when the clusters reached the fully ripe stage (commercial maturity TSS ≥ 16o brix). Dates of harvesting were the indicator for measuring the impact of different interactions between date of spray and treatments on detecting the superiority of such treatment in invading market earlier than others, to maximize the economic gain either of the vine orchard or for the producer.
Number of cluster: was recorded/vine.
Cluster weight (g): was determined using 10 clusters per replicate and weighed.
Total yield (kg/vine): The average weight of cluster at harvest date (commercial maturity TSS ≥ 16o brix) and the yield /vine was expressed as follows: vine yield (kg) =average weight of cluster (g) x number of cluster per vine.
Cluster length and width (cm): at harvesting, two clusters were taken at random from each vine to determine cluster length and width.
Berry dimensions (cm): berry length and diameter were measured (cm) in 10 berries by using vernal clipper; the average length and diameter of berries were calculated.
Weight and volume 100 berries: weight of 100 berries was determined using digital balance; the volume (cm^3) of the same berries was determined by the water displacement method.
Soluble solids content (TSS %): was determined as percentage in juice by means of hand refractometer apparatus according to A.O.A.C. (1985).
Sugar contents in berries Juice (%): the total sugars were determined according to A.O.A.C. (1985).
Titratable acidity (%): berries juice titratable acidity was determined according to A.O.A.C. (1990)
Statistical analysis: the obtained data were subjected to analysis of variance according to **Clarke and Kempson (1997).** Means were differentiated using Range test at the 0.05 level (Duncan, 1955).

RESULTS AND DISCUSSION

1. Bud Burst % and Time Length for Blooming

Data in table (4) clear that bud burst and time length for blooming were affected significantly by the three dates of spraying in both seasons.

Table (4). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on bud burst % and time length for blooming in Flame Seedless grapevine at 2016 and 2017.

Parameters / Treatments	Bud burst (%)		Time length for blooming (No. of days from spraying)	
	Season 2016	Season 2017	Season 2016	Season 2017
Effect of spraying dates				
D_1	74.07c	74.96c	108.48a	113.93a
D_2	80.47a	81.22a	71.70c	77.44c
D_3	76.86b	77.94b	82.19b	88.39b
Effect of spraying hydrogen cyanamide (H_2CN_2) and garlic extract (GE)				
Control	72.73e	73.34d	112.53a	119.38a
H_2CN_2 (3%)	76.78d	77.80c	83.05b	89.87b
H_2CN_2 (5%)	77.82c	78.74b	81.37c	86.71c
GE (3%)	78.42b	79.37b	80.99c	86.40c
GE (5%)	79.93a	80.79a	79.35d	84.90d

The interaction between spraying dates (D) and hydrogen cyanamide (H_2CN_2) and garlic extract (GE)

Date	Treatments	Bud burst (%)		Time length for blooming (No. of days from spraying)	
		Season 2016	Season 2017	Season 2016	Season 2017
D_1	**Control**	73.00i	73.16j	112.67a	119.24a
	H_2CN_2 (3%)	73.53hi	74.83ghi	109.81b	115.64b
	H_2CN_2 (5%)	74.24gh	75.16gh	108.12c	112.21c
	GE (3%)	74.12fg	75.50fg	107.47c	112.33c
	GE (5%)	75.47ef	76.17ef	104.33d	110.25d
D_2	**Control**	72.76i	73.50ij	112.35a	119.43a
	H_2CN_2 (3%)	80.65c	81.14c	63.58 h	70.57h
	H_2CN_2 (5%)	81.58b	82.53b	61.01i	66.75i
	GE (3%)	82.91b	83.16b	61.25ij	66.33i
	GE (5%)	84.47a	85.28a	60.34j	64.13j
D_3	**Control**	72.43i	73.36hij	112.57a	119.47a
	H_2CN_2 (3%)	76.17e	77.45e	75.77e	83.41e
	H_2CN_2 (5%)	77.64d	78.53d	75.00ef	81.18f
	GE (3%)	78.23d	79.46d	74.27f	80.56f
	GE (5%)	79.86c	80.92c	73.38g	77.34g

Means having the same letter(s) in each column of first factor, second factor or interaction are not significantly different at 5% level. $D_{1=}$ the first of December, $D_{2=}$ mid of December and $D_{3=}$ the end of December. *While, cont.= sprayed with tap water, H_2CN_2 (3%) hydrogen cyanamide (3%), H_2CN_2 (5%)= hydrogen cyanamide (5%), GE (3%)= garlic extract (3%) and GE (5%)= garlic extract (5%).

Whoever, D_1 produced the longest time length for blooming in both seasons. In addition, D_2 gave the shortest time length for blooming in both seasons. Whoever D_1 produced the lowest bud burst percentage in both seasons. Furthermore, D_2 gave the highest bud burst percentage in both seasons. In addition, bud burst and time length for blooming were significantly affected by all treatments in both seasons. However, spraying 5% GE gave the highest bud burst (79.93% in the 1st and 80.79% in the 2nd season) and the lowest time length for blooming (79.35 date and 84.90 date in the first and second seasons, respectively).

The obtained data from the interaction between spraying dates (D), H_2CN_2 and GE cleared that, 5% GE with D_2 recorded the highest bud burst percentage and the lowest time length for blooming in both seasons. While the three control spraying dates recorded the lowest bud burst percentage and the longest time length for blooming in both seasons.

These results mean that grapevine reached full bloom in response to 5% GE earlier than control. This proves that full bloom of grapevine was advanced with increasing GE on D_2. The earliness of flowering of vines sprayed with GE at a high concentration may be explained due to the advance of bud break and consequently advance of full bloom, coinciding with that observation by Hosoki et al. (1984), who found that fresh garlic paste resulted in early flowering of peony tree (*Paeonia suffruticosa*), when applied to dormant buds. Garlic extract has presence of active substances [i.e. sulphur and allyl group (H_2CHCH_2), mainly diallyl disulfide, which is the most abundant sulphate in garlic] (Kubota and Miyamuki, 1992). In addition, Pinto et al. (2007) stated that GE breaking of dormancy in temperate fruits, i.e. through oxidative stress; through accumulating H_2O_2 and thus with the possibility for promising results in flowering plants.

These results also agree those of Serag El- Deen (2002) and Botelho et al. (2007) on grapevine, Botelho and Müller (2007) on apple, Kim and Kim (1999 and 2000) on grapevines, Mostafa and El-Yazal (2013) on apple, Botelho and Müller (2007 a and b) on apple, Jullyanna et al. (2016) on grapevines and Arispuro et al. (2008) on grapes cv. They clearly showed that GEs hastened bud break and very effective in hastening flowering and enhanced date of floral bud break and increased percentage of bud break.

2. Leaves Number, Leaf Area and Chlorophyll Content

Data presented in table (5) show that leaves number, leaf area and chlorophyll content were affected significantly by the three dates of spraying in both seasons. However, D_2 produced the highest leaves number**,** leaf area and chlorophyll content in both seasons. In addition, D_1 was the lowest in leaves number**,** leaf area and total chlorophyll content in both seasons.

Table (5). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on leaves number, leaf area and total chlorophyll content in Flame Seedless grapevine at 2016 and 2017.

Parameters / Treatments	Number of leaves per new shoot		Leaf area (cm^2)		Total chlorophyll content (SPAD)	
	Season 2016	Season 2017	Season 2016	Season 2017	Season 2016	Season 2017
Effect of date spraying (D)						
D_1	35.89c	36.24c	123.89c	125.02c	33.58c	34.65c
D_2	41.46a	42.49a	128.07a	129.01a	37.46a	38.81a
D_3	37.97b	38.43b	126.01b	126.67b	35.06b	36.63b
Effect of spraying hydrogen cyanamide (H_2CN_2) and garlic extract (GE)						
Control	32.74e	33.39e	122.04d	122.72d	32.55d	33.59d
H_2CN_2 (3%)	38.31d	38.78d	126.21c	127.37c	35.22c	36.53c
H_2CN_2 (5%)	39.40c	40.01c	126.74b	127.82b	35.65c	36.95c
GE (3%)	40.36b	41.21b	127.19b	127.05b	36.52b	37.80b
GE (5%)	41.44a	41.88a	127.77a	128.55a	37.89a	38.62a
The interaction between spraying dates (D) and hydrogen cyanamide (H_2CN_2) and garlic extract (GE)						
Date / Treatments	**Number of leaves per new shoot**		**Leaf area (cm_2)**		**Total chlorophyll content (SPAD)**	
	Season 2016	**Season 2017**	**Season 2016**	**Season 2017**	**Season 2016**	**Season 2017**
D_1 Control	33.45 k	33.67j	121.45i	122.65j	32.85j	33.80h
H_2CN_2 (3%)	35.17j	35.66 i	122.47h	123.79i	33.00ij	34.23h
H_2CN_2 (5%)	36.22ij	36.67h	124.23g	125.53h	33.83hi	34.47gh
GE (3%)	36.77hi	37.33gh	125.00 g	125.88gh	34.00gh	35.33fg
GE (5%)	37.85gh	38.00g	126.33ef	127.27ef	34.23fg	35.46ef
D_2 Control	32.66kl	33.33j	122.25hi	122.93ij	32.10j	33.57h
H_2CN_2 (3%)	41.67d	42.00d	128.18cd	129.46cd	37.41c	38.80c
H_2CN_2 (5%)	43.33c	44.00c	129.00bc	129.98bc	38.00c	39.56c
GE (3%)	44.32b	45.66b	129.92b	130.90b	39.57b	40.35b
GE (5%)	45.47a	47.33a	131.00a	131.78a	40.23a	41.78a
D_3 Control	32.11 l	33.33 j	122.42hi	122.58ij	32.71j	33.42h
H_2CN_2 (3%)	38.10fg	38.33g	128.00d	128.87d	35.25ef	36.58de
H_2CN_2 (5%)	38.67 f	39.33f	127.00e	127.97e	35.13e	36.82d
GE (3%)	40.00 e	40.33e	126.67ef	127.37ef	36.00de	37.73 d
GE (5%)	41.00d	40.67e	126.00 f	126.60fg	36.23d	38.63c

Means having the same letter(s) in each column of first factor, second factor or interaction are not significantly different at 5% level. $D_{1=}$ first of December, $D_{2=}$ mid of December and $D_{3=}$ end of December. *While, cont.$_=$ sprayed with tap water, H_2CN_2 (3%)$_=$ hydrogen cyanamide (3%), H_2CN_2 (5%)= hydrogen cyanamide (5%), GE (3%)= garlic extract (3%) and GE (5%)= garlic extract (5%).

In addition, leaves number**,** leaf area and chlorophyll content were significantly affected by all treatments in both seasons. However, spraying 5% GE gave the best leaves number (41.44 in the 1st and 41.88 in the 2nd season), leaf area (127.77 and 128.55 cm^2 in the first and second seasons, respectively) and leaf chlorophyll content (37.89 in the 1st and 38.62 in the 2nd season) and 3% GE comes the second in both seasons.

Furthermore, the interaction between spraying dates (D), H_2CN_2 and GE cleared that, 5% GE with D_2 recorded the highest values of leaves number, leaf area and leaf chlorophyll content in both seasons. While control recorded the lowest leaves number, leaf area and leaf chlorophyll content in both seasons.

These results are in agreement with those of Botelho and Müller (2007 a and b) on apple, El-Desouky et al. (1998) and Wanas et al. (1998) on squash, Sheren and Eman (2015) on pear, El-Sharony et al (2015) on mango and El-Salhy et al. (2017) on grapevines. The previous investigators found that GE enhanced vegetative growth.

3. Harvest Date

It was obvious when measuring ripening stage that there were clear differences between harvests dates for each treatment under the same date of spray, so that harvest of each treatment according to ripening date detected in an interactions table.

Data in table (6) and fig (1) present that spraying 5% GE on mid-December (D_2) resulted in the earliest harvest date in both seasons, followed by spraying 3% GE and 5% H_2CN_2 on D_2 in both seasons. In addition, spraying 5% GE on D_3 comes after D_2. Generally, spraying D_1 was the later in harvest date as compared with the other two times in both seasons.

It is obvious from the obtained results that increasing GE concentration was positively related with an advance in harvest time. These results are in agreement with those found by Serag El-Deen (2002), who mentioned that 10 and 20% GE application were significantly effective in advancing harvesting date of Thompson seedless grape than the control. Kubota et al. (2000) found that GE advanced bud break of grapevines ('Pione' and 'Thompson Seedless') significantly and caused uniformity in bud break, but the effectiveness varied according to the concentration. The GE showed a great potential for bud break in organic production presenting similar effects of cyanamides in bud break and garlic extract improved the sprouting percentage, number of clusters, accelerated the beginning of sprouting and reduced the cycle between pruning and harvest in grape **(**Botelho et al., 2010).

Table (6). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on harvest day in Flame Seedless grapevine at 2016 and 2017.

Date / Treatments	(D_1) 2016	(D_1) 2017	(D_2) 2016	(D_2) 2017	(D_3) 2016	(D_3) 2017
Control	01-Jul	05-Jul	01-Jul	01-Jul	01-Jul	01-Jul
H_2CN_2 (3%)	28-Jun	30-Jun	16-May	20-May	05-Jun	12-Jun
H_2CN_2 (5%)	18-Jun	22-Jun	14-May	19-May	04-Jun	10-Jun
GE (3%)	17-Jun	22-Jun	14-May	19-May	04-Jun	10-Jun
GE (5%)	15-Jun	20-Jun	12-May	17-May	01-Jun	07-Jun

$D_{1=}$ first of December, $D_{2=}$ mid of December and $D_{3=}$ end of December. *While, control= sprayed with tap water, H_2CN_2 (3%)= hydrogen cyanamide (3%), H_2CN_2 (5%)= hydrogen cyanamide (5%), GE (3%)= garlic extract (3%) and GE (5%)= garlic extract (5%).

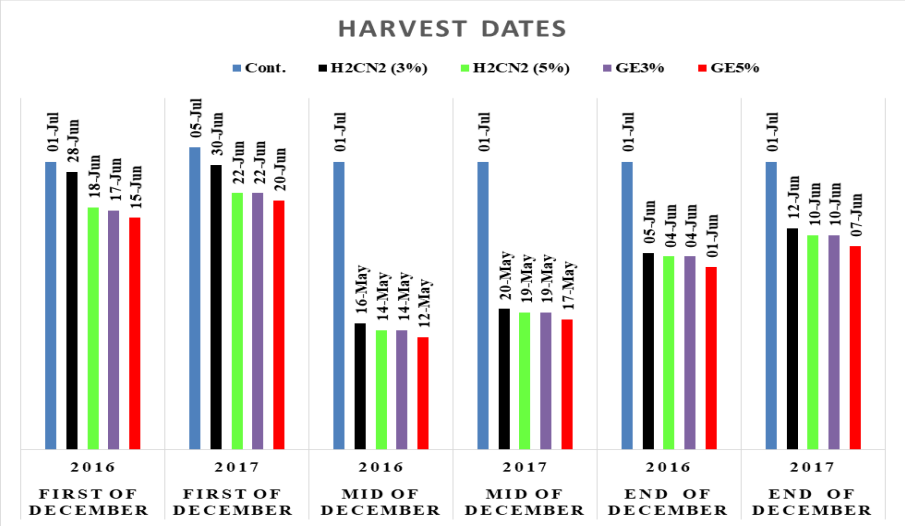

Fig. (1). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on harvest day in Flame Seedless grapevine at 2016 and 2017.

4. Cluster Weight, Number and Yield

Concerning the results in table (7), cluster weight, cluster number and yield were significantly affected by the three dates of spraying in both seasons. Whoever, D_2 produced the highest cluster weight (574.17 g in the 1st and 690.74 g in the 2nd season), cluster number (31.66 in the 1st and 32.11 in the 2nd season) and yield (17.64 kg and 18.08 kg in the first and second seasons, respectively). While, D_1 was the lowest in cluster weight (432.76 g in the 1st and 443.54g in the 2nd season), cluster number (25.00 in the 1st and

25.47 in the 2nd season) and yield (10.93 kg in the 1st and 11.36 kg in the 2nd season).

Cluster weight, cluster number and yield were significantly affected by all treatments in both seasons. However, spraying 5% GE resulted in the best cluster weight, number and yield in both seasons. On the other side, control was significantly the lowest in cluster weight, cluster number and yield in both seasons. Furthermore, the obtained data from the interaction between spraying dates (D), H_2CN_2 and GE cleared that, 5% GE with D_2 recorded the highest cluster weight, cluster number and yield in both seasons. While control with the three dates of spraying recorded the lowest cluster weight, number and yield in both seasons.

The beneficial effects of GE on breaking bud-endo-dormancy, promoting the growth and yield (Tables 5 and 7) of grapevines might be attributed to their higher content of sulfur containing compounds, amino acids and various volatiles. Sulfur in constitute of the three amino acids cystene, cysteine and methionine and hence proteins. They play definite roles in enhancing the biosynthesis of GA_3, indoles, free water, total carbohydrates and most organic foods and reducing phenols and ABA (Kubota et al., 1999 and 2000).

The obtained results agree with El-Desouky et al. (1998) and Wanas et al. (1998) on squash plant, Serag El-Deen (2002) on 'Thompson seedless' grapes, Chowdhury et al. (2007) on mango, Botelho et al. (2010) on grape, Abd El-Razek et al. (2013) on 'Le Conte' pear and Mostafa and El-Yazal (2013) on "Anna" apple. They found that the natural extract of garlic cloves improve growth, fruit yield and the quality of such product.

5. Weight and Volume of 100 Berries

It is evident from the data in table (8), that weight and volume of 100 berries were affected significantly by the three dates of spraying in both seasons. Whoever, D_2 produced the highest weight and volume of 100 berries in both seasons. In addition, D_1 was the lowest in weight and volume of 100 berries in both seasons.

In addition, the weight and volume of 100 berries was significantly affected by all treatments in both seasons. However, spraying 5% GE gave the best weight of 100 berries (276.89 g in the 1st and 287.22 g in the 2nd season) and the best volume of 100 berries (259.88 cm^3 in the 1st and 270.36 cm^3 in the 2nd season), while 3% GE in both seasons comes after.

The obtained data from the interaction between date of spraying (D), H_2CN_2 and GE showed that, 5% GE with D_2 recorded the highest values of weight and volume of 100 berries in both seasons. While control on the three spraying date recorded the lowest weight and volume of 100 berries in both seasons.

Table (7). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on cluster weight, number and yield in flame seedless grapevine at 2016 and 2017

Parameters / Treatments	Cluster weight (g)		Cluster number		Yield (kg)	
	Season 2016	Season 2017	Season 2016	Season 2017	Season 2016	Season 2017
Effect of date spraying (D)						
D_1	432.76c	443.54c	25.00c	25.47c	10.93c	11.36c
D_2	546.15a	555.12a	31.66a	32.11a	17.64a	18.08a
D_3	506.29b	517.06b	27.22b	27.84b	14.03b	14.49b
Effect of spraying hydrogen cyanamide (H_2CN_2) and garlic extract (GE)						
Control	387.48e	394.22e	23.61e	24.14e	9.21e	9.50e
H_2CN_2 (3%)	493.50d	505.32d	27.60d	28.00d	13.89d	14.23d
H_2CN_2 (5%)	515.31c	525.78c	28.46c	29.02c	14.94c	15.43c
GE (3%)	529.64b	540.63b	29.29b	30.04b	15.90b	16.40b
GE (5%)	549.41a	560.05a	30.84a	31.18a	17.07a	17.58a

The interaction between spraying dates (D) and hydrogen cyanamide (H_2CN_2) and garlic extract (GE)

Date	Treatments	Cluster weight (g)		Cluster number		Yield (kg)	
		Season 2016	Season 2017	Season 2016	Season 2017	Season 2016	Season 2017
D_1	**Control**	387.21m	397.71m	23.58k	24.11h	9.16m	9.54l
	H_2CN_2 (3%)	405.86l	418.47l	24.64ij	25.01gh	9.99l	10.46k
	H_2CN_2 (5%)	432.47k	441.35k	25.13hi	25.27g	10.95k	11.33j
	GE (3%)	450.58j	462.00j	25.27h	26.00fg	11.56j	12.01i
	GE (5%)	487.68i	498.17i	26.38g	27.00ef	12.99i	13.46h
D_2	**Control**	388.00m	387.28m	24.00jk	24.31h	9.31m	9.42l
	H_2CN_2 (3%)	574.47d	585.78d	31.18c	31.78c	18.18d	18.54d
	H_2CN_2 (5%)	580.75c	593.00c	33.00b	33.64b	19.16c	19.76c
	GE (3%)	587.34b	598.00b	34.34a	35.00a	20.37b	20.93b
	GE (5%)	600.21a	611.00a	35.82a	35.85a	21.22a	21.78a
D_3	**Control**	387.25m	397.68m	23.27k	24.00h	9.16 m	9.54l
	H_2CN_2 (3%)	500.17h	511.72h	27.00fg	27.21e	13.50h	13.98h
	H_2CN_2 (5%)	532.72g	543.00g	27.26f	28.17de	14.73g	15.20g
	GE (3%)	551.00f	561.91f	28.27e	29.13d	15.79f	16.27f
	GE (5%)	560.35e	571.00e	30.33d	30.71c	17.00e	17.50e

Means having the same letter(s) in each column of first factor, second factor or interaction are not significantly different at 5% level. $D_{1=}$ the first of December, $D_{2=}$ mid of December and $D_{3=}$ the end of December. *While, control= sprayed with tap water, H_2CN_2 (3%)= hydrogen cyanamide (3%), H_2CN_2 (5%)= hydrogen cyanamide (5%), GE (3%)= garlic extract (3%) and GE (5%)= garlic extract (5%).

Table (8). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on weight and volume of 100 berries in flame seedless grapevine at 2016 and 2017.

Parameters / Treatments	Weight of 100 berries		Volume of 100 berries	
	Season 2016	Season 2017	Season 2016	Season 2017
Effect of date spraying (D)				
D_1	235.43c	245.77c	218.17c	228.53c
D_2	285.41a	295.84a	271.34a	281.60a
D_3	257.11b	267.59b	240.18b	250.69b
Effect of spraying hydrogen cyanamide (H_2CN_2) and garlic extract (GE)				
Control	228.25e	238.41e	212.15e	222.48e
H_2CN_2 (3%)	258.52d	268.12d	241.90d	252.11d
H_2CN_2 (5%)	264.06c	274.52c	248.35c	258.89c
GE (3%)	268.86b	279.39b	253.87b	264.18b
GE (5%)	276.89a	287.22a	259.88a	270.36a
The interaction between spraying dates (D) and hydrogen cyanamide (H_2CN_2) and garlic extract (GE)				
Date / Treatments	**Weight of 100 berries**		**volume of 100 berries**	
	Season 2016	**Season 2017**	**Season 2016**	**Season 2017**
D_1 **Control**	228.38	238.11n	212.00m	222.13m
H_2CN_2 (3%)	230.23l	240.67l	214.88l	225.14l
H_2CN_2 (5%)	234.44k	245.10k	218.21k	229.13k
GE (3%)	238.43j	249.00j	220.65j	231.25j
GE (5%)	245.71i	256.00i	225.14i	235.00i
D_2 **Control**	228.00	238.36mn	212.33m	223.00m
H_2CN_2 (3%)	287.57d	298.22d	275.51d	285.54d
H_2CN_2 (5%)	297.23c	308.14c	285.43c	295.34c
GE (3%)	303.55b	313.47b	289.26b	299.14b
GE (5%)	310.73a	321.01a	294.17a	305.00a
D_3 **Control**	228.39	238.77m	212.12m	222.33m
H_2CN_2 (3%)	257.77h	268.47h	235.33h	245.67h
H_2CN_2 (5%)	260.53g	270.34g	241.43g	252.22g
GE (3%)	264.62f	275.72f	251.71f	262.15f
GE (5%)	274.24e	284.67e	260.34e	271.10e

Means having the same letter(s) in each column of first factor, second factor or interaction are not significantly different at 5% level. D_1= the first of December, D_2= mid of December and D_3= the end of December. *While, control= sprayed with tap water, H_2CN_2 (3%)= hydrogen cyanamide (3%), H_2CN_2 (5%)= hydrogen cyanamide (5%), GE (3%)= garlic extract (3%) and GE (5%)= garlic extract (5%).

6. Cluster Length, Width, Berry Length and Diameter

Data in table (9) clear that cluster length, width, berry length and diameter were affected significantly by the three spraying dates in both seasons. Whoever, D_2 produced the highest cluster length, width, berry length and diameter in both seasons. In addition, D_1 was the lowest in cluster length, width, berry length and diameter both seasons

In addition, cluster length, width, berry length and diameter were significantly affected by all treatments in both seasons. However, spraying 5% GE gave the best cluster length (23.12 cm in the 1st and 24.85 in the 2nd season) cluster width (15.81 cm in the 1st and 16.50 cm in the 2nd season), berry length (1.76 cm in the 1st and 1.77 cm in the 2nd season) and berry diameter (1.71 cm in the 1st and 1.74 cm in the 2nd season). On the other side, control gave the lowest cluster length, width, berry length and diameter in both seasons.

The obtained data from the interaction between date of spraying (D), H_2CN_2 and GE indicated that, 5% GE with D_2 produced the highest cluster length, width, berry length and diameter in both seasons. While control with the three spraying date recorded the lowest cluster length, width, berry length and diameter in both seasons.

7. Total Soluble Solid, Total Sugar and Total Acidity %

Concerning the results in table (10), total soluble solid, total sugar and total acidity were affected significantly by the three dates of spraying treatments in both seasons. Whoever, D_2 produced the highest total soluble solid (20.42% in the 1st and 21.33 in the 2nd season), total sugars (18.47% in the 1st and 19.01 in the 2nd season) and the lowest total acidity (0.53% in the 1st and 0.52% in the 2nd season). While, D_1 decreased total soluble solid, (16.82% in the 1st and 17.58% in the 2nd season), total sugars (14.65% in the 1st and 15.21% in the 2nd season) and increased total acidity (0.58% in both seasons).

In addition total soluble solid, total sugars and total acidity were significantly affected by all spraying treatments in both seasons. However, spraying 5% GE increased total soluble solid, total sugar and decreased total acidity in both seasons. On the other side, control was significantly decreased in total soluble solid, total sugar and increased total acidity in both seasons.

The obtained data from the interaction between spraying dates (D), H_2CN_2 and GE resulted that, 5% GE with (D_2) increased total soluble solid, total sugars and decreased total acidity in both seasons. While control with three date spraying gave the lowest total soluble solid, total sugars and the highest total acidity in both seasons.

Table (9). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on cluster length, width, berry length and diameter in flame seedless grapevine at 2016 and 2017.

Parameters / Treatments	Cluster length (cm)		Cluster width (cm)		Berry length (cm)		Berry diameter (cm)	
	Season 2016	Season 2017	Season 2016	Season 2017	Season 2016	Season 2017	Season 2016	Season 2017
Effect of date spraying (D)								
D_1	20.24c	21.74c	12.49c	13.32c	1.49c	1.50c	1.40c	1.43c
D_2	23.03a	24.64a	15.76a	16.58a	1.77a	1.78a	1.72a	1.75a
D_3	21.49b	23.20b	14.31b	14.82b	1.62b	1.63b	1.56b	1.61b
Effect of spraying hydrogen cyanamide (H_2CN_2) and garlic extract (GE)								
Control	18.21d	19.88d	11.40d	12.17d	1.39e	1.39e	1.31e	1.34e
H_2CN_2 (3%)	21.84c	23.37c	14.17c	14.84c	1.62d	1.63d	1.55d	1.58d
H_2CN_2 (5%)	22.18c	23.51c	14.56c	15.22c	1.66c	1.67c	1.60c	1.62c
GE (3%)	22.59b	24.35b	15.00b	15.82b	1.72b	1.72b	1.64b	1.68b
GE (5%)	23.12a	24.85a	15.81a	16.50a	1.76a	1.77a	1.71a	1.74a
The interaction between spraying dates (D) and hydrogen cyanamide (H_2CN_2) and garlic extract (GE)								
Date / Treatments	**Cluster length (cm)**		**Cluster width (cm)**		**Berry length (cm)**		**Berry diameter (cm)**	
	Season 2016	**Season 2017**	**Season 2016**	**Season 2017**	**Season 2016**	**Season 2017**	**Season 2016**	**Season 2017**
D_1 **Control**	18.21j	19.96j	11.71jkl	12.50ij	1.40m	1.39m	1.31m	1.35mn
H_2CN_2 (3%)	20.22i	21.43i	12.00jk	12.83hi	1.47l	1.48l	1.34l	1.37l
H_2CN_2 (5%)	20.55hi	21.87hi	12.28ij	13.16h	1.50k	1.51k	1.37k	1.41k
GE (3%)	21.00gh	22.53gh	13.01hi	13.85g	1.54j	1.54j	1.45j	1.49j
GE (5%)	21.23fg	22.91fg	13.46gh	14.28g	1.57i	1.58i	1.53i	1.56i
D_1 **Control**	18.31j	19.88j	11.25kl	12.25jk	1.39m	1.39m	1.32m	1.35m
H_2CN_2 (3%)	23.65bc	25.24bc	16.05c	16.87cd	1.80d	1.80d	1.74d	1.76d
H_2CN_2 (5%)	24.00bc	25.45bc	16.54bc	17.28c	1.84c	1.85c	1.81c	1.84c
GE (3%)	24.22ab	25.83ab	17.00b	17.80b	1.90b	1.90b	1.84b	1.88b
GE (5%)	25.00a	26.81a	18.00a	18.72a	1.95a	1.96a	1.91a	1.94a
D_3 **Control**	18.11j	19.80j	11.24l	11.76k	1.39m	1.39m	1.31m	1.34n
H_2CN_2 (3%)	21.65fg	23.44fg	14.47fg	14.83f	1.60h	1.60h	1.58h	1.62h
H_2CN_2 (5%)	22.00ef	23.23ef	14.88ef	15.23f	1.64g	1.65g	1.61g	1.63g
GE (3%)	22.55de	24.71de	15.00de	15.81e	1.72f	1.72f	1.64f	1.67f
GE (5%)	23.14cd	24.85cd	15.98cd	16.50d	1.76e	1.77e	1.70e	1.74e

Means having the same letter(s) in each column of first factor, second factor or interaction are not significantly different at 5% level. $D_{1=}$ the first of December, $D_{2=}$ mid of December and $D_{3=}$ the end of December. *While, control= sprayed with tap water, H_2CN_2 (3%)= hydrogen cyanamide (3%), H_2CN_2 (5%)= hydrogen cyanamide (5%), GE (3%)= garlic extract (3%) and GE (5%)= garlic extract (5%).

Table (10). Effect of spray in three times (D) with hydrogen cyanamide (H_2CN_2) and garlic extract (GE) on total soluble solid, total sugar and total acidity% in flame seedless grapevine at 2016 and 2017.

Parameters / Treatments	TSS (%)		Total sugar (%)		Total acidity (%)	
	Season 2016	Season 2017	Season 2016	Season 2017	Season 2016	Season 2017
Effect of date spraying (D)						
D_1	16.82c	17.58c	14.65c	15.21c	0.58a	0.58a
D_2	20.42a	21.33a	18.47a	19.01a	0.53c	0.52c
D_3	18.04b	18.89b	16.04b	16.53b	0.56b	0.55b
Effect of spraying hydrogen cyanamide (H_2CN_2) and garlic extract (GE)						
Control	15.24d	16.06d	13.20e	13.71e	0.59a	0.59a
H_2CN_2 (3%)	18.32c	19.14c	16.28d	16.84d	0.56b	0.55b
H_2CN_2 (5%)	18.94b	19.81b	16.84c	17.35c	0.55c	0.54c
GE (3%)	19.45b	20.26b	17.40b	17.93b	0.54d	0.54d
GE (5%)	20.18a	21.08a	18.21a	18.76a	0.53e	0.53d
The interaction between spraying dates (D) and hydrogen cyanamide (H_2CN_2) and garlic extract (GE)						
Date / **Treatment**	**TSS (%)**		**Total sugar (%)**		**Total acidity (%)**	
	Season 2016	**Season 2017**	**Season 2016**	**Season 2017**	**Season 2016**	**Season 2017**
D_1 **Cont.**	15.53i	16.15i	13.31j	13.86j	0.59 a	0.60a
H_2CN_2 (3%)	16.37h	17.01h	14.22i	14.81i	0.58b	0.58bc
H_2CN_2 (5%)	17.28g	18.14g	15.00hi	15.45hi	0.58bc	0.57cd
GE (3%)	17.27g	18.11g	15.22gh	15.76gh	0.57cd	0.57cd
GE (5%)	17.65fg	18.52fg	15.54fgh	16.20fgh	0.57de	0.56de
D_2 **Cont.**	15.00i	15.85i	13.00j	13.47j	0.59a	0.60a
H_2CN_2 (3%)	20.61c	21.54c	18.61c	19.28c	0.52h	0.52hi
H_2CN_2 (5%)	21.23bc	22.19bc	19.30bc	19.88bc	0.51i	0.51ij
GE (3%)	22.00b	22.88b	20.00b	20.62b	0.50j	0.50jk
GE (5%)	23.30a	24.22a	21.45a	21.82a	0.50j	0.50k
D_3 **Control**	15.19i	16.20 i	13.31j	13.81j	0.600a	0.59ab
H_2CN_2 (3%)	18.00fg	18.87fg	16.01fg	16.44fg	0.56e	0.56de
H_2CN_2 (5%)	18.31ef	19.10ef	16.22ef	16.73ef	0.55f	0.55ef
GE (3%)	19.10de	19.81de	17.00de	17.41de	0.54g	0.54fg
GE (5%)	19.61d	20.50d	17.66d	18.27d	0.54g	0.53gh

Means having the same letter(s) in each column of first factor, second factor or interaction are not significantly different at 5% level. D_1 = the first of December, D_2 = mid of December and D_3= the end of December. *While, control= sprayed with tap water, H_2CN_2 (3%)= hydrogen cyanamide (3%), H_2CN_2 (5%)= hydrogen cyanamide (5%), GE (3%)= garlic extract (3%) and GE (5%)= garlic extract (5%).

These results in tables (8, 9 and 10) may be due to that GE enhanced cell division and elongation as well as the tolerance of plants to different stresses. Garlic extract enhanced growth and vine nutritional status that shifted the balance of competition between growth and reproductive organs that was in favor of the latter. In addition, the positive action of these extracts on stimulating the biosynthesis of sugars and plant pigments is surely reflected on advancing maturity and promoting fruit quality (Kubota et al., 2000; Corrales-Maldonado et al., 2010; Ali et al., 2012; Gadel-Kareem and Abdel-Rahman, 2013; Uwakiem, 2014; Gouda, 2016 and Rizkalla, 2016).

The obtained results are in agreement with those reported by El-Desouky et al. (1998) and Wanas et al. (1998) on squash plant, Serag El-Deen (2002) on grapevine, Botelho et al. (2007) on apple, Chowdhury et al. (2007) on mango, Ahmed et al. (2009) on peach, Abd El-Razek et al. (2011) on 'Canino' apricot, Abd El-Razek et al. (2013) on 'Le Conte' pear, El-Sharony et al. (2015) on mango cv. Fagri Kalan, Sheren and Eman (2015) on pear and El-Salhy et al. (2017) on Flame Seedless grapevines. All previous researchers generally found that the natural extract of garlic cloves improved both of fruit yield and quality.

CONCLUSION

Regarding mentioned results it can be concluded that spraying Flame Seedless grapevine with GE at 5% on mid-December is the best treatment for harvesting earlier than spraying in the usual time. In addition, this treatment could be one of the valuable technologies that assist in improving plant growth, fruit quality and vine productivity. Moreover, substitution of garlic as a naturally friendly environmental material instead of H_2CN_2, which could be recommended to break vine bud dormancy without any harmful dangers on human health.

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دراسة مقارنة بين مستخلص الثوم وسينامید الهيدروجين على التزهير والعقد والانتاجية في العنب

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أجريت هذه التجربة خلال موسمي ٢٠١٦ و٢٠١٧ على كروم العنب المنزرعة في تربة رملية تحت نظام الري بالتنقيط في منطقة الخطاطبة، بمحافظة المنوفية، مصر. يعد المناخ هو أحد العوامل الهامة التي تتحكم في إنتاج العنب، وفي المناطق الشتوية الدافئة تصبح الحاجة إلى استخدام مواد كيميائية لكسر سكون البراعم عاملًا مهيمنًا للحفاظ على الإنتاج الاقتصادي لعنب المائدة. ومع ذلك فإن المشكلة تكون أكثر حدة عند الرغبة في إنتاج العنب عضويًا، لذلك فقد هدفت هذه الدراسة إلى تقييم تأثير مستخلص الثوم كمادة طبيعية بالمقارنة مع استخدام سينامید الهيدروجين كأحد المركبات الكيماوية التقليدية لكسر سكون البراعم وتأثيره على جودة المحصول من كروم العنب صنف الفليم سيدلس تحت ظروف منطقة الدراسة التي تهدف إلى استبدال المواد الكيميائية بالمواد العضوية، بالإضافة إلى غزو الأسواق في وقت مبكر لتحقيق أقصى قدر من الفوائد للمنتجين. وتجنب الآثار السلبية التي تتعرض لها كرمات العنب عند التأخر في ميعاد الحصاد لارتفاع درجات حرارة الصيف. وعلاوة على ذلك، فإن هذه الدراسة عبارة عن اختبار لمستخلص الثوم ليعوض الاحتياجات من ساعات البرودة. حيث تم تطبيق خمسة معاملات للرش الورقي؛ ماء الصنبور (المقارنة)، سينامید الهيدروجين بتركيز ٣٪، سينامید الهيدروجين بتركيز ٥٪، مستخلص الثوم بتركيز ٣٪ ومستخلص الثوم بتركيز ٥٪ على العنب في ثلاث مواعيد؛ الأول من شهر ديسمبر ومنتصف شهر ديسمبر وفي نهاية شهر ديسمبر. وقد أظهرت النتائج التي تم الحصول عليها أن جميع المعاملات كانت فعالة جدًا في تشجيع النمو الخضري وتفتح البراعم والانتاجية والخصائص الفيزيائية والكيميائية للثمار. كذلك حقق الرش في منتصف شهر ديسمبر أفضل نتائج بالمقارنة بالموعدين الآخرين. وقد أظهرت الدراسة أن العنب الذي تم رشه بمستخلص ثوم ٥٪ في منتصف شهر ديسمبر كان الأفضل من حيث التبكير في ميعاد الحصاد مقارنة بالموعدين الآخرين للرش. بالإضافة إلى ذلك، أدت هذه المعاملة إلى زيادة نسبة تفتح البراعم، وعدد الأوراق بكل النموات الحديثة، ومساحة الورقة، ومحتوى الورقة من الكلوروفيل الكلي، والإنتاجية، ووزن وحجم ١٠٠ عنيبة، ووزن وعدد وطول وعرض العنقود، وطول وقطر الحبة، والمادة الصلبة الذائبة الكلية، والسكريات الكلية، وكذلك تم خفض عدد الأيام للوصول إلى التزهير الكامل وكذلك الحموضة الكلية.