Websites:
http://www.sciencepub.net/nature
http://www.sciencepub.net

Emails:
naturesciencej@gmail.com
editor@sciencepub.net

Nature and Science

MARSLAND PRESS
Multidisciplinary Academic Journal Publisher

Effects of Hydrogen Cyanamide, Mineral Oil, and Garlic Oil on Bud Opening and Vegetative Growth of "Basateen MKM" Pear Cultivar

El-Sabagh, Ahmed, S.[1,2]; Atef, M. Hussein[3]; Amr, M. Haikal[2], and Dalia, G. Shehata[3]

[1]Plant Production Department, College of Food and Agricultural Science, King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia.
[2]Department of Horticulture, Faculty of Agriculture, Damanhur University, Egypt.
[3]Deciduous Fruit Department, Horticulture Research Institute- Agriculture Research Center, Egypt.
dalia.7@yahoo.com

Abstract: This study was conducted during successive seasons in 2017 and 2018 to determine the effects of hydrogen cyanamide (HC), mineral oil (MO), and garlic oil (GO) alone or their combinations on the date of bud opening and vegetative growth of pear cultivar "Basateen MKM". The trees were grown on *Pyrus betulaefolia* rootstock in sandy soil in a private orchard in south Tahreer City, EL-Beheira Governorate, Egypt. Trees were sprayed with the aforementioned substance during the dormant bud stage on 10 and 15 January in both years. The results showed that all treatments led to the break of bud dormancy and compensated for the lack of chilling requirements compared with the control in both seasons. Accumulated chilling hours in the second season was significantly higher than that of the first one Furthermore, treatments of HC and GO hastened the time of budbreak by 10 days when compared to the untreated control in both seasons. Different chemicals were more effective in improving budbreak in the second season than in the first one. Trees treated with 1% HC exhibited the highest values for the percentage of vegetative buds opening as compared to that of the untreated control and other treatments in both seasons. Individual application of 1% GO provided superior increase in the percentage of flowering buds opening as compared to that of the control and other treatments in both seasons. All vegetative growth parameters were enhanced with 1% HC when compared to untreated control in both seasons. The earlier application was more effective than the late one in improving all vegetative growth parameters in both seasons. Regarding leaf mineral content, spraying trees with 1% HC induced the highest values for leaf N, P, and K content as compared to that of the control in both seasons.
[El-Sabagh, Ahmed, S.,; Atef, M. Hussein; Amr, M. Haikal, and Dalia, G. Shehata. **Effects of Hydrogen Cyanamide, Mineral Oil, and Garlic Oil on Bud Opening and Vegetative Growth of "Basateen MKM" Pear Cultivar.** *Nat Sci* 2020;18(7):22-33]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 4. doi:10.7537/marsnsj180720.04.

Keywords: Pear, Dormex, garlic oil, Mineral oil, bud opening, vegetative growth, Chilling hours, leaf mineral content.

1. Introduction

The pear (*Pyrus communis* L.) is one of the most important temperate zone fruits (FAO, 2011). A major problem facing pear production under Egyptian conditions is an insufficient chilling requirement. Pears need cool winters (600–680) hrs. below 7.2 °C. When the chilling requirement is not met, delayed bud opening, a prolonged and scattered flowering period, non-uniform leaf bud opening, and inhomogeneous crop development occur (Erez, 2000). Although much work has been conducted to select new low-chilling cultivars, the use of synthetic dormancy breaking agents (DBAs) is still needed (Erez, 1995). Recently, in Egypt, yield began to gradually increase with selection of a new low-chilling clone (Basateen MKM). In addition, artificial substances are being used, such as DBAs, to compensate for the lack of natural chilling (Erez, 1995), advance bud development (Erez et al., 1993). Spraying hydrogen cyanamide, mineral oil and garlic extract alone or in their combinations increased the percentage of bud opening and advanced full bloom (El-sabagh, et al., 2012 & Abd El-Razek *et al*. 2013). Chilling, garlic extract and hydrogen cyanamide induced earlier bud break by 2 weeks and gave the highest percentage of bud break as compared to the Control (80 %) (Vasconcelos *et al*. 2007).

DBAs are applied to trees to overcome the adverse effects of warm late-winter temperatures on their buds (Morsi and El-Yazal, 2008). Additionally, they increase the percentage of bud breaking with positive effects on shoot development and flower fertility (Costa, 2003). Dormex® (49% H_2CN_2) has been widely used to break bud dormancy and shortening the duration of flowering (Seif El-Yazal and Rady 2012). Moreover, it is rapidly metabolized by plants and aids in the synthesis of amino acids through catalase activity (Seif El-Yazal et al., 2012).

Using natural products is becoming the main goal because they are less toxic, cost less, and easily available (Dimitri and Oberholtzer, 2006). In this respect, oil was the first chemical used to break dormancy and considered the most helpful rest breaking treatment for apple and has been used effectively to supplement cold temperature, to attain satisfactory bud break (Seif El Yazal et al., 2018). However, its effect was moderate and it needed to be applied in combination with other chemicals to enhance the dormancy breaking effect (Sagredo et al., 2005). Oil accelerated respiration when applied immediately before the separation of the bud scales.

Garlic has a high concentration of sulfur compounds (1–3%) (Koch and Lawson, 1996). It has been used to break bud dormancy in apple trees and its effects have been varied according to the concentration and the duration of exposure (Kubota et al., 1999 & Rady and Seif El-Yazal 2014). Substances with sulfur molecules interrupt the dormancy breaking of different species of deciduous plants (Hartmann, 2000).

The objective of this study was to examine the effects of timing and concentration of various rest breaking agents (Dormex, garlic oil, and mineral oil), alone and in combination, on floral and vegetative bud break time, vegetative growth parameters and leaf mineral content of Basateen MKM pear trees, under conditions of inadequate winter chilling in Egypt.

2. Material and methods

This study was conducted during successive seasons in 2017 and 2018 on 5-year-old trees of the early pear cultivar Basateen MKM budded on *Pyrus betulaefolia* rootstock. Trees were planted in sandy soil in a private orchard in south Tahreer City, EL-Beheira Governorate. The trees were spaced at 5 × 4 m, open-vase shape trained, irrigated with a drip irrigation system, and received similar cultural practices adopted throughout the orchard. Seventy-eight trees were selected that were as uniform as possible in growth, productivity, and appearance for this study. Trees were sprayed once with the chemicals during the dormant bud stage on two dates (January 10 and January 15) in each season with chemical solutions until run off. The following treatments were investigated:

T1. Control (water only).
T2. 1 % hydrogen cyanamide (HC)
T3. 2 % hydrogen cyanamide (HC)
T4. 0.5 % garlic oil (GO)
T5. 1 % garlic oil (GO)
T6. 1% hydrogen cyanamide (HC) + 0.5 % garlic oil (GO)
T7. 1% hydrogen cyanamide (HC) + 1 % garlic oil (GO)
T8. 2% hydrogen cyanamide (HC) + 0.5 % garlic oil (GO)
T9. 2% hydrogen cyanamide (HC) + 1 % garlic oil (GO)
T10. 1% hydrogen cyanamide (HC) + 1 % mineral oil (MO)
T11. 1% hydrogen cyanamide (HC) + 2 % mineral oil (MO)
T12. 2% hydrogen cyanamide (HC) + 1 % mineral oil (MO)
T13. 2% hydrogen cyanamide (HC) + 2 % mineral oil (MO)

2.1 Measurements and studied parameters

2.1.1 Chilling requirements (meteorological data)

Chilling hours from defoliation (November) until the beginning of bud burst (February) were recorded as follows:

a) Number of hours at ≤7 °C.
b) Number of hours at ≤10 °C.

2.1.2 Phonological observations

To determine days from bud opening to full bloom and petal fall, four branches from each side of the tree were selected, labeled, and data were recorded in February and March in 2017 and 2018, respectively. Additionally, the percentage of vegetative, flowering, and dormant buds were calculated according to the equations:

Flower buds%= (No. of opened flowering buds/Total number of buds) ×100

Vegetative buds % = (No. of opened vegetative buds /Total number of buds) × 100

Dormant buds % = (No. of dormant buds ÷ Total number of buds) × 100

2.1.3 Vegetative growth

In May of each season, 20 developing shoots during the spring cycle were tagged at a constant height at all directions on each tree. During September in both years, the average shoot length, diameter (cm), the number of leaves per shoot, and the number of current shoots were determined.

2.1.4 Leaf mineral content

At the end of the experimental season (end of September), 20 leaves/tree were collected representing the four cardinal directions. Total nitrogen and phosphorus were determined colorimetric ally according to the methods of Murphy and Riley (1962) and Evenhuis and Dewaard (1976), respectively. Potassium was determined against a standard, using an air propane flame photometer (Chapman and Pratt, 1961). The concentration of nitrogen, phosphorus, and potassium was expressed as a percentage.

2.2 Statistical analysis

This experiment consisted of 26 treatments (13 treatment × 2 dates) arranged as a factorial experiment in a randomized complete block design with three replicates for each treatment and one tree for each replicate. The least significant difference (LSD) at the 0.05 % level of probability was calculated using the Computer Statistical Package (CO-STATE) according to Snedecor and Cochran (1980).

3. Results

3.1 Accumulated chilling hours

Data in Table 1 shows that the highest chilling hours occurred during the second season especially for ≤10 °C. However, a few insufficient number of hours for ≤7 °C was accumulated in both seasons.

3.2 Phonological observations

3.2.1 Number of days from bud opening to full bloom and petal fall on both 1-year-old shoots and spur buds:

The data presented in Table 2 shows that all treatments significantly decreased the number of days to reach both of full bloom and petal fall stages compared to the untreated control in both seasons. 2 % HC + 1 % GO treatment resulted in the least significant number of days compared to the untreated control and other treatments in both seasons (Table 2). Treatments of 2 % HC + 1 % GO and 2 % HC + 0.5 % GO significantly shortened the number of days compared to the untreated control and other treatments in the first season and second season respectively (Table 2). The first application date significantly reduced the average number of days from the bud opening stage to full bloom and petal fall stages on both one-year-old shoots and spur buds compared to the second one in both seasons (Fig. 1 & 2).

Table 1. Accumulated chilling hours during the 2016–2017 and 2017–2018 seasons.

The Models	*Numbers of Chilling hours	
	2016-2017	2017-2018
≤7 °C	28	30
≤10 °C	208	303

*Numbers of Chilling hours from the beginning of leaf fall (November) until the beginning of bud burst (February) for the "Basateen MKM" pear cultivar.

Table 2. Main Effects of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on the number of days from bud opening stage to full bloom and petal fall stages on one-year-old shoot and spur buds of "Basateen MKM" pear cultivar during 2017 and 2018 seasons.

	Full Bloom				**Petal Fall**			
	One year old shoot		**Spur buds**		**One year old shoot**		**Spur buds**	
	1^{st}2	2nd	1^{st}	2nd	1^{st}	2nd	1^{st}	2^{nd}
Control	44.00 A	31.00 A	44.00 A	31.00 A	49.00 A	36.0 A	49.00 A	36.00 A
1% HC	34.00 B	22.00 B	34.00 B	22.00 B	41.00 B	27.0 B	41.00 B	27.00 B
2%HC	31.00 D	20.00 CD	31.00 D	20. CD	38.00 D	25.0 CD	38.00 D	25.00 D
0.5%GO	32.00 C	21.00 BC	32.00 C	21. BC	39.00 C	26. BC	39.00 C	26.00 C
1%GO	31.00 D	20.00 CD	31.00 D	20. CD	38.00 D	25.0 CD	38.00 D	25.00 D
1%HC+0.5%GO	32.00 C	21.00 BC	32.00 C	21. BC	39.00 C	26. BC	39. C	26.00 C
1% HC+1%GO	31.00 D	20.00CD	31.00 D	20. CD	38.00 D	25. CD	38. D	25.00 D
2%HC +0.5%GO	31.00 D	20.00CD	31.00 D	19. D	38.00D	25.0 CD	38.00 D	24.00 E
2%HC +1%GO	30.00 E	19.00 D	30.00 E	21. BC	37.00 E	24. D	37. E	26.00 C
1%HC +1%MO	32.00 C	21.00BC	32.00C	21. BC	39.00 C	26. BC	39. C	26.00 C
1%HC +2%MO	32.00 C	21.00BC	32.00 C	21. BC	39.00C	26. BC	39. C	26.00 C
2%HC +1%MO	31.00 D	20.00CD	31.00 D	20. CD	38.00 D	25. CD	38.00 D	25.00 D
2%HC +2%MO	31.00 D	20.00CD	31.00D	20. CD	38.00 D	25. CD	38. D	25.00 D
LSD	0.8518	1.177	0.8905	1.074	0.8588	1.172	0.8742	0.9118

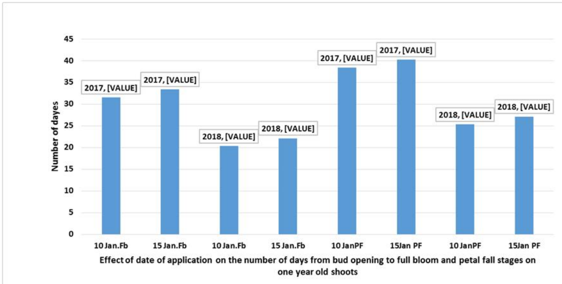

Figure (1): Effect of date of application on the number of days from bud opening to full bloom and petal fall stages on one-year-old shoots

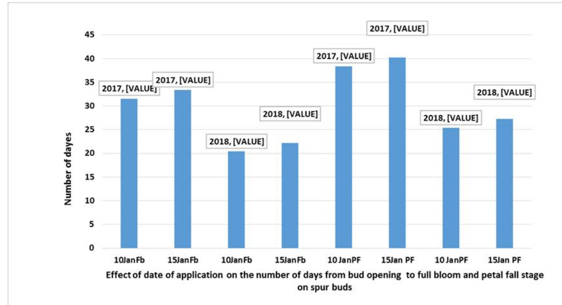

Figure (2): Effect of date of application on the number of days from bud opening to full bloom and petal fall stage on spur buds

The interaction effects showed that 2 % HC + 1 % GO in both seasons for the first application date in both seasons decreased significantly the number of days to reach both of full bloom and petal fall stages (Table 3).

Table 3. Interaction effects of Effect of hydrogen cynamid (HC), mineral oil (MO) and garlic oil (GO) on the number of days from bud opening stage to full bloom and petal fall stages on one-year-old shoot and spur buds of "Basateen MKM" pear cultivar during 2017 and 2018 seasons.

	Full bloom								**Petal fall**							
	1year old shoot				**Spur bud**				**1 year old shoot**				**Spur bud**			
	1st2017		**2nd2018**		**1st2017**		**2nd2018**		**1st2017**		**2nd2018**		**1st2017**		**2nd2018**	
Date of application.	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja	10J	15J	10J	15J	10J	15J	10Ja	15Ja	10Ja	15Ja
Control	44 A	44 A	31 A	31 A	44 A	44A	31 A	31 A	49A	49 A	36A	36 A	49 A	49 A	36 A	36 A
1% HC	33 C	35 B	21CD	23 B	33 C	35 B	21D	23 B	40C	42B	2CD	28 B	40 C	42. B	26CD	28B
2%HC	30 EF	32CD	19 EF	21 CD	30 EF	32D	19EF	21CD	37EF	39CD	24EF	26CD	37EF	39CD	24EF	26CD
0.5%GO	31 DE	33 C	20 DE	22 BC	31 DE	33 C	20DE	22BC	38DE	40C	25DE	27BC	38DE	40C	25 DE	27 BC
1%GO	30 EF	32 CD	19 EF	21 CD	30 EF	32CD	19EF	21CD	37EF	39CD	24EF	26CD	37EF	39 CD	24 EF	26CD
1%HC+0.5%GO	31 DE	33 C	20DE	22 BC	31DE	33C	20DE	22BC	38DE	40C	25DE	27BC	38DE	40C	25DE	27BC
1% HC+1%GO	30 EF	32 CD	19EF	21CD	30 EF	32CD	19EF	21CD	37EF	39CD	24EF	26CD	37EF	39CD	24 EF	26 CD
2%HC +0.5%GO	30 EF	32 CD	19EF	21CD	30 EF	32CD	18 F	20DE	37EF	39CD	24EF	26CD	37EF	39CD	23 F	25 DE
2%HC +1%GO	29 F	31 DE	18F	20DE	29 F	31DE	20DE	22BC	36F	38DE	23F	25DE	36F	38DE	25 DE	27BC
1%HC +1%MO	31 DE	33 C	20DE	22 BC	31 DE	33 C	20DE	22BC	38DE	40C	25DE	27BC	38DE	40C	25 DE	27 BC
1%HC +2%MO	31 DE	33 C	20DE	22BC	31 DE	33 C	20DE	22BC	38DE	40C	25DE	27BC	38DE	40C	25 DE	27 BC
2%HC +1%MO	30 EF	32 CD	19EF	21 CD	30 EF	32CD	19EF	21CD	37EF	39CD	24EF	26CD	37EF	39CD	24EF	26 CD
2%HC +2%MO	30 EF	32 CD	19EF	21 CD	30EF	32CD	19EF	21CD	37EF	39CD	24EF	26CD	37EF	39CD	24 EF	26CD
LSD	1.205		1.664		1.259		1.518		1.215		1.658		1.197		1.289	

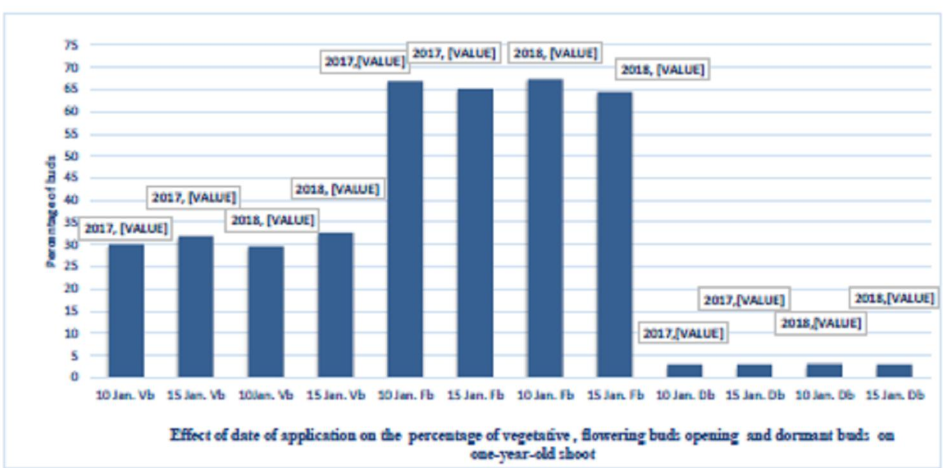

Figure (3): Effect of date of application on the percentage of vegetative and flowering buds opening and dormant buds on one-year-old shoot.

Vb.= vegetative bud, Fb = Flowering Buds, Db = Dormant buds

3.2.2 Percentage of vegetative buds opening on 1-year-old shoots and on spur buds:

All treatments significantly decreased the percentage of vegetative buds opening on 1-year old shoots and on spur buds compared to that of the untreated control in both seasons, except for the 1 % HC treatment, which produced the highest significant percentage of vegetative buds opening on spur buds (Table 4). However, the treatment of 1% GO significantly reduced the percentage of vegetative buds opening in both seasons compared to the other treatments on both one-year-old shoots and spur buds respectively (Table 4). The Percentage of vegetative buds opening on one-year-old shoots of the second date of application was significantly higher than that of the first one in both seasons (fig.3).

Table 4. Main Effects of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on the percentage of vegetative, flowering buds opening and dormant buds on one-year-old shoot and spur buds of "Basateen MKM" pear cultivar during 2017 and 2018 seasons.

	Vegetative bud %				Flowering bud %				Dormant bud %			
	One year old shoot		Spur buds		One year old shoot		Spur buds		One year old shoot		Spur buds	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	62.67A	55.78A	43.21 B	50.09B	26.00 I	32.67 H	46.12H	38.00G	11.33 A	11.55 A	10.67 A	11.91 A
1% HC	37.96B	36.03B	48.88 A	54.5 A	59.71H	61.39G	48.84G	43.28F	2.330E	2.58BC	2.28G	2.22EF
2%HC	21.30H	13.89H	17.70H	21.63D	76.32B	83.83A	71.50D	76.17D	2.375D	2.285EF	2.46C-E	2.21F
0.5%GO	25.77G	22.98F	23.55 F	16.42F	71.95C	74.65C	74.17C	81.50B	2.270H	2.355DE	2.29G	2.11GH
1%GO	9.815I	16.40G	9.93 I	4.05G	87.79A	81.39 B	87.67A	93.83A	2.390C	2.205F	2.40E-G	2.12G
1%HC+0.5%GO	38.74 B	36.93B	37.51C	36.14C	58.84 H	61.35G	59.83F	62.17E	2.415B	2.048G	2.605 B	2.205F
1% HC+1%GO	35.03C	32.83D	30.58D	22.58D	62.54G	64.97E	66.83E	75.33D	2.390C	2.180FG	2.58 BC	2.075HI
2%HC +0.5%GO	26.74 FG	33.38D	27.52E	35.10C	70.89CD	64.46EF	70.17D	62.83E	2.286G	2.160FG	2.32FG	2.06 I
2%HC +1%GO	32.60D	34.79C	29.45D	19.58E	65.23F	63.10F	67.00E	78.17C	2.18 I	2.605B	2.54BD	2.25DE
1%HC +1%MO	29.05E	32.50D	22.97F	18.83E	68.64E	65.03 E	74.17C	78.83C	2.30 F	2.455C	2.57 BC	2.33C
1%HC +2%MO	26.11FG	28.08 E	26.10E	16.88F	71.51C	69.44D	71.33D	80.67B	2.365D	2.465CD	2.57BC	2.27 D
2%HC +1%MO	29.25E	32.31D	19.73G	16.24F	68.43E	65.29E	77.83B	81.50B	2.305F	2.390DE	2.44 DF	2.27 D
2%HC +2%MO	27.76 EF	28.80 E	22.48F	19.24E	69.75DE	68.98D	75.17C	78.56C	2.280G	2.215 F	2.4EG	2.380 B
LSD	1.835	1.410	1.518	1.591	1.490	1.383	1.588	1.537	0.01150	0.1360	0.1311	0.03636

The percentage of vegetative buds opening on spurs for the second date was significantly higher than that of the first in the first season. However, in the second season, the average percentage of vegetative buds opening on spur buds for the first date was significantly higher than that of the second one (fig. 4).

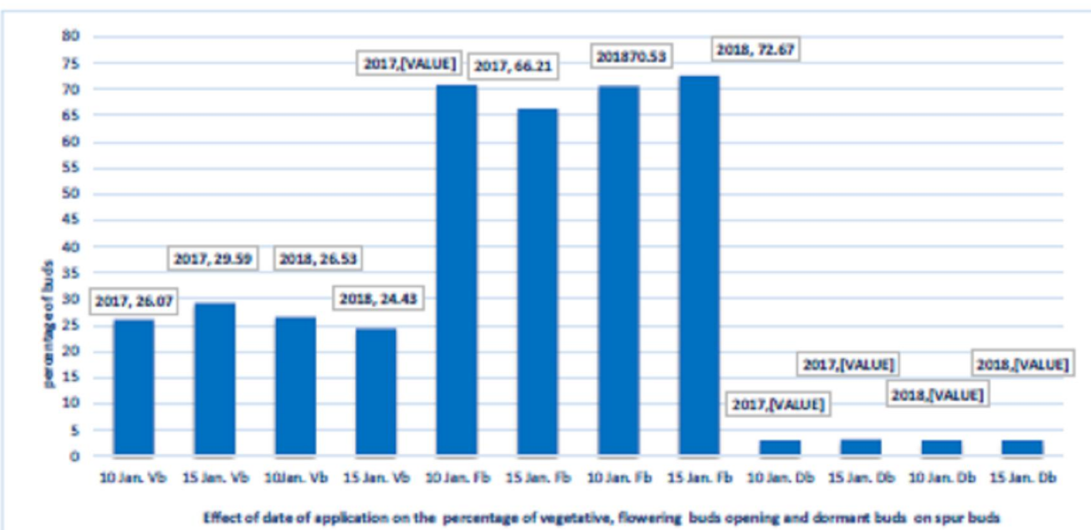

Figure (4): Effect of date of application on the percentage of vegetative and flowering buds opening and dormant buds on one-year-old shoot.

Vb= vegetative bud, Fb = Flowering Buds, Db = Dormant bud

The interaction effects showed that the treatment with 1 % GO resulted in the lowest percentage of vegetative buds opening on both one-year-old shoots and spur buds in the first date in both seasons (Table 5).

The interaction effects showed that the highest significant percentage of vegetative buds opening on spur buds produced by 1 % HC in both dates in both seasons. (Table 5).

3.2.3. Percentage of flowering buds on both 1-year-old shoots and spur buds:

All treatments significantly increased the percentage of flowering buds opening on one-year-old shoots and spur buds compared to the untreated control in both seasons (Table 4) Moreover, 1 % GO treatment significantly increased the percentage of flowering buds opening on one-year-old shoots compared to the untreated control and the other treatments in the first season, whereas in the second season, 2 % HC treatment significantly increased the average flowering bud opening percentage followed by the treatment with 1%Go in comparison to other treatments (Table 4). Treatment with 1 % GO produced the highest significant percentage of flowering buds opening on spur buds compared to the other treatments in both seasons. (Table 4). Regarding the effect of application date, the average percentage of flowering buds opening on one-year-old shoots for the first date of application was significantly higher than that of the second one in both seasons (fig.3). However, the percentage of flowering buds opening on spur buds increased significantly for both the first and the second date of application in the first season and in the second season, respectively (fig. 4).

Table 5. Interaction effects of Effect of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on the percentage of vegetative and flowering buds opening and dormant buds on one-year-old shoot and spur buds of "Basateen MKM" pear cultivar during 2017 and 2018 seasons

	Vegetative bud %							
	1year old shoot				**Spur bud**			
	1st 2017		**2nd 2018**		**1st 2017**		**2nd 2018**	
Date of application.	**10Ja**	**15Ja**	**10Ja**	**15Ja**	**10Ja**	**15Ja**	**10Ja**	**15Ja**
Control	62.6a	62.6a	55. a	55.7a	43.2c	43.2c	50.09 b	50. b
1% HC	38.61cd	37.3cd	33.9def	38.0b	51. a	45.8b	57.56 a	51. b
2%HC	24.5ijk	18.01	17. n	10.2o	15.31	20.0jk	26. f	16.8kl
0.5%GO	27.1hi	24.3jk	21. m	24.51	24.8g	22.2hi	19.8hj	12. m
1%GO	9.3m	10. m	8.49o	24.31	4.2m	15.61	4.3 n	3.78n
1%HC+0.5%GO	39.2c	38.2cd	35.3cd	38.4b	33.5e	41.4c	36. d	35.4d
1% HC+1%GO	36.3d	33.6e	32.8efg	32.8efg	30.2f	30.9f	21h	23.9g
2%Hc+0.5%Go	30.7f	22.7k	34.3de	32.3fgh	24.7g	30.2f	28. e	41.2c
2%HC +1%GO	31.6ef	33.5e	32.4efg	37. bc	20. i-k	38.3dd	18.3jk	20.8hi
1%HC +1%MO	30.1fg	27.9gh	31. gh	34. def	24.9g	21. ij	19.3hij	18.3jk
1%HC +2%MO	26.9hi	25.3ijk	27.2jk	28.9ij	23.1gh	29.f	18.5jk	15.1lm
2%HC +1%MO	15.7l	42.7b	26.7k	37.8b	20.9ij	18.5k	18.9ijk	13.5m
2%HC +2%MO	18.2 l	37.2cd	27.1jk	30.4hi	21.0ij	23.9gh	24.5fg	13.9m
LSD	**2.595**		1.995		2.147		2.249	

	Flowering bud %							
	1 year old shoot				**Spur bud**			
	1st 2017		**2nd 2018**		**1st 2017**		**2nd 2018**	
Date of application.	**10Ja**	**15Ja**	**10Ja**	**15Ja**	**10Ja**	**15Ja**	**10Ja**	**15Ja**
Control	26. n	26.n	32.6o	32.6 o	46.1m	46.1m	38.n	38.n
1% HC	59. kl	60.2kl	63. kl	59. n	45.6m	52.l	40.1n	46. m
2%HC	73. de	79.6c	80.1 b	87.5a	82. b	60.6j	71.3 i	81.de
0.5%GO	70.5fg	73.3de	76.0c	73.2d	73.0fg	75.3de	78.fg	85. b
1%GO	88.3a	87.2a	89.1a	73 d	93. a	81. b	93. a	94. a
1%HC+0.5%GO	58.3l	59.3kl	62.3lm	60. n	64. i	55.6 k	26k	62.3k
1% HC+1%GO	61.2k	63.8j	64.8ijk	65.0ijk	67.3h	66h	76.67g	74.h
2%Hc+0.5%Go	66.7h	75.c	63. kl	65.4hij	73.0fg	67.3h	69.j	56.6l
2%HC +1%GO	66.1hi	64.3ij	65. ij	60.8mn	75.def	59.j	79. ef	77.g
1%HC +1%MO	67.5h	69.7g	66.4hi	63.5jk	72.6g	75.6de	78.3fg	79.ef
1%HC +2%MO	70.6fg	72.3ef	70.3ef	68.5fg	74.3e-g	68.3h	78.6fg	82.cd
2%HC +1%MO	82b	54. m	70.8e	59. n	76.6d	79.c	78.6fg	84.bc
2%HC +2%MO	79.3c	60. kl	70.5e	67.3gh	76.6d	73.7e-g	73.1hi	84.bc
LSD	2.107		1.956		2.246		2.173	

	Dormant bud							
	1 year old shoot				**Spur bud**			
	1st 2017		**2nd 2018**		**1st 2017**		**2nd 2018**	
Date of application.	**10Ja**	**15Ja**	**10Ja**	**15Ja**	**10Ja**	**15Ja**	**10Ja**	**15Ja**
Control	11. a	11.3a	11.5a	11. a	10.67a	10.67a	11.91 a	11.91 a
1% HC	2.24l	2.42c	2.60c	2.5 cd	2.38gj	2.18j	2.29 de	2.14 hj
2%HC	2.4d	2.35f	2.29fghi	2.2fgh	2.30hj	2.61cf	2.22 fg	2.19gh
0.5%GO	2.25k	2.29i	2.49cde	2.2fgh	2.16j	2.4gh	2.14h-j	2.08kl
1%GO	2.35f	2.43c	2.33efgh	2.0 j	2.13j	2.7ed	2.01m	2.22fg
1%HC+0.5%GO	2.39de	2.44b	2.26fghij	1.8k	2.4gh	2.81b	2.16hi	2.25ef
1% HC+1%GO	2.4d	2.38e	2.25fghij	2.1 ij	2.4gh	2.8bc	2.09jkl	2.06lm
2%Hc+0.5%Go	2.33g	2.24k	2.1ghij	2.1 ij	2.20ij	2.4fh	2.06lm	2.06m
2%HC +1%GO	2.23l	2.12n	2.18hij	3.0 b	2.4g-i	2.7bc	2.360 bc	2.13ijk
1%HC +1%MO	2.3e	2.29i	2.5 cde	2.4 def	2.7bc	2.4 fh	2.330 cd	2.33cd
1%HC +2%MO	2.44b	2.291i	2.4cdef	2.5cde	2.5eh	2.7be	2.400 b	2.14hij
2%HC +1%MO	2.27j	2.34f	2.3 defg	2.4def	2.38gi	2.5dg	2.400 b	2.14hij
2%HC +2%MO	2.39de	2.17m	2.2 fghi	2.1hij	2.30hj	2.4gh	2.36 bc	2.40 b
LSD	0.01626		0.1924		0.1854		0.05141	

The interaction effects showed that the highest percentage of flowering buds opening on one-year-old shoots and on spur buds resulted from the treatment of 1 % GO in the first date in both seasons (Table 5).

3.2.3. Percentage of dormant buds on 1-year-old shoots and on spur buds:

All treatments significantly decreased the percentage of dormant buds on both one-year-old shoots and on spur buds compared to the untreated control in both seasons (Table 4).

Regarding the application date, the percentage of dormant buds on one-year-old shoots in the first date of application was significantly higher than that of the second date in the first season. However, spraying dates did not significantly differ in their effect on the percentage of dormant buds in the second season (fig.3). However, the lowest average percentage of dormant buds on spur buds resulted from the first date of application in the first season. Conversely, in the second season, the second date was more effective in decreasing the percentage of dormant buds than the first one (fig. 4).

The interaction effects showed that the lowest percentage of dormant buds on one-year-old shoots resulted from the treatment of 2 % HC + 1 % GO in the second date of application in the first season and by the treatment of 1% HC + 0.5 % GO in the second date of application in the second season (Table 4). The interaction effects showed that in both dates, the treatment of 1 % GO produced the lowest average percentage of dormant buds on spur buds in both seasons (Table 5).

3.3 Vegetative growth

3.3.1 Average shoot length, shoot diameter, number of new current shoots and number of leaves on new current shoot:

Generally, the 1 % HC treatment significantly increased the average shoot length, shoot diameter, number of new current shoot and number of leaves compared to that of the untreated control and the other treatments in both seasons (Table 6 & 8). Regarding the effects of the application date, all vegetative growth parameters for the first date of application was significantly higher than that of the second one in both seasons (fig. 5 & 6 & 7 & 8).

Table 6. Main Effects of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on shoot length and diameter of "Basateen MKM" pear cultivar during 2017 and 2018 seasons

	Shoot length (cm)		Shoot diameter (mm)	
	1st2017	2nd2018	1st2017	2nd2018
Control	93.78 BC	92.00C	0.90 C	0.96 A
1% HC	106.0 A	105.7A	0.96AB	0.97 A
2%HC	87.00EF	86.83DE	0.82E	0.87 C
0.5%GO	78.33 G	78.83 F	0.97 AB	0.98 A
1%GO	71.83 H	73.67 G	0.87 CD	0.87C
1%HC+0.5%GO	91.67CD	90.83 C-E	0.86 CD	0.88C
1% HC+1%GO	85.33 F	86.67E	0.88 CD	0.88 BC
2%HC +0.5%GO	79.33 G	81.00 F	0.88 CD	0.88 BC
2%HC +1%GO	87.33 EF	87.50DE	0.96 AB	0.95 A
1%HC +1%MO	89.50 DE	91.00 CD	0.85 DE	0.97 C
1%HC +2%MO	96.67 B	97.33 B	0.94 B	0.91B
2%HC +1%MO	89.50DE	90.83 C-E	0.98 A	0.97A
2%HC +2%MO	90.00CD	89.50 C-E	0.97 AB	0.97 A
LSD	3.830	4.295	0.03636	0.03598

Table 7. Interaction effects of Effect of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on shoot length and diameter of "Basateen MKM" pear cultivar during 2017 and 2018 seasons.

	Shoot length (cm)				Shoot diameter (mm)			
	1st2017		2nd 2018		1st2017		2nd 2018	
Date of application	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja
Control	93.78 C-E	93.78 C-E	92.00 CD	92.00 CD	0.90 D-F	0.90D-F	0.9600A-C	0.9600 A-C
1% HC	117.0 A	95.00 B-D	116.3 A	95.00 BC	0.9600 BC	0.9500B-D	0.9900 AB	0.9400 B-D
2%HC	90.67 E	83.33FG	92.33 C	81.33 E-G	0.80 H	0.8300 GH	0.9000D-F	0.8333 J
0.5%GO	83.33 FG	73.33 IJ	81.33E-H	76.33 G-I	0.98 A-C	0.9600 BC	1.0000 A	0.9600 A-C
1%GO	73.00 IJ	70.67J	75.67 HI	71.67 I	0.57 FG	0.8700 FG	0.88EFG	0.8533 H-J
1%HC+0.5%GO	98.67BC	84.6 F	96.67 BC	85.00 E	0.90D-F	0.8300GH	0.9133C-E	0.8300 J
1% HC+1%GO	91.67 DE	79.00GH	92.67 C	80.67 E-G	0.90 D-F	0.8633FG	0.9000D-F	0.8600 G-J
2%HC +0.5GO	81.67 F-H	77.00 HI	83.67 EF	78.33 F-H	0.90 EF	0.8700FG	0.8900D-I	0.8667 F-J
2%HC +1%GO	95.33 B-E	79.33F-H	94.33 BC	80.67E-G	1.02 A	0.9000 DE	1.0000 A	0.9000D-G
1%HC +1%MO	95.67 B-E	83.33 FG	96.00 BC	86.00 DE	0.87 FG	0.8300 GH	0.8900D-I	0.8400 IJ
1%HC +2%MO	99.33 B	94.00B-D	100.0 B	94.67 BC	0.95 BC	0.9310 CD	0.9200C-E	0.9067 D-G
2%HC +1%MO	95.67B-E	83.33FG	97.67 BC	84.00 EF	1.02 A	0.9400C-E	1.0100 A	0.9333 CD
2%HC +2%MO	96.33 B-D	83.67FG	96.67 BC	82.3 E-G	1.00 AB	0.9400C-E	1.0067 A	0.9333CD
LSD	5.417		6.074		0.05141		0.049989	

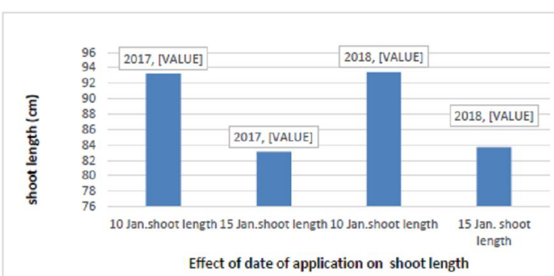

Figure (5): Effect of date of application on shoot length

In general, the interaction effects showed that all vegetative growth parameters reached the highest average in response to the 1% HC treatment for the first date in both seasons. Conversely, the lowest average of shoot length, number of leaves and number of new current shoots was attained when trees were sprayed with 1 % GO on the second date in both seasons (Table 7 & 9). However, the highest average of shoot diameter resulted from the 2 % HC + 1 % MO treatment on the first date in both seasons. Conversely, the lowest average shoot diameter was attained for 2 % HC alone and 1 % HC + 0.5 % GO when sprayed on the second date in both seasons (Table 7).

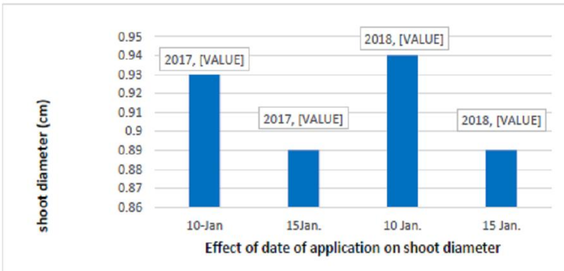

Figure (6): Effect of date of application on shoot diameter

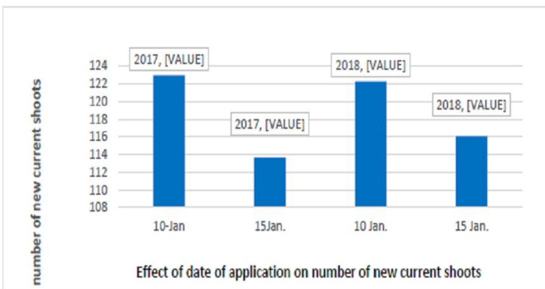

Figure (7): Effect of date of application on number of new current shoots

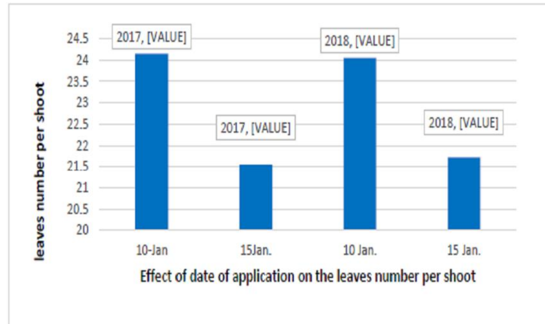

Figure (8): Effect of date of application on the leaves number per shoot

Table 8. Main Effects of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on the leaves number per shoot and the number of new current shoots of Basateen MKM pear cultivar during 2017 and 2018 seasons.

	Leaves number per shoot		Number of new current shoots/tree	
	1st 2017	2nd 2018	1st 2017	2nd 2018
Control	24.33 B	22.33 CD	85.00 H	90.00 H
1% HC	26.61 A	27.33 A	157.6 A	111.7 F
2%HC	22.07 DE	22.33 CD	119.8D	128.5 C
0.5%GO	21.00 E	20.50E	111.2 F	121.7 D
1%GO	18.67 F	18.83 F	122.3CD	129.9 BC
1%HC+0.5%GO	23.33 BCD	23.00BC	104.2G	107.1 G
1% HC+1%GO	22.17DE	22.33CD	108.8 F	120.8 D
2%HC +0.5%GO	21.00 E	21.00 DE	110.0 F	115.7 E
2%HC +1%GO	23.17 BCD	22.83BC	104.2 G	112.2 F
1%HC +1%MO	24.00 B	22.83 BC	137.3 B	138.2 A
1%HC +2%MO	24.17 B	26.33 A	138.6 B	119.3 D
2%HC +1%MO	22.67 CD	23.50 BC	123.8 C	119.3 D
2%HC +2%MO	23.83 BC	23.33 BC	115. E	132.7 B
LSD	1.323	1.334	3.373	3.261

Table 9. Interaction effects of Effect of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on the leaves number per shoot and the number of new current shoots of Basateen MKM pear cultivar during 2017 and 2018 seasons.

	Leaves number per shoot				**Number of new current shoots/tree**			
	1st2017		2nd 2018		1st2017		2nd 2018	
Date of application	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja
Control	24.33CDE	24.3 CDE	22.33EFG	22.33 EFG	85.00 O	85.0 O	90.00 I	90.00 I
1% HC	29.33 A	23.89 CDEF	29.00 A	25.67BC	165.3 A	150.0 B	115.3 G	108.1 H
2%HC	22.93DEFGH	21.21 IJK	23.67DEF	21.00 GHIJ	125.3 E	114.3 HIJ	124.3 DE	132.7 C
0.5%GO	23.00DEFGH	19.00L	21.33GHI	19.6 IJK	117.3 GHI	105.0 LM	127.0D	116.3 G
1%GO	18.67 L	18.67 L	19.33 JK	18.33 K	124.7EF	120.0 FG	133.7C	126.0 DE
1%HC+0.5%GO	24.67BCD	22.00 GHIJ	24.33 CD	21.67 GH	108.5KL	100.0 N	108.0 H	106.3 H
1% HC+1%GO	24.00 CDEF	20.33 JKL	24.00CDE	24.00CDE	115.7 GHIJ	102.0 MN	126.3 DE	115.3G
2%HC +0.5GO	22.33 FGHI	19.67 KL	22.00 FG	20.0 HIJK	113.7 IJ	106.3 LM	124.3 DE	107.0 H
2%HC +1%GO	24.67BCD	21.67 HIJ	24.33 CD	21.33 GHI	108.3 KL	100.1 N	116.7 G	107.7 H
1%HC +1%MO	26.33 B	21.67 HIJ	25.33 BCD	22.33 EFG	141.3 C	133.3 D	143.4 A	133.0C
1%HC +2%MO	25.00 BC	23.33CDEFG	27.00 B	25.67BC	142.0 C	135.3 D	117.0G	121.7EF
2%HC +1%MO	23.6CDEFG	21.67 HIJ	25.00 CD	22.00 FG	132.7D	115.0HIJ	125. DE	118.7FG
2%HC +2%MO	25.00 BC	22.6EFGHI	25.00 CD	21.67GH	119.0 GH	112.3 JK	138.7 B	126.7 D
LSD	1.81		1.887		4.771		4.612	

Table10. Main Effects of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on leaf N, P and K content of Basateen MKM pear cultivar during 2017 and 2018 seasons.

	Leaf N content (%)		**Leaf P content (%)**		**Leaf K content (%)**	
	1st2017	2nd 2018	1st2017	2nd 2018	1st2017	2nd 2018
Control	2.35CF	2.21C-F	0.22B	0.20B	1.22E	1.25F
1% HC	2.62A	2.47A	0.28A	0.26A	1.51A	1.43A
2%HC	2.47BC	2.33BC	0.26AB	0.25AB	1.45AB	1.40A-C
0.5%GO	2.35 CF	2.20D-F	0.23B	0.21AB	1.32C-E	1.29EF
1%GO	2.33D-F	2.19D-F	0.22B	0.21B	1.30DE	1.27F
1%HC+0.5%GO	2.35C-F	2.28B-E	0.25AB	0.22AB	1.41A-C	1.38BC
1% HC+1%GO	2.40B-E	2.27C-E	0.27AB	0.25AB	1.45AB	1.41A-C
2%HC +0.5%GO	2.23F	2.13F	0.22B	0.20B	1.27DE	1.27EF
2%HC +1%GO	2.29EF	2.17EF	0.22B	0.21AB	1.22E	1.24F
1%HC +1%MO	2.46BD	2.31B-D	0.25AB	0.23AB	1.35B-D	1.32DE
1%HC +2%MO	2.40BE	2.30B-D	0.26AB	0.24AB	1.42A-C	1.36CD
2%HC +1%MO	2.47BC	2.33B-C	0.23AB	0.21AB	1.45AB	1.42AB
2%HC +2%MO	2.52AB	2.40AB	0.25AB	0.24AB	1.38B-D	1.40A-C
LSD	0.1311	0.1206	0.05141	0.05141	0.1150	0.05141

Table 11. Interaction effects of Effect of hydrogen Cyanamid (HC), mineral oil (MO) and garlic oil (GO) on leaf N, P and K content of Basateen MKM pear cultivar during 2017 and 2018 seasons.

	Leaf N content (%)				**Leaf P content (%)**				**Leaf K content (%)**			
	1st2017		2nd 2018		1st2017		2nd 2018		1st2017		2nd 2018	
Date of application	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja	10Ja	15Ja
Control	2.350G-F	2.35CG	2.21D-G	2.21D-G	0.22A-C	0.22A-C	0.20A	0.20A	1.22GH	1.22GH	1.25H	1.25h
1% HC	2.71A-C	2.71AC	2.53A	2.41AB	0.29A	0.27A-C	0.25A	0.27A	1.53A	1.53A	1.42A-C	1.46A
2%HC	2.53AC	2.41BF	2.37A-D	2.29BF	0.28AB	0.24abc	0.22A	0.27A	1.43A-D	1.46A-C	1.37B-F	1.43AB
0.5%GO	2.4BF	2.32DG	2.27B-G	2.13FG	0.24A-C	0.21BC	0.20A	0.22A	1.29D-H	1.34B-H	1.28GH	1.29GH
1%GO	2.36C-G	2.3E-G	2.27B-G	2.11G	0.22A-C	0.22A-C	0.21A	0.20A	1.29D-H	1.30C-H	1.25H	1.28GH
1%HC+0.5%GO	2.39B-F	2.31D-G	2.33B-E	2.23C-G	0.26A-C	0.23A-C	0.20A	0.24A	1.38A-G	1.44A-D	1.35C-G	1.41A-D
1% HC+1%GO	2.41B-F	2.40B-F	2.29B-F	2.25B-G	0.28AB	0.25A-C	0.24A	0.25A	1.42AD	1.48AB	1.40A-E	1.42A-C
2%HC +0.5GO	2.27E-G	2.19G	2.16E-G	2.11G	0.23A-C	0.20C	0.20A	0.20A	1.25D-G	1.29D-H	1.29GH	1.25H
2%HC +1%GO	2.31D-G	2.26FG	2.21D-G	2.13FG	0.21BC	0.22A-C	0.22A	0.20A	1.20H	1.23F-H	1.24H	1.24H
1%HC +1%MO	2.52B-C	2.39B-F	2.32B-E	2.29B-F	0.26A-C	0.23A-C	0.22A	0.24A	1.31C-H	1.39A-F	1.33E-F	1.31F-H
1%HC +2%MO	2.43B-F	2.37B-G	2.30B-F	2.31B-E	0.28AB	0.24A-C	0.22A	0.25A	1.39A-F	1.44A-D	1.34D-G	1.38B-F
2%HC +1%MO	2.49B-D	2.45B-E	2.33B-E	2.33B-E	0.25A-C	0.22A-C	0.20A	0.23A	1.42A-D	1.48AB	1.41A-D	1.44AB
2%HC +2%MO	2.55AB	2.49B-D	2.41AB	2.39A-C	0.27A-C	0.24A-C	0.23A	0.25A	1.34B-H	1.41A-E	1.39A-E	1.43AB
LSD	0.19		0.17		0.07271		0.07271		0.1626		0.07271	

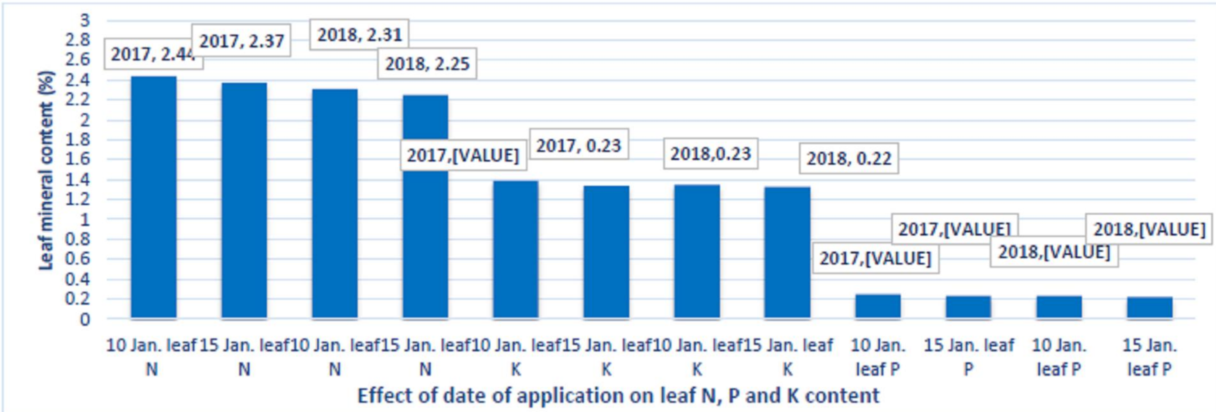

Figure (9): Effect of date of application on leaf N, P and K content

3.4 Leaf mineral content

3. 4.1. Nitrogen, Phosphorus and potassium

Treatment with 1 % HC significantly increased the percentage of leaf nitrogen, phosphorus and potassium as compared to that of the untreated control and other treatments in both seasons. Conversely, the lowest percentages of leaf nitrogen, phosphorus and potassium generally, resulted from the treatment of 2 % HC + 0.5 % GO compared with that of the control and other treatments in both seasons (Table 10).
Regarding spraying dates, the percentage of both leaf nitrogen and potassium for the first date was significantly higher than that of the second date in both seasons (Fig. 9). However, for the phosphorus content, the percentage of leaf P for the first date was significantly higher than that of the second in the first season. However, in the second season, there was no significant difference between the two application dates (Fig. 9). Generally, the treatment of 1 % HC resulted in the highest percentage of both leaf nitrogen, potassium and phosphorus in both dates in both seasons. Conversely, the treatment of 2 % HC + 0.5 % GO approximately resulted in the lowest percentage of leaf nitrogen, phosphorus and potassium for the second date in both seasons (Table 11).

4. Discussion

The effects of Dormex on the promotion of early and uniform bud opening in the present study may have been caused by an increased respiration rate and reduced effect of catalase. Catalase plays an important role in plants because it detoxifies hydrogen peroxide by catalyzing its breakdown into water and oxygen. When the action of catalase is inhibited by Dormex, the consequent accumulation of peroxides in the cell leads to metabolic reactions that stimulate the plant and breaks dormancy (Shulman et al., 1986). In addition, Kuroi (1985) and Yang et al. (1990) concluded that cyanide ions may play a role in inducing enzyme activities that promote the translocation of stored reserves and the uptake of nitrogen leading to bud break. Moreover, trees treated with Dormex had increased levels of proline and biogenic amine, which are associated with greater stimulation of the pentose-phosphate pathway resulting in the highest percentage of bud break (Linsley-Noakes, 1989).

Exogenous application of garlic extract hastened budbreak and enhanced flowering parameters. This may have been attributable to sulfur-containing compounds, in particular, diallyl mono, di- and tri-sulfides, and dimethyl disulfide according to Kubota et al. (1999). Furthermore, dimethyl disulfide has specifically been identified as being responsible for this effect (Kubota et al., 2003). In this process, sulfur is fixed as cysteine by the plants after the reduction process (Saito, 2000). Cysteine is the initial material for the production of reduced glutathione, which is responsible for detoxing cells through the elimination of free radicals and reactive oxygen species that accumulate during different types of stress (Saito, 2004; Zhang, 2004).

The increase in vegetative and flowering bud opening percentages and decrease in the dormant bud percentage as a result of Dormex and GO may have been caused by rapid starch degradation and sugar accumulation in the buds and bark tissues of floral and vegetative buds immediately after treatment. The breakdown of starch was intimately connected with the increase in sucrose, glucose, and fructose concentrations. These results are in agreement with Hussain et al. (2016), who worked with the Wonhwang pear cultivar. They found that starch concentration was high in dormant floral buds and declined during the forcing of bud break. Additionally, Dormex can be attributed to advanced bud break by approximately 10 days and an increase in the percentage of vegetative buds.

The reduction in the vegetative growth parameters as a result of GO application may have been caused by the effect of GO on increasing fruit set, the number of fruits, and yield, which resulted in reduced vegetative growth. Thus, it might be caused by competition between fruit and vegetative growth. Such effects could also be interpreted as the fruit being a strong sink for assimilates. In this respect, it is noteworthy that the higher density of flowers on shoots from trees treated with Dormex, GO, and MO was probably related to the reduction of shoot length, which could stimulate cluster bud development as a result of saving assimilates necessary for flowering.

5. Conclusion

Based on the results of the present study, it can be concluded that spraying trees with Dormex or/and GO individually or in combination produced early and uniform bud opening by 10 days relative to that of the control, increased the percentage of flowering buds and decreased the percentage of dormant buds. Furthermore, treatment with 1 % HC enhanced all vegetative growth parameters compared to that of the untreated control. The early application date (January 10) was more effective than the second date for all vegetative growth parameters.

Acknowledgements:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Abd El-Razek, E. Abd El-Migeed, M. M.M. and Abdel-Hamid, N. (2013). Response of "Le Conte" Pear Trees to Garlic Extract and GA3 as Budbreak Dormancy Agents Middle-East Journal of Scientific Research, 14 (11): 1407-1413.
2. Chapman, H. D. and P. F. Pratt. (1961). Methods of analysis for soils, plant and water. Univ. of California-Division of Agri. Sci. Rev. California.
3. Costa, G., 2003. Recenti innovazioni nella tecnica colturale e nell'impollinazione dell'actinidia. Proceedings of the National Convention: Kiwi, Fruit of Twentieth Century Novelty. Verona, Italy. 105–134.
4. Dimitri, C., Oberholtzer, L., 2006. EU and U.S. organic markets face strong demand under different policies. Amber Waves. Economic Research Service USDA 4, 12–19.
5. El-Sabagh, A.S., 1995. Studies on effect of some treatments on the burst of Anna apple buds. Msc. Thesis, Fac. of Agric., Cairo Univ., Egypt.
6. El-Sabagh, A.S., 1999. Effect of some treatments on the relation between vegetative growth and fruiting of Anna apple trees under desert condition. PhD. Thesis. Fac. of Agric., Cairo Univ., Egypt.
7. El-Sabagh, A.S., Othman, S.A., Al-Abdaly, A.N., 2012. Performance of anna apple cultivar grown on two different rootstocks in response to hydrogen cyanamide winter spraying. World J. Agric. Sci. 8, 1–12.
8. Erez, A., 1995. Means to compensate for insufficient chilling to improve bloom and leafing. Acta Hortic. 395, 81–95.
9. Erez, A., 2000. Bud dormancy; phenomenon, problems and solutions in the tropics and subtropic, in: Erez, A. (Ed.), Temperate Fruit Crops in Warm Climate. Kluwer Academic Publishers, Bet-Dagan, pp. 17–48.
10. Erez, A., Rignwald, S., Yablowitz, Z. 1993. New means to break bud rest and advance bloom in apple and peach. ISHS, Sym. on (TZFTS) Cairo, Egypt, Abst, 33.
11. Evenhuis, B. and P.W. Dewaard (1976). Nitrogen detremination. Agric. Res. Royal Tropical. Ins, Amesterdam.
12. FAO. 2011. State Agriculture Data. http:// faostat.fao.org/.
13. Hartmann, T., Mult, S., Suter, M., Rennenberg, H., Herschbach, C., 2000. Leaf age-dependent differences in sulphur assimilation and allocation in poplar (*Populus tremula* x *P. alba*) leaves. J. Exp. Bot. 51,1077–1088.
14. Hussain, S., Teng, Y., Hamid, A., Zulfiqar, S., Shah, A., Shah, A.H., Yaqoob, A., Ali, T Ahmed, M., Hussain, I., Arif, U., 2016. Carbohydrate changes during dormancy release in floral, vegetative buds and bark tissues of pear cultivar 'Wonhwang' cuttings following dormancy breaking agent's treatment. Int. J. Environ. Agric. Res. 2, 53–64.
15. Koch, H.P., 1996. Biopharmaceutics of garlic's effective compounds, in: Koch, H.P., Lawson, L.D., (Eds.), Garlic. The Science and Therapeutic Application of *Allium sativum* L. and Related Species. Williams & Wilkins, Baltimore, Maryland, pp. 213–220.
16. Kubota, N., Yamane, Y., Toriu, K., Kawazu, K., Higuchi, T., 1999. Identification of active substances in garlic responsible for breaking bud dormancy in grapevines. J. Japan. Soc. Hort. Sci. 68,1111–1117.
17. Kubota, N., K. Tpriu, Y. Yamane, K. Kawazu, T. Higuchi, and S. Nishimura. (2003). Identification of active substance in Chinese chive and rakkyo plants responsible for breaking bud dormancy in

grape cutting. J. Japan. Soc. Hort. Sci. 72:268-274.
18. Kuroi, I. (1985). Effects of calcium cyanamide on bud break of 'Kyoho' grape. Journal of the Japanese Society for Horticultural Science, 54: 301–306.
19. Linsley-Noakes, G.C. (1989). Improving flowering of kiwifruit in climatically marginal areas using hydrogen cyanamide. Scientia Horticulturae, 38(3-4): 247-259.
20. Murphy, J. and P. Riley. (1962). A modified single solution method for the determination of phosphorus in natural water. Anal. Chim. Acta 27: 31-36.
21. Morsi, M.E., El-Yazal, M.A., 2008. Effect of potassium nitrate, garlic and onion extracts on bud break, growth, yield and some chemical constituents of apple (*Malus sylvestris* Mill.) trees. Fayoum J. Agric. Res. Dev. 22, 82–93.
22. Rady, M.M., Seif El-Yazal, M.A., 2014. Garlic extract as a novel strategy to hasten dormancy release in buds of 'Anna' apple trees. S. Afr. J. Bot. 92, 105–111.
23. Sagredo, K.X., Theron, K.I., Cook, N.C., 2005. Effect of mineral oil and hydrogen cyanamide concentration on dormancy breaking in "Golden Delicious" apple trees. S. Afr. J. Plant Soil 22, 251–256.
24. Saito, K., 2000. Regulation of sulfate transport and synthesis of sulfur-containing amino acids. Curr. Opin. Plant Biol. 3, 188–195.
25. Saito, K., 2004. Sulfur assimilatory metabolism. The long and smelling read. Plant Physiol. 136, 2443–2450.
26. Seif El-Yazal, M.A., Rady, M.M., 2012. Changes in nitrogen and polyamines during breaking bud dormancy in Anna apple trees with foliar application of some compounds. Sci. Hort. 136, 75–80.
27. Seif El-Yazal, M.A., Rady, M.M. and Seif S.A. (2012). Foliar-applied dormancy-breaking chemicals change the content of nitrogenous compounds in the buds of apple (Malus sylvestris Mill. cv. Anna) trees. Journal of Horticultural Science & Biotechnology 87 (4): 299–304.
28. Seif El Yazal, M.A, Rady, M.M, Seif El Yazal, S.A. (2018) Foliar-applied mineral oil enhanced hormones and phenols content and hastened breaking bud dormancy in "Astrachan" apple trees. International Journal for Empirical Education and Research,1:57–73.
29. Shulman, Y., Nir, G., Lavee, S., 1986. Oxidative process in bud dormancy and the use of hydrogen cyanamide in breaking dormancy. Acta Hortic. 179, 141–148.
30. Snedecor, G.W., Cochran, W.G., 1980. Statistical methods, 6th ed. Iowa St. Univ. Press, Ames, USA.
31. Vasconcelos, R., Pozzobom, A., Paioli, E., Monteiro, M. and Lopes, M. (2007). Effects of chilling and garlic extract on bud dormancy release in cabernet sauvignon grapevine cuttings. Amer J Enolo Viti. 58(3):402-404.
32. Yang, Y.S., Chang, M.T., Shen, B.K., 1990. The effect of calcium cyanamide on bud break retranslocation of accumulated 14C-assimilates and changes of nitrogen in grapevines in Taiwan. Acta Hortic. 279, 409–425.
33. Zhang, M., Bourbouloux, A., Cagnac, O., Srikanth, C., Rentsch, D., Bachhawat, A., 2004. A novel family of transporters mediating the transport of glutathione derivates in plants. Plant Physiol. 134, 482–491.

7/7/2020