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Impact of Bud Break Substances on Bud Behavior and Productivity of Grape Cv. Crimson

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ABSTRACT

The experiment was conducted at El-Mahala City, Gharbia Governorate, Egypt, during 2016/2017 and 2017/2018 growing seasons on 12-year-old "Crimson"seedless grape vines to find cheap alternatives to hydrogen cyanamide to help regularize the sprouts in the grapes of the Crimson variety, in addition study of the effect of these alternatives and hydrogen cyanamide on the behavior of grapevine grapes.Crimson seedless grape with the combination treatment of Dormex (2.5%) + Flaxseed oil (2.5 %) + ZnSO4 (0.5%) + urea (2.5 %) produced the highest percentages of bud burst and fertility,total sugars and glutathione content and the same time the lowest percentages of crude protein and total phenols content in buds in both seasons.The best treatment for increasing vegetative growth characters,physical characteristics of clusters and berries, chemical constituents of Crimson seedless grape berries and yield (yield/vine and yield/feddan)was obtained when treating Crimson seedless grapevines with the combination treatment of Dormex (2.5%) + flaxseed oil (2.5 %) + $ZnSO_4$ (0.5%) + urea (2.5 %), which resulted in the highest values of these traits in both seasons.

Keywords: Crimson seedless, Bud break, Dormancy, Dormex,Flaxseed oil, Urea, Zink sulfate, Grapevines.

INTRODUCTION

Across the world, Grape occupies the first position of deciduous fruit crop and the second place of fruit crop in Egypt after citrus. Egypt takes an important place in viticulture of the world and occupies the 10th place in grape production, hence the total cultivated area of grape in Egypt during 2017 season reached about 77895 hectares (185390 feddan) producing about 1703394 tons referring to (FAO, 2019).

Crimson seedless is one of the most desired planted cultivars of table grape vineyards in Egypt. The popularity of 'Crimson seedless' can be ascribed to the following; it is a late maturing, red seedless grape, which is not susceptible to berry crack thus allowing for a longer ripening period; and fruit kept in cold storage tends to remain in good condition. Another reason for its popularity could be that 'Crimson Seedless' was released as a public cultivar, with no restrictions on its propagation.

Crimson seedless (*Vitis vinifera* L.) grape is a late season, attractive, red seedless grape cultivar, introduced in 1989 as a seedless alternative to Emperor. Crimson seedless is the result of five generations of hybridization at the U.S. Department of Agriculture, Horticultural Field Station in Fresno, California. It was received favorably by consumers due to its elongated, firm berries and crisp eating quality (Ramming *et al.,* 1995). The clone C33-199, a late ripening, white seedless grape with all white grapes in its parentage, was used in the hybridization with 'Emperor' to produce 'Crimson seedless'. The cross was made in 1979 by David Ramming and Ron Tarailo, with 85 resultant seedlings that were planted in 1980. Out of four seedlings selected, 'Crimson Seedless' was the only red seedless cultivar. 'Crimson Seedless' was selected in 1983 and tested as C102-26. The source of seedless is 'Thompson seedless' (also known as 'Sultanina'), which was used as a parent in the first generation crossing (Ramming *et al*., 1995).

Compared to many other deciduous fruit crops, grapevines require relatively little exposure to chilling to terminate rest. Previous studies indicate that the chilling exposure necessary for normal bud growth ranges between 50 and 400 hours at temperatures $\leq 7\ ^{o}C$.

Hydrogen cyanamide (H_2CN_2), commercially known as dormex, which was originally developed for breaking dormancy in grapevines, is most efficient (Lavee *et al.,* 1984). The mechanism by which dormex exerts its dormancy-breaking effect is not clear, but it has been shown to inactivate catalase enzyme in grape buds shortly after its application (Amberger, 2013), leading to the accumulation of hydrogen peroxide and the development of oxidative stress. It has been shown that dormex can induce earlier and more uniform bud break on grapevines. The time of dormex application is critical; early application of dormex may advance fruit maturity by 2-6 weeks. This advancement can be useful in warm climates (Smit, 1985).

Anyway, the use of natural products in agricultural operations vice other synthetic chemical products is demanded for many fruit crop producers. Recently, some seed extracts are used for improving bud burst and production of grapeviens instead of dormex.

Flaxseed oil has a special glyphonic effect and related to the structure of oil from unsaturated fatty acids (Linoleic 17-24%, linolenic 40-63%), which combines with oxygen and becomes a neutral yellowish liquid that dries in thin layers when the oil is exposed to air. Furthermore, Petri *et al.* (2016) mentioned that trees receiving flaxseed oil during dormancy flowered earlier and in a shorter period compared to the untreated vines.

Among the different essential mineral nutrients, zinc (Zn) is an important micronutrient involved in enzymatic systems essential for protein synthesis, seed production and rate of maturity in plants. It is required for synthesis of tryptophan, which is a precursor of indole acetic acid. It also plays an important role in starch metabolism in plants. It is well known that Zn acts as a co-factor of many enzymes and affects many biological processes such as photosynthesis, nucleic acids metabolism, and biosynthesis of proteins and carbohydrates. The positive effects of Zn sprays are on nutritional status, increase flowering, fruit set, fruit size, and control fruit drop and ultimately increase the yield.

Foliar application of Zn can improve grape cluster yield and quality and control the premature fruit drop (Marschner, 2012).

Nutrient preserve in perennial tissues at the end of a growing season is an important and well-recognized characteristic of deciduous tree fruit crops. The amount of residual nitrogen at the end of the growing season affects tree growth and yield in the next season (Roubelakis-Angelakis and Kliewer, 1992). First growth of fruit trees in the spring is supported by remobilization of residual nitrogen and there is a positive relevance between spring growth and the amount of residual nitrogen for many species and varieties (Cheng *et al*., 2002 and Dong *et al*., 2002). Increasing residual nitrogen has become one of the targets of vineyard management, to maintain high production. Urea is considered the most suitable form of N for foliar treatment because of its, high solubility, low phytotoxicity, rapid absorption and nonpolarity (Knoche*et al*., 1994 and Bondada *et al*., 2001).Many reports have demonstrated that urea as foliar application increases nitrogen inside tissues and enhance leaf color and shoot growth (Tagliavini *et al.* 1998, Bondada *et al.* 2001, Johnson *et al.* 2001).Moreover, urea foliar application can be usedduring the growing season at anytimeespecially an autumn application which may be the most effective for grapevines because high urea concentrations can be used with minimal concern about phytotoxicity (Johnson *et al.* 2001).Following urea treatment, amino acid concentrations increased quickly in leaves, showing that the conversion of nitrogen from urea to amino acids appeared mainly in Leaves. After urea application, it has broken down to NH_4^+ and analyzed to amino acids that were then translocated to tissues, where nitrogen was needed (Swietlik and Faust 1984).

The most important problem related to the cultivation of grapevines in warm subtropical regions is considered to be the lack of adequate chilling. For this, the target of this investigation is; 1) Find cheap alternative materials to hydrogen cyanamide to help regularize the sprouts in the grapes of the Crimson variety, 2) Study of the effect of these alternatives and hydrogen ncyanamide on the behavior of crimson grapevine grapes.

MATERIALS AND METHODS

1- Plant materials and experimental procedure.

This study was donethrough two successive seasons 2016/2017 and 2017/2018 ; hence two hundred and sixteen vines were selected for this investigation, almost uniform in vigor, growth and in good physical condition. This study was performed on 12 - year - old "Crimson"seedless grapevines growing in a clay soil, drip irrigated and cultivated at 2 meter within rows and 3.5 meter between-rows with supporting by jabel trating system, located at El-Mahala City, Gharbia Governorate, Egypt. The experiment was designed as a randomized complete blocks design with three replicates (six vines for each replicate). The studied bud beak substances used as foliar application treatments were as follow;

1- Control (vines sprayed with water only).
2- Dormex (2.5%).
3- Flaxseed oil (2.5 %).
4- Dormex (5%).
5- Flaxseed oil (5%).
6- $ZnSO_4$ (0.5%) + urea (2.5%).
7- Dormex (2.5%) + Flaxseed oil (2.5 %).
8- Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%).
9- Flaxseed oil (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%).
10- Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%).
11- Flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%).
12- Dormex (2.5%)+Flaxseed oil (2.5 %)+$ZnSO_4$ (0.5%) + urea (2.5 %).

Zinc sulfate and urea were sprayed after harvest at 6/9/2016 and 1/10/2017 during both seasons, respectively. While, the other breaking dormant agents (dormex and flaxseed oil) were sprayed at Dormant bud stage at 19/2/2017 and 16/2/2018 during the both seasons, respectively.

2- Bud behavior.

Both seasons, during pruning time at 18/2/2017 and 15/2/2018, respectively. The total number of dormant buds per vine was recorded. After two weeks of spraying with dormex and flaxseed oil, total sugar %, crude protein %, and total phenol mg/100 g were determined according toMazumadar (2003) and glutathione mg/L was analyzed in buds by using (UPLC) according to the method described by Fracassette *et al.* (2011). Furthermore, after 30 days of bud break of each season, number of bursted buds, fruitful buds and clusters per vine were counted then the percentages of opened bud, fertility and fruitfulness were calculated as follows; Bud burst % (number of burst buds per vine divided by total number of buds per vine ×100) at 2/4/2017 and 8/4/2018 during both seasons, respectively. Bud fertility % (the number of clusters per vine divided by total number of buds per vine × 100) and Fruitfulness % (the number of fruitful buds divided by number of bursted buds × 100) (Bessis ,1960)at 29/4/2017 and 28/4/2018 during both seasons, respectively.

3- Vegetative growth.

During both seasons, at full bloom stage the following characterswere estimated:

1- **Average shoot length (cm).** It was calculated by measuring the average length of 4 shoot per vine.`
2- **Average shoot number.** It was calculated by measuring the average number of shoots per vine.
3- **Internode length(cm).** The third basal internode length was measured for each replicate and the average was expressed in cm.

4- Characteristics of clusters and berries.

Six clusters from each replicate were harvested with firm berries having crimson red color when average of total soluble solids content percentage in berry juice attained about 18-19% and taken to measure the following characters:

1- Physical characteristics of clusters.

- Average cluster weight (g).
- Average cluster length and diameter (cm).

2- Physical and chemical characteristics of berries.

Samples of 100 berries from each replicate were collected at random to measure an average berry diameter (mm). Berry juice was extracted to measure chemical characteristics of the berries such as; soluble solids content using a manual temperature-compensated refractometer. The results were expressed as a percentage (%). Titratable acidity was expressed as a percentage of tartaric acid equivalents according to AOAC (1980). Furthermore, SSC / acidity ratio was calculated by dividing the soluble solidscontent to acidity percentages.

5- Yields.

During both seasons, average yield per vine was measured by multiplying an average of the number of clusters per vine by the average weight of clusters per vine in kilograms. Average yield per feddan was measured by using yield per vine and the number of vines per feddan in tons at 27/9/2017 and 12/8/2018 during both, respectively.

RESULTS AND DISCUSSION

The results of this study concerning the effect of bud break treatments (hydrogen cyanamide and its alternatives substances *i.e.* flaxseed oil, and Zn and $^{+}$ urea) on bud behavior and productivity of Crimson seedless grapevine will be presented and discussed in the following topics:

A- Bud characteristics.

B- Vegetative growth.

C- Clusters and berries Characteristics.

D- Yield.

A- Bud Characteristics:

1- Bud behavior:

Bud behavior characters (bud burst and bud fertility percentages) of Crimson seedless grape as affected by bud break treatments during 2017 and 2018 seasons are presented in Table 1.

Data from Table 1 show that all bud break treatments significantly enhanced bud behavior traits (bud burst and bud fertility percentages) of Crimson seedless grapevines during both seasons of study. The highest significant effect in bud burst and bud fertility percentages were obtained with combination treatment of Dormex (2.5%) + flaxseed oil (2.5 %) + $ZnSO_4$ (0.5%) + Urea (2.5 %), hence the percent attributed due to this treatment was 88.17 and 77.42 % for bud burst and 74.65 and 67.34% of bud fertility in the first and second seasons, respectively.

These results may be ascribed to combine the beneficial effect of Dormex, flaxseed oil, zinc sulphate and urea on bud behavior. The mechanism of Dormex in dormancy-breaking has been shown to;inactivate catalase enzyme in grape buds shortly after its application, leading to the accumulation of hydrogen peroxide and the development of oxidative stress (Perez and Lira, 2005), regulating the contents of proline, arginine and phyto hormones in buds (Seif El-Yazal *et al*., 2014) and induced gradually increase bud contents of IAA and GA_3 and a gradual decrease of ABA from treated date towards buds burst (El-Sabrout, 1998 and Mohamed and Gouda, 2017).

Thus, Dormex spraying shortened the flowering period (Petri *et al*., 2016) In addition, hydrogen cyanamide regulates the expression of select genes encoding enzymes belonging to the ascorbate glutathione cycle "AGC" (glutathione reductase, VvGR) to the oxidative pentose phosphate pathway "oPPP" (glucose-6-phosphate dehydrogenase, VvG6PD) and a key enzyme for dormancy release (Vergara and Perez, 2010). More to the point, hydrogen cyanamide has frequently been used to break dormancy in grapevine floral buds by preventing accumulation of reactive oxygen species (ROS) and reactive nitrogen species (RNS), subsequently induces cell wall loosening and expansion for bud sprouting (Sudawan *et al.,* 2016 a). Also, application of flaxseed oil during dormancy leads to early flowering and shortage period compared to the control (Petri *et al*., 2016). In addition, the role of Zn that acts as a co-factor of many enzymes and affects many biological processes such as photosynthesis, nucleic acids metabolism and biosynthesis of proteins and carbohydrates, which leads to improve nutritional status, increase flowering and fruit set (Marschner, 2012).

Besides, foliar urea applications improve fruiting due to leaves rapidly absorb a majority of the urea form foliar spray applications in fall, even during leaf senescence and translocate the absorbed N from the leaves into storage tissues (Dong *et al.,* 2002). Reversely, The untreated vines significantly induced the lowest percentages in this respect, since, the percent level due to this treatment was 54.75 and 50.34 % for bud burst and 46.34 and 49.61 % for bud fertility in the first and second seasons, respectively. Furthermore, a high concentration of flaxseed oil and Dormex in the presence of zinc sulfate and urea showed a better effect on bud behavior compared to their own use. Indeed, the combination treatment of Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%) significantly increased the bud burst and fertility percentages than those obtained with the combination treatment of flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%) of Crimson seedless grapevines. However, higher concentration of Dormex was superior to flaxseed oil concentrations alone or in combination with zinc sulfate and urea concerning its effect on bud behavior during both seasons.The current results are in agreement with those reported by Abu-Qaoud (2004), El-Akkad (2004), Abdalla (2007), Potjanapimon *et al.* (2007), Arora *et al.* (2011), Hegazi (2012), Abo El-Wafa *et al.* (2016), Sudawan *et al.* (2016 b) and El-Masri *et al.* (2018) since, they found that Dormex application induced bud burst uniformity, increased bud burst percent and number of flowers. In addition, Abo-El-Wafa *et al.* (2016) showed that zinc sulfate 3%, urea 10% and dormex 4% hastened the beginning of bud burst significantly and shortened the duration of bud burst rather than the control.

Table 1. Bud burst and fertility percentages of Crimson seedless grape as affected by bud break treatments during 2017 and 2018 seasons.

Characters	Bud burst (%)		Bud fertility (%)	
Treatments	2017	2018	2017	2018
Control	54.75	50.34	49.61	46.34
Dormex (2.5%)	68.74	66.62	64.23	54.48
Flaxseed oil (2.5 %)	67.70	59.20	58.67	50.63
Dormex (5%)	77.04	70.82	67.35	62.08
Flaxseed oil (5%)	72.53	69.79	65.96	58.97
$ZnSO_4$ (0.5%) + urea (2.5%)	67.84	59.95	62.84	52.03
Dormex (2.5%) + Flaxseed oil (2.5 %)	78.35	72.56	70.11	63.15
Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	78.07	71.86	69.09	62.45
Flaxseed oil (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	71.14	69.42	65.61	56.89
Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	88.15	74.97	72.91	64.9
Flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	81.55	73.98	72.49	63.49
Dormex (2.5%)+Flaxseed oil (2.5 %)+$ZnSO_4$ (0.5%) + urea (2.5 %)	88.17	77.42	74.65	67.34
LSD at 5 %	0.95	0.55	0.56	0.59

2-Chemical constituents of buds:

Chemical constituents of Crimson seedless grape buds (total sugars , crude protein percentages, total phenols, and glutathione contents) was affected by bud break treatments during 2017 and 2018 seasons are accessible in Table 2.

Regarding bud break treatments, the results in Table 2 clearly that show a significant impact on chemical constituents of Crimson seedless grape buds *i.e.* total sugars, crude protein percentages, total phenols and glutathione contents due to these treatments in both seasons. It is worthy to notice that treating Crimson seedless grape with the combination treatment with Dormex (2.5%) + Flaxseed oil (2.5 %) + ZnSO4 (0.5%) + urea (2.5 %) produced the highest percentages of total sugars (3.87 and 3.77) and glutathione content (6.38 and 6.08 mg/L) and the same time the lowest percentages of crude protein (7.63 and 8.13) and total phenols content (187.2 and 187.8 mg/100 g) in buds in the first and second seasons, respectively. These results may be attributed to the advantageous gather effect of Dormex, flaxseed oil, zinc sulphate and urea on chemical constituents of buds. Where, the physiological effect of cyanamide may be due to its strong inhibition of catalase, caused by the reaction of the nitrile group with the thiols and haematin of the enzyme, and the subsequent increase in H_2O_2 content and the development of chemical constituents of buds (Amberger, 2013). On the other hand, the untreated vine recorded the lowest percentages of total sugars (2.24 and 2.14) and glutathione content (3.76 and 3.46 mg/L) and on contrary, the highest percentages of crude protein (12.98 and 13.48) and total phenols content (292.9 and 293.6 mg/100 g) in buds in both first and second seasons, respectively. Additionally, the combination treatment of high concentration of both flaxseed oil and Dormex besides zinc sulfate and urea illustrated enhance the effect on chemical constituents of buds as compared with other studied bud break treatments. The combination treatment of Dormex (2.5%) + flaxseed oil (2.5 %) came after the aforementioned treatments and followed by the combination treatment of Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)and then the highest concentration of Dormex (5%) and flaxseed oil (5%) concerning its effect on chemical constituents of Crimson seedless grapevines buds in both seasons. These results are similarly with those reported by Naderi *et al.* (2014), they concluded that the application of Dormex significantly increased the qualitative characteristics of grapevine.

Table 2. Total sugars, crude protein percentages, total phenols and glutathione contents in Crimson seedless grape bud as affected by bud break treatments during 2017 and 2018 seasons.

Characters / Treatments	Total sugars (%)		Crude protein (%)		Total phenols (mg/100 g)		Glutathione (mg/L)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	2.24	2.14	12.98	13.48	292.9	293.6	3.76	3.46
Dormex (2.5%)	2.72	2.62	11.45	11.95	262.1	262.8	4.45	4.15
Flaxseed oil (2.5 %)	2.38	2.28	12.55	13.05	283.2	283.9	3.98	3.68
Dormex (5%)	3.21	3.11	10.08	10.58	232.3	233.0	5.31	5.02
Flaxseed oil (5%)	3.06	2.96	10.54	11.04	241.5	242.2	5.03	4.73
$ZnSO_4$ (0.5%) + urea (2.5%)	2.53	2.43	11.97	12.47	272.0	272.7	4.24	3.94
Dormex (2.5%) + Flaxseed oil (2.5 %)	3.48	3.38	9.10	9.60	214.5	215.2	5.73	5.43
Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	3.30	3.20	9.55	10.03	223.1	223.8	5.49	5.19
Flaxseed oil (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	2.90	2.80	11.02	11.52	252.3	253.0	4.75	4.45
Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	3.76	3.66	8.11	8.61	196.2	196.9	6.22	5.92
Flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	3.62	3.52	8.62	9.12	205.7	206.4	5.98	5.68
Dormex (2.5%)+Flaxseed oil (2.5 %)+$ZnSO_4$ (0.5%) + urea (2.5 %)	3.87	3.77	7.63	8.13	187.2	187.8	6.38	6.08
LSD at 5 %	0.09	0.96	0.24	0.24	5.0	5.0	0.15	0.16

B- Vegetative Growth:

The averages of vegetative growth characters (shoot length, shoot number, and internode length) of Crimson seedless grape as affected by bud break treatments during 2017 and 2018 seasons are presented in Table 3.

The statistical analysis of the obtained data of on the subject matter of vegetative growth characters *i.e.* shoot length, shoot number and internode length of Crimson seedless grape significantly affected by bud break treatment of Crimson seedless grape in both seasons. Data in Table 3 show that the best treatment for increasing vegetative growth characters was obtained when treating Crimson seedless grapevines with the combination treatment of Dormex (2.5%) + flaxseed oil (2.5 %) + $ZnSO_4$ (0.5%) + urea (2.5 %), which resulted in the highest values of shoot length (110.37 and 106.53 cm), shoot number (9.08 and 5.87) and internode length (13.04 and 12.37 cm) in the first and second seasons, respectively. These results may confirm the valuable effect of Dormex, flaxseed oil, zinc sulphate and urea on vegetative growth characters. Hence, hydrogen cyanamide (H_2CN_2 "Dormex") has been the most effective in bud breaking agent for field use and very effective for early and vigorous vegetative growth (El – Salhy , 2002). Foliar urea applications improve N reserves and in turn promoting growth. This effect may be due to that leaves rapidly absorb a majority of theurea form foliar spray applications in fall, even during leaf senescence and translocate the absorbed N from the leaves into storage tissues (Dong *et al.,* 2002). The second best treatment for increasing vegetative growth characters was the combination treatment of Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%), without significant differences on shoot number and internode length and followed by flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%), then Dormex (2.5%) + flaxseed oil (2.5 %), Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%) and Dormex (5%) in both seasons. Whilst, Crimson seedless grapevines left without treatment (control treatment) recorded the lowest values of shoot length (96.95 and 97.94 cm), shoot number (4.24 and 4.11) and internode length (9.87 and 8.59 cm) in the first and second seasons, respectively. These results are in partial compatible with those recorded by Al-Hameedawi (2016) andEl-Masri *et al.* (2018).

Table 3. Shoot length, shoot number and internode length of Crimson seedless grape as affected by bud break treatments during 2017 and 2018 seasons.

Characters / Treatments	Shoot length (cm)		Shoot number		Internode length (cm)	
	2017	2018	2017	2018	2017	2018
Control	96.95	97.94	4.24	4.11	9.87	8.59
Dormex (2.5%)	104.49	101.49	6.29	4.95	11.04	10.28
Flaxseed oil (2.5 %)	102.58	99.58	4.37	4.33	10.62	9.16
Dormex (5%)	106.87	103.87	7.3	5.29	11.83	11.54
Flaxseed oil (5%)	105.45	102.45	7.08	5.20	11.58	10.87
$ZnSO_4$ (0.5%) + urea (2.5%)	103.12	100.12	5.62	4.77	10.79	10.12
Dormex (2.5%) + Flaxseed oil (2.5 %)	107.08	104.08	8.54	5.45	12.08	11.95
Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	106.91	103.91	7.66	5.41	11.87	11.83
Flaxseed oil (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	104.74	101.74	6.53	5.20	11.58	10.45
Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	108.33	105.33	8.91	5.80	12.70	12.24
Flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	108.24	105.24	8.62	5.58	12.62	12.16
Dormex (2.5%)+Flaxseed oil (2.5 %)+$ZnSO_4$ (0.5%) + urea (2.5 %)	110.37	106.53	9.08	5.87	13.04	12.37
LSD at 5 %	0.57	0.49	0.42	0.43	0.72	0.62

C- Characteristics Of Clusters And Berries:

1- Physical characteristics of clusters and berries:

Physical characteristics of clusters and berries (cluster length, cluster diameter, cluster weight, and berry diameter) of Crimson seedless grape as affected by bud break treatments during 2017 and 2018 seasons are obtainable in Table 4.

Data in Table 4 demonstrate that all studied bud break treatments in this study significantly affected physical characteristics of clusters and berries *i.e.* cluster length, cluster diameter, cluster weight and berry diameter of Crimson seedless grapevines during both seasons of 2017 and 2018.The highest significant effect on physical characteristics of clusters and berries were obtained with application of combination treatment of Dormex (2.5%) + flaxseed oil (2.5 %) + $ZnSO_4$ (0.5%) + Urea (2.5 %), which recorded the highest values of cluster length, cluster diameter, cluster weight and berry diameter of Crimson seedless grapevines {(25.16and 19.66 cm), (19.73 and 19.06 cm), (533.53 and 535.32 g) and (19.73 and 19.07 mm)} in the first and second seasons, respectively. These results may be certified to the favorable gather effect of Dormex, flaxseed oil, zinc sulphate and urea on physical characteristics of clusters and berries. Where, Dormex has the most effect on the uniform and high percentage of bud burst and resulted in the best physical properties of clusters and berries and ensured the best vegetative growth parameters (Sabry *et al.*, 2011). In addition, high concentration of Dormex and flaxseed oil in the presence of zinc sulfate and urea showed better effect on physical characteristics of clusters and berries when compared with other bud break treatments and ranked after the formerly mentioned combination treatment and followed by the combination treatments of Dormex (2.5%) + Flaxseed oil (2.5 %) and Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%), respectively in both seasons. However, high concentration of Dormex (5 %) was superior to flaxseed oil in high concentration (5 %) and followed by flaxseed oil at low concentration (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%), then Dormex at low concentration (2.5%), $ZnSO_4$ (0.5%) + urea (2.5%) and flaxseed oil at low concentration (2.5 %) concerning its effect on physical characteristics of clusters and berries during both seasons.On the contrary, control treatment (without spraying with any substances) significantly induced the lowest values of cluster length (19.83 and 17.00 cm), cluster diameter (14.07 and 13.56 cm), cluster weight (311.16 and 187.63 g) and berry diameter (14.07 and 13.56 mm) of Crimson seedless grapevines in the first and second seasons, respectively. The current results are in agreement with those reported Eshghi *et al.* (2010), Hegazi (2012) and Al-Hameedawi (2016). Moreover. Conversely, Abu-Qaoud (2004) found that average cluster weight was not significantly affected by the application of potassium nitrate and Dormex.

Table 4. Cluster length, cluster diameter, cluster weight and berry diameter of Crimson seedless grape as affected by bud break treatments during 2017 and 2018 seasons.

Characters / Treatments	Cluster length (cm)		Cluster diameter (cm)		Cluster weight (g)		Berry diameter (mm)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	19.83	17.00	14.07	13.56	311.16	187.63	14.07	13.56
Dormex (2.5%)	21.83	17.67	18.06	17.67	376.16	319.29	18.06	17.66
Flaxseed oil (2.5 %)	21.50	17.25	16.60	13.60	314.66	240.72	16.60	13.60
Dormex (5%)	22.33	18.66	18.40	17.80	429.03	451.29	18.40	17.81
Flaxseed oil (5%)	22.17	18.66	18.20	17.80	417.17	390.41	18.20	17.80
$ZnSO_4$ (0.5%) + urea (2.5%)	21.83	17.33	17.53	17.46	335.63	276.63	17.53	17.46
Dormex (2.5%) + Flaxseed oil (2.5 %)	22.75	18.67	18.53	18.13	449.20	466.53	18.53	18.13
Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	22.33	18.66	18.53	18	431.63	461.75	18.53	18.00
Flaxseed oil (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	21.83	18.53	18.06	17.67	415.13	337.43	18.06	17.66
Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	23.16	19.58	19.06	19	507.46	523.30	19.06	19.00
Flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	22.83	18.75	18.53	18.33	506.4	476.70	18.53	18.33
Dormex (2.5%)+Flaxseed oil (2.5 %)+$ZnSO_4$ (0.5%) + urea (2.5 %)	25.16	19.66	19.73	19.06	533.53	535.32	19.73	19.07
LSD at 5 %	1.49	1.25	1.54	1.45	8.23	7.39	1.55	1.12

2-Chemical constituents of berries:

The averages of chemical constituents of juice Crimson seedless grape berries *i.e.* total soluble solids (TSS) and titratable acidity percentages, total soluble solids/acidity ratio and anthocyanin content as affected by bud break treatments during 2017 and 2018 seasons are accessible in Table 5.

Regarding to the effect of studied bud break treatments in this study, the results tabulated in Table 5 evidently illustrate that bud break treatments exhibited a significant effect on chemical constituents of Crimson seedless grape berries *i.e.* total soluble solids (SSC) and titratable acidity percentages, total soluble solids/acidity ratio and anthocyanin content in both seasons. It is valuable to point out that using the combination treatment of Dormex at the low concentration (2.5%) + flaxseed oil at the low concentration (2.5 %) + ZnSO4 (0.5%) + urea (2.5 %) produced the highest values of SSC (22.86 and 22.66 %), , total soluble solids/acidity ratio (51.98 and 72.01) and anthocyanin content (1.68 and 1.64 mg/100 g) and lowest titratable acidity (0.40 and 0.31 %) in Crimson seedless grape berries in the first and second seasons, respectively.

Moreover, the combination treatment of high concentration of Dormex (5 %) besides zinc sulfate (0.5%) and urea (2.5 %) came after the aforesaid treatment and followed by the combination treatment of high concentration of flaxseed oil (5%) in addition zinc sulfate (0.5%) and urea (2.5 %) and then the combination treatment of low concentrations of both Dormex (2.5%) and flaxseed oil (2.5 %) concerning its effect on chemical constituents of Crimson seedless grapevines berries in both seasons. These results may be explained to the combine useful effect of Dormex, flaxseed oil, zinc sulphate and urea on chemical constituents of Crimson seedless grape berries. So, Dormex has been the most effective material in uniform and a high percentage of bud burst and resulted in the best chemical properties of berries. Furthermore, zinc sulfate could significantly influence the expression of phenolics biosynthetic pathway genes throughout berry development, and the results of expression analysis supported the promotion of Zn treatments on phenolics accumulation (Song *et al*., 2015). The descending order of other studied bud break treatments was as follow; Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%), Dormex (5%), Flaxseed oil (5%), Flaxseed oil (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%), Dormex (2.5%), $ZnSO_4$ (0.5%) + urea (2.5%) and Flaxseed oil (2.5 %) concerning its effect on chemical constituents of Crimson seedless grapevines berries in both seasons. While, the control (without treatment with bud break substances) recorded the lowest values of SSC (18.80 and 18.33 %), titratable acidity (0.68 and 0.49 %), and anthocyanin content (0.09 and 0.14 mg/100 g) and highest value of total soluble solids/acidity ratio (27.46 and 37.20) in Crimson seedless grape berries in the first and second seasons, respectively. These results with those reported by Malik *et al.* (2000), who reported that the maximum total soluble solids and ascorbic acid were found in vines that sprayed with 1.5 % urea and 0.4% zinc sulfate. While Arora *et al.* (2011) stated that the fruit quality in term of higher total soluble solids and lower acidity was also achieved in treated vines. Hegazi (2012) revealed that chemical fruit characteristics were improved by spraying apricot trees with hydrogen cyanamide at 1, 2 or 3%, which were more effective than urea and control treatment. Moreover, Abdel-Salam *et al.* (2009) and Naderi *et al.* (2014) concluded that the application of Dormex significantly improved the qualitative characteristics of grapevine (increased TSS, reducing sugars and anthocyanin contents and decreased the total acidity relative to the control). On the other hand, Eshghi *et al.* (2010) indicated that dormancy-breaking chemicals had little effect on TSS, total acid and the vitamin C of ripened fruits. Also, Abu-Qaoud (2004) found that berries pH, Brix, total soluble solids and specific gravity were not affected by the application of potassium nitrate and Dormex.

Table 5. Total soluble solids (TSS) and titratable acidity percentages, total soluble solids/acidity ratio and anthocyanin content in Crimson seedless grape berries as affected by bud break treatments during 2017 and 2018 seasons.

Characters / Treatments	SSC (%)		Acidity (%)		SSC / acidity ratio		Anthocyanin (mg/100 g)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	18.80	18.33	0.68	0.49	27.46	37.20	0.09	0.14
Dormex (2.5%)	20.46	19.67	0.55	0.43	36.15	45.69	0.32	0.36
Flaxseed oil (2.5 %)	19.06	19.33	0.61	0.46	31.04	43.96	0.13	0.25
Dormex (5%)	20.93	21.00	0.49	0.38	45.09	55.31	0.80	0.63
Flaxseed oil (5%)	20.73	21.00	0.50	0.42	42.83	48.05	0.59	0.49
$ZnSO_4$ (0.5%) + urea (2.5%)	19.86	19.33	0.57	0.44	35.9	44.63	0.17	0.31
Dormex (2.5%) + Flaxseed oil (2.5 %)	21.27	21.66	0.46	0.37	47.06	57.77	1.03	0.85
Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	21.06	21.33	0.47	0.38	45.71	56.13	0.88	0.67
Flaxseed oil (2.5%)+$ZnSO_4$ (0.5%) + urea (2.5%)	20.73	20.67	0.50	0.43	37.87	46.88	0.38	0.41
Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	22.20	22.33	0.43	0.34	48.44	64.85	1.57	1.25
Flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	21.66	22.33	0.46	0.35	47.15	62.03	1.04	1.19
Dormex (2.5%)+Flaxseed oil (2.5 %)+$ZnSO_4$ (0.5%) + urea (2.5 %)	22.86	22.66	0.40	0.31	51.98	72.01	1.68	1.64
LSD at 5 %	1.22	1.01	0.04	0.02	4.72	4.69	0.16	0.14

D- Yield:

The means of Crimson seedless grapevines yield (yield/vine and yield/feddan) as affected by bud break treatments during 2017 and 2018 seasons are accessible in Table 6.

The statistical analysis of the obtained data in Table 6 on the subject of Crimson seedless grapevines yield (yield/vine and yield/feddan) confirm that the studied bud break treatments significantly affected yield/vine and yield/feddan of Crimson seedless grape in both seasons.

Data in Table 6 explain that the best treatment for increasing yield of Crimson seedless grape was the combination treatment of low concentrations of both Dormex (2.5%) and flaxseed oil (2.5 %) in addition using $ZnSO_4$ (0.5%) and urea (2.5 %), which resulted in the highest values of yield/vine (26.59 and 23.06 kg) and yield/feddan (15.95 and 13.83 t/fed) in the first and second seasons, respectively. These findings might be owing to combine helpful effect of Dormex, flaxseed oil, zinc sulphate and urea on the yield of Crimson seedless grape.

Hence, Dormex has been the most effective in uniform and a high percentage of bud burst and resulted in the greatest yield and its components and ensured the best vegetative growth parameters. Additionally, the role of Zn that acts as a co-factor of many enzymes and affects many biological processes such as photosynthesis, nucleic acids metabolism and biosynthesis of proteins and carbohydrates, which leads to improve nutritional status, increase fruit size and control fruit drop and ultimately increase the yield (Marschner, 2012).The second best treatment in this respect was the combination treatment of high concentration of Dormex (5%) besides $ZnSO_4$ (0.5%) and urea (2.5%), and followed by high concentration of flaxseed oil (5%) plus $ZnSO_4$ (0.5%) and urea (2.5%), then low concentrations of both Dormex (2.5%) and flaxseed oil (2.5 %), low concentration of Dormex (2.5%) plus $ZnSO_4$ (0.5%) and urea (2.5%) and high concentration of Dormex (5%) only concerning its effect on Crimson seedless grape yields in both seasons. The descending order of other studied bud break treatments was as follow; high concentration of flaxseed oil (5%) only, low concentration of flaxseed oil (2.5%) plus $ZnSO_4$ (0.5%) and urea (2.5%), low concentration of Dormex (2.5%) only, $ZnSO_4$ (0.5%) plus urea (2.5%) and low concentration of flaxseed oil (2.5 %) only concerning its effect on Crimson seedless grape yields inboth seasons. Whilst, Crimson seedless grapevines left without treatment (control treatment) resulted in the lowest values of yield/vine (7.65 and 6.31 kg) and yield/feddan (4.59 and 3.78 t/fed) in the first and second seasons, respectively. These results are in partial compatible with those recorded by Al-Hameedawi (2016). Malik *et al.* (2000) who reported that the maximum yield per vine was found in vines that sprayed with 1.5 % urea and 0.4% zinc sulfate. Moreover, Naderi *et al.* (2014) found that concluded that the application of Dormex significantly increased the quantitative and qualitative characteristics of grapevine.

Table 6. Yield of Crimson seedless grape as affected by bud break treatments during 2017 and 2018 seasons.

Characters / Treatments	Yield/vine (kg) 2017	Yield/vine (kg) 2018	Yield/feddan (ton) 2017	Yield/feddan (ton) 2018
Control	7.65	6.31	4.59	3.78
Dormex (2.5%)	12.71	12.53	7.62	7.51
Flaxseed oil (2.5 %)	9.33	8.90	5.60	5.19
Dormex (5%)	19.45	16.06	11.67	9.64
Flaxseed oil (5%)	16.54	15.96	9.92	9.57
$ZnSO_4$ (0.5%) + urea (2.5%)	12.44	10.60	7.46	6.35
Dormex (2.5%) + Flaxseed oil (2.5 %)	20.87	16.29	12.52	9.77
Dormex (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	19.75	16.18	11.85	9.70
Flaxseed oil (2.5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	14.11	13.75	8.46	8.25
Dormex (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	22.14	20.42	13.28	12.25
Flaxseed oil (5%) + $ZnSO_4$ (0.5%) + urea (2.5%)	21.56	17.27	12.93	10.36
Dormex (2.5%)+Flaxseed oil (2.5 %)+$ZnSO_4$ (0.5%) + urea (2.5 %)	26.59	23.06	15.95	13.83
LSD at 5 %	1.25	1.23	0.96	1.51

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تأثير المواد الكاسرة لسكون البراعم على سلوك البراعم وإنتاجية العنب صنف الكريمسون

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أجريت التجربة في مدينة المحلة ، بمحافظة الغربية ، مصر ، خلال عامي 2017/2016 و 2018/2017 تم زراعة كرمات العنب "كريمسون" البالغة من العمر 12 عامًا لإيجاد بدائل رخيصة لسياناميد الهيدروجين للمساعدة على انتظام تفتح البراعم في عنب صنف كريمسون ، بالإضافة إلى دراسة تأثير هذه البدائل على سلوك البراعم. حيث اعطت كرمات العنب المعامله بمزيج من دورمكس 2.5 % + زيت بذور الكتان2.5٪ + سلفات الزنك 0.5%+ اليوريا 2.5٪ أعلى النسب المئوية للتفتح , خصوبة البراعم , السكريات الكلية ومحتوى الجلوتاثيون ، وفي الوقت نفسه كانت النسب المئوية الأدنى من محتوى البروتين الخام ومجموع الفينولات في البراعم في كلا الموسمين. تم الحصول على أفضل معاملة لزيادة النمو الخضرى والخصائص الفيزيائية للعناقيد والحبات ، والمكونات الكيميائية للحبات والمحصول (المحصول / الكرمة)و(المحصول / الفدان) عند معالجة كرمات العنب بالدورميكس 2.5% + زيت بذور الكتان 2.5 ٪ + سلفات الزنك 0.5% + اليوريا 2.5 ٪ ، مما أدى إلى أعلى القيم لهذه الصفات في كلا الموسمين. .