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PLANT PRODUCTION

Effects of Thiourea, Potassium Nitrate and Gibberellic Acid on Bud Break, Yield and Berry Quality of Thompson Seedless Grapevines (*Vitis vinifera* L.)

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Abstract. Trials were carried out to study the effect of spraying Thompson seedless grapevines with a solution containing Thiourea (1% or 2%) (H_2NCSNH_2), KNO_3 (2% or 4%) or GA_3 (0.1% or 0.2%) on bud break, yield and berry quality during 1995 and 1996 seasons. The vines were 15 – year – old and trained to the cane system (60 buds/vine). All chemical agents exhibited bud break in the first date sampling after application compared to the control in both seasons, except with 0.2% GA_3 in the second season. Also, Thiourea treatments promote the bud break greater than KNO_3 or GA_3, while the GA_3 had the same effect of KNO_3. No significant difference was obtained in leaf area as affected by different chemical agents, while they reduced cane length. Control treatment produced the highest pruning wood weight, while 1% Thiourea and 0.1% GA_3 gave the lowest values. KNO_3 at 4% increased total yield/vine in the first season, while GA_3 at o.1% increased it in the second season. The data showed no significant difference between Thiourea and KNO_3 treatments in yield/vine in both seasons. As for physical and chemical fruit properties, data showed no clear response as affected by the used different chemical in this study.

Introduction

Rest period is an arrest in development of seed embryos, buds or spores. High temperatures are known to have a negative effect on breaking rest in dormant buds and controlled the rate of breaking rest in woody plants. Dormancy of buds of woody plants is dependent on winter chilling. The effect is cumulative, increasing with the chilling period up to a certain limit, which is interpreted as the chilling requirement of the cultivar [1]. In many sub-temperate and sub-tropical regions, winter temperatures are not low enough to satisfy the Chilling requirements (CR) of grapes. The low CR grape cultivars now commercially available are lacking and ununiformity in bud opening, yield and fruit quality. Investigation have been conducted to study the termination of bud do rmancy in woody plants, including grapes, by the application of chemicals such as

mineral oils [2,3], plant growth regulators [4,5,6], dinitro-O-cresol (DNOC) [7], Thiourea (H_2NCSNH_2) [8], calcium cyanamide ($CaCN_2$) [5, 9], potassium nitrate (KNO_3) [10] and hydrogen cyanamide (H_2CN_2) [11, 12, 13].

This study was designed to study the effects of Thiourea, KNO_3 and GA_3, on breaking bud dormancy in Thompson seedless grapevines cultivar (*Vitis vinifera* L.), grown in Riyadh region, Saudi Arabia.

Materials and Methods

This experiment was carried out on Thompson seedless grapevines (*Vitis vinifera* L.) grown at the Experiment Research Station, Deirab, College of Agriculture, King Saud University, during the growing seasons of 1995 and 1996. Selected vines were almost representing the average growth condition prevailing in the area. The soil was sandy loam and the trees were planted at 2x3 m apart. The vines were maintained by standard practices used in Deirab. The experimental design was completely randomized design with ten vines of similar vigor for each treatment. The vines were selected randomly, trained on the cane system, pruned to 5 canes with 12 buds per each cane (≈ 60 buds/vine).

Dormant pruned vines were treated with either Thiourea (1% or 2%) (H_2NCSNH_2), potassium nitrate (2% or 4%) (KNO_3) or Gibberellic acid (0.1% or 0.2%) (GA_3) at 8th and 10th January in 1995 and 1996 seasons, respectively. The various chemical material solutions were sprayed within one hour after mixing with water. A wetting agent (Tween 20) at 0.1% (w/v) was added to enhance absorption. They were applied as foliar sprays to run-off just after pruning in both seasons. The vines of control treatment were sprayed in the same time with tap water. To determine the effect of the chemical agents, percent of bud break was determined and monitored once a week from the time of the first burst bud (from February to April). Moreover, leaf area using portable area meter LI-COR model LI-3000 A No. PAM 1671 and pruning wood weight were determined. Number and weight of clusters, and yield/vine (Kg) were determined. At harvest time (8th and 15th June in 1995 and 1996 seasons, respectively) weight, volume, length, diameter, length / diameter ratio of berries and juice volume of 100 berries were determined. Also, total soluble solids (TSS%) were determined using hand refractometer. Titratable acidity as gram of tartaric acid per 100 ml of juice and TSS/acid ratio were determined according to standard methods A.O.A.C. [14]. The collected data were subjected to statistical analysis using analysis of variance according to Steel and Torrie [15].

Results and Discussion

Bud break

Bud break percent was hastened by all chemical used in Thompson seedless in both seasons (Table 1). Thiourea at 1% or 2% and GA_3 at 0.1% accelerated and increasing bud break percent in the first date for both seasons (Feb.27th and Feb.17th in 1995 and

1996 seasons, respectively). Generally, Thiourea at 2% gave the highest bud break percent compared with all chemical treatments in the first, second, third, fourth and later sampling at 1995 season, while in the first and second sampling at 1996 season. No significant difference was found in bud break percent when KNO_3 and GA_3 were used at the first sampling in both seasons. Also, the promotion of bud break by 1% or 2% Thiourea and 0.1% GA_3 was distinguished in the second, third and fourth dates for both seasons. At the same time, all chemical compounds used in this study exhibited a great bud break percent in the first date sampling as compared with control treatment in both seasons, except 4% KNO_3 in 1995 season and both 4% KNO_3 and 0.2% GA_3 in 1996 season. The data showed that at the two later dates, no differences were found in bud break percent between treatments compared with the control treatment. It is concluded that Thiourea promotes the bud break greater than KNO_3 or GA_3, at the same time the GA_3 had the same effect as KNO_3 on bud break percent (Table 1). Many investigators showed that different chemical applications had improved and forced bud break when applied to grape vines in region where insufficient chilling was a problem [10, 12, 13, 16-21]. On the other hand, Cutting *et al.* [22] stated that xylem sap cytokinin concentration increased rapidly in response to the rest breaking chemicals and packed just before or at bud break. The rapid increase in cytokinin was closely followed by increasing in calcium and magnesium concentrations in the sap. Also, sorbitol levels dropped rapidly as a result of the rest-breaking materials and appeared to be used rapidly in bud-break and early bud growth. Moreover, they showed that many of the rest breaking chemicals inhibited catalase and allowed activation of certain peroxidase.

Table 1. Effect of some chemical compounds on percent bud break of Thompson seedless grapevines in 1995 and 1996 seasons

Sampling date (1995 season)							
Treatments	**Feb.27th**	**Mar.3rd**	**Mar.10th**	**Mar.17th**	**Mar.25th**	**April 2nd**	**April 17th**
1% Thiourea	3.92b	7.02ab	13.06ab	29.75b	43.69b	63.26a	64.66a
2% Thiourea	9.31a	14.99a	24.22a	41.96a	55.41a	60.76a	68.95a
2% KNO_3	2.13bc	4.70ab	12.92ab	24.10bc	38.16bc	62.26a	66.40a
4% KNO_3	0.99c	2.81b	7.99b	17.84c	29.05d	60.73a	68.78a
0.1% GA_3	2.23bc	6.14ab	10.10b	24.20bc	35.00cd	62.14a	63.93a
0.2% GA_3	1.52bc	4.03ab	10.06b	25.37bc	38.88bc	63.65a	67.60a
Control	1.51bc	3.43ab	8.45b	21.39bc	33.83cd	61.82a	64.54a
Sampling date (1996 season)							
Treatments	**Feb.17th**	**Feb.24th**	**Mar.3 rd**	**Mar.12th**	**Mar.19th**	**Mar.26th**	**Mar.30th**
1% Thiourea	0.75a	27.96a	52.66a	61.61a	70.99ab	76.58a	77.23a
2% Thiourea	0.83a	26.49a	49.54a	62.62a	73.22ab	70.40a	74.62a
2% KNO_3	0.25a	24.17a	46.80a	54.30a	66.94ab	70.16a	74.55a
4% KNO_3	0.42a	23.48a	50.54a	62.22a	70.95ab	73.81a	75.89a
0.1% GA_3	0.42a	26.11a	56.80a	69.44a	82.63a	74.88a	78.44a
0.2% GA_3	0.25a	21.13a	44.21a	53.40a	59.22b	74.16a	75.35a
Control	0.33a	23.24a	45.84a	54.39a	66.27ab	72.96a	73.53a

Means not sharing the same letter (s) within each column are significantly different at 0.05 level.

Vegetative growth

Data in Table (2) showed the effects of different chemical agents on vegetative growth parameters including, leaf area, cane length and pruning wood weight. Application of KNO_3 at 2% and Thiourea at 2% gave the highest leaf area in the first and second seasons, respectively. The statistical analysis showed no significant differences were found in leaf area despite of application of different compounds at various concentrations.

Table 2. Effect of some chemical compounds on vegetative growth of Thompson seedless grapevines in 1995 and 1996 seasons

Treatments	Leaf area (cm^2)	Cane length (cm) 1995	Pruning wood weight (kg)	Leaf area (cm^2)	Cane length (cm) 1996	Pruning wood weight (kg)
1% Thiourea	101.94a	69.08ab	2.17b	125.56a	86.57b	2.17bc
2% Thiourea	100.31a	59.66b	3.08a	136.27a	103.67a	2.70ab
2% KNO_3	107.69a	58.75b	2.83ab	125.51a	89.47b	2.38abc
4% KNO_3	102.34a	69.16ab	2.83ab	121.10a	90.57b	2.35abc
0.1% GA_3	101.14a	74.00ab	2.17b	133.55a	96.57ab	1.83c
0.2% GA_3	97.25a	66.75ab	3.25a	132.95a	90.57b	2.32abc
Control	104.98a	75.83a	3.50a	130.18a	97.43ab	3.00a

Means not sharing the same letter (s) within each column are significantly different at 0.05 level.

All treatments applied to the vines reduced mean cane length with no toxic effects as compared with trees treated with tap water (control) except with Thiourea at 2% in 1996 season. Also, data in Table (2) revealed that KNO_3 at 2% and GA_3 at 0.2% reduced mean cane length in 1995 and 1996 seasons, respectively. No significant differences were obtained among 1% Thiourea, 2% or 4% KNO_3 and 0.1% or 0.2% GA_3 treatments in both seasons. Pszczolkowski *et al.* [8] found that application of 2% Thiourea 45 days before bud break increacane growth, while Ahmedullah *et al.* [23] and Paioli-Pires *et al.* [24] reported that chemical agents such as calcium cyanamide at 200 or 400 g/litter and paclobutrazol at 5000-20000 ppm applied to the pruning wounds delayed shoot growth.

Table (2) showed that control treatment produced highest pruning wood weight, while Thiourea at 1% and GA_3 at 0.1% produced the lowest pruning wood weight in both seasons. Application of GA_3 at 0.1% decreased the pruning wood weight significantly as compared with Thiourea at 2% and control treatments. Also, GA_3 at 0.2% significantly increased pruning wood weight comparing with Thiourea at 1% in the first season. Ahmedullah *et al.* [23] stated that there was no effect of paclobutrazol treatments on pruning weight of "Concord" grape when applied after pruning at 5000-20000 ppm.

Yield (Kg\vine)

Data in Table (3) showed that GA_3 application with 0.1% was more effective in increasing cluster weight than other treatments in both seasons. On the other hand, 4%

KNO_3 and 1% Thiourea treatments gave the lowest values of cluster weight in 1995 and 1996 seasons. In terms of the number of cluster/vine, Thiourea at 1% being the lowest result in both seasons, whereas GA_3 treatments at 0.2% and 0.1% showed an increase in the number of cluster produced per vine in 1995 and 1996 seasons, respectively. No significant differences were found between Thiourea and KNO_3 treatments in yield/vine in the first season, while KNO_3 at 4% decreased total yield/vine in 1995 season, GA_3 at 0.1% increased it in 1996 season. Reddy and Shikhamany [12] on Thompson seedless grape vines, concluded that 3% hydrogen cyanamide caused three-fold increase in the number of clusters per cane (2.7 vs. 0.9 in the control). On the other hand, Shehata [13], Larios *et al.* [19], Paioli-Pires *et al.* [24] and Murisier *et al.* [25] on grapevines, reported that treatments with different chemical agents applied after pruning were less effective on yield production.

Table 3. Effect of some chemical compounds on yield components of Thompson seedless grapevines in 1995 and 1996 seasons

Treatments	Cluster weight (gm)	cluster number /vine 1995	Yield /vine (Kg)	Cluster weight (gm)	cluster number/vine 1996	Yield /vine (Kg)
1% Thiourea	110.80c	7.25c	0.80a	227.01b	14.83b	3.37b
2% Thiourea	107.90c	10.16ab	1.10a	246.35ab	17.58ab	4.33ab
2% KNO_3	88.00d	11.91a	1.05a	280.30ab	20.42ab	5.72ab
4% KNO_3	85.70d	8.91bc	0.76a	238.59ab	17.50ab	4.18b
0.1% GA_3	351.70a	8.16bc	2.87a	284.54a	21.08a	6.00a
0.2% GA_3	89.20d	11.91a	1.06a	268.62ab	20.42ab	5.49ab
Control	130.18b	2.34d	1.41a	251.01ab	15.92ab	4.00b

Means not sharing the same letter (s) within each column are significantly different at 0.05 level.

Fruit physical properties

The effects of Thiourea, KNO_3 and GA_3 treatments on physical properties of fruits are illustrated in Table (4). The highest mean weight and volume of berry were obtained with GA_3 at 0.2% and 0.1% treatments, while the lowest values recorded with KNO_3 at 2% and Thiourea at 1% treatments in 1995 and 1996 seasons, respectively. However, the data shows that no differences were found between Thiourea and KNO_3 treatments in both seasons, in one hand, and among Thiourea, KNO_3 and GA_3 treatments on the other.

As for length, diameter and L/D ratio of berries, the differences were almost significant. This was true for both experimental years (Table 4). It was noticed that Thiourea at 1% gave more elongated berries in both seasons. Juice of 100 berries differently affected by chemical treatments. The same response was concluded by Shehata [13], Larios *et al.* [19], Murisier *et al.* [25] and Williams [26].

Table 4. Effect of some chemical compounds on some physical properties of berries of Thompson seedless grapevines in 1995 and 1996 seasons

Treatments	Berry weight (gm)	Berry volume (cm^3)	Berry length (L) (cm)	Berry diameter (D) (cm)	Berry shape L/D	Volume juice of 100 berries
			(1995 season)			
1% Thiourea	1.12abc	1.05a	1.49a	1.16ab	1.28ab	66.50a
2% Thiourea	1.20abc	1.11a	1.41ab	1.19a	1.19b	68.50a
2% KNO_3	1.08bc	0.98a	1.34ab	1.13ab	1.20b	59.00a
4% KNO_3	1.22ab	1.01a	1.27b	1.11ab	1.15b	65.00a
0.1% GA_3	1.01c	1.03a	1.34ab	1.08b	1.24ab	59.75a
0.2% GA_3	1.31a	1.15a	1.53a	1.17ab	1.38a	62.00a
Control	1.17abc	1.12a	1.52a	1.19ab	1.28ab	9.25a
			(1996 season)			
1% Thiourea	1.20b	1.28b	1.52ab	1.14b	1.33a	61.58b
2% Thiourea	1.32ab	1.40ab	1.46b	1.17b	1.25a	67.91ab
2% KNO_3	1.37a	1.46a	1.52ab	1.20ab	1.03a	69.83a
4% KNO_3	1.31ab	1.41ab	1.56a	1.17b	1.33a	68.33ab
0.1% GA_3	1.38a	1.47a	1.55ab	1.24a	1.25a	70.83a
0.2% GA_3	1.26ab	1.35ab	1.47ab	1.17b	1.26a	65.16ab
Control	1.24b	1.32b	1.48ab	1.16b	1.28a	60.08b

Means not sharing the same letter (s) within each column are significantly different at 0.05 level.

Fruit chemical properties

Chemical properties of produced fruits including TSS (%), acidity (%) and TSS/acid ratio are concluded in Table (5). Obviously data shows that there was no influence being as a result of application of used compounds on acidity (%) and TSS/acid ratio in 1995 season, and on TSS (%) and TSS/acid ratio in 1996 season. It was noticed that KNO_3 at 2% and 4% significantly increased TSS (%) and acidity (%) in 1995 and 1996 seasons, respectively. Such results were found by Shehata [13], Murisier *et al.* [25] and Williams [26]. On the other hand, Larios *et. al.* [19] found that application of ethrel, alar and cycocel on some grapevines improved fruit quality.

Table 5. Effect of some chemical compounds on some chemical properties of berries of Thompson seedless grapevines in 1995 and 1996 seasons

Treatments	TSS (%)	Acidity (%)	TSS/acid ratio	TSS (%)	Acidity (%)	TSS/acid ratio
		1995			1996	
1% Thiourea	20.17ab	0.972a	21.29a	21.98a	0.706ab	31.25a
2% Thiourea	19.67b	1.007a	19.57a	22.00a	0.707ab	31.34a
2% KNO_3	20.87a	1.027a	20.43a	21.68a	0.725ab	30.16a
4% KNO_3	20.67ab	1.035a	20.08a	21.88a	0.738a	29.87a
0.1% GA_3	20.70ab	0.965a	21.51a	21.88a	0.694b	31.88a
0.2% GA_3	20.25ab	1.025a	19.75a	22.01a	0.721ab	30.65a
Control	20.60ab	0.990a	21.01a	22.34a	0.713ab	31.73a

Means not sharing the same letter (s) within each column are significantly different at 0.05 level.

It can be concluded from the above mentioned data that all chemical agents used in this investigation improved and forced bud break when applied to grapevines in region where insufficient chilling was a problem. The application of 2% Thiourea gave the best bud break and vegetative growth results as compared with potassium nitrate and Gibberellic acid. On the other hand, Thiourea at 1% and Gibberellic acid at 0.1% increased yield/vine, while potassium nitrate treatments did not affected on yield.

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تأثير الثيويوريا، نترات البوتاسيوم وحمض الجبريللين على كسر سكون البراعم، المحصول، وجودة الثمار في العنب البناتي

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قسم الإنتاج النباتي، كلية الزراعة، جامعة الملك سعود، الرياض، المملكة العربية السعودية.

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ملخص البحث. أجريت هذه التجربة لدراسة تأثير رش شجيرات العنب البناتي بمحاليل احتوت على ١ ، ٢٪ ثيويوريا ، ٢ ، ٤٪ نترات البوتاسيوم ، ٠,١ ، ٠,٢٪ حمض الجبريللين على نسبة كسر سكون البراعم ، المحصول وجودة الثمار خلال موسمي ١٩٩٥ ، ١٩٩٦. الشجيرات عمرها ١٥ سنة ومرباة بطريقة التربية القصبية (٦٠ عين/شجيرة). وقد وجد من نتائج هذه الدراسة أن جميع المعاملات الكيميائية المستخدمة وتركيزاتها قد زادت من النسبة المئوية لكسر طور سكون البراعم وذلك في التاريخ الأول بعد الرش مقارنة بالمعاملة القياسية في كلا موسمي الدراسة ، فيما عدا حمض الجبريللين عند تركيز ٠,٢٪ في الموسم الثاني. كما أظهرت النتائج أيضا أن معاملات الثيويوريا قد شجعت على كسر طور الراحة في البراعم بدرجة أكبر من معاملات نترات البوتاسيوم وحمض الجبريللين ، حيث كان تأثير كل من نترات البوتاسيوم وحمض الجبريللين متساو تقريبا. لم تظهر هذه الدراسة وجود أي فروق معنوية في المساحة الورقية نتيجة لتأثير المعاملات المختلفة ، بينما قللت المعاملات من متوسط طول القصبات. وقد أعطت المعاملة القياسية أعلى وزن من خشب التقليم ، بينما أعطت معاملات الثيويوريا بتركيز ١٪ ، حمض الجبريللين بتركيز ٠,١٪ أقل قيمة. أدى الرش بمحلول نترات البوتاسيوم بتركيز ٤٪ إلى زيادة المحصول الكلي للشجيرة في الموسم الأول ، بينما تحقق ذلك مع حمض الجبريللين بتركيز ٠,١٪ في الموسم الثاني. وقد

أظهرت النتائج أيضا ، عدم وجود فروق معنوية بين معاملات الثيوبوريا ومعاملات نترات البوتاسيوم في كمية المحصول للشجيرة في كلا موسمي الدراسة. أما بالنسبة للصفات الطبيعية والكيميائية للثمار ، فقد أظهرت النتائج أنه لم يكن هناك تأثير محدد للرش بالمركبات الكيميائية المستخدمة ، على الرغم من وجود بعض الاختلافات المعنوية وذلك في كلا موسمي الدراسة.