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Effect of Some Growth Bioregulators on Controlling of Suckers, Fruit Characteristics and Yield of Fig and Pomegranate Trees

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Abstract. Two concentrations of each of Naphthaleneacetic Acid (NAA) at 10,000 and 20,000 ppm, Paclobutrazol (PP_{333}) at 500 and 1,000 ppm and Mefluidide (MF) at 1,000 and 2,000 ppm were applied to mature fig cv. Al-madina and pomegranate trees cv. Al-madina. Hand cutting of suckers and control treatments were also included. All treatments were carried out after desuckering. The effective control suckers regrowth was achieved on individual cuts in all treatments. Weight, number and mean length of suckers were reduced for the two fruit tree species under application of all concentrations as compared with hand cut and control treatments. The percentages of reduction in regrowth of suckers number and length were high in 20,000 ppm NAA and 1,000 ppm PP_{333} for fig and with 10,000 and 20,000 ppm NAA in pomegranate. No significant differences were found in the mean weight, length and number of suckers between the NAA and Paclobutrazol. NAA at 20,000 ppm increased the mean number of fruits as well as yield per tree in fig, while MF at 2,000 ppm decreased them as compared with control and hand cut treatments in pomegranate. Although, application of NAA, PP_{333} and MF were less effective on fruit physical properties in the two species, PP_{333} at 500 or 1,000 ppm increased both TSS % and vitamin C in fig and pomegranate fruits, respectively. NAA increased total sugar percentages in fig fruits and reduced TSS % slightly in pomegranate.

Introduction

Pomegranate and fig trees are knowing for suckering during the growing season. These suckers grow vigorously without branching and when allowed to grow for several years tend to change the tree into unproductive bush. The trees with numerous suckers show a straggling appearance, long weak shoots and bear very little crop. In addition, suckers compete for growth with the rest of the tree, being therefore undesirable formations which behave similarly to weeds [1,2].

The suckers of pomegranate and fig can be removed by hand at the end of the growing season using sharp knife-like tools. However, this practice is costly and time consuming. The mechanization of this operation is not easy due to the irregular form and difficult access to the basal part of the tree.

Many researchers have studied the effect of chemical control of suckers in different fruit species such as, pomegranate [3], fig [4], grape [5;6], guava [7], peach [8], and apple and pear [9-12]. They all achieved successful reduction in sucker growth, shoot extension growth and increased fruitfulness.

The objectives of this work were to determine the effectiveness of three plant growth bioregulators namely, NAA, PP_{333}, and MF using several concentrations applied to individual thinned suckers development as well as their effect on yield and fruit quality of fig "Al-madina" and pomegranate "Al- madina" cultivars.

Materials and Methods

Field studies were carried out on fifteen year- old pomegranate (*Punica granatum* L.) Al-madina cv. and fig (*Ficus carica* L.) Al-madina cv. grown on their own roots during 1995 and 1996 seasons. The trees were grown at 5x5 m apart and grown in sandy loam soil at the Agricultural Research Experiment Station, College of Agriculture, King Saud University. Forty nearly similar trees were used from each fruit tree species. Irrigation, pruning, fertilization and pest control practices were carried out as those recommended and applied in the region. The layout of the experiment was a randomized complete block design with eight treatments in five blocks[13]. In January 1995, the suckers were removed, then all treatments were applied directly following suckers removal on a cut surface from the point of attachment at the main trunk outward for a distance of 50 cm around the trees [14].

Eight treatments were carried out as follows:

1. Control (without desuckering)
2. Hand cut only
3. 10,000 ppm Naphthaleneacetic acid
4. 20,000 ppm Naphthaleneacetic acid
5. 500 ppm Paclobutrazol
6. 1,000 ppm Paclobutrazol
7. 1,000 ppm Mefluidide
8. 2,000 ppm Mefluidide

The number and length of suckers of each tree were recorded just prior to application of the regulators on January 1995 and again towards which the end of the experiment occurred to be mid June 1996. The percentages of decrement or increment in sucker number or length were calculated. The suckers from each tree were removed and weighed for the two species. Average mean length of shoots was recorded for fig trees. Fruits from each tree in the two species were harvested, counted and weighed to estimate the yield. A fruit sample (10 fruits) for each treatment was collected at harvest time to determine the fruit physical and chemical characteristics (AOAC[15]). Fruit length, diameter, length to diameter ratio, TSS, acidity, TSS / acid ratio and vitamin C were determined in both fig and pomegranate fruits. Total sugars, reducing and non-reducing sugar percentages were estimated in fig fruits.

Results and Discussion

Growth of suckers

All chemical treatments were on the same level of significance and significantly reduced final sucker number in Al-madina fig (Table 1).

Table 1. Influence of trunk application of NAA, PP_{333} and MF on initial and final number and length of suckers and mean shoot length in Al- madina fig trees(1)

Treatments (2)	Initial number of suckers	Final number of suckers	Initial length of suckers (cm)	Final length of suckers (cm)	Mean shoot length (cm)
Control	77.5 abc	104.0 a	168.0 a	258.0 a	23.8 de
Hand Cut	79.8 abc	86.5 a	137.8 a	133.3 b	27.3 cde
NAA (ppm)					
10,000	26.3 c	1.8 b	179.3 a	25.8 e	35.8 ab
20,000	109.5 a	4.8 b	164.8 a	19.8 e	38.1 a
mean	67.9	3.3	172.1	22.8	37.0
PP_{333} (ppm)					
500	97.5 ab	21.0 b	152.8 a	44.0 de	23.6 de
1,000	48.0 bc	7.0 b	145.8 a	20.8 e	22.0 e
mean	72.8	14.0	149.3	32.4	22.8
MF (ppm)					
1,000	66.3 abc	18.8 b	172.0 a	87.8 c	32.0 bc
2,000	60.3 abc	12.8 b	171.0 a	69.0 cd	28.7 cd
mean	63.3	15.8	171.5	78.4	30.4

(1) Values have the same letters in each column are not significantly different at 5% level according to Duncan,s multiple range test.

(2) NAA:Naphthaleneacetic acid , PP_{333}: Paclobutrazol, MF: Mefluidide.

NAA (20,000 ppm) and PP_{333} (1,000 ppm) treatments reduced the mean suckers weight and final number of suckers as compared with the conventional control of suckers (hand cut) and untreated control treatments in fig and pomegranate trees. All the regulators with their concentrations were on the same level of significance in final number of sucker in the two species (Tables 1,2 and Fig. 1).

Table 2. Influence of trunk application of NAA, PP_{333} and MF on initial and final number and length of suckers in Al- madina pomegranate trees[(1)]

Treatments[(2)]	Initial number of suckers	Final number of suckers	Initial length of suckers (cm)	Final length of Suckers (cm)
Control	59.5 ab	99.0 a	110.5 abc	160.0 a
Hand Cut	57.5 ab	37.5 ab	111.5 abc	134.5 ab
NAA (ppm)				
10,000	32.3 b	5.3 b	130.5 ab	39.5 c
20,000	73.0 ab	6.0 b	134.5 a	16.5 c
mean	52.7	5.7	132.5	28.0
PP_{333} (ppm)				
500	102.5 a	7.8 b	123.5 ab	49.8 bc
1,000	92.8 a	8.5 b	90.8 c	24.8 bc
mean	97.7	8.3	107.2	37.3
MF (ppm)				
1,000	75.0 ab	23.5 b	102.3 bc	20.3 c
2,000	39.8 b	7.5 b	123.0 ab	52.8 bc
mean	57.4	15.5	112.7	36.6

(1) Values have the same letters in each column are not significantly different at 5% level according to Duncan,s multiple range test.

(2) NAA:Naphthaleneacetic acid , PP_{333}: Paclobutrazol, MF: Mefluidide.

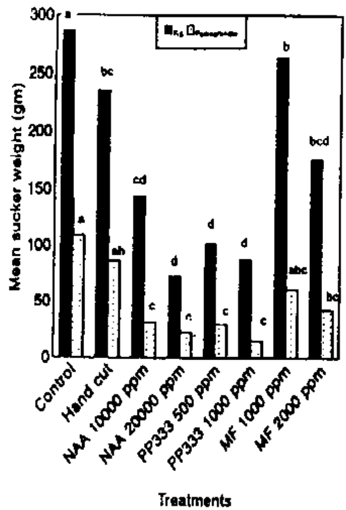

Fig. 1. Influence of hand cut and trunk appliction of NAA, PP333 and MF treatments on mean suckers weight of pomegranate and fig trees.

In fig trees, the percentage of reduction in suckers number were 93.8, 92.7 and 87.3 for 1,000 ppm PP_{333}, 20,000 ppm NAA and 2,000 ppm MF, respectively as compared with the control treatment. However, differences among NAA, PP_{333} and MF concentrations were not significant for both species. Furthermore, conventional method of control of suckers (hand cut) significantly increased the percentage of reduction in suckers number by 38.6 and 62.4 as compared with the control treatment for fig and pomegranate, respectively (Fig.2). NAA at 20,000 ppm was more effective in controlling the suckers weight in both species. Also, PP_{333} at 1,000 ppm greatly reduced mean weight of suckers in pomegranate (Fig.1). The successful inhibition of suckers weight and numbers by NAA and PP_{333} concentrations in fig and pomegranate trees in the current study is supported by Couvillon *et al.*[8] and Aldrich and Arnold[16] on peach, Stephen and Ware[14] on apple; Reynolds[6] on grape; Boswell and McCarty[4] and LaRue *et al.* [3] on pomegranate .

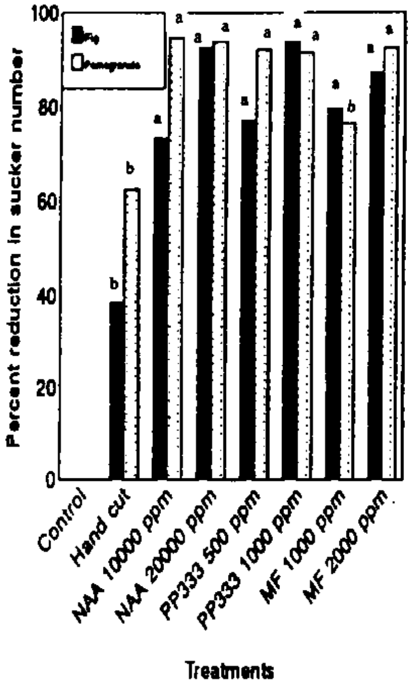

Fig. 2. Influence of hand cut and trunk application of NAA, PP333, and MF treatments on percent reduction in suckers number of pomegranate and fig trees.

NAA at 10,000, 20,000 ppm and PP_{333} at 1,000 ppm concentrations strongly inhibited the final suckers length when applied to individual cut surfaces of fig and pomegranate trees. No differences were found in final length of suckers between control and hand cut treatments in pomegranate trees, while differences were significant in fig trees. Response to the NAA and PP_{333} concentrations did not differ significantly in final length of suckers in both species (Tables 1,2). NAA levels increased the percentage of reduction in suckers length, followed by PP_{333} and MF treatments in fig and pomegranate trees (Fig.3). The same trend was found by Reynolds[6]. He reported that trunk application of NAA and PP_{333} decreased the mean sucker length of `Okanagna Riesling` vines.

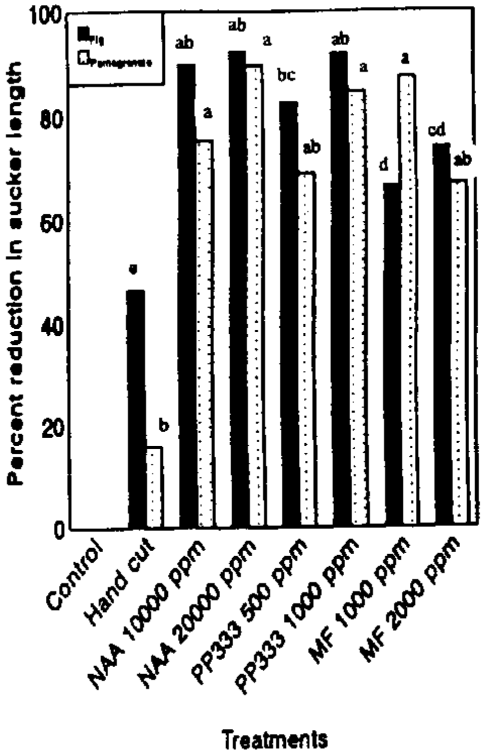

Fig. 3. Influence of hand cut and trunk application of NAA, PP333, and MF treatments on percent reduction in suckers length of pomegranate and fig trees.

Mean shoot length showed significantly higher values in the NAA treated fig trees as compared to the control, hand cut, PP_{333} or the 2,000 ppm MF treatments. Moreover, the PP_{333} treatments were not significantly different from the control or the hand cut treatments (Table 1). Hunter [17] reported that, PP_{333} inhibited shoot extension growth, and moves almost exclusively in the xylem. Furthermore, Paclobutrazol modified canopy structure of trees by inhibiting growth of the main shoot apex and of axillary buds of shoots. Also Stephen and Ware[14] found that application of NAA (1%) to the trunk of `Delicious` apple inhibit shoot growth. These results are in accordance with those found in this experiment.

Yield components

Yield components as influenced by growth regulators showed that there were no significant differences between untreated control and other applied treatments except the 500 ppm PP_{333} treatment which gave the highest mean fruit weight of fig trees, while Mefliudide at 2,000 ppm gave the least mean fruit weight in pomegranate trees. No other significant differences were observed in this parameter (Tables 3-6).

Table 3. Influence of trunk application of NAA, PP_{333} and MF on yield and physical fruit properties of Al- madina fig trees[1]

Treatments[2]	Mean fruit weight (gm)	Mean number of fruits per tree	Yield / tree (kg)	Fruit length (L) (cm)	Fruit diameter (D) (cm)	L / D ratio
Control	27.3 b	487.5 abc	13.3 bc	4.2 ab	3.5 c	1.2 a
Hand Cut	29.7 ab	475.0 abc	14.1 abc	4.4 ab	3.7 bc	1.2 a
NAA (ppm)						
10,000	27.9 b	487.5 abc	13.6 bc	4.1 b	3.7 abc	1.1 a
20,000	30.3 ab	625.0 a	18.9 a	4.6 a	3.9 ab	1.2 a
mean	29.1	556.3	16.3	4.35	3.8	1.15
PP_{333} (ppm)						
500	34.1 a	437.5 c	14.9abc	4.3 ab	4.0 a	1.1 a
1000	30.5 ab	362.5 c	11.1 c	4.3 ab	3.8 ab	1.1 a
mean	32.3	400.0	13.0	4.3	3.9	1.1
MF (ppm)						
1,000	32.5 ab	425.0 c	13.8 abc	4.6 a	3.8 ab	1.2 a
2,000	27.7 b	612.5 ab	17.0 ab	4.3 ab	3.8 ab	1.1 a
mean	30.1	518.8	15.4	4.45	3.8	1.15

(1) Values have the same letters in each column are not significantly different at 5% level according to Duncan's multiple range test.

(2) NAA: Naphthaleneacetic acid, PP_{333}: Paclobutrazol, MF: Mefluidide.

Table 4. Influence of trunk application of NAA, PP_{333} and MF on Yield and physical fruit properties of Al- madina pomegranate trees[1]

Treatments[2]	Mean fruit weight (gm)	Mean number of fruits per tree	Yield / tree (kg)	Fruit length (L) (cm)	Fruit diameter (D) (cm)	L / D ratio
Control	371.5a	123.8 bc	46.0c	8.1 ab	9.1 a	0.89 ab
Hand Cut	317.8 ab	147.5 abc	46.9c	7.9 ab	8.7 ab	0.91 a
NAA (ppm)						
10,000	381.3 ab	160.0 ab	61.0a	7.5 bc	8.4 ab	0.90 a
20,000	366.0 a	172.8 a	61.8a	8.3 a	9.2a	0.92 a
mean	373.7	164.4	61.4	7.9	8.8	0.91
PP_{333} (ppm)						
500	312.6 ab	171.3 a	53.5b	8.0 ab	8.7 ab	0.92 a
1000	312.7 ab	133.8ac	41.8c	7.9 abc	8.8 ab	0.90 a
mean	312.7	152.6	47.7	8.0	8.8	0.91
MF (ppm)						
1,000	347.0 a	140.0a c	48.6c	7.8 abc	9.2 a	0.85 b
2,000	233.0 b	112.5c	26.2d	7.2 c	7.9 b	0.92 a
mean	280.0	126.3	37.4	7.5	8.6	0.89

(1) Values have the same letters in each column are not significantly different at 5% level according to Duncan's multiple range test.

(2) NAA:Naphthaleneacetic acid , PP_{333}: Paclobutrazol, MF: Mefluidide.

Table 5. Influence of trunk application of NAA, PP_{333} and MF on chemical fruit properties of Al - madina fig trees[1]

Treatments[2]	TSS (%)	Acidity (%)	TSS/acid Ratio	Vit. C (mg/100 ml juice)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)
Control	19.3 b	0.34 b	57.0 b	4.5 bc	15.6 c	9.7 c	5.9 bc
Hand Cut	20.2 ab	0.34 b	59.7 ab	4.6 abc	16.9 bc	10.3 bc	6.6 abc
NAA (ppm)							
10,000	21.1 a	0.43 a	51.4 b	5.0 ab	20.4 a	11.6 a	8.8 a
20,000	18.9 b	0.32 b	58.7 ab	4.0 c	19.3 ab	10.8 ab	8.5 ab
mean	20.0	0.38	55.1	4.5	19.9	11.2	8.7
PP_{333} (ppm)							
500	19.8 ab	0.35ab	56.3 b	5.5 a	16.6 bc	10.8 ab	5.8 c
1,000	19.3 b	0.30 b	67.5 a	4.9 abc	18.3abc	10.6 abc	7.7 abc
mean	19.6	0.33	61.9	5.2	17.5	10.7	6.8
MF (ppm)							
1,000	19.5 b	0.36ab	55.0 b	4.5 bc	19.2 ab	10.4 abc	8.8 a
2,000	20.3 ab	0.36ab	57.2 b	5.0 ab	16.6 bc	10.2 bc	6.4 abc
mean	19.9	0.36	56.1	4.8	17.9	10.3	7.6

(1) Values have the same letters in each column are not significantly different at 5% level according to Duncan's multiple range test.

(2) NAA:Naphthaleneacetic acid , PP_{333}: Paclobutrazol, MF: Mefluidide

Table 6. Influence of trunk application of NAA, PP_{333} and MF on chemical fruit properties of Al - madina pomegranate trees[1]

Treatments[2]	TS S (%)	Acidity (%)	TSS/acid ratio	Vit. C (mg/100 ml juice)
Control	15.4 b	1.000 abcd	16.5 abc	1.1 c
Hand Cut	15.6 b	0.878 cd	19.2 ab	1.5 bc
NAA (ppm)				
10,000	15.3 b	0.925 b	18.7 ab	4.9 ab
20,000	15.4 b	1.013 abcd	16.9 abc	1.2 bc
mean	15.35	0.969	17.8	3.1
PP_{333} (ppm)				
500	16.3 a	1.067 abc	15.8 abc	2.7 abc
1,000	15.4 b	1.093 abc	15.8 bc	6.8 a
mean	15.9	1.08	15.8	4.75
MF (ppm)				
1,000	15.8 ab	1.195 a	13.3 c	1.3 bc
2,000	15.7 ab	0.808 d	21.4 a	4.4 abc
mean	15.8	1.001	17.4	2.9

(1) Values have the same letters in each column are not significantly different at 5% level according to Duncan,s multiple range test.

(2) NAA:Naphthaleneacetic acid , PP_{333}: Paclobutrazol, MF: Mefluidide.

Alunedullah and Wolfe[2] and Reynolds[6] reported that berry weight of grape varied directly with applied different concentrations of PP_{333} to control regrowth of suckers. In the present study, highest mean number of fruits per fig tree was observed in the 20,000 ppm NAA and the 2,000 ppm MF treatments. On the other hand, pomegranate fruit number of the 20,000 ppm NAA and the 500 ppm PP_{333} were significantly higher than the control and the 2,000 ppm MF treatments. Yield per tree after PP_{333} application was reduced by increasing PP_{333} concentration to 1,000 ppm in fig. The same was observed in the 2,000 ppm MF treatment of pomegranate trees.

Also, NAA at 20,000 ppm produced the highest yield in both figs and pomegranate. Direct or indirect influence of NAA on yield was found by Nauer and Boswell[18] on citrus and fig. They concluded that the translocation of NAA from cut surface into the rachis of the fruits resulted increasing in fruit set and weight. Reynolds[6] found that PP_{333} cause an increase in berry weight of grapes. Also, Stinchcombe and Stott[1] stated that the tendency of olive yield increased as the number and dry weight of suckers decreased probably as a result of the competition between suckers and other growing organs of the trees, particularly the fruits which are important photosynthetic sinks.

In fig, application of NAA at 20,000 ppm significantly increased fruit length as compared to the 10,000 ppm. Applied PP_{333} at 500 ppm level significantly increased fruit diameter as compared with untreated and hand cut. Highest fruit length of pomegranate fruits was obtained in the 20,000 ppm NAA treatment, while the 2,000 ppm MF was significantly lower. Moreover, the lowest fruit diameter value was that of the 2,000 ppm MF treatment. Otherwise, no significant differences were observed in this parameter. In general, the treatments did not affect the L/D ratio (shape) of fig fruits. Calculation of L/D ratios in pomegranate showed that, the 1,000 MF treatment had significantly lower ratios than all other treatments including the hand cut treatment. However, it was not significantly different as compared to the control (Tables 3,4). These results are in agreement with Ahmedullah and Wolfe [2] and Reynolds[6] on grapes.

NAA at 10,000 ppm increased total soluble solids, acidity, vitamin C, total sugar percentages and reducing sugar percentage, while PP_{333} at 500 ppm reduced total sugar and non-reducing sugar percentages in fig fruits. Also, in fig fruits, PP_{333} at 1,000 ppm level gave the highest TSS/acid ratio as compared with other treatments. At the same time, PP_{333} at 500 ppm increased vitamin C in fig fruits. In pomegranate fruits, 500 ppm of PP_{333} increased TSS as compared with hand cut and control treatments . Also, NAA and PP_{333} increased both acidity and TSS/acid ratio slightly, but MF at 1,000 ppm reduced vitamin C (Tables 5,6). Ahmedullah and Wolfe [2] found that NAA lead to reduce acidity and brix in grapevine. On the other hand, Reynolds[6] found improvement in fruit quality of grapes after paclobutrazol application.

It could be concluded from the above mentioned results that, there was a tendency for yield of fig and pomegranate to be increased as the number and weight of suckers decreased. Conventional control of suckers (hand cutting) takes long time and costly . The chemical control of suckers growth would be a great advantage to the fig and pomegranate production. It is recommended that NAA at 20,000 ppm, PP_{333} at 1,000 ppm and MF at 2,000 ppm concentrations to be the most effective application treatments for controlling the growth of suckers with some advantages over the traditional hand cutting control of suckers.

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تأثير بعض منظمات النمو على نمو السرطانات وصفات ثمار ومحصول أشجار التين والرمان

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(قدم هذا البحث للنشر في ١٤١٧/١٢/١٠هـ؛ وقبل للنشر في ١٤١٩/٢/٧هـ)

ملخص البحث. تم استخدام مستويين من كل من نفثالين حمض الخليك (١٠,٠٠٠و٢٠,٠٠٠جزء في المليون)، البكلوبترازول (٥٠٠ و١,٠٠٠جزء في المليون) والمفلودايد (١,٠٠٠ و٢,٠٠٠ جزء في المليون) على أشجار مثمرة من التين والرمان، كما استخدمت معاملات قطع السرطانات فقط وبدون قطع (المقارنة).

وقد أجريت جميع المعاملات بعد إزالة السرطانات فى شهر يناير ١٩٩٥م. وأشارت النتائج إلى أن استخدام المواد السابقة قد أدى إلى التحكم في نمو السرطانات فى جميع معاملات الإضافة، وأدت إضافة التركيزات المختلفة إلى حدوث نقص فى وزن السرطانات وأعدادها وأطوالها بالنسبة لكلا النوعين تحت الدراسة، وذلك بالمقارنة بمعاملتى القطع اليدوي والمقارنة. وأدت المعاملات ٢٠,٠٠٠جزء في المليون من نفثالين حمض الخليك، ١,٠٠٠ جزء في المليون من البكلوبترازول بالنسبة لأشجار التين، والمعاملات ١٠,٠٠٠ و ٢٠,٠٠٠جزء في المليون من نفثالين حمض الخليك، بالنسبة لأشجار الرمان إلى انخفاض في كل من أعداد السرطانات الناتجة وأطوالها، على التوالي. لم يكن هناك أى اختلافات معنوية في متوسط وزن السرطانات، أطوالها وأعدادها بين معاملات نفثالين حمض الخليك والبكلوبترازول.

أدت إضافة نفثالين حمض الخليك بتركيز ٢٠,٠٠٠جزء في المليون إلى زيادة متوسط عدد الثمار لكل شجرة، وبالمثل المحصول لكل شجرة، وذلك فى أشجار التين، بينما العكس كان صحيحا مع المفلودايد بتركيز ٢٠,٠٠٠جزء في المليون في أشجار الرمان. وقد أوضحت هذه الدراسة بأنه على الرغم من أن إضافة نفثالين حمض الخليك، البلكلوبترازول والمفلودايد كانت أقل تأثيرا على الصفات الطبيعية للثمار فى كلا النوعين، فإن

البكلوبترازول بتركيز ٥٠٠ جزء في المليـون أدى إلى زيـادة محتوى الثمـار من المـواد الصلبـة الذائبـة الكليـة وفيتـامين (ج)، وبالمثل البكلوبترازول بتركيز ١,٠٠٠ جزء في المليون في ثمار الرمان. كما أدت المعاملة بنفثالين حمض الخليك إلى زيادة النسبة المئوية للسكريات الكلية فى ثمار التين وخفض نسبة المواد الصلبة الذائبة الكلية فى ثمار الرمان.