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Study the effect of spraying growth regulators on flowering, fruit set and yield of Haied and Amal apricot cultivars

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Abstract

This study was conducted during two successive seasons of 2016 and 2017 on Haied and Amal apricot cultivars trees (5 years old) grown at 5 x 4 meters apart in Sandy soil of a private orchard at Nobaria, Beheira governorate. The treatments including Hockley Alpha the commercial name of (Naphthyl acetic acid 45%, Naphthyl acetamide 1.20%) sprayed alone at 120 g / 200 L of water and Nano Bloom the commercial name of (Naphthyl acetic acid 2%, Naphsoxy acetic acid 3%, Cytokinin 1.40%, Gibberellin 0.75%, Oxyinat 0.009%, Vitamin B, H, K 20%, Phosphorus 20%, Boron 3%, Cobalt 0.1%, Molybdium 0.01% and improved substances and its fillings 52.89%) sprayed alone at 20 g / 100 L of water and the control (sprayed with water) all of them were sprayed twice (at 50 to 60 % of the flowering and Initial fruit set each season) on both apricot cultivars. Hockley Alpha and Nano Bloom treatments reduced percentage of fruit drop, increased percentage of retained fruit and increased fruit yield (kg/tree) of the two cultivars compared with control in the two studied seasons. Economic study cleared, spraying Hockley Alpha or Nano Bloom increased yield and total income /feddan (feddan = 1.038 acres) LE of Haied and Amal cvs. with lowest coast..

Keywords: apricot, Haied, Amal, fruit drop, retained fruit, yield.

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1. Introduction

Apricot (*Prunus armeniaca* L.) is a deciduous fruit tree related to Rosaceae family, subfamily Prunoideae, which produces stone fruits (Drupe). In current years, the total area of apricot production has begun to decrease compared to previous years. In 2015 total planted area in Egypt amounted 15785 feddan (feddan = 1.038 acres) and fruiting area reached 14398 feddan and the total production recorded 94831 ton (Economic Affairs Sector, 2015). While in 2008 total planted area in Egypt amounted 18559 feddan and fruiting area reached 15278 feddan and the total production recorded 101139 ton (Economic Affairs Sector, 2008). This decline is due to many problems facing apricot trees such as the fall of the flowers by a large proportion in the spring and especially in the trees planted in the desert land (newly reclaimed lands) during the winds of Al Khamassin in Egypt, which led to a decrease in the quantity of the crop and especially in the varieties of early apricots in the flowering such as Haied and Amal cvs. Many studies used growth regulators to solve this problem such as naphthalene acetic acid. Naphthalene acetic acid, commonly abbreviated as NAA is an organic compound, which is a synthetic plant hormone of auxin group and is an ingredient in many commercial horticultural products (Dimitrios *et al*., 2008). Functions of NAA are cell elongation, elongation of shoot, photosynthesis, RNA synthesis, membrane permeability and water uptake involved in many physiological processes like prevention of pre-harvest fruit drop, flower induction, fruit set, delayed senescence and prevention of bud sprouting, leaf chlorophyll content and increased yield in fruit crops. An exogenous application of naturally occurring or synthetic plant growth regulators affects endogenous hormonal pattern of the plant either by supplementation of sub-optimal levels or by interaction with their synthesis, translocation or inactivation of existing hormone levels (Basuchaudhuri, 2016). Gibberellic acid has been reported to influence vegetative growth, flowering, fruiting and various disorders in many fruit crops (Thompson and Guttridge, 1959; Paroussi *et al*., 2002; Singh and Kaul, 1970). It is also used widely in other horticultural crops for stimulating fruit set in various fruit species, such as peach (Stutte and Gage, 1990), ‘Clementine’ mandarin (Talon *et al*., 1992), pear (Deckers and Schoofs, 2002), also to control apple russeting (Taylor and Knight, 1986) and cracking of pomegranate fruit (Sepahi, 1986). Gibberellic acid (GA3) applied at fruit set is used extensively to increase berry size of *Vitis vinifera* seedless table grapes. Gibberellins primarily affect growth by controlling cell elongation and division, which is reflected on yield and its components and fruit quality of various grape cultivars (Pires *et al*., 2000). Gibberellic acid is responsible for cell elongation, rather than cell division (Kappel and MacDonald, 2001). Gibberellic acid is one of the important growth stimulating substance help in the growth and development of many plants. There are many cultural and chemical practices to increase the yield of the

crops (Chao and Lovatt, 2006). At the full bloom stage of foliar application, the higher fruit yield/tree on apricot was recorded in the treatment GA3 (10 ppm) + NAA (10 ppm). But in pea stage the maximum yield per tree was recorded in the treatment GA3 (15 ppm) + NAA (10 ppm) followed by GA3 (10 ppm) + NAA (10 ppm) and the minimum fruit yield was observed in control (Devrari, 2016). Combined treatment of GA3 (20 ppm) + BA (10ppm), GA3 (10 ppm) + BA (5 ppm) and GA3 (10 ppm) + promalin (250 ppm) when applied as single spray at full bloom increased fruit set, fruit retention, yield efficiency and fruit quality (Sharma and Karan, 2008). Nkansha *et al*. (2012) conducted an experiment to study the effect of plant growth regulators on fruit set and yield on "Keitt" mango trees in order to study the effect of GA3 and NAA sprays at different concentrations on fruit retention, fruit quality and yield. Trees were sprayed at full bloom stage. All sprayed chemicals significantly increased fruit retention and tree yield. Gibberellic acid (25 ppm) and NAA (25 ppm) gave the best results in terms of increasing fruit set, fruit retention, number of fruits cluster^{-1} and plant^{-1}, fruit weight and yield. No significant differences were observed between the quality of fruits harvested from treated and control trees. Fifty five ppm of GA3 and 25 ppm of NAA can be employed for spraying mango flowers at full bloom to increase mango fruit set, retention and yield of growers. Synthetic cytokinin increases fruit size by enhancing cell division, cell expansion or both processes (Patterson *et al*., 1993), when applied to plants has significant physiological activity on many fruits. The primary physiological effects of cytokinin on grapevines involve the regulation of fruit set, berry growth and development. Hopping (1976) demonstrated that applications of cytokinin and auxin were effective in promoting normal development of poorly pollinated fruit. Boron is important for pollen tube growth and thus, needed at bloom to aid fruit set, it is also needed for movement of plant sugars, important in pollen germination and pollen tube growth, which is likely to increase fruit set. Therefore, boron fertilization may increase yield (Ganie *et al*., 2013). Phosphorous participates in several biochemical reactions like respiration, wax metabolism and energy transformation and is a constituent of most enzymes (Marschner, 2012). In the apple tree, P deficiency reduces root growth, causing premature leaf abscission as well as negative effects on flowering and fruiting (Basso and Suzuki, 2002). Cobalt, a transition element is an essential component of several enzymes and co-enzymes. It has been shown to affect growth and metabolism of plants (Palit *et al*., 1994). Molybdenum is utilized by selected enzymes to carry out redox reaction. Enzymes that require molybdenum for activity include nitrate reductase, xanthine dehydrogenase, aldehyde oxidase and sulfite oxidase (Kalser *et al*., 2005). Previous studies have shown that plant growth regulators play an important role, improvement in the yield and quality of the crops mainly depends on the concentration of plant growth regulator and time of application. The

aim of the research was to reduce the percentage of flowers drop and increase the percentage of fruit set and yield with lowest cost in the apricot trees planted in the desert land during the winds of Al Khamassin by using growth regulators such as naphthalene acetic acid (NAA) and naphthalene acetamide (NAD) which are helpful to reduce fruit drops and increase fruit yield, quality and the physical-chemical properties of fruits may be improved of " Haied and Amal" apricot cultivars.

2. Materials and methods

2.1 The experimental design and treatments

This study was conducted during two successive seasons of 2016 and 2017 on fruiting Haied and Amal cvs. apricot trees (5 years old) grown at 5 x4 meters apart in Sandy soil of a private orchard at Nobaria, Beheira governorate, Egypt. Nine nearly uniform Haied cv. trees and nine nearly uniform Amal cv. trees were selected and were healthy and similar in the vigor, as possible, same cultural practices and drip irrigation was adopted in this area for the investigation. The trees were subjected to the ordinary orchard management. Each treatment consisted of three replicates with one tree for each replicate and three shoots and three spurs were selected on each replicate around the perimeter of the tree. The trees were sprayed twice, first spray at 50 to 60 % of the flowering and second spray at Initial fruit set each season with the following treatments:

- Hayd cv. trees sprayed with Hockley Alpha with a concentration of 120g/200 liters of water.
- Hayd cv. trees sprayed with Nano Bloom with a concentration of 20g/100 liters of water.
- Hayd cv. trees Control (sprayed with water).
- 4-Amal cv. trees sprayed with Hockley Alpha with a concentration of 120g/200 liters of water.
- Amal cv. trees sprayed with Nano Bloom with a concentration of 20g/100 liters of water.
- Amal cv. trees Control (sprayed with water).

Hockley Alpha is the commercial name of (Naphthyl acetic acid 45%, Naphthy l acetamide 1.20%). Nano Bloom is the commercial name of (Naphthy l acetic acid 2%, Naphsoxy acetic acid 3%, Cytokinin 1.40% Gibberellin 0.75%, Oxyinat 0.009% Vitamin B, H, K 20%, Phosphorus 20%, Boron 3%, Cobalt 0.1%, Molybdium 0.01% and improved substances and its fillings 52.89%).

2.2 Experiment measurements

2.2.1 Percentage of flower and vegetative buds per shoot, percentage of flower and vegetative buds per spur

The total number of buds on shoot or spur was calculated. Flowering and vegetative

buds were counted and percentage of each kind was calculated as related to the total number of buds on shoot or spur for all treatment.

$$\text{Percentage of flower buds} = (F / T) \times 100$$

Where: F = the number of flowering buds, T = total number of buds on the shoot or spur.

$$\text{Percentage of vegetative buds} = (V / T) \times 100$$

Where: V = vegetative buds, T = total number of buds on the shoot.

$$\text{Percentage of dormant buds} = (D / T) \times 100$$

Where: D = dormant buds, T = total number of dormant buds on the shoot.

2.2.2 Complete fruit set (%)

Complete fruit set for Haied cv. it was at (13/3/2016) in the first season and (23/3/2017) in the second season. While Amal cv. was at (12/3/2016) in the first season and (30/3/2017) in the second season. The percentage of fruit set on spurs and shoots was calculated according the next formula:

$$\text{Fruit set percent} = \frac{\text{No of fruit set}}{\text{Total number flowering}} \times 100$$

2.2.3 Fruit drop (%)

Fruit drop was calculated after 15 days from initial fruit set or one week from complete fruit set for Haied cv. it was at (21/3/2016) in the first season and (30/3/2017) in the second season, while Amal cv. was at (28/3/2016) in the first season and (7/4/2017) in the second season. The percentage of fruit drop on spurs and shoots was calculated according the next formula:

$$\text{Fruit drop \%} = \frac{\text{fruit set No - retained fruits No}}{\text{No of fruit set}} \times 100$$

2.2.4 Fruit retention (%)

The percentage of fruit retention one week before harvesting on spurs and shoots was calculated according the next formula:

$$\text{Fruit retention \%} = \frac{\text{No of retained fruits}}{\text{No of fruit set}} \times 100$$

2.2.5 Fruit yield

At the commercial picking time of the Haied and Amal cultivars, yield (kg/tree) was weighed. Analysis of mature fruit was carried out when fruits attained maturity according to stands recorded by Kader, (1999). At the mature stage for Haied cv. it was at (9/5/2016) in the first season and (11/5/2017) in the second season, while Amal cv. was at (15/5/2016) in the first season and (18/5/2017) in the second season.

2.2.6 Fruit quality

Twenty random selected fruits from each tree were picked to determine the Physical and chemical properties of mature fruits that carried out when fruits of control attained maturity according to stands recorded by Kader (1999). Physical and chemical characteristics were evaluated.

2.2.6.1 Physical characteristics

- Fruit weight (g.): Average of fruit weight was determined by weighting a sample of five fruits from each replicate and the average fruit weight was calculated.
- Fruit size (cm^3): Using water displace meter method.
- Fruit firmness (Lb/Inch2): It was determined from the two sides of fruits by using a pressure tester (Advance Force Gorge RH13, UK).
- Fruit dimensions (cm): Fruit diameter and fruit length in cm were measured by using a vernier caliper.
- L/D ratio: It was measured by dividing the fruit length on fruit diameter.
- The thickness of fruit flesh (cm). It was measured from the two sides of fruit by using a vernier caliper.
- Fruit flesh weight (g): Average of fruit flesh weight was determined by weighting a sample of five fruits without seed from each replicate and the average fruit weight was calculated.

2.2.6.2 Chemical characteristics

- Total soluble solids (T.S.S.): TSS (%) was determined in fruit juice sample of five fruits by using a hand refrectometer (Portable Refractometer ATC).
- Total acidity (%): It was determined in terms of anhydrous malic acid as a percentage after titration by 0.1 N sodium hydroxide using phenolphthalein as an indicator (A.O.A.C., 2000).
- TSS/acid ratio: It was calculated by dividing total soluble solids on total acidity.

2.3 Statistical analysis

The experimental treatments were arranged in a randomized complete block design with three replicates. Each replicate consisted of one tree. Obtained data were subjected to analysis of variance according to Snedecor and Cochran (1990). Means were compared using the Duncan multiple range test at 5% level (Duncan, 1955).

3. Results

3.1 Percentage of flower, vegetative bud and fruit set of Hayed and Amal cv. tree branches

Data presented in Table (1) illustrated the effect of foliar sprays of different treatments on the percentage of flower, vegetative bud and fruit set of Hayed cv. tree branches in 2016 and 2017 seasons. Results indicated that for the percentage of flower bud Hockley alpha treatment recorded the highest significant value in the first season (41.87 %) while, Nano bloom gave the higher value in the second season (16.40 %) while other treatments has no significant compared with control in the both seasons. As for percentage of

vegetative bud in the first season there were significant differences between the Hockley alpha and Nano bloom treatments and between control treatment they recorded (19.44, 18.23 %) and (15.73 %) respectively. While, in the second season Nano bloom treatment showed the highest significant value (18.17 %). On the other hand Hockley alpha and control treatments showed the lowest percentages without significant differences between them. Percentage of fruit set: Both treatments Hochley alpha and Nano bloom gave the highest significant fruit set than control (74.86 and 77.93 %) in the first season respectively while in the second season spraying with the two treatments didn't differ significantly compared with control.

Table (2) showed the percentage of flower buds, vegetative buds and percentage of fruit set in 2016 & 2017 seasons for Amal cv. tree branches. As for percentage of flower all of three treatments gave statistically the same effect they have (43.92, 45.55 and 43.54 %) for Hockley alpha, Nano bloom and control respectively, in the second season only Hockley alpha and Nano bloom gave affected higher values than control they recorded (33.71, 30.24 and 21.62%) respectively. For percentage of vegetative buds in the first season both of Hockley alpha and Nano bloom showed the same effect without significant differences between them and with significant differences between the controls they recorded (21.49, 20.18 and 17.78 %) respectively, in the second season Hockley alpha obtained the highest significant percent (30.25%) compared to other treatments. As for percentage of fruit set Nano bloom at the first season and Hockley alpha in the second season gave the highest significant values (78.17 & 37.77 %) respectively than the other treatments.

Table (1): Effect of treatment on Hayed cultivar branches flower bud percentage, vegetative bud percentage and fruit set percentage in seasons of 2016 and 2017.

Treatment	Flower bud (%)		Vegetative bud (%)		Fruit set (%)	
	2016	2017	2016	2017	2016	2017
Hockley alpha	41.87[a]	11.21[b]	19.44[a]	16.15[b]	74.86[a]	82.61[a]
Nano bloom	33.53[b]	16.40[a]	18.23[a]	18.17[a]	77.93[a]	84.25[a]
Control	33.90[b]	9.41[b]	15.7 [b]	15.09[b]	32.33[b]	80.15[a]

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (2): Effect of treatment on Amal cultivar branches flower bud percentage, vegetative bud percentage and fruit set percentage in seasons of 2016 and 2017.

Treatment	Flower bud (%)		Vegetative bud (%)		Fruit set (%)	
	2016	2017	2016	2017	2016	2017
Hockley alpha	43.92[a]	33.71[a]	21.49[a]	30.25[a]	63.46[b]	37.77[a]
Nano bloom	45.55[a]	30.24[a]	20.18[a]	21.63[b]	78.17[a]	34.45[b]
Control	43.54[a]	21.62[b]	17.78[b]	18.15[b]	60.81[b]	32.32[b]

Means having the same letter (s) in each column are statistically insignificant at 5% level.

3.2 Percentage of flower, vegetative bud and fruit set of Hayed and Amal cv. tree spurs

Effect of treatments on Hayed cv. spurs flower, vegetative buds and fruit set. Table (3) cleared that for percentage of flower buds Hockley alpha recorded the highest significant value in the first and the second seasons (54.71 and 22.92 %) respectively also Nano bloom recorded the highest value in the second season only (25.11 %) than the control. Data of vegetative bud showed that Nano bloom only gave the highest significant vegetative bud percentage than Hockley alpha and control treatments (12.77 %) in season 2016 but in 2017 season both of Hockley alpha and Nano bloom recorded the higher value than control they have (12.50, 14.90 and 9.64 %) respectively. As for fruit set percentage both of the two seasons have the same trend that Hockley alpha gave the higher significant values in the first & second season (84.49 and 84.76 %) respectively than Nano bloom and control treatments. Amal cv. spurs flower, vegetative buds and fruit set Table (4) cleared that for percentage of flower buds in the first season Nano bloom only had the highest significant value (63.76 %) while in the second season both of Hockley alpha and Nano bloom recorded the highest percentages (48.43 and 39.18 %) without significant differences between them and with a significant difference between the control. For the percentage of vegetative buds both of Nano bloom and the control treatments recorded the highest value (19.66 and 15.06 %) respectively without significant differences between them. Hockley alpha recorded the lowest significant value (8.58 %). But in the second season there were no significant differences between the three treatments. As for percentage of fruit set Nano bloom only gave the highest significant percent (92.50 %) in the first season while in the second season all of the three treatments gave statistically the same effect between them.

Table (3): Effect of treatment on Hayed cultivar spurs flower bud percentage, vegetative bud percentage and fruit set percentage in seasons of 2016 and 2017.

Treatment	Flower bud (%)		Vegetative bud (%)		Fruit set (%)	
	2016	2017	2016	2017	2016	2017
Hockley alpha	54.7[a]	22.92[a]	5.34[b]	12.50[a]	84.49[a]	84.76[a]
Nano bloom	49.89[b]	25.11[a]	12.77[a]	14.90[a]	75.98[b]	75.98[b]
Control	46.14[b]	15.08[b]	8.71[b]	9.64[b]	74.86[b]	74.68[b]

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (4): Effect of treatment on Amal cultivar spurs flower bud percentage, vegetative bud percentage and fruit set percentage in seasons of 2016 and 2017.

Treatment	Flower bud (%)		Vegetative bud (%)		Fruit set (%)	
	2016	2017	2016	2017	2016	2017
Hockley alpha	58.79[b]	48.43[a]	8.58[b]	25.33[a]	81.70[b]	52.38[a]
Nano bloom	63.76[a]	39.18[a]	19.66[a]	23.15[ab]	92.50[a]	51.71[a]
Control	52.92[b]	28.47[b]	15.06[a]	27.76[a]	80.22[b]	50.07[a]

Means having the same letter (s) in each column are statistically insignificant at 5% level.

3.3 Fruit drop and retained fruit percentage of Hayed and Amal cv. branches and spurs

Effect of treatments on Hayed cv. branches fruit drop and retained fruit Table (5) showed that both of Hockley alpha and Nano bloom recorded the lowest significant fruit drop percent than control treatment in the both seasons they have (61.89 and 68.48 %) and (48.33 and 54.56 %) in the first and the second seasons respectively. While the two treatments have the highest values of branches retained fruit also in the both seasons in a significant difference between the control they have (38.11 & 31.52 %) in the first season and (51.67 and 45.45 %) in the second season respectively. The spurs have different trend than the branches so that both of Nano bloom and control recoded the highest significant fruit drop percentage (73.09 and 78.72 %) in the first season while Hockley alpha has the lowest significant percent (56.67 %) in the same season. On the other hand, Hockley alpha has the lowest percent (77.50%) without significant differences compared to Nano bloom treatment on the second season. For retained fruit Hockley alpha gave the highest significant value (43.34%) than Nano bloom and control in the first season. While in the second season both of Hockley alpha and Nano bloom recorded the highest significant values of retained fruit than the control they have (22.50 and 21.94 %) respectively.

Table (5): Effect of treatment on Hayed cultivar fruit drop percentage and retained fruit percentage on branches and spurs of tree in seasons of 2016 and 2017.

Treatment	Fruit drop % on branch		Retained fruit % on branch		Fruit drop % on spurs		Retained fruit % on spurs	
	2016	2017	2016	2017	2016	2017	2016	2017
Hockley alpha	61.89^{b}	48.33^{b}	38.11^{a}	51.67^{a}	56.67^{b}	77.50^{b}	43.34^{a}	22.50^{a}
Nano bloom	68.48^{b}	54.56^{b}	31.52^{a}	45.45^{a}	73.09^{a}	78.07^{ab}	26.91^{b}	21.94^{a}
Control	84.32^{a}	87.74^{a}	15.68^{b}	12.27^{b}	78.72^{a}	82.75^{a}	21.28^{b}	17.25^{b}

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (6): Effect of treatment on Amal cultivar fruit drop and retained fruit in branches and spurs of tree in seasons of 2016 and 2017.

Treatment	Fruit drop % on branch		Retained fruit % on branch		Fruit drop % on spurs		Retained fruit % on spurs	
	2016	2017	2016	2017	2016	2017	2016	2017
Hockley alpha	47.05^{b}	27.50^{b}	52.95^{a}	72.50^{a}	47.31^{b}	12.51^{b}	52.69^{a}	87.49^{a}
Nano bloom	63.05^{a}	29.28^{b}	36.95^{b}	70.71^{a}	51.34^{b}	20.69^{b}	48.66^{a}	79.31^{a}
Control	64.70^{a}	35.00^{a}	35.30^{b}	65.00^{b}	60.60^{a}	33.03^{a}	39.40^{b}	69.97^{b}

Means having the same letter (s) in each column are statistically insignificant at 5% level.

The effect of Amal cv branches fruit drop and retained fruit percentage Table (6) indicated that Hockley alpha treatment showed the lowest significant values in the both seasons for percentage of fruit drop (47.05 and 27.50 %) respectively and Nano bloom in the second season only recorded (29.28 %) the same trend for percentage of retained fruit also the Hockley alpha treatment recorded the highest significant percent in the both seasons (52.95 and 72.50 %) respectively and Nano bloom treatment in the second season only recorded (70.71 %) all of them with a significant differences between the control treatment. The spurs showed different trend than the branches we can see that both of Hockley alpha and Nano bloom treatments recorded the lowest fruit drop percentage in the both seasons in a significant differences between the control they have (47.31 and 51.34 %) in the first season and (12.51 and 20.69 %) respectively in the second season. As for percentage of retained fruit all of Hockley alpha and Nano bloom have the highest significant percentages than the control in the first and second seasons them recorded (52.69 and 48.66 %) in the first and (87.49 and 79.31 %) in the second respectively.

3.4 Fruit yield, weight, volume and firmness of Hayed and Amal

According to Table (7), it's clear that the effect of treatments on Hayed cv. fruit yield, weight, volume and firmness in 2016 and 2017 seasons. It is obvious from Table (7) that both of Hockley alpha and Nano bloom resulted in the highest significant fruit yield (kg / tree) without significant differences between them in the first season while Hockley alpha only resulted the highest value in the second season. On the other hand, the control resulted the lowest significant value. Thus, it is apparent of the data of fruit weight (g) that also Hockley alpha and Nano bloom showed the highest values in the one season but in the second season there were no significant differences between the three treatment. Fruit size (cm^3) take the nearly same trend of the fruit weigh so that treatment of Nano bloom showed the greatest significant fruit volume (31.24 cm^3) but Hockley alpha and control exhibited the lowest values without significant differences between them. As for fruit firmness ($Lb/inch^2$) the two seasons are in harmony in the results that Hockley alpha and control treatments achieved the greatest fruit firmness in the first and the second seasons without significant differ between them while Nano bloom showed the lowest fruit firmness in both season. Table (8) exhibits the effect of treatments of Amal cv. fruit yield, weight, volume and firmness in 2016 and 2017 seasons. It is cleared that both of Hockley alpha and Nano bloom resulted the highest yield / tree (49.74 and 45.66 kg / tree) and (61.45 and 59.70 kg / tree) in the first and the second seasons respectively. On the other hand control treatment gave the lowest significant value in both seasons (37.87 and 46.72 kg / tree). Fruit weight (g) there are insignificant differences for all values in the first season but in the second control treatment recorded the highest significant value (32.19 g) while Hockley

alpha and Nano bloom have the lowest values without significant differ between them. As for fruit size (cm^3) also the three treatments didn't show significant differences between them in the first season. While in the second Hockley alpha and control recorded the highest significant volume (29.16 and 27.77 cm^3) and Nano bloom showed the lowest value (24.99 cm^3). There were no differences between treatments for the result of fruit firmness in the first season while in the second Nano bloom and control treatments resulted the highest fruit firmness (5.59 and 7.02 $Lb/inch^2$) without significant different between them. But Hockley alpha treatment showed the lowest significant value (3.47 $Lb/inch^2$).

Table (7): Effect of treatment on Hayed cultivar fruit yield (kg/tree), weight (g), size (cm^3) and firmness ($Lb/inch^2$) in seasons of 2016 and 2017.

Treatment	Fruit yield (kg/tree)		Fruit weight (g)		Fruit size (cm^3)		Fruit firmness ($Lb/inch^2$)	
	2016	2017	2016	2017	2016	2017	2016	2017
Hockley alpha	40.14^{a}	37.97^{a}	29.37^{ab}	34.25^{a}	29.16^{b}	34.71^{a}	6.10^{a}	7.75^{a}
Nano bloom	42.28^{a}	26.38^{b}	33.31^{a}	36.25^{a}	31.24^{a}	33.32^{a}	4.37^{b}	6.05^{b}
Control	36.80^{b}	18.56^{c}	26.87^{b}	33.66^{a}	26.38^{b}	34.57^{a}	6.49^{a}	8.57^{a}

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (8): Effect of treatment on Amal cultivar fruit yield (kg/tree), weight (g), size (cm^3) and firmness ($Lb/inch^2$) in seasons of 2016 and 2017.

Treatment	Fruit yield (kg/tree)		Fruit weight (g)		Fruit size (cm^3)		Fruit firmness ($Lb/inch^2$)	
	2016	2017	2016	2017	2016	2017	2016	2017
Hockley alpha	49.74^{a}	61.45^{a}	20.98^{a}	28.85^{b}	21.46^{a}	29.16^{a}	6.53^{a}	3.47^{b}
Nano bloom	45.66^{a}	59.70^{a}	21.47^{a}	27.75^{b}	21.46^{a}	24.99^{b}	6.23^{a}	5.59^{a}
Control	37.87^{b}	46.72^{b}	23.41^{a}	32.19^{a}	22.85^{a}	27.77^{a}	6.30^{a}	7.02^{a}

Means having the same letter (s) in each column are statistically insignificant at 5% level.

3.5 Fruit length, diameter and shape of Hayed and Amal

Table (9) stated the effect of three treatments in fruit length, diameter and shape on Hayed cv. tree Spraying trees with Nano bloom achieved significant the greatest fruit length in both seasons in the same value (3.88 cm) while Hockley alpha and control recorded the lowest significant fruit length with the same values in both seasons (3.64 and 3.53 cm) respectively. Differ direction of fruit diameter results that there were insignificant differences between the three treatments in both seasons. For fruit shape index in general, it is obvious that spraying Hayed cv. trees with the three treatments induced fruit tended to be ovate or oblong in its shape. Without significant differ between Nano bloom and control but with significant differ with Hockley alpha which resulted the lowest value of shape index (L/D) in the first season only. While in the second season there were no significant differences between three treatments.

Table (9): Effect of treatment on Hayed cultivar fruit length (cm), diameter (cm) and shape (L/D), in seasons of 2016 and 2017.

Treatment	Fruit length (cm)		Fruit diameter (cm)		Fruit shape (L/D)	
	2016	2017	2016	2017	2016	2017
Hockley alpha	3.64 [b]	3.64 [b]	3.55 [a]	3.72 [a]	1.026 [b]	1.06 [a]
Nano bloom	3.88 [a]	3.88 [a]	3.68 [a]	3.80 [a]	1.052 [a]	1.05 [a]
Control	3.53 [b]	3.53 [b]	3.38 [a]	3.72 [a]	1.043 [a]	1.00 [a]

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (10): Effect of treatment on Amal cultivar fruit length (cm), diameter (cm) and shape (L/D) in seasons 2016 and 2017.

Treatment	Fruit length (cm)		Fruit diameter (cm)		Fruit shape (L/D)	
	2016	2017	2016	2017	2016	2017
Hockley alpha	3.18 [a]	3.66[a]	3.20[a]	3.53[b]	0.997[a]	1.035[a]
Nano bloom	3.22[a]	3.52[a]	3.22[a]	3.53[b]	1.001[a]	0.996[a]
Control	3.28[a]	3.73[a]	3.30[a]	3.68[a]	0.996[a]	1.014[a]

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (10) illustrated the effect of different treatments on fruit length, diameter and fruit shape index of Amal cv. trees. For fruit length all studied treatments didn't show significant differences between them in this concern in the both seasons. Also all treatments didn't have significant differences between them for fruit diameter result only in the first season but in the second season the control gave the highest significant value (3.68 cm). While Hockley alpha and Nano bloom gained the same fruit diameter (3.53 cm).As for fruit shape index it is cleared that all treatments resulted in fruit nearly to be ovate or oblong and nearly round in its shape, without significant differences between them.

3.6 Pulp weight, thickness, TSS, acidity and TSS / acidity on Hayed and Amal

Table (11) showed the effect of treatments on Hayed cv. pulp weight, thickness, TSS, acidity and TSS / acidity in seasons of 2016 and 2017. Data cleared that Hockley alpha and Nano bloom recoded the highest value of pulp weight with insignificant differ between them and with a significant differ between the control in the first season only. For pulp thickness results indicated that there were no significant differences between the all of treatments in the both season. Also, for TSS there is no significant different between treatments only in the first season while in the second season Hockley alpha showed the highest value without significant differ between Nano bloom treatment and with significant differ to the control. The nearly same trend of TSS result the acidity takes this trend. As for TSS / acidity the results cleared that Nano bloom had the highest significant value (66.26 and 63.33) in both season respectively while Hockley alpha and control achieved the lowest values in both seasons without significant differences between them.

Table (11): Effect of treatment on Hayed cultivar pulp weight (g), pulp thickness (cm), TSS percentage, acidity percentage and TSS/acidity in seasons of 2016 and 2017.

Treatment	Pulp weight (g)		Pulp thickness (cm)		TSS %		Acidity %		TSS/Acidity	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Hockley alpha	26.45^{a}	31.77^{a}	1.19^{a}	1.07^{a}	10.17^{a}	11.00^{a}	0.17^{a}	0.20^{a}	59.80^{b}	56.05^{b}
Nano bloom	29.21^{a}	32.66^{a}	1.19^{a}	1.10^{a}	10.50^{a}	9.50^{ab}	0.16^{a}	0.15^{b}	66.26^{a}	63.33^{a}
Control	24.03^{a}	30.71^{a}	1.09^{a}	1.07^{a}	10.00^{a}	8.00 ^{a}	0.17^{a}	0.15^{b}	57.98^{b}	52.22^{b}

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (12): Effect of treatment on Amal cultivar pulp weight (g), pulp thickness (cm), TSS percentage, acidity percentage and TSS/acidity in seasons of 2016 and 2017.

Treatment	Pulp weight (g)		Pulp thickness (cm)		TSS %		Acidity %		TSS/Acidity	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Hockley alpha	20.35^{a}	27.18^{ab}	0.99^{b}	0.96^{a}	10.67^{a}	9.67^{a}	0.24^{a}	0.21^{a}	45.16^{a}	46.42^{a}
Nano bloom	19.23^{a}	25.93^{b}	0.91^{b}	0.99^{a}	8.67^{b}	8.00^{b}	0.19^{b}	0.18^{b}	44.93^{a}	44.53^{a}
Control	20.96^{a}	28.33^{a}	1.22^{a}	0.99^{a}	7.67^{b}	7.83^{b}	0.19^{b}	0.18^{b}	41.09^{a}	44.64^{a}

Means having the same letter (s) in each column are statistically insignificant at 5% level.

Table (12) cleared the effect of treatments on Amal cv. pulp weight, thickness, TSS, acidity and TSS / acidity. It is obvious from pulp weight results that there was no significant different between all treatments in the first season only while in the second season control treatment showed highest value (28.33 g) without significant different with Hockley alpha. Nano bloom treatment recorded the lowest value. As for pulp thickness control treatment gained the greatest significant value (1.22 cm) while Hockley alpha and Nano bloom showed the lowest values without significant differ between them that in the first season. In the second season there were no significant differences between the studied treatments. The results of TSS and acidity have the same trend in the both seasons. So, that Hockley alpha recorded the greatest values with a significant differences between Nano bloom and control which they showed the least values without significant differences between them in the two season. Differ trend of TSS / acidity results that all of three treatments didn't show significant differences between them so all of them have the nearly same values.

3.7 The Economic Study

Table (13) showed the economic study of yield production and the main economic criteria were cost of each substance (Hockley Alpha and Nano Bloom) for Haied and Amal cultivars that used under search (LE / feddan) (feddan = 1.038 acres). Other expenses such as the costs of supervision and royalties were not taken into consideration in this study. The package price of Hockley Alpha was (30 LE / 120g), package price of Nano Bloom (15 LE /20 g). The study also revealed that the cost of labor that were used per treatment and thus the total costs were calculated. From this table it is cleared that for Haied cultivar Hockley Alpha and Nano Bloom increased the total income/feddan LE than control treatment by 4.907 and 8.05 in the first season, and

34.646 and 13.957 LE/ feddan in the second season respectively in while Amal cultivar recorded (17.451 & 11.452 LE/ feddan) in the first season and (26.291and 23.171 LE/ feddan) in the second season respectively.

Table (13): Economical comparison between Hockley Alpha and Nano Bloom treatments for Haied and Amal cultivars and the increase in yield than the control.

Treatment	Average cost LE/feddan*	Yield Ton/ feddan**		Total income / feddan LE***	
		2016	2017	2016	2017
Haied					
Hockley Alpha	262.5	8.429	7.973	59.003	67.770
Nano Bloom	315	8.878	5.539	62.146	47.081
control	water	7.728	3.897	54.096	33.124
Amal					
Hockley Alpha	262.5	10.445	12.904	73.115	109.684
Nano Bloom	315	9.588	12.537	67.116	106.564
control	water	7.952	9.811	55.664	83.393

*Cost of material sprayed for one tree x number of additions x number of tree / feddan (210 tree), **Fruit yield kg/tree x no. of trees / feddan (210 tree). ***Price of one kg apricot in the farm x tree yield ton/ feddan. The price of one kg apricot (7.0 & 8.5 LE) in the first and second season

4. Discussion

The obtained results are in accordance with those found by Harminder *et al*. (2008) who studied the effect of spraying growth regulators, NAA (10, 25 and 50 ppm) and GA3 (25, 50 and 100 ppm) twice *i.e.* during the 4th week of March and 2nd week of April to check the pre-harvest fruit drop in plum (*Prunus salicina* Lindl) cv. Satluj Purple and the results indicated that minimum fruit drop and maximum fruit retention was observed in GA3 (50 ppm) followed by NAA (25 ppm). Iqbal *et al*. (2009) revealed that NAA significantly reduced pre-harvest fruit drop of guava (*Psidium guajava* L.). Maximum reduction (8.83%) in fruit drop was observed with (45 ppm/sprays). Fruit yield was significantly increased by NAA application. Maximum yield (44.80 kg per treatment) was recorded in case of 45 ppm closely followed by 60 ppm (44.60 kg). Also, Nkansha *et al*. (2012) conducted an experiment to study the effect of plant growth regulators on fruit set and yield on Keitt mango trees in order to study the effect of Gibberellic acid (GA3) and Naphthalene Acetic Acid (NAA) sprays at different concentrations on fruit retention, fruit quality and yield. Trees were sprayed at full bloom stage. All sprayed chemicals significantly increased fruit retention and tree yield. GA3 (25 ppm) and NAA (25 ppm) gave the best results in terms of increasing fruit set, fruit retention, fruit weight and yield. No significant differences were observed between the quality of fruits harvested from treated and control trees. This results are agree with of Arora and Singh (1970) whom mentioned that no significant improvement could be observed due to phosphorus and potassium concentrations but slight depressing effect was observed

in comparison to check trees. In the more Tuan *et al*. (2013) concluded that both GA3 and 2,4-D spray have positive effects on fruit development, reduced fruit drop, fruit crack and improved fruit quality of wax apple under field conditions. In addition the same results obtained by (Devrari, 2016) who reported that in apricot the fruit quality and yield of fruits can be increased by using foliar application at full bloom stage the growth regulators such as NAA and GA3 which are helpful to reduce fruit drops and increase fruit yield, quality and improve the physico-chemical properties of fruits, in addition he reported that spray of GA3 (10 ppm) + NAA (10 ppm) at full bloom stage of flowering showed maximum fruit set percentage (60.59%). Also, Wojcik and Marzena (2003) found that foliar applications of boron (B) sprays before full bloom or after harvest increased B concentrations in flowers, and fruitlets at 40 days after flowering of pear (*Pyrus communis* L.) tree.

5. Conclusions

It can be concluded that, spraying Haied and Amal cvs. apricot trees planted in desert lands with Hockley Alpha or Nano Bloom twice (at 50 to 60 % of the flowering and Initial fruit set) reduced fruit drop percentage and increased fruit yield (kg/tree) compared with the control. Economic study cleared, spraying Hockley Alpha or Nano Bloom increased yield and total income / feddan LE of Haied and Amal cvs. with lowest coast.

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