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Response of Pear Trees to Girdling and Foliar Spray with Naphthalene Acetic acid and Yeast Extract under the Conditions of New Valley

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ABSTRACT

A field experiment was carried out during 2020 and 2021 seasons on 8 years old early pear cultivar "Basateen MKM" trees grown in sandy soil under drip irrigation system at a private orchard on Al-Farafra road, Al-Wadi Al-Gadid governorate, Egypt. This study aimed to evaluate two levels of NAA foliar spray (15, and 30 ppm), two levels of yeast (0.4 and 0.6%) and girdling whether alone or with NAA and yeast and their effects on some vegetative growth characteristics, leaf mineral content as well as total yield and fruit quality. The obtained results showed that the combination of girdling and NAA at 15 ppm recorded the best results of total chlorophyll, fruit set %, total number of fruits/tree, yield, P, K, Ca, Mg percentages, B at ppm, C/N ratio, also, physical and chemical fruit traits when compared with the untreated trees (water spray only). On the other hand, the same treatment reduced the leaf area, N%, and fruit firmness. In conclusion, combining girdling with other treatments improved the fruit quality. It increases the number of seeds, which may ameliorate fruit growth, facilitate the absorption of mineral elements, and affect the fruit size and chemical composition. Therefore, it concluded that the number of seeds in the fruits is considered one of the quality indicators of the early pear cultivar "Basateen MKM" under Al-Wadi Al-Gadid governorate conditions.

Keywords: Pear; girdling, Naphthaline Acetic Acid, Yeast, New Valley

1. Introduction

Pear fruits are considered one of the best fruits in the temperate climate zone. The pear takes the third level among the deciduous fruits worldwide and ranked the fourth fruit distributed among all fruit crops across the world market (FAO, 2021). The early pear cultivar "Basateen MKM" was produced through five years of selections from several orchards in Egypt's Northern Governorates. It bloomed five weeks early, preventing it from being infected with the fire blight disease (Mohamed *et al*., 2012).

Al-Wadi Al-Gadid (The New Valley governorate), is situated in Egypt's western desert's southwest corner. The area covers around 376505 square kilometers, or roughly 56% of Egypt's western desert and 37.6% of Egypt's overall land area. The New Valley Governorate's five districts (Al-Kharga, Paris, Balat, Mut, and Al-Farafra as well as the East Ewinate) are the only permitted areas for agricultural expansion (Salah *et al.*, 2017). Numerous powerful and promising agricultural projects have recently been initiated in the region (Sara *et al.*, 2018) . Fruit trees are raised with an eye on producing high-value crops and minimizing fruit drop by balancing the output and quality. Numerous farming methods, including interfering with the major tree organs' translocation (e.g. girdling), are used to accomplish this (Goren *et al.*, 2004). The girdling technique is a traditional method for raising crop productivity (Casanova *et al.*, 2009). Girdling is an attempt to control the distribution of photosynthate, mineral nutrients, and plant bio-regulators by interfering with the phloem transfer between the canopy and roots (Goren *et al*., 2004).

This method involves removing a strip of bark from a fruit tree's trunk or main limbs. By doing this, it prevents photosynthates and metabolites from moving through the phloem downward, which lowers fruit drop and increases fruit development and yield (Zhao *et al.*, 2013). Girdling methods enhance fruit set, and enhance pear fruit quality (Fayek *et al.*, 2004). Also, Smit *et al.* (2005) showed that girdling

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pears is a technique used to reduce the overabundance of vegetative growth in fruit trees, which in turn increases fruit set and size, and improves the yield. The same was found with Mohamed (2012) who reported that shoot girdling of three-year-old "Le Conte" pear trees enhanced fruit set %, total number of fruits per tree, and fruit quality.

Although, it resulted in a notable reduction in fruit firmness, acidity, and N content of the leaves of Anna apple trees (Kandil *et al.*, 2006). On pear, there may also be an increase in the total soluble solids content Gurbinder *et al.* (2016).

Additionally, to support the fruit's physical and chemical qualities as well as the leaf to fruit ratio, more intensive fertilization programs must be implemented as reported by Ibrahim *et al.* (2016). Bio-fertilizers offer an economically appealing and ecologically sound approach of lowering external inputs, while enhancing quality and quantity (Mehdizadeh and Mushtaq, 2020)

Applying active bread yeast as a novel biofertilizer has been shown to have a variety of beneficial effects attributed to it's unique composition of higher protein content, natural sources of various growth-promoting substances (thiamine, riboflavin, niacin, pyridoxine, and vitamins B1, B2, B3, and B12), cytokinins, .Also, it contains various other nutrient elements and organic compounds like carbs, nucleic acid, and lipids. Because of its high auxin and cytokinin content and promotion of carbohydrate build up, yeast extract has been proposed to play a beneficial role during vegetative and reproductive growth by increasing fruit set in some plants (Hashem *et al.*, 2008). Plants can benefit from the dry yeast extract, which includes amino acids, plant hormones, carbohydrates, carbon, nitrogen, phosphorus, potassium, calcium, magnesium, and other micronutrients (Manea *et al.*, 2019).

Plant growth agents application in agriculture to modify fruit size (Casanova *et al.*, 2009). Plant hormones, as plant growth regulators, are chemical compounds that high plants naturally make. At low concentrations and distant from their production site, they regulate and stimulate physiological and development processes. Utilizing growth regulators has become a significant practice in agriculture, particularly for fruit trees. Auxin spraying, for example, is frequently used to lower fruit drop and enhance fruit quality (Suman *et al.*, 2017). Growth regulators are now a crucial instrument in the cultivation of many fruit crops. In horticulture, growth regulators have gained importance as a way to improve flowering, fruit set, fruit drop management, fruit size, yield, and fruit quality (Guirguis *et al.*, 2010).

Plant growth regulators, like NAA, decrease flower drop, increase floral retention, and yield, and improve fruit quality in mango and other fruit species, including citrus, apple, and guava (Iqbal *et al.*, 2009). Applying NAA during the early stages of fruit development promotes fruit development and results in larger final fruits on pears (Chen *et al.*, 2012). The maximum fruit set percentage and lowest fruit drop percentages on sweet orange trees (Nucellar) were both improved by the NAA treatment (Somwanshi *et al.*, 2017). The maximum fruit drop reduction, the greatest number of fruits per tree, and the highest yield per tree were all attained with NAA treatment on mandarin (Nawaz *et al.*, 2011) and on sweet orange trees cv. Jaffa (Rana *and* Chandramohan, 2018). Additionally, it increased fruit weight, size, firmness, fruit set, and production, and enhanced the amount of N, P, Ca, and Mg in the leaves compared to the control (Walid *et al.*, 2015). Spraying NAA improved fruit size and retention, leading to an increase in fruit yield, fruit weight and total soluble solid on plum cv "Satluj purple" (Gupta and Kaur , 2007). Fruit set, fruit retention, fruit weight, fruit count per plant, and yield on "Keitt" mango trees were all markedly enhanced by NAA (Nkansah *et al.*, 2012).

The physical and chemical characteristics of Balady lime fruits were enhanced with the use of NAA, resulting in a progressive increase in the yield (Gomaa, 2020). Fruit weight was considerably boosted by girdling, particularly when paired with NAA. The application of NAA resulted in a considerable decrease in total soluble solids (TSS); on the other hand, girdling increased TSS (Pedram *et al.*, 2008).

The aim of this study is to improve pear productivity and quality by using girdling and foliar spray with naphthalene acetic acid and yeast extract under the conditions of Al-Wadi Al-Gadid (The New valley governorate).

2. Material and Methods

The present investigation was carried out during two successive seasons (2020 and 2021) at a private orchard on Al-Farafra road, Al-Wadi Al-Gadid governorate(27°52'43.8N,28°36'01.3E) Egypt on early pear cultivar "Basateen MKM". The trees were 8 years old at the start of the experiment. The trees were grown on *Pyrus betulaefolia* rootstock in sandy soil in a private orchard. The trees were spaced at 5 × 4 m apart, open-vase shape trained, and irrigated with a drip irrigation system. Soil particle size distribution % was: Sand: 97.44 -Silt: 1.7 and Clay: 0.86, so the texture class is sandy soil.

The trees were in normal growth, uniform in vigor and received normal fertilization and agricultural practices as scheduled in the commercial farm. Trees received similar cultural practices adopted throughout the orchard. Physical and chemical analysis of the experimental soil are illustrated in Table 1.

Table 1: Some physical and chemical properties of the initial studied soil and irrigation water (meq/L).

Some physical and chemical properties of the initial studied soil									
pH	**EC (ds/m)**	**Ca (Meq/l)**	**Mg (Meq/l)**	**Na (Meq/l)**	**K (Meq/l)**	**CO_3 (Meq/l)**	**HCO_3 (Meq/l)**	**Cl (Meq/l)**	**SO_4 (Meq/l)**
7.21	3.11	21.20	5.96	0.50	3.48	0.00	13.10	7.76	10.28
Some Chemical properties of irrigation water (meq/L):									
pH	**EC (ds/m)**	**Ca (Meq/l)**	**Mg (Meq/l)**	**Na (Meq/l)**	**K (Meq/l)**	**CO_3 (Meq/l)**	**HCO_3 (Meq/l)**	**Cl (Meq/l)**	**SO_4 (Meq/l)**
6.96	0.52	1.59	1.30	0.61	1.77	0.16	0.52	3.20	1.39

This study included ten treatments established as follows: - control treatment (spraying with water only), yeast at 0.4 and 0.6%, NAA at 15 and 30 ppm, and girdling. All treatments were sprayed three times at full bloom (at the beginning of March), a month later and then two months after the first spray in the two seasons. The experiment was arranged in a complete block randomized design with three replicates, each replicate consists of two trees. Ten treatments x three replicates (2 trees per each) =60 trees for each season. The treatments were arranged as follows:-

1	Control water spray	6	Girdling (GRD)
2	NAA at 15 ppm	7	GRD +NAA at 15ppm
3	NAA at 30 ppm	8	GRD +NAA at 30 ppm
4	Yeast at 0.4 %	9	GRD +Yeast 0.4%
5	Yeast at 0.6 %	10	GRD +Yeast 0.6%

Dry yeast contains several nutrients including N, P, K, Mg, Ca, Na, Mn, Zn, Cu, B andMo, total protein, total carbohydrates, and some hormones (IAA and GA3) (Tartoura, 2001)

2.1. Foliar Nutrition Factor of Dry Yeast Extract (DYE)

It was prepared by dissolving dry baking yeast powder in water according to the studied concentrations of 0.4%, and 0.6%. Adding sugar at 1:1 ratio, then keep the mixture for 24 hours to activate and multiply the yeast (El-Tohamy *et al.*, 2009).

2.2. Girdling: Girdling was carried out two weeks before flowering. It was performed using a girdling knife that simultaneously cuts and removes the bark strips. The width of the girdle was 2 mm on the four main branches. Partial ringing of 75% was applied by removing a partial ring 4 cm long and leaving a connecting strip (2 mm) on the four main branches. The cut reached the cambium and was left bare without injury to the inner layer.

The following measurements were recorded:

1- Vegetative growth

Four main branches which were nearly uniform in growth, diameter, foliage density and distribution around the periphery of each tree were chosen and labeled.

Average leaf area (cm^2): Full mature leaves area were measured using leaf area meter.

Average total chlorophyll content: Total chlorophyll in the leaves were determined at the end of August in the field as Spad unit (spad = 100 mg chlorophyll/gm fresh weight) using portable set chlorophyll meter (Minolta 502).

2- Leaf mineral status (N, P, K, Ca, Mg and B)

Samples of Thirty leaves from the middle part of the shoot were selected at random from each replicate (Mid-August) of each season. The leaves were washed, dried at 70ºC till constant weight, grind and digested according to the method of Rebbeca (2004).

N, P, K, Ca, Mg and B were determined in the digested solution as follows:

- Total nitrogen was determined by the semi-micro Kjeldahl method Wilde *et al.* 1985).
- Phosphorus was determined by using the method of Bringham (1982).
- Potassium was determined by using the flame-photometer according to Jackson (1973).
- Magnesium(Mg) and Calcium (Ca) percentages were determined using an Atomic absorption spectrophotometer Chapman and Pratt (1982)
- Leaf boron ppm was colorimetrically determined according to the method of Jackson (1973)

Shoot total carbohydrate and C/N ratio

Total carbohydrate content was determined in dried shoot powder as a percentage according to Smith *et al.* (1956).

The C:N ratio was calculated as the ratio of the estimated carbon percentage to the estimated total nitrogen in the respective shoots

3- Final fruit set % and yield per tree:

Final fruit set %:- For determining the fruit set from the tagged branches on the experimental trees, the number of flowers and the total number of fruits at harvest were counted, and calculated using the following formula:

Final fruit set percentage = (Number of fruits at harvest /Number of flowers) x100

The tree yield (Kg) and number of fruits /tree:

The number of fruits was counted at harvest and the yield/tree (kg) was calculated as the number of fruits X fruit weight.

4-Fruit quality

Samples of 15 fruits/trees at harvest time were collected to determine the physical and chemical properties

Physical properties

- Fruit dimensions (length and diameter (cm) by using a digital caliper.
- Fruit weight (g) using digital balance.
- Fruit volume (cm^3) submerging fruit in a container with water and measuring the volume of the displaced water.
- Fruit firmness ($lb/inch^2$) by using a penetrometer.
- Number of seeds / fruit was calculated.

Chemical properties

- Total soluble solids percentage (T.S.S.%) was measured by using a digital refractometer
- Titratable acidity (TA) was determined by titration with 0.1 N NaOH and expressed as citric acid as mentioned by A.O.A.C (2003).
- Total sugars were determined after hydrolyzing with hydrochloric acid according to the method of A.O.A.C (2003).
- Total carotenoids were measured as (µg /100g fw) by A.O.A.C (2003).

5- Sensory evaluation determination

Sensory evaluation of ripe fruits carried out by a panel of semi-trained judges. The sensory characters like skin color, pulp color and appearance, pulp texture, taste and flavor, and overall acceptability were evaluated on a 5-point Hedonic scale using the score card as mentioned by Manasa *et al.* (2019) 1 very Poor, 2 Fair, 3 Good, 4 Very good and 5 Excellent.

Statistical analysis

The obtained data in the two studied seasons were conducted in a complete block randomized design with three replications. The obtained data were subjected to Analysis of variance (ANOVA) using MSTAT-C software (MSTAT Michigan University East Lansing). Duncan's multiple range test (LSR)at $p<0.05$ was performed to determine any significant difference among various treatments and the decision for significant differences was done according to Snedecor and Cochran (1990).

3. Results and Discussion

Vegetative growth

Average leaf area (cm^2)

Results recorded in Table (2) indicate significant differences between the treatments used during the experiment seasons. The untreated trees were distinguished by increasing the leaf area, followed by yeast extract alone (the lowest number of fruits and the lowest yield for the tree table_(2). On the other hand, the treatment of tree girdling with the use of NAA at 15 ppm in the first season and at 30 ppm in the second season achieved the least leaf area (these treatments recorded the highest number of fruits and the highest value of the yield in both seasons).

Average total chlorophyll content

Results in Table (2) show that all treatments were significantly effective on early pear total chlorophyll content. However, trees treated with girdling +NAA at 15 ppm showed an increase in total chlorophyll (60.6 and 69.6 spad) followed by trees treated with girdling +NAA at 30 ppm. The control treatment recorded lower values of total chlorophyll (44.1 and 43.7 spad) in both seasons, respectively.

Table 2: Effect of girdling with foliar spray of naphthalene acetic acid and yeast extract on leaf area and total chlorophyll of the early cultivar "Basateen MKM" pear trees during 2021 and 2022 seasons.

Treatments	Leaf area (cm^2)		Total chlorophyll (SPAD)	
	1st	2nd	1st	2nd
Control	48.16a	44.64a	44.1f	43.7g
NAA 15ppm	33.81cd	35.42b	53.6cd	59.8c
NAA 30 ppm	31.85cd	30.12c	49.8e	52.1de
Yeast 0.4%	36.85c	38.00b	47.5ef	48.4ef
Yeast 0.6%	42.90b	44.18a	47.5ef	46.7fg
Girdling (GRD)	34.68cd	36.22b	50.7de	54.2d
GRD +NAA 15ppm	23.2f	25.26d	60.6a	69.6a
GRD +NAA 30PPM	26.3ef	24.78d	57.9ab	64.2b
GRD +Yeast 0.4%	29.4de	30.11c	55.4bc	63.8bc
GRD +Yeast 0.6%	35.25c	37.50b	53.4cd	55.6d

Means having the same letter (s) in each column is not significantly different at 5% level

Studies by Mohammad *et al.* (2012) indicate that, the best results of chlorophyll content compared to control on red apple wax cv. Jambu madu was done with the C-shaped girdling technique applied two weeks before flowering. Also, Rufato *et al.* (2015) pointed out, that the vegetative growth from adult orchards of Packham's Triumph pear trees was reduced when using trunk cutting and girdling. Balance between gibberellin, auxin and cytokininand floral induction control was done by Bangerth *et al.* (2000).

Girdling affects the polar transport of IAA, the interruption of the phloem by girdling causes a reduction in the flow of IAA to the roots (Hartmann *et al.*, 2002), since it induces lower vegetative growth, promoting the balance between vegetative and reproduction. This explains the somewhat lower vegetative growth of the plants subjected to the practice of incision in terms of canopy volume, trunk diameter and annual growth of the scion, confirming that productivity related negatively with the vigor.

Leaf mineral status (N, P, K, Ca, Mg and B)

In general, the applied treatments had a significant effect on P, K, Ca, Mg and B contents in pear leaves as recorded in Table (3). An evident increase in the studied elements by all applied treatments compared to control in both studied seasons was observed. However, treating trees with girdling + NAA at 15ppm gave the highest leaf phosphorus value (0.41 and 0.42%), potassium (1.44 and 1.51%), calcium (2.72 and 2.7), magnesium (0.56 and 0.51%) and boron (43.0 and 47.9 ppm) in the first and second seasons, respectively followed by the trees treated with girdling + NAA at 30 ppm in early pear in both seasons. On the other side, the untreated trees and yeast treatments recorded the minimum level of elements studied in both seasons.

Table 3: Effect of girdling with foliar spray naphthalene acetic acid and yeast extract on P%, K%, Ca%, Mg% and B ppm of the early cultivar "Basateen MKM"pear trees during 2021 and 2022 seasons

Treatments	P%		K%		Ca%		Mg%		B ppm	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	0.24d	0.26d	1.12e	1.05d	1.28f	1.31f	0.29f	0.30e	24.9f	25.1f
NAA 15ppm	0.36ab	0.31cd	1.29bc	1.35b	2.18c	2.12c	0.48b	0.45c	35bc	45.5bc
NAA 30 ppm	0.35bc	0.33bc	1.19cde	1.21c	1.72e	1.83de	0.35de	0.37d	29.7d	37.4d
Yeast 0.4%	0.31c	0.34bc	1.15de	1.17c	1.65e	1.75e	0.35de	0.36d	28.4de	33.5e
Yeast 0.6%	0.28cd	0.3cd	1.14e	1.17c	1.41f	1.36f	0.33ef	0.31e	26.0ef	30.7e
Girdling (GRD)	0.34bc	0.32bc	1.22cd	1.31b	1.87de	2.00cd	0.38d	0.41c	33.1c	40.1d
GRD + AA 15ppm	0.41a	0.42a	1.44a	1.51a	2.72a	2.71a	0.56a	0.51a	43.0a	47.9ab
GRD + AA 30PPM	0.39a	0.41a	1.41a	1.46a	2.44b	2.64ab	0.51b	0.47b	41.5a	50.4a
GRD + Yeast 0.4%	0.38ab	0.37ab	1.38ab	1.40ab	2.31b	2.43b	0.49b	0.46b	37.2b	46.7b
GRD + Yeast 0.6%	0.33bc	0.34bc	1.25cd	1.32b	2.00cd	2.01cd	0.43c	0.42c	34.5bc	43.2c

Means having the same letter (s) in each column is not significantly different at 5% level

Nitrogen percentage

As illustrated in Table (4), girdling plus NAA at 15 ppm exhibited the least leaf nitrogen content followed by the other treatments in ascending order in both seasons. On the contrary, the control treatment achieved higher levels of nitrogen with slight differences than NAA at 30 ppm that recorded the highest nitrogen values significantly.

Carbohydrate percentage

Results in Table (4) show a significant difference between treatments. The treated trees with girdling + yeast at 0.4% presented the highest carbohydrate percentage by recording 39.99 % in the first season and 39.26 % in the second season, respectively. On the contrary, NAA at 15 ppm recorded the least significant values (29.7 % in the first season and 30.2 % in the second season). The other treatments showed descending values of carbohydrate percentage in this respect in both seasons under study.

C/N ratio

As shown in Table (4), all treatments affect significantly C/N ratio of the early pear trees. In this concern, the girdling treatments gave a higher C/N ratio than the others during the two studied seasons. Girdling + NAA at 15 ppm recorded 16.49 in the first season and 15.91 in the second season followed by girdling + yeast at 0.4%. On the other hand, NAA at 15 ppm recorded the lowest value (10.6 in the first season and 10.27 in the second season, respectively). The other treatments gave intermediate values in this respect.

Amrendra *et al.* (2017) studied the effect of varied extent of girdling in litchi *(Litchi chinensis* sonn). All the girdled shoots showed greater accumulation of carbohydrates in the leaves compared to the control , and observed a decrease in nitrogen content with increasing girdling level. Also, a study of the yeast effect on olive trees by Rasha and Dulaimi (2022), they noticed a significant superiority on the length of the branch, leaf area, the number of hermaphrodite flowers per inflorescence, the weight of the whole fruits, the increase in fruit Size and the percentage of carbohydrates in the leaves. In the same vein, El-Shazly and Mustafa (2015) demonstrated the effect of yeast extract on Washington navel orange trees. The obtained results revealed that the total yield was increased. Fruit weight, fruit juice, total soluble solids (TSS) and total sugar contents were increased significantly with biostimulant treatments compared to the control and enhanced the mineral content of the leaves (N, P, K, Ca and Mg).

Table 4: Effect of girdling with foliar spray naphthalene acetic acid and yeast extract on N%, carbohydrate % and C/N ratio of the early cultivar "Basateen MKM"pear trees during 2021 and 2022 seasons.

Treatments	N%		Carbohydrate %		C/N ratio	
	1st	2nd	1st	2nd	1st	2nd
Control	3.06a	3.14 ab	34.6 de	36.15cd	11.4de	11.51 cd
NAA 15ppm	2.8bc	2.94b	29.7 f	30.2 e	10.6 e	10.27d
NAA30 ppm	3.11a	3.25a	33.2 e	34.9 d	10.68 e	11.74cd
Yeast 0.4%	2.97ab	3.11 ab	35.9cd	35.6 cd	12.09 de	11.45cd
Yeast 0.6%	3.05a	3.01 b	36.6 cd	38.4 ab	12.00 de	12.76bc
Girdling (GRD)	2.85bc	2.95 b	37.05 bc	35.02 d	13.00cd	11.87cd
GRD + NAA15ppm	2.25d	2.42 d	37.1 bc	38.51 ab	16.49 a	15.91a
GRD + NAA30PPM	2.31d	2.44 cd	36.7bc	35.11 d	15.89ab	14.39ab
GRD + Yeast 0.4%	2.69c	2.53cd	39.9 a	39.26 a	14.83 a-c	15.52 a
GRD + Yeast 0.6%	2.71c	2.64c	38.72 ab	37.12bc	14.29bc	14.06ab

Means having the same letter (s) in each column is not significantly different at 5% level

Final fruit set percentage and yield properties:

Final fruit set, yield (kg /tree), and number of fruits /tree

It is evident from the results in Table (5) that the yield/tree of the early pear was significantly affected by all treatments in both seasons. Moreover, treated trees with girdling + NAA at 15ppm gave the highest fruit set percentage (22.8 in the first season and 23.44 % in the second one), the maximum number of fruits /tree (273.8 in the first season and 281.5 in the second season), also recorded the highest yield (55.77 kg in the season and 52.69 kg/tree in the second season), followed by treated trees with girdling + NAA at 30 ppm. The results clear that the control gave the minimum values of fruit set percentage (10.0 % in the first season and 9.68 % in the second one), number of fruits /tree (123.7 fruits in the first season and 119.8 in the second season) and total yield (21.63 kg in the first season and 22.13 kg/tree in the second one).

Mohammad *et al.* (2012) showed that the C-shaped girdling technique produced the best results in the fruit setting compared to the control. In addition, it can be concluded that C-shaped girdling applied two weeks before flowering produced the best yield of red wax apple cv. Jambu madu fruits. As indicated by Amrendra *et al.* (2017), the effect of varied extent of girdling for induction of flowering in litchi (*Litchi chinensis* sonn.) was studied and the results indicated that circular girdling of 2mm on 50% of primary branches produced more fruit yield compared to un-girdled trees (control). In the same direction, fruit set, fruit harvest percentage in olive and average yields from all girdled treatments were about three to five times higher than the control (Faisal *et al.*, 2012).

Abd El-Rhman *et al.* (2017) observed the positive effect of spraying mango trees with NAA on improving fruit set, fruit retention, yield/tree and number of fruits and weight/tree. Also, spraying NAA contributed to the promotion of soluble total solids, and total sugars with reducing acidity percentage in both seasons compared to the control.

Table 5 : Effect of girdling with foliar spray naphthalene acetic acid and yeast extract on fruit set %, fruit number and total yield/tree (kg) of the early cultivar "Basateen MKM" pear trees during 2021 and 2022 seasons

Treatments	Fruit set %		Fruit number		Total yield /tree (kg)	
	1st	2nd	1st	2nd	1st	2nd
Control	10.0 h	9.68e	123.7 h	119.8f	21.63 g	22.13f
NAA 15ppm	19.3 bc	18.55b	231.8 bc	222.1b	35.44 c	37.01c
NAA30 ppm	17.4 de	16.50c	209.0 de	198.4bc	28.51 de	28.27de
Yeast 0.4%	13.2 fg	13.90cd	158.5 g	166.9de	26.7 ef	28.42de
Yeast 0.6%	12.7 g	12.27de	152.3 g	147.2e	24.45 fg	24.30ef
Girdling (GRD)	14.6 f	15.67c	175.3 f	188.2cd	28.77 de	29.03de
GRD + NAA15ppm	22.8 a	23.44a	273.8 a	281.5a	55.77 a	52.69a
GRD + NAA30PPM	20.1 b	21.07ab	241.4 b	253.1a	42.58 b	45.91b
GRD + Yeast 0.4%	17.9 cd	16.18c	215.0 cd	194.4bc	41.15 b	39.91c
GRD + Yeast 0.6%	16.1 e	15.02cd	193.4 e	180.5cd	31.70 cd	29.62d

Means having the same letter (s) in each column is not significantly different at 5% level

Fruit quality

Fruit Physical measurements

Fruit length (cm)

Results in Table (6) reveal that the fruit length of the early pear was significantly affected by all treatments in both seasons. Treating trees with girdling + NAA at 15 ppm gave the best fruit length (9.45 cm in the first and 10.13 cm in the second seasons). The trees treated with NAA at 30 ppm gave the lowest fruit length (5.31 cm in the first season and 5.11 cm in the second season), respectively. Shortly, the other treatments recorded an intermediate value.

Fruit diameter(cm)

As shown in Table (6), fruit diameter increased by girdling treatments whether individually or used with the other treatments. Girdling + NAA at 15 ppm recorded the highest fruit diameter values (7.16 cm in the first season and 7.21 cm in the second one) followed by the other treatments. On the other hand, spraying trees with NAA at 30 ppm gave the lowest values of fruit diameter (4.00 and 4.35 cm) in both seasons, respectively. The obtained results of fruit diameter on the early pear trees due to the number of fruits / tree.

Fruit weight(g)

In Table (6) , the trees treated with girdling combined with the low concentration of both NAA and yeast were superior in fruit weight. Girdling + NAA 15 ppm achieved 203.7 g in the first season and 187.2 g in the second season, while the girdling + 0.4% yeast recorded (205.3 g in the first season and 191.7 g in the second season . The control treatment gave an average value (174.8 g in the first season and 184.7 g in the second season) of fruit weight .

On the other hand, individual treatments showed a decline in fruit weight. However, spraying trees with NAA at 30 ppm gave the least significant values (205.3 g in the first season and 191.7 g in the second season).

Fruit size (cm^3)

Results in Table (6) reveal that the fruit size of the early pear was significantly affected by all treatments in both seasons. Treating trees with girdling + NAA at 15ppm and girdling + yeast at 0.4% gave the best fruit size in the first and the second seasons. On the other side, less effect on fruit size observed when the early pear trees were applied with NAA at 30ppm. Shortly, the other treatments recorded intermediate values.

Table 6 : Effect of girdling with foliar spray naphthalene acetic acid and yeast extract on fruit length (cm), fruit diameter (cm) and fruit weight (g) of the early cultivar "Basateen MKM"pear trees during 2021 and 2022 seasons

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit weight (g)	
	1st	2nd	1st	2nd	1st	2nd
Control	8.27 bc	8.51bc	6.9 ab	6.84ab	174.8 c	184.7b
NAA 15ppm	6.14 ef	6.33e	4.68 de	5.25c	152.9 f	166.1c
NAA30 ppm	5.31 f	5.11f	4.00 e	4.35d	136.4 g	142.5e
Yeast 0.4%	6.54 de	6.28e	4.88 d	5.07cd	168.4 c-e	170.3c
Yeast 0.6%	6.37 e	6.92de	4.63 de	5.11c	160.3 ef	165.1c
Girdling (GRD)	7.00 de	6.55e	5.25 cd	4.95cd	164.1 de	154.3d
GRD + NAA15ppm	9.45 a	10.13a	7.16 a	7.21a	203.7 a	187.2b
GRD + NAA30PPM	8.04 bc	7.84cd	6.36 b	6.91ab	176.6 c	181.4b
GRD + Yeast 0.4%	8.63 ab	9.08b	7.13 a	6.80ab	191.4 b	205.3a
GRD + Yeast 0.6%	7.47 cd	8.25bc	5.64 c	6.24b	170.9 cd	164.1cd

Means having the same letter (s) in each column is not significantly different at 5% level

Fruit firmness

The results in Table (7) show a significant difference between treatments. Treat trees with NAA at 15 ppm presented the highest firmness (15.6 lb/inch^2 in the first season and 16.1 lb/inch^2 in the second season, respectively). On the contrary, girdling + NAA 15 ppm recorded the least values (12.6 lb/inch^2 in the first season and 13.0 lb/inch^2 in the second one). Meanwhile, the other treatments scored values in between in this respect.

Number of seeds /fruit

As shown in Table (7) in general, an increase in the number of seeds/fruit for girdling treatment combined with NAA at 15 ppm. Meanwhile, the other combined treatments showed the number of seeds/fruit in descending order. On the other hand, spraying trees with water as control has the lowest values for the number of seeds/fruit in both seasons, respectively. It could be concluded from the previous results that the number of seeds in the fruit can be taken as one of the quality characteristics of the fruit.

Table 7: Effect of girdling with foliar spray naphthalene acetic acid and yeast extract on fruit size cm^3, fruit firmness and number of seeds /fruit of the early cultivar "Basateen MKM"pear trees during 2021 and 2022 seasons

Treatments	Fruit size cm^3		Fruit firmness (Lb/inch^2)		Number of seed /fruit	
	1st	2nd	1st	2nd	1st	2nd
Control	170.2 c	163.1d	14.0 de	13.6dc	1.80f	2.03f
NAA 15 ppm	147.5 f	151.1e	15.6 a	16.1a	3.63ab	3.63bc
NAA30 ppm	133.2 g	142.1f	15.0 b	14.8c	2.80cd	2.90de
Yeast 0.4%	161.7 de	148.2e	13.6 ef	14.0d	2.60de	2.76de
Yeast 0.6%	157.3 e	160.2d	14.2 d	14.6c	2.16 ef	2.23f
Girdling (GRD)	158.3 e	166.7c	14.8 bc	15.4b	3.06cd	3.26cd
GRD + NAA 15 ppm	200.8 a	184.2b	12.6 h	13.0f	4.03a	4.30a
GRD + NAA 30 PPM	171.1 c	171.5c	13.2 fg	13.4ef	3.93a	3.73bc
GRD + Yeast 0.4%	187.3 b	190.3a	13.0 gh	13.4ef	3.8ab	3.90ab
GRD + Yeast 0.6%	164.3 d	158.3d	14.4 cd	14.8c	3.37bc	0.56bc

Means having the same letter (s) in each column is not significantly different at 5% level

The most important precondition of the fruit to be maintained on the tree is its seed content. The seed content such as auxin is an important factor for maintaining the fruit on the tree. Fruit with less seed are more susceptible to environmental adversities i.e. water stress, poor nutrition and are prone to

fruit drop (Rai *et al.*, 2013). The maximum seed number may have increased carbohydrate synthesis and result in increasing vegetative growth and balancing the C/N ratio (Hernandez, 1997).

Seeds are important sites of hormone production especially auxin and gibberellin, that can enhance fruit growth and facilitate mineral elements (Boselli *et al.*, 1995). Several works has shown that in various species, fruit size and flesh chemical composition depend on seed number (Lai *et al.*, 1990). A significant relationship was found among seed number, acidity and soluble solid content of grapevine (Coombe, 1992) and apple (Buccheri and Di Vaio, 2005).

EL-Tohamy *et al.* (2009) studied the use of yeast and found that it breaks down into amino acids and vitamins and can act as growth regulator. The yeast stimulates cell division and therefore has a role in increasing the amount of accumulated dry matter due to its efficiency in photosynthesis and respiration. Also, the yeast contains a high amount of tryptophan as an amino acid which contributes to the initiation or construction of IAA which is directly responsible for cell division, cell wall elasticity and increasing cell size, thus helping in improving vegetative growth and fruit quality of fruit trees.

Girdling had a distinctive and significant effect on most of the fruit quality characteristics of mandarin fruit "Nova" (Peter and Anastassios, 2011). In this regard, Mohammad *et al.* (2012) reported the application of C-shaped girdling two weeks before flowering on red wax apple trees cv. Jumbo Mado fruits led to faster fruit growth, resulting in the best length and final diameter of the fruit. Also, Amrendra *et al.* (2017) indicated that circular girdling of 2mm on 50% of primary branches produced more fruit size in Shahi litchi trees compared to the un-girdled trees (control).

Fruit Chemical measurements

TS.S. %, Total sugar % and acidity %

Concerning the results in Table (8) all treatments had a significant difference in T.S.S %, total sugar% and acidity % in both seasons. However, treated trees with girdling + NAA at 15ppm gave the highest T.S.S. (15.5% in the first season and 15.1 % in the second season), total sugars (12.88% in the first season and 12.68 % in the second season and decreased total acidity (0.47% in the first season and 0.49% in the second season). The untreated trees showed the lowest values of TS.S % in both seasons, reduction in total sugar percentage in the trees treated with the yeast at 0.6% in the first season and control trees in the second season. Also, the highest acidity was recorded with the yeast at 0.4% in the first season and NAA 30 ppm in the second season. Meanwhile, the other treatments showed intermediate values in this respect.

Table 8: Effect of girdling with foliar spray naphthalene acetic acid and yeast extract on T.S.S %, Total sugar%, acidity % and sensory evaluation of the early cultivar "Basateen MKM"pear trees during 2021 and 2022 seasons

Treatments	T.S.S %		Total sugar %		Acidity %		Carotenoids (µg /100g f w).		Sensory evaluation	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	13.0 g	12.8d	10.14 d	9.86e	0.61 b	0.59bc	40f	42e	2.9 f	3.0 f
NAA 15ppm	14.1 d	14.4b	11.56b	12.00ab	0.64 ab	0.63ab	50bc	51bc	3.9 cd	4.0 cd
NAA30 ppm	13.6 e	14.0c	10.76cd	11.00cd	0.67 a	0.65a	46de	48 cd	3.6 de	3.6 de
Yeast 0.4%	13.4 ef	13.1d	10.44d	10.64de	0.68 a	0.61ab	44ef	44de	3.3 ef	3.5 e
Yeast 0.6%	13.1 fg	12.8d	10.08d	10.20de	0.60 bc	0.59bc	41f	42e	3.5 de	3.8 de
Girdling (GRD)	14.6 c	15.0a	11.54bc	12.75a	0.57 c	0.53de	47cde	47cd	4.1 bc	4.3 bc
GRD + NAA15ppm	15.5 a	15.1a	12.88a	12.68a	0.47 e	0.49e	55a	57a	4.6 a	4.8 a
GRD + NAA30PPM	15.1 ab	14.8ab	12.23ab	11.80b	0.51 de	0.50e	53ab	55a	4.4 ab	4.6 ab
GRD + Yeast 0.4%	14.7 bc	14.5b	11.61b	11.46bc	0.59 bc	0.55cd	51bc	53ab	4.0 bc	4.4 ab
GRD + Yeast 0.6%	14.4 cd	14.6b	11.48bc	11.00cd	0.55 cd	0.56cd	49bcd	48c	4.1 bc	4.3 bc

Means having the same letter (s) in each column is not significantly different at 5% level

Total Carotenoids (µg /100g f w)

The total carotenoids in fruit peel were positively increased with all used treatments compared to control and yeast alone due to the positive effect of those treatments on accelerating fruit maturation.

The great effect in this respect was recorded by girdling plus NAA at 15ppm, NAA at 30 ppm and yeast at 0.4% which recorded the highest values of total carotenoids in "Basateen" pear fruits. On the contrary, the control and yeast treatments recorded the lowest values of carotenoids.

Sensory evaluation

It is evident from the results in Table (8), sensory evaluation of the early pear was significantly affected by all treatments in both seasons. Moreover, treated trees with girdling + NAA at 15ppm gave the highest values of sensory evaluation (4.6 in the first season and 4.8 in the second season) followed by girdling + NAA at 30ppm with slight significant differences between them (4.4 in the first season and 4.6 in the second season). On the contrary, undesired sensory evaluation was observed with the untreated trees by recording 2.9 and 3.5 in both seasons, respectively. The other treatments presented intermediate values in this concern.

Farag and Nagy (2012) sprayed Washington naval orange with NAA at a concentration of 25 ppm at full bloom and found a decrease in total acidity compared with the control. Also, Khan *et al.* (2014) found that application with NAA at 20 ppm after the fruit set increased TSS of 'Blood Red' sweet oranges compared with the control. The significant decline in total acidity might be attributed to the incitement that happened in orange maturity, whereas the fruits were ripened earlier than those of untreated plants (Hifny *et al.,* 2009).

Peter and Anastassios (2011) reported that girdled scaffolds resulted in the highest sweetness index, and girdling had a distinctive and significant effect on most of the fruit quality characteristics on mandarin fruit trees. The results by Mohamed *et al.* (2012) showed an increase in TSS content that occurred when applying C-shaped girdling technique before two weeks of flowering on apple trees. Amrendra *et al.* (2017) Indicated that, circular girdling of 2mm on 50% of primary branches produced more TSS in Shahi litchi (*Litchi chinensis* sonn.) fruits compared to the un-girdled trees.

Several studies have shown that spraying yeast extract improves fruit weight , increases fruit yield, improves the chemical properties of the fruit (TSS, total sugars, total acidity ,and vitamin C), the leaf mineral content (nitrogen, phosphorus, potassium, zinc, iron, manganese) . In addition to the effectiveness of spraying yeast in reducing fruit drop percentages in pear trees cv. Le-Conte (Hafez *et al*., 2018), apricot (Haggag *et al.,* 2016) and mandarin (Silem, 2020).

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Conflict of interest

The author declares that they have no competing interests.

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