

Effect of timing of mineral oil spraying on budburst and metabolic changes in “Barkhar” apple trees under conditions of inadequate winter chilling in Egypt

Abstract

The impact of mineral oil at completely different dates to work out the foremost effective date for spraying buds of “Barkhar” apple (*Malus sylvestris*, Mill) trees was investigated. Also, their effects on metabolic changes within the content of buds from chemical substances throughout their release from dormancy were detected. The potency of early bud break was noticed in varied degrees with oil at completely different dates. It fully determined that the applied treatment at completely different dates results in early bud break, short flowering length, high percentages of bud break, fruit-set, yield/ tree(kg), yield parts (number of fruits per tree, fruit weight, fruit size, fruit length and fruit width). Also as high contents of some chemical constituents of fruits (total soluble solids (TSS) and vitamin C) and low content of total acidity with the appliance of the various dates. Additionally, high contents of buds from water content, total carbohydrates, total sugars, total indoles, indole-3-acetic acid, gibberellin, total free amino acids, total flavonoids, total and conjugated phenols, as well as, low content of non-soluble carbohydrates, abscisic acid and free phenols were achieved. In line with the results, it's counseled that mineral oil spraying at 5% in date of fifteen th of Jan as operator safer bud break promoters for reach to the first break dormancy in buds of “Barkhar” apple trees under Egyptian winter conditions and therefore the most yield by control the metabolic changes in buds.

Keywords: apple, dormancy, mineral oil, hormones, phenols, amino acids, carbohydrates, yield

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Introduction

The term “dormancy” is related to temporary suspension of visible growth. It includes true dormancy (“rest” or “endodormancy”) triggered by internal factors, and environmental condition dormancy (“quiescence” or “ecodormancy”) controlled by external factors. Bud dormancy may be a crucial step within the phenology cycle, as its progression over winter determines the dates of bud break, flowering and fruit-set.^{1,2} These phases of dormancy are relieved by completely different elements: unleash of endodormancy needs cold accumulation here as ecodormancy advances with heat accumulation toward bud break. For perennial fruit species, within the context of worldwide warming, endodormancy unleash is also a crucial step within the future because of insufficient chill accumulation, directly touching flowering quality and uniformity, and therefore resulting in a forceful reduction of fruit production. In the past decades, several studies, supported metabolic, physiological, sub cellular, genetic, and genomic analyses, have unraveled mechanisms underlying bud dormancy progression.³ Mineral oil is that the most helpful rest breaking treatment for apple and has been used effectively to supplement cold temperature, to attain satisfactory bud break and to reinforce cropping.⁴⁻⁷ Moreover, the result of temporal arrangement of rest breaking agents on budburst were studied by many researchers.^{4,6,8,9} Initiation and break of dormancy are connected in different plant species to changes in endogenous growth regulations concentration.^{7,10-12} The relationship between plant phenols and bud dormancy likewise as bud break were studied by many researchers.^{7,12-15} Changes within the state of water are connected with bud dormancy in many woody plants.¹⁶ Water

was certain at the start of dormancy and was free before growth was resumed.¹⁷ Numerous changes within the level of carbohydrates occurred in buds as they supported the non-growing stage and starting of growth. Starch accumulated throughout the amount of chemical action activity and was used for regeneration of growth within the spring.¹⁸ Changes in chemical compound like amino alkaloid acid profiles are related to the discharge of buds from dormancy.¹⁹ Because of the winter in Egypt is brief and doesn't meet the chilling necessities of buds, the delay in break the buds of “Barkhar” apple trees till late winter exposes them to break below the influence of hot temperature and/or delays them in getting into in dormancy within the following year ends up in some physiological defects which will lead to weakness and death. This threatens the “Barkhar” apple productivity in Egypt, therefore this work focuses in the main to elucidate the behavior of the plant growth regulations, phenols, sugars and total free amino acids contents in buds and their reflections within the length to full buds break, and also the percentages of bud break and fruit-set as a results of spraying “Barkhar” apple trees with oil at completely different dates elucidating their impacts in fast the dormancy break.

Materials and methods

Trees selection and treatments

Uniform, 14-year-old “Barkhar” apple trees (*Malus sylvestris* Mill) grafted on Malling-Merton 106 (MM 106) rootstock were chosen willy-nilly, for a preliminary study in 2014/2015 and for the most analysis studies within the 2015/2016 and 2016/2017 seasons. All trees (n=24) were grown in the Orchard of the Horticultural

Station in Abshawai, Fayoum, Egypt (29170N; 30530E). For the most 2-season study, chosen trees of every treatment (n=6) were tagged in November 2015 and 2016, received the foliar treatments at completely different dates (1st Jan, fifteenth Jan and first Feb) of a similar two years and sampled from fifteenth December–15th February 2015/2016 and 2016/2017. Trees chosen for the study within the initial season isn't a similar tree that was chosen for the second season. Every tree was designed united replicate, and every treatment enclosed six trees (total n=24). Foliar-spray applications (4 l tree-1; six trees per treatment) were conducted as follows: treatment 1; control trees did not receive any compound, only tap water; trees of treatment two were foliar sprayed in first of Jan to runoff with 5% (v/v) mineral oil MO; Guangzhou Hanglian Chemical Industry Co. Ltd., Guangzhou, P. R. China); trees of treatment three were foliar sprayed in 15th of January to runoff with 5% (v/v) mineral oil MO; trees of treatment 4 were foliar sprayed in 1st February to runoff with 5% (v/v) mineral oil MO; All spray treatments were applied using 20 L Knapsack Sprayer. Triton B [0.1% (v/v)] was added as a wetting agent to each spray solution. A preliminary study was conducted in 2014/2015 during which MO were applied once at completely different dates for each. The rate of 5% (v/v) was found to be the foremost vital concentrations for later bud growth in "Barkhar" apple trees (data not shown). These treatment levels were used later for the main study.

Morphological characteristics and yield measurements

Buds count was created for every tree of all treatments. The dates of floral buds began to open were recorded. Number of floral buds was counted for all buds once it had been opened and therefore the percentages were calculable. The dormant buds were additionally counted and expressed as a proportion of the overall range of buds. The dates at that flowering reached twenty fifth, fifty, seventy fifth and 100 percent of the overall flowers were calculable in every treatment. Flowers whose calyx began to extend were tagged Flowers in order to measure the percentage of fruit-set. At harvest stage, apple fruits were harvested, counted and weighed for every examined tree.

In order to determine fruit quality, ten fruits were taken arbitrarily from every tree as a sample. Samples were transferred straight off to the laboratory wherever physical analyses were undertaken. Fruit weight, size, diameter and height were measured. Every fruit within the sample was weighted to induce the common fruit weight. Average fruit size decided by rising the fruit in an exceedingly jar containing water and receiving the surplus water in an exceedingly graduate. The caliper was used for measure fruit diameter and height.

Determination of endogenous hormone in apple buds

In different experiments (2g) floral buds were collected 15-day intervals beginning from 15 December up to 15 February for determining the metabolic changes in the hormonal content in buds. Buds were randomly sampled and immediately transported to the laboratory. Floral bud samples were taken from each tree of each treatment, frozen in liquid nitrogen and stored at -20°C until extraction and assay as adopted and described.^{20,21}

Determination of total indoles in apple buds

Total indols in buds were determined as µg/g fresh weight according.²² Estimation of free, conjugated and total phenolics content in apple buds using folin-ciocalteu reagent. Total and free phenols in buds were determined as mg/g fresh weight using folin-ciocalteu reagent and Sodium carbonate solution according.²³

Extraction and determination of total flavonoids in apple buds

One hundred milligrams of samples was extracted with 10ml 80 % aqueous methanol. The mixture was centrifuged for 10 min at 2,000g. The supernatants were used for subsequent analysis. The flavonoid content was measured employing the colorimetric assay described.²⁴ 0.5ml aliquots of extracts were added to 10ml volumetric flask containing 4.5ml distilled water, 0.3ml 5% sodium nitrite was added to each aliquot after 5 min, and then 0.6ml of 10% aluminum chloride was added. After 6 min, 2 ml of 1 M sodium hydroxide was added to the mixture, followed by the addition of 2.1ml of distilled water. Absorbance was recorded at 510nm, and flavonoid content was expressed as mg of rutin equivalent per gram of fresh weight.

Total carbohydrate determination in apple buds

Procedure:

Total carbohydrate was extracted from apple buds by placed 10mg dry sample with 10ml of H₂SO₄ (0.1N) in test tube and extracted on a boiling water bath for 30 minutes. The sample was filtered to remove the insoluble material. After filtering, the solution was completed to 100ml by distilled water. Carbohydrate contents were determined by phenol-sulfuric acid method.²⁵ Briefly, to 1ml of sugar solution, 50µl 80% phenol and then 3ml 98% sulfuric acid was added. The mixture vortexed were kept at room temperature for 30min and the absorbance read at 490nm.

Total sugars determination

Total sugars were determined as mg/g fresh weight using phosphomolybdic acid reagent.²⁶

Non soluble carbohydrates

Non soluble carbohydrates were determined by subtracted total sugars from total carbohydrates.

Total free amino acids determination in apple buds

Total free amino acids were determined by reaction with ninhydrin using glycine as standard.^{27,28}

Water content determination

The water content of floral buds was determined by the methods specified.²⁶

Chemical determinations in fruits

1. Total soluble solids (TSS):

The percentage of TSS in fruit juice was determined by a hand refractometer (CARL ZEISS JENA DDR 78,227 0...30%).

2. Total acidity:

It was estimated in fruits as malic acid by using sodium hydroxide for a known normality and phenolphthalein as an indicator, according.²⁶

3. Total soluble soluble solids /acid ratio

The TSS/Acid ratio was calculated.

4. Vitamin C content:

The Vitamin C content in fruits was determined according to the method described²⁶

Statistical analysis

The values of the determined characters were subjected to statistical analysis according to the standard procedure described by.²⁹ The ‘F’ test was applied to assess the significance of the treatment at 5% level of probability.

Results

Date of floral bud break

The foliar application of “Barkhar” apple trees with mineral oil

at 5% on first, 15th of January and first of February was hastened the floral bud break as comparison with the untreated trees during which trees were sprayed with water (Table 1). The period to the first floral bud break was shortened by four, five and three days, and six, seven and five days, respectively in the first and second season as comparison with the untreated trees. Additionally, the amount to full flowering were shortened by two, three and a pair of days and one, two and one days within the initial and second seasons, severally as compared to the untreated trees. The best results were obtained when mineral oil at 5% was sprayed on 15th of January.

Table 1 Effect of mineral oil spray at different dates on the date of flower bud opening and flowering period in “Barkhar” apple trees

Date of spraying	Date of flower bud opening										Flowering period (day)	
	Beginning		25% flowering		50% flowering		75% flowering		End		2015	2016
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016		
Control	10	11	13-Feb	13-Feb	15	16	17	18	24	26	15	16
	Feb	Feb			Feb	Feb	Feb	Feb	Feb	Feb		
January, I	6	5	7	8	10	11	13	14	18	19	13	15
	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb		
January, 15	5	4	7	7	10	11	13	15	16	17	12	14
	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb		
February, I	7	6	10	9	13	14	16	17	19	20	13	15
	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb	Feb		

Floral bud break and fruit set

Table 2 shows that, all tested dates considerably increased the percentages of floral bud break and fruit-set in comparison to the control. However, mineral oil sprayed at 5% on fifteenth of January was the foremost effective than all others. It surpassed the faucet water by 5.72-11.10% and 35.25–46.60% for bud break and fruit-set within the first and second seasons, severally.

Table 2 Effect of mineral oil spray at different dates on the percentage of bud break and fruit set in “Barkhar” apple trees

Date of spraying	Bud break (%)		Fruit-set (%)	
	2015	2016	2015	2016
Control	77.53b	75.00b	58.55c	54.11c
January, I	81.43a	83.06a	77.87a	76.25a
January, 15	81.97a	83.33a	79.19a	79.33a
February, I	81.59a	83.96a	64.82b	69.14b

Mean pairs followed by different letters are significantly different (p = 0.05) by Duncan's test; n=6

Fruit yield and its components

Table 3 shows that, all tested dates increased number of apple fruits tree⁻¹ and total fruit yield tree⁻¹ when compared to the untreated trees. Mineral oil sprayed at 5% on 15th of January was most effective only during this concern. It exceeded the untreated trees by 36.16–39.74% and 43.17–58.57% for number of fruits tree⁻¹ and fruit yield

tree⁻¹ in the two experimental seasons, respectively. The maximum increases in yield components (fruit weight, fruit size, fruit length, fruit width and number of fruits/tree) were recorded with mineral oil sprayed at 5% on 15th of January (Table 4) (Table 5).

Table 3 Effect of mineral oil spray at different dates on No. of fruit tree⁻¹ and total yield tree⁻¹ of “Barkhar” apple trees

Date of spraying	No. of Fruit tree ⁻¹		Total yield tree ⁻¹ (kg)	
	2015	2016	2015	2016
Control	474.17c	465.11c	24.04c	21.58c
January, I	643.34b	645.28b	33.79b	32.39b
January, 15	645.63b	649.98b	34.42b	34.22b
February, I	635.84a	636.21a	33.39a	33.47a

Mean pairs followed by different letters are significantly different (p = 0.05) by Duncan's test; n=6

Water content in buds

Table 6 indicates that water content in floral buds of “Barkhar” apple trees were increased when mineral oil at 5% was applied. The best results were recorded when mineral oil was sprayed on the 15th of January as compared to the control during which trees were sprayed with tap water.

Carbohydrates in buds

In the time within which no vital variations were noticed between

any of the three dates of spray with mineral oil for carbohydrates in all sampled dates, mineral oil at 5% was significantly increased total carbohydrates, total sugars and decreased non soluble carbohydrates when compared to the control (Table 6). With relevancy the impact of the date of spray treatments on total carbohydrates, it's clear from the current information that just about all treatments gave higher values of total carbohydrates and total sugars if compared to the control trees. The most effective results were obtained by spraying with mineral oil at the rate of 5% on the 15th of January as compared to the untreated trees.

Table 4 Effect of mineral oil spray at different dates on fruit weight and fruit size of "Barkhar" apple fruit quality

Date of spraying	Fruit weight (gm)		Fruit size(cc3)	
	2015	2016	2015	2016
Control	51.27c	50.10c	63.54c	61.32 c
January,1	59.13a	59.12a	75.78b	74.18b
January,15	59.49a	59.21a	79.09a	80.10a
February,1	55.06b	54.18b	71.72b	70.29b

Mean pairs followed by different letters are significantly different (p = 0.05) by Duncan's test; n=6

Table 5 Effect of mineral oil spray at different dates on fruit dimensions of "Barkhar" apple fruit quality

Date of spraying	Fruit diameter (cm)		Fruit height(cm)	
	2015	2016	2015	2016
Control	4.80c	4.91c	4.84c	4.90c
January,1	5.15a	5.18a	5.10a	5.29a
January,15	5.18a	5.27a	5.18a	5.41a
February,1	4.83b	4.90b	4.97b	5.00b

Mean pairs followed by different letters are significantly different (p = 0.05) by Duncan's test; n=6

Hormonal content in buds

Foliar-applied mineral oil at 5% on 15th of January increased the contents of total indols, indole-3-acetic acid (IAA) and gibberellic acid (GA₃) and decreased the contents of abscisic acid (ABA) within the floral buds of "Barkhar" apple trees when compared to the control in within which trees were sprayed with water as shown in Table 6 & 7. The results of all hormones obtained with mineral oil sprayed at 5% on 15th of January treatment were surpassed the results found with mineral oil sprayed at 5% on 1st of January and 1st of February in most of the sampled dates. The maximum contents of total indols, IAA and GA₃ were obtained from buds applied with mineral oil on 15th of January and collected in 15 February (buds were released from dormancy), while their minimum contents were obtained from buds applied with mineral oil at 5% on 1st of January and 1st of February and sampled in 15th December & 1st January (buds were still dormant) as shown in Table 5. For ABA, the alternative result was found. Additionally, the most ratios of IAA/ABA and GA₃/ABA were noted within the 1st February sample (buds were released from dormancy), whereas the minimum ones were found in the 15th December and 1st January samples (buds were still dormant) as shown in Table 7.

Table 6 Effect of mineral oil spray at different dates on water content, total carbohydrates, total sugars, non-soluble carbohydrates and total indoles in buds of "Barkhar" apple trees

Date of spraying	Water content %				
	15-Dec	1-Jan	15-Jan	1-Feb	15-Feb
Control	44.01c	42.50 c	53.97 b	58.35a	61.70 a
January,1	44.01c	42.50 c	53.98 b	60.10a	63.10 a
January,15	44.01c	42.50 c	53.97 b	61.25 a	64.12 a
February,1	44.01c	42.50 c	53.97 b	58.35 a	62.99 a
Total carbohydrates (mg g ⁻¹ DW)					
Control	112.86 c	113.66 b	115.38 a	115.40 a	115.48 a
January,1	112.86 c	113.66 b	117.38 a	118.94 a	118.98 a
January,15	112.86 c	113.66 b	117.38 a	119.00 a	119.20 a
February,1	112.86 c	113.66 b	117.38 a	118.76 c	119.48 a
Total sugars (mg g ⁻¹ DW)					
Control	77.66 d	82.02 c	100.10 b	103.00 b	106.73 a
January,1	77.66 d	82.02 c	102.38 b	107.99 b	113.50 a
January,15	77.66 d	82.02 c	100.10 b	108.50 b	114.00 a
February,1	77.66 d	82.02 c	100.10 b	108.40 b	114.20 a
Non-soluble carbohydrates (mg g ⁻¹ DW)					
Control	35.20 d	31.64 d	15.28 c	12.40 b	8.75 a
January,1	35.20 d	31.64 d	15.10 c	10.95 b	5.48 a
January,15	35.20 d	31.64 d	17.28 c	10.50 b	5.20 a
February,1	35.20 d	31.64 d	17.28 c	10.36 b	5.28 a
Total Indoles (µg g ⁻¹ DW)					
Control	41.12 d	44.13 c	47.25 c	55.15b	60.33a
January,1	41.12 d	44.13 c	47.25 b	58.15 b	68.77a
January,15	41.12 b	44.13 c	50.20 c	59.15b	69.01a
February,1	41.12 b	44.13 c	47.25 c	55.15b	67.99a

Mean pairs followed by different letters are significantly different (p = 0.05) by Duncan's test; n=6

Total free amino acids in buds

Data bestowed in Table 8 usually show that the total free amino acids content in "Barkhar" apple variety gradually increased from the first sample 15th December till 1st February (last sample) Concerning the effect of the date of spray treatments on total free amino acids, it's clear from this information that just about all dates gave higher values of total free amino acids in if compared to the untreated trees. The most effective results were obtained by spraying the trees by mineral oil at the rate of 5% on the 15th of January.

Table 7 Effect of mineral oil spray at different dates on hormonal content in buds of "Barkhar" apple trees

Date of spraying	Indole acetic acid (IAA) ($\mu\text{g g}^{-1}$ DW)				
	15-Dec	1-Jan	15-Jan	1-Feb	15-Feb
Control	1.42c	1.86 c	4.71 b	5.99a	6.11 a
January,1	1.42 c	1.86 c	4.77 b	6.14a	6.92 a
January,15	1.42 c	1.86 c	4.97 b	6.81 a	6.93 a
February,1	1.42 c	1.86 c	4.77 b	6.20 a	6.89 a
Gibberellic acid (GA3) ($\mu\text{g g}^{-1}$ DW)					
Control	1.41 c	1.68 b	1.85b	3.15 a	3.55a
January,1	1.41 c	1.68 b	1.89 b	3.49 a	3.95 a
January,15	1.41 c	1.68 b	1.95 b	3.51 a	3.99 a
February,1	1.41 c	1.68 b	1.85 b	3.15 a	3.98 a
Abscisic acid (ABA) ($\mu\text{g g}^{-1}$ DW)					
Control	4.20 d	4.00 c	3.75 b	2.80 b	1.68 a
January,1	4.20 d	4.00 c	3.55 b	2.28 b	1.33 a
January,15	4.20 d	4.00 c	3.15 b	2.25 b	1.31 a
February,1	4.20 d	4.00 c	3.55 b	2.30 b	1.42 a
IAA/ABA ratio					
Control	0.33 d	0.42 d	1.25 c	2.13 b	3.63 a
January,1	0.33 d	0.42 d	1.34 c	2.69 b	5.20 a
January,15	0.33 d	0.42 d	1.57 c	3.02 b	5.29 a
February,1	0.333 d	0.42 d	1.34 c	2.69 b	4.85 a
GA3/ABA ratio					
Control	33.57 a	0.42 d	0.49 d	1.12 c	2.11 b
January,1	33.57 a	0.42 d	0.53 d	1.53 c	3.01 b
January,15	33.57 a	0.42 d	0.61 d	1.56 c	3.04 b
February,1	33.57 a	0.42 d	0.52 d	1.12 c	2.80 b

Mean pairs followed by different letters are significantly different ($p = 0.05$) by Duncan's test; $n=6$

Phenolic content in buds

Total soluble phenols and conjugated phenols will increase with foliar-applied mineral oil at 5%, whereas the free phenols decreases within the floral buds of "Barkhar" apple trees in comparison to the control as shown in Table 8. The data of all phenols obtained with mineral oil at 5% treatment were surpassed the data found with the control in most of the sampled dates. The maximum contents of total soluble phenols and conjugated phenols were obtained from buds applied with mineral oil at 5% on the fifteenth of January and picked up in fifteen February (buds were discharged from dormancy), whereas their minimum contents were obtained from buds applied with mineral oil and sampled in 1st January (buds were still dormant).

For free phenols, the alternative result was found. Additionally, the utmost increase in total flavonoids were noted within the fifteen February sample (buds were discharged from dormancy), whereas the minimum ones were found within the first January samples (buds were still dormant) as shown in Table 8.

Table 8 Effect of mineral oil spray at different dates on total free amino acids, total, free and conjugated phenols and total flavonoids content in buds of "Barkhar" apple trees

Date of spraying	Total free amino acids (mg g^{-1} DW)				
	15-Dec	1-Jan	15-Jan	1-Feb	15-Feb
Control	51.95 c	58.03 c	74.12b	75.03 b	77.01a
January,1	51.95 c	58.03 c	82.03 b	85.03 a	87.95 a
January,15	51.95 c	58.03 c	74.12 b	85.36 a	88.00 a
February,1	51.95 c	58.03 c	74.12 b	85.33 a	87.62 a
Total phenols (mg g^{-1} DW)					
Control	36.29 c	36.79 c	43.16 b	50.41 a	53.14 a
January,1	36.29 c	36.79 c	45.16 b	52.01 a	56.22 a
January,15	36.29 c	36.79 c	43.16 b	54.15 a	57.15 a
February,1	36.29 c	36.79 c	43.16 b	50.41 a	56.18 a
Free phenols (mg g^{-1} DW)					
Control	18.35 d	13.91 c	12.48 b	8.57 b	7.61 a
January,1	18.35 d	13.91 c	10.15 b	7.01 b	6.41 a
January,15	18.35 d	13.91 c	12.48 b	6.89 b	6.35 a
February,1	18.35 d	13.91 c	12.48 b	8.57 b	6.37a
Conjugated phenols (mg g^{-1} DW)					
Control	17.94 d	22.88 d	30.68 c	41.84 b	45.53 a
January,1	17.94 d	22.88 d	35.01 c	45.00 b	49.81a
January,15	17.94 d	22.88 d	30.68 c	47.26 b	50.80a
February,1	17.94 d	22.88 d	30.68 c	41.84b	49.81 a
Total flavonoids (mg g^{-1} DW)					
Control	1.88 c	2.02 b	2.15 b	2.31 a	2.42 a
January,1	1.88 c	2.02 b	2.23 b	2.45 a	2.55 a
January,15	1.88 c	2.02 b	2.15 b	2.43 a	2.56 a
February,1	1.88 c	2.02 b	2.15 b	2.31 a	2.53 a

Mean pairs followed by different letters are significantly different ($p = 0.05$) by Duncan's test; $n=6$

Chemical constituents of fruits

Data of Table 9 & 10 clearly showed that spraying apple trees with the tested substance considerably improved the chemical constituents of fruits (total soluble solids (TSS), vitamin C and TSS/total acidity) as compared to the untreated trees. Such trend was true throughout the two studied seasons. The utmost increase were recorded with mineral

oil at 5% on 15th January which recorded 12.17 & 12.15% within the first and second seasons, severally over the control trees for total soluble solids. The same trend was true for vitamin C and TSS/total acidity which recorded 3.82% with the primary season and 3.66% in the second season, respectively over the control trees for vitamin C and 23.86% in the first season and 23.36% in the second season, severally over the control trees for TSS/total acidity. On the opposite hand, the data in Table 9 additionally showed a marked decrease in total acidity concentrations in fruits once when trees were sprayed with the tested substance examination with the control trees.

Discussion

It is clear from the present study that breaking of dormancy is coincided with several changes in different chemical constituents of buds. Particularly the contents of water, carbohydrates (Table 6) endogenous hormones (Total natural indoles, IAA, GA₃ and ABA) (Table 6) (Table 7) total free amino acids (Table 8) and endogenous phenols (Total, free, conjugated phenols and total flavonoids) (Table 8) play a vital role in regulating dormancy and bud break. In this concern,³⁰ found that the transition of buds from the dormant stage to the bursting process is related to a rise within the water content within the tissue, mobilization of nutrients, activation of hydrolytic enzymes and intensification of respiration. The stimulating impact of mineral oil as foliar spray on total carbohydrates concentrations in buds of sprayed trees may be directly or indirectly thanks to sure enzymes that activate the anabolic processes resulting in the buildup of these substances. In this connection³¹ concluded that the period of increase in dry weight of both flower and vegetative buds appear to seem to result to the movement of metabolites may have come back from twigs, branches and roots of trees. Furthermore the rise in total free amino acids in buds after mineral oil treatments could also be because of the rise in mineral component movement specially nitrogen. In this concern³² found that there was a decrease in the nitrogen concentration of the woody tissues within the spring, significantly within the bark tissues of shoots. This was attributed to the movement of nitrogenous compounds from the bark and wood to the developing flower buds and growing points. Also³³ indicated that the nitrogen (including amino acid) was low level in buds or roots throughout dormant stage and reached maximum just prior to bud break, the nitrogen stored mostly in the roots and translocate to buds before bud break and early growth. Moreover,³⁴ observed that a probable correlation might exist between the state of dormancy and therefore the dominant total amino acids within the buds. Many studies centered on the link between the endogenous hormones and dormancy in buds.³⁵ During the whole testing period, IAA and GA₃ concentrations in buds of "Barkhar" apple at their release from dormancy was higher than those of before bud break. In contrast, ABA concentration in floral buds was higher before bud break than that of at dormancy releasing (Table 7). This suggested that higher IAA and GA₃ contents and lower ABA content were needed for release of "Barkhar" apple buds from dormancy. In this concern,³⁵ showed that, growth-promoting hormones like GA₃ and IAA found to be step by step exaggerated, whereas, growth-inhibiting hormones like ABA diminished throughout bud break. Moreover, the results showed that when the dormancy released, IAA/ABA ratio had the same changing tendency to IAA content (Table 4). Moreover, GA₃/ABA ratio in buds had the same changing tendency to GA₃ content during release from dormancy (Table 7). So, it could be presumed that IAA/ABA and GA₃/ABA ratio determined the metabolism direction. In addition, the ratios of IAA/ABA and GA₃/ABA in apple buds were decreased in dormant buds, while increased

in opening ones. In this concern,³⁵ suggested that the balance of many hormones played a more important role than the amount of certain single hormone in the procedure of dormancy releasing and opening of buds. several High levels of endogenous IAA and GA₃ and low level of endogenous ABA contents (Table 7) which noticed in "Barkhar" apple trees applied with mineral oil at different dates agreed with the explanation of,³⁶ which assumption that mineral oil application magnified all substances stimulate flower formation, like GA₃, Auxins etc., and shrivelled the flowering inhibitor like ABA etc. The physiological impact of oil on bud break is via respiration; thus its impact is powerfully influenced by the prevailing temperatures and during the week following application. It's been shown that a high day-time temperature is essential for an honest impact³⁷ the cause for impact may be a temporary anaerobic condition within the buds. This resulting in alcohol production that successively causes the impact.^{38,39} Ethanol production explains the sensitivity of buds to treatments with oil throughout excessive temperature and once the soil is water logged. Beneath traditional things the phytotoxic risk is low, facultative application even at bud swell. It absolutely was shown that at this stage the swelling terminal buds square measure inhibited (by oil) and this could increase the potential of the laterals to interrupt.⁴⁰ In this concern,⁴¹ reported that in response to chemical element like oxygen deprivation, plants accumulate amino acid (Ala), succinate and c-amino saturated fatty acid (GABA). This development is presently explained by the activation of the GABA-shunt or the Ala fermentative pathway.⁴² The GABA-shunt could be a metabolic pathway that includes salt (Glut) within the TCA cycle, bypassing 2 enzymes of the cycle, specifically a-ketoglutarate dehydrogenase and Succinyl-CoA ligase.⁴³ In this concern,⁴⁴ found that the oil-DNOC sprays definitely diode to terribly speedy shriveling of bud-scales. On the opposite hand chilling isn't An absolute demand for bud break, as a result of high temperatures,⁴⁵ bud scale removal⁴⁶ which means wounding stress, and anaerobic conditions³⁸ will replace the chilling necessities olefine production will increase following numerous disturbances or stresses in plants. These disturbances is iatrogenic by abiotic or biological agents.⁴⁷ Environmental stresses that induce ethene production embody physical wounding and cutting, chilling, drought, and water flooding.⁴⁸ Moreover, stress, ensuing from several rest-breaking treatments like tree defoliation, shoots decapitation or application of boundchemicals is understood to extend ethene levels in plants⁴⁹ during this respect,⁵⁰ according that bud scale removal enhanced bud break and 1- aminocyclopropane-1-carboxylic acid (ACC) content in buds. Moreover, the mode of action of oil spray in increasing bud break ar to the reduction within the quantity of water lost from the buds and principally forestall them from drying out, so that, they will continue their traditional metabolic activities and mobilization of nutrients to the developed buds.^{30,51} Environmental stresses that induce ethene production embody physical wounding and cutting, chilling, drought, and water flooding.⁴⁸ Moreover, stress, ensuing from several rest-breaking treatments like tree defoliation, shoots decapitation or application of boundchemicals is understood to extend ethene levels in plants.⁴⁹ During this respect,⁵⁰ according that bud scale removal enhanced bud break and 1- aminocyclopropane-1-carboxylic acid (ACC) content in buds. Moreover, the mode of action of oil spray in increasing bud break are to the reduction within the quantity of water lost from the buds and principally forestall them from drying out, so that, they will continue their traditional metabolic activities and mobilization of nutrients to the developed buds.^{30,51} In general, dormancy-breaking agents and time of application absolutely affected advancing bud break still as flowering as a results of enhanced yield. Even supposing oil provides the same have an effect on bloom

temporal arrangement, i might suspect that it works in an exceedingly completely different manner. i might guess that dormant oil will increase the physical phenomenon temperature of the tree, creating it "feels" hotter than actual close air temperature. So, if chill hours are accumulated, and also the nights are short enough, the tree would bloom since it's currently heat enough.⁵² The most of phenol compounds have been isolated from bud scales and have growth inhibitor role in buds. Literature reported by researchers and our works (Table 8) indicate that phenol compounds increased during rest in flower buds, then decreased after rest and completely eliminated at blooming. The chilling period influences during disappear them. Moreover,⁵³ reported that, phenol composition are redoubled from November to Gregorian calendar month and so, are shriveled in March and are eliminated on blooming stage in peach buds. Many studies have shown correlation between bud break and seasonal variation of phenols in trees.⁵⁴ The analysis of dormant buds has shown that, phenol compounds seldom occur in an exceedingly free state among the cell; rather they're normally conjugated with different molecules. This finding may be taken some proof, that, phenols may be play vital role to protection buds throughout winter, dormant season and bud break. The decrease in free phenols and the increase in conjugated phenols after mineral oil at different date's treatment (Table 8) may be due to that the reduction in free phenols contrasted with the increase in total indoles (Table 6) i.e. endogenous promoters increased and consequently endogenous inhibitors decreased in the buds which led to increasing in plant growth parameters. Moreover,⁵⁵ hypothesized that inhibitor flavonoids have protecting functions throughout several stresses and it appears that flavonoids accumulation within the leaves and flowers may be, helpful for its resistance to environmental stresses. The favorable effect of mineral oil at different dates on the date of flower bud opening (Table 1) may be due to their stimulation effect on natural GA₃. In this connection,⁵² concluded that the induction of flowering may well be related to with a natural rise in GAs in plants to facilitate the formation of flowering endocrine within the leaves or expressing it within the growing buds. In our study, oil at totally different dates absolutely affected the date of bud gap. This may be due to the increase in GA₃ and IAA and the decrease in ABA contents (Table 7). The increase in percentage of bud break and fruit set (Table 2) may be attributed to their stimulation effect of buds opening on formation of sink in shoot tip. In this concern,⁵⁶ reported that once a bud opens and attains the form of shoot, its tip acts as a powerful sink for metabolites and therefore being interception center for photosynthates and nutrient ends up in earlier begin of the bloom. The improving effect of mineral oil at different dates on yield and its components (Table 3) (Table 4) was mainly attributed to its positive action on enhancing growth parameters and photosynthetic pigments.

Moreover, the stimulating effect of mineral oil at different dates on physical characters (fruit weight, size and dimensions) and chemical fruit characters (T.S.S, total acidity, vitamin C) was mainly attributed to its positive action on enhancing growth parameters (Table 9) (Table10). Concerning the effect on TSS and acidity in fruits, the results showed that all treatments increased TSS significantly and decreased the total acidity. This increase in TSS may be due to the increase in synthesis of carbohydrates and its accumulation in the developing fruits of the treated trees. In this connection,⁵⁷ mentioned that sugars diagrammatic regarding seventieth of the full soluble solids (T.S.S) in apple fruits and therefore the increase in sugars result in increase in TSS. He conjointly another that the rise in cellular sap result in decrease in acidity as a results of dilution of the organic acids furthermore.^{58,59} on pear, found that the rise in TSS is also because

of fast conversion of starch, and therefore the decrease in total acids content with advancement of ripening amount is also because of that the acids square measure regenerate into soluble solids during this connection⁶⁰ urged that water and nutrients might also be mobilized to the growing points at the expense of the developing fruits. Moreover,⁵⁸ found that the rise in accumulation of TSS and sugars throughout maturation has been associated with accumulation of aldohexose, plant product and better levels of ketohexose in "Bartlett" pear. Also,⁶¹ found that a daily decrease in acidity towards maturity can be because of consistent rise in temperature that ends up in varied degree of oxidization of substrates through respiration. Moreover,⁶² according that, the rise in antioxidant is also because of that fruits synthesize vitamin C from monosaccharide sugars, and thus the adequate offer of those precursors would greatly rely on the chemical action activity.

Table 9 Effect of mineral oil spray at different dates on T.S.S. and acidity of "Barkhar" apple fruit quality

Date of spraying	T.S.S. (%)		Acidity(%)	
	2015	2016	2015	2016
Control	11.97c	11.49c	1.10 c	1.09 c
January,1	11.63b	11.70b	0.54a	0.59a
January,15	12.17a	12.15a	0.51a	0.52a
February,1	12.10a	12.09a	0.68b	0.66b

Mean pairs followed by different letters are significantly different (p = 0.05) by Duncan's test; n=6

Table 10 Effect of mineral oil spray at different dates on T.S.S./acid ratio and vitamin C of "Barkhar" apple fruit quality

Date of spraying	T.S.S./acid ratio		Vitamin C (mg/100ml juice)	
	2015	2016	2015	2016
Control	10.88c	10.54c	2.19c	2.32c
January,1	21.53a	19.83b	2.47b	2.55b
January,15	23.86a	23.36a	3.82a	3.66a
February,1	17.79b	18.31b	2.69b	2.85b

Mean pairs followed by different letters are significantly different (p = 0.05) by Duncan's test; n=6

Conclusion

The foliar application with mineral oil at different dates for "Barkhar" apple trees hastened the bud break, shortened the period of flowering and improved bud growth and fruit set. Mineral oil at 5% on the 15th January was found the foremost effective and considerably improved the contents of endogenous IAA, GA₃, conjugated phenols and total flavonoids further as reduced ABA and free phenols content. This can be is led to the increasing within the percentages of the bud break and fruit set, further because the reduction within the period of flowering, and at last the increasing in the yield. Therefore, we tend to suggest mistreatment mineral oil at 5% as operator safer bud break promoters for the rise in "Barkhar" apple trees productivity. It should give a well strategy for the rise in the percentages of bud break and fruit set, and therefore the reduction in the flowering period to protect the floral buds against the high temperature in late winter in Egypt.

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Conflicts of interest

The author declares there is no conflicts of interest.

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