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PHYSIOLOGICAL STUDIES ON KEITT MANGO CULTIVAR

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ABSTRACT: This investigation was carried out during two consecutive seasons (2016 and 2017) in a private farm at EL-Sadat region, Menoufia Governorate, Egypt, to study the effect of foliar application with phenylalanine, putrescine and sea algae extract on vegetative growth aspects, nutritional status, yield and fruit quality attributes of Keitt mango cultivar. All trees were six years old, spaced at 2 x 3 meters apart, grown in sandy soil and irrigated by the drip irrigation system. Ten treatments were applied as follows: foliar application with phenylalanine at (100, 200 and 400ppm), putrescine at (125, 250 and 500ppm) and sea algae extract at (0.5, 1.0 and 1.5%) in additionally control treatment. All foliar application treatments were carried out through the three times: the beginning of spring growth flush (the first week of March), the full bloom (the first week of April) and just after fruit setting (the third week of May). The results revealed that all application substances at high doses significantly outperformed the use of medium and low doses of each. However, foliar spraying with phenylalanine at 400ppm, putrescine at 500ppm and sea algae extract at 1.5% had the best results in terms of ensuring the best vegetative growth traits, increasing leaf mineral content, achieving the highest yield with its components and improving the physical and chemical characteristics of fruits of Keitt mango trees.

Key words: Mango, Keitt cultivar, phenylalanine, putrescine, sea algae extract, vegetative growth traits, yield, fruits.

INTRODUCTION

Mango is a tropical fruit crop having an important role in supporting nutrition requirement for the population as well as increasing the grower income. In Egypt, mango cultivated areas reached 304118 feddans with total production estimated to 1091535 tons according to the latest statistics from Ministry of Agriculture (2019). The most serious problems faced by growers today are low fruit set percentage, yield and inferior fruit quality. This is attributed to wide tree spacing, malformation, alternate bearing, environmental factors and fruit drop (Jana and Sharangi, 1998).

Providing adequate nutritional management and hormonal balance are fundamental factors to overcome the fruit decline in mangoes (Siddiq *et al.,* 2017). In this context, researchers have used plant bio-stimulants are an alternative in mango tree cultivation to objective of increasing the nutritional efficiency of crops and tolerance to abiotic stresses, as well as improving the quality of agricultural products (Ribeiro *et al.*, 2017).

Bio-stimulants have physiological effects similar to those of phytohormones, acting to promote, modify, or inhibit physiological processes when applied to plants (Castro, 2006). According to Jardin (2012), there are many categories of substances that act as bio-stimulants: amino acids, polyamines, se algae extract......etc.

Amino acids are considered as precursors and constituents of proteins (Rai, 2002), which are important for stimulation of cell growth. They contain both acid and basic groups and act as buffers, which help to maintain favorable pH value within the plant cell (Davies, 1982). Amino acids can directly or indirectly influence the physiological activities in plant growth and development such as exogenous application of amino acids have been reported to modulate the growth, yield and biochemical quality of mango trees (El-Kosary *et al.,* 2011).

Putrescine is one of the polyamines that are considered growth substances. It participates in several processes of plant growth and developmental processes including regulation of

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DNA replication, transcription of genes, cell division, organ development floral process and fruit ripening (Applewhite *et al.,* 2000 and Aziz *et al.,* 2001). Furthermore, it works as antioxidant and improves cell membrane stability (Li *et al.,* 2015) and plays role in modulating the defense response of plants to varied environmental stresses including drought stress (Ahmed *et al.,* 2017).

Algae extract as a new bio fertilizer containing macro- and micronutrients as well as some growth regulators, polyamines and vitamins applied to improve nutritional status, vegetative growth, yield and fruit quality in different fruit orchards (Abd El-Migeed *et al.,* 2004; Abd El-Moniem & Abd-Allah, 2008 and Spinelli *et al.,* 2009). The mechanisms effect of algae extract on cell metabolism are mainly through the physiological action of major and minor nutrients, amino acids, vitamins, and also growth regulators affect cellular metabolism in treated plants leading to enhanced growth and crop yield (Stirk *et al.,* 2003; Ordog *et al.,* 2004 and Abd El-Motty *et al.,* 2010).

The objective of the present to study the effect of foliar application with phenylalanine, putrescine and sea algae extract on vegetative growth aspects, nutritional status, yield and fruit quality attributes of Keitt mango cultivar.

MATERIALS AND METHODS

This investigation was carried out during two consecutive seasons (2016 and 2017) in a private farm at EL-Sadat region, Menoufia Governorate, Egypt, to study the effect of foliar application with phenylalanine, putrescine and sea algae extract on vegetative growth aspects, nutritional status, yield and fruit quality attributes of Keitt mango cultivar. All trees were six years old, spaced at 2 x 3 meters apart, grown in sandy soil and irrigated by the drip irrigation system. The experimental trees were healthy, similar in growth vigor and received the same horticultural practices. Thirty uniform trees were chosen for this investigation. Each tree acted as a replicate and each three replicates were treated by one of the used treatments.

Ten treatments were applied as follows:

1- Phenylalanine at 100ppm
2- Phenylalanine at 200ppm
3- Phenylalanine at 400ppm
4- Putrescine at 125ppm
5- Putrescine at 250ppm
6- Putrescine at 500 ppm
7- Sea algae extract at 0.5%
8- Sea algae extract at 1%
9- Sea algae extract at 1.5%
10- Tap water (Control)

All foliar application treatments were carried out through the three times: the beginning of spring growth flush (the first week of March), the full bloom (the first week of April) and just after fruit setting (the third week of May). Triton B as a wetting agent was added at 0.1 % to all foliar solutions and spraying was done till runoff.

The following parameters were adopted to evaluate the tested treatments:-

1. Vegetative growth characteristics

a) Shoot length and number of leaves per shoot

Twenty new shoots were randomly chosen at the first week of September around canopy tree and tagged to measure the shoot length (cm) and number of leaves per shoot.

b) Leaf area and total foliage area per shoot (cm^2)

The leaf area was calculated using the following formula according to Nii *et al.* (1995).

$$Y = 0.146 + 0.706X$$

Where X = leaf length (cm) X leaf width (cm)

Y = leaf area (cm^2)

The total foliage area per shoot was determined by multiplying the total number of new leaves by leaf area.

2. Leaf macro-elements content

To determine percentages of N, P and K, fifty mature leaves from fruiting shoots at the first week of September according to Summer (1985) were taken. Leaves are dried at 70 °C and digested using H_2so_4 and H_2o_2 (Piper, 1950). In digestion, percentages of nitrogen according to Pregl (1945), phosphorus according to Chapman and Pratt (1975) and potassium according to Brown and Lilliland (1946) were determined.

3. Fruit drop, fruit retention and yield

Five panicles of different sizes per tree were collected to determined the total perfect flowers. In each tree, ten panicles from all directions were tagged, before treatment, by wrapping adhesive plastic around the shoots, 5 cm below the panicle. Total number of fruitlets on tagged panicles was counted after fruit set.

Fruit drop percentage was estimated at harvest by subtracting the number of mature fruits per panicle from number of fruitlet per panicle, then dividing by the number of fruitlet per panicle at multiplying the product by 100.

Fruit retention percentage was estimated at harvest by dividing the number of mature fruits per panicle by the number of fruitlet per panicle at multiplying the product by 100.

Total yield (kg) was estimated by multiplying number of fruits per tree by average fruit weight.

4. Physical properties of fruits

Ten ripe fruits from each tree were randomly taken at maturity stage according to Hussein and Youssef (1972); the following parameters were taken as three fruits per sample of each replicate.

- Average fruit weight (g) was weighed of ten fruits by digital balance.
- Average fruit size (cm^3) was estimated by the volume of water displaced by immersing ten fruits in a graduated jar filled with water.
- Average pulp weight (%) was estimated by dividing pulp weight by the fruit weight at multiplying the product by 100.
- Average peel weight (%) was estimated by dividing peel weight by the fruit weight at multiplying the product by 100.
- Average seed weight (%) was estimated by dividing seed weight by the fruit weight at multiplying the product by 100.
- Average fruit firmness (kg/cm^2) was measured on two sides of each fruit with an Effegi pentrometer (Model NI, McCormick Fruit. Tech, Yakima, Washington).

5. Chemical properties of fruits

- Total soluble solids (TSS %) was determined by using a Carl-Zeiss hand refractrometer.
- Titratable acidity (%) was determined by titrating 10 ml juice with a standard alkali 0.1 NaOH using phenolphthalein as an indicator, and then calculated as anhydrous grams of citric acid per 100ml of juice (A.O.A.C., 2005).
- Total sugars (%) was determined by using picric acid method as (A.O.A.C., 2005).
- Ascorbic Acid (Vitamin C) was determined periodically as mg ascorbic acid/100 ml fruit juice by titration with 2-6 dichlorophenol indophenols solution in the percentage of oxalic acid solution (A.O.A.C., 2005).

• Experimental design and statistical Analysis

The randomized complete block design was adopted for this experiment. The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using the L.S.D. values at 5% level (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

1. Vegetative growth

Date presented in Table (1) indicated that all vegetative growth characteristics *i.e.* average shoot length, average number of leaves, average leaf area and total leaf area per shoot were significantly enhanced by all foliar application substances compared to the control treatment of Keitt mango trees in both seasons.

The foliar spraying of phenylalanine, putrescine and sea algae extract at high doses significantly outperformed the use of medium and low doses of each.

Longest significant shoot was achieved by foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas the least one was attributed to the control trees in both seasons.

With respect to average number of leaves, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the highest number of leaves followed by putrescine at 500ppm followed by sea algae extract at 1.5%. On the other hand, control trees resulted in the lowest one in both seasons.

Concerning average leaf area, it is obvious that the largest significant leaf area was occurred from foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, while the least one was attributed to the control trees in both seasons.

As far total foliage leaf area per shoot, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the highest total foliage leaf area per shoot followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas control trees resulted in the lowest one in both seasons.

Regarding the positive effect of phenylalanine on vegetative growth aspects could be attributed to the amino acids play role in enhancing the biosynthesis and movement of total carbohydrates as well as its positive action on stimulating both cell division and cell enlargement, which are reflected on stimulating growth (Nijjar, 1985).

Table 1. Effect of foliar application with phenylalanine, putrescine and sea algae extract on vegetative growth characteristics of Keitt mango cultivar during 2016 and 2017 seasons

Treatment	Average shoot length (cm)	Average number of leaves	Average leaf area (cm^2)	Total leaf area/shoot (cm^2)
	2016 season			
Phenylalanine at 100ppm	20.26	9.02	42.28	381.4
Phenylalanine at 200ppm	22.87	9.38	43.07	404.0
Phenylalanine at 400ppm	25.09	9.64	44.01	424.3
Putrescine at 125ppm	20.14	8.93	41.93	374.4
Putrescine at 250ppm	22.38	9.24	42.81	395.6
Putrescine at 500ppm	24.67	9.57	43.86	419.7
Sea algae extract at 0.5%	19.94	8.67	41.59	360.6
Sea algae extract at 1%	21.53	9.13	42.67	389.6
Sea algae extract at 1.5%	23.74	9.46	43.31	409.7
Control	19.37	8.53	41.38	353.2
L.S.D at 5 %	0.37	0.04	0.14	4.47
	2017 season			
Phenylalanine at 100ppm	21.43	9.19	43.51	399.9
Phenylalanine at 200ppm	23.09	9.55	44.23	422.4
Phenylalanine at 400ppm	24.51	9.78	45.13	441.4
Putrescine at 125ppm	20.92	9.06	43.09	390.4
Putrescine at 250ppm	22.54	9.43	43.97	414.6
Putrescine at 500ppm	23.95	9.69	44.87	434.8
Sea algae extract at 0.5%	20.07	8.98	42.87	385.0
Sea algae extract at 1%	21.89	9.32	43.76	407.8
Sea algae extract at 1.5%	23.43	9.61	44.61	428.7
Control	19.85	8.71	42.13	367.0
L.S.D at 5 %	0.43	0.07	0.17	5.27

The obtained results regarding the positive effect of phenylalanine application on vegetative growth aspects are in agreement with those obtained by El-Souda (2011), Abd El-Razek and Saleh (2012), Hanafy *et al.* (2012), Khan *et al.* (2012) and Abd El-Rahman *et al.* (2019).

Concerning the beneficial influence of putrescine on vegetative growth aspects might be attributed to polyamines can act as a source of nitrogen which stimulates growth by increasing the amount of endogenous promoters such as auxin, gibberellins and cytokinins which accompanied with decreasing ABA inhibitors either content or activity, and also can bind to negatively charged molecules and stabilizes them, in addition, putrescine is a polyamine that is involved in different plant growth and developmental processes (Talaat and Gamal EL-Din, 2005, Ahmed *et al.,* 2013 and Ahmed *et al.,* 2017).

The obtained results regarding the beneficial influence of putrescine application on vegetative growth aspects are in harmony with those confirmed by Mohamed *et al.* (2018).

With respect to the promotion effect of sea algae extract on vegetative growth aspects could be attributed to their higher content of amino acids, cytokinins, vitamins B, GA_3 and mineral (Abou-Zaid, 1984).

The obtained results regarding the promotion effect of sea algae extract application on vegetative growth aspects are the line with those reported by Khan *et al.* (2012), Ahmed *et al.* (2015), El-Sharony *et al.* (2015), Abd El-Rahman *et al.* (2017) and El-Mahdy *et al.* (2017).

2. Leaf macro-elements content

Date presented in Table (2) indicated that leaf macro-elements content *i.e.* total nitrogen, phosphorus and potassium were significantly increased by all foliar application substances compared to the control treatment of Keitt mango trees in both seasons.

The foliar spraying of phenylalanine, putrescine and sea algae extract at high doses significantly outperformed the use of medium and low doses of each.

Highest significant total nitrogen was achieved by foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas the least one was attributed to the control trees in both seasons.

With respect to phosphorus, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the highest magnitude of phosphorus followed by putrescine at 500ppm followed by sea algae extract at 1.5%. On the other hand, control trees resulted in the lowest one in both seasons.

Concerning potassium, it is obvious that the highest significant potassium was occurred from foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, while the least one was attributed to the control trees in both seasons.

Regarding the positive effect phenylalanine on nutritional status might be attributed to its positive action on increasing cell division and the biosynthesis of organic foods, which are reflected in enhancing nutritional status (Ahmed and Abd El-Hameed, 2003).

The obtained results regarding the positive effect of phenylalanine application on leaf NPK content are in agreement with those achieved by Abd El-Rahman (2011), Abd El-Razek and Saleh (2012), Hanafy *et al.* (2012) and Abd El-Rahman *et al.* (2019).

Concerning the beneficial influence of putrescine on leaf mineral content could be attributed to help in the uptake of minerals like N, P and K from soil (Shawky, 2003).

The obtained results regarding the beneficial influence of putrescine application on leaf mineral content are in harmony with those supported by Qing-Sheng and Zou (2009) and Ali *et al.* (2017).

With respect to the promotion effect of sea algae extract on leaf mineral content might be attributed to mainly through the physiological action of nutrients, vitamins, and growth regulators, which reflected on improved nutritional status of tree (Abd El-Migeed *et al.*, 2004, Abd El-Moniem and Abd-Allah 2008 and Abd El-Moniem *et al.*, 2008).

The obtained results regarding the promotion effect of sea algae extract application on leaf mineral content are the line with those reported by Ahmed *et al.* (2015), Amro (2015) and El-Sharony *et al.* (2015).

Table 2. Effect of foliar application with phenylalanine, putrescine and sea algae extract on leaf macro-elements content of Keitt mango cultivar during 2016 and 2017 seasons

Treatment	Total nitrogen (%)	Phosphorus (%)	Potassium (%)
	2016 season		
Phenylalanine at 100ppm	2.05	0.15	0.27
Phenylalanine at 200ppm	2.15	0.23	0.32
Phenylalanine at 400ppm	2.27	0.32	0.39
Putrescine at 125ppm	2.01	0.13	0.25
Putrescine at 250ppm	2.10	0.20	0.31
Putrescine at 500ppm	2.21	0.29	0.37
Sea algae extract at 0.5%	1.98	0.12	0.24
Sea algae extract at 1%	2.07	0.19	0.28
Sea algae extract at 1.5%	2.19	0.25	0.34
Control	1.93	0.09	0.21
L.S.D at 5 %	0.04	0.02	0.02
	2017 season		
Phenylalanine at 100ppm	2.06	0.22	0.23
Phenylalanine at 200ppm	2.13	0.26	0.29
Phenylalanine at 400ppm	2.21	0.35	0.36
Putrescine at 125ppm	2.03	0.19	0.21
Putrescine at 250ppm	2.09	0.25	0.27
Putrescine at 500ppm	2.17	0.33	0.35
Sea algae extract at 0.5%	2.01	0.17	0.20
Sea algae extract at 1%	2.07	0.23	0.26
Sea algae extract at 1.5%	2.16	0.30	0.31
Control	1.97	0.13	0.18
L.S.D at 5 %	0.03	0.01	0.01

3. Fruit drop, fruit retention and yield/tree

Date presented in Table (3) indicated that fruit drop, fruit retention and yield/tree were significantly affected by all foliar application substances compared to the control treatment of Keitt mango trees in both seasons.

The foliar spraying of phenylalanine, putrescine and sea algae extract at high doses significantly resulted in the lowest percentage of fruit drop and the highest percentage of fruit retention and yield compared to those at the medium and low.

Lowest significant fruit drop was occurred from foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, while the highest one was attributed to the control trees in both seasons.

As far fruit retention, data take an adverse line concern to fruit drop. However, foliar spraying with phenylalanine at 400ppm significantly had the highest fruit retention followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas control trees resulted in the lowest one in both seasons.

Concerning yield per tree, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the highest value of yield per tree followed by putrescine at 500ppm followed by sea algae extract at 1.5%. On the other hand, control trees resulted in the lowest one in both seasons.

The increment in fruit retention with exogenous application of phenylalanine, putrescine and sea algae extract could be attributed to enhance nutritional status of trees, which its reflect to improve fruit growth and thereby reduce the fruit drop and increase the fruit retention.

The obtained results regarding the positive effect of phenylalanine application on fruit drop and retention are in agreement with those obtained by El-Kosary *et al.* (2011) and Khattab *et al.* (2016).

The obtained results regarding the beneficial influence of putrescine application on fruit drop and retention are in harmony with those confirmed by Ali *et al.* (2017) and Shaban *et al.* (2017).

The obtained results regarding the promotion effect of sea algae extract application on fruit drop and retention are the line with those reported by Ahmed *et al.* (2015), Amro (2015), El-Sharony *et al.* (2015) and Abd El-Rahman *et al.* (2017).

Regarding the positive effect of phenylalanine on yield might be attributed to its positive action on enhancing the biosynthesis of proteins and natural hormones like, IAA, ethylene, cytokinins and GA_3 as well as enzymes which are important for stimulation of cell growth, which are reflected on improving productivity (Kowalczyk and Zielony, 2008).

The obtained results regarding the positive effect of phenylalanine application on yield are in agreement with those achieved by Hanafy *et al.* (2012), Khattab *et al.* (2016) and Abd El-Rahman *et al.* (2019).

Concerning the beneficial influence of putrescine on yield could be attributed to enhance nutritional status of trees, which its reflect to improve fruit growth and thereby increase the productivity (Boniel and Protacio, 2002).

The obtained results regarding the beneficial influence of putrescine application on yield are in harmony with those supported by Ali *et al.* (2017), Shaban *et al.* (2017) and Hagagg *et al.* (2020).

With respect to the promotion effect of sea algae extract on yield might be attributed to it content on the minerals, vitamins and growth regulators especially, IAA and cytokinins which induced a positive effect on increase the yield kg/tree (Abd El-Motty *et al.*, 2010).

The obtained results regarding the promotion effect of sea algae extract application on yield are the line with those reported by Abd El-Rahman *et al.* (2017), El-Mahdy *et al.* (2017) and Alebidi *et al.* (2021).

Table 3. Effect of foliar application with phenylalanine, putrescine and sea algae extract on fruit drop, fruit retention and yield/tree of Keitt mango cultivar during 2016 and 2017 seasons

Treatment	Fruit drop (%)	Fruit retention (%)	Yield/tree (kg)
	2016 season		
Phenylalanine at 100ppm	78.1	21.87	16.61
Phenylalanine at 200ppm	77.8	22.21	17.83
Phenylalanine at 400ppm	76.4	23.59	19.55
Putrescine at 125ppm	78.4	21.61	15.69
Putrescine at 250ppm	77.9	22.06	17.59
Putrescine at 500ppm	76.6	23.35	19.22
Sea algae extract at 0.5%	78.7	21.35	15.03
Sea algae extract at 1%	78.1	21.88	17.19
Sea algae extract at 1.5%	77.3	22.71	18.49
Control	79.2	20.78	14.33
L.S.D at 5 %	0.19	0.21	0.29
	2017 season		
Phenylalanine at 100ppm	78.6	21.42	16.93
Phenylalanine at 200ppm	78.2	21.81	18.18
Phenylalanine at 400ppm	77.8	22.18	19.10
Putrescine at 125ppm	78.6	21.39	15.90
Putrescine at 250ppm	78.2	21.78	17.90
Putrescine at 500ppm	77.9	22.08	18.74
Sea algae extract at 0.5%	79.0	21.04	15.34
Sea algae extract at 1%	78.3	21.72	17.65
Sea algae extract at 1.5%	78.0	21.95	18.51
Control	79.6	20.43	14.67
L.S.D at 5 %	0.23	0.23	0.33

4. Physical properties of fruits

Date presented in Table (4) indicated that all fruit physical properties *i.e.* average fruit weight, average fruit size, average fruit pulp, fruit peel, fruit seed and fruit firmness were significantly affected by all foliar application substances compared to the control treatment of Keitt mango trees in both seasons.

The foliar spraying of phenylalanine, putrescine and sea algae extract at high doses significantly outperformed the use of medium and low doses of each.

Highest significant fruit weight was achieved by foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas the least one was attributed to the control trees in both seasons.

With respect to average fruit size, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the highest fruit size followed by putrescine at 500ppm followed by sea algae extract at 1.5%, while control trees resulted in the lowest one in both seasons.

Concerning average fruit pulp, it is obvious that the highest significant fruit pulp was occurred from foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, while the least one was attributed to the control trees in both seasons.

As far fruit peel, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the highest fruit peel followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas control trees resulted in the lowest one in both seasons.

Regarding average fruit seed, it was evident that the least significant fruit seed was achieved by foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, while the highest one was attributed to the control trees in both seasons.

Table 4. Effect of foliar application with phenylalanine, putrescine and sea algae extract on fruit physical properties of Keitt mango cultivar during 2016 and 2017 seasons

Treatment	Fruit weight (g)	Fruit size (cm^3)	Pulp weight (%)	Peel weight (%)	Seed weight (%)	Fruit firmness (kg/cm^2)
	2016 season					
Phenylalanine at 100ppm	428.4	393.8	81.45	8.83	9.72	9.27
Phenylalanine at 200ppm	452.4	415.9	82.74	8.95	8.31	8.82
Phenylalanine at 400ppm	467.3	429.6	83.94	9.05	7.01	8.46
Putrescine at 125ppm	409.5	376.5	80.91	8.79	10.30	9.38
Putrescine at 250ppm	449.7	413.4	82.31	8.91	8.78	8.97
Putrescine at 500ppm	464.2	426.7	83.47	9.02	7.51	8.57
Sea algae extract at 0.5%	397.1	365.1	80.23	8.76	11.01	9.51
Sea algae extract at 1%	443.1	407.3	81.72	8.86	9.42	9.13
Sea algae extract at 1.5%	459.3	422.2	83.32	8.98	7.70	8.70
Control	388.9	357.5	79.34	8.71	11.95	9.68
L.S.D at 5 %	3.9	2.7	0.37	0.02	0.29	0.11
	2017 season					
Phenylalanine at 100ppm	439.6	403.2	81.92	8.91	9.17	9.95
Phenylalanine at 200ppm	467.1	428.5	83.23	9.04	7.73	9.56
Phenylalanine at 400ppm	482.1	442.2	84.53	9.14	6.33	9.13
Putrescine at 125ppm	418.7	384.1	81.34	8.87	9.79	10.11
Putrescine at 250ppm	462.9	424.6	82.94	8.99	8.07	9.67
Putrescine at 500ppm	476.5	437.1	84.11	9.12	6.77	9.26
Sea algae extract at 0.5%	404.3	370.9	80.81	8.83	10.36	10.23
Sea algae extract at 1%	457.2	419.4	82.47	8.96	8.57	9.82
Sea algae extract at 1.5%	472.7	433.6	83.78	9.09	7.13	9.42
Control	393.2	360.7	80.13	8.74	11.13	10.37
L.S.D at 5 %	4.3	3.1	0.41	0.01	0.33	0.13

With respect to average fruit firmness, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the lowest fruit firmness followed by putrescine at 500ppm followed by sea algae extract at 1.5%. On the other hand, control trees resulted in the highest one in both seasons.

Regarding the positive effect of phenylalanine on fruit physical characteristics could be attributed to its positive action on in increasing cell division and the biosynthesis of organic foods which reflected in enhancing growth, vine nutritional status, it is led to improving physical characteristics of fruits (Ahmed and Abd El-Hameed, 2003).

The obtained results regarding the positive effect of phenylalanine application on fruit physical characteristics are in agreement with those obtained by Hanafy *et al.* (2012), Khan *et al.* (2012), Kotb *et al.* (2018) and Abd El-Rahman *et al.* (2019).

Concerning the beneficial influence of putrescine on fruit physical characteristics might be attributed to the improvement of fruit growth and uptake of nutrients that accelerate metabolic processes (Abd El-Migeed *et al.*, 2013).

The obtained results regarding the beneficial influence of putrescine application on fruit physical characteristics are in harmony with those confirmed by Abd El-Migeed *et al.* (2013), Ali *et al.* (2017), Shaban *et al.* (2017) and Hagagg *et al.* (2020).

With respect to the promotion effect of sea algae extract on fruit physical characteristics could be attributed to mainly through the physiological action of nutrients, vitamins, and growth regulators, which reflected on fruit quality (Abd El-Migeed *et al.*, 2004, Abd El-Moniem and Abd-Allah 2008 and Abd El-Moniem *et al.,* 2008).

The obtained results regarding the promotion effect of sea algae extract application on fruit physical characteristics are the line with those reported by Badran (2016), Abd El-Rahman *et al.* (2017), El-Mahdy *et al.* (2017) and Alebidi *et al.* (2021).

5. Chemical properties of fruits

As shown in Table (5), it is obvious that all fruit chemical properties *i.e.* TSS, acidity, total sugars and ascorbic acid (vitamin C) were significantly improved by all foliar application substances compared to the control treatment of Keitt mango trees in both seasons.

The foliar spraying of phenylalanine, putrescine and sea algae extract at high doses significantly had the highest value of TSS, total sugars and ascorbic acid (vitamin C) and the lowest value of juice acidity compared to those at the medium and low.

Highest significant TSS was achieved by foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%. On the contrary, the least percentage of TSS was attributed to the control trees in both seasons.

As far juice acidity, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the lowest juice acidity followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas control trees resulted in the highest one in both seasons.

Regarding average total sugars, it was evident that the highest significant total sugars was achieved by foliar spraying with phenylalanine at 400ppm followed by putrescine at 500ppm followed by sea algae extract at 1.5%, whereas the least one was attributed to the control trees in both seasons.

With respect to ascorbic acid, it worth mentioned that, foliar spraying with phenylalanine at 400ppm significantly had the highest ascorbic acid followed by putrescine at 500ppm followed by sea algae extract at 1.5%. On the other hand, control trees resulted in the lowest one in both seasons.

Regarding the positive effect of phenylalanine on fruit chemical characteristics might be attributed to its positive action on protecting plant cells from oxidation and all stresses as well as enhancing the biosynthesis and translocation of sugars in the fruit juice (Ahmed and Abd El-Hameed, 2003 and Kowalczyk and Zielony 2008).

Table 5. Effect of foliar application with phenylalanine, putrescine and sea algae extract on fruit chemical properties of Keitt mango cultivar during 2016 and 2017 seasons

Treatment	TSS (%)	Acidity (%)	Total sugars (%)	Ascorbic acid (mg /100 ml)
	2016 season			
Phenylalanine at 100ppm	16.96	0.68	12.60	54.27
Phenylalanine at 200ppm	17.03	0.62	12.64	54.37
Phenylalanine at 400ppm	17.11	0.57	12.72	54.49
Putrescine at 125ppm	16.93	0.69	12.57	54.23
Putrescine at 250ppm	17.01	0.65	12.63	54.36
Putrescine at 500ppm	17.07	0.60	12.68	54.43
Sea algae extract at 0.5%	16.91	0.72	12.55	54.18
Sea algae extract at 1%	16.97	0.66	12.61	54.33
Sea algae extract at 1.5%	17.06	0.61	12.67	54.41
Control	16.87	0.74	12.51	54.11
L.S.D at 5 %	0.03	0.02	0.03	0.04
	2017 season			
Phenylalanine at 100ppm	16.99	0.65	12.63	54.51
Phenylalanine at 200ppm	17.05	0.59	12.71	54.64
Phenylalanine at 400ppm	17.14	0.54	12.77	54.76
Putrescine at 125ppm	16.95	0.67	12.61	54.48
Putrescine at 250ppm	17.04	0.61	12.67	54.62
Putrescine at 500ppm	17.11	0.56	12.74	54.71
Sea algae extract at 0.5%	16.94	0.68	12.60	54.43
Sea algae extract at 1%	17.01	0.64	12.64	54.55
Sea algae extract at 1.5%	17.07	0.57	12.73	54.70
Control	16.91	0.71	12.57	54.37
L.S.D at 5 %	0.02	0.01	0.02	0.03

The obtained results regarding the positive effect of phenylalanine application on fruit chemical characteristics are in agreement with those achieved by Khan *et al.* (2012), El-Sayed (2013), Kotb *et al.* (2018) and Abd El-Rahman *et al.* (2019).

Concerning the beneficial influence of putrescine on fruit chemical characteristics could be attributed to enhancing fruit quality is notably due to the bio regulatory effect on enzymatic activity and translocation processes from leaves to fruits, linking or converting to other plant metabolites (Serafini-Fracassini and Del Duca, 2008).

The obtained results regarding the beneficial influence of putrescine application on fruit chemical characteristics are in harmony with those supported by Abd El-Migeed *et al.* (2013), Ali *et al.* (2017), Shaban *et al.* (2017) and Venu and Ramdevputra (2018).

With respect to the promotion effect of sea algae extract on fruit chemical characteristics might be attributed to mainly through the physiological action of nutrients, vitamins, and growth regulators, which reflected on fruit quality (Abd El-Migeed *et al.*, 2004, Abd El-Moniem and Abd-Allah 2008 and Abd El-Moniem *et al.*, 2008).

The obtained results regarding the promotion effect of sea algae extract application on fruit chemical characteristics are the line with those reported by Badran (2016), Abd El-Rahman *et al.* (2017), El-Mahdy *et al.* (2017) and Alebidi *et al.* (2021).

From the foregoing results, it can be concluded that all application substances at high doses significantly outperformed the use of medium and low doses of each. However, foliar spraying with phenylalanine at 400ppm, putrescine at 500ppm and sea algae extract at 1.5% had the best results in terms of ensuring the best vegetative growth traits, increasing leaf mineral content, achieving the highest yield with its components and improving the physical and chemical characteristics of fruits of Keitt mango trees.

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دراسات فسيولوجية على المانجو صنف الكيت

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الملخص العربى

أجريت هذه الدراسة خلال الموسمين المتتاليين (٢٠١٦ و ٢٠١٧) في مزرعة خاصة بمنطقة السادات بمحافظة المنوفية لدراسة تأثير الرش الورقي لكل من الفينيل ألانين ، البوتريسين ومستخلص الطحالب البحرية على صفات النمو الخضري ومحتوى الأوراق من العناصر المعدنية والمحصول وجودة الثمار لأشجار المانجو صنف الكيت. كان عمر جميع الأشجار ست سنوات، منزرعة على مسافة ٢ × ٣ متر، نامية في تربة رملية والمروية تحت نظام الري بالتنقيط. تم إجراء عشر معاملات على النحو التالي: الرش الورقي لكل من الفينيل ألانين عند تركيزات (١٠٠، ٢٠٠، ٤٠٠ جزء في المليون)، البوتريسين عند تركيزات (١٢٥، ٢٥٠، ٥٠٠ جزء في المليون) ومستخلص الطحالب البحرية عند تركيزات (٠,٥، ١، ١,٥٪)، بالإضافة إلى معاملة الكنترول. تم الرش الورقي لجميع معاملات ثلاث مرات: بداية دورة نمو الربيع (الأسبوع الأول من مارس) ، الإزهار الكامل (الأسبوع الأول من أبريل) وبعد عقد الثمار مباشرة (الأسبوع الثالث من مايو). أظهرت النتائج أن جميع المعاملات عند التركيزات العالية تفوقت بدرجة ملحوظة على استخدام التركيزات المتوسطة والقليلة لكل منهم. حيث أكدت الدراسة أن الرش الورقي بالفينيل ألانين بمعدل ٤٠٠ جزء في المليون، والبوتريسين عند ٥٠٠ جزء في المليون ومستخلص الطحالب البحرية بنسبة ١,٥٪ سجلت أفضل النتائج من حيث الحصول على أفضل صفات للنمو الخضري، وزيادة المحتوى المعدني للأوراق، وتحقيق أعلى محصول بمكوناته وتحسين الصفات الطبيعية الكيميائية لثمار أشجار المانجو صنف الكيت.

الكلمات الدالة: اليوسفي البلدي، مانجو، صنف الكيت، الفينيل ألانين ، البوتريسين، مستخلص الطحالب البحرية، صفات النمو الخضرى، المحصول، الثمار.