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Effect of Foliar Sprays by GA_3, NAA and Algae Extract on Vegetative Growth, Yield, Fruit Quality and Fruit Retention Percentage of Mango cv. Hindi under Newly Reclaimed Soils conditions

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ABSTRACT

The experiment was carried out at during 2015 and 2016 seasons at private farm located at El-Tahady road beside the desert road of Alexandria – Cairo, Egypt on 12 years old mango tree cv. "Hindi" to assess the effect of foliar sprays by GA_3 at (10, 20 and 40 ppm), NAA at (10, 20 and 40 ppm) and algae extract at (0.5, 1and 2 %) on vegetative growth**,** yield, fruit quality and fruit retention percentage. The treatments were as follows :- Control (water only) (T1), GA_3 at 10ppm (T2), GA_3 at 20ppm (T3), GA_3 at 40ppm (T4), NAA at 10ppm (T5), NAA at 20ppm (T6), NAA at 40ppm (T7), Algae extract at 0.5%. (T8), Algae extract at 1%. (T9) and Algae extract at 2% (T10). It was found that spraying mango trees with GA_3, NAA and algae extract by all concentrations was very effective in improving all vegetative growth parameters, fruit set, and fruit retention parameters, yield as (kg) / tree and number of fruits or weight (kg) / tree. Also, data recorded that all treatments slightly increased all fruit physical properties and enhanced total soluble solids TSS, total and reducing sugars and finally enhanced ascorbic acid in both seasons compared to control. Meanwhile, it reduced acidity percentage compared with the control treatment. The best results for all parameters were obtained by spraying mango tree with GA_3 at 40ppm (T4) which recorded the highest values in both seasons compared with control and other treatments.

Key words: GA_3, NAA, algae extract, fruit retention and mango

Introduction

Mango *(Mangifera indica*L.), belongs to Anacardiaceae family, is the world's most luscious fruit has been recognized as the 'King of fruits'. The nutritional and economic importance makes mango very popular over the world. It is fifth most widely produced fruits crop in the world after banana, citrus, grape and apple (Anonymous, 2012). Total mango production in the world is 48090497 metric tonnes from the area of about 5602923 ha. In Egypt, mango is considered the most popular fruit and occupies the third place in acreage after citrus and grapes. Mango cultivated area reached about 230,000 fed. (Ministry of Agriculture and Land Reclamation Statistics, Egypt. 2015). Many problems face and affect mango productivity, i.e. poor fruit set and high fruit drop percentage at different fruit growth stages, especially in the newly reclaimed lands. Such trees grow under sandy soil conditions are poorly yielded with low fruit quality due to lacking their mineral constituent (Singh and Singh, 1995). (Sanchez *et al*., 2004; Vazques and Perez, 2006; Perez-Baraza *et al*., 2008 and Vazquez–Valdivia *et al*., 2009) they found that delayed flowering of Ataulfo mango trees was observed only in GA_3 treated trees (50 and 100 ppm) compared with no delayed flowering in the control. The flower and fruit abscission is a result of fruit complex physiological phenomena which occurs in many mango cultivars at all stages of development, but is more explicit during the first 3-4 weeks after pollination and accounts for over 90% loss of set fruitlets (Bains *et al.,* 1997; Wahdan and Melouk, 2004). Flower drop and fruits are being attributed to lack of pollination and failure of fertilization, ovule abortion, embryo degeneration, hormone content, high temperatures inadequate soil moisture and low photosynthetic level (Whiley, 1986). Naturally occurring hormones play a major role in fruit growth and fruit drop of mango (Ram, 1992). An increase in auxin level corresponds with a period of rapid growth while a high level of inhibitor corresponds with a high rate of fruit drop.

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Gibberellins promote seed germination, stimulate stem elongation, leaf expansion, flowering, pollen and seed development and delay fruit ripening Rosenvasser, (2006). The foliar application of gibberellic acid(GA_3) increased weight, volume, and length of "Amrapali" mango fruits because it helps to multiply and lengthen the meristem cells Sarker and Ghosh (2005).Chattha *et al*. (1999) indicated that NAA application induced the high positive effect in reducing fruit drop. Moreover, NAA application reduced flowers drop, and gave high flowers retention and increased yield as well as improved fruit quality of mango (Hairdy *et al*., 1997 and Vejendla *et al*., 2008).The use of plant growth regulators such as NAA and GA3 reduced flower drop, gave a high flower retention and increased yield and fruit quality in mango and other fruit species such as citrus, apple and guava Iqbal, *et al* (2009). The spraying of "Keitt" mango trees at full bloom stage with 25 mg/l from GA3 or NAA significantly improved fruit set, fruit retention, the number of fruits per cluster and per plant, fruit weight and yield Nkansah,*et al* (2012). Foliar sprays of growth regulators (NAA and GA_3) could be used as one of these horticultural practices that reduce fruit drop enhance yield and fruit quality of mangoes (Anila and Radha, 2003). Furthermore, foliar spray of NAA and GA_3 enhanced yield and fruit quality as well as reduced fruit drop of mango trees (Muarya and Singh, 1981 and Nkansah *et al*., 2012).Moti-Singh *et al*., (1987) with Langra and Dashehari cvs stated that NAA or GA_3 each 5-25 ppm once sprayed at full bloom or twice at full bloom and at pea stage or thrice plus at marble stage increased fruit retention. The use of growth substances and some chemical compounds may regulate fruit set in many fruit crops. Many investigators found that spraying mango trees with NAA at different concentrations (20, 25 and 40 ppm) increased fruit set percentages and fruit retention (Oksher *et al*., 1980).The use of plant growth regulator **s**uch as NAA, GA_3 by many researchers have shown reduced flower drop, high flower retention, increased yield and fruit quality in mango and other fruit species such as citrus, apple and guava (Hairdry *et al*., 1997; El-Shewy, 1999; Iqbal *et al*., 2009).

Algae extract as a new biofertilizer containing N, P, K, Ca, Mg, and S as well as Zn, Fe, Mn, Cu, Mo, and Co, some growth regulators, polyamines and vitamins applied to improve nutritional status, vegetative growth, yield and fruit quality in different orchard as well as vineyards (Abd El-Migeed *et al*, 2004onolive seedling; Spinelli *et al*., 2009; Elham *et al*., 2010and El-Sharony, 2015 on mango trees. The mechanisms effect of algae 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 Abd El-Motty *et al*.,**(** 2010**)**.Abd El-Wahab (2007) ;Hegab *et al*. (2005) ;Adam (1999);Kulk (1995) and Osthuyes (1993)reported that algae extract have a positive effect on fruit set, yield and fruit quality of Balady orange trees. Eman, Abd El-Moniem and Abd-Allah (2008) mentioned that spraying algae extract at 50% improved yield, fruit quality of William banana plants. Also, Hassan, *et al* (2010) showed that algae extract application was very effective in promoting growth and fruiting of Balady orange trees. Abd El-motty *et al*. (2010) showed that spraying "Keitte" mango trees once at full bloom with algae at 2% alone or in combination with yeast at 0.2% improved fruit set, fruit retention, the number of fruits/ tree and yield. Besides, it also increased fruit length, fruit width, fruit weight, pulp/fruit percentage and total soluble solids and reduced fruit drop and weight of peel and seed comparing with the control. Therefore, this experiment was carried out to increase fruit set and fruit retention, productivity and improving fruit quality of mango cv. Hindi trees grown under sandy soil conditions by using GA_3 , NAA and algae extract.It grows under a wide range of climatic and soil conditions.

Materials and Methods

This study was conducted during two successive seasons (2015 and 2016) on 12 years old mango trees cv. "Hindi" planted at 5X5 m apart in sandy soil under drip irrigation system at a private farm located at El-Tahady road beside the desert road of Alexandria –Cairo, Egypt. The selected trees were uniform in growth and vigor. Fertilization program and other agricultural practices were the same for all trees. The trees were sprayed with GA_3, NAA and Algae extract treatments were as follows:-

T1.Control (Tree spray with water only).

T2. Tree spray with GA_3 at 10ppm.

T3. Tree spray with GA_3at20ppm.
T4. Tree spray with GA_3 at 40ppm.
T5. Tree spray with NAA at 10ppm.
T6. Tree spray with NAA at 20ppm.
T7. Tree spray with NAA at 40ppm.
T8. Tree spray with Algae extract at 0.5%.
T9. Tree spray with Algae extract at 1%.
T10. Tree spray with Algae extract at 2%.

All trees were sprayed four times i.e. Half November, half Jun., full bloom and one month later. Triton B at 0.1 % as a wetting agent was added to all treatments .Algae extract formulation: Algae extract (oligo-x) obtained from Agas (Arabian group for agricultural service) company having the following composition: (3% oligosaccharide), 5% algnic acid, 0.003% phytin and 0.001% menthol with natural growth regulators (0.001% cytokinine, 0.0002% indol acetic acid and 0.02% pepsin and minerals (12%potassium oxide, 0.5% phosphorus oxide, 1%N, 0.3% Zn, 0.2% Fe and 0.1% Mn).

The following parameters were measured for both seasons:

- Date of first panicle emergence.
- Date of full bloom.
- Fruit set % was calculated as follows: $= \frac{\text{Number of fruit set}}{\text{Total number of perfect flowers}} \times 100$
- Fruit drop% $= \frac{\text{Total no.of fruit set} - \text{Total no. of fruits at harvest}}{\text{Total no. of fruit set}} \times 100$
- At the beginning of the first growth cycle, ten shoots per tree were tagged. Shoot length (cm), number of leaves per shoot and leaf area (cm^2) were measured according to Ahmed and Morsy (1999) and total chlorophyll contents was determined using Minolta chlorophyll meter SPAD- 502 was estimated.
- Fruit retention / panicle recorded at mature stage (a week before harvest) in both seasons.
- Number of fruits per tree was recorded at harvest time (first week of August) for all treatments in both seasons.
- Yield (kg/tree): The total yield per tree was recorded in kilogram at harvest time.
-Fruit number per tree was counted and recorded.
- Yield / feddan (ton) was estimated.
- Fruit quality: a sample of 10 ripe fruits of each tree was taken at the harvest time to be used for determining the physical and chemical properties i.e. fruit weight (g),, fruit length (cm), fruit diameters (cm), pulp fruit weight, peel fruit weight (g), seed weight (g). The total soluble solids percentage (TSS %) was determined by using a hand refractometer and the acidity % as citric acid content using fresh juice with titration against 0.1Na OH. The total sugars %, reducing sugars %, non-reducing sugars% and ascorbic acid were determined according to A.O.A.C (2000).

- Experimental design and Statistical analysis:

Complete randomized blocks design was used for treatments arrangement. Each treatment was replicated three times with two trees for each replicate. All the obtained data were tabulated and statistically analyzed according to (Snedecor and Cochran 1980). Treatment means were compared according to Duncan,s multiple 1955, range test at 0.5 level of probability.

Results

1- Effect of date of panicle emergence and date of full bloom:

As shown in Table (1) cleared that, GA_3, NAA and algae extract with all concentrations delayed panicle emergence and full bloom compared with the control (sprayed with water only).

Additional, the higher values of delaying bloom were found with (T4) GA_3at 40 ppm concentration which was more effective than the lower concentration and control treatments in both seasons. In this concern, the delay in panicle emergence and full bloom goes in the benefit of mango production under Egyptian condition. Delays panicle emergence and flowering occur under warmer weather conditions which improve the activity of the pollinating insects, consequently pollination and fruit set. Furthermore, panicle emergence and flowering (on the control) may enhance the probability of fungal disease infection (powdery mildew & flower blight) under conditions of cool and humid weather. Moreover, pollination and fruit set are usually inferior under such weather conditions. This results, delay in panicles emergence and full bloom by GA_3 or NAA were in agreement with (Sanchez *et al*., 2004; Vazques and Perez, 2006; Perez-Baraza *et al*., 2008 and Vazquez–Valdivia *et al*., 2009) they found that delayed flowering of Ataulfo mango trees was observed only in GA3 treated trees (50 and 100 ppm) compared with no delayed flowering in the control.

Table 1: Date of first panicle emergence and date of full bloom as affected by foliar spray treatments withGA_3, NAA and algae extract of mango trees cv. "Hindi" during 2015 and 2016 seasons.

Treatments	Date of first panicle emergence		Date of full bloom	
	2015	2016	2015	2016
T1. Control (water only).	18/2	17/2	19/3	18/3
T2. GA_3 at 10ppm.	5/3	9/3	6/4	8/4
T3. GA_3 at 20ppm.	7/3	11/3	8/4	11/4
T4. GA_3 at 40ppm.	9/3	15/3	10/4	15/4
T5. NAA at 10ppm.	5/3	9/3	2/4	7/4
T6. NAA at 20ppm.	6/3	11/3	4/4	9/4
T7. NAA at 40ppm.	6/3	13/3	5/4	10/4
T8. Algae extract at 0.5%.	26/2	26/2	29/3	1/4
T9. Algae extract at 1%.	1/3	1/3	29/3	5/4
T10. Algae extract at 2%.	2/3	3/3	1/4	5/4

2- Fruit set, drop and retention %:

Fruit set%:

Data in Table, (2) showed that all spraying treatments i.e.GA_3 at (10,20 and 40ppm), NAA at (10,20 and 40ppm) and Algae extract at (0.5,1 and 2%)each alone significantly increased fruit set compared to(T1)untreated trees(control) which gave the lowest fruit set in the two studied seasons(13.12 and 15.94), respectively. Data also showed that all GA_3 concentration surpassed NAA and Algae extract and recorded the best results of fruit set followed by NAA treatments trees in both seasons. In this respect, the higher value of mango trees cv. "Hindi" fruit set (22.91 and 23.78%) was proved with (T4) 40ppm GA_3, respectively, compared with control and other treatments.

Fruit drop %:

Table, (2) revealed that all spraying treatments GA_3, NAA and algae extract at all concentrations caused a reducing fruit drop percentage of mango trees cv. "Hindi" and gave significantly lower values compared with control in the two seasons2015 and 2016. On the other hand, untreated treatments trees gave the highest fruit drop percentage in the two seasons (59.05 and 60.86), respectively. Furthermore, spraying GA_3at 40 ppm (T4) gave the lowest value of fruit drop (33.38 and 34.11), respectively in both studied seasons compared to control and other treatments.

Fruit retention%:

As shown in Table, (2) the obtained results indicated that control trees exhibited the lowest fruit retention %(1.98 and2.05), respectively in the two studied seasons. On the contrary, trees treated

with GA3 at 40ppm (T4) gave the higher number of fruit retention at mature stage in both seasons (6.86 and 6.47), respectively followed by NAA treatments at all concentrations compared with control and other treatments. In addition, foliar application of algae extract in the two seasons had also a beneficial effect in this concern as compared with the control. Finally, from data recorded in Table, (2) GA3 and NAA treatments surpassed all algae extract treatments and gave a positive effect on increasing fruit set and fruit retention and decreasing fruit drop percentage in both studied seasons.

Table 2: Effect of foliar sprays by GA_3, NAA and algae extract on fruit set, drop and retention% of mango trees cv. "Hindi" during 2015 and 2016 seasons.

Treatments	Fruit set (%)		Fruit drop (%)		Fruit retention (%)	
	2015	2016	2015	2016	2015	2016
T1. Control (water only).	13.12	15.94	59.05	60.86	1.98	2.05
T2. GA_3 at 10ppm.	20.16	21.51	33.68	34.57	5.77	5.61
T3. GA_3 at 20ppm.	21.24	21.61	33.71	34.81	5.65	5.92
T4. GA_3 at 40ppm.	22.91	23.78	33.38	34.11	6.86	6.47
T5. NAA at 10ppm.	20.37	21.08	35.73	38.99	5.29	5.13
T6. NAA at 20ppm.	20.30	21.59	36.01	39.24	5.34	5.64
T7. NAA at 40ppm.	20.30	21.98	36.05	39.12	5.45	5.60
T8. Algae extract at 0.5%.	19.43	19.33	39.47	39.98	4.58	5.61
T9. Algae extract at 1%.	19.29	19.37	39.68	40.67	4.56	4.96
T10. Algae extract at 2%.	19.30	19.72	39.33	40.09	4.79	5.07
LSD at 0.5%	0.545	1.527	0.869	1.024	0.349	0.412

The enhanced effect of GA_3 and NAA treatment on fruit set, fruit drop, and fruit retention may be due to the role of GA3 through multiplying and to lengthily the meristem cells, which induced a positive effect on reducing fruit drop and increase fruit set and fruit retention. The obtained results of $GA_3$and NAA regarding its positive effect on fruit set, fruit retention are in harmony with the findings by Nkansah, *et al* 2012; Iqbal, *et al* 2009; Anila and Radha, 2003 and Oksher *et al*., 1980 on mango trees.

From the above results, it could be concluded that the presence of minerals and some growth regulators in algae extract may have a positive effect on increasing fruit set, fruit retention and decreasing fruit drop. This may be due to the improving effect of such treatments on the nutritional status of the trees, which reflected on increasing fruit set and fruit retention. In this respect, Hegab *et al*. (2005); Adam (1999) and Kulk (1995) reported that the improvement of fruit set percentage could be explained as a result to increase pollen grains germination. The previous results are agreed with those obtained by Abd El-Wahab (2007) and Osthuyes (1993) who reported that spraying mango trees with algae and yeast extracts increased fruit set, fruit retention and reduced fruit drop and finally, Abd El-motty *et al*. (2010) showed that spraying "Keitte" mango trees once at full bloom with algae at 2% alone or in combination with yeast at 0.2% improved fruit set, fruit retention, number of fruits/ tree and yield. Besides, it also reduced fruit drop compared with the control.

3-Vegetative growth:

All GA_3,NAA and Algae extract treatments significantly increased the shoot length compared with control, Table (3), The highest values (45.84 and 45.78 cm), respectively were obtained from foliar application algae extract at 2% (T10), while the control gave the lowest values (30.65 and 29.72), respectively in the first and second seasons. From the same table data stated that all concentrations of GA_3, NAA and algae extract treatments had significant effects on the number of leaves per shoot of mango trees in 2015 and 2016 seasons compared to control. The highest values reached (30.46 and 30.96), respectively leaves per shoot with algae extract at (T10) 2% compared with control (22.83 and 21.85) and other treatments in the first and second seasons, respectively. Results in Table (3), cleared that leaf area significantly increased by using GA_3, NAA and algae extract treatments compared with control in mango trees cv. "Hindi". Also, algae extract at (T10) 2% when sprayed alone on mango trees gave the highest values (5.70 and 5.91cm^2) compared with control (3.53 and 3.69 cm^2) in the first and second seasons, respectively. Regarding, data from same

table (3) showed that all spraying treatments with all concentrations i.e.GA_3 at (10,20 and 40ppm), NAA at (10,20 and 40ppm) and Algae extract at (0.5,1 and 2%) significantly increased total chlorophyll compared to (T1)untreated trees which gave the lowest total chlorophyll in the two studied seasons (38.95 and 39.26), respectively. On the other hand, the highest values of total chlorophyll in both studied seasons were obtained when mango trees were sprayed with algae extract at 2% (45.31 and 44.41), respectively. Finally, from data recorded in Table (2) cleared that, algae extract treatments surpassed all GA3, NAA and control treatments and gave a positive effect on increasing vegetative growth parameters of mango trees in both studied seasons 2015 and 2016.The mechanisms effect of algae 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. The obtained results may confirm the previous work done by (Abd El-Migeed *et al*, 2004 on olive seedling; Hegab *et al*., 2005 on Balady orange trees; Eman, Abd El-Moniem and Abd-Allah., 2008 on Williama banana; Abd El-Motty *et al*., 2010 and El-Sharony, 2015 on mango trees cv. "Keitte" and Fagri Kalan.

GA_3 applications increase positively shoots length, number of leaves and leaf area. Treatments of GA_3 at 20 or 40 ppm on mango trees cv. Sukkary Abiad under Egyptians conditions increased significantly shoot length, the number of leaves per shoot and leaf area Wahdan *et al*., 2011.

Table 3: Effect of foliar sprays by GA_3, NAA and algae extract on vegetative growth of mango trees cv. "Hindi" during 2015 and 2016 seasons.

Treatments	Shoot length (cm)		no.of leaves/ shoot		Leaf area (cm^2)		Total chlorophyll	
	2015	2016	2015	2016	2015	2016	2015	2016
T1. Control (water only).	30.65	29.72	22.83	21.85	3.53	3.69	38.95	39.26
T2. GA_3 at 10ppm.	37.00	38.88	26.24	27.58	4.11	4.41	39.51	40.94
T3. GA_3 at 20ppm.	38.49	39.58	26.98	26.75	4.00	4.47	40.08	41.96
T4. GA_3 at 40ppm.	39.95	43.07	28.37	28.80	4.01	4.52	39.89	43.21
T5. NAA at 10ppm.	37.53	39.97	28.55	25.72	4.80	4.57	40.47	41.36
T6. NAA at 20ppm.	38.79	40.39	27.94	26.25	4.51	4.60	42.97	42.04
T7. NAA at 40ppm.	40.42	42.26	28.92	26.61	4.55	4.93	42.24	43.17
T8.Algae extract at 0.5%.	42.90	43.44	30.12	27.13	5.56	5.60	44.46	44.35
T9. Algae extract at 1%.	44.82	44.70	30.22	30.03	5.59	5.81	45.31	44.41
T10. Algae extract at 2%.	45.84	45.78	30.46	30.96	5.70	5.91	45.85	45.24
LSD at 0.5%	2.081	1.763	0.636	1.949	0.384	0.274	0.890	1.197

4-Fruit yield:

Fruit weight (gm):

The results presented in Table (4) recorded the effect of spraying mango tree with various treatments on fruit weight. It is clear that fruit weight was significantly increased by all foliar application treatments at all concentrations compared with the control. The untreated trees (T1) had recorded (128.37 and 128.86) fruit weight in the first and second seasons, respectively. On the other hand, spraying trees with (T4) GA_3 at40ppm reached the maximum number of mango fruit weight in both seasons (241.57and 243.39), respectively. Meanwhile, all GA_3 and NAA treatments gave the best and intermediate values of mango fruit weight compared with algae extract treatments at all concentration in two seasons 2015 and 2016.

Number of fruits/ tree:

Data in table (4) showed that number of fruits per tree was significantly increased by all treatments ofGA_3, NAA and algae extract at all concentrations compared to the control. The control trees (T1) had recorded (170.78and 170.48) number of fruits per tree in both studied seasons, respectively. Furthermore, spraying trees with GA_3 at 40ppm (T4) recorded the maximum number of mango fruit per tree in both seasons (231.36 and 235.60), respectively.

Yield as (Kg)/ tree and yield as (ton)/feddan:

It could be noticed from Table (4) that all treatments significantly increased yield (kg)per tree and yield as (ton)/feddan than the control in both seasons. Also, spraying trees with (T4) GA_3 at 40 ppm produced the highest yield (kg) per tree and yield as (ton)/feddan (45.81and 44.29kg/tree) and (7.69 and 7.44 ton/feddan) in the first and second seasons, respectively. On the other hand, the control trees exhibited the lowest yield weight (28.34and 28.47kg/tree) and (4.76 and 4.78) in the first and second seasons, respectively. Finally, all GA_3 and NAA treatments gave better values of mango yield weight (kg) per tree and yield as (ton)/feddan compared with algae extract treatments at all concentration in two seasons 2015 and 2016.

Table 4: Effect of foliar sprays by GA_3, NAA and algae extract on fruit yield of mango trees cv. "Hindi" during 2015 and 2016 seasons.

Treatments	Fruit weight (g)		No. of fruit/ tree		Yield/tree (kg)		Yield/feddan (ton)	
	2015	2016	2015	2016	2015	2016	2015	2016
T1. Control (water only).	128.37	128.86	170.78	170.48	28.34	28.47	4.76	4.78
T2. GA_3 at 10ppm.	226.56	228.34	224.02	228.19	41.45	40.92	6.96	6.87
T3. GA_3 at 20ppm.	231.98	235.22	229.39	231.42	44.21	41.80	7.42	7.02
T4. GA_3 at 40ppm.	241.57	243.39	231.36	235.60	45.81	44.29	7.69	7.44
T5. NAA at 10ppm.	215.19	220.85	227.09	224.86	41.95	40.43	7.04	6.79
T6. NAA at 20ppm.	223.12	220.82	226.06	226.65	41.73	40.85	6.91	6.92
T7. NAA at 40ppm.	226.30	229.85	225.22	227.20	42.33	41.43	7.09	6.96
T8. Algae extract at0.5%.	205.60	213.91	195.72	208.52	39.69	39.13	6.67	6.57
T9. Algae extract at 1%.	210.58	212.29	199.48	215.05	39.46	38.19	6.62	6.41
T10. Algae extract at 2%.	211.35	215.38	200.12	217.06	39.81	38.78	6.68	6.51
LSD at 0.5%	4.702	4.098	7.268	6.569	0.935	1.311	0.169	0.209

From the previous results, it is clear that yield as (kg/ tree) was increased and reached the maximum by spraying trees with GA_3 treatments followed in descending order by NAA and algae extract treatments .The obtained results of GA_3 regarding its positive effect on fruit set, fruit retention, the number of fruit per tree and yield are in harmony with the findings of Muarya and Singh (1981) who reported that foliar spray of GA_3 and NAA enhanced yield and reduced fruit drop of mango trees. Moreover, foliar spray of growth regulators GA_3 enhanced yield of mangoes (Anila and Radha, 2003). Furthermore, Sarkar and Ghosh (2005) indicated that the GA_3sprays increased the yield of mango fruits. On the other hand, enhancing fruit yield due to the fact that the mechanisms effect of algae 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 the obtained results may confirm the previous work done by Abd El-Migeed *et al*, 2004 on olive seedling ;Spinelli*et al*., 2009; Elham *et al*., 2010 and El-Sharony, 2015 on mango trees and finally, Abd El-motty *et al*. (2010) showed that spraying "Keitte" mango trees once at full bloom with algae at 2% alone or in combination with yeast at 0.2% improved fruit set, fruit retention, number of fruits/ tree and yield. Besides, it also increased fruit length, fruit width, fruit weight, pulp/fruit percentage and total soluble solids and reduced fruit drop and weight of peel and seed comparing with the control.

5- Fruit quality:

a) - Physical properties:

Results in Table (5) cleared that GA_3, NAA and algae extract treatments significantly increased fruit length (cm), fruit width (cm), pulp weight (g), peel weight (g) and seed weight (g) than the control in the both seasons. In this respect, the highest value for fruit physical properties parameters was recorded from trees sprayed with GA_3 at 40 ppm (T4) in both studied seasons compared with control and other treatments. However the control trees (T1) exhibited the lowest fruit length (8.86 and8.91cm), fruit width (6.66 and6.43cm), pulp weight (80.58 and80.72gm), peel weight (27.88

and28.09gm) and seed weight (19.91 and19.98gm) compared with GA_3, NAA and algae extract at all concentration in the first and second seasons, respectively. Furthermore, from the previous results in Table (5), it is clear that fruit physical properties was increased and reached the maximum by spraying trees with GA_3 treatments followed by NAA treatments followed in descending order by spraying algae extract.

Table 5: Effect of foliar sprays by GA_3, NAA and algae extract on fruit physical properties of mango trees cv. "Hindi" during 2015 and 2016 seasons.

Treatments	Fruit length (cm)		Fruit width (cm)		Pulp weight (g)		Peel weight (g)		Seed weight (g)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
T1.Control (water only).	8.86	8.91	6.66	6.43	80.58	80.72	27.88	28.09	19.91	19.98
T2.GA_3 at 10ppm.	10.64	11.24	8.62	7.86	156.52	156.93	41.93	38.20	28.11	28.29
T3.GA_3 at 20ppm.	11.03	11.32	8.71	7.81	161.56	164.99	42.11	39.78	28.31	28.26
T4.GA_3 at 40ppm.	11.64	11.93	8.97	8.74	165.16	167.83	45.56	43.89	30.58	31.12
T5.NAAat 10ppm.	10.28	11.01	8.23	7.64	149.52	150.97	40.97	39.77	23.74	27.05
T6.NAA at 20ppm.	10.45	11.05	8.25	7.84	153.83	153.83	41.44	40.31	25.14	27.80
T7.NAA at 40ppm.	11.19	11.21	8.40	8.07	155.70	158.71	42.93	42.16	26.01	28.69
T8.Algae extract at 0.5%.	10.53	10.64	8.23	7.85	141.12	147.33	40.49	39.80	23.42	27.08
T9.Algae extract at 1%.	10.61	10.92	8.25	7.89	145.84	147.02	40.94	40.49	23.76	27.05
T10.Algae extract at 2%.	11.05	10.99	8.32	8.02	146.18	148.11	41.76	40.96	24.27	27.50
LSD at 0.5%	0.272	0.212	0.206	0.248	2.268	2.050	0.732	1.515	0.952	0.603

b) - Chemical properties:

Results presented in Table (6 and 7) indicated that total soluble solids percentage TSS in mango cv. "Hindi" fruits were significantly increased by different treatments compared with the control in the two seasons. However, TSS tended to increase gradually through increasing the concentration of GA_3, NAA and algae extract. In this respect, GA_3 at 40ppm (T4) gave the higher values (19.89 and 20.40%) and compared with control (16.71 and 17.08%) and other treatments in the two seasons, respectively.

Table 6: Effect of foliar sprays by GA_3, NAA and algae extract on fruit chemical properties of mango trees cv. "Hindi" during 2015 and 2016 seasons.

Treatments	TSS (%)		Acidity (%)		Total Sugars	
	2015	2016	2015	2016	2015	2016
T1. Control (water only).	16.71	17.08	0.58	0.56	11.11	10.93
T2. GA_3 at 10ppm.	18.66	19.35	0.43	0.43	13.41	12.64
T3. GA_3 at 20ppm.	19.28	19.52	0.43	0.42	13.41	12.87
T4. GA_3at 40ppm.	19.89	20.40	0.43	0.42	14.37	13.26
T5. NAA at 10ppm.	18.14	18.92	0.43	0.42	13.07	12.77
T6. NAA at 20ppm.	18.43	19.03	0.39	0.38	13.08	12.61
T7. NAA at 40ppm.	18.88	19.29	0.39	0.36	13.43	12.81
T8. Algae extract at 0.5%.	18.18	18.17	0.38	0.36	13.10	12.08
T9. Algae extract at 1%.	18.36	18.34	0.36	0.32	13.17	11.98
T10. Algae extract at 2%.	18.63	18.22	0.32	0.32	13.24	12.15
LSD at 0.5%	0.4137	0.698	0.0347	0.030	0.3351	0.700

Concerning fruit total acidity it's obvious that, spraying mango trees with GA_3, NAA and algae extract reduced the fruit content of total acidity% in both seasons in comparison with control treatment. While, the (T1) control in the first season and second one recorded the highest values (0.58and0.56%), respectively. Concerning the total and reducing sugars% as shown in Table (6 and 7) the obtained results indicated that untreated trees exhibited the lowest total sugars (11.11and 10.93%), non-reducing (7.38 and 7.06 %) and reducing sugars(3.73 and 3.86 %), respectively in the two studied seasons. On the other hand, trees treated with GA_3 at 40ppm superiority and gave the higher percentages of mango total sugars (14.37 and 13.26 %), non-reducing sugars (9.63 and 9.15 %)

meanwhile, reducing sugars was given the same trend in both seasons, respectively. As concerns of ascorbic acid (mg/100ml juice), data presented in the same table reveal that in both seasons the highest values were obtained in the fruits harvested from trees sprayed with $GA_3$40 ppm (48.23 and 47.67 mg/100ml juice).

The obtained results of GA_3 and NAA regarding its enhancing effect on fruit quality are in harmony with the findings of Nkansah, *et al* (2012); Iqbal, *et al* (2009); Vejendla *et al*., 2008); Sarker and Ghosh (2005) and Anila and Radha, 2003) all of them mentioned that NAA spraying on mango trees increased SSC, SSC/acid ratio, sugars and decreased both acidity and vitamin C..

The obtained results of algae extract regarding its positive effect fruit quality are in harmony with the findings of Eman, Abd El-Moniem and Abd-Allah (2008);Abd El-Wahab (2007);Hegab *et al*. (2005);Sarkar and Ghosh (2005);Adam (1999);Kulk (1995) and Osthuyes (1993.

Table 7: Effect of foliar sprays by GA_3, NAA and algae extract on fruit chemical properties of mango trees cv. "Hindi" during 2015 and 2016 seasons.

Treatments	Reducing sugar (%)		Non-reducing sugar (%)		Ascorbic acid (mg/100 ml juice)	
	2015	2016	2015	2016	2015	2016
T1. Control (water only).	7.38	7.06	3.73	3.86	37.65	35.98
T2. GA_3 at 10ppm.	8.64	8.49	4.77	4.15	44.84	43.23
T3. GA_3 at 20ppm.	8.70	8.79	4.70	4.08	45.75	44.88
T4. GA_3 at 40ppm.	9.63	9.15	4.75	4.12	48.23	47.67
T5. NAA at 10ppm.	8.27	8.09	4.80	4.68	43.79	43.20
T6. NAA at 20ppm.	8.33	8.44	4.75	4.17	44.28	43.36
T7. NAA at 40ppm.	8.72	8.80	4.71	4.01	45.10	44.82
T8. Algae extract at 0. 05%.	8.45	8.08	4.65	4.23	42.02	40.99
T9. Algae extract at 1%.	8.36	8.14	4.81	3.84	42.67	41.26
T10. Algae extract at 2%.	8.46	8.38	4.77	3.77	43.64	41.42
LSD at 0.5%	0.2724	0.458	0.3411	0.842	1.094	1.567

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