

The Synergistic Effects of Using Plant Extracts and Salicylic Acid on Yield and Fruit Quality of Keitte Mango Trees

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Abstract: During 2012 and 2013 seasons, Keitte mango trees subjected to foliar application of some plant extracts namely oils of onion and garlic and extracts of green tea and turmeric each at 0.1% and / or salicylic acid at 100 ppm. The study focused on the impact of plant extract and salicylic acid treatments on growth, percentages of healthy and malformed inflorescences, length and six ratio of these inflorescences , plant pigments, N, P, and K in the leaves, fruit setting %, yield and fruit quality. Single and combined applications of onion and garlic oils as well as extracts of green tea and turmeric each at 0.1% and/ or salicylic acid at 100 ppm was very effective in stimulating growth , healthy inflorescences % , plant pigments , nutrients, fruit setting%, yield and fruit quality relatively to the control treatment. Using all plant extracts was favourable than using salicylic acid in this respect. Application of onion oil, garlic oil, green tea extract and turmeric extract, in ascending order had an announced effect on fruiting of the trees. Using each plant extract plus salicylic acid was superior than using each alone in this respect. The best results with regard to yield and fruit quality of Keitte mango trees were obtained due to spraying the trees three times with turmeric extract at 0.1% plus salicylic acid at 100 ppm.

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1. Introduction

Yield decline is suggested to be a major problem that faces Keitte mango trees growers in middle Egypt conditions. The great reduction of panicles and the highest dropping of fruits and flowers due to the unsuitable environmental conditions are considered the main reasons for yield decline. Recently, public health and environmental safety encouraged the use of plant extract as a complete replacement of chemicals for improving the production of fruit crops. Turmeric contains 2 to 9% curcuminoids which contains 60% curcumin desmethoxy curcumin, bisdemethoxy curcumin; dihydrocurcumin and cyclocurmin, vanillin, carbohydrates, arabinoyalacton, essential oils and plant pigments (Srimal 1997 and Ammon and Wehle, 1999). Green tea extract contains different tannins, vitamins, antioxidants and minerals. The higher own contents of onion and garlic oils from volatile compounds and sulphur compounds put both in the top for their essential roles on fruiting of fruit crops (Bruneton, 2001; Parakash and Majeed , 2003 and Pons, 2003). All plants extracts had an obvious effect on controlling various disorders (Srivastava and Lal, 1997). Trials were made for detecting compound that is responsible for reducing abiotic stress. Out of those compound salicylic acid is very essential for enhancing cell division, flowering, fruit setting, uptake of nutrients, resistance of the trees

to attack by fungus, photosynthesis and plant pigments (Raskin, 1992; Lee *et al.*, 1995; Shah, 2003; Harvath *et al.*, 2007; Hayat and Ahmed, 2007 and Szepesi *et al.*, 2009).

Plant extracts were found by many authors to enhance growth, nutritional status, yield and fruit quality of fruit crops (Obagwu *et al.*, 1997; Paik and Chung, 1997; Purohit, 2000; Okigbo and Emoghene, 2003, Chawdhury *et al.*, 2007; Bhdwaj, *et al.*, 2010; Abd El- Rahman and El- Masry, 2012; Ahmed *et al.*, 2013b and Mohamed and Mohamed, 2013).

The results of Srivastava and Dwivedi (2000); Zgang *et al.*, (2003) ; Imran *et al.*, (2007); Josph *et al.*, (2010); Ahmed (2011); Saied (2011) ; Shaaban *et al.*, (2011); Masoud and El- Sehrawy (2012); Al-Wasfy (2012) and Ahmed *et al.*, (2013) confirmed the beneficial effects of using salicylic acid on growth and fruiting of fruit crops.

The merit of this study was examining the effect of spraying plant extracts and/ or salicylic acid on fruiting of Keitte mango trees.

2. Material and Methods

This study was carried out during 2012 and 2013 seasons on uniform in vigour thirty, 8- years old Keitte mango trees onto seedling rootstocks. The trees are grown in a private orchard located at West

Samalout Samalout district, Minia Governorate. The selected trees are planted at 5 x 5 meters apart. Drip irrigation system was followed (Four drippers/ tree and each drip drain 4 L water / hour). The texture of the soil is sandy with a water table depth not less than two meters. The selected trees were kept under the normal horticultural practices except for the treatment of this study.

This study included the following ten plant extract and salicylic acid treatments.

- 1- Untreated trees(water sprayed trees).
- 2- Spraying onion oil at 0.1%.
- 3- Spraying garlic oil at 0.1%
- 4- Spraying green tea extract at 0.1%.
- 5- Spraying turmeric extract at 0.1%
- 6- Spraying salicylic acid (SA) at 100 ppm
- 7- Spraying onion oil at 0.1 % + SA at 100%
- 8- Spraying garlic oil at 0.1 % + SA at 100%
- 9- Spraying green tea extract at 0.1 % + SA at 100 %
- 10- Spraying turmeric extract at 0.1 % + SA at 100 g.

Each treatment was replicated three times, one tree per each. Plant extracts and salicylic acid were sprayed three times at growth start (1st week of Mar.) ; just after fruit setting (2nd week of April) and at one month later (2nd week of May) . Solutions of salicylic acid were adjusted to pH 6.0 by using NaOH followed by solubilized in few drops of ethyl alcohol. Triton B as a wetting agent was used at 0.05%. Statistical analysis was done using randomized complete block design (RCBD) with three replicates.

During both seasons, the following parameters were measured:

- 1- Vegetative growth characters namely shoot length (cm), number of leaves/ shoot and leaf area (cm²)(Ahmed and Morsy, 1999) in the spring growth cycle.
- 2- Percentages, length (cm.) and sex ratio of malformed and healthy inflorescences.
- 3- Plant pigments namely chlorophylls a & b, total chlorophylls and total carotenoids (mg/ 100 g F.W.) (Von- Wettstein, 1957).
- 4- Percentages of N, P and K in the leaves from non fruiting shoots of spring growth cycle (Summer, 1985) (Chapman and Pratt, 1965 and Wilde *et al.*, 1985).
- 5- Percentages of initial fruit setting and fruit retention.
- 6- Yield / tree expressed in number of fruits/ tree and weight (kg.)
- 7- Physical and chemical characteristics of the fruits namely fruit weight (g.); length and width (cm.)

of fruit; fruit peels%, seeds %, pulp %; fruit firmness (lb/ inch²) by using pressure tester, T.S.S. %, total acidity (as g citric acid/ 100 ml juice); T.S.S. /acid and total, reducing and non – reducing sugars %, vitamin C content (mg/ 100 ml juice) , and total fibre % (A.O.A.C, 2000).

The proper statistical analysis was done and the treatment means were compared using new L.S.D. at 5 % (Mead *et al.*, 1993).

3. Results and Discussion

1-Vegetative growth characters:

Data in Table (1) clearly show that single and combined applications of plant extracts (onion, garlic, green tea and turmeric) at 0.1% and salicylic acid (SA) at 100 ppm significantly stimulated shoot length, number of leaves/ shoot leaf area in the spring growth cycle rather than untreated trees. The promotion was significantly associated with using oils of onion and garlic and extracts of green tea and turmeric, in ascending order. Using plant extracts was significantly superior than using SA. Using plant extracts plus SA significantly surpassed the application of each alone in this respect. Using turmeric extract at 0.1% plus SA at 100 ppm gave the maximum values of shoot length (52.9 & 53.2 cm), number of leaves / shoot (49.0 & 49.4 leaves) and leaf area (88 & 90 cm²) during both seasons , respectively. The minimum values were recorded on untreated trees. These results were true during both seasons.

2-Percentages and length of healthy and malformed inflorescences.

It is evident from the data in Table (1) that using the four plant extracts namely onion, garlic, green tea and turmeric each at 0.1% and/ or SA at 100 ppm significantly was responsible for improving percentages and length of healthy inflorescences as well as the length of malformed ones over the check treatment. The present treatments significantly declined the percentage of malformed inflorescences than the check treatment. Significant differences were observed among all plant extract and SA treatments. Using plant extracts was significantly favourable than using SA in this respect. The best plant extracts in this connection was turmeric extract, green tea, garlic and onion, in descending order. Combined application of plant extracts plus SA was better than using each alone in promoting percentage and length of healthy inflorescences and length of malformed ones and reducing percentage of malformed inflorescences. Spraying turmeric extract in combined with SA gave the maximum values of healthy inflorescences (96.1 & 96.9 %) and lowest values of malformed ones (3.9 &

3.1 %) during both seasons, respectively. Similar trend was noticed during 2012 and 2013 seasons.

3- Sex ratio in the healthy and malformed inflorescences:

Sex ratio in both healthy and malformed inflorescences were significantly reduced in response to foliar application of the four plant extracts and/ or SA over the control treatment. The reduction was associated significantly with using onion, garlic, green tea and turmeric extracts, in ascending order. Using plant extracts was preferable than using SA in reducing sex ratio in both healthy and malformed inflorescences. The lowest values were recorded on sex ratio of healthy inflorescences (1.32 and 1.28) and malformed inflorescences (4.60 and 4.51) when the trees were sprayed with turmeric extract at 0.1% plus SA at 100 ppm. Untreated trees produced the maximum values of sex ratio in malformed inflorescences (9.51 & 9.55%) and healthy ones (1.93 and 1.99%) . Similar results were announced during 2012 and 2013 seasons (Table1).

4- Plant pigments and percentages of N, P and K in the leaves.

Data in Tables (2 & 3) measurably reveal that single and combined applications of the four plant extracts (onion, garlic, green tea and turmeric) at 0.1 % and SA at 100 ppm significantly was accompanied with enhancing chlorophyll a & b , total chlorophylls , total carotenoids as well as percentages of N, P and K in the leaves over the check treatment. Foliar application of onion oil, garlic oil and extracts of green tea and turmeric, in ascending order was significantly very effective in enhancing these plant pigments and nutrients in the leaves. Using plant extracts was significantly preferable than using SA in this respect. Using each plant extract incorporated with SA gave the best results with regard to plant pigments and nutrients relatively to using each alone. Spraying the trees with turmeric extract at 0.1% besides SA at 100 ppm gave the maximum values. The lowest values were recorded on untreated trees. Similar results were announced during 2012 and 2013 seasons.

5- Fruit setting and yield:

It is clear from the data in Tables (3) that spraying Keitte mango trees three times with the four plant extracts (onion, garlic , green tea and turmeric) each at 0.1% and / or SA at 100 ppm significantly was responsible for improving the percentages of initial fruit setting, and fruit retention, as well as yield and number of fruits per tree over the check treatment. Using plant extracts was significantly preferable than using SA in this respect. The promotion on fruit

setting % and yield significantly was associated with foliar application of onion, garlic, green tea and turmeric extract, in ascending order. Using any one of the four plant extracts plus SA significantly was superior than using plant extracts or SA each alone. Spraying turmeric extract + SA gave the best results with regard to fruit setting % and yield. The untreated trees produced the minimum values. The promised treatment (turmeric + SA) produced yield reached 39.1 and 40.0 kg during 2012 and 2013 seasons, respectively. The yield produced by the untreated trees reached 24.2 and 24.8 kg during both seasons, respectively. The percentage of increase on the yield due to application of the recommended treatment reached 61.6 and 61.3% over the check treatment during 2012 and 2013 seasons, respectively. These results were true during both seasons.

6- Fruit quality:

It is clear from the data in Tables (3 to 5) that spraying Keitte mango trees three times with the four plant extracts each at 0.1% and / or SA at 100 ppm caused a significant promotion on fruit quality in terms of increasing weight, length and width of fruit , pulp %, fruit firmness, T.S.S. % , T.S.S. / acid, total and reducing sugars % and vitamin C content and decreasing percentages of seeds and peels, total acidity % and total fibre % over the check treatment. The present treatments had no significant effect on the percentage of non – reducing sugars during both seasons. Using plant extracts significantly was accompanied with improving fruit quality when compared with using SA. In ascending order, using onion oil, garlic oil, green tea extract and turmeric extract effectively enhanced fruit quality. Combined applications of plant extracts and SA significantly were preferable than using each group alone in improving fruit quality. Significant differences on all quality parameters were observed among the ten plant extract and SA treatments. The best results were obtained due to spraying Keitte mango trees three times with turmeric extract at 0.1% besides SA at 100 ppm. Untreated trees produced unfavourable effects on fruit quality. These results were true during both seasons.

4. Discussion

The outstanding effect of plant extracts on growth, nutritional status of the trees, yield and fruit quality might be attributed to the higher own contents of plant pigments from tannins, carbohydrates, oils, volatile compounds, sulphur compounds, amino acids and antioxidants (Srimal, 1997 , Pons, 2003 and Parakash and Majeed, 2003).

These results are in harmony with those obtained by Abd El- Rahman and El- Masry (2012);

Mohamed and Mohamed (2013) and Ahmed *et al.*, (2013b).

The essential roles of SA on enhancing the biosynthesis of natural hormones and carbohydrates, stimulating cell division and the tolerance of plants to all stresses namely diseases, water and salt stresses and protecting plant cells from oxidation by free

radicals could explain the present results (Raskin, 1992; Lee *et al.*, 1995 and Shah, 2003).

These results are in agreement with those obtained by Ahmed (2011), Saied (2011); Masoud and El- Sehrawy (2012); Al Wasfy (2012) and Ahmed *et al.*, (2013a).

Table (1): Effect of spraying some plant extracts and / or salicylic acid on some growth characters, percentages of healthy and malformed inflorescences and length of the same two inflorescences of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Shoot length (cm.)		Number of leaves / shoot		Leaf area (cm ²)		Malformed inflorescences %		Healthy inflorescences %		Length of healthy inflorescences (cm)		Length of malformed inflorescences (cm)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	41.0	41.3	40.0	40.4	71.0	69.9	9.6	10.1	90.4	89.9	35.1	35.9	14.1	14.2
Onion oil at 0.1%	43.4	43.8	42.1	42.5	74.7	74.3	8.7	8.1	91.3	91.9	38.1	38.5	15.1	16.0
Garlic oil at 0.1%	44.5	44.9	43.3	43.5	76.6	76.6	8.2	7.6	91.8	92.4	40.0	40.3	15.7	16.6
Green tea extract at 0.1%	45.6	46.0	44.5	44.8	77.9	78.8	7.5	6.9	92.5	93.1	41.8	42.1	16.6	17.5
Turmeric extract at 0.1%	46.7	47.0	46.0	46.3	80.0	81.9	7.1	6.5	92.9	93.5	43.4	43.8	18.0	18.9
Salicylic acid at 100 ppm (SA)	42.3	42.6	41.0	41.4	73.0	72.0	9.2	8.6	90.8	91.4	36.7	37.0	14.6	15.5
Onion oil + SA	48.0	48.4	47.0	47.4	81.9	84.3	6.6	6.0	93.4	94.0	45.0	45.5	18.5	19.4
Garlic oil + SA	49.1	49.4	48.0	48.3	84.0	86.0	6.2	5.5	93.8	94.5	46.7	47.0	18.9	19.8
Green tea + SA	50.3	50.5	48.3	48.6	86.3	87.8	5.1	4.5	94.9	94.9	48.0	48.3	19.3	20.2
Turmeric + SA	52.9	53.2	49.0	49.4	88.0	90.0	3.9	3.1	96.1	96.9	49.1	50.0	21.2	22.1
New L.S.D. at 5%	1.1	1.0	1.0	1.0	1.5	1.6	0.3	0.4	0.5	0.5	1.0	0.9	0.4	0.3

Table (2): Effect of spraying some plant extracts and / or salicylic acid on sex ratio in malformed and healthy inflorescences, plant pigments and percentage of N in the leave of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Sex ratio in malformed inflorescences		Sex ratio in healthy inflorescences		Chl. a (mg/ 100 g F.W.)		Chl. b (mg/ 100 g F.W.)		Total chlorophylls (mg/ 100 g F.W.)		Total carotenoids (mg/ 100 g F.W.)		Leaf N %	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	9.51	9.55	1.93	1.99	1.01	1.21	0.41	0.48	1.42	1.69	0.50	0.57	1.41	1.47
Onion oil at 0.1%	8.80	8.73	1.80	1.77	1.81	1.81	0.63	0.70	2.40	2.44	0.72	0.79	1.63	1.63
Garlic oil at 0.1%	8.10	8.03	1.74	1.71	2.11	2.22	0.74	0.81	2.85	3.93	0.84	0.90	1.70	1.71
Green tea extract at 0.1%	7.11	7.04	1.67	1.64	2.41	2.51	0.85	0.92	3.26	3.43	0.95	1.01	1.75	1.81
Turmeric extract at 0.1%	6.09	6.02	1.60	1.57	2.82	2.92	0.96	1.03	3.78	3.95	1.05	1.12	1.81	1.87
Salicylic acid at 100 ppm (SA)	9.21	9.14	1.88	1.84	1.40	1.51	0.52	0.59	1.92	2.10	0.61	0.69	1.57	1.55
Onion oil + SA	5.71	5.64	1.55	1.51	3.11	3.32	1.09	1.16	4.20	4.48	1.19	1.26	1.87	1.94
Garlic oil + SA	5.14	5.07	1.49	1.45	3.52	3.61	1.22	1.30	4.74	4.91	1.32	1.40	1.92	1.99
Green tea + SA	4.90	4.81	1.41	1.38	3.91	4.01	1.33	1.40	5.34	5.41	1.43	1.50	1.98	2.09
Turmeric + SA	4.60	4.51	1.32	1.28	4.21	4.31	1.44	1.52	5.65	5.83	1.54	1.62	2.02	
New L.S.D. at 5%	0.22	0.18	0.04	0.03	0.33	0.31	0.09	0.08	0.31	0.26	0.07	0.08	0.05	0.06

Table (3): Effect of spraying some plant extracts and / or salicylic acid on the percentages of P and K in the leaves, percentages of initial fruit setting , and fruit retention ,yield and fruit weight of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Leaf P %		Leaf K %		Initial fruit setting%		Fruit retention %		No. of fruits /tree		Yield/tree (kg.)		Fruit weight(g.)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	0.18	0.17	1.00	1.02	10.1	9.1	0.90	1.01	41.0	42.0	24.2	24.8	590.0	591.0
Onion oil at 0.1%	0.27	0.23	1.10	1.12	10.7	11.2	0.97	1.02	51.0	51.0	30.7	30.8	601.0	604
Garlic oil at 0.1%	0.31	0.26	1.16	1.20	11.0	11.5	1.01	1.06	55.0	56.0	33.4	34.2	607.0	610
Green tea extract at 0.1%	0.35	0.27	1.22	1.25	11.3	11.9	1.05	1.10	56.0	56.0	34.4	34.7	615.0	619
Turmeric extract at 0.1%	0.39	0.30	1.27	1.30	11.7	12.3	1.15	1.20	57.0	57.0	35.5	35.7	623.0	627
Salicylic acid at 100 ppm (SA)	0.23	0.20	1.05	1.08	10.4	10.9	0.94	0.99	46.0	46.0	27.4	27.4	596.0	603
Onion oil + SA	0.41	0.34	1.33	1.36	12.2	12.7	1.29	1.34	57.0	58.0	35.9	36.8	629.0	634
Garlic oil + SA	0.44	0.40	1.40	1.43	12.7	13.2	1.33	1.38	58.0	59.0	37.1	38.3	639.0	644
Green tea + SA	0.47	0.44	1.45	1.48	13.3	14.0	1.41	1.46	59.0	60.2	38.1	39.0	646.0	650
Turmeric + SA	0.48	0.47	1.51	1.57	14.0	14.5	1.48	1.53	60.0	61.0	39.1	40.0	651.0	655
New L.S.D. at 5%	0.04	0.03	0.04	0.05	0.3	0.3	0.02	0.02	3.6	3.8	2.1	2.3	4.1	4.8

Table (4): Effect of spraying some plant extracts and / or salicylic acid on some physical and chemical characteristics of the fruits of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Fruit length(cm.)		Fruit width (cm.)		Peels%		Seeds%		Pulp%		Fruit firmness (lb/inch ²)		T.S.S %	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	14.0	13.91	10.00	10.02	12.1	12.2	8.0	8.0	79.9	79.8	33.0	33.1	9.5	9.7
Onion oil at 0.1%	14.20	14.25	10.16	10.18	11.3	11.4	7.6	7.7	81.1	80.9	33.5	33.6	10.0	10.2
Garlic oil at 0.1%	14.31	14.36	10.22	10.25	11.0	11.0	7.5	7.5	81.5	81.5	33.7	34.0	10.3	10.5
Green tea extract at 0.1%	14.41	14.46	10.28	10.31	10.7	10.6	7.4	7.4	81.9	82.0	34.0	34.3	10.5	10.7
Turmeric extract at 0.1%	14.51	14.56	10.40	10.41	10.2	10.2	7.4	7.3	82.4	82.5	34.3	34.5	10.7	11.0
Salicylic acid at 100 ppm (SA)	14.08	14.14	10.10	10.11	11.7	11.7	7.8	7.8	80.5	80.5	33.3	33.6	9.8	10.0
Onion oil + SA	14.62	14.67	10.50	10.51	9.9	10.0	7.2	7.2	82.9	82.8	35.0	35.6	11.0	11.2
Garlic oil + SA	14.79	14.85	10.61	10.62	9.7	9.8	7.0	7.0	83.4	83.2	35.3	36.0	11.6	11.8
Green tea + SA	14.82	14.87	10.71	10.72	9.4	9.5	6.8	6.7	83.8	93.8	35.9	36.7	12.0	12.0
Turmeric + SA	15.01	15.06	10.80	10.81	9.1	9.2	6.8	6.6	84.1	84.2	36.3	37.2	12.2	12.5
New L.S.D. at 5%	0.03	0.03	0.03	0.03	0.2	0.2	0.2	0.2	0.4	0.4	0.2	0.2	0.2	0.2

Table (5): Effect of spraying some plant extracts and / or salicylic acid on some chemical characteristic of the fruits of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Total acidity%		T.S.S /acid		Total sugars%		Reducing sugars%		Non-reducing sugars%		Vitamin C (mg/100g pulp)		Total fibre%	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	1.511	1.521	6.29	6.38	8.51	8.41	3.11	3.03	5.40	5.38	40.0	38.9	2.01	2.02
Onion oil at 0.1%	1.430	1.423	7.00	7.17	8.67	8.71	3.25	3.30	5.42	5.41	41.0	40.7	1.82	1.75
Garlic oil at 0.1%	1.371	1.364	7.51	7.70	8.75	8.79	3.32	3.37	5.43	5.42	41.6	41.5	1.71	1.64
Green tea extract at 0.1%	1.340	1.333	7.84	8.03	8.85	8.90	3.40	3.45	5.45	4.45	42.2	42.7	1.50	1.43
Turmeric extract at 0.1%	1.301	1.294	8.22	8.50	8.92	8.97	3.46	3.50	5.46	5.47	43.0	43.1	1.37	1.30
Salicylic acid at 100 ppm (SA)	1.470	1.463	6.67	6.84	8.57	8.64	3.18	3.23	5.39	5.41	40.5	39.9	1.92	1.85
Onion oil + SA	1.275	1.268	8.63	8.83	8.98	9.05	3.52	3.57	5.46	5.48	43.7	44.1	1.26	1.20
Garlic oil + SA	1.250	1.243	9.28	9.49	9.04	9.11	3.56	3.61	5.48	5.50	44.2	44.9	1.61	1.04
Green tea + SA	1.225	1.218	9.80	9.85	9.11	9.20	3.64	3.71	5.47	5.49	44.7	45.3	1.00	0.93
Turmeric + SA	1.201	1.194	10.16	10.47	9.20	9.26	3.71	3.77	5.49	5.49	45.3	46.0	0.95	0.85
New L.S.D. at 5%	0.021	0.019	0.30	0.29	0.05	0.06	0.05	0.05	NS	NS	0.4	0.4	0.07	0.08

Table (1): Effect of spraying some plant extracts and / or salicylic acid on some growth characters, percentages of healthy and malformed inflorescences and length of the same two inflorescences of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Shoot length (cm.)		Number of leaves / shoot		Leaf area (cm ²)		Malformed inflorescences %		Healthy inflorescences %		Length of healthy inflorescences (cm)		Length of malformed inflorescences (cm)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	41.0	41.3	40.0	40.4	71.0	69.9	9.6	10.1	90.4	89.9	35.1	35.9	14.1	14.2
Onion oil at 0.1%	43.4	43.8	42.1	42.5	74.7	74.3	8.7	8.1	91.3	91.9	38.1	38.5	15.1	16.0
Garlic oil at 0.1%	44.5	44.9	43.3	43.5	76.6	76.6	8.2	7.6	91.8	92.4	40.0	40.3	15.7	16.6
Green tea extract at 0.1%	45.6	46.0	44.5	44.8	77.9	78.8	7.5	6.9	92.5	93.1	41.8	42.1	16.6	17.5
Turmeric extract at 0.1%	46.7	47.0	46.0	46.3	80.0	81.9	7.1	6.5	92.9	93.5	43.4	43.8	18.0	18.9
Salicylic acid at 100 ppm (SA)	42.3	42.6	41.0	41.4	73.0	72.0	9.2	8.6	90.8	91.4	36.7	37.0	14.6	15.5
Onion oil + SA	48.0	48.4	47.0	47.4	81.9	84.3	6.6	6.0	93.4	94.0	45.0	45.5	18.5	19.4
Garlic oil + SA	49.1	49.4	48.0	48.3	84.0	86.0	6.2	5.5	93.8	94.5	46.7	47.0	18.9	19.8
Green tea + SA	50.3	50.5	48.3	48.6	86.3	87.8	5.1	4.5	94.9	94.9	48.0	48.3	19.3	20.2
Turmeric + SA	52.9	53.2	49.0	49.4	88.0	90.0	3.9	3.1	96.1	96.9	49.1	50.0	21.2	22.1
New L.S.D. at 5%	1.1	1.0	1.0	1.0	1.5	1.6	0.3	0.4	0.5	0.5	1.0	0.9	0.4	0.3

Table (2): Effect of spraying some plant extracts and / or salicylic acid on sex ratio in malformed and healthy inflorescences, plant pigments and percentage of N in the leave of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Sex ratio in malformed inflorescences		Sex ratio in healthy inflorescences		Chl. a (mg/ 100 g F.W.)		Chl. b (mg/ 100 g F.W.)		Total chlorophylls (mg/ 100 g F.W.)		Total carotenoids (mg/ 100 g F.W.)		Leaf N %	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	9.51	9.55	1.93	1.99	1.01	1.21	0.41	0.48	1.42	1.69	0.50	0.57	1.41	1.47
Onion oil at 0.1%	8.80	8.73	1.80	1.77	1.81	1.81	0.63	0.70	2.40	2.44	0.72	0.79	1.63	1.63
Garlic oil at 0.1%	8.10	8.03	1.74	1.71	2.11	2.22	0.74	0.81	2.85	3.93	0.84	0.90	1.70	1.71
Green tea extract at 0.1%	7.11	7.04	1.67	1.64	2.41	2.51	0.85	0.92	3.26	3.43	0.95	1.01	1.75	1.81
Turmeric extract at 0.1%	6.09	6.02	1.60	1.57	2.82	2.92	0.96	1.03	3.78	3.95	1.05	1.12	1.81	1.87
Salicylic acid at 100 ppm (SA)	9.21	9.14	1.88	1.84	1.40	1.51	0.52	0.59	1.92	2.10	0.61	0.69	1.57	1.55
Onion oil + SA	5.71	5.64	1.55	1.51	3.11	3.32	1.09	1.16	4.20	4.48	1.19	1.26	1.87	1.94
Garlic oil + SA	5.14	5.07	1.49	1.45	3.52	3.61	1.22	1.30	4.74	4.91	1.32	1.40	1.92	1.99
Green tea + SA	4.90	4.81	1.41	1.38	3.91	4.01	1.33	1.40	5.34	5.41	1.43	1.50	1.98	2.09
Turmeric + SA	4.60	4.51	1.32	1.28	4.21	4.31	1.44	1.52	5.65	5.83	1.54	1.62	2.02	
New L.S.D. at 5%	0.22	0.18	0.04	0.03	0.33	0.31	0.09	0.08	0.31	0.26	0.07	0.08	0.05	0.06

Table (3): Effect of spraying some plant extracts and / or salicylic acid on the percentages of P and K in the leaves, percentages of initial fruit setting , and fruit retention ,yield and fruit weight of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Leaf P %		Leaf K %		Initial fruit setting%		Fruit retention %		No. of fruits /tree		Yield/tree (kg.)		Fruit weight(g.)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	0.18	0.17	1.00	1.02	10.1	9.1	0.90	1.01	41.0	42.0	24.2	24.8	590.0	591.0
Onion oil at 0.1%	0.27	0.23	1.10	1.12	10.7	11.2	0.97	1.02	51.0	51.0	30.7	30.8	601.0	604
Garlic oil at 0.1%	0.31	0.26	1.16	1.20	11.0	11.5	1.01	1.06	55.0	56.0	33.4	34.2	607.0	610
Green tea extract at 0.1%	0.35	0.27	1.22	1.25	11.3	11.9	1.05	1.10	56.0	56.0	34.4	34.7	615.0	619
Turmeric extract at 0.1%	0.39	0.30	1.27	1.30	11.7	12.3	1.15	1.20	57.0	57.0	35.5	35.7	623.0	627
Salicylic acid at 100 ppm (SA)	0.23	0.20	1.05	1.08	10.4	10.9	0.94	0.99	46.0	46.0	27.4	27.4	596.0	603
Onion oil + SA	0.41	0.34	1.33	1.36	12.2	12.7	1.29	1.34	57.0	58.0	35.9	36.8	629.0	634
Garlic oil + SA	0.44	0.40	1.40	1.43	12.7	13.2	1.33	1.38	58.0	59.0	37.1	38.3	639.0	644
Green tea + SA	0.47	0.44	1.45	1.48	13.3	14.0	1.41	1.46	59.0	60.2	38.1	39.0	646.0	650
Turmeric + SA	0.48	0.47	1.51	1.57	14.0	14.5	1.48	1.53	60.0	61.0	39.1	40.0	651.0	655
New L.S.D. at 5%	0.04	0.03	0.04	0.05	0.3	0.3	0.02	0.02	3.6	3.8	2.1	2.3	4.1	4.8

Table (4): Effect of spraying some plant extracts and / or salicylic acid on some physical and chemical characteristics of the fruits of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Fruit length(cm.)		Fruit width (cm.)		Peels%		Seeds%		Pulp%		Fruit firmness (lb/inch ²)		T.S.S %	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	14.0	13.91	10.00	10.02	12.1	12.2	8.0	8.0	79.9	79.8	33.0	33.1	9.5	9.7
Onion oil at 0.1%	14.20	14.25	10.16	10.18	11.3	11.4	7.6	7.7	81.1	80.9	33.5	33.6	10.0	10.2
Garlic oil at 0.1%	14.31	14.36	10.22	10.25	11.0	11.0	7.5	7.5	81.5	81.5	33.7	34.0	10.3	10.5
Green tea extract at 0.1%	14.41	14.46	10.28	10.31	10.7	10.6	7.4	7.4	81.9	82.0	34.0	34.3	10.5	10.7
Turmeric extract at 0.1%	14.51	14.56	10.40	10.41	10.2	10.2	7.4	7.3	82.4	82.5	34.3	34.5	10.7	11.0
Salicylic acid at 100 ppm (SA)	14.08	14.14	10.10	10.11	11.7	11.7	7.8	7.8	80.5	80.5	33.3	33.6	9.8	10.0
Onion oil + SA	14.62	14.67	10.50	10.51	9.9	10.0	7.2	7.2	82.9	82.8	35.0	35.6	11.0	11.2
Garlic oil + SA	14.79	14.85	10.61	10.62	9.7	9.8	7.0	7.0	83.4	83.2	35.3	36.0	11.6	11.8
Green tea + SA	14.82	14.87	10.71	10.72	9.4	9.5	6.8	6.7	83.8	93.8	35.9	36.7	12.0	12.0
Turmeric + SA	15.01	15.06	10.80	10.81	9.1	9.2	6.8	6.6	84.1	84.2	36.3	37.2	12.2	12.5
New L.S.D. at 5%	0.03	0.03	0.03	0.03	0.2	0.2	0.2	0.2	0.4	0.4	0.2	0.2	0.2	0.2

Table (5): Effect of spraying some plant extracts and / or salicylic acid on some chemical characteristic of the fruits of Keitte mango trees during 2012 & 2013 seasons.

Treatment	Total acidity%		T.S.S /acid		Total sugars%		Reducing sugars%		Non-reducing sugars%		Vitamin C (mg/100g pulp)		Total fibre%	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	1.511	1.521	6.29	6.38	8.51	8.41	3.11	3.03	5.40	5.38	40.0	38.9	2.01	2.02
Onion oil at 0.1%	1.430	1.423	7.00	7.17	8.67	8.71	3.25	3.30	5.42	5.41	41.0	40.7	1.82	1.75
Garlic oil at 0.1%	1.371	1.364	7.51	7.70	8.75	8.79	3.32	3.37	5.43	5.42	41.6	41.5	1.71	1.64
Green tea extract at 0.1%	1.340	1.333	7.84	8.03	8.85	8.90	3.40	3.45	5.45	4.45	42.2	42.7	1.50	1.43
Turmeric extract at 0.1%	1.301	1.294	8.22	8.50	8.92	8.97	3.46	3.50	5.46	5.47	43.0	43.1	1.37	1.30
Salicylic acid at 100 ppm (SA)	1.470	1.463	6.67	6.84	8.57	8.64	3.18	3.23	5.39	5.41	40.5	39.9	1.92	1.85
Onion oil + SA	1.275	1.268	8.63	8.83	8.98	9.05	3.52	3.57	5.46	5.48	43.7	44.1	1.26	1.20
Garlic oil + SA	1.250	1.243	9.28	9.49	9.04	9.11	3.56	3.61	5.48	5.50	44.2	44.9	1.61	1.04
Green tea + SA	1.225	1.218	9.80	9.85	9.11	9.20	3.64	3.71	5.47	5.49	44.7	45.3	1.00	0.93
Turmeric + SA	1.201	1.194	10.16	10.47	9.20	9.26	3.71	3.77	5.49	5.49	45.3	46.0	0.95	0.85
New L.S.D. at 5%	0.021	0.019	0.30	0.29	0.05	0.06	0.05	0.05	NS	NS	0.4	0.4	0.07	0.08

Conclusion

For improving yield and fruit quality of Keitte mango trees, it is suggested to spray the trees three times with a mixture of turmeric extract at 0.1% plus salicylic acid at 100 ppm.

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