Response of Keitte Mango Trees to Spraying Nano NPK Mg Fertilizers

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Abstract: This study was undertaken during 2017 and 2018 seasons to examine the effect of spraying normal and nano- technology NPK Mg on fruiting of Keitte mango trees. The trees sprayed four times at the middle of Feb, Mar., Apr., and May. Spraying normal and nano NPKMg was very effective in improving growth, pigments, nutrients, yield and fruit quality over the control. Using nano NPKMg was materially Superior than using normal form in this respect. A slight effect on the investigated parameters was observed when NPKMg nano fertilizers were applied at concentrations above 0.1%. The best results with regard to yield and fruit quality of Keitte mango trees were obtained with spraying nano- NPKMg at 0.1%.

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1. Introduction

Nanotechnology has provided the feasibility of exploiting nanooscale or nanostructred materials as fertilizers carries or controlled – release vectors for building of so- called smart fertilizer as new facilities to enhance nutrient use efficiency **(Al-Amin- Sadek and Jayasuriya, 2007).**

Encapsulation of fertilizers within a nanoparticle is one of these new facilities which are done in three ways a) the nutrient can be encapsulated inside nanoporous materials, b) coated with thin polymer film, or c) delivered as particle or emulsions of nanoscales dimensions (**Rai *et al.,* 2012)**. In addition. nanofertilizers will combine nanodevices in order to synchronize the release of Fertilizer-N and -P with their uptake by crops, so preventing undesirable nutrient losses to soil, water and air via direct internalization by crops, and avoiding the interaction of nutrients with soil, microorganisms, water, and air (**Derosa *et al.,* 2010)**.

Coating and binding of nano and subnano-composites are able to regulate the release of nutrients from the fertilizer capsule (**Liu *et al.,* 2006**). In this regard, **Jinghua (2004)** showed that application of a nano-composite consists of N, P, K, nuicronutrients. mannose and amino acids enhance the uptake and use of nutrients by grain crops. Moreover, nanotechnology could supply tools and mechanisms to synchronize the nitrogen release from fertilizers with crop requirements. This will be accomplished only when they can be directly internalized by the plants. Zinc- aluminiumlayered double'- hydroxide nanocomposites have been employed for the controlled release of chemical compounds 'which act as plant growth regulators. Studies have shown that fertilizer incorporation into cochleate nanotubes (rolled-up lipid bilayer sheets), had improved crop yield (**Derosa *et al.,* 2010)**.

More recent strategies have focused on technologies to provide nanofertilizer delivery systems which react to environmental changes. The final goal is production of nanofertilizers that will release their shipment in a cardrailled manner (slowl ok quickly) in reaction to different signals such heat. moisture and etc. (**FAO, 2015**).

Since fertilizers, particularly synthetic fertilizers, have a potential to pollute soil, water and air, in recent rears, many efforts were done to minimize these problems by agriculture practices and the design of the new improved fertilizers. The appearances of nanotechnology open up potential novel applications in different fields of agriculture and biotechnology. Nanostructured formulation through mechanisms such as targeted deliver or slow/controlled release mechanisms, conditional release, could release their active ingredients in responding to environmental triggers and biological demands more precisely. There is the possibility of using these mechanisms to design and construction of nanofertilizers. The use of these nanofertilizers causes an increase in their efficiency, reduces soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application. Nanofertilizers mainly delays the release of the nutrients and extends the fertilizer effect period. Obviously. there is an opportunity for nanotechnology to have a significant influence on energy, the economy and the environment, by improving fertilizers. Hence, nanotechnology has a high potential for achieving sustainable agriculture. especially in developing countries. (**Sultan *et al.,* 2009**, **Prasad *et al.,* 2014; Mukhopudhyyay, 2014 and Mahjunatha *et al.,* 2016**).

Using nutrients via normal method was found by **El- Sayed Esraa (2010) and Ahmed (2014)** to improve the yield of Ewaise and Keitte mango trees.

Previous studies showed that using fertilizers via nano technology was superior than using via normal methods in improving growth, yield and fruit quality of different fruit crops (**Sabir *et al.,* 2014; Refaai, 2014; Roshdy and Refaai, 2016; Wasse *et al.,* 2014 Mohamed *et al.,* 2014, Roshdy and Rafaai, 2016, Wassel *et al,*. 2014; Ahmed, 2018, Abou- Bakr- Basma, 2018 and Abdalla, 2018)**.

The merit of this study was examining the effect of NPK Mg applied via nano technology on fruiting of Keitte mango trees.

2. Materials and Methods

This study was carried out during 2017 and 2018 seasons on eighteen uniform in vigour Keitte mango trees grafted onto Succary mango rootstock. The selected trees are grown in sandy loam soil in a private orchard situated at Wady El- Nokra region, Kom Ombo district, Aswan Governorate, Egypt. The selected trees were 14 years old and healthy and planted at 5x5 meters apart. The trees received the same agricultural and horticultural practices that already applied in the orchard. Surface irrigation system was followed.

Soil analysis was done according to the proceeding that outlined by **Wilde *et al.,* (1985)** and the obtained data are shown in Table (1).

Table (1): Analysis of the tested soil

Constituents	Values
Sand %	74.9
Silt %	10.1
Clay %	15.0
Texture	Sandy loam
$CaCO_3$ %	2.01
pH (1: 2.5 extract)	7.8
O.M. %	0.31
Total N %	0.08
P (Olsen, ppm)	1.9
K (ammonium acetate, ppm)	195

This study included the following six treatments:

1- Control.
2- Spraying Normal NPKMg at 0.5%.
3- Spraying Normal NPKMg at 0.05%.
4- Spraying Normal NPKMg at 0.1 %.
5- Spraying Normal NPKMg at 0.2%.
6- Spraying Normal NPKMg at 0.4%.

Each treatment was replicated three times, one tree per each. Normal and nano NPKMg fertilizers were sprayed four times at the middle of Feb. Mar. Apr. and May. Triton B as a wetting agent was applied at 0.05% and spraying was done till run off.

During both seasons, the following parameters were measured:

1- Shoot length (cm) and leaf area (cm2) (**Ahmed and Morsy, 1999**) in the spring growth flush.

2- Total chlorophylls by summation of chlorophylls a and b (mg/ g. F.W.) (**Von-Wettstein, 1957**).

3- Percentages of N, P, K and Mg in the non-fruiting shoots (**Summer, 1985**) according to **Chapman and Pratt (1965)**.

4- Percentage of fruit retention and yield / tree (kg.)

5- Physical characteristics of the fruits namely weight of fruit (g.), percentages of seeds, peels and flesh of the fruits and edible to none dibble portions of fruits.

6- Chemical characteristics of the fruits namely T.S.S. %, total and reducing sugars, total acidity % (as g citric acid/ 100 g pulp), vitamin C (as mg/ 100 g pulp) and total fiber% (**A.O.A.C., 2000**).

Statistical analysis was done using new L.S.D. at 5% to differentiate among the six treatment means (**Mead, *et al*,. 1993**).

3. Results and Discussion

1- Shoot length and leaf area:

It is clear from the data in Table (2) that spraying normal (0.5%) and nano- technology NPKMg at 0.05 to 0.4% significantly stimulated the shoot length and leaf area in the Spring growth cycle over the control. Using nano- NPKMg fertilizers was significantly superior than using normal NPKMg in stimulating such two growth aspects. Insignificant promotion on such two growth aspects was observed when nano- NPKMg was sprayed at concentrations higher than 0.1%. There was a gradual aspects with increasing nano NPKMg fertilizer concentrations. The maximum values were recorded on the trees that received nano- NPKMg fertilizers at 0.4%. The untreated trees produced the lowest values. These results were true during both seasons.

2- Total chlorophylls:

Data in Table (2) clearly show that spraying normal NPKMg (at 0.5%) and nano- NPKMg at 0.05 to 0.4 % significantly enhanced total chlorophylls in the leaves compared to the control. Spraying nano NPKMg at 0.05 to 0.4% was significantly superior than using normal NPKMg in enhancing total chlorophylls. Using NPKMg nano fertilizers at concentrations above 0.1% had no significant stimulation on such chemical parameters total chlorophylls was gradually increased with increasing concentration of nano NPKMg. The maximum values were recorded on the trees that sprayed with NPKMg at 0.4%. The lowest values were recorded on untreated trees. These results were true during both seasons.

3- Percentages of N, P, K and Mg in the leaves:

Data in Table (2) clearly show that spraying the trees with normal or nano- NPKMg significantly was accompanied with enhancing N, P, K and Mg in the leaves relative to the control. Spraying Nano- NPKMg at 0.05 to 0.4% significantly enhanced all nutrients than using normal NPKMg. There was a gradual promotion on these nutrients with increasing concentrations of nano NPKMg. Increasing concentration of nano- NPKMg from 0.1 to 0.4% had no significant promotion on these nutrients. Treating the trees with nano NPKMg at 0.4% gave the maximum values. The lowest values were recorded on untreated trees. Similar results were announced during both seasons.

4- Percentage of fruit retention:

As shown in Table (3), percentage of fruit retention was significantly improved in response to spraying normal (at 0.5%) and nano NPKMg at 0.05 to 0.4% relative to the control. The promotion was associated with increasing concentrations of nano NPKMg. However, spraying nano- NPKMg at concentrations higher than 0.1% failed significantly to show noticeable increase on the percentage of fruit retention. Spraying nano NPKMg fertilizers was significantly superior than using normal ones in this connection. The maximum values (1.03 % 1.07%) of fruit retention was detected on the trees that sprayed with nano NPKMg at 0.4% during both seasons, respectively. The untreated trees produced the minimum values (0.79 & 0.81 %) during both seasons, respectively. These results were true during both seasons.

5- Yield/ tree

Yield/ tree was significantly improved owing to spraying Keitte mango trees with normal or nano NPKMg over the control. Spraying nano NPKMg at 0.05 to 0.4% was significantly superior than using normal NPKMg in improving the yield/ tree. Meaningless promotion on the yield was attributed to spraying normal NPKMg at concentrations higher than 0.1%. Therefore, from economical point of view, it is suggested to spray nano NPKMg at 0.1%. Under such promised treatment yield per tree reached 35.9 and 38.0 kg during both seasons, respectively. The untreated trees produced 25.0 & 26.1 kg during 2017 and 2018 seasons, respectively. The percentage of increment on the yield due to application of Nano NPKMg at 0.1 % over the control reached 59.6 and 45.6 % during both seasons, respectively. These results were true during both seasons.

6- Physical and chemical characteristics of the fruits:

Data in Tables (3 & 4) obviously reveal that spraying normal or nano NPKMg fertilizers was significantly very effective in improving fruit quality in terms of increasing fruit weight, flesh %, edible / non- edible portions of fruits, T.S.S.%, total and reducing sugars and vitamin C and decreasing the percentages of seed and peel weights, total acidity %, and total fibre relative to the control. The promotion was associated with increasing nano NPKMg fertilizer concentrations using nano NPKMg was significantly preferable than using normal NPKMg in enhancing fruit quality. Using nano NPKMg fertilizers at concentrations greater than 0.1% had no significant promotion on fruit quality, therefore from economical point of view, the best results with regard to fruit quality were recorded on the trees that sprayed with nano NPKMg at 0.1%. These results were true during both seasons.

Table (2): Effect of spraying normal and nano NPKMg fertilizers on some growth traits, pigment and nutrients in the leaves of Keitte mango trees during 2017 / 2018 seasons

Treatments	Shoot length (cm)		Leaf area (cm)^2		Total chlorophyll (mg/ g F.W.)		Leaf N %		Leaf P %		Leaf K %		leaf Mg %	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	41.1	39.9	73.3	74.1	13.1	14.1	1.59	1.61	0.141	0.139	1.38	1.41	0.55	0.56
Normal NPKMg at 0.5%	44.4	43.8	76.8	77.6	14.9	14.9	1.69	1.72	0.151	0.152	1.48	1.51	0.61	0.62
Normal NPKMg at 0.05%	46.3	45.9	79.9	80.8	16.3	16.9	1.81	1.84	0.171	0.172	1.60	1.59	0.66	0.68
Normal NPKMg at 0.1%	48.0	48.9	84.3	82.0	16.9	17.6	1.89	1.85	0.178	0.184	1.67	1.64	0.62	0.73
Normal NPKMg at 0.2 %	48.1	49.0	84.3	82.2	17.1	17.7	1.91	1.91	0.179	0.185	1.68	1.65	0.70	0.71
Normal NPKMg at 0.4 %	48.2	49.1	84.4	82.3	17.2	17.8	1.92	1.92	0.180	0.186	1.69	1.66	0.71	0.75
New L.S.D. at 5%	1.1	1.0	0.8	1.1	0.6	0.4	0.06	0.05	0.006	0.008	0.05	0.04	0.03	0.04

Table (3): Effect of spraying normal and nano NPKMg fertilizers on the percentage of fruit retention, yield and some physical characteristics of the fruits of Keitte mango trees during 2017 / 2018 seasons

Treatments	Fruit retention %		Yield / tree (kg.)		Fruit weight (g.)		Seed weight %		Peel weight %		Flesh %		Edible / non edible portions	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	0.79	0.81	25.0	26.1	345.5	355.0	14.1	13.9	18.9	18.7	67.0	67.4	2.04	2.07
Normal NPKMg at 0.5%	0.88	0.90	27.9	30.0	361.0	381.0	13.0	12.7	17.0	16.8	70.0	70.5	2.33	2.39
Normal NPKMg at 0.05%	0.96	0.99	31.0	33.0	399.5	410.0	12.0	11.8	15.5	15.3	72.5	72.9	2.64	2.69
Normal NPKMg at 0.1%	1.01	1.06	35.9	38.0	441.0	451.9	11.1	11.0	14.1	14.0	74.8	75.0	2.97	3.00
Normal NPKMg at 0.2 %	1.02	1.06	36.1	38.2	442.0	452.0	11.0	10.9	14.0	14.0	75.0	75.1	3.00	3.02
Normal NPKMg at 0.4 %	1.03	1.07	36.3	38.5	444.1	454.1	10.9	10.8	13.9	13.9	75.2	75.3	3.03	3.05
New L.S.D. at 5%	0.05	0.06	1.1	1.3	11.9	11.5	0.4	0.5	0.6	0.5	1.0	1.1	0.21	0.22

Table (4): Effect of spraying normal and nano NPKMg fertilizers on some chemical characteristics of the fruits of Keitte mango trees during 2017 / 2018 seasons

Treatments	T.S.S. %		Total acidity %		Total sugars %		Reducing sugars %		Vitamin C (mg/ 100 ml pulp)		Total fibre %	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	9.9	10.0	0.910	0.921	6.9	7.0	2.9	3.0	41.5	42.2	1.00	0.97
Normal NPKMg at 0.5%	10.5	10.7	0.870	0.881	7.5	7.4	3.3	3.3	4.0	45.0	0.91	0.90
Normal NPKMg at 0.05%	11.0	11.3	0.830	0.841	8.1	8.2	3.7	3.7	46.0	45.9	0.81	0.80
Normal NPKMg at 0.1%	11.6	12.0	0.801	0.812	8.6	8.9	4.0	4.0	48.9	47.9	0.71	0.72
Normal NPKMg at 0.2 %	11.7	12.1	0.800	0.811	8.7	9.0	4.1	4.1	49.0	48.0	0.70	0.71
Normal NPKMg at 0.4 %	11.8	12.2	0.799	0.810	8.8	9.1	4.2	4.2	49.1	48.1	0.69	0.70
New L.S.D. at 5%	0.4	0.4	0.022	0.026	0.3	0.4	0.2	0.2	1.0	0.8	0.04	0.06

4. Discussion

The previous beneficial effects of nano technology use of nutrients on fruiting of Keitte mango trees could be explained to its effect in enhancing nutrient use efficiency (**Jayasuriya, 2007**) and preventing the release of fertilizers and their uptake by crops so preventing nutrients losses to soil, water and air and the interaction of nutrients with soil, micro organisms water and air (**Derosa *et al.*, 2010**).

These results are in harmony with those obtained by **Sabir *et al.*, (2014); Refaai (2014), Roshdy and Refaai (2016); Wassel *et al.*, (2017); Mohamed *et al.*, (2017), Ahmed (2018); Abou-Bakr Basma (2018) and Abdalla (2018).**

Conclusion

The best results with regard to yield and fruit quality of Keitte mango trees were obtained due to spraying nano NPKMg at 0.1%.

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