Sudan Journal of Science and Technology (2014) **15**(1): 28-35

Sudan Journal of Science and Technology
Journal homepage: http://jst.sustech.edu/

The Impact of Argel (*Solennostemma argel* Del., Haynne) and Micro-elements Applications on Flowering and Fruiting of Malformed Trees of 'Kent' Mango Cultivar

Tagelsir I.M. Idris[1], Hamdan S. Elnour[1] and Farouk H. Attahir[2]

[1]Department of Horticulture, Sudan University of Science and Technology
[2]Department of Horticulture, University of Khartoum

ARTICLEINFO

Article history

Received: 24August2014

Accepted: 8September 2014

Available online: 10December2014

Keywords:

Mango (*Mangifera indica)*,

Malformation,

Argel,

Micro-elements,

Fruit set,

Fruit retention.

ABSTRACT

This study aimed to investigate the influence of argel and micro-elements foliar applications on flowering, fruit set and fruit retention in vegetatively malformed 'Kent' mango cultivar, following an immediate comprehensive malformation combating treatment. The comprehensive treatment counteracted malformation successfully as symptoms of the malady were not detected in all trees including the control. The foliar application of either argel plus Mn, Mn or argel alone, increased the number of flowering branches significantly. Compared to the control, all foliar treatments of argel and micro-elements resulted in significant increase in fruit set. The number of fruits retained per panicle 16 weeks after treatments was significantly increased by argel + Fe or sole argel foliar treatments. As the number of flowering branches and number of retained fruits per panicle are among yield enhancing components, these results may be used as a baseline for further studies to improve productivity of mangos under Sudan's conditions.

INTRODUCTION

The mango (*Mangifera indca* L.), a native of India and South East Asia was introduced to Sudan in the early years of the last century. Currently it leads Sudan horticultural exports. Most of the trees are seedlings originated from the local cultivar "Kitchener". Recently new improved cultivars were introduced from South Africa. However, symptoms of vegetative malformation at nursery and field stages were observed in these introductions. Vegetative and floral malformations were encountered in the newly introduced cultivars in the mango orchard of the College of Agricultural Studies at Shambat, Khartoum North,

Sudan. It is noteworthy that vegetative or floral malformations were not recognized among mango threats in Sudan.

The malformation is a malady of mango pathological and physiological disorders that hamper normal vegetative growth and lead to heavy yield losses in adult trees. In its pathological part, the malady was attributed to fungal infections especially by different species and races of *Fusarium* (Chakrabarty and Ghosal, 1989; Britz *et al.* 2002; Haggag *et al*., 2010). The epidemiology of malformation had been reported as one of the most serious threats of mango in several countries (Ploetz, 2001; Iqbal *etal*., 2004; Youssef *et al*., 2007). The incidence was attributed to several factors including variety, environmental conditions and cultural practices (Kumar and Chakrabarti, 1997; Haggag 2010). Floral malformation appears in the panicles causing negative impacts on fruit production since affected inflorescences usually do not set fruit, and is therefore a more serious problem than vegetative malformation (Mahrous, 2004). Management of mango malformation included removal of affected vegetative and floral terminals to reduce the intensity of malformation (Ploetz *et al*., 2002), pruning followed by use of chemicals (Yadav, 1999; Barbosa-Martinez *et al.*, 2002), and spray with some plants extracts having anti-fungal properties (Kumar *et al*., 2007; Kumar *et al*., 2009).

The objective of this research was to study the effects of micro-elements and argel (*Solennostemma argel* Del., Haynne) applications on flowering, fruit-set and retention in malformed 5 years old trees of 'Kent' mango cultivar as part of integrated management under the conditions of Shambat, Khartoum North, Sudan.

MATERIALS and METHODS

This study was conducted at the mango orchard of the College of Agricultural Studies, Shambat, Khartoum North, Sudan, during November 2010 – March 2011. The trees were recent imports from South Africa, with signs of vegetative malformation expressed as tip necrosis, twig-die back; rosette terminal leaves growth and weak canopy growth. Prior to experimentation, all trees received the following common treatments: Pruning of branches and twigs 5 cm or more below tips with signs of malformation to ensure white clean tissue free of fungal infections, followed by immediate spray with 50 mg/l Stroby (acaricide-fungicide) to run-off to prevent new incidents of fungal infections, coupled with a soil dressing dose of fertilizer composed of 100 g urea (46% nitrogen) and 100 g calcium super phosphate.

The single and combined effect of argel stems powder, Fe and Mn micro-elements were tested in spray form. The treatments were:

1- Control (no spray).
2- Spray with cold water extract of argel stems powder: 16g of ground argel stems were soaked in a liter of tap water for one hour and then filtered with sash cloth for immediate application.
3- Spray to run-off with 50 mg/l Fe $SO_4.7H_2O$.
4- Spray to run-off with 50 mg/l Mn $SO_4.5\ H_2O$.
5- A combined spray to run-off with cold water extract of argel stems powder plus Mn: 16g of ground argel stems were soaked in a litre of tap water for one hour and then filtered

with sash cloth. Then 50 mg/l of Mn $SO_4.5H_2O$ was added to the solution for immediate spray.

6- A combined spray to run-off with cold water extract of argel stems powder plus Fe: 16g of ground argel stems were soaked in a liter of tap water for one hour and then filtered with sach cloth. Then 50 mg/l of Fe $SO_4.7H_2O$ was added to the solution for immediate spray.
7- A combined spray to run-off with Fe + Mn: In a litre of tap water, 50 mg of Fe $SO_4.7H_2O$ + 50 mg of Mn_2 SO_4. $7H_2O$ were dissolved and sprayed together.

In each experiment, there were 7 blocks and in each block one tree was considered a replicate of each treatment A 10 litre manual sprayer was used for the sprayings. Data were collected for flowering parameters 40 days after application, fruit set (60 days after application), and fruit retention (14 and 16 weeks after application). The measurements were: Number of flowering branches/tree to determine percentage, number of secondary spikes within inflorescence, number of tertiary spikes within inflorescence, length of inflorescence (cm), length of secondary spikes within inflorescence (cm), distance between successive secondary spikes (cm), number of flowers/ tertiary spikes, number of fruits set per inflorescence and number of retained fruits per inflorescence after fruit set. Data were subjected to analysis of variance for the randomized complete block design, and means were separated by Duncan's multiple range test at 95% confidence limit using MStatC computer program.

RESULTS

The foliar application of either argel plus Mn, Mn or argel alone, increased the number of flowering branches significantly, and the opposite was encountered upon spraying with a combination of Fe + Mn, compared to the control (Table 1).

Table 1: Effect of argel and micro-elements on percentage of flowering branches in "Kent" mango cultivar, 40 days after application

Treatment	Percentage of flowering branches
Control	71.71c
Argel	83.57ab
Fe	77.00bc
Mn	85.71a
Argel +Fe	68.57cd
Argel +Mn	87.86a
Fe+Mn	61.00d

Means followed by the same letter(s) within the same column are not significantly different at P=0.05.

Table (2), illustrates the effects of argel and micro-elements on the characteristics of the inflorescence. The untreated control was not exceeded by any treatment for the length of the main spike and the number of secondary spikes per inflorescence. However, the number of tertiary spikes was increased significantly by the combined Fe + Mn treatment, followed by the single Mn treatment, while the least number of

tertiary spikes was recorded for the control. The length of secondary spikes was best upon spray with Fe, although it did not differ significantly from the control or the Mn treatment. The distance between secondary spikes was increased significantly by the single applications of either argel or Fe, and the combination of the two resulted in slight insignificant decrease from their single effects.

Table 2: Effect of argel and micro-elements on the characteristics of inflorescence in "Kent" mango cultivar, 40 days after application

Treatment	Length of main spike (cm)	No of secondary spikes	No of tertiary spikes	Length of secondary spikes (cm)	Distance between secondary spikes (cm)
Control	29.00a	26.82a	6.42d	6.84ab	3.87b
Argel	23.39bc	23.86ab	7.71bcd	3.75d	4.14a
Fe	26.86b	24.43ab	7.42cd	7.22a	4.15a
Mn	23.66bc	22.86b	9.00b	6.84ab	3.21c
Argel +Fe	28.46a	23.57ab	8.25bc	5.22c	4.00ab
Argel +Mn	25.80bc	22.86b	7.57bcd	4.47cd	3.55bc
Fe+Mn	23.19c	22.71b	13.43a	5.77bc	3.80bc
CV%	14.72	12.97	14.74	20.26	13.59

Means followed by the same letter(s) within the same column are not significantly different at P=0.05.

The number of flowers in tertiary spikes is presented in Figure (1). The number was significantly increased by the combined treatment of argel and Mn.According to Figure (2), all foliar treatments increased fruit set significantly compared with the control. Retention of these fruits in presented in Table 3. Retention in reading 1 i.e. 14 weeks after application, was high in trees treated with argel alone. In reading 2 (16 weeks after application), the highest number of fruits per panicle was obtained from the combined argel + Fe treatment, which was not significantly different from the single argel treatment. It is worthy to note that the least number of retained fruits was recorded for the control.

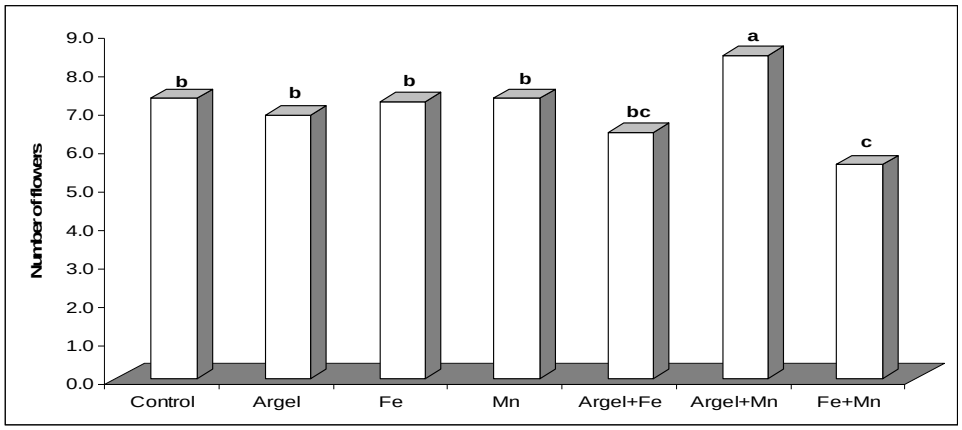

Figure 1: The effect of argel and micro-elements on the number of flowers per tertiary spikes in Kent mango cultivar 40 days after application

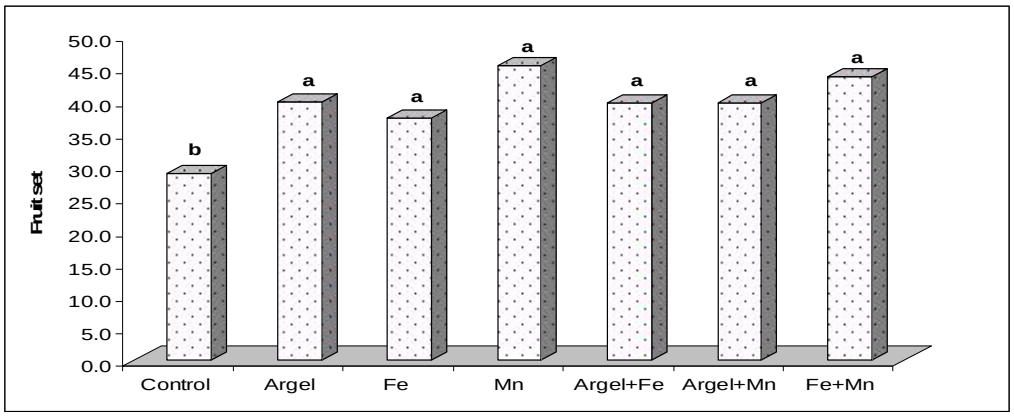

Figure 2: Effect of argel and micro-elements on fruit-set in "Kent" mango cultivar 60 days after application

Table 3: Effect of argel and micro-elements on fruit retention in "Kent" mango cultivar 14 and 16 weeks after application

Treatments	Number of retained fruits per panicle	
	Reading 1 (14 weeks)	Reading 2 (16 weeks)
Control	5.00cd	1.71d
Argel	7.14a	3.64ab
Fe	5.86bc	2.71bc
Mn	4.29de	2.42cd
Argel +Fe	6.29ab	4.28a
Argel +Mn	3.57e	3.00bc
Fe+Mn	5.43bc	3.28bc

Means followed by the same letter(s) within the same column are not significantly different at P=0.05.

DISCUSSION

Malformation increases the number of male flowers in an inflorescence and the ovary of malformed bisexual flowers is exceptionally enlarged and non-functional with poor pollen viability or either sterile or, if fertilized, eventually abort (Shawky *et al*., 1980 and Ploetz, 2004). Affected panicles either do not set fruit or abort fruit shortly after they have set leading to yield reduction (Ploetz, 2001).

Micronutrients have roles in the functioning of the genetic apparatus and several are involved with the activity of growth substances. Manganese (Mn) is one of the most important microelements and has been included in the majority of plant tissue culture media. In this study Mn combined with argel increased the number of flowers per tertiary spike. Such a character is a reflection of active growth. The most probable role for Mn is its involvement in the structure of metalloproteins involved in respiration and photosynthesis (Clarkson and Hanson, 1980). It is known to be required for the activity of several enzymes, which include decarboxylases, dehydrogenases, kinases and oxidases and superoxide dismutase enzymes

(George *et al.*, 2008). Manganese is necessary for the maintenance of chloroplast ultra-structure. Because Mn (II) can be oxidized to Mn (IV), manganese plays an important role in redox reactions. The evolution of oxygen during photosystem II of the photosynthetic process is dependent on Mn containing enzyme and is proportional to Mn content (Mengel and Kirkby, 1982; Shkolnik, 1984).

In plants, iron is primarily used in the chloroplasts, mitochondria and peroxisomes of plants for effecting oxidation/reduction (redox) reactions. The element is required for the formation of amino acids acting as precursors of chlorophyll and its deficiency leads to marked leaf chlorosis. Iron is also a component of ferredoxin proteins, which function as electron carriers in photosynthesis. Nevertheless, Minessey *et al.,* (1971). Reported successful use of Fe for the control of mango malformation.

The single and combined treatments of argel and micro elements on Kent mango trees were capable of inducing higher number of flowering branches than the control. Argel alone or its combination with Fe almost performed alike as inhibitors of fruit drop in advanced fruit developmental stages. This advantage of fruit retention after set would end in higher yield per tree. The result might be attributed to the growth regulator-like effect of argel as proposed by Idris *et al.*, (2011). Besides, argel chemical composition might be rich in micro elements, thus resembling the individual effect of the micro elements. The beneficial effects obtained in this study upon use of stems powder is an additional advantage to the agro-uses of argel as the preceding studies were based on leaf uses only. The response to the foliar applications of argel and microelements might be attributed to soil pH as the orchard's soil was calcareous with a pH of 8.2; therefore unavailability of micro-elements to plants roots is expected. This would also raise a question on the content of argel stems powder and whether they provide adequate quantities of micro elements to correct the possible deficiencies if any. The organic composition of argel might be responsible for the beneficial responses resulting from argel applications. It is noteworthy that analytical organic and biochemical studies related to the agricultural uses of argel are lacking. In conclusion, better flowering and fruit retention attributes were obtained by sprays of cold water extracts of argel stems and micro-elements. These attributes are among yield enhancing factors and these practical results can be used as baseline for further studiesaiming to improve mango productivity in Sudan. However, progress on the agricultural uses of argel necessitate urgent definition of chemical constituents of its leaves and stems to fascilitate better interpretation of the beneficial responses gained from such applications. For Further confirmation, these results can be tried on other fruit trees.

REFERENCES

Barbosa-Martinez C.J.; Sepulveda-Sanchez, N.D. and de-Leon-Garcia L.P. (2002). Effects of ozone, iodine and chlorine on spore germination of fungi isolated from mango fruits. *Revista Maxicana de Fitopatologia*, 20: 60-65.

Britz, H., Steenkamp, E.T., Coutinho, T.A., Wingfield, B.D., Marasas, W.F.O. and Wingfield, M.J.

(2002). Two new species of *Fusarium* section *Liseola* associated with mango malformation. *Mycologia*,**94**:722-730.

Chakrabarty, D.K. and Ghosal, S. (1989). Disease cycle of mango malformation induced by *Fusarium moniliforme* var. subglutinans and the curative effects of mangiferin metal chelates. *Journal ofPhytopathology*,**125**: 238-246.

Clarkson,T. and Hanson, J.B. (1980) The mineral nutrition of higher plants. *Annual Review of Plant Physiology*,**31**: 239-298.

George, E.F., Hall, M.A. and DeKlerk, G.J. (2008). *Plant Propagation by Tissue Culture*; 3rd edition, Vol. 1; The background. Springer, Dordrecht, Netherlands pp 504.

Haggag, W.M. (2010). Mango diseases in Egypt. *Agriculture and Biology Journal of North America*, **1**(3): 285-289.

Haggag,W.M., Hazza, M., Sehab, A. And Abd El-Wahab, M. (2010). Scanning electron microcopy studies on mango malformation. *Nature and Science*.**8**:122-127.

Idris, T.I.M., Ibrahim, A.M.A. Mahdi, E.M. and Taha, A.K. (2011). Influence of argel (*Solenostemma argel* Del. Hayne) soil application on flowering and yield of date palm (*Phoenix dactylifera* L.). *Agriculture and Biology Journal of North America*,**2**(3): 538-542.

Iqbal, Z., Saleem, A. and Dasti, A.A. (2004). Assessment of Mango Malformation in Eight Districts of Punjab (Pakistan). *International Journal of Agriculture and Biology*, **6**: 620–623.

Kumar, J. and Beniwal, S.P.S. (1992). Mango malformation. In: J. Kumar, H.S. Chaube, U.S. Singh and A.N. Mukhopadhyay (eds.), Plant Diseases of International Importance. Diseases of Fruit Crops. Vol. 3. *Prentice Hall, Englewood Cliffs, N.J*. p.357-393.

Kumar, R. and D.K. Chakrabarti. (1997). Spatial patterns of spread of floral malformation of mango, *Acta Horticulturae*, **455**: 600-608.

Kumar, P., A.K. Misra and B.K. Pandey, (2007). *In vitro* evaluation of *Trichoderma* spp. against vegetative mango malformation pathogen *Fusarium moniliformae* var. *subglutinans*. *Eco-Friendly Agriculture Journal*, **2**: 187-189.

Kumar, P., A.K. Misra, B.K. Pandey, S.P. Misra and D.R. Modi, (2009). Eco- friendly management of mango malformation *Fusarium moniliforme* var. *subglutinans* from leaf extracts. *Eco-Friendly Agriculture Journal*,**4**: 61-64.

Mahrous, H.A.H.**(**2004). Effect of spraying some chemical substances and a fungicide on floral malformation disease in mango. *Acta Horticulturae*, **645**: 481-486.

Mengel, K. and Kirkby, E.A. (1982). *Principles of Plant Nutrition*. 3rd Edition. International Potash Institute, Bern, Switzerland.

Minessey, F.A., Biely, M.P. and El-Fahal, A. (1971). Effect of iron chilates in correcting

malformation of terminal bud growth in mango. *Sudan Agriculture Journal,* 6: 71-74.

Ploetz, R.C. (2001). Malformation: a unique and important disease of mango, *Mangifera indica* L.In B. A. Summerell, J. F. Leslie, D. Backhouse, W. L. Bryden and L. W. urgess (eds), *Fusarium: Paul E. Nelson Memorial Symposium* (St Paul: APS Press), pp. 233-247.

Ploetz, R., Zheng, Q., Vázquez, A., Abdel Sattar, M.A. (2002). Current status and impact of mango malformation in Egypt. *International Journal of Pest Management*, (in press).

Ploetz, R.C. (2004). The Major Diseases of Mango: Strategies and Potential for Sustainable Management. *Acta Horticulturae,***645**: 137-150.

Shawky, I., Z. Zidan, A.El. Tomi and Dahshan, D.I. (1980). Flowering malformation in relation to vegetative growth of Taimour mangoes. *Egyptian Journal of Horticulture,***5**: 123–132.

Shkolnik, M.Y.A.(1984).Trace Elements in Plants. *Developments in Crop Science* 6. Elsevier Amsterdam, Oxford, New York, Tokyo.

Yadav, V.K. (1999). Mango malformation - a review. *Journal of Applied Horticulture,***1**(1)70-78.

Yousef, S.A., Maymoun, M., Zveibil A., Klein-Gueta, D., Sztejnberg, A., Shalaby, A.A. and Freeman, S. (2007). Epidemiological aspects of mango malformation disease caused by *Fusarium mangiferae* and source of infection in seedlings cultivated in orchards in Egypt. *Plant Pathology* **56**: 257-263.