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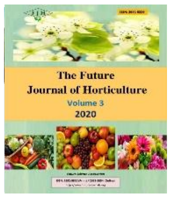


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# RESPONSE OF NEEM (*Azadirachta indica*) SEEDLINGS GROWN IN SANDY SOIL TO THE APPLICATION OF FILTER MUD AND SOME MICRONUTRIENTS

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**ABSTRACT**: The present work was carried out during the two successive seasons of 2018. and 2019 to assessment the influence of filter mud as organic manure and some micronutrients, as well as, their interactions on plant growth traits and chemical constituents of neem (*Azadirachta indica*) seedlings. Filter mud was applied to the soil of neem seedlings at the levels of 0, 30, 60 and 90 g/ seedling. Micronutrients applied namely, zinc (Zn) as $ZnSo_4.7H_2o$ and manganese (Mn) as $MnS0_4.H_2o$. The seedlings were sprayed with these nutrients as follows: control (0), 50 ppm Zn, 100 ppm Zn, 50 ppm Mn, 100 ppm Mn, 50 ppm Zn + 50 ppm Mn and 100 ppm Zn + 100 ppm Mn. The obtained results showed that the use of filter mud at all levels resulted a significant increase in stem length, stem diameter, leaves dry weight seedling, stem dry weight seedling and the three examined elements of N, P and K% in the dried leaves, except for the low level of filter mud (30 g/ seedling) regarding stem diameter in both seasons and also stem dry weight, in the first season. Clearly, applying the high level of filter mud (90 g/ seedling) gave the highest values of these previous traits. Obviously, foliar spray with Zn or Mn either single or together led of significant augment in above mentioned parameters, except for Zn at 50 ppm for both stem length and stem diameter, in the first season, as well as, 50 ppm Mn for leaves dry weight, in the first season and 50 ppm Mn for stem dry weight, in the second one. The highest values of the studied traits were detected by 100 ppm Zn + 100 Mn. The listed data indicated that the interaction effect was significant on all examined characteristics. Apparently, most combined treatments significantly augmented all tested aspects. Obviously, supplying the seedlings with filter mud at the high level (90 g/ seedling) plus foliar spray with 100 ppm Zn + 100 ppm Mn achieved the highest values of the studied traits.

**Key words**: Neem, *Azadirachta indica*, filter mud, zinc, manganese

## INTRODUCTION

Neem (*Azadiracta indica* A Juss.) tree is one of the promising woody trees introduced to Egypt. It is an evergreen tree in mahogany Family Meliaceae and it can be grow rapidly in the tropic and semi-tropic climates **(Ajala *et al.*, 2014)**. It is native to dry areas of Asia such as, India, Pakistan and others. neem tree is cultivated successfully in the avid regions of Egypt. neem tree is useful roles for examples: excellent wood, windbreak, fuel wood, seed oil, veterinary, medicine, fertilizers production and pest control.

Organic agriculture is based on minimizing the use of inputs and avoiding applying synthetic fertilizer and pesticides **(Galal and Ali, 2004)**. **Douda *et al.* (2008)** proved that organic manures canable serve as an alternative to mineral fertilizers for improving the structure of soil. Recently, one of the organic manures applied is filter mud; it is a local organic fertilizer, containing a lot of macro and micronutrients, which is beneficial role in enhancing the growth and productivity, as well as, chemical constituents.

The distinctive roles of organic manures in augmenting plant growth traits and chemical constituents of some woody trees were demonstrated by **Ahmed *et al.* (2006)** and **Mahmmoud (2014)** on *Populus sp.*, **Wroblewska *et al.* (2009)** on *Salix purpurea*, **William *et al.* (2012)**, **Abou El. Makarem (2016)** and **Hussien (2019)** on Moringa, **Ali *et al.* (2020)** and **Abd El Raheem (2020)** on *Taxodium disticum*, **Abo- Quta *et al.* (2020)** and **Abo- Quta (2021)** on *Khaya senegalensis*.

Micronutrients namely Zn and Mn are involved in many physiological processes, Zinc plays important role either as metal component of enzymes or acts a structural, functional and regulatory co-factor for many enzymes **(Grotz and Guerinot, 2006).** Zinc is a vital role in activating enzymes and involved in the metabolism of carbohydrates, protein, lipids and nucleic acid **(Zlatimira and Doncheva, 2002)**. Manganese is one of the main components in enzymes structure, which have to be effective in photosynthesis and other reactions, and Mn defficiency reduced photosynthesis **(Heckman, 2000)**. Mn plays beneficial role whereas activates decarboxylase and dehydrogenase, as well as, is a component of complex PS11 protein SOD and phosphatase. Mn deficiency causes an inhibitor of growth, necrosis, chlorosis, early fall of leaves and low reutilization **(Kabata Pendias and Pendias, 1999).**

The capability of Zn and Mn on enhancing the growth aspects and chemical constituents of some woody trees was studied by **Taha (1994)** *Parkinsonia aculeata*, **Badran *et al.* (1994)**, **Aly *et al.* (1994)**, **Ahmed (1995)**, and **Ahmed and Aly (1998)** on leuraena, **Mahdy (2002)** on *Albizzia lebbek*, **Mohamed (2001)**, **Ali *et al.* (2015)** and **Abd El Raheem (2015)** on *Khaya senegalensis* and **Abdou and Badran (2018)** on *Delonix regia*.

Therefore, this investigation was designed to study the influence of filter mud as organic manure and some micronutrients namely (Zn and Mn) and their interactions on the growth parameters and chemical constituents of neem seedlings.

## MATERIALS AND METHODS

A pot experiment design was conducted during the two growing seasons of 2018 and 2019 at Qus, Qena Governorate, Egypt to determine the effect of filter mud as organic manure and some micronutrients (Zn and Mn), as well as, their interactions on the plant growth traits and chemical constituents of neem (*Azadirachta indica* A. Juss.) seedlings. One-year-old of neem seedlings (healthy and uniform, average 24- 27 cm. in length and 0.25 - 0.29 cm. in diameter, for both seasons, respectively). These seedlings were planted. on the first week of March, in the two seasons, in polyethylene bags of 20x30 cm. filled with 10 Kg sandy soil (Each bag contained one seedling). The chemical properties of the used soil were estimated according to **Jackson (1973)** and are listed in Table (1).

**Table 1. Some physical and chemical properties of the experimental soil (average for two seasons)**

| Characters | | PH | EC | Ca% | Mg% | $Co_3$ % | CL% | N% | P% | K% |
|---|---|---|---|---|---|---|---|---|---|---|
| **Texture** | Sandy | 8.7 | 4.6 | 0.2 | 0.12 | 0.252 | 3.98 | 0.030 | 0.024 | 0.07 |
| **Sand%** | 77.52 | | | | | | | | | |
| **Clay%** | 12.48 | | | | | | | | | |
| **Silt%** | 10.0 | | | | | | | | | |

The design of this research was a split plot with three replicates and five seedlings/ replicate, filter mud levels at 0, 30, 60 and 90 g/bag assigned to the main plots (A), while micronutrient treatments represented the sub-plots(B). The applied filter mud was obtained from sugarcane industry at Qus, Qena Governorate, Egypt and added to the soil before the planting seedlings. The chemical properties of applied filter mud were determined according to **Black *et al.* (1965)** and are indicated in Table (2).

**Table 2. Chemical analysis of used filter mud (average of the two seasons)**

| Content | O.M (%) | T.C (%) | T.N (%) | Available P (ppm) | K (ppm) | pH | C/N ratio | Zn ppm | Mn ppm | Fe ppm | Cu ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Value** | 23.5 | 22.5 | 1.3 | 42.5 | 88.2 | 6.4 | 17.8 | 130 | 180 | 2150 | 45 |

The used micronutrients namely, zinc (Zn) as, $ZnSo_4.7H_2o$ and manganese (Mn) as $MnSo_4.H_2o$ and the treatments of these micronutrients as follows: Control (no sprayed), 50 ppm Zn, 100 ppm Zn, 50 ppm Mn, 100 ppm M, 50 ppm Zn + 50 ppm Mn and 100 ppm Zn + 100 ppm Mn. The seedlings were foliar sprayed with these treatments three times at two week intervals starting April 21$^{th}$, in the two seasons. The seedlings were sprayed till run off. Trition B at 0.05% was added as a wetting agent to all sprays. So, spraying control seedlings with water containing Trition B. All other agricultural practices were carried out as usual. On the first week of November, in both seasons, the following data were recorded: stem length (cm.), stem diameter (Cm.), leaves dry weight (g) /seedling and stem dry weight (g) / seedling, as well as, the -percentages of N, P and K % in the dried leaves were determined as follows: Nitrogen (%) was estimated according to the method of modified micro Kjeldahl as described by **Wilde *et al.* (1985)**, Phosphorus (%), was determined calorimetrically according to **Chapman and Pratt (1975)** and also Potassium (%) was estimated by Flame photometer according to **Cottenie *et al.* (1982).** The data were tabulated and statistically analyzed according to **MSTATE -C (1986)** using L.S.D. at 5% to know the differences among all treatments according to **Mead *et al.* (1993).**

## RESULTS AND DISCUSSION

### Stem length (cm)

The presented data in Table (3) cleared that stem length of neem seedlings was significantly increased as a result of applying filter mud as organic manure at all levels, in the two seasons, comparing to the check treatment. The longest stems were obtained due to the use of the high level of filter mud (90g/ seedling) reached 12.8 and 14,7 % over unfertilized. plants, in both seasons, respectively.

**Table 3. Effect of filter mud, Zn and Mn, as well as, their interaction on Stem length (cm) of neem seedlings during the two seasons of 2018 and 2019**

| Micronutrients (ppm) (B) | Filter mud level (g/ seedling) (A) | | | | |
|---|---|---|---|---|---|
| | **Control** | **30** | **60** | **90** | **Mean (B)** |
| | | | **First season** | | |
| **Control** | 118.1 | 126.6 | 127.0 | 130.2 | **124.9** |
| **Zn50** | 123.2 | 131.1 | 131.4 | 136.4 | **129.9** |
| **Zn100** | 129.7 | 133.8 | 136.5 | 142.0 | **135.3** |
| **Mn50** | 122.4 | 133.6 | 136.7 | 139.0 | **132.4** |
| **Mn100** | 127.3 | 135.9 | 142.3 | 144.0 | **137.6** |
| **Zn50 +Mn50** | 131.4 | 139.4 | 145.7 | 151.7 | **141.7** |
| **Zn100+Mn100** | 136.1 | 141.0 | 149.0 | 158.1 | **145.1** |
| **Mean(A)** | 126.9 | 134.5 | 138.4 | 143.1 | |
| **L.S.D. for 5%** | | **A : 3.7** | **B : 5.1** | **AB : 10.1** | |
| | | | **Second season** | | |
| **Control** | 119.8 | 126.3 | 128.5 | 133.4 | **127.0** |
| **Zn50** | 124.7 | 131.0 | 135.0 | 141.5 | **133.1** |
| **Zn100** | 131.0 | 134.7 | 138.7 | 145.4 | **137.5** |
| **Mn50** | 124.4 | 131.5 | 138.8 | 140.9 | **133.9** |
| **Mn100** | 130.4 | 136.4 | 144.1 | 149.3 | **140.1** |
| **Zn50 +Mn50** | 132.2 | 139.7 | 147.2 | 156.9 | **144.0** |
| **Zn100+Mn100** | 138.0 | 143.4 | 151.3 | 165.7 | **149.6** |
| **Mean(A)** | 128.7 | 134.7 | 140.5 | 147.6 | |
| **L.S.D. for 5%** | | **A : 2.9** | **B : 3.7** | **AB : 7.5** | |

The increments of stem length due to using organic manure was also discussed by **Ali *et al*. (2001)** and **El-Sayed and Abdou (2002)** on khaya plant**, Saleh (2000)** on *Ficus benjamina*, **Ali *et al*. (2002), Ahmed *et al*. (2006), Mahmmoud (2014)** and **Ahmed (2014)** on poplar species, **Abdou *et al*. (2003)** on *Delonix regja* and **William *et al*. (2012)** on moringa plants.

With respect to micronutrient treatments, data in Table (3) indicated that spraying neem seedlings with micronutrients examined (Zn or Mn) either separatly or together, during both seasons, led to a significant augment in stem length, except for 50 ppm Zn in the first season, as compared to untreated ones.

The longest stems were detected from applying the combined treatment (Zn at 100 + Mn at 100 ppm) as ranged 16.2 and 17,8 % over untreated plants in the first and second seasons, respectively.

The positive influence of Zn or Mn on augmenting stem length was also studied by **Abdou (1987)** and **Mohamed (2001)** on *Khaya senegalensis*, **Taha (1994)** on *Parkinsonia aculeate*, **Badran *et al*. (1994)** on *Leucaena leucocephala*, **Manoly (2001)** on *Zinnia elegans* and **Ali *et al*. (2002)** on apple trees.

As for the interaction, it was significant effect on stem length of neem seedlings, during the two consecutive seasons (Table, 3). Apparently, most of combined treatments caused a significant increase in such trait, in both seasons, comparing to untreated ones. Clearly, the highest values of stem length, in both seasons, were detected due to supplying neem seedlings with filter mud at the high level (90 g/seedling) with the combined treatment (Zn at 100 and Mn at 100 ppm), in comparison with those given by other combination treatments.

**Stem diameter (cm)**

The obtained results in Table (4) revealed that the use of filter mud at all levels, during both seasons, resulted a significant augment in stem diameter of neem seedlings, except for Filter mud at the low level (30 g/ seedling), in the two seasons, as compared to control plants. It could be noticed that utilizing filter mud at the high level (90 g/seedling) registered thicker stems reached 30,0 and 29,1 % over the check treatment, during the two growing seasons, respectively.

The role of organic manures in increasing stem diameter was also reported by **Ali *et al.* (2001)** and **El-Sayed and Abdou (2002)** on khaya plant, **Ali *et al*. (2002), Ahmed *et al*. (2006), Mahmmoud (2014)** and **Ahmed (2014)** on *Populus nigra*, **Saleh (2000)** on *Ficus benjamina*, **Abdou *et al*. (2003)** on *Delonix regja***, Badran *et al.* (2003)** on *Acacia saligna*, **Abdou *et al*. (2008)** and **Abdou and Ashour (2012)** on jojoba seedlings, **Fagbenro *et al.* (2013), Pahla *et al.* (2013)** and **Abou El-Makarem (2016)** on moringa plants, **Adejobi *et al.* (2015)** on cocoa seedlings and **Hamed (2017)** on anise.

Obviously, spraying neem seedlings with Zn or Mn concentrations either alone or in combination, in both seasons, led to a significant augment in stem diameter, except for 50 ppm Zn for the first season, in relative to no sprayed plants. Apparently, the highest values of stem diameter were observed when foliar spray with Zn at 100 + Mn at 100 ppm followed by Zn at 50 + Mn at 50 ppm which increased it by 27.8, 22,8, 27,3 and by 22.1 % over untreated ones, during both seasons, respectively, as clearly illustrated in Table (4).

The enhancement in stem diameter as result of using Zn or Mn was also insured by **Badran *et al*. (1994)** on *Leucaena leucocephala***, Mohamed (2001)** on *Khaya senegalensis*.

Data in Table (4) showed that the combined effect between the two studied factors on stem diameter of neem seedlings had statistically significant, during the two experimental seasons.

It is obvious that stem diameter was significantly increased by supplying neem seedlings with most combined treatments, in both seasons, as compared to untreated plants. From the revealed data, it could be noticed that the use of filter mud at the high level (90 g/ seedling) plus the combined treatment (100 ppm Zn + 100 ppm Mn) resulted thicker stems, in comparison with those obtained by other combination treatments, in the two seasons.

**Table 4. Effect of filter mud, Zn and Mn, as well as, their interaction on Stem diameter (cm) of neem seedlings during the two seasons of 2018 and 2019**

| Micronutrients (ppm) (B) | Filter mud level (g/ seedling) (A) | | | | |
|---|---|---|---|---|---|
| | Control | 30 | 60 | 90 | Mean (B) |
| | | | First season | | |
| **Control** | 0.68 | 0.74 | 0.83 | 0.92 | **0.79** |
| **Zn50** | 0.76 | 0.79 | 0.89 | 0.93 | **0.84** |
| **Zn100** | 0.83 | 0.86 | 0.93 | 1.06 | **0.92** |
| **Mn50** | 0.79 | 0.83 | 0.91 | 0.98 | **0.88** |
| **Mn100** | 0.85 | 0.86 | 0.95 | 1.01 | **0.92** |
| **Zn50 +Mn50** | 0.83 | 0.90 | 1.03 | 1.13 | **0.97** |
| **Zn100+Mn100** | 0.86 | 0.88 | 1.04 | 1.27 | **1.01** |
| **Mean(A)** | 0.80 | 0.84 | 0.94 | 1.04 | |
| **L.S.D. for 5%** | | **A : 0.05** | **B : 0.06** | **AB : 0.12** | |
| | | | Second season | | |
| **Control** | 0.65 | 0.72 | 0.83 | 0.88 | **0.77** |
| **Zn50** | 0.75 | 0.81 | 0.89 | 0.96 | **0.85** |
| **Zn100** | 0.80 | 0.89 | 0.91 | 1.06 | **0.92** |
| **Mn50** | 0.78 | 0.81 | 0.89 | 0.97 | **0.86** |
| **Mn100** | 0.83 | 0.84 | 0.93 | 0.98 | **0.90** |
| **Zn50 +Mn50** | 0.82 | 0.84 | 0.99 | 1.09 | **0.94** |
| **Zn100+Mn100** | 0.87 | 0.89 | 0.94 | 1.20 | **0.98** |
| **Mean(A)** | 0.79 | 0.83 | 0.91 | 1.02 | |
| **L.S.D. for 5%** | | **A : 0.05** | **B : 0.05** | **AB : 0.10** | |

## Leaves dry weight (g/seedling)

The obtained results in Table (5) emphasized that the application of filter mud as organic manure at all levels, during the two seasons, resulted a significant augment in leaves dry weight/ seedling of neem, in relative to the check treatment. The heaviest leaves dry weight was detected by using filter mud at the high level (90 g/ seedling) as ranged 44.7 and 27.9 % over unfertilized plants, in both seasons, respectively.

**Table 5. Effect of filter mud, Zn and Mn, as well as, their interaction on Leaves dry weight (g/seedling) of neem seedlings during the two seasons of 2018 and 2019**

| Micronutrients (ppm) (B) | Filter mud level (g/ seedling) (A) | | | | |
|---|---|---|---|---|---|
| | Control | 30 | 60 | 90 | Mean (B) |
| | | | First season | | |
| **Control** | 5.9 | 7.5 | 8.4 | 9.6 | **7.9** |
| **Zn50** | 7.2 | 9.0 | 9.5 | 10.2 | **9.0** |
| **Zn100** | 7.7 | 8.8 | 9.8 | 11.0 | **9.4** |
| **Mn50** | 7.0 | 8.1 | 9.0 | 10.0 | **8.5** |
| **Mn100** | 8.5 | 8.9 | 10.3 | 11.1 | **9.7** |
| **Zn50 +Mn50** | 7.8 | 9.4 | 10.9 | 11.7 | **10.0** |
| **Zn100+Mn100** | 8.8 | 10.2 | 11.1 | 13.1 | **10.8** |
| **Mean(A)** | 7.6 | 8.8 | 9.9 | 11.0 | |
| **L.S.D. for 5%** | | **A : 0.5** | **B : 0.8** | **AB : 1.5** | |
| | | | Second season | | |
| **Control** | 6.6 | 8.2 | 10.0 | 10.5 | **8.8** |
| **Zn50** | 8.2 | 9.3 | 10.3 | 11.4 | **9.8** |
| **Zn100** | 8.3 | 9.8 | 11.1 | 12.3 | **10.4** |
| **Mn50** | 7.8 | 9.3 | 10.0 | 11.5 | **9.7** |
| **Mn100** | 9.0 | 9.8 | 10.7 | 12.4 | **10.5** |
| **Zn50 +Mn50** | 9.7 | 10.8 | 12.1 | 13.5 | **11.5** |
| **Zn100+Mn100** | 10.3 | 11.8 | 13.1 | 14.2 | **12.4** |
| **Mean(A)** | 8.6 | 9.9 | 11.0 | 12.3 | |
| **L.S.D. for 5%** | | **A : 1.0** | **B : 0.8** | **AB : 1.6** | |

The beneficial effect of organic manures in increasing leaves weight was also demonstrated by **Ali *et al.* (2001)** and **El-Sayed and Abdou (2002)** on *Khaya senegalensis* seedlings, **Ali *et al*. (2002), Ahmed *et al.* (2006), Ahmed (2014)** and **Mahmmoud (2014)** on *Populus nigra*, **Abdou (2003)** on *Washingtonia filifera* seedlings, **Abdou and Ashour (2012)** on jojoba seedlings, **Ali *et al.* (2014)** on *Cassia acutifolia* and **Abou El-Makarem (2016)** on *Moringa oliefera***.**

Concerning micronutrient treatments, the listed data in Table (5) indicated that leaves dry weight/ seedling of neem was significantly increased due to foliar spray with the two micronutrients tested (Zn or Mn) either individual or mixture, in both seasons, except for the low concentration of Mn (50 ppm) in the first season, comparing to control.

Clearly, the heaviest leaves dry weight was observed by receiving the seedlings the combined treatment namely 100 ppm Zn + 100 ppm Mn which increased it by 36,7 and by 40,9 % over no sprayed ones, during both seasons, respectively.

The promoting effect of Zn or Mn on enhancing leaves weight was also explored by **Mohamed (2001)** on *Khaya senegalensis*.

The interaction effect between the two studied factors on leaves dry weight/ seedling of neem was statistically significant, during the two growing seasons. It could be noticed that such trait was significantly increased due to using all combined treatments, in both seasons, except for 0 filter mud + 50 ppm Zn in the first and, also 0 filter mud plus 50 ppm Mn in both seasons, as compared to untreated plants. Apparently, the utilization of filter mud at the high level (90 g/ seedling) with the combined treatment (100 ppm Zn + 100 ppm Mn), followed by the same level of filter mud plus the combined one (50ppm Zn + 50 ppm Mn) achieved the heaviest leaves dry weight of neem, in comparison with those detected by other combination treatments, during the two consecutive seasons, as clearly shown in Table (5).

**Stem dry weight (g/ seedling)**

Shown data in Table (6) claimed that stem dry weight/ seedling of neem was significantly increased as a result of supplying the seedlings with filter mud at all levels, except for the low level (30 g/seedling), in the first season, comparing to the check treatment. Obviously, the use of the high level of filter mud (90 g/ seedling) gave the heaviest stem dry weight which increased it by 28,3 and by 29,6 % over control, in both seasons, respectively.

The unique role of organic manures in augmenting stem weight was also proved by **Ali *et al.* (2001)** and **El-Sayed and Abdou (2002)** on *Khaya senegalensis* seedlings, **Badran *et al.* (2003)** on *Acacia saligna* **Ali *et al.* (2002)**, **Ahmed (2014)** and **Mahmmoud (2014)** on *Populus nigra* and **Abou El-Makarem (2016)** on *Moringa oliefera* plants.

With respect to micronutrient treatments, the listed data in Table (6) revealed that stem dry weight of neem seedlings was significantly augmented, in the two seasons due to foliar spray with the two examined micronutrients (Zn or Mn) either single or together, except for 50 ppm Mn, in the second season, as compared to no sprayed ones.

Obviously, supplying neem seedlings with the combined treatment (100 ppm Zn + 100ppm Mn.) registered the heaviest stem dry weight/ seedling reached 43,8 and 43,0 % over control plants, during the two experimental seasons, respectively.

The role of Zn or Mn in enhancing stem weight was also insured by **Badran *et al.* (1994)** and **Ahmed (1995)** on *Leucaena leucocephala***,** **Mohamed (2001)** on *Khaya senegalensis*, and **Manoly (2001)** on *Zinnia elegans*.

Concerning the combined effect between the two studied factors, it was significant effect on stem dry weight/ seedling of neem, during the two growing seasons (Table, 6). Clearly, the use of all combined treatments, in both seasons, led to a significant increase in stem dry weight / seedling, except for 0 filter mud with 50 ppm Zn or 50 ppm Mn and filter mud at the low level (30 g/ seedling) plus 0 micronutrient in the first season, besides to 0 filter mud + 50 ppm Mn and the low level of filter mud + 0 micronutrients for the second one, as compared to untreated plants. Apparently, the heaviest stew dry weight/ seedling was detected when applying filter mud at the high level (90 g/ seedling) in combination with 100 ppm Zn + 100 ppm Mn followed by with 50 ppm Zn +50 ppm Mn and by filter mud at the moderate level (60 g/ seedling) plus 100 ppm Zn + 100 ppm Mn, in comparison with those given by other combination treatments, during the two seasons.

**Table 6. Effect of filter mud, Zn and Mn, as well as, their interaction on Stem dry weight (g/ seedling) of neem seedlings during the two seasons of 2018 and 2019**

| Micronutrients (ppm) (B) | Filter mud level (g/ seedling) (A) | | | | |
|---|---|---|---|---|---|
| | Control | 30 | 60 | 90 | Mean (B) |
| | | | **First season** | | |
| **Control** | 11.1 | 13.4 | 14.4 | 16.0 | **13.7** |
| **Zn50** | 13.7 | 15.3 | 16.8 | 17.7 | **15.9** |
| **Zn100** | 15.0 | 16.1 | 17.5 | 18.3 | **16.7** |
| **Mn50** | 13.2 | 14.2 | 16.0 | 17.4 | **15.2** |
| **Mn100** | 15.3 | 16.2 | 17.2 | 18.2 | **16.7** |
| **Zn50 +Mn50** | 16.3 | 17.٦ | 18.6 | 20.4 | **18.2** |
| **Zn100+Mn100** | 16.7 | 19.3 | 20.3 | 22.6 | **19.7** |
| **Mean(A)** | **14.5** | **16.0** | **17.3** | **18.6** | |
| **L.S.D. for 5%** | | **A : 1.6** | **B : 1.2** | **AB : 2.4** | |
| | | | **Second season** | | |
| **Control** | 10.9 | 13.2 | 14.4 | 15.7 | **13.5** |
| **Zn50** | 12.5 | 14.6 | 15.7 | 17.2 | **15.0** |
| **Zn100** | 14.7 | 15.5 | 16.3 | 18.1 | **16.2** |
| **Mn50** | 12.8 | 13.8 | 15.9 | 16.7 | **14.8** |
| **Mn100** | 14.5 | 16.0 | 17.0 | 18.4 | **16.5** |
| **Zn50 +Mn50** | 16.0 | 17.5 | 18.6 | 20.7 | **18.2** |
| **Zn100+Mn100** | 18.0 | 18.0 | 19.5 | 21.9 | **19.3** |
| **Mean(A)** | **14.2** | **15.5** | **16.8** | **18.4** | |
| **L.S.D. for 5%** | | **A : 1.0** | **B : 1.4** | **AB : 2.8** | |

### Nitrogen, phosphorus and potassium percentages

The listed data in Tables (7, 8 and 9) pointed out that the application of filter mud as organic manure at all levels led to a significant increase in N, P and K% in the dried leaves of neem seedlings, during both seasons, as compared to the check treatment. From the revealed data, it could be noticed that the highest values of the three examined elements (N, P and K%.) were obtained by supplemented the seedlings with the high level of filter mud (90 g/seedling) as ranged 17,3 and 18,2 % for N %, 18,4 and 18,3 % for P % and 27,1 and 33,3 % for K % over unfertilized ones, in the two seasons, respectively.

The importance of organic manures in augmenting the elements of N, P and K was also reported by **Saleh (2000)** and **Siraj *et al.* (2001)** on *Ficus benjamina*, **Ali *et al.* (2001)** and **El-Sayed and Abdou (2002)** on *Khaya Senegalensis*, **Ali *et al.* (2002), Ahmed *et al.* (2006)** and **Mahmmoud (2014)** on *Populus nigra*, **Abdou *et al.* (2003)** *Delonix regia*, **Badran *et al*. (2003)** on *Acacia saligna* seedlings, **El-Khateeb *et al.* (2006)** on *Ficus alii*, **Hassan *et al*. (2010)** on dill plants **Ahmadloo *et al.* (2012)** on cypress seedlings, **Adejobi *et al*. (2015)** on cocoa plant, **Asaolu *et al.* (2012)** and **Abou El-Makarem (2016)** on Moringa plant and **Hamed (2017)** on anise.

As for the influence of micronutrient treatments, the given data in Tables (7, 8 and 9) indicated that foliar spray with Zn or Mn either separately or mixture led to a great significant augment in the three studied elements (N, P and K %) in the dried leaves of neem seedlings comparing to no sprayed plants, during the two experimental seasons. Obviously, the highest values of these elements were obtained due to the application of the combined treatment (100ppm Zn + 100 ppm Mn) reached 35,5 and 31,6 % for N %,26,0 and 26,0 for P% and 47,4 and 42,2 % for K % over untreated plants, during both seasons, respectively.

The augment in the elements of N, P and K as a result of applying Zn or Mn was also examined by **Abdou (1987)** on *Khaya senegalensis* seedlings, **Shehata (1995)** and **Aly *et al.* (1994)** on *Poinciana regia*, **El-Humaid (1998)** on rose plants, **Manoly (2001)** on *Zinnia elegans*, **Gable *et al.* (1985)** on banana plant, **Farag *et al.* (1991)** on *Solanum melongana*, **Mohamed (2001)** on some seedlings, **Badran *et al.* (2002)** on anise plants and **El-Morsy *et al.* (2010)** on sweet potato.

**Table 7. Effect of filter mud, Zn and Mn, as well as, their interaction on N% of neem seedlings during the two seasons of 2018 and 2019**

| Micronutrients (ppm) (B) | Filter mud level (g/ seedling) (A) | | | | |
|---|---|---|---|---|---|
| | **Control** | **30** | **60** | **90** | **Mean (B)** |
| **First season** | | | | | |
| **Control** | 2.09 | 2.24 | 2.24 | 2.43 | **2.28** |
| **Zn50** | 2.33 | 2.42 | 2.42 | 2.68 | **2.50** |
| **Zn100** | 2.43 | 2.52 | 2.52 | 2.88 | **2.66** |
| **Mn50** | 2.38 | 2.55 | 2.55 | 2.82 | **2.61** |
| **Mn100** | 2.52 | 2.69 | 2.69 | 2.96 | **2.76** |
| **Zn50 +Mn50** | 2.72 | 2.84 | 2.84 | 3.23 | **2.95** |
| **Zn100+Mn100** | 2.89 | 2.92 | 2.92 | 3.36 | **3.09** |
| **Mean(A)** | 2.48 | 2.60 | 2.60 | 2.91 | |
| **L.S.D. for 5%** | | **A : 0.05** | **B : 0.06** | **AB : 0.12** | |
| **Second season** | | | | | |
| **Control** | 2.15 | 2.28 | 2.48 | 2.58 | **2.37** |
| **Zn50** | 2.32 | 2.41 | 2.69 | 2.77 | **2.55** |
| **Zn100** | 2.50 | 2.76 | 2.89 | 2.97 | **2.78** |
| **Mn50** | 2.41 | 2.49 | 2.78 | 2.95 | **2.66** |
| **Mn100** | 2.58 | 2.76 | 2.92 | 3.07 | **2.83** |
| **Zn50 +Mn50** | 2.75 | 2.92 | 3.02 | 3.22 | **2.98** |
| **Zn100+Mn100** | 2.94 | 3.08 | 3.14 | 3.32 | **3.12** |
| **Mean(A)** | 2.52 | 2.67 | 2.84 | 2.98 | |
| **L.S.D. for 5%** | | **A : 0.04** | **B : 0.04** | **AB : 0.09** | |

**Table 8. Effect of filter mud, Zn and Mn, as well as, their interaction on P % of neem seedlings during the two seasons of 2018 and 2019**

| Micronutrients (ppm) (B) | Filter mud level (g/ seedling) (A) | | | | |
|---|---|---|---|---|---|
| | **Control** | **30** | **60** | **90** | **Mean (B)** |
| **First season** | | | | | |
| **Control** | 0.275 | 0.294 | 0.314 | 0.332 | **0.304** |
| **Zn50** | 0.296 | 0.312 | 0.347 | 0.354 | **0.327** |
| **Zn100** | 0.305 | 0.314 | 0.365 | 0.372 | **0.339** |
| **Mn50** | 0.298 | 0.319 | 0.357 | 0.361 | **0.334** |
| **Mn100** | 0.330 | 0.345 | 0.370 | 0.386 | **0.358** |
| **Zn50 +Mn50** | 0.340 | 0.358 | 0.376 | 0.395 | **0.367** |
| **Zn100+Mn100** | 0.361 | 0.371 | 0.392 | 0.408 | **0.383** |
| **Mean(A)** | 0.315 | 0.330 | 0.360 | 0.373 | |
| **L.S.D. for 5%** | | **A : 0.004** | **B : 0.006** | **AB : 0.011** | |
| **Second season** | | | | | |
| **Control** | 0.283 | 0.300 | 0.327 | 0.337 | **0.312** |
| **Zn50** | 0.299 | 0.319 | 0.354 | 0.358 | **0.332** |
| **Zn100** | 0.320 | 0.333 | 0.368 | 0.386 | **0.352** |
| **Mn50** | 0.315 | 0.325 | 0.355 | 0.372 | **0.342** |
| **Mn100** | 0.333 | 0.345 | 0.363 | 0.382 | **0.356** |
| **Zn50 +Mn50** | 0.341 | 0.352 | 0.387 | 0.405 | **0.371** |
| **Zn100+Mn100** | 0.364 | 0.382 | 0.401 | 0.425 | **0.393** |
| **Mean(A)** | 0.322 | 0.337 | 0.365 | 0.381 | |
| **L.S.D. for 5%** | | **A : 0.006** | **B : 0.006** | **AB : 0.013** | |

**Table 9. Effect of filter mud, Zn and Mn, as well as, their interaction on K% of neem seedlings during the two seasons of 2018 and 2019**

| Micronutrients (ppm) (B) | Filter mud level (g/ seedling) (A) | | | | |
|---|---|---|---|---|---|
| | Control | 30 | 60 | 90 | Mean (B) |
| | | | **First season** | | |
| **Control** | 1.29 | 1.43 | 1.61 | 1.61 | **1.52** |
| **Zn50** | 1.46 | 1.59 | 1.75 | 1.75 | **1.68** |
| **Zn100** | 1.69 | 1.86 | 1.95 | 1.95 | **1.90** |
| **Mn50** | 1.60 | 1.75 | 1.82 | 1.82 | **1.79** |
| **Mn100** | 1.72 | 1.89 | 2.05 | 2.05 | **1.97** |
| **Zn50 +Mn50** | 1.86 | 2.03 | 2.22 | 2.22 | **2.11** |
| **Zn100+Mn100** | 2.00 | 2.22 | 2.32 | 2.32 | **2.24** |
| **Mean(A)** | 1.66 | 1.83 | 1.96 | 1.96 | |
| **L.S.D. for 5%** | | **A : 0.05** | **B : 0.06** | **AB : 0.11** | |
| | | | **Second season** | | |
| **Control** | 1.31 | 1.56 | 1.72 | 1.88 | **1.61** |
| **Zn50** | 1.52 | 1.63 | 1.86 | 2.04 | **1.76** |
| **Zn100** | 1.66 | 1.83 | 2.01 | 2.25 | **1.94** |
| **Mn50** | 1.48 | 1.66 | 1.95 | 2.11 | **1.80** |
| **Mn100** | 1.66 | 1.81 | 2.12 | 2.24 | **1.96** |
| **Zn50 +Mn50** | 1.89 | 2.06 | 2.31 | 2.41 | **2.17** |
| **Zn100+Mn100** | 2.05 | 2.24 | 2.38 | 2.48 | **2.29** |
| **Mean(A)** | 1.65 | 1.83 | 2.05 | 2.20 | |
| **L.S.D. for 5%** | | **A : 0.03** | **B : 0.04** | **AB : 0.09** | |

Accordingly, the three tested elements (N, P and K %) in the dried leaves of neem seedlings were significantly affected by the interaction between the two factors, during the two growing seasons. Clearly, the use of all combined treatments caused a significant increase in the three studied elements (N, P and K %), as compared to control, during the two consecutive seasons. Moreover, the addition of filter mud at the high level (90 g/ seedling) with the combined treatment (100 ppm Zn + 100 ppm Mn) gave the highest values of N, P and K %, in comparison with those obtained by other combination treatments, in the two seasons, as clearly indicated in Tables (7,8 and 9).

From the obtained results, it could be discussed as follows: The augment in stem length, stem diameter, leaves dry weight / seedling and stem dry weight / seedling and the elements of N, P and K% in the dried leaves of neem seedlings as a result of the application. of filter mud as organic manure reflect the positive, biological and physiological roles of organic manures which were examined by many authors for example: **Bohn *et al.* (1985)** proved that organic manure is main source of N, P and S, besides, it contains high concentrations of B and Mo. These authors indicated that organic matter is a source of energy for Azotobacter growth. **Saber (1997)** mentioned that organic manure canable minimized the loss of nutrients by leaching. **Natarajan (2007)** and **Sreenivasa *et al.* (2010)** pointed out that organic manure contains growth stimulating hormones (IAA and GA3) macronutrients, essential micronutrients and beneficial microorganisms. Moreover, organic manure augments microbial activities in the root zone by utilizing it via the soil **(Taiwo *et al.*, 2002).** The enhancement in the previous aspects in this work resulting from foliar spray with Zn or Mn either single or mixture may be due to the positive, biological and physiological roles of Zn and Mn which were studied by several investigators such as, Zinc is an essential element of plant as a participation in tryptophan synthesis that is a result of its precursor of the synthesis of IAA and it required for various enzymes activity as co-factor, as dehydrogenases, isomerases, aldolases and RNA and DNA polymerases **(Swietlik, 1999)**. Also Zinc is a vital role in the metabolism of nucleic acid and starch in plant and affects photosynthesis reaction, likewise the biosynthesis of carbohydrates and Protein **(Marschner 1995 and Alloway, 2008) Collins (1981)** suggested that Zinc is an important role in cell division, cell expansion, the synthesis of protein and in carbohydrates, nucleic acid and lipid metabolism.

As for Mn, it is involved in the oxygen - evolving step of photosynthesis and function of membrane, besides to serving as an important activator of numerous enzymes in the cell **(Wiedenhoeft, 2006)**, **Heckman (2000)** proved that Mn is one main components in enzymes structure, which are effective in photosynthesis and other reactions. The author added that Mn deficiency extremely decreased photosynthesis. The elements of Zn and Mn augment auxin biosynthesis and play an important role in the mechanism of action of IAA on cell growth **(Yagodin, 1984).** Furthermore, Mn is predominant enzyme activating metal of Krebs cycle and it required in the metabolism of nitrogen, photosynthesis and IAA (Bidwell, 1974). From the obtained results, it could be recommended to supply the soil of (*Azadirachta indica*) neem seedlings with filter mud at 90 g/ seedling and foliar spray with 100 ppm Zn + 100 ppm Mn to enhance the plant growth traits and some chemical constituents under the research conditions.

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