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Response of *Adansonia digitata* to Compost and Zeolite in Replacement of Chemical Fertilization

[1]*Amira Sh. Soliman* and [2]*Abdelwahab M. Mahmoud*

[1]Department of Natural Resources, Institute of African Research and Studies, Cairo University, Giza, Egypt
[2]Plant Physiology Division, Agricultural Botany Department,
Faculty of Agriculture, Cairo University, Giza, Egypt

Abstract: The unique cation exchange, adsorption, hydration-dehydration and catalytic properties of natural zeolite (as granules) loaded with micronutrients, have promoted their use in clean agriculture as soil amendments and slow-release fertilizers. This study was conducted in open field for two successive seasons 2011 and 2012 to investigate the effect of natural zeolite, organic fertilizer (compost) and combination of them on growth and chemical constituents of *Adansonia digitata* L. seedlings. The results indicated that zeolite loaded with micronutrients mixed with organic fertilizer led to significant increase in growth characters with reference to (fresh weight, dry weight, number of leaves, leaf area, as well as stem diameter) and chemical composition symbolized in (net photosynthesis, stomatal conductance, crude protein, water use efficiency, plant pigments, total carbohydrates, ascorbic acid, N, P, K, Zn, Fe, Mn, B, Ca, Mg) besides indigenous hormones such as indole acetic acid (IAA), gibberellic acid (GA_3) and cytokinins (CK) in comparison with the recommended dose of chemical fertilizers NPK (as control) under the same conditions. These results undoubtedly confirm that zeolite and organic fertilizer (compost) mixture could replace the application of chemical fertilizers and consequently improve the quality and quantity of *Adansonia* tree. Generally, this application may have direct impacts on safety and efficacy of active constituents which entail for medicinal and aromatic products. Besides minimizing economic costs and pollution of agricultural environment.

Key words: *Adansonia digitata* · Chemical composition · Compost · Growth characters · Indigenous hormones · Zeolite

INTRODUCTION

Effective agriculture, sanitary, safety treatments and collection practices for medicinal and aromatic plants is only the first step in quality assurance on which the safety and efficacy of medicinal and aromatic products directly depend upon [1]. Lately, the safe agriculture is one of the main attitudes in the world [2]. Also, there has been an increasing awareness of the undesirable impact of chemical fertilizers on the environment, as well as the potentially dangerous effects of chemical residues in plant tissues on the health of human and animal consumers. Therefore, organic fertilizers are very important in plant fertilization in many countries including Egypt due to their beneficial effects on the soil, growth and increase the productivity as well as improving the quality of plant production [3] on Onion; [4] on Sweet pepper and [5] on Garlic and Onion. Natural zeolite (clinoptilolite) containing micronutrients is an amazing crystalline mineral capable of adsorbing and absorbing many different types of gases, moisture, petrochemicals, heavy metals, low-level radioactive elements and a multitude of various solutions besides high cation exchange capacities, also produces long term soil improvements as well as slow release fertilizer of nutrients beside avoid the loss of nitrogen [6] and environmental protection [7]. Zeolite can also act as water moderators, in which they will adsorb up to 55% of their weight in water and slowly release it under plant demand [8]. Other studies, Krutilina *et al.* [9] indicated that zeolite improved biomass production and photosynthesis rate in maize and barley. Also, Miller [10] on Bermudagrass found that, zeolite works as soil amendment and has potential to influences soil water content.

Corresponding Author: Amira Sh. Soliman, Department of Natural Resources,
Institute of African Research and Studies, Cairo University, Giza, Egypt

Adansonia digitata L. (Bombacaceae) is a largely tropical plant of African origin known as baobab tree [11]. Baobab has been identified as among the top ten agroforestry tree species to be conserved and domesticated in West Africa [12]. It has been referred to as "arbre a palabre", meaning the place in the village where the elders meet to resolve problems [13]. Various parts of the plant are also, used as food so it is a key economic species used daily in the diet of rural communities in West Africa [14]. In addition, various parts of the plant (Leaves, bark, pulp and fruits) are traditionally employed in several African regions as famine food to prepare decoctions, sauces and natural refreshing drink, due to its nutritional properties [15, 16]. El-Rawy *et al.* [17], De Caluwe *et al.* [18] and Nguta *et al.* [19] reported that the plant is medicinally used in many African cultures for the treatment of various ailments including febrifuge, analgesic, anti-diarrhea/anti-dysentery and for treatment of smallpox and measles [20] prophylactic, colic fever asthma, diarrhea, gastro enteric inflammation, ulcer amongst other and for medicinal purposes [21] and for that reason baobab is also named "the small pharmacy" or "chemist tree" [22, 23].

Therefore, this study aims to investigate effect of natural zeolite, organic fertilizer (compost) and combination of them on growth and chemical constituents of *Adansonia digitata* L. seedlings

MATERIALS AND METHODS

Two field experiments were carried out at Wadi El-Notron region, Behaira Province, Egypt, during two successive seasons 2011 and 2012. Physical and chemical characteristics of the soil site were determined according to Richards [24] and Jackson [25] as shown in Table 1. The chemical characteristics of compost (Table 2), which obtained from Soil and Water and Environment Research Institute, Agriculture Research Center, Giza, Egypt were accomplished as described by Page *et al.* [26] before planting. Natural zeolite loaded with micronutrients as granules used in this study was obtained from Prima Company, Yogyakarta, Indonesia as shown in Table 3.

Plant Material: Seeds of *Adansonia digitata* L. (Labill.) were obtained from Agriculture Station of El-khartom, Sudan, by cracking dry fruits and washing away the dry, powdery coating. Subsequently, collected seeds were soaked in boiling water for 5-7 min. then left to cool overnight place [27]. At the 1st of November 2010 the treated seeds were sown in the experimental field, with a distance of 60 cm between rows and 60 cm between hills.

Fertilizers Treatments: The treatments used were as follows:

- NPK (chemical fertilizers as control)
- Compost
- Zeolite
- Compost + Zeolite

Compost at the rate of 5 ton/feddan as well as Zeolite at the rate of 210 Kg/feddan (one feddan=0.42ha) and combination of them (1:1) were applied at 20 days before planting. Chemical fertilizers as recommended dose were added at the rate of 150 Kg /feddan ammonium nitrate (33.5% N) was added in two equal doses, the first after 3 weeks from planting and the second at six weeks later. Phosphorus and potassium fertilizers were applied before planting in the form of Calcium superphosphate (15.5% P_2O_5) and Potassium sulphate (48-50% K_2O) at the rate of

Table 1: Some physical and chemical properties of experimental soil site

Physical properties (%)			Chemical properties												
								Cations (meq/ l)				Anion (meq/l)			
Sand	Silt	Clay	Soil texture	pH	EC (dS/m)	Organic C (%)	Total N (%)	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
90.5	6.50	3.0	Sandy	7.8	1.37	0.38	0.03	4.16	1.52	3.24	0.21	--	0.54	3.31	2.13

Table 2: Chemical analysis of compost

pH (1:5)	EC (1: 5) dS/m	OM (%)	Organic C %	Total content of bacteria	Phosphate dissolving bacteria	Humidity (%)	Weed seeds	Total N %	Total K %	Total P %	C/N ratio	Fe ppm	Mn ppm	Cu ppm	Zn ppm
7.5	3.1	70	33.11	2.5×10^7	2.5×10^6	25	--	1.82	1.25	1.29	14.1	1019	111	180	280

Table 3: Chemical composition of Zeolite

Chemical composition (%)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	Fe O	Mn O	Mg O	Ca O	Na_2O	K_2O	Sr O	P_2O_3	Loss on ignition
	45.50	2.81	13.30	5.40	8.31	0.51	6.30	9.52	2.83	0.87	0.22	0.67	3.76
Trace elements (ppm)	Ba	Co	Cr	Se	Cu	Zn	Zr	Nb	Ni	Rb	Y	--	--
	10	1.2	35	0.8	19	64	257	13	55	15	22	--	--

200 and 50 Kg/feddan, respectively. The experimental design was Randomized Complete Block Design (RCBD) with ten replicates. Agricultural practices were followed as recommended throughout the two years of seedlings growing using dripping irrigation system. At the 1st November 2011 and 2012 the seedlings of *Adansonia digitata* were harvested and the following data were recorded.

Growth Characters: Plant height (cm), Number of leaves, Leaf area (cm^2), Stem diameter (cm), Herb fresh and dry weights (g/plant), fresh weight (ton/fedden).

Chemical Analysis

Macro and Microelements: Dried leaves samples were digested as reported by Piper [28] and the extract was analyzed to determine:

Nitrogen and Crude protein: The total nitrogen content (% of dry weight) was determined by using the modified-micro-Kjeldahl method as described by A.O.A.C. [29]. The nitrogen percentage was multiplied by 6.25 to estimate the crude protein percentages.

Phosphorus: Phosphorus (% of dry weight) was determined calorimetrically by using the chlorostannous molybdophosphoric blue color method in sulphuric acid according to Jackson [25].

Potassium: Potassium concentrations were determined by using the flame photometer apparatus (CORNING M 410, Germany) [30].

Calcium, Magnesium, Iron, Manganese, Boron and Zinc: Concentration of Ca, Mg, Fe, Mn, B and Zn were determined using Atomic Absorption Spectrophotometer with air-acetylene, fuel (Pye Unicam, model SP-1900, US) [31].

Photosynthetic Pigments, Total carbohydrates and Vitamin C: Total chlorophylls and carotenoids content (mg/g fresh weight) were measured by Spectrophotometer and calculated according to the equation described by Nornai [32]. Total carbohydrates (%) in plant herbs were determined by phosphomolybdic acid method as reported by A.O.A.C. [29]. Vitamin C as ascorbic acid (mg/g fresh weight) was determined and estimated per100 ml fresh leave juice, according to A.O.A.C. [29] method.

Net Photosynthesis: Measurements of net photosynthesis on an area basis (µmol CO_2 m^{-2} s^{-1}), leaf stomatal conductance (mol H_2O $m^{-2}s^{-1}$) and water use efficiency (carbon fixed/water lost) of five different leaves per treatment were monitored using a LICOR 6400 (Lincoln, Nebraska, USA) infrared gas analyzer (IRGA). Light intensity (Photosynthetically active radiation, PAR) within the sampling chamber was set at 1500 µmol $m^{-2}s^{-1}$, using a Li-6400- 02B LED light source (LI-COR). The CO_2 flow into the chamber was maintained at a concentration of 400 µmol/mol using a LI-6400-01 CO_2 mixer (LI-COR).

Endogenous Phytohormones: Freeze-dried plant herbs (equivalent 6 g FW) were ground to a fine powder within a mortar and pestle. The powdered material was extracted three times (1 x 3h. 2 x1h) with methanol (80% v/v, 15 ml/g FW), supplemented with butylated hydroxy toluene (2. (6)–Di-tret-Butyl-P-crosol) as an antioxidant at 4°C in darkness. The extract was centrifuged at 4000 rpm. The supernatant was transferred into flasks wrapped with aluminum foil and the residue was twice extracted again. The supernatants were combined and the volume was reduced to 10 ml at 35°C under vacuum. The aqueous extract was adjusted to pH 8.6 and extracted three times with an equal volume of pure ethyl acetate. The combined alkaline ethyl acetate extract was dehydrated over anhydrous sodium sulphate then filtered. The filtrate was evaporated to dryness under vacuum at 35°C and redissolved in 1 ml absolute methanol. The methanol extract was used after methylation for the determination of cytokinins (CK) [33]. The remaining aqueous extract was acidified to pH 2.6 and extracted as previously described by ethyl acetate. The methanol extract was used after methylation according to Fales and Jaouni [34] for determination of Gibberellic acid (GA) and indole-acetic acid (IAA). The quantification of the endogenous phytohormones was carried out with Ati-Unicum gas-liquid chromatography, 610 Series, equipped with flame ionization detector according to the method described by Vogel [35]. The fractionation of phytohormones was conducted using a coiled glass coulumn (1.5 m x 4 mm) packed with 1% OV-17. Gases flow rates were 30, 30, 330 ml/min, for nitrogen, hydrogen and air, respectively. For cytokinins fractionation, the temperature were for injector 260°C, detector 300° C and column initially for 3 min. at 220°C then programmed at 20°C/min. for 220°C to 240°C. Then, isothermally at 240° C for 8 min. For IAA and GA, the initial column temperature was 200°C for 3 min. then programmed at 20°C/min. for 200°C to 220°C, then isothermally at 220°C for 4 min, then programmed at 20°C/min. for 220°C to 240°C, then isothermally at 240°C for 6 min. The peaks identification and quantification of phytohormones were performed by using external authentic hormones and a Microsoft program to calculate the concentrations of the identified peaks.

Statistical Analysis: The data were analyzed using ANOVA at 5% significance level, the difference between treatments then analyzed using DMRT (Duncan Multiple Range Test) at 5% [36].

RESULTS AND DISCUSSION

Growth Characters: The obtained results revealed that, compost associated with Zeolite mixture significantly increased all growth characters *in Adansonia digitata* seedlings in both seasons compared to control treatment (plants received recommended dose of NPK) (Table 4). Shoot fresh weight per fadden was increased by 44% and 45% in the first and second season, respectively. Concerning this, it was outstanding that Zeolite treatment unaccompanied with compost, also donate results significantly superior to results of control plants in all morphological parameters during both seasons. On the other hand, there were insignificant increments recorded with application of compost alone in comparison with control plants on the subject of both shoot fresh weight ton per Fadden (0.32,0.43), respectively although, these increments were in the favor of control plants which recorded 0.37 and 0.46, respectively.

These results provide a plausible mechanism for how the combination of compost and zeolite together led to increase growth parameters over control, this raise spring from their beneficial effects on seedlings represented in nutrients availability and improvement of soil physical, chemical and biological properties resulted in more water retention simultaneously with available elements to be absorbed by plants roots and its insightful effect on the physiological processes such as photosynthesis activity as well as the utilization of carbohydrates. Supportive evidence for this view was reported by El-Kassas [37], El-Desuki *et al*. [38] on sweet fennel, Shaalan [39] on borage (*Borago officinalis*) plants showed that, fertilization plants with organic manures and compost improved plant growth characters expressed as plant height and number of branches, yield fresh and dry weight, while Milosevic and Milosevic [40] on apricot trees indicated that, organic manures and natural zeolite gave significant results compared to control plants. Moreover, Krutilina *et al.* [9] on barley and maize, Ranjbar *et al.* [41] on of tobacco plant and Bernardi *et al.* [42] on Oat stated that, zeolite application increased leaf area, plant height and stem diameter relative to the control without zeolite.

Table 4: Effect of compost and zeolite on growth characters of *Adansonia digitata* during 2011 and 2012

Treatment	Season	Plant height (cm)	No. of leaves	Leaf area (cm^2)	Stem diameter (cm)	Herb fresh weight (g/plant)	Herb dry weight (g/plant)	Fresh weight (ton/fed)
Control (N,P,K)	1st	27e	15c	20.04e	1.9c	31.64e	8.21c	0.37e
	2nd	35d	18c	24.34d	2.0c	38.55d	9.75c	0.46d
Compost	1st	24e	11d	15.59f	1.7d	26.15e	5.66d	0.32e
	2nd	33d	16c	23.34d	2.0c	36.11d	9.22c	0.43d
Zeolite	1st	44c	21b	31.51c	2.9b	40.06d	11.85c	0.48d
	2nd	48b	24b	35.29b	3.4a	51.39c	13.46c	0.61c
Compost + Zeolite	1st	50b	29a	32.79c	4.0a	67.96b	18.51b	0.81b
	2nd	54a	32a	38.65a	4.5a	86.71a	23.84a	1.04a

Means with the same letter in a column are not significantly different by DMRT 5%.

Table 5: Effect of compost and zeolite on chemical analysis of *Adansonia digitata* during 2011and 2012

Treatments	Season	Total chlorophyll (mg/g f.w.)	Carotenoids (mg/g f. w.)	Total carbohydrates (%)	Ascorbic acid (mg/g f.w.)	Crude protein (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe ppm	Zn ppm	B ppm	Mn ppm
Control	1st	0.99d	0.45c	9.30c	0.5c	0.812d	0.13d	1.12e	6.31e	5.21c	0.48e	67.33e	87.68e	19e	29.44e
(N,P,K)	2nd	1.08c	0.50b	10.22b	0.7c	1.062c	0.17c	1.53d	8.22d	6.34c	0.97b	82.41d	95.22d	22d	37.18d
Compost	1st	0.87e	0.40d	8.21c	0.9b	0.5f	0.08f	0.95f	5.18e	4.98d	0.32f	55.27f	76.37f	18e	22.93f
	2nd	1.14b	0.55b	11.45b	1b	1.125c	0.18c	1.57d	8.59d	6.79b	0.66d	70.49e	90.42d	26d	40.21d
Zeolite	1st	0.97d	0.46c	11.20b	1b	0.687e	0.11e	1.89c	9.49d	7.58b	0.81c	86.52d	93.71d	30c	48.32c
	2nd	1.18b	0.49b	12.34a	1.1b	0.75d	0.12d	2.42b	11.22c	8.24a	0.96b	98.44c	108.11c	39b	53.11c
Compost	1st	1.16b	0.62a	12.56a	1.7a	1.312b	0.21b	3.32a	13.47b	8.55a	1.45a	100.25b	119.24b	43a	63.57b
+Zeolite	2nd	1.51a	0.66a	13.37a	1.9a	1.875a	0.30a	4.57a	16.86a	9.13a	1.87a	131.40a	151.11a	48a	76.28a

Means with the same letter in a column are not significantly different by DMRT 5%.

Chemical Analysis

Macro and Microelements: Data presented in Table 5 indicated that the concentrations of macro and micronutrients in the shoot of *Adansonia digitata* significantly increased as a result of combination between compost and zeolite treatment in comparison with control plants in the first and second seasons, these augmentation with reference to main macro-elements N, P and K were 58.8%, 33.5% and 47.9%, respectively over control plants. While, the increment of Fe, Zn and B were 64.6%, 67.6% and 45%, respectively over control plants. Concerning zeolite treatment alone a significant increase was detected over control plants in most macro and microelements concentration in the second season. Many studies have shown that the fertilizing power of compost is due to its content of stabilized organic matter and as a result of the amount of nutritive elements contained therein [43]. Increasing macro and micronutrient concentrations by compost fertilization might be due to the increase in root surface per unit of soil volume as well as the high capacity of the plants supplied with compost fertilizer in building metabolites, which in turn contribute much to the increase of nutrient uptake [44], alongside the vital role of natural zeolite containing macro and micronutrients and its channels that provide large surface areas on which chemical reactions can take place through making fertilizers more effective by preventing leeching and holding valuable nutrients such as ammonium, potassium, magnesium and calcium as well as trace elements for slow release as needed [45, 46].

The aforementioned data are in trustworthiness with the Sukhmal *et al.* [47] on geranium (*Pelargonium graveolens*) showed that application of compost increased total carbohydrate, N, P, K, Zn, Mn and Fe contents. Marzeh *et al.* [48] on tomato and cucumber reported that, compost treatment at the rate of 60% and 100% increased total chlorophyll as well as some essential elements. In addition, Pino *et al.* [49] on spinach (*Ipomoea aquatica* Forsk) and Bernardi *et al.* [50] on *Citrus limonia* reported that, use of zeolite increased dry matter production, leaf area, N, P, K, Fe, Zn, Ca, B, Mn and chlorophyll levels relative to the control without zeolite.

Total Chlorophyll, Carotenoids Content, Total Carbohydrates, Ascorbic Acid and Crude Protein: Data in Table 5 indicated that, appliance of compost mixed with zeolite significantly increased total chlorophyll, carotenoids content, total carbohydrates, ascorbic acid and crude protein in baobab seedlings in comparison with control plants where, these increments were 71.5%, 74.1%, 76.4%, 36.8 and 56.6, respectively. In the second season, it was noticed that application of zeolite treatment alone significantly increase total chlorophyll, total carbohydrate and ascorbic acid compared to the control treatments. The elevated amount in total chlorophyll, carotenoids content, total carbohydrate, ascorbic acid and crude protein may be attributed to the beneficial effects of compost mixture with zeolite represented in increasing liberate of more nutrients from the unavailable reserves as correcting iron and zinc deficiency which returned in efficiency of photosynthesis process, increasing amino acids and vitamins to be absorbed by plant roots. Hence may this play an important role in plant metabolism, notably the most significant function would appear to involve in carbohydrate metabolism [51]. In addition, zeolite components of available macro and micro nutrients and their role in increasing root surface per unit of soil volume as well as the high capacity of the plants building metabolites, which in turn contribute much to increase of nutrients uptake.

Preceding results are in harmony with those obtained by Khalil *et al.* [52] on African marigold (*Tagetes erecta*) who cited that, compost treatment increased chlorophyll a and b, carotenoids content, total carbohydrate. Also, Abdelwahab [53] on rosemary plants, El-Sherbeny *et al.* [54] on Montana plants found that, compost treatment significantly increased plant pigments and total carbohydrate over control plants and Marzeh *et al.* [48] on tomato and cucumber found that, application of compost resulted in an increment over control plants. Hereabout Krutilina *et al.* [9] on Barley and Maize and Ranjbar *et al.* [41] on Tobacco mentioned that, application of zeolite increased photochemical activity of chloroplasts, total chlorophyll content as well as total carbohydrate.

Net Photosynthesis, Stomatal Conductance and Water Use Efficiency: The diurnal mean leaf photosynthesis rate of *Adansonia* under different treatments as shown in Fig. 1 undoubtedly divulged that, seedlings under compost and zeolite mixture treatment significantly gave higher value of net photosynthesis rate 17.04±0.8 μmol CO_2 $m^{-2}s^{-1}$ compared to those under control plants 9.25±0.8 μmol CO_2 $m^{-2}s^{-1}$. Regardless of treatments, photosynthesis rate values were highest in the 1200 hour and can be attributed to the considerable availability of photosynthetic active radiation throughout the study period. From noon, all photosynthesis rate values declined slightly towards the 1600 hour could be due to either higher evaporative demand or the reduction of photosynthetic active radiation.

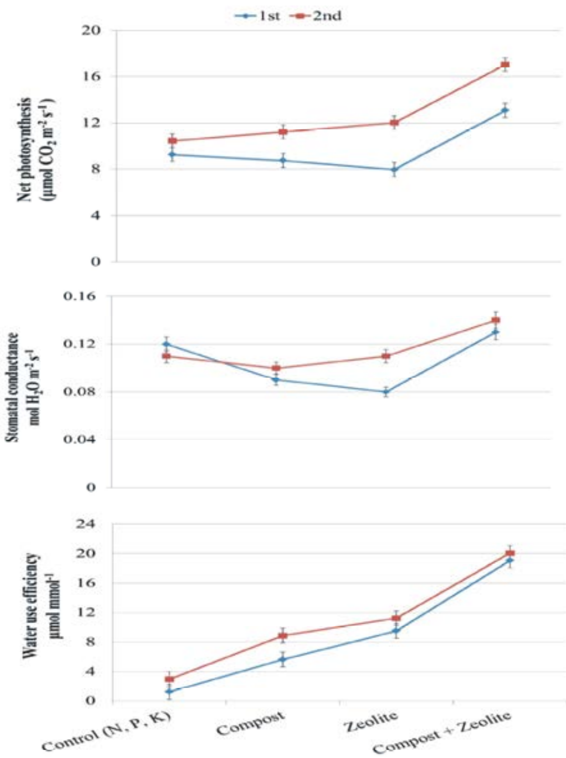

Fig. 1: Effect of compost and zeolite on A) net photosynthesis, B) stomata conducted and C) water use efficiency in the leaves of *Adansonia digitata* during 2011 and 2012.

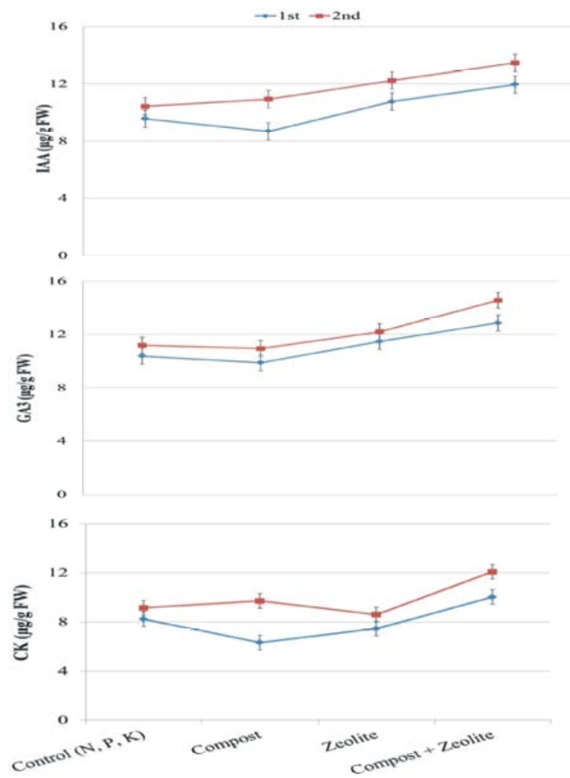

Fig. 2: Effect of compost and zeolite on A) IAA, B) GA3, C) CK (µg/g FW) in the leaves of *Adansonia digitata* during 2011 and 2012.

Go along with stomatal conductance, the data as depicted in Fig. 1 showed that, the highest significant value of stomatal conductance outcome form treatment of compost mixture with zeolite 0.14±0.02 mol H_2O m^{-2} s^{-1} in comparison with control plants 0.11±0.02 mol H_2O m^{-2} s^{-1}, the stomatal conductance values were relatively higher at the 1200 hour which contributed to higher photosynthetic active of the seedlings. This was due to the impact of stomatal opening which maintained photosynthetic efficiency without much considerable change in water potential under desert condition [55]. From these data we can decipher that, there is positive relationship between photosynthesis rate and stomatal conductance where the higher stomatal conductance increased photosynthesis rate. The decreased of either photosynthesis rate or stomatal conductance in other treatments can be attributed to the direct inhibition of biochemical processes through ionic, osmotic or other conditions were induced by loss of cellular water. Some other factor that contributed to this diminish might be the limited CO_2 diffusion into the intercellular spaces of the leaf as a consequence of reduced stomatal conductance [56]. Side by side with previous data, application of compost mixed with zeolite produced significant increment in water use efficiency under desert condition and dripping water system since prior combined gave 20.06 µmol/mmol compared to control plants 2.96 µmol/mmol, the result may be due to elevation of CO_2 and this is beneficial to crops grown in water limited areas [57].

Generally crop water use efficiency is an especially important consideration where irrigation water resources are limited or diminishing and where rainfall is a limiting factor as the condition of Egypt reclaimed desert. Moreover one of the components of a management system that affects water use efficiency is soil fertility; consequently a complete fertility represented in combination of compost with zeolite helps to produce a crop with roots that explore more soil volume for water and nutrients in less time. This results in a healthier crop that can more easily withstand seasonal stresses or conditions [58].

Phytohormones: The results of hormonal analysis Indole-3-acetic acid (IAA), Gibberellic acid (GA_3) and cytokinins (CK) in *Adansonia digitata* seedlings as affected by different treatments are shown in Fig. 2, clearly revealed that, the highest mean values of IAA, GA_3 and CK (12.70, 13.71, 11.06 µg/g FW), respectively were recorded with compost and zeolite mixture in comparison with both control plants which gave (10.01, 10.71, 8.69 µg/g FW), respectively and other treatments represented in whether zeolite treatment alone or compost alone. Also, it was notable that, application of zeolite alone granted an increment of IAA as well as GA_3 amounts when judged against control plants in both seasons. The promotive effects of combination treatment compost with zeolite may be attributed to the production of endogenous phytohormones from compost as it mentioned by Marek and Skorupska [59] who indicated that, the presence of organic matter represented in compost which consider a source of macro and micronutrients and their ability to stimulate plant growth, besides source of hormones like substances as auxin-like activity and had a gibberellin-like activity which could interact with hormone-binding proteins in the membrane systems, evoking a hormone-like response. Moreover, the ability of zeolite to retain most essential elements to supply plants in time of needs especially zinc (Zn) which increased tryptophan concentration and tryptophan is the precursor of auxin [60], as well boron (B) and its relation with cytokinins [61].

CONCLUSION

In the light of previous information and data, the research is strongly proved the profound influence of zeolite with organic matters application to coarse textured soils where, the mixture of compost and zeolite was enhanced the growth characters and chemical composition of *Adansonia digitata* seedlings. Therefore it could be concluded that, the chemical fertilizers of NPK could be replaced by the compost with zeolite mixture for improving the quality of the produced yield under safe agriculture conditions, in addition to decreasing the production costs and environmental pollution.

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