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Soil-Less Seed Germination and Root Growth of Date Palm Affected by Biochar and Metal Nanoparticles

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ABSTRACT

Nanomaterials and organic derived-biochar are proposed to be the materials for the new millennium, particularly in agricultural sector. Smarter use of these materials in crop production could be achievable to solve a lot of problems. However, a thorough understanding of the interactions of nanoparticles and biochar with plants is required prior to general recommendation. The present study serves to investigate the impact of silver (Ag) and zinc (Zn) nanoparticles (NPs) and biochar on a problematic seed germination and seedling early growth rate of Zaghloul date palm (*Phoenix dactylifera*). Two laboratory experiments were undertaken in soil-less culture systems; (i) soil-less petri dish was used to improve the seed germination of date palm under different concentrations of AgNPs (0, 1, 5, 10, 20, 40 mgl^{-1}) and biochar (0, 0.5, 1, 2, 3, 5 g/petri dish) and (ii) hydroponic system was used to study the impact of ZnNPs (0, 0.002, 0.01, 0.02, 0.04, 0.05 and 0.1 %) in root growth rate of date palm according to the results obtained from experiment (i). The results showed that a significant increasing in seed germination rates for all treatments compare with the control. Although higher concentration of AgNPs (40 mgl^{-1}) and biochar (3 and 5 g / petri dish) showed an increasing values of seed germination comparing to the control, they pose initial inhibitory effect of seed germination comparing to their lower concentrations. However, the addition of either 20 mg AgNPs l^{-1} or 2 g / petri dish biochar showed the highest germination values. These concentrations were further studied under hydroponic culture system to investigate the effect of ZnNPs on root growth rate of date palm. The addition of ZnNPs improves root growth rate of date palm for all treatments. However, the root growth empirical model confirms that the seed initially treated by 2 g/ petri dish biochar had a superior root growth comparing to seed initially treated by AgNPs. Therefore, we recommend using both treatments (AgNPs and biochar), at lower concentrations, combined by nanofertilzer of ZnNPs to improve Zaghloul seed germination and seedling growth.

Keywords: Soil-less petri dish; Hydroponic; Silver; Zinc; Nanoparticles; Biochar; Date palm

INTRODUCTION

Soil is a complex system that can alter the absolute effects of novel applications such as plant nutritional or antimicrobial based nanoparticles and organic-derived biochars depending on soil characteristics (Bronick and Lal, 2005). In this context, silver nanoparticles (AgNPs) are one of the most commonly used manufactured nanoparticles in consuming products where they are increasingly used for their antimicrobial properties (Cornier *et al.,* 2017, Solaiman *et al.,* 2017). In addition, it has been reported in pure systems studies that AgNPs are toxic to animal and human cells (van der Zande *et al.,* 2011), and algae (Miao *et al.,* 2009). Recently, there have been only a few studies of the influence of AgNPs on higher plants (Yin *et al.,* 2012, Thuesombat *et al.,* 2014, Cvjetko *et al.,* 2017), but these have steadily shown that AgNPs have different effects (negative or positive) on seed germination and plant growth.

Moreover, It was established that Zn is important for plant nutrition (Römheld and Marschner, 1991) and its deficiency is one of the most widespread disorders in a number of plants (Alloway, 2004) which in turn reflected on 'stunting' in children (Kumar and Qureshi, 2012). For example, Zn deficiency associated with nutritional dwarfism was reported from Egypt in 1963 (Halsted *et al.,* 1972) and it was observed among Egyptian young people from the lowest social classes (Hussein and Bruggeman, 1997). Therefore, nanotechnology may assist fertilizer industry by designing Zn nanoparticles (ZnNPs) that supply plants with their nutrition requirements. Zinc forms (ions or NPs) in soybean roots germinated in a soil-less bioassay with 0, 500, 1000, 2000 and 4000 mg Zn l^{-1} as ZnNPs showed that the NPs were not exist in the root even at higher concentrations (López-Moreno *et al.,* 2010). Nevertheless, applying of ZnNPs to some extent increased seed germination and root growth of soybean plants up to 1000 mg Zn l^{-1} in the solution medium.

Biochar is a highly stable form of carbon created by pyrolysis process. They may remain in soil for several years (Ascough *et al.,* 2009). It is used as a soil conditioners that can act as a carbon sink in arable land as well as improve soil fertility (Chan *et al.,* 2007). However, biochars may contain unwanted substances such as hydrocarbons (PAHs), phenolic compounds and metals that may pose significant risk to plants, microbes and humans (Thies and Rillig, 2009). Some compounds in biochars have the potential to either inhibit or stimulate seed germination and seedling growth as they contain essential nutrients for plant (Gaskin *et al.,* 2008).

It is important to consider that different soil characteristics (pH, organic matter, redox potential etc.) might affect the fate of NPs in the soil. Hence, the behaviour of NPs can turn from the ones theoretically expected. Given reported studies on the contradiction effects of both Zn and Ag nanoparticles in soils for plant growth, it is initially urgent to develop understanding on the fate of both element forms (as NPs) on seed germination and early seedling growth. In addition, biochar has been reported to either increase (Chan *et al.,* 2008) or decrease (Deenik *et al.,* 2010) plant growth and yield. Moreover, there have been very few studies reporting the influence of biochar on plant early stage growth such as on seed germination and seedling growth. According to our knowledge, there is no previous study that has tried to combine AgNPs, ZnNPs and biochar for promoting seed germination and seedling early growth stage.

Date palm (*phoenix dactylifera*) are considered the main fruit in Arab nations such as Saudi Arabia, Iraq, and Egypt. Date palms are not only used as fruit producing trees, but are also used in landscape decoration. The major problem in date palm cultivation is the poor method of propagation. (Badawy *et al.,* 2005). The date palm (Zaghloul cv.) was selected as the best model system that has problem in seed germinations and early growth stage and has not been used before under nanomaterial or biochar applications. Petri dish and hydroponic bioassays are simple and rapid method for preliminary evaluations of biochar and metal nanoparticles applications under soil-less conditions. It was expected that biochar and metal nanoparticles would differ in their effects on early germination and root growth rate of plant, and that the petri dish and hydroponic bioassays would be a simpler preliminary screening method than a complex soil based bioassay that consume time (maybe three growing seasons), interactions with different soil characteristics and components and increase labour intense works. Therefore the objectives of this work were to: (i) determine whether AgNPs and biochar could increase Zaghloul date palm seed germination rate and assess the promising addition of both treatments using petri dish soil-less bioassay, and (ii) from (i), evaluate and model root growth rate of Zaghloul date palm as affected by commercial zinc nano-fertilizer in a simple hydroponic experiment.

MATERIALS AND METHODS

Silver nanoparticle preparation

Silver nanoparticles was purchased from Agriculture Research Centre (ARC) Giza, Egypt. The AgNP was synthesised as described by Vigneshwaran *et al.,* (2006). Briefly, silver nanoparticles was produced using green chemistry method where 1.0 g of soluble starch was dissolved in 100 ml of deionized water. One ml of a 100 mM $AgNO_3$ was added and well stirred. This mixture was autoclaved at 15 psi pressure, 121 ºC for 5 min. The resulting colour of the nanoparticle suspension solution was clear yellow indicating the formation of silver nanoparticles (Vigneshwaran *et al.,* 2006). Silver nanoparticles were brought from ARC at concentration of 100 mgl^{-1} and at diameter size less than 100 nm. To check the nanosize of AgNP provided from ARC, scanning electron microscope (SEM; Quanta 450 FEG-ESEM, FEI Company) was used as seen in Figure1 which confirm a size of less than 100 nm.

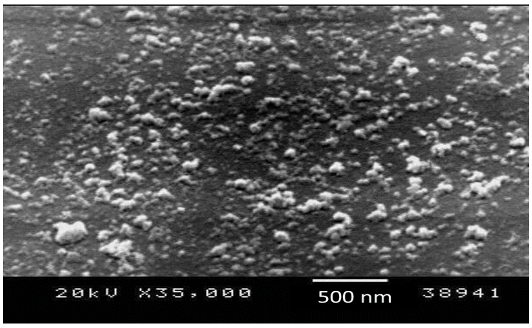

Figure 1. SEM image of silver nanoparticles that confirm the size of less than 100 nm.

Biochar preparation and characterization

Olive pomace wastes were collected from experimental oil extractor at Faculty of Environmental Agricultural Sciences, Arish University and used to produced biochar. A known quantity of air dried material was taken in closed crucible and heated in muffle furnace at 450 °C at 60 min as described by Vijayanand *et al.,* (2016). The morphological features of the produced biochar were investigated by scanning electron microscope (SEM; Quanta 450 FEG-ESEM, FEI Company). Figure 2 showed smooth surfaces with different porosity sizes. The pore sizes were not uniform and were in the range of tens of nano- to micro-meters. Produced biochar was chemically characterized; biochar pH was measured using pH meter (Model pH 209, HANNA Instruments, UK) in water:solid ratio of 1: 2.5. Total metal concentrations were measured in acid digested biochar (aqua regia; 3:1 mixture of concentrated HCl and HNO_3) using atomic absorption spectrophotometry (SHIMADZU AA-6800). Biochar organic matter was estimated using the oxidizable dichromate method (Walkley and Black, 1934). Table 1 summarized chemical characteristics of olive pomace-derived biochar.

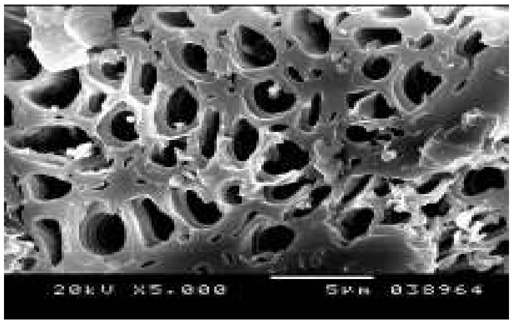

Figure 2. Scanning electron micrograph of biochar produced at 450 ºC.

Table 1. Summary of chemical characteristics of olive pomace-derived biochar

	pH (1:2.5)	OM (%)	Zn	Fe	Na	Mg	K	Ca
			($g\ kg^{-1}$)					
Biochar	8.94	52.9	0.022	0.410	0.06	3.05	13.2	23.1

Seed germination experiment

Zaghloul date palm seed (*Phoenix dactylifera*) were sown in petri dishes (8.5 cm diameter) on three layers of filter paper moistened with distilled water. Silver nanoparticles were added at a concentrations of 0, 1, 5, 10, 20 and 40 mgl^{-1}. These concentrations were selected to cover a wide range of AgNPs as described by (Yin *et al.,* 2012). Distilled water was used as check to determine the effect of nanoparticles and biochar applications on germination of seed as a control treatment. For both treatments, the amount of water (20 mL) added to the filter paper was calculated based on the water holding capacity of the biochar and the requirement of the highest biochar rate (5 g). The same amount of water was added to the Petri dish for each rate of biochar and AgNPs. Biochar was added at the rates 0, 0.5, 1, 2, 3, 5.0 g/Petri dish (equivalent to 0, 10, 20, 40, 60, 100 ton ha^{-1} on a volume basis at 10 cm soil depth) with triplicates and 6 seed in each plate following the design described by Morrison and Morris (2000). An individual petri dish was considered as a replicate. All petri dishes were covered with lids and incubated in the dark at 30 °C for a required time (typically 15 days) when germination percentage were assessed. Germination percentage was measured after sowing days by following formula:

Germinability (G) is the germination percentage is calculated by dividing number of germinated seed (n) by total seed number (n_t)

$$G = \frac{n}{n_t} X\, 100 \quad (1)$$

Mean germination time is calculated by the expression

$$t^{-} = \frac{\Sigma_{i=t}^{k} ni\ ti}{\Sigma_{i=t}^{k} ni} \quad (2)$$

where t_i : time from the start of the experiment to the i^{th} observation (day for the example); ni: number of seed germinated in the i^{th} time (not the accumulated number, but the number correspondent to the ith observation), and k: last time of germination. Mean germination rate is calculated as the reciprocal of the mean germination time. All equations were solved using Microsoft Excel 2016 according to the method developed by Ranal *et al.,* (2009).

Date palm root growth rate as affected by commercial Zn nanoparticles

According to the results obtained from germination experiment, promising results obtained from date palm germinated seed were selected for further study. As biochar and AgNP were initially used to enhance germinability of date palm, commercial Zn nanoparticles (ZnNPs) were used to study the effect of ZnNP on root growth rate of date palm that initially treated by biochar and AgNP in a simple hydroponic experiment.

Zinc nanoparticle (NP) fertilizer was purchased from Agrochemical company, Giza, Egypt with unknown size particles and concentration of 6 % ZnNPs. For each treatment, four date palm seedlings (initially treated by biochar and AgNPs) were placed in Perspex strips on top of 400 mL glass beakers filled to the brim with 1.0 mM $CaCl_2$ and 5.0 mM H_3BO_3. The beakers were placed under laboratory and all beakers surrounded by hot radiator to maintain the temperature to be close to approximately 30 °C. Date Palm seedlings grown for approximately 24 hrs in this basal solution. The strips were then transferred to ZnNP-containing solutions for exposure period (typically 24 hrs). The experimental design was summarized in Figure 3 as described by Kopittke et al. (2011) . A wide range of ZnNPs concentrations were used: 0, 0.002, 0.01, 0.02, 0.04, 0.05 and 0.1 % ZnNPs as a whole solution taken from ZnNPs fertilizer. These concentrations were selected to cover a wide range of Zn levels and based on the recommended concentration by the product provider and within the previously published results by López-Moreno et al. (2010). Root length was assessed with digital photographs Sony DLSAR A2 (Japan) using ImageJ tools software (https://imagej.net/Welcome) and the growth (%) was then calculated.

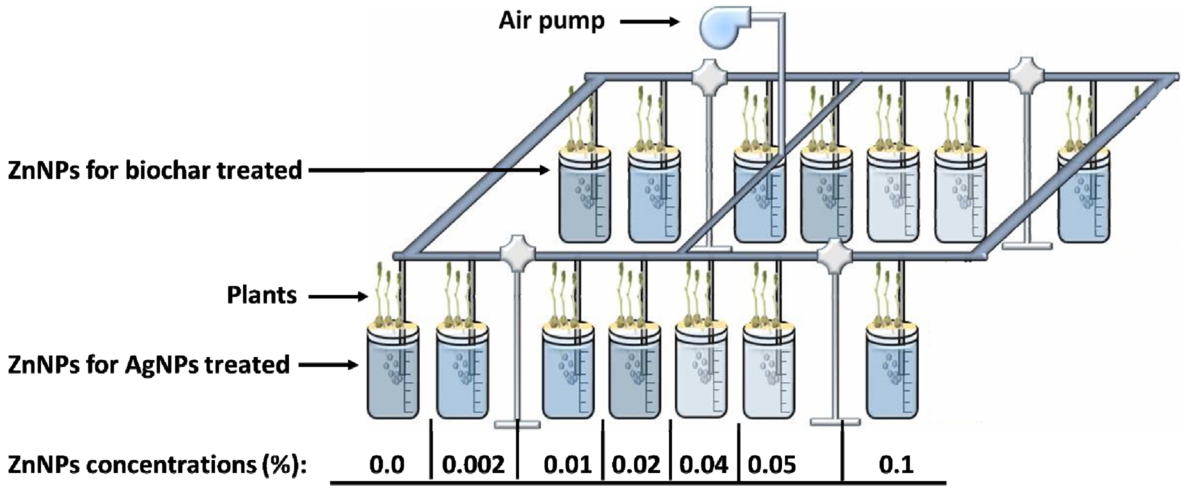

Figure 3. Schematic representation shows the overall experimental layout. ZnNPs were added at concentrations of 0, 0.002, 0.01, 0.02, 0.04, 0.05 and 0.1 %, in triplicates, for both date palm seedlings initially treated by biochar and AgNP.

Root growth model was calculated according to an exponential first order equation model using solver MS Excel 2016. A growth model has been used to predict the growth rate as shown by equation 3 developed from Misra *et al.,* (2011):

$$\mathbf{Y_g = 100\ (1 - exp^{-KC})} \quad \mathbf{(3)}$$

Where Y_g is the predicted root growth value, K is the constant growth rate and C is the concentration of ZnNPs used. The RSD (residual standard deviation) and correlation coefficient have been used to assess the model performance for root growth rate affected by 'ZnNPs'.

RESULTS AND DISCUSSION

Effect of silver nanoparticles and biochar on germination of date palm seed

The results showed that general average of germination rate (%) showed 85.2 ± 17.7 (± standard deviation) and 86.1 ± 18.8 % for AgNPs and biochar applications, respectively (Fig 4). The germinability reached 100 % after 9 ± 2 days at AgNPs of 5 mgl^{-1} and after 11.3 ± 0.67 days at biochar rates of 0.5, 1.0 g/petri dish. The lowest germination rate was observed at control (50.0 ± 14.4 %) where the first apparent germination was observed after 13.3 ± 2.1 days. The lowest germination rate was observed at 20 and 40 mgl^{-1} (88.9 %) for AgNPs and 2g/petri dish (83.3) for biochar. The first start germination varied between 3 and 5 days and between 3 to 8 days for biochar and AgNPs applications. The overall results showed that the germination rate (%) was favoured by 5 mgl^{-1} of AgNP and by 0.5 and 1 g/petri dish of biochar additions. This finding confirms that biochar has a powerful effect to promote germination of date palm seed over AgNPs. Our results showed the superior of both treatment for increasing date palm germination rate (%) comparing to the results obtained by Azad et al. (2011). The authors treated the date palm (*Phoenix dactylifera*) seed with different temperatures and growing media and found that the germination started from 21 to 26 days. Wagner (1982) reported different species of date palm such as: seed of Mexican fan palm (*Washingtonia robusta*) may begin to germinate in less than 2 weeks, seed of areca palm (*Dypsis lutescens*) in 3-4 weeks, while seed of parlor palm (*Chamaedorea elegans*) may not begin to germinate for several months and then continue sporadically for over a year. Therefore, treating seed with both AgNPs and biochar has a favour comparing to published results.

In addition, mean germination time (MGT) is another way to calculate germination speed and widely used by scientists (Chen *et al.,* 2013, Zhang *et al.,* 2014). The general average of mean germination time (MGT) was observed to be 8.23 ± 2.97 and 8.91 ± 2.83 days for both AgNPs and biochar respectively (Figure 5).

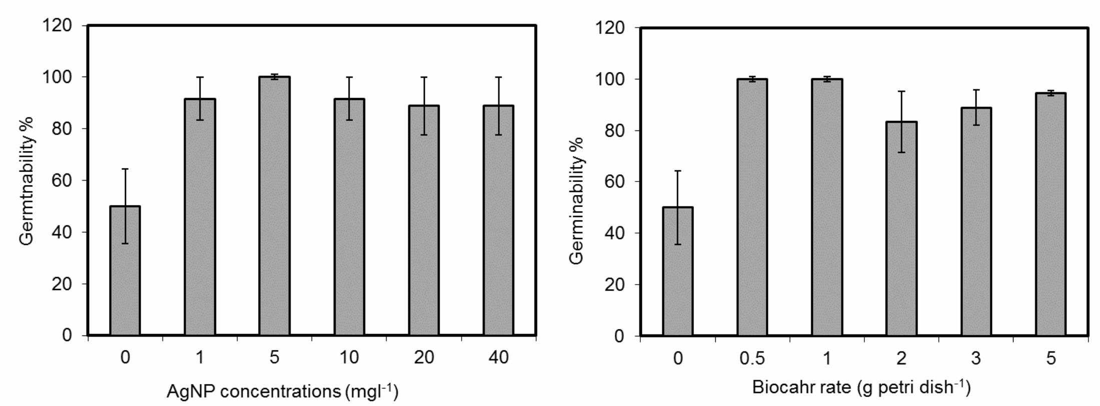

Figure 4. Germinability % of Date palm seed treated by Ag nanoparticles and biochar at different rates. Error bars represent standard errors of triplicates.

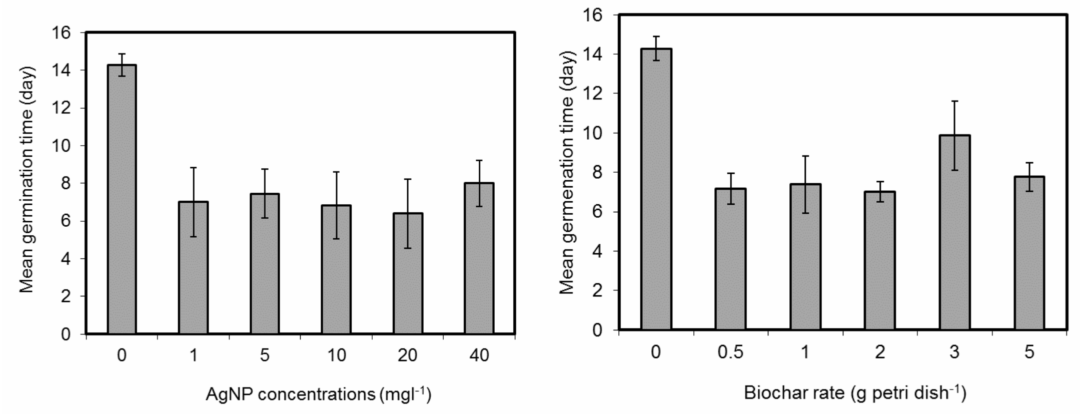

Figure 5. Mean germination time (day) of Date palm seed treated by Ag nanoparticle and biochar applications at different rates. Error bars represent standard errors of triplicates.

MGTs were 14.3, 7, 7.44, 6.83 and 6.39 days for seed lots of 0, 1, 5 and 10 mg l^{-1} of AgNP, respectively (Fig. 5). However, at higher AgNPs concentration (40 mgl^{-1}) the MGT was increased (8 days) showing an initial inhibition of germination due to toxicity effect at higher AgNPs concentration, however, MGT at the higher AgNPs concentration was lower than that of control. This could be attributed to the source of Ag^{+}, and AgNP-cell-Ag^+ interactions at the cell interface that initiate AgNPs' toxicity due to higher AgNPs concentration (40 mgl^{-1}) (Yin *et al.,* 2012). These results indicated that seed treated by AgNPs can increase the germination rate because MGT is relatively decreased until AgNPs increased up to 20 mgl^{-1} as seen in Fig 5. Yin et al. (2012) studied different concentrations of AgNPs (0, 1, 10, 40 mgl^{-1}) using two coated substances (20 nm polyvinyl pyrrolidine coated silver nanoparticles (PVPAgNPs) and 6 nm gum arabic coated silver nanoparticles (GAAgNPs)) on germination and growth of different species of common wetland plants using soil free assay. They found that PVPAgNPs had no effect on germination while 40 mg Ag l^{-1} GAAgNP exposure significantly reduced the germination rate of three species and enhanced the germination rate of one species. Their results demonstrated that particle size and coating substances of AgNPs and plant types should be considered in terms of toxicity experiment. However, in the current study, the manufactured AgNPs were undertaken by green chemistry; AgNPs concentrations significantly enhanced germination rate of date palm seed compare with control. The same trend has been obtained with biochar application with exception of the last two addition rates (3 and 5g/petri dish). The biochar rates at 0.5, 1 and 2g/petri dish showed a significant enhancement of MGT compare with the control. It is necessary to mention that these three biochar rates showed insignificant difference among them. The lowest MGTs were obtained at concentration of 20 mg AgNP l^{-1} (6.39 ± 1.83) and 2g/petri dish biochar addition (7.01 ± 0.50).

All these finding was translated in Figure 6 in which it shows mean germination rate per day (MGR). The general average values were 0.14 ± 0.04 and 0.12 ± 0.03 day^{-1} for AgNPs and biochar applications, respectively. The results showed that control seed present a beginning of the germination slower than the treated seed. A great MGR was observed again at concentration of 20 mg AgNP l^{-1} (0.17 ± 0.04) and 2g/petri dish biochar addition (0.14 ± 0.01). General speaking, T-paired test showed insignificant differences between AgNPs and biochar treatments for % germination (T value = -0.4; p = 0.71), MGT (T value = -1.01; p = 0.36) and MGR (T value = 1.52; p = 0.18). However, visual characteristics of seed treated by biochar show more thickness root than that of seed treated by AgNPs. This observation could by supported by the nutrient existed in the produced biochar as shown in Table 1 through which early stage germination could be supplied by required nutrient during experimental course. However, increasing rate of biochar might reduce germination rate comparing with other biochar additions due to undesirable substances that may be contained in olive pomace-derived biochar (Thies and Rillig, 2009). Therefore, promising results in germination experiment (seed treated by 20 mgl^{-1} AgNP and 2g/petri dish biochar) were used in a simple hydroponic experiments to observe the growth rate of seed roots as affected by nanofertilizer of Zn nanoparticles (ZnNPs).

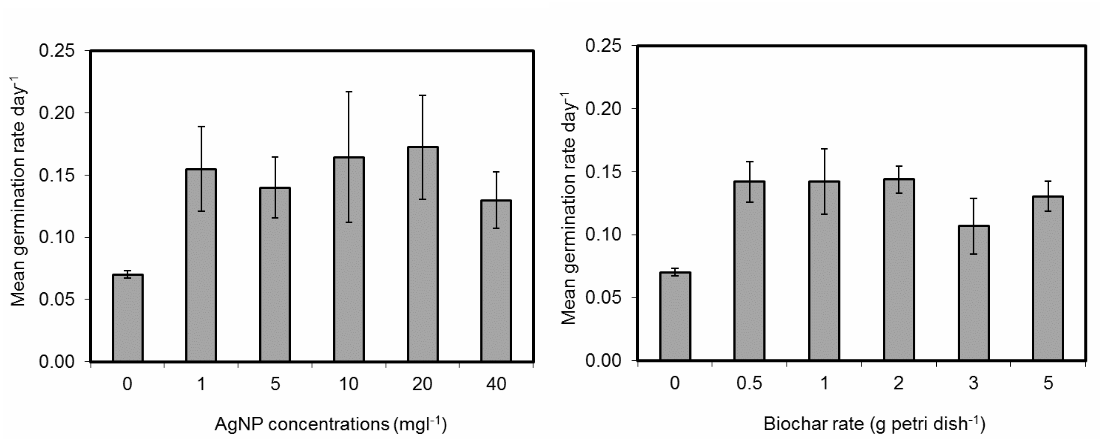

Figure 6. Mean germination rate (day) of date palm seed treated by Ag nanoparticle and biochar applications at different rates. Error bars represent standard errors of triplicates.

Date Palm root growth (%)

It has been assumed that the maximum growth length of the date palm root equals to the average length between the tip of the roots and the container bottom at zero time. This assumption based on that the container bottom will render a free growing of the root within experimental time (24 hrs). However, it was observed that growing roots during the 24 hours did not reach the assumed value. In addition, the used empirical model has an assumption to reach 100% growing rate at asymptote concentrations.

The results showed that root growth (%) was increased by increasing ZnNPs concentrations. This finding was observed for both initially treated seed. However, Figures 7 and 8 show seed germinated by adding biochar for promoting germination were higher than that of initially AgNPs treated in terms of root growth (%). The general average value of this increment was approximately 200% during experimental course.

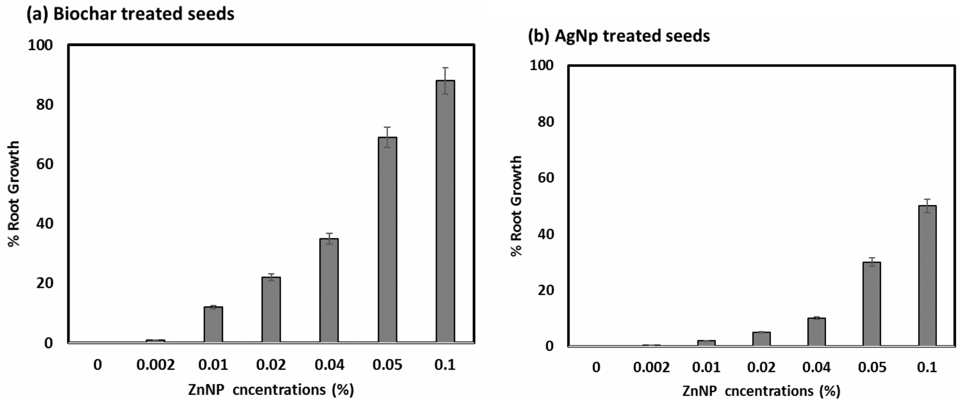

Figure 7. Effect of ZnNPs concentrations on date palm root growth (%) for initially seed treated by (a) biochar and (b) silver nanoparticles (AgNPs). Error bars represent the standard error of triplicates.

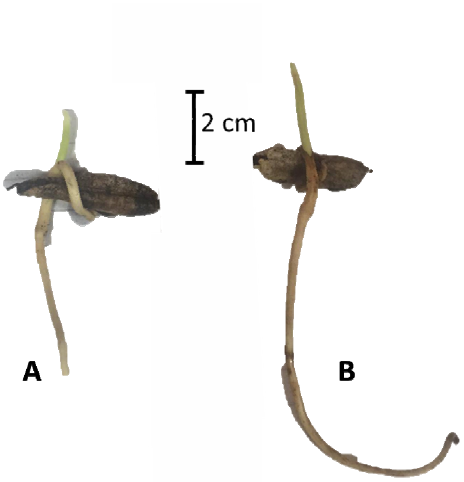

Figure 8. Effect of initially treated seed by AgNPs (20 mgl^{-1}; A) and biochar (2g/petri dish; B) for date palm after growing in ZnNPs hydroponic experiment at 0.05% ZnNPs. The best growing was selected for demonstrating the general differences only.

Equation 3 was employed to predict the highest concentration through which the date palm root may reach 100% growth according to assumed maximum growing root length. The results were judged by comparing r (Pearson coefficient), p (probability) , RSD and K values (Table 2).

Table 2. Date Palm root growth rate predicated by equation 3 parametized by ZnNPs concentrations for both initially treated seed by biochar (2g/petri dish) and AgNP (20 mgl^{-1}).

Treated Seed	r value	p - value	RSD value	K value
Biocahr	0.969	0.001	9.44	16.6
AgNPs	0.960	0.001	6.61	5.85

r; correlation value, P; probability, RSD; residual standard deviation and K; growth rate

Figure 9 showed the effect of different ZnNPs concentrations on date palm root growth (%) at two initially treated seed (biochar and AgNPs). The best modelled fit by equation 3 has been observed with initially biochar treated seed. These results have been justified depending on the results showed in Table 1. The r value (0.97) showed a significant correlation between measured and modelled values at P-values less than 0.01.

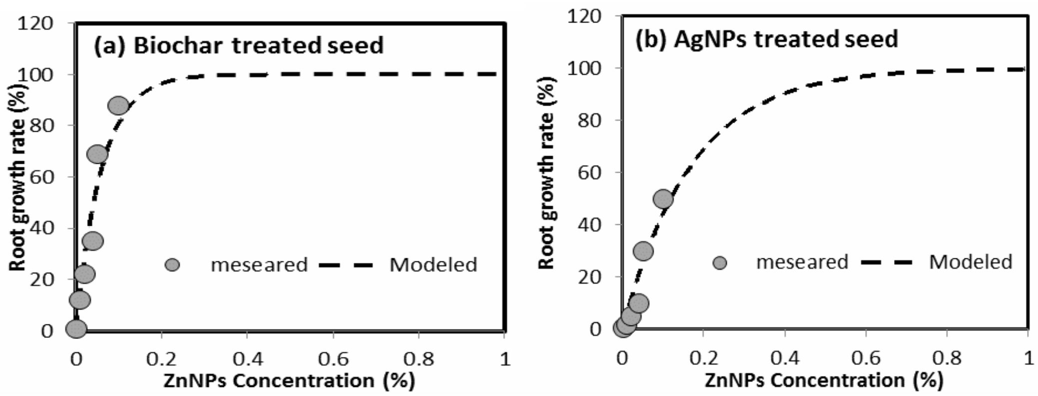

Figure 9. The root growth (%) of Date Palm initially treated by biochar (a) and AgNPs (b) as a function of different concentration treatments of ZnNPs. All data were fitted with a first order exponential equation.

In contrast, although the modelled values at biochar treated seed showed a significant relationship between modelled and measured values, the RSD values were lower in AgNPs treated seed. These values were 16.6 and 5.85 at biochar and AgNPs treated seed, respectively. Generally, all modelled values represent a good estimation of the measured values with significant levels ($P < 0.01$). These results confirm that the developed modelled equation could be used in the future to predict the root growth values of date palm by parameterizing the equation 3 only by tested ZnNPs concentrations.

The rate of root growth values (K; Table 2) showed the superiority of biochar treated seed which further highlights powerful of biochar over AgNPs initially treated seed. The root growth rate of date palm was fastest for biochar treated seed (16.6). Such observations are important in testing bioaccumulation and toxicity of ZnNPs to be taken into account while interpreting the results or more importantly while designing experiments. Prasad et al. (2012) studied the effect of different ZnNPs concentration on root growth rate of peanut. The authors found that root growth was increased with increasing ZnNPs up to 1000 mgl^{-1} and these results were corresponding with the current study. However, they reported that a higher concentration of ZnNPs (2000 mgl^{-1}) reduced the root growth rate due to their toxicity effect. There is no doubt that higher concentrations has a highly significant effect on growth rate as shown from the sold modelled lines in Figure 9 a and b. However, the results did not indicate the toxicity level of ZnNPs as this is not the scope of the current study.

CONCLUSION

Zaghloul date palm (Phoenix dactylifera) is an important tree for agroforestry due to its economic and social benefits in Arab countries. Therefore, an attention has been taken to improve its germination techniques using novel approaches. Different AgNPs, ZnNPs and olive pomace-derived biochar concentrations were used to enhance seed germination properties and seedling growth of Zaghloul palm. The results showed significant improvement of AgNPs and biochar on seed germination characteristics compare with the control. The MGR and MGT results showed that AgNPs at lower concentration (< 40 mgl^{-1}) had a promising results comparing to other treatments. However, the concentration of 20 mg AgNPs l^{-1} showed the highest seed germination values. Nevertheless, biochar at the 2 g/petri dish rate showed a promising results over other treatments on date palm seed germination properties although lower concentration (< 3 g/petri dish) of biochar additions improved the seed germination values comparing to other treatments. More studies are actually needed to explain the mechanism of germination enhancement for date palm upon AgNPs and biochar applications. Moreover, the hydroponic experiment showed unexpected results. It was assumed that ZnNPs will be the main factor affecting the growth rate of date palm root. The initial biochar application play an important role in motivating root cell to respond for ZnNPs and it reaches 200 times (in average) the initially AgNPs treated seed. Therefore, we recommend using both treatment together (biochar and ZnNPs) for solving the date palm germination and seedling rate problems. Further works presumably are needed to study the interior mechanism of ZnNPs interact with root cell. The current results should be more investigated under soil condition to figure out the impact of different soil properties on Ag and ZnNPs as well as biochar behaviours in contact with date palm seed utilizing the current results.

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إنبات ونمو جذور بذور النخيل بدون تربة تحت تأثر البيوتشار و المعادن النانوية

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تعتبر جزيئات المواد النانوية و الفحم الحيوي (البيوتشار) من الاصل العضوى هى مواد الالفية الجديدة و على وجه الخصوص فى القطاع الزراعى. ان الاستخدام الحكيم من تلك المواد فى الانتاج الزراعى يمكننا من حل العديد من المشكلات. لكن يجب ان يتم فهم تفاعلات المواد النانوية و البيوتشار مع النباتات النامية قبل تعميم استخدامها. الدراسة الحالية تفتح الباب لدراسة تأثير الفضة و الزنك النانوية إضافة الى البيوتشار على مشكلات الانبات و النمو المبكر لبذور نخيل البلح (الصنف المحلى الزغلول). تم اجراء تجربتين معمليتين باستخدام تقنية الزراعة بدون تربة: التجربة الاولى استخدام طريقة اطباق بترى بدون تربة لتحسين عملية انبات البذور تحت تأثير تركيزات مختلفة من جزيئات النانو فضة (صفر – 1 – 5 – 10- 20 – 40 ميللجرام / اللتر) و البيوتشار (صفر – 0.5 – 1 – 2 – 3 – 5 جرام لكل طبق بترى) و التجربة الثانية استخدام زراعة الهيدروبونك لدراسة تأثير تركيزات مختلفة من جزيئات الزنك النانويه (صفر – 0.002 – 0.01 – 0.02 – 0.04 – 0.05 – 0.1 %) على النمو المبكر للجذور بناءا على معطيات التجربة الاولى. اثرت النتائج زيادة معنوية فى قياسات معدلات النبات مقارنة بالكنترول و ذلك لكل المعاملات. على الرغم ان التركيزات العالية من الفضة النانوية (40 مليجرام / اللتر) و البيوتشار (3 و 5 جرام لكل طبق بترى) اظهرت نتائج ايجابية للانبات مقارنة بالكنترول الا انها شكلت بداية تثبيط لانبات البذور مقارنة بالمعاملات الاقل تركيزا. إضافة الى ذلك اظهرت كلا من جزيئات الفضة النانوية بتركيز 20 ملليجرام / اللتر و البيوتشار بتركيز 2 جرام لكل طبق بترى اعلى معدلات انبات لبذور نخيل البلح. تم استخدام البذور المستنبته من تلك التركيزات (الفضة النانوية (40 مليجرام / اللتر) و البيوتشار (3 و 5 جرام لكل طبق بترى) فى تجربة هيدروبونك لدراسة تأثير جزيئات الزنك النانوية على نمو الجذور لنخيل البلح. ان اضافة تركيزات مختلفة من جزيئات الزنك النانوية ادت الى تحسن معدل نمو الجذورلكل المعاملات على حدا سواء مقارنة بالكنترول. و لكن تبعا للنموذج الرياضى المستخدم لدراسة نمو الجذور، تم تأكيد ان البذور المعاملة اوليا بالبيوتشار اظهرت نمو اعلى من البذور المعاملة اوليا باستخدام جزيئات الفضة النانوية. لذلك نوصى باستخدام معاملتى الفضة النانوية عند التركيزات المنخفضة للمساهمة فى سرعة الانبات و ايضا البيوتشار مع اضافة سماد الزنك النانو لتحسين خواص انبات البذور و نمو الجذور لاشجار نخيل البلح.