Effect of Nano Fertilizers and Its Applying Methods on Growth Parameters of Senna (Cassia Angustifolia) Seedling Plant

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Abstract

The experiment was carried out at Plant Production Department, Agricultural Technical College, Mosul, Iraq at spring 2020 to investigate the effect of two Nano fertilizers kind ( K 27% and Complex fertilizer ( Cu 1%, S 13%, Zn 11.5 %, Mn 6.5%, Fe 7.5%, and Citric Acid 3.5 %) and control (zero fertilizer) with three applying methods (spraying, soil addition, spraying + soil addition) on Senna seedlings. The treatments were layout in factorial experiment in RCBD Design with three replicates. The results showed that adding nano fertilizers by spraying + soil addition increase significantly plant length, number of leaves per plant, Stem diameter, Chlorophyll content (SPAD), fresh and dry weight of vegetative growth and roots. Also applying Complex Nano fertilizer increase significantly all the parameters (plant length, number of leaves per plant, Stem diameter, Chlorophyll content (SPAD), fresh and dry weight of vegetative growth and roots) compared with control and the increasing percentage were (62.12, 28.22, 123.37, 19.19, 197.95, 154.48, 261.64, 114.26%) for the parameters respectively. The interaction treatments between nano fertilizers an applying methods show a significant effect for all the parameters.

Keywords: Senna, Nano fertilizer, Spraying, Seedlings, Chlorophyll.

1.Introduction

Senna (Cassia angustifolia) belongs to the Caesalpiniaceae family, an important medicinal plant, which is widely known and used to cure a large number of intestinal diseases, anaemia, jaundice skin diseases, and typhoid fever [1,2]. Senna pods and leaves contain sennosides: A, B, C, D, aloe-amine, rhein, kaempferin and iso-rhein in free and compound (glycosides) forms. There are used the leaves and fruits which have a pharmaceutical utilization to treat the acute or chronic constipation. It is also used for hemorrhoids, epilepsy, dermatological disorders, respiratory diseases, skin infections, migraine and heart diseases [3]. [4], found that FYM application increased senna leaves, pods and leaves equivalent yields significantly than control, and increased N, P and K uptake, respectively was recorded with FYM over control. [5], found an increasing of green biomass and plant vegetative growth of Senna by application of chicken manure and bio fertilizer.

The fertilizers are very important in plants growth, but the mineral fertilizers may get lost in due to many environmental processes such as runoff, leaching, emissions and volatilization. The use of chemical fertilizers have many serious environmental problems such as accumulation of heavy metals in soil and plant system [6]. In general, about 50-70 % of the applied conventional chemical fertilizers get lost in the environment causing economic, agronomical, environ-mental concerns and health threats. Therefore, new alternatives should be used for eco-friendly, economic and organic or sustainable agriculture such as organic-, bio- & nano-fertilizers as well as slow or controlled release fertilizers [7]. The new types of fertilizers based on nanotechnology are considered promising and non-traditional solution to upgrade the farming production worldwide. The common applications of nanotechnology in agriculture include nano-fertilizers, nano-pesticides and nano-carriers [8]. The aim of this study is to investigate the effect of kand Complex Nano-fertilizer with three applying methods on Senna seedlings.

2.Materials and Methods

The experiment was conducted at Plant Production Department, Technical Agricultural College, Mosul, Iraq at spring 2020 to investigate the effect of two Nano fertilizers kind ( K 27% and Complex fertilizer ( Cu 1%, S 13%, Zn 11.5 %, Mn 6.5%, Fe 7.5%, and Citric Acid 3.5 %), with three applying methods (spraying, soil addition, spraying + soil addition) on Senna seedlings. The seeds were sowing in plastic continuers in 15th Feb., and after the second true leaf transplant to plastic
Nanofertilizers were applying at 2 gm L⁻¹: constrictions four times monthly intervals, the first one in May after the fourth true leaf of the plant. The treatments were laid out in a factorial experiment in RCB with three replicates. The following parameters were recorded:

1. Seedlings length and number of leaves recorded five times at the first of June, July, August, Sep., and Oct.
2. Chlorophyll content (SPAD)
3. Stem diameter (cm)
4. Fresh weight of Vegetative growth (g)
5. Fresh weight of roots (g)
6. Dry weight of Vegetative growth (g)
7. Dry weight of roots (g)

The data were statistically analyzed according to the statistical analysis system (SAS) and the means were compared with Duncan multiple range test at 0.05 level [9].

3. Results

Table 1 revealed the effect of nanofertilizers and applying methods in plant length of Senna seedlings at five growth stages. It was found that the applying methods of fertilizer have a significant effect on plant length at the five growth stages except the first one and the highest length was (27.197, 49.581, 64.858, 107.767 cm) after 120, 150, 180, 210 days of planting respectively from the method (Spraying+ Soil Addition) which significantly superior than the other two methods. Also the types of fertilizers have a significant effect on plant length at the five growth stages and the highest length was (19.643, 32.943, 57.083, 81.737, 123.618 cm) after 90, 120, 150, 180, 210 days of planting respectively from the Complex nano fertilizer, which significantly superior than K- nano and zero fertilizers.

**Table 1. Effect of nanofertilizers and applying methods in plant length (cm) of Senna seedlings at five growth stages.**

| Treatments                        | Methods of fertilizer Addition | after 90 days | after 120 days | after 150 days | after 180 days | after 210 days |
|-----------------------------------|--------------------------------|---------------|---------------|---------------|---------------|---------------|
| Spraying                          |                                | 18.513 b      | 26.816 a      | 44.700 b      | 62.956 ab     | 95.607 c      |
| Soil Addition                     |                                | 18.823 a      | 26.170 b      | 44.690 b      | 61.717 b      | 100.283 b     |
| Spraying+ Soil Addition           |                                | 18.476 a      | 27.197 a      | 49.581 a      | 64.858 a      | 107.676 a     |
| Types of fertilizers              |                                |               |               |               |               |               |
| Zero Fertilizer                   |                                | 17.660 b      | 20.521 c      | 32.810 c      | 42.878 c      | 76.250 c      |
| K- nano                           |                                | 18.510 b      | 26.720 b      | 49.070 b      | 64.916 b      | 103.698 b     |
| Complex nano                      |                                | 19.643 a      | 32.943 a      | 57.083 a      | 81.737 a      | 123.618 a     |

Means with the same letter are not significantly different according to D.M.R. test at P=0.05 level.

**Table 2. Effect of interaction between nanofertilizers and applying methods in plant length (cm) of Senna seedlings at five growth stages.**

| Treatments                        | after 90 days | after 120 days | after 150 days | after 180 days | after 210 days |
|-----------------------------------|---------------|---------------|---------------|---------------|---------------|
| Spraying                          | Zero Fertilizer | 17.6600 b     | 20.5200 g     | 32.760 e      | 43.270 d      | 76.250 e      |
| Soil Addition                     | K- nano       | 17.8300 b     | 25.4100 f     | 45.180 d      | 64.180c       | 98.140 d      |
| Spraying                          | Complex nano  | 20.0500 a     | 34.5200 a     | 56.160 b      | 81.420 a      | 112.430 c     |
| Soil Addition                     | Zero Fertilizer| 17.6600 b     | 20.5200 g     | 32.737 e      | 42.090 d      | 76.250 e      |
| Spraying+ Soil Addition           | K- nano       | 19.2100 ab    | 26.3200 e     | 49.913 c      | 62.410 c      | 101.430 d     |
| Soil Addition                     | Complex nano  | 19.6000 a     | 31.6700 c     | 51.420 c      | 80.653 a      | 123.170 b     |
| Spraying+ Soil Addition           | Zero Fertilizer| 17.6600 b     | 20.5233 g     | 32.933 e      | 43.277 d      | 76.250 e      |
| Spraying+ Soil Addition           | K- nano       | 18.4900 ab    | 28.4300 d     | 52.140 c      | 68.160 b      | 111.523 c     |
| Soil Addition                     | Complex nano  | 19.2800 ab    | 32.6400 b     | 63.670 a      | 83.140 b      | 135.253 a     |

Means with the same letter are not significantly different according to D.M.R. test at P=0.05 level.

Table 2 revealed the effect of interaction treatments between nanofertilizers and applying methods in plant length of Senna seedlings at five growth stages. It was found that the highest values of plant length (20.0500, 34.5200, cm) after (90, 120 days) from interaction treatment between Spraying methods and Complex nano and (63.670, 83.140, 135.253 cm) after (150, 180, 210 days) respectively from the interaction treatment between Spraying +Soil Addition with Complex nano fertilizer with significant superior than the other treatments. While the lowest values of plant length was from interaction treatment between Spraying methods and zero fertilizer in the five growth stages of Senna seedlings.

Table 3 illustrated the effect of nanofertilizers and applying methods in number of leaves of Senna seedlings at five growth stages. It was found that the applying Methods of fertilizer have no significant effect on leaves number.
But the types of fertilizers have a significant effect on leaves number at the five growth stages and the highest leaves number was (7.033, 9.664, 12.163, 14.303, 16.323) after (90, 120, 150, 180, 210 days) of planting respectively from the Complex nano fertilizer which significantly superior than K- nano and zero fertilizers.

**Table 3.** Effect of nano fertilizers and applying methods in number of leaves per plant of *Senna* seedlings at five growth stages.

| Treatments           | after 90 days | after 120 days | after 150 days | after 180 days | after 210 days |
|----------------------|---------------|----------------|----------------|----------------|---------------|
| Spraying             | 6.436 a       | 8.165 a        | 10.551 a       | 12.356 a       | 14.0700 a     |
| Soil Addition        | 6.473 a       | 8.693 a        | 10.733 a       | 12.787 a       | 14.7600 a     |
| Spraying+ Soil Addition | 6.476 a       | 8.790 a        | 11.071 a       | 13.023 a       | 14.9533 a     |
| Zero Fertilizer      | 5.660 b       | 7.320 c        | 9.180 c        | 11.160 c       | 12.7300 c     |
| K- nano              | 6.693 a       | 8.664 b        | 11.012 b       | 12.704 b       | 14.7300 b     |
| Complex nano         | 7.033 a       | 9.664 a        | 12.163 a       | 14.303 a       | 16.3233 a     |

Means with the same letter are not significantly different according to D.M.R. test at $P=0.05$ level.

Table 4 revealed the effect of interaction treatments between nano fertilizers and applying methods in number of leaves of *Senna* seedlings at five growth stages. It was found that the highest values of number of leaves (10.010, 12.520, 14.860, 17.010) after (120, 150, 180, 210 days) respectively was from the interaction treatment between Spraying + Soil Addition with Complex nano fertilizer with significant superior than most other treatments. While the lowest values of number of leaves was from interaction treatment between Spraying methods and zero fertilizer in the five growth stag soft *Senna* seedlings.

**Table 4.** Effect of interaction between nano fertilizers and applying methods in number of leaves of *Senna* seedlings at five growth stages.

| Treatments           | after 90 days | after 120 days | after 150 days | after 180 days | after 210 days |
|----------------------|---------------|----------------|----------------|----------------|---------------|
| Spraying             |               |                |                |                |               |
| Zero Fertilizer      | 5.6600 b      | 7.3200 c       | 9.1800 d       | 11.1600 f      | 12.7300 f     |
| K- nano              | 6.3200 ab     | 8.1233 bc      | 10.5133 c      | 12.130 e       | 14.0400 e     |
| Complex nano         | 7.3300 a      | 9.0533 b       | 11.9600 ab     | 13.7800 bc     | 15.4400 c     |
| Zero Fertilizer      | 5.6600 b      | 7.3200 c       | 9.1800 d       | 11.160 f       | 12.7300 f     |
| Soil Addition        |               |                |                |                |               |
| K- nano              | 6.9900 a      | 8.8300 b       | 11.0100 bc     | 12.9333 d      | 15.0300 d     |
| Complex nano         | 6.7700 ab     | 9.9300 a       | 12.0100 ab     | 14.2700 ab     | 16.5200 b     |
| Zero Fertilizer      | 5.6600 b      | 7.3200 c       | 9.1800 d       | 11.160 f       | 12.7300 f     |
| Spraying+ Soil Addition |           |                |                |                |               |
| K- nano              | 6.7700 ab     | 9.0400 b       | 11.5133 abc    | 13.0500 cd     | 15.1200 d     |
| Complex nano         | 7.0000 a      | 10.1000 a      | 12.5200 a      | 14.8600 a      | 17.0100 a     |

Means with the same letter are not significantly different according to D.M.R. test at $P=0.05$ level.

Table 5 illustrated the effect of nano fertilizers and applying methods in stem diameter, chlorophyll content, fresh weight of vegetative growth and roots,and dry weight of vegetative growth and roots of *Senna* seedlings. It was found that the applying Methods of fertilizer have a significant effect and the highest values of stem diameter (1.1211 cm.), chlorophyll content (74.723 SPAD), fresh weight of vegetative growth and roots (107.533, 39.243 g.), and dry weight of vegetative growth and roots (7.586, 12.981 g.) from spraying+ soil addition of fertilizer with significant superior than the other two methods.

Also the types of fertilizers have a significant effect and the highest values of stem diameter (1.29556 cm.), chlorophyll content (78.013 SPAD), fresh weight of vegetative growth and roots (172.280, 56.0633 g.), and dry weight of vegetative growth and roots (10.5600, 15.1567 g.) from Complex nano fertilizer significant superior than the other two treatments.

**Table 5.** Effect of nano fertilizers and applying methods in stem diameter, Chlorophyll content, fresh and dry weight of vegetative growth and roots of *Senna* seedlings.

| Treatments           | Stem diameter (cm.) | Chlorophyll content (SPAD) | F. W. of Vegetative growth (g.) | F. W. of roots (g.) | D.W. of Vegetative growth (g.) | D.W. of roots (g.) |
|----------------------|---------------------|---------------------------|-------------------------------|-------------------|--------------------------------|-------------------|
| Spraying             | 0.89667 b           | 68.803 b                  | 94.173 c                      | 32.3587 b         | 4.8200 c                       | 9.5311 c          |
| Soil Addition        | 1.06111 a           | 72.993 a                  | 101.547 b                     | 33.1967 b         | 5.8633 b                       | 10.9311 b         |
| Spraying+ Soil Addition | 1.12111 a           | 74.723 a                  | 107.533 a                     | 39.2433 a         | 7.5867 a                       | 12.9811 a         |

Means with the same letter are not significantly different according to D.M.R. test at $P=0.05$ level.
Means with the same letter are not significantly different according to D.M.R. test at P=0.05 level.

**Table 6.** Effect of interaction between nano fertilizers and applying methods methods in Stem diameter, Chlorophyll content, fresh and dry weight of vegetative growth and roots of Senna seedlings.

| Treatments | Stem diameter (cm.) | Chloroph. content (SPAD) | F. W.of Vegetative growth (g.) | F. W.of roots growth (g.) | D. W.of Vegetative growth (g.) | D. W.of roots (g.) |
|------------|---------------------|--------------------------|-------------------------------|--------------------------|-------------------------------|-------------------|
| Spraying   | Zero Fertilizer     | 0.58000 d                | 65.450 e                    | 57.820 f                  | 22.030 e                      | 6.860 f           |
|            | K- nano Complexnano | 1.03000 c                | 68.650 d                    | 66.300 e                  | 24.633 d                      | 9.310 e           |
|            | Zero Soil Fertilizer| 0.58000 d                | 65.450 e                    | 57.820 f                  | 22.030 e                      | 6.860 f           |
| Addition   | K- nano Complexnano | 1.28000 b                | 74.210 bcd                  | 72.500 e                  | 24.920 d                      | 11.420 d          |
|            | Spraying + Soil     | Zero Fertilizer          | 0.58000 d                  | 65.450 e                  | 57.820 f                      | 6.860 f           |
|            | Addition            | K- nano Complexnano      | 1.30000 b                  | 76.310 bcd                | 80.660 d                      | 30.560 c          |

Table 6 revealed the effect of interaction treatments between nano fertilizers and applying methods in Stem diameter, Chlorophyll content, Fresh weight of Vegetative growth and roots, Dry weight of Vegetative growth and roots of Senna seedlings. It was found that the highest values of number of Stem diameter (1.4833 cm.), Chlorophyll content(82.410 SPAD), Fresh weight of Vegetative growth (184.120 g.), Fresh weight of roots65.140g.) Dry weight of Vegetative growth(18.540 g.), Dry weight of roots (13.520g.) was from the interaction treatment between Spraying + Soil Addition with Complex nano fertilizer with significant superior than the other treatments. While the lowest values of all the parameters was from interaction treatment between Spraying methods and zero fertilizer.

**4. Discussion**

The superiority of nano-fertilizers over control in all studied traits is because of their nanoparticles have a huge surface area increasing the enzymes and biochemical reactions. As they go directly to their intended destination and are characterized by ease of solubility and proliferation, which leads to increased reactions and enzymatic activities and increase cellular divisions, as well as the nanoparticles reduce or inhibit the formation of Reactive oxygen species (ROS) decreasing the oxidative damage, delaying senescence, and encouraging the vegetative growth of plant [10,11]. It is also attributed to the role of nanoparticles in adjusting the gene expression leading to biological paths affecting plant growth and development, as the unique properties of nanoparticles adjust the physicochemical properties of plants affecting the plant growth differently [12].

The increase in the values of the studied traits affected by applying Complex fertilizer ( Cu 1%, S 13%, Zn 11.5 %, Mn 6.5%, Fe7.5%, and Citric Acid 3.5 %) may be due to the role of these elements in influencing the plant growth and enhancing the vegetative part for utilizing them thus reflected positively on these traits. Iron plays in participating in constructing the main plant cell constituents of plant cell such as cytochromes, phytofurthin and ferredoxins which act as an electron transport in the process of photosynthesis, which stimulates the growth and thus, contributing to the plant height and leaf area increment [13], zinc role in the amino acid, Tryptophan, the major material participating in the synthesis of Indol Acetic Acid (IAA), that hormone is necessary for cell and stem elongation [14]. Zinc also has a role in increasing the dry matter accumulation in different plant parts.

**Conclusion**

It can be concluded that adding nano fertilizers by Spraying + Soil Addition increase significantly plant length, number of leaves per plant, Stem diameter, Chlorophyll content (SPAD), fresh and dry weight of vegetative growth and roots. Also applying Complex Nano fertilizer increase significantly all the parameters. So this will producing a large and suitable seedlings in short period.
References

[1] Singh DV, Srivastava GC, and Abdin MZ (2001). Amelio ration of negative effect of water stress in Cassia angustifolia by benzyladenine and/or ascorbic acid. Biol. Plant., 44(1): 141–143.

[2] Khammari, I. Galavi, M., Ghanbari, A., Solouki, M. and Poorchaman, M. R. A.. (2012) The effect of drought stress and nitrogen levels on antioxidant enzymes, proline and yield of Indian Senna (Cassia angustifolia L.) Journal of Medicinal Plants Research Vol. 6(11): 2125-2130.

[3] Srivastava M, Srivastava S, Khatoon S, Rawat AKS, Mehrotra S, and Puh pangadan P., (2006.)Pharmacognostical evaluation of Cassia angustifolia seeds. Pharmaceut. Biol. 44 (3); 202-207.

[4] Pratibha, G.; Korwar, G. R.; and Yadav, S. K.( 2010).Productivity, quality, nutrient use efficiency and economics of senna (Cassia angustifolia) as influenced by FYM and fertilizer nitrogen under rainfed conditions. Indian Journal of Agronomy 55 (1):79-83.

[5] Abdallah, A. A., Kambalawi, Y. O., and Osman, A.G. (2012). Response of Senna plant (Cassia senna L.) to Organic, Mineral and microbial FertilizationJournal of Agriculture and Biological Sciences. 3(1) :240 –249.

[6] Abdel, Wahab. M.M., El-attar, A.B. and Abdel, Mahmoud..A. (2017) Economic evaluation of nano and organic fertilizers as an alternative source to chemical fertilizers on Carum carviL. plant yield and components. Agriculture (Polnohospo-dárstvo). 63(1), 33-49.

[7] Alshaal, T. and El-Ramady, H. (2017) Foliar application: from plant nutrition to biofortification Env. Biodiv. Soil Security. 1, 71-83.

[8] Belal, E. and El-Ramady, H. (2016) Nanoparti-cles in water, soils and agriculture. In: Ranjan,S., Dasgupta, N., Lichtfouse,E. (eds.) Nano-science in Food and Agriculture 2.Sustainable Agriculture Reviews. Vol.21.Springer. Cham., 311-358.

[9] Al-Rawy, K.M.and A.M. Kalaf.(2000). Design and Analysis of Agricultural Experiments. 2nd ed. Iraq: Dar Al-Kutub Publishing,265 pp.

[10] Mohammed, M.A., Salman, S.R., (2017), Structural and surface roughness effects on sensing properties of ZnO doping with Al thin films deposited by spray pyrolysis technique, Journal of Engineering and Applied Sciences, 12 (Specialissue6), pp. 7912-7918.

[11] Morteza, E., P. Moaveni, H. A. Farahani and M. Kiyani (2013).Study of photosynthetic pigments changes of maize (Zea mays L.) under nano TiO2 spraying at various growth stages. Springer Plus, 2 : 247-249.

[12] Aslani, F., S. Bagheri, N. M. Julkapli, A. Juraimi, F. S. G. Hashemi and A. Baghdadi (2014). Effects of engineered nanomaterials on plants growth: An Overview. The Scientific World Journal.; 1-28.

[13] Sajjad H. J. Al-Bdair and Jawad Abdul kadhem, 2021, The Effect of Biofertilizer of Azola, Phosphate and Nitrogen Fertilizers on Yield and Grain Quality of Rice, Al-Qadisiyah Journal For Agriculture Sciences, 11, 1, 23-31. doi: 10.33794/qjas.2021.168287

[14] Hosseini, S. M., M. Maftoun, N. Karimian, A. Ronaghi and Y. Emam (2007). Effect of zinc X boron interaction on plant growth and tissue nutrient concentration of corn. J. of Plant Nutrition, 30(5) : 773-781.