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# Effect of magnetically treated water and foliar nano-fertilizer on some physiological indicators in pepper (capsicum annuum L)

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***Abstract***---This study was done on one nurseries affiliated to the center of Najaf governorate during the growing season 2021-2022 corresponding to 25/11/2021 to determination the effect of Irrigation with magnetically treated water with three intensity (0, 750, 1500) gauss and uses of Super Micro Nano-fertilizer with three levels, first level (0 $g.L^{-1}$), second level (1 $g.L^{-1}$) and third level (2 $g.L^{-1}$). On some physiological indicators in pepper (*Capsicum annuum* L.). The indicators was (chlorophyll (a, b), α and β carotenes, Catalase enzyme (CAT) and Superoxide Dismutase (SOD) enzyme) in the leaves of pepper plants. The results show that the plants irrigated with intensity 1500 gauss outperformed in physiological indicators (chlorophyll b, alpha-carotene, beta-carotene, Superoxide Dismutase enzyme (SOD) and Catalase enzyme (CAT)) over the rest treatments, While the effect of interaction between the two experimental factors was shown superiority of magnetically treated water with intensity 1500 gauss and the second level (1g.L) of Nano fertilizer and third level (2$g.L^{-1}$) in the content of( β-carotene, catalase enzyme, Superoxide Dismutase enzyme). While the control treatment outperformed in (chlorophyll b, α-carotene).

***Keywords***---physiological, indicators, capsicum annuum L, foliar, nano-fertilizer.

## Introduction

Pepper (*Capsicum annuum* L.) one of important vegetables having a high nutritional value, It cultivated all over the world as a beneficial food and

medicinal plant, Pepper one of important sources of vitamin C, as well as contains vitamin E and A with many antioxidants. It is used as anti-inflammatory, anti-cancer and anti-allergic. Researchers have proven the possibility of reducing the risk of cancer by using red pepper (Sitthiwong *et al.*, 2005; Shaha *et al*;, 2013; Santosh, 2013). Because of the importance of pepper and other crops, Scientists in the botanical field seek to invent new means that meet the requirements of the growing markets in quantity and quality, provide the product without impediment, safe and environmentally friendly ways, One of the modern technologies that had a clear role in improve plant production is using of magnetically treated water for plant irrigation.

By passing water across a magnetic field of different intensity to increasing the energy of this water (Amin and Qasim, 2009; Kozyrskiy *et al.*, 2020). And also irrigation with magnetized water leads to increase in the availability of nutrients in the soil, reduces the percentage of the salt, this helps to improve plant growth (Kronenberg, 1985; Vasilev *et al.*, 2018). And it is not hidden that the plant nutrients play important role in development of plant, and any decrease, increase or change in the amount of these nutrients leads to imbalance in metabolic and physiological processes of the plant.( Aziz *et al.*, 2010) Nano-fertilizer is the best, They having at least one dimension less than 100 nanometers, this alteration in size of materials to the Nano-scale leads to change in catalytic activities as well as biological, chemical and physical properties, New properties appear in this modified particles like increased chemical efficiency, solubility, ease of penetration into the cell membrane, in addition to the fact that the capacity of plant uptake of nanoparticles is higher than traditional fertilizers. (Mazaherinia *et al.* ,2010; Zahedi *et al.* ,2020).

**Materials and Methods**

The experiment carried out in growing season of 2021-2022 corresponding to 25/11/2021 using the method of planting inside the anvils for pepper seedlings to studying the effect of magnetically treated water and Nano-fertilizer in the indicators of some physiological indicators of pepper (*Capsicum annuum* L. , cv. California Wonder).

**Experiment preparation**

Black plastic put with a capacity of 10 kg and Diameter 35 cm, were filled with mixed soil (clay + organic fertilizer) at a ratio of (2:1), respectively, Pepper seedlings were planted in put.

**magnetically treated water**

Magnetrons are connected to tap water to magnetizing irrigation water, The device used is homemade with a diameter of 1/2 inch, the first is with an intensity 750 gauss, while the second is with an intensity 1500 gauss.

**Nano foliar fertilizer**

Super Micro Plus Fertilizer was used from the Iranian company Fanvar Seperhr Parmis. The fertilizer contains eleven essential nutrients for plant growth (Fe, Zn, Mn, K, Mg, P, Cu, Mo, B, Ca ,N ). As for the concentrations recommended by the manufacturer, they depend on the type of plant and its need for nutrients.

**Experiment design and implementation**

The design of the experiment was carried out according to the Randomized Complete Blaock Design (RCBD) for a factorial experiment consisting of two factors and three replications for each factor (3 magnetically treated water x 3 foliar Nano-fertilizer x 3 replications), as the first factor contains three magnetic tension (0, 750, 1500) Gauss. While the second factor was Nano-fertilizer with three concentrations( first level, comparison (0 $g.L^{-1}$), second level recommended (1$g.L^{-1}$),third level, double recommended (2$g.L^{-1}$)) according to the instructions on the Nano-fertilizer by the Iranian company Fanaver Seperhr Parmis, the manufacturer of Nano-fertilizer. The Nano fertilizer was added after completely dissolving it in distilled water then spraying the fertilizer on the vegetative part of the plant. The entire experiment included (27) experimental units.

**Plant Studied Parameters**

- Chlorophyll (a,b): The content of chlorophyll (a,b) in leaves was estimated based on method Mackinney (1941)
- α and β carotenes: The estimation of α and β carotenes in leaves was According to method Duxbury and Yentsch, 1956 ).
- Catalase enzyme in the leaves: The process of estimating the activity of catalase enzyme was carried out according to (Aebi, 1984)
- Superoxide Dismutase (SOD: Concentrations of SOD enzyme in the leaves of pepper plant were determined according to (Marklund and Marklund, 1984).

**Results**

**Chlorophyll a content in leaves (mg. $g^{-1}$ fresh weight)**

The results of Table (1) indicated that there were significant differences in the content of chlorophyll a in the leaves of pepper plant as a result of using magnetized water. The plants irrigated with non-magnetized water recorded the highest average (0.1474) mg. $g^{-1}$ fresh weight compared to rest treatments that recorded lowest average for plants irrigated with intensity (750) gauss, which recorded 0.1302 $mg.g^{-1}$ fresh weight. As for the effect of Nano-fertilizer, the third level of the Nano-fertilizer record highest average of chlorophyll a 0.1380 $mg.gm^{-1}$, while the lowest level of chlorophyll-a was in plants with the first level of leaf Nano-fertilizer 0.1226 $mg.g^{-1}$. The interaction of Non-magnetically treated water with second and third levels Nano-fertilizer had the highest concentration of chlorophyll a in the leaves (0.1582, 0.1535) $mg.g^{-1}$ fresh weight respectively. While the interaction of magnetized water with intensity (750) gauss and the first level of

nanoparticles had the lowest level of chlorophyll a concentration (0.1072) mg.gm$^{-1}$.

Table 1
Effect of magnetically treated water and Nano-fertilizer and the interaction between them on the content of chlorophyll a in *C. annuum*

| Fertilization levels | Magnetic Water | | | Mean of fertilization |
|---|---|---|---|---|
| | 0 | 750 | 1500 | |
| L1 | 0.1305 | 0.1072 | 0.1303 | 0.1226 |
| L2 | 0.1582 | 0.1254 | 0.1300 | 0.1379 |
| L3 | 0.1535 | 0.1303 | 0.1302 | 0.1380 |
| Mean of Magnetic water | 0.1474 | 0.1210 | 0.1302 | |
| L.S.D. 0.05 Fertilization = 0.005, Magnetic water = 0.005, Interaction = 0.009 | | | | |

**Chlorophyll b content in leaves (mg.g$^{-1}$) fresh weight**

The results of Table (2) showed that there were significant differences for the use of magnetically treated water on the content of chlorophyll b in pepper, the treatment with intensity (1500) gauss recorded (0.2134) mg.g$^{-1}$ fresh weight. the lowest concentration of chlorophyll b in the leaves was in treatments irrigated with non-magnetically treated water (0.0872) mg.g$^{-1}$ fresh weight. The significant effect of using Nano-fertilizer on the content of chlorophyll b in the leaves, the first level of Nano-fertilizer gave the highest concentration which was (0.2182) mg.g$^{-1}$ fresh weight, the lowest average was when treated with the second level of Nano-fertilizer which was (0.1259) mg.g$^{-1}$ fresh weight. The interaction between two factors of the study show superiority the plants treated with non-magnetically treated water and the first level of Nano fertilizer it recorded (0.2262) mg.g$^{-1}$ fresh weight, Then the interaction between intensity 1500 gauss and the third and second level of Nano-fertilizer and intensity 750 gauss and the third level, as they recorded content of chlorophyll b in the leaves (0.2259, 0.1885, 0.2258) mg.g$^{-1}$ fresh weight, respectively, Compared to rest treatments, which recorded the least significant difference in plants irrigated with non-magnetically treated water and the second level of Nano-fertilizer (0.0114) mg. g$^{-1}$ soft weight.

Table 2
Effect of magnetically treated water and Nano-fertilizer and the interaction between them on the content of chlorophyll b of *C. annuum*

| Fertilization levels | Magnetic Water | | | Mean of fertilization |
|---|---|---|---|---|
| | 0 | 750 | 1500 | |
| L1 | 0.2262 | 0.2026 | 0.2258 | 0.2182 |
| L2 | 0.0114 | 0.1778 | 0.1885 | 0.1259 |
| L3 | 0.0240 | 0.2258 | 0.2259 | 0.1586 |
| Mean of Magnetic water | 0.0872 | 0.2021 | 0.2134 | |
| L.S.D. 0.05 Fertilization = 0.025, Magnetic water = 0.025, Interaction = 0.061 | | | | |

**α-carotene content (mg.g$^{-1}$ fresh wt.)**

The results of statistical analysis presented in Table (3) indicated the significant effect of irrigation with magnetically treated water on the content of α-carotene in the leaves of pepper The treatment with intensity 1500 gauss over the rest of the treatments by recording the highest amount (105.16) mg.g$^{-1}$ fresh weight. The lowest average was when the treatment irrigated with non-magnetically treated water, it recorded (97.21) mg.g$^{-1}$ fresh weight. The first level of the Nano-fertilizer was superior in the content of α-carotene by recording the highest average (105.59) mg.g$^{-1}$ fresh weight over the rest of the other treatments, while the lowest average was recorded at the third level of the Nano-fertilizer, which was (100.29) mg.g$^{-1}$ fresh weight. The interaction between experimental factors showed the highest significant significance when the treatment irrigated with non-magnetically treated water and the first level of Nano-fertilizer with an average 106.68 mg.g$^{-1}$ fresh weight, while the lowest significant significance was when the treatment irrigated with non-magnetically treated water and the third level of Nano fertilizer with an average amount of (89.68) mg.g$^{-1}$ fresh weight.

Table 3
Effect of magnetically treated water and Nano-fertilizer and the interaction between them on the content of α-carotene of *C. annuum*

| Fertilization levels | Magnetic Water | | | Mean of fertilization |
|---|---|---|---|---|
| | 0 | 750 | 1500 | |
| L1 | 106.68 | 104.44 | 105.64 | 105.59 |
| L2 | 95.28 | 104.52 | 104.36 | 101.39 |
| L3 | 89.68 | 105.72 | 105.48 | 100.29 |
| Mean of Magnetic water | 97.21 | 104.89 | 105.16 | |
| L.S.D. 0.05 Fertilization = 1.835, Magnetic water = 1.835, Interaction = 2.991 | | | | |

**Content of β-carotene in the leaves (mg.g$^{-1}$) fresh weight**

The results of the statistical analysis presented in Table (4) the significant effect of using magnetically treated water on the content of (β-carotene) in pepper leaves, and it was shown that the treatments with intensity (1500) gauss superior to the other treatments by recording 107.56 mg.g$^{-1}$ fresh weight While the plants not treated with magnetized water recorded the lowest (97.71) mg.g$^{-1}$ fresh weight. As for the effect of Nano-fertilizer on (β-carotene) content, the first level of Nano-fertilizer outperformed the rest of treatments by recording (107.17) mg.g$^{-1}$ fresh weight, while the third level of Nano-fertilizer recorded the lowest (101.01) mg. g$^{-1}$ soft weight. The results of interaction between the two experimental factors indicated that there was no significant difference between treatments with intensity (1500) gauss and the first, second and third levels of Nano fertilizer, as well as treatment with intensity (750) gauss and the third level of Nano fertilizer and treatment with non-magnetized water and the first level of Nano fertilizer, all recorded as average Its amount was (107.5) mg.g$^{-1}$ fresh weight, while the lowest was when treating with non-magnetized water and the third level of Nano-fertilizer (87.92) mg.g$^{-1}$ fresh weight.

Table 4
Effect of magnetically treated water and Nano fertilizer and the interaction between them on the content of β-carotene in *C. annuum*

| Fertilization levels | Magnetic Water | | | Mean of fertilization |
|---|---|---|---|---|
| | 0 | 750 | 1500 | |
| L1 | 107.84 | 106.24 | 107.44 | 107.17 |
| L2 | 97.36 | 106.20 | 107.52 | 103.69 |
| L3 | 87.92 | 107.56 | 107.56 | 101.01 |
| Mean of Magnetic water | 97.71 | 106.67 | 107.51 | |
| L.S.D. 0.05 Fertilization = 1.887, Magnetic water = 1.887, Interaction = 3.251 | | | | |

**Catalase enzyme (CAT) in leaves**

Table (5) displays the result of the statistical analysis of the effect of irrigation with magnetically treated water on the content of (CAT) in the leaves of pepper and the superiority of the treatment irrigated with t intensity (1500) gauss by recording (155.00) mol.min$^{-1}$.mg$^{-1}$ With a significant difference from the other treatments, the lowest of which was for plants irrigated with intensity (750) gauss was recorded (69.17) mol.min-$^{1}$.mg$^{-1}$. the effect of Nano-fertilizer on the content of catalase enzyme, we note the superiority of the third level of Nano-fertilizer, it recorded (145.00) mol.min$^{-1}$.mg$^{-1}$, superior to the rest treatments, which was the lowest in plants irrigated with the second level of Nano-fertilizer (68.33) mol. min$^{-1}$.mg$^{-1}$. The interaction between the two experimental workers indicated that the catalase enzyme ratio was superior to plants irrigated with water treated with intensity (1500) gauss and Nano fertilizer at the third level (325.00) mol.min$^{-1}$.mg$^{-1}$ superior to all treatments, the least interaction When treated with magnetized water with intensity 750 gauss and the second level of Nano fertilizer, which recorded (12.50) mol.min$^{-1}$.mg$^{-1}$.

Table 5
Effect of magnetically treated water and Nano-fertilizer and the interaction between them on the content of catalase enzyme (CAT) in leaves of *C. annuum*

| Fertilization levels | Magnetic Water | | | Mean of fertilization |
|---|---|---|---|---|
| | 0 | 750 | 1500 | |
| L1 | 75.00 | 125.00 | 50.00 | 83.33 |
| L2 | 102.50 | 12.50 | 90.00 | 68.33 |
| L3 | 40.00 | 70.00 | 325.00 | 145.00 |
| Mean of Magnetic water | 72.50 | 69.17 | 155.00 | |
| L.S.D. 0.05 Fertilization = 5.523, Magnetic water = 5.523, Interaction = 8.092 | | | | |

**Superoxide Dismutase (SOD) Content in Leaves**

The results of the statistical analysis shown in Table (6) showed that the SOD ratio in plants irrigated with water treated with intensity (1500) gauss exceeded the other treatments by recording (45.67) units. mg$^{-1}$ of protein, and it was the

lowest in the control treatment with an average (42.25) units $mg^{-1}$ of protein. The percentage of (SOD) when treated with Nano-fertilizer at the first level ($0g.L^{-1}$), which recorded (47.25) units.$mg^{-1}$ of protein, outperformed the rest treatments that recorded the lowest percentage at the third level($2g.L^{-1}$) of Nano-fertilizer (40.00) units.$mg^{-1}$ of protein. The interaction between the two factors of the study shown the superiority of (SOD) ratio when treating with intensity (1500) gauss and the second level of Nano fertilizer ($1g.L^{-1}$) by recording (55.75) units. $mg^{-1}$ of protein. It was followed by the control treatment and the first level of Nano-fertilizer with a percentage (54.25) units. $mg^{-1}$ of protein There is no significant difference between the two percentages that outperformed the other percentages, which was the least significant difference was recorded when the interaction between plants irrigated with water with intensity 1500 gauss and the third level of Nano-fertilizer (34.75) units. $mg^{-1}$ of protein.

Table 6
Effect of magnetically treated water and Nano-fertilizer and the interaction between them on the (SOD) content in leaves of *C. annuum*

| Fertilization levels | Magnetic Water | | | Mean of fertilization |
|---|---|---|---|---|
| | 0 | 750 | 1500 | |
| L1 | 54.25 | 41.00 | 46.50 | 47.25 |
| L2 | 36.75 | 40.00 | 55.75 | 44.17 |
| L3 | 35.75 | 49.50 | 34.75 | 40.00 |
| Mean of Magnetic water | 42.25 | 43.50 | 45.67 | |
| L.S.D. 0.05 Fertilization = 2.367, Magnetic water = 2.367, Interaction = 3.885 | | | | |

**Discussion**

It is noted from the results of the current study that some indicators outperform at intensity 1500 gauss, such as (chlorophyll b, α-carotene, β-carotene, SOD enzyme and catalase enzyme) that because of the change in the mineral content of the water after strong magnetic treatment with intensity 1500 gauss, and the water quality can be improved by increasing the magnetic field.. (Toledo et al. 2008; Alhasnawi and Aljanaby, 2022). This is clear in this study by increasing some physiological indicators at intensity 1500 gauss, the reason could be the type of plant and its ability to absorb nutrients available in the soil by the effect of water treated with intensity 1500 gauss, The different in response the plants to the two stresses (750, 1500) gauss can be attributed to the stimulating effect of treated water on the biosynthesis of the molecular structure and its biological interactions in various processes in the plant, as the magnetic field has a positive effect on water in terms of reducing surface tension Surface Tension and Viscosity increase which makes the water after treatment more stable with less Molecular energy and higher Activation energy (Cai et al. 2009; Medhat and Aljanaby, 2022).

The effect of use Nano-fertilizer on pepper show Positive effect in the (content of chlorophyll a, content of catalase enzyme) at the third level of Nano-fertilizer that doe to increasing the absorption of nutrients and water, Also, increase in the proportion of chemical components in the plant body as a result of treating pepper with Nano-fertilizer to increasing the speed of vital reactions and due to

the large surface capacity of nanoparticles, which increases the speed of reactions leading to the production of growth materials.(Shadravan et al. 2018; Aljanaby et al., 2022). The results of the binary interaction between the two experimental factors showed a clear effect on the content of chlorophyll a at the interaction between irrigation with tap water and the second level of Nano-fertilizer and content of chlorophyll b at the plant irrigated with intensity 1500 gauss and first level of Nano-fertilizer and third, and content of catalase enzyme at interactions between intensity 1500 gauss and third level ($2g.L^{-1}$) of Nano-fertilizer, and content of Superoxide Dismutase enzyme between intensity 1500 gauss and second level ($1g.L^{-1}$)of Nano-fertilizer in leaves of pepper plant the increase in this indicators according to the interaction between the magnetization factors and the Nano-fertilizer factor can be explained on the basis of what previous studies have shown that magnetically treated water Increases the solubility and deep penetration of fertilizers in soils irrigated with magnetized water compared to soils irrigated with normal water (Rokhinson et al., 1994; Hadi and Aljanaby, 2022). The effects of magnetically treated water vary according to the type of plant, the irrigation water used, and the interaction between the factors used. Irrigation with treated water achieves an increase in growth indicators and the efficiency of photosynthesis and the conversion of photo-assimilates through the cracking of salts of dissolved particles, thus improving the different growth parameters.( Abobatte, 2015).

**References**


Aljanaby, A. A. J., Al-Faham, Q. M. H., Aljanaby, I. J., & Hasan, H. H. (2022). Immunological role of cluster of differentiation 56 and cluster of differentiation 19 in patients infected with mycobacterium tuberculosis in Iraq. Gene Reports, 26, 101514.

Abobatta, W. (2015). Influence of magnetic iron and k-humate on productivity of Valencia orange trees (*Citrus Sinensis* L.) under salinity conditions. International Journal of Scientific Research in Agricultural Sciences, 2 (Proceedings), 108-119..

Aebi, H.,(1983).Catalase in vitro, Methods of Enzymology,105:121-126

Alhasnawi, H. M. R. J., & Aljanaby, A. A. J. (2022). Evaluation of Galectin-3 and CD19 in Helicobacter pylori patients infected with stomach cancer. Gene Reports, 26, 101520

Al-Khafaji, Makki Alwan and Faisal Abdul-Hadi Al-Mukhtar (1989). Fruit and vegetable production, Ministry of Higher Education and Scientific Research, University of Baghdad. House of wisdom. The Republic of Iraq.

Amin, Sami Karim Muhammad and Qasim, Ali Farouk (2009). Effect of the salinity of magnetized irrigation water on the vegetative growth characteristics of Gerbera jamesonii L.. Damascus University Journal of Agricultural Sciences, 25 (1), 63-74

Aziz, E. E., El-Danasoury, M., & Craker, L. (2010). Impact of sulfur and ammonium sulfate on dragonhead plants grown in newly reclaimed soil. *Journal of herbs, spices & medicinal plants, 16*(2), 126-135.

Cai, R., Yang, H., He, J., & Zhu, W. (2009). The effects of magnetic fields on water molecular hydrogen bonds. *Journal of Molecular Structure, 938*(1-3), 15-19.

Duxbury, A.C. and Yentsch, C.S., (1956). Plankton pigment monograph, J. of Marine Research, 15: 92-101.

Giri, M. K. W. (2019). Immunological side in overtraining exercise. International Journal of Health & Medical Sciences, 2(1), 1-6. https://doi.org/10.31295/ijhms.v2n1.52

Hadi, H. I. & Aljanaby, A. A. J. (2022). Helicobacter Pylori-oncogenic protein cytotoxin-associated gene A and assessment of CD14 and CD163 in duodenal ulcer and gastric cancer patients. International Journal of Health Sciences, 6(S2), 839–851. https://doi.org/10.53730/ijhs.v6nS2.5134

Kozyrskiy, V., Savchenko, V., Sinyavsky, O., & Bunko, V. (2020). Energy-saving technologies for pre-sowing seed treatment in a magnetic field *Handbook of Research on Energy-Saving Technologies for Environmentally-Friendly Agricultural Development* (pp. 213-242): IGI Global.

Kronenberg, K. (1985). Experimental evidence for effects of magnetic fields on moving water. *IEEE Transactions on Magnetics, 21*(5), 2059-2061

Mackinney, G. (1941). Absorption of light by chlorophyll solutions. *Journal of biological chemistry, 140*(2), 315-322.

Marklund,S.and Marklund,M,(1974).Involvement of the superoxide anion

Mazaherinia, S., Astaraei, A. R., Fotovat, A., & Monshi, A. (2010). Nano iron oxide particles efficiency on Fe, Mn, Zn and Cu concentrations in wheat plant. *World Applied Sciences Journal, 7*.

Medhat, A. R., & Aljanaby, A. A. J. (2022). Epidemiology of typhoid fever in Balad City, Iraq. International Journal of Health Sciences, 6(S1), 1049-1063. https://doi.org/10.53730/ijhs.v6nS1.4834

Ochoa-Alejo, N., and Ramirez-Malagon, R. (2001). In vitro chili pepper biotechnology. In vitro Cellular and Developmental Biology-Plant, 37(6), 701-729

Rokhinson, E., Gak, E., & Klygina, L. (1994). Agricultural magnetic treaters for seeds and water. *International Agrophysics, 8*(2).

Santosh, K. (2013). Genetic variability studies in bell pepper (*Capsicum annuum* L.). Asian Journal of Horticulture, 8(1), 280-284.

Shadravan, B., Janmohammadi, M., Dashti, S., & Sabaghnia, N. (2018). INFLUENCE OF INTEGRATED APPLICATION OF NANO-CHELA-TED TRACE ELEMENTS AND SULFUR ON DESI CHICKPEA IN THE SHORT-SEASON MEDITERRANEAN-TYPE ENVIRONMENT. *Botanica, 24*(1), 15-25.

Shaha, R. K., Rahman, S., ana Asrul, A. (2013). Bioactive compounds in chilli peppers *(Capsicum annuum* L.) at various ripening (green, yellow and red) stages. Annals of Biological Research, 4(8), 27-34.

Sitthiwong, K., Matsui, T., Sukprakarn, S., Okuda, N., and Kosugi, Y. (2005). Classification of pepper (*Capsicum annuum* L.) accessions by RAPD analysis. Biotechnology, 4(4), 305-309

Toledo, E. J., Ramalho, T. C., & Magriotis, Z. M. (2008). Influence of magnetic field on physical–chemical properties of the liquid water: Insights from experimental and theoretical models. Journal of Molecular Structure, 888(1-3), 409-415

Vasilev, S., Mashkov, S. V., Syrkin, V. A., Gridneva, T. S., & Yudaev, I. V. (2018). Results of studies of plant stimulation in a magnetic field. Research journal of pharmaceutical, biological and chemical sciences, 9(4), 706-710.

Widana, I.K., Sumetri, N.W., Sutapa, I.K., Suryasa, W. (2021). Anthropometric measures for better cardiovascular and musculoskeletal health. *Computer Applications in Engineering Education*, *29*(3), 550–561. https://doi.org/10.1002/cae.22202

Zahedi, S. M., Karimi, M., & Teixeira da Silva, J. A. (2020). The use of nanotechnology to increase quality and yield of fruit crops. Journal of the Science of Food and Agriculture, 100(1), 25-31