

## Effect of cultivar and fertilizer combinations of nano and traditional NPK on the qualitative traits of potato *Solanum tuberosum* L.

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### Abstract

The experiment was conducted in the vegetable field of the Department of Horticulture and Landscaping, College of Agriculture and Forestry, University of Mosul in the spring season 2021. To study the effect of two factors, the first: three cultivars of potatoes, Arizona, Montreal, Florice, and the second: five levels of the fertilizer combination: 100% chemical, 75% chemical + 25% nano, 50% chemical + 50% nano, 25% chemical + 75% nano. Chemical Zero + 100% Nano. The experiment was designed in a split plot system using the R.C.B.D. complete block design with three replicates. The results can be summarized as follows: The Montreal cultivar achieved the highest significant values in the percentage of dry matter and starch in the tubers and the qualitative weight of the tubers, while the Arizona cultivar recorded the highest significant value in tubers hardness, While the cultivar Florice achieved the highest significant value in the percentage of protein in the tubers. The fertilizer combination 50% chemical + 50% nano achieved the highest values in the percentage of dry matter and starch in the tubers and the qualitative weight of the tubers. The fertilizer combination 75% chemical +25% nano gave the highest nitrate content in the tubers, while the 25% chemical +75% nano fertilizer combination achieved the highest significant value of vitamin C content in the tubers. The interaction treatment between Arizona cultivar and the fertilizer mixture 50% chemical +50% nano gave the highest significant values in the percentage of dry matter and starch and the qualitative weight of the tubers. The interaction between Florice cultivar with 100% nano had the highest significant value in the protein content in the tubers, and the interaction between Florice cultivar and the fertilizer combination 25% chemical + 75% nano was the highest significant value in the tubers content of vitamin C, The Arizona cultivar with 100% nano gave the highest significant value in tuber hardness and the lowest value in tuber nitrate content, and the interaction between Montreal cultivar and the fertilizer combination 25% chemical +75% nano gave the highest significant value in TSS ratio in tubers.

**Key words:** potato qualitative characteristics, nano-fertilizer, cultivars

### Introduction

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops in the world, and it belongs to the Solanaceae family. The origin country of the potato is South America, after which it moved to Europe and North America (Manea et al., 2019). Tuber crops top the list, where they are one of the important vegetable crops that humans can consume in relatively large quantities because they constitute an important source of many nutrients and come in the fourth place among the most cultivated crops after wheat, rice and corn (Daniels-Lake, 2013, AL-Taey et al.,

2019), The potato crop is affected by many factors, the most important of which is the cultivar that is suitable for the environmental conditions in the production area, its resistance to disease and insect infestations spread in the production area, and that it has high productivity and its tubers are desirable to the consumer in terms of shape and color (Mosali, 2000). Hassan et al. (2017) found the superiority of Arizona cultivar in the percentage of dry matter and starch in tubers compared to Riviera and Volare cultivars. AL-Bayati et al. (2018) reported the superiority of the Burren variety in the percentage of dry matter in the tubers, while

the Arizona cultivar excelled in the proportion of protein in the tubers. AL-Bayati and AL-Quraishi (2019) noted the Arizona cultivar excelled in the percentage of dry matter and starch in tubers and tubers qualitative weight compared to Riviera and Agria cultivars. AL-Zebari et al. (2021) found the superiority of Laperla cultivar in the percentage of dry matter and starch in tubers, TSS percentage in tubers and tubers qualitative weight compared to Arizona, Montreal and Florice cultivars. Nanotechnology is used as a technology with multidisciplinary windows in agricultural and food sciences and contributes to a lot of agricultural research that can lead to new ways to solve many agricultural problems (AL-Taey and AL-Musawi, 2019), Nano-fertilizers are one of the modern methods used to increase agricultural production, due to the increase in their surface area (AL-Juthery et al., 2018), as well as due to the slow partial release of nutrients from them, which leads to efficient absorption of nutrients by crops. Moreover, it is an excellent technology for sustainability and new nutrient delivery systems that penetrate the porous surfaces of nano-coated plants, restore soil fertility and reduce environmental pollution (AL-Juthery et al., 2020). The success of using nanomaterials as fertilizers in plant growth depends on the types of plants and some other factors such as size, concentration, components and chemical properties of nanomaterials (Thakur and Kumar, 2018). When classified, nano-fertilizers contain nutrients such as nitrogen, phosphorous and potassium, or they may contain micro-nutrients such as magnesium, calcium and some essential micro-nutrients for plants (Bruinsma and Alexandratos, 2012). Abboud and Mijwel (2018) found that the addition of chemical fertilizer with nano-fertilizer spraying at a concentration of  $2 \text{ g L}^{-1}$  to potato plants caused a significant increase in the percentage of dry matter and starch in tubers

While Ali (2019) mentioned that spraying Arizona potato plants with nano-fertilizer containing macro and micro elements at a concentration of  $1 \text{ g L}^{-1}$  led to giving the highest significant values in the percentage of dry matter, starch and TSS in tubers. Mijwel and Muhsin (2019) indicated that spraying potato plants with nano-fertilizer at a concentration of  $2 \text{ g L}^{-1}$  caused a significant increase in starch content in tubers. Abd El-Azeim et al. (2020) observed that spraying 50% NPK nano fertilizer for Cara potato plants gave the lowest nitrate content in tubers. Al-Abdali (2021) found that the fertilizer recommendation 25% chemical + 75% nano, at a concentration of  $2 \text{ g L}^{-1}$  for plants of two cultivars of potatoes, Arizona and Montreal, gave the highest significant values in the percentage of dry matter and starch in the tubers and the qualitative weight in tubers and the lowest nitrate content in tubers. compared to other treatments. This study aims to know the best cultivar of the studied cultivars suitable for the environmental conditions of Nineveh province, Iraq, and the best fertilizer combination to obtain the highest moral values of the studied traits and the lowest nitrate content in the tubers.

### Materials and methods

The experiment was conducted during the spring agricultural season of 2021, in the vegetable field of the Department of Horticulture and Landscaping, College of Agriculture and Forestry, University of Mosul. Samples were taken from the field soil from the surface layer down to a depth of 30 cm in order to conduct a laboratory examination to know the physical and chemical properties of the field soil before planting and Table No. (1) shows the most important physical and chemical properties of the measured soil.

**Table (1) shows some physical and chemical properties of the soil of the experimental field before cultivation**

| traits                                      | values |
|---|--------|
| PH  | 7.2    |
| Electrical conductivity EC (m-1/dc)         | 0.3    |
| % organic matter                            | 1.3    |
| Availability Nutrients Content              |        |
| Nitrogen mg kg-1                            | 27.2   |
| Phosphorous mg kg-1                         | 6.5    |
| Potassium mg kg-1                           | 100    |
| Physical soil components g kg <sup>-1</sup> |        |
| sand gram kg <sup>-1</sup>                  | 420.5  |
| silt Gram kg <sup>-1</sup>                  | 340    |
| Clay kg kg <sup>-1</sup>                    | 239.5  |
| texture                                     | Loam   |

The land was prepared for cultivation by tillage with a triple Moldboard plow and two perpendicular plows, and the smoothing and leveling of the soil was conducted. The chemical fertilizer NPK 15:15:15 was added according to the treatments and mixed with the soil. The experimental field was divided into three sectors, and each sector was divided into 15 experimental units with a length of 2 m and then work the troughs at an average of three troughs for the experimental unit and extend the drip irrigation pipes. The seeds were planted on February 13, 2021, for the cultivars Arizona, Montreal, and Florice, rank E, The experimental unit included three furrows with a length of 2 m, a width of 2.25 m, and the distance between one meadow and another is 75 cm. The area of the experimental unit was 4.5 m<sup>2</sup> and 8 tubers were planted in each furrows. The number of tubers in the experimental unit was 24, and they were planted at a depth of 15 cm. The method was drip irrigation. The agricultural service operations were conducted as is the

case in the commercial fields of the potato crop in the same methods for all the experimental units, from weeding and weeding (twice during the growing season), exporting the soil for plants (once during the growing season) and controlling diseases and insects.

Two factors were studied in the experiment:

The first factor: Three types of seed grade E:

- 1- Arizona
- 2- Montreal
- 3- Florice

The second factor: Fertilizer combination treatments :

1. Chemical fertilizer NPK 15: 15: 15 The full recommendation is only 400 kg ha<sup>-1</sup> (Al-Fadli, 2006).

2. 75% NPK 15:15:15 chemical fertilizer + 25% NPK 20:20:20 nano fertilizer.
3. 50% chemical fertilizer NPK 15: 15: 15 + 50% nano fertilizer NPK 20: 20: 20.
4. 25% NPK 15:15:15 chemical fertilizer + 75% NPK 20:20:20 nano fertilizer.
5. Only nano fertilizer (100% nano).

The nano-fertilizer was sprayed three times during the growing season, and the chemical fertilizer was added 15:15:15 before planting. The first spray is a week after the completion of tuber germination, the second is 20 days after the first, and the third spray is 20 days after the second spray. The experiment was carried out in the split plot system once, where the cultivars were placed in the main plots and the fertilizer combination treatments were placed in the split plots and with three replicates.

#### Studied traits:

The percentage of dry matter in the tubers, the percentage of starch in the tubers, the qualitative weight of tubers, the protein content in tubers%, tubers hardness ( $\text{kg cm}^{-2}$ ),

the nitrate content of tubers: ( $\text{mg}^{-1}$  dry weight), the percentage of TSS in tubers % ,The content of the tubers of vitamin C ( $\text{mg 100 g}^{-1}$  fresh weight)

#### Results and discussion

The results in Table(2) indicate that the Montreal cultivar gave the highest percentage of dry matter and starch and qualitative weight in tubers reached 21.05% and 14.77% 1.084, respectively, and did not differ significantly from Arizona cultivar. While the lowest percentage of dry matter and starch and qualitative weight in tubers was 19.09%, 13.02% and 1.075, respectively, while Florice cultivar gave the highest protein content in tubers 9.341% and the lowest value for this trait reached 8.392% in Montreal cultivar. As for the fertilizer combination, it is noted that there are no significant differences in the percentage of protein in the tubers, While the V3 treatment gave the highest percentage of dry matter and starch and qualitative weight in the tubers amounting to 21.79%, 15.42% and 1.087, respectively, and the lowest values for these traits were in the V5 treatment, amounting to 18.54%, 12.53% and 1.072, respectively.

**Table (2): Effect of cultivar and fertilizer combination on some qualitative traits of potato tubers.**

| Treatments             | The percentage of dry matter in the tubers | The percentage of starch in tubers | Qualitative weight of tubers | protein in tubers% |
|------------------------|--|------------------------------------|------------------------------|--------------------|
| Arizona                | 20.44 a                                    | 14.22 a                            | 1.081a                       | 8.403 b            |
| Montreal               | 21.05 a                                    | 14.77 a                            | 1.084 a                      | 8.392 b            |
| Florice                | 19.09 b                                    | 13.02 b                            | 1.075 a                      | 9.341 a            |
| Fertilizer combination |  |                                    |                              |                    |
| V1                     | 19.68 c                                    | 13.54 c                            | 1.077                        | 8.447 a            |
| V2                     | 20.08 c                                    | 13.90 c                            | 1.079 c                      | 9.107 a            |
| V3                     | 21.79 a                                    | 15.42 a                            | 1.087 a                      | 8.150 a            |
| V4                     | 20.87 b                                    | 14.60 b                            | 1.083 b                      | 8.997 a            |
| V5                     | 18.54 d                                    | 12.53 d                            | 1.072 d                      | 8.859 a            |

The averages with the same letter or letters within the same column and the interaction coefficients do not differ between them significantly according to Duncan's polynomial test under the probability level of 0.05, V1 = chemical only, V2 = chemical 75% + 25% nano, V3 = chemical 50% + 50% Nano, V4 = chemical 25% + 75% nano, V5 = 100% nano

It is noted from the results in Table (3) that the interaction treatment between Arizona cultivar and V3 treatment gave the highest percentage of dry matter, starch and qualitative weight in tubers, amounting to 22.98%, 16.49% and 1.093, respectively, while

**Table (3): The effect of interaction between cultivar and fertilizer combination on some qualitative traits of potato tubers.**

| Treatments | Fertilizer combination | The percentage of dry matter in the tubers | The percentage of starch in tubers | Qualitative weight of tubers | protein in tubers% |
|------------|------------------------|--|------------------------------------|------------------------------|--------------------|
| Arizona    | V1                     | 19.72 efg                                  | 13.57 efg                          | 1.078 efg                    | 7.868 bc           |
|            | V2                     | 20.09 ef                                   | 13.91 ef                           | 1.079 ef                     | 9.213 abc          |
|            | V3                     | 22.98 a                                    | 16.49 a                            | 1.093 a                      | 8.115 bc           |
|            | V4                     | 21.44 cd                                   | 15.11 cd                           | 1.086 cd                     | 7.995 bc           |
|            | V5                     | 17.95 h                                    | 12.01 h                            | 1.069 i                      | 8.821 abc          |
| Montreal   | V1                     | 20.57 de                                   | 14.34 de                           | 1.082 de                     | 8.638 abc          |
|            | V2                     | 21.17 cd                                   | 14.87 cd                           | 1.085 cd                     | 8.851 abc          |
|            | V3                     | 22.67 ab                                   | 16.20 ab                           | 1.092 ab                     | 7.880 bc           |
|            | V4                     | 21.91 bc                                   | 15.53 bc                           | 1.088 bc                     | 9.076 abc          |
|            | V5                     | 18.94 g                                    | 12.88 g                            | 1.074 gh                     | 7.511 c            |
| Florice    | V1                     | 18.74 gh                                   | 12.71 gh                           | 1.073 ghi                    | 8.831 abc          |
|            | V2                     | 18.98 g                                    | 12.92 g                            | 1.074 gh                     | 9.255 abc          |
|            | V3                     | 19.73 efg                                  | 13.58 efg                          | 1.078 efg                    | 8.455 abc          |
|            | V4                     | 19.26 fg                                   | 13.17 fg                           | 1.076 fgh                    | 9.918 ab           |
|            | V5                     | 18.74 gh                                   | 12.71 gh                           | 1.073 hi                     | 10.246 a           |

The averages with the same letter or letters within the same column and the interaction treatments do not differ between them significantly according to Duncan's polynomial test under the probability level of 0.05, V1 = chemical only, V2 = chemical 75% + 25% nano, V3 = chemical 50% + 50% Nano, V4 = chemical 25% + 75% nano, V5 = 100% nano

It is noted from Table (4) that there are no significant differences between the cultivars, the content of tubers of vitamin C, the percentage of TSS in tubers, While the Arizona cultivar gave the highest tuber hardness of 11.14 kg cm<sup>2</sup> and the lowest value for this trait was 9.49 kg cm<sup>2</sup> in the Montreal cultivar.

**Table (4): Effect of cultivar and fertilizer combination on yield characteristics of potato on some qualitative traits of potato tubers.**

| Treatments             | Tubers hardness (kg cm <sup>2</sup> ) | The nitrate content of the tubers (mg kg <sup>-1</sup> dry weight) | TSS percentage in tubers% | Vitamin C content of tubers (mg 100 g <sup>-1</sup> fresh wt.) |
|------------------------|---------------------------------------|--|---------------------------|--|
| Arizona                | 11.14 a                               | 0.902 b  | 5.26 a                    | 17.13 a  |
| Montreal               | 9.49 c                                | 0.977 a  | 5.33 a                    | 18.34 a  |
| Florice                | 10.63 b                               | 0.977 a  | 5.09 a                    | 17.81 a  |
| Fertilizer combination |                                       |  |                           |  |
| V1                     | 10.35 a                               | 0.930 bc   | 4.99 b                    | 17.03 b  |
| V2                     | 10.29 a                               | 0.995 a  | 5.23 b                    | 17.28 b  |
| V3                     | 10.47 a                               | 0.964 ab   | 5.71 a                    | 17.72 b  |
| V4                     | 10.44 a                               | 0.985 ab   | 5.81 a                    | 21.32 a  |
| V5                     | 10.57 a                               | 0.886 c  | 4.41 c                    | 15.48 b  |

The averages with the same letter or letters within the same column and the interaction treatments do not differ between them significantly according to Duncan's polynomial test under the probability level of 0.05, V1 = chemical only, V2 = chemical 75% + 25% nano, V3 = chemical 50% + 50% Nano, V4 = chemical 25% + 75% nano, V5 = 100% nano

It is noticed from table (5) that the highest hardness of tubers was 11.48 kg cm<sup>2</sup> and the lowest nitrate content in tubers was 0.847 mg kg<sup>-1</sup> dry weight in the treatment of Arizona cultivar with V5. The highest TSS ratio was 6.00 in the Montreal cultivar treated with V4, and the highest content of vitamin C in tubers was 22.17 in the Florice cultivar treated with V4. From the above results, the Montreal cultivar was significantly superior in the percentage of dry matter and starch in the tubers, and the Florice variety in the proportion of protein in the tubers (Table 2) and the cultivar Arizona gave the highest value in tubers hardness and the lowest value in nitrate content in tubers (Table 4) This may be due to genetic differences between the cultivated potato cultivars (NIVAA, 2107). There are significant differences between potato cultivars in the qualitative traits of tubers, and these results are consistent with what was mentioned by (AL-Bayati et al., 2018), (AL-Bayati and AL-Quraishi, 2019) and (AL-Zebari et al., 2021). The fertilizer

mixture 50% chemical + 50% nano is significantly excelled in the percentage of dry matter and starch in the tubers and the qualitative weight of tubers (Table 2). The percentage of TSS in tubers (Table 4) and the 100% nano fertilizer combination gave the lowest value in the tubers content of nitrate, and the 25% chemical + 75% nano fertilizer combination gave the highest value in the tubers content of vitamin C (Table 4) This may be due to the fact that the use of nano-fertilizers in the form of a fertilizer combination with chemical fertilizers led to an improvement in vegetative growth and thus an increase in the efficiency of the photosynthesis process, which increases the accumulation of dry matter in plants and transferring those outputs from the manufacturing center in the leaves Source to the storage centers in the tubers Sink, which increases all the qualitative traits of the tubers (AL-Bayati et al., 2019), It may also be due to the homogeneity of fertilizers in the fertilizer mixture added to the soil, which led to an

increase in the readiness of the elements in the soil solution and an increase in the amount absorbed by the roots and spraying with nano-fertilizers for the leaves and through direct absorption of these fertilizers, all of which led to an improvement in the qualitative traits of the tubers and the fertilizer combination 100% nano, gave the lowest nitrate content in the tubers due to the lack of accumulation of nitrogen fertilizer in addition to the ground

and foliar spraying of this element, which caused a reduction in its accumulation in the leaves and thus reduced its transmission to the tubers. These results are consistent with what was mentioned by (Abboud and Mijwel, 2018), (Abd El-Azeim et al., 2020) and (Abdali, 2021) that the recommendation of ground fertilizer with spraying nano fertilizers for potato plants caused a significant increase in the qualitative characteristics of the tubers.

**Table (5): The effect of the interaction between the cultivar and the fertilizer combination on the yield traits of potato**

| Treatments | Fertilizer combination | Tubers hardness (kg cm <sup>2</sup> ) | The nitrate content of the tubers (mg kg <sup>-1</sup> dry weight) | TSS percentage in tubers% | Vitamin C content of tubers (mg 100 g <sup>-1</sup> fresh wt.) |
|------------|------------------------|---------------------------------------|--|---------------------------|--|
| Arizona    | V1                     | 10.86 bcd                             | 0.847 c  | 4.91 cde                  | 16.57 bcd  |
|            | V2                     | 10.88 bcd                             | 0.945 abc  | 5.41 abc                  | 17.03 a-d  |
|            | V3                     | 11.13 abc                             | 0.930 abc  | 5.73 ab                   | 16.80 bcd  |
|            | V4                     | 11.37 ab                              | 0.941 abc  | 5.82 ab                   | 20.33 abc  |
|            | V5                     | 11.48 a                               | 0.847 c  | 4.44 ef                   | 14.93 d  |
| Montreal   | V1                     | 9.48 e                                | 0.977 ab   | 5.18 bcd                  | 17.73 a-d  |
|            | V2                     | 9.38 e                                | 1.006 a  | 5.31 bc                   | 17.73 a-d  |
|            | V3                     | 9.83 e                                | 1.007 a  | 5.65 ab                   | 18.92 a-d  |
|            | V4                     | 9.33 e                                | 1.019 a  | 6.00 a                    | 21.47 ab   |
|            | V5                     | 9.45 e                                | 0.874 bc   | 4.56 def                  | 15.87 cd   |
| Florice    | V1                     | 10.70 cd                              | 0.964 abc  | 4.87 cde                  | 16.80 bcd  |
|            | V2                     | 10.63 cd                              | 1.034 a  | 4.98 cde                  | 17.03 a-d  |
|            | V3                     | 10.45 d                               | 0.954 abc  | 5.74 ab                   | 17.43 a-d  |
|            | V4                     | 10.62 cd                              | 0.994 ab   | 5.61 ab                   | 22.17 a  |
|            | V5                     | 10.77 cd                              | 0.935 abc  | 4.24 c                    | 15.63 cd   |

The averages with the same letter or letters within the same column and the interaction coefficients do not differ between them significantly according to Duncan's polynomial test under the probability level of 0.05, V1 = chemical only, V2 = chemical 75% + 25% nano, V3 = chemical 50% + 50% Nano, V4 = chemical 25% + 75% nano, V5 = 100% nano

## Conclusions

It is concluded from this study that the Arizona variety was one of the best cultivated cultivars and the fertilizer combination was 50% chemical + 50% nano in giving the best results in the studied qualitative traits .

## References

Hassan, Keshaw Muhammad, Hussein Zahir Taher, and Omar Hashem Mosleh (2017). Effect of water pressure for drip irrigation and potato cultivars (*Solanum tuberosum* L). Growth, yield and quality under autumn season conditions in Kirkuk governorate. Kirkuk University Journal of Agricultural Sciences, Journal Supplement 8: 87-99.

Al-Abdali, Rana Saadallah Aziz (2021). Response of growth, yield and quality of two potato cultivars *Solanum tuberosum* L. to NPK chemical and nano complex fertilizer. PhD thesis, College of Agriculture and Forestry, University of Mosul, Iraq.

Ali, Ghadeer Mounir (2019). Response of potato growth and yield to spraying with nano fertilizer and ground application of corn compost. Master Thesis, College of Agriculture and Forestry, Al-Qasim Green University, Iraq.

Al-Fadhli, Jawad Taha (2006). Effect of adding NPK to soil and spraying on growth, yield and components of potato *Solanum tuberosum* L.. Master's thesis, College of Agriculture, University of Baghdad, Iraq.

Moussalli, Hassan Ali (2000). Potatoes Cultivation and pest storage and manufacture of their products. Aladdin House Publications. Damascus. Syria.

Abd El-Aziem, M. M; M.A. Shrief; M.S Hussien; I.AA. Tantawy and S.O. Bashandy (2020). Impacts of non-Nano fertilizers on Potato quality and Productivity. *Acta Ecologica Sinica*, 40: 388-397.

AL- Bayati , H.J.M. and G.M.A.ALQuraishi (2019). Response of three potato varieties To Seaweed extracts. Kufa.

Journal for Agricultural Sciences,11(1): 36-48.

Al-bayati, H. J. M; Mijwel, A. K., and Zeki, Z. B.(2018). Response of Growth and Yield of tow potato cultivars (*Solanum tuberosum* L.) for soaking with Gibberellic, and Plant and seaweed extracts, and humic fertilization for autumn season. *Euphrates Journal of Agriculture Science*.10(1): 43-55

AL-Bayati, H.J., Ibraheem F.F., Allela,W.B. and D. K.A. AL-Taey .2019. ROLE OF ORGANIC AND CHEMICAL FERTILIZER ON GROWTH AND YIELD OF TWO CULTIVARS OF PEA (*PISUM SATIVUM* L.). *Plant Archives* Vol. 19, Supplement 1, 2019 pp. 1249-1253.

Alexandratos, N., Bruinsma, J., 2012. World agriculture towards 2030/2050: the 2012 revision. ESA Working Paper No. 12-03. FAO, Rome.

Al-Juthery H. W. A., N. S. Ali., , D.K.A. Al-Taey and E. A. H. M. Ali.2018. The impact of foliar application of nanofertilizers , seaweed and hypertonic on yield Potato. *Plant Archives*,18 ( 2) , 2207-2212.

Al-Juthery,H.W.A., Ali , E.H.A.M., Al-Ubori,R.N., Al-Shami,Q.N.M. and AL-Taey, D.K.A.(2020). ROLE OF FOLIAR APPLICATION OF NANO NPK, MICRO FERTILIZERS AND YEAST EXTRACT ON GROWTH AND YIELD OF WHEAT. *Int. J. Agricult. Stat. Sci.* Vol. 16, Supplement 1, : 1295-1300. DocID: <https://connectjournals.com/03899.2020.16.1295>

Al-Taey DKA, Al-Musawi ZJM.2019. Effect of Nano-fertilizers, salicylic acid, and organic matter in growth and yield of rocket (*Eruca sativa* Mill) under Salt stress. *International Journal of BotanyStudies*. 2019;4(3):77-81. <http://www.botanyjournals.com/archive/s/2019/vol4/issue3/4-2-49>



- AL-Taey, D.K.A., I.J.C. Al-Naely and B.H. Kshash.(2019). A study on the effects of water quality, cultivars, organic and chemical fertilizers on potato (*Solanum tuberosum* L.) growth and yield to calculate the economic feasibility. Bulgarian Journal of Agricultural Science, 25 (6), 1239–1245
- Al-Zebari ,Y.I. ;A.M.S. Kahlel ,S.Y.H.AL-Hamdany (2021). Response of four Potato (*Solanum tuberosum* L.) Varieties to Four Nano Fertilizers.IOP Conf.Series :Earth and Environmental Science 761(2021)012060 doi:10.1088/1755-1315/767/1/012060.
- Daniels- Lake, B. J. (2013).Carbon Dioxide and Ethylene Gas in the Potato Storage Atmosphere and their Combined Effect on Processing C Thesis of Ph.D. Wageningen University.
- Manea, A. I., H. J. AL-Bayati, and D.K.A. AL-Taey .(2019). Impact of yeast extract, zinc sulphate and organic fertilizers spraying on potato growth and yield. *Res. on Crops* 20 (1) : 95-100. DOI : 10.31830/2348-7542.2019.013.
- Mijwel, A.K. and A.K. Abboud (2018). Growth and yield of potato (*Solanum tuberosum* L.) as influenced by nano-fertilizers and different planting dates. *Res. on Crops*, 19 (4) : 649-654.
- Mijwel, A.K. and H.H. Muhsin (2019). Effect of genotype and nano- Fertilizers on some traits and yield of potato. *Indian Journal of Ecology*, 46 (8): 168-172.
- NIVAA, (2017). Netherlands catalogue of Potato Varieties Wageningen Holland.
- Thakur, S; T. Thakur and R. Kumar(2018). Bio-nanotechnology and its role in agriculture and food industry. *J. Mol. Genet. Med*, 1–5.