Plant Archives Vol. 20, Supplement 1, 2020 pp. 2753-2761 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

RESPONSE OF DATURA PLANT GROWN ON DIFFERENT SPACING TO MINERAL, ORGANIC AND NANO- FERTILIZERS

Hiyam A. Mohammed* and M. A. Al-Naqeeb
Department of Field Crops, College Of Agriculture, University of Baghdad, Iraq
Hayamamer2016@gamail.com, dr.m_alnakeb@yahoo.com

Abstract

The study aims to increase the active substance of the Datura plant grown at different distances by using organic and nano-materials instead of mineral fertilizer or part of it. The field experiment was carried out in the experimental station of the College of Agricultural Engineering Sciences/ University of Baghdad during the two summer seasons of 2018 and 2019, following the Randomized Complete Block Design and three replicates. The study consisted of two factors: the first factor is fertilization factors, the addition of mineral fertilizer N, P and K according to the recommendations, and the spraying of organic fertilizer and nano-fertilization, adding 50% of the recommendation to N, P and mineral K + organic and adding 50% of the recommendation to N and Mineral P and K + nano particles + organic spray + nano particles and adding 50% of the recommendation to N, P and mineral K + organic + nano particles, these treatment occupied the main plots, the second factor the distances between planting (50, 60 and 70 cm) these treatment occupied the sub-plots. The results showed that there were significant differences between fertilization treatments in the studied characteristics, fertilization treatment was superior to adding 50% of the recommendation to NPK + organic spray + nanoparticle in the capacity of the number of branches (22.72 and 24.75) and the number of leaves (101.40 and (106.41) and the percentage of nitrogen in the leaves) 3.02 and (3.27%) and the percentage of phosphorus in the leaves (0.59 and 0.53%) and the dry weight of the leaves (35.89 and 38.89 g plant^{-1}) which resulted in an increase in the yield of the leaves (809.90 and 877.32 kg h^{-1}), which was reflected in the increase in the percentage of alkaloids in the leaves (5.32 and (5.69%). The distance is 70 cm between plants significantly superior and gave the highest averages in the number of branches (23.15 and 25.01), the number of leaves (101.89 and (105.06), the percentage of nitrogen (2.76 and 2.97), phosphorus (0.64 and 0.57%) in leaves and the dry weight of the leaves (34.34 and 37.65 gm plants) which resulted in an increase in the percentage of alkaloids in the leaves (4.90 and 5.19%), while the distance of 50 cm between the plants significantly superior in the highest yield of leaves (879.94 and 950.90 kg h^{-1}). The results indicated that there was a significant interaction between the fertilization factors and the distances between plants in the studied characteristics. This indicates the different response of the datura to the fertilization factors according to the different distances between plants.
***Keywords*:** Datura plant, mineral, organic, nano-fertilizers

Introduction

Datura is a medicinal plant for the family *Solanaceae* and important in the dictionary of modern medicine because it contains a group of chemical compounds, the most important of which is the group of Tropan alkaloids, including Hyosamin and Scopolamine (Tashakori and others, 2011) that are included in many pharmaceutical preparations, including analgesics for nervous system pain and system diseases. Respiratory and for people suffering from eye diseases where atropine is available as a drop to treat ocular infections and dilate the pupil of the eye for medical examinations, and the highest content of alkaloid compounds in plant leaves is compared to other parts of the plant. To increase production, it is necessary to use agricultural methods, plant growth is affected by the surrounding conditions, starting with soil and crop service operations, and the distance between plants is one of the things that must be taken care of and that is reflected in its content of the active substance. Mineral elements, major or minor, play an important role in the life of the plant. The importance of the elements and the degree of their need by the plant differ from one element to another, where the element nitrogen comes in the first place to come after phosphorus and then potassium Mineral elements, major or minor, play an important role in the life of the plant. The importance of the elements and the degree of their need by the plant differ from one element to another, where the element nitrogen comes in the first place to come after phosphorus and then potassium. Mineral elements, major or minor, play an important role in the life of the plant. The importance of the elements and the degree of their need by the plant differ from one element to another, where the element nitrogen comes in the first place to come after phosphorus and then potassium (Nasrallah, 2012). As balanced fertilization of the elements N, P and K encourages increased vegetative growth and the accumulation of alkaline compounds for most medicinal plants and that the presence of these elements in the soil is not sufficient for plant growth, therefore fertilizers are added to meet the need, as the utilization rate of mineral fertilizers does not exceed 50% due to its exposure to loss by washing, blowing, or settlin Therefore, the recent directions for agriculture call for the use of natural and environmentally safe compounds such as liquid organic fertilizers, including humic acid as an alternative or complement to mineral fertilizers in order to improve the strength of the plant as the effectiveness of humic acid is similar to the effectiveness of natural hormones within the plant and this is reflected in increasing plant growth and efficiency in production and is considered humic acid is safe and highly soluble in water and does not leave any harmful effects on the plant and nano-fertilizers are characterized by their ease of application and use in less quantities as a suitable alternative to traditional fertilizers for easy absorption by plants and soil. They were called smart fertilizers because they are efficient in the use and codification of nutrients (Boopati and Chinnamuthu, 2010) which means targeting fertilizers to places of need in the soil or the Plant (Nair *et al*., 2010). As the technology of using nano-fertilizers provides nutrition to the plant in a scientific manner without pollution, and the nano-fertilizer has an important role in plant nutrition, whether it has been sprayed on the vegetative system or added to the soil, including an increase in the activity of photosynthesis by increasing the leaf content of chlorophyll and increasing resistance to diseases and increasing the active substance in the Plant (Guru *et al*., 2015). The use of nano-fertilizer as a substitute for conventional fertilizers or as carriers for their components has several advantages, such as the ability to control the orientation process and transport compounds to the target locations in the plant, whether they are roots, leaves or fruits (Boehm *et al*., 2003). Al-Anbari (1999) when studying Datura plant with three distances between plants 40 cm, 50 cm and 60 cm, indicated that there were significant differences in the number of leaves in the plant superior the third treatment in giving the highest average of 687.5 leaves. Plant compared to the first distance that gave 236,333 leaves Plant and the highest dry weight of the leaves was achieved at a distance of 60 cm with an average of 0.420 kg plant^{-1} and the percentage of alkaloids in the leaves was 0.264% compared to a distance of 40 cm that gave the lowest average. Al-humaid (2003) when studying the effect of adding five levels of compound fertilizer NPK (100, 200, 400, 600 and 800 kg h^{-1}) in addition to the control treatment (not adding fertilizer) for the type of *Datura innoxia* where he gave the rate of adding 600 kg h^{-1} has the highest average number of leaves in the plant 160.27, the dry weight of the leaves 62.61 g and the percentage of alkaloids in the leaves is 1.93% compared to the comparison treatment that gave the lowest averages. Al-Qaisi (2015) significant increase when adding three levels of humic acid, which are (1, 2 and3) kg dunam^{-1}, the level of adding 3 kg dunam^{-1} gave the highest averages in the percentage of nitrogen in the leaves 3.42% and the percentage phosphorus in the leaves is 0.67% and the percentage of potassium in the leaves is 2.50% compared to the control treatment that gave the lowest values to the above characteristics. This experiment aims to increase the active substance of the datura plant by using organic and nano-fertilizer instead of mineral fertilizer or part of it and under different agricultural distances.

Materials and Methods

A field experiment was conducted at the research station of Field Crop, College of Agricultural Engineering Science–University of Baghdad–Al–Jaderyah during the summer season of 2018 and 2019. The field was prepared by the plowing twice vertically, using mold board plow and the soil was smoothed and settled then canals were ditched, Datura seeds obtained from the Medicinal Plants Unit of the College of Agricultural Engineering Sciences-University of Baghdad were washed with running water for 24 hours and then soaked in GA3 concentration of 750% American origin 99% (Al-Hatimi and Bashir, 2009) by dissolving ethyl alcohol concentration of 50% and then put on The thermal magnetic mixer until complete melting and at a temperature of 75 °C. Then complete the volume to 1 liter and for 12 hours to remove the germination inhibitors. The experiment was carried Randomized according to the complete block design (RCBD) with split plot order consisted of three replicates. The area of the secondary plot was 3 m * 3 m, included two factors the first fertilizing factors which included NPK mineral according to the recommendations for nitrogen 300 kg N h^{-1} (Mahdawi, 2004) source from urea 46% N added in two stage before planting and one month after planting, phosphorus 220 kg P. h^{-1} (Qutb, 1979) Source: Mono superphosphate 21% P_2O was added below the planting line, potassium 100 kg Kh^{-1} (Qaisi and Aqeel, 2016) Source from Potassium Sulfate 43% K_2SO_4 in two stage before planting and one month after planting, respectively. Spray organic fertilizer humaic acid concentration of (1 ml. Liters^{-1}) on the vegetative system after one month and 60 days after planting. Spray the liquid nano-fertilizer for nitrogen, phosphorus and potassium NPK (20-9-10%) obtained from Iran (FanAvar Sepehr Parmis) company on the vegetable total after a month and 60 days after planting at a concentration of 1 ml l^{-1}. Nano-fertilizer was examined with the AFM atomic force microscope, which is a microscope that gives accurate information about the surface of the sample at the atomic level (the average grain size) in the laboratories of the College of Science/Department of Chemistry / University of Al-Nahrain. The average diameter of the nitrogen fertilizer sample was 30.50nm, the phosphate fertilizer sample was 60.75nm, and the potassium fertilizer sample was 25.01 nm. Experimental units included different treatments of fertilizers (the main factor) which are fertilizing parameters for N, P and K mineral according to recommendations and give the code F0 promised control treatment, spray the organic fertilizer gave the code F1, spray the nano fertilizer give the code F2, add 50% of the recommendation For N, P and K mineral + organic give the code F3, add 50% of the recommendation for N, P and K mineral + nano give the code F4, organic spray + nano give the code F5, add 50% of the recommendation to N, P and K Mineral + Organic + Nano-given F6., The second secondary factor is the distances between plants (50, 60, 70) cm. The distance is 60 cm. The comparison treatment is as recommended by Al-Anbari (1999). Symbols gave (D1, D2, D3), leaving a space of 1.5 m between the plot to avoid any effect on nearby plots. The indicators of vegetative growth were measured at the beginning of flowering stage, days after 70 from planting, by taking 5 plants randomly from the middle rows for each plot for following characters :Number of branches , Number of leaves mean , Percentage of nitrogen in the leave estimated nitrogen according to the Kildal method using the Micro-Kjeldahl apparatus (Haynes, 1980) was extracted, Percentage of phosphorus in leaves using a Spectrophotometer device at a wavelength of 882 nm according to the Page and others method (1982), dry weight of leaves, yield leaves :-

calculated from the following equation :

$$\text{Yield leaves} = \frac{\text{Dry weight of leaves} \times \text{Plant density}}{1000}$$

and Percentage of alkaloids in leaves calculated and expressed as a percentage of weight of sample analyzed (Harborne, 1973; Ijarotimi *et al*., 2013).

Results and Discussion

The number of branches in the plant

Shows table 1 that there was a significant effect of fertilizer treatments and the distance between plants and the interaction between them in the number of branches in the plant. The treatment F6 gave the highest rate was 22.72 and 24.75 compared to the treatment F1 fertilizer which gave the lowest Rate for this quality was 13.95 and 16.08 plant branches^{-1} for the two seasons respectively. The reason for the superiority of the treatment F6 may be attributed to the complementary role of the mineral fertilizer added to the soil and the nano and organic fertilizer add spray on the plant, as these fertilizers collectively Increased availability of nutrients and provide the raw materials necessary for cell division, growth and development by increasing the rate and rates of reactions, enzymatic activity and efficiency Carbon representation, which may be due to the advantages of organic fertilizers and nano-fertilizers that help penetrate plant tissue and increase the rate of absorption and thus perform a better nutritional role within the tissues (Ali and Hayawi, 2017), Which may contribute to stimulating new growth sites in the plant, including buds that develop into new branches. The results of the table show significantly superior distance between plants giving D3 cm highest average of 23.15 and 25.01 compared with the distance of D1 cm that gave the lowest rate of 13.95 and 15.68. The reason for the increase in the number of branches at the wide distance may be due to the provision of appropriate environmental factors and the low of competition for these factors and to the better growth and spread of the root system of the plant and thus the formation of the largest number of peaks and this in turn works to manufacture cytokines that work to break the apical sovereignty Encouraging the formation of branches in the plant (Al-Hassan, 2016). Show the results of the table that the fertilizer treatment F6 with a distance of D3 gave the highest rate 27.84 and 30.39 while the fertilizer treatment F1 with a distance of D1 gave the lowest rate of 10.42 and 11.89 for the two seasons respectively.

The number of leaves in the plant

Fertilization treatments and distances between of plants and their interaction significantly affected the number of leaves per plant and for both seasons table 2. The of fertilizer treatment F6 recorded the highest average for this trait 101.40 and 106.41 leaves of plants^{-1} while F1 treatment which gave the lowest mean for this trait was 85.52 and 88.43 leaf^{-1} for the two seasons respectively. The superiority of the F6 treatment is due to the equivalent of adding organic and nano fertilizer from the mineral fertilizer recommendation by half in increasing the readiness of the elements, which is reflected in the vegetative growth of the plant, including the number of leaves and to the positive role in the superiority of this treatment to give the highest number of branches in the plant table 1 While we note that the treatment of spraying organic fertilizer only F1 without adding mineral fertilizer gave the lowest rate for this trait, which leads to the importance of balanced fertilization while reducing the addition of mineral fertilizers. The results of table 2 show distances between plants have a significant effect on the number of leaves in the plant as It gave a distance of D3 cm higher average of 101.89 and 105.06 plant leaves^{-1} compared to the minimum distance of D1 cm which gave the lowest average of 83.92 and 89.66 leaves^{-1}. This could be due to that wide space distance between plants has less competition for plant members for the nutrients requirements necessary for plant growth, and thus growth is good and there is more opportunity to increase the number of leaves, while plants grown at narrow distances suffer from intense competition for growth requirements from water and nutrients. This is in line with what Anbari found (1999), which indicated an increase in the number of leaves in the plant at the most spaced distance between plants. Show the results of the table that the plants grown between distance of D3 cm the inequities when adding fertilizer treatment F6 to them had given the highest average for this trait 110.84 and 113.00 plant leaves^{-1} while plants grown between distance of D1cm when F1 fertilizer treatment gave the lowest mean of this trait 77.38 and 80.36 leaves per plant^{-1} respectively for both seasons.

The percentage of nitrogen in the leaves

The results of table 3 show the significant effect of both fertilization factors and the distance between plants and their interaction on the percentage of nitrogen in the leaves of plants for both seasons. Fertilizer treatment F6 recorded the highest mean of 3.02 and 3.27% compared to the treatment of F1 which gave the lowest average for this quality of 2.01 and 2.30% for the two seasons respectively. The increase may be due to the fact that the plants that were sprayed in the vegetative stage of the organic fertilizer, which is a source of major nutrients and nano-fertilizer, increased supply of the elements, especially nitrogen, as the fertilizers work in their nanoparticles by stimulating the activities of the enzymes responsible for the transport of mineral elements from their absorption sites to plants parts (Grover *et al*., 2012), Thus it enhances its absorption in the plant better efficiently in addition to the action of mineral fertilizer as nanomaterials contribute to stimulating the plant to absorb mineral elements from the soil all of these factors combined led to an increase in the percentage of nitrogen in the leaves. The distance between of plants D3 cm achieved the highest average rate for this trait of 2.76 and 2.97% compared to the distance of D1 cm which gave the lowest average for this trait of 2.40 and 2.55% for the two seasons respectively. This may be attributed to the less competition between plants for growth factors, including nutrients, and thus an increase in the absorption of elements, including nitrogen, which was reflected in the increase in the percentage of nitrogen in the leaves. Shows the results of the table that significant effect of the interaction between the study factors. The treatment F6 when adding to the distance between plants D3 cm giving the highest average of 3.23 and 3.54% compared to the treatment of the fertilizer spray F1 to the distance between plants that gave the lowest average 1.85 and 2.05% for both seasons.

The percentage of phosphorus in the leaves

The results of the averages table 4 indicate that there were significant differences between the fertilizer treatments and the distance between plants and the interaction between in the percentage of phosphorus in the leaves for the two seasons of the study 2018 and 2019. The fertilizer treatment F6 gave the highest mean for this trait 0.59 and 0.64% compared to the fertilizer treatment F1 which gave the lowest rate for this trait was 0.40 and 0.43% for both seasons respectively. The increase in the percentage of phosphorous may be due to increased supply and increased absorption by the plant, which was reflected in an increase in the percentage of phosphorous in the leaves. The results of the table showed that the distance between plants was D3 cm in giving the highest average for this trait of 0.53 and 0.57% compared to the distance of D1 cm, which gave the lowest average of 0.46 and 0.49% for the two seasons respectively. This may be due to the few of competition between plants at the low density on nutrients, including phosphorous, and thus an increase in absorption and an increase in its percentage. The results of table show the of the significant effect of the interaction between the fertilization treatments and the distance between plants, treatment F6 was when adding it to plants at the distance of D3 cm the highest average of this trait was 0.65 and 0.71% compared to F1 spraying fertilizer when adding it to plants at the distance D1 cm which gave the lowest average was 0.36 and 0.40%.

Dry Weight of leaves

The results of table 5 show the significant differences between the study factors for both fertilizer treatments and distances between plant and the interaction between them in the dry weight of the leaves and for the two seasons. Fertilizer treatment F6 gave the highest rate of 35.89 and 38.89 g plant^{-1} compared to the fertilizer F1 which gave the lowest average of 31.31 and 33.96 g plant-1 for both seasons. The reason for the increase in this may be attributed to the effective contribution of this treatment to the main biological processes within the plant in increasing indicators of vegetative growth, including the number of branches and the number of leaves table 1 and 2, which reflected positively on dry weight .The wide space distance between plants D3 cm, gave highest rate was 34.34 and 37.65 g plant^{-1}, compared with the lowest distance between plants, which gave the lowest average of 33.00 and 33.66 g plant^{-1} seasons, respectively. This is due to an increase in some indicators of vegetative growth, including the number of branches and the number of leaves, which results in increased production of photosynthesis rates and thus an increase in the dry weight of the leaves. This is consistent with what Al-Anbari found (1999). Observed in from the data of the table, significant effect of interaction, treatment F6 gave with a distance of D3 the highest average of 36.76 and 40.00 g plant^{-1} while the gave treatment F1 with a distance of D1 the lowest rate was 30.59 and 33.41 g plant^{-1}.

Yield leaves

The results of table 6 show the significant differences for both fertilization treatments and distances between plants and their interaction in the yield leaves and for the two seasons of study. The fertilizer treatment F6 gave highest average of 809.90 and 877.32 kg h^{-1} compared to fertilizer treatment F1 which gave the lowest average for this trait, was 706.39 and 766.79 kgh^{-1} for the two seasons. This increase may be attributed to the superiority of F6 fertilizer treatment in giving it the highest dry weight of leaves table 5, which was reflected in an increase in the yield of the leaves of the plant. The plants grown on distance D1 cm recorded the highest average for this trait and for both seasons it was 879.94 and 950.90 kg h^{-1} compared to the plants grown at a distance of D3 cm which gave the lowest average of 651.94 and 715.26 kg h^{-1}. The treatments achieved (50% NPK mineral + spraying the organic fertilizer + nano- fertilizer) in the plants grown at a distance of D1 cm the highest average was 931.71 and 1.009.31 kg h^{-1}, while the treatments gave (spraying the organic fertilizer to the plants grown at a distance of D3 cm the lowest average for this trait was 612.37 and 660.82 kg. h^{-1} for the two seasons.

The percentage of alkaloids in the leaves

The results of table 7 show the significant effect of each of the two study factors and the interaction between them in the percentage of alkaloids in the leaves of the datura and for both seasons. The fertilizer treatment F6 gave the highest rate for this trait of 5.32 and 5.69%, while the fertilizer treatment F1 gave the lowest average of 3.81 and 4.02% for the two seasons respectively. The reason for the increase in this may be due to the role of fertilizers in the treatment of F6 of nutrients, as that of low supply of the elements may lead to Inhibition and reduce the enzymatic activity required for the synthesis of alkaloids (Nasrallah, 2012) and an increase in the percentage of nitrogen and phosphorus in the leaves table 3. The common role of these elements in improving the vital processes necessary for the synthesis of basic compounds in the formation of alkaloids where many studies have indicated the important role of nitrogen in building amino acids is the primary initiator in the synthesis and accumulation of alkaloids (Mondy and Munshi, 1990 and Abu Zaid, 2006) and to the importance of phosphorous in the formation of amino acids through its role in forming the enzymes necessary for the biological reactions of building the amino acids, which reflected positively on raising the efficiency of photosynthesis and increasing its metabolic products, which led to an increase in the dry weight of the leaves and then increasing the first products and its secondary ones alkaloids. A distance of D3 cm between of plants recorded highest average for this trait was 4.90 and 5.19%, compared to a distance of D1 cm that achieved the lowest average of 4.23 and 4.47% for the two seasons respectively, the increase is due to the exploitation of the elements, especially nitrogen, in the synthesis of protein, which in turn converts to the amino acids that are considered the starting agents for the synthesis of alkaloidal compounds (Nassar *et al*., 2015), The interaction a significant effect on the percentage of alkaloids in the leaves, gave treatment F6 with a distance of D3 cm the highest average of 5.69 and 6.12% in which the combination gave treatment F1 with a distance of D1 cm the lowest average was 3.41 and 3.58%

Table 1 : Effect of fertilization treatments and the distance between plants on the number of branches in the plant for the two seasons

2018				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
F0 (NPK)	12.36	16.49	21.89	16.91
Spray humic acid (F1)	10.42	13.88	17.56	13.95
Spray nano fertilizer (F2)	13.86	17.90	22.91	18.22
50NPK+ Spray humic (F3)	12.00	16.56	21.73	16.76
50NPK+ Spray nano fertilizer (F4)	15.28	19.20	24.98	19.82
Spray humic acid + nano fertilizer (F5)	15.00	19.43	25.11	19.85
50NPK+ Spray nano fertilizer + humic (F6)	18.70	21.62	27.84	22.72
LSD 0.05	1.12			1.05
Mean	13.95	17.87	23.15	
LSD 0.05	0.42			
2019				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
NPK (F0)	14.25	18.50	22.93	18.56
Spray humic acid (F1)	11.89	15.90	20.46	16.08
Spray nano fertilizer (F2)	15.38	19.96	24.50	19.95
50NPK+ Spray humic (F3)	14.16	18.24	23.14	18.51
50NPK+ Spray nano fertilizer (F4)	16.97	21.65	26.86	21.83
Spray humic acid + nano fertilizer (F5)	17.00	21.54	26.77	21.77
50NPK+ Spray nano fertilizer + humic (F6)	20.11	23.74	30.39	24.75
LSD 0.05	0.86			0.71
Mean	15.68	19.93	25.01	
0.33	0.33			

Table 2 : Effect of fertilization treatments and the distance between plants on the number of leaves per plant for the two seasons.

2018				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
F0 (NPK)	81.41	89.18	97.35	89.18
Spray humic acid (F1)	77.38	85.52	94.00	85.52
Spray nano fertilizer (F2)	83.97	92.16	100.68	92.16
50NPK+ Spray humic (F3)	81.25	89.08	96.99	89.08
50NPK+ Spray nano fertilizer (F4)	86.36	95.98	106.76	95.98
Spray humic acid + nano fertilizer (F5)	85.92	95.85	106.64	95.85
50NPK+ Spray nano fertilizer + humic (F6)	91.14	101.40	110.84	101.40
LSD 0.05	2.40			1.51
Mean	83.92	92.41	101.89	
LSD 0.05	0.91			
2019				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
NPK (F0)	86.95	95.23	102.24	94.80
Spray humic acid (F1)	80.33	91.51	93.42	88.43
Spray nano fertilizer (F2)	89.59	97.65	105.91	97.72
50NPK+ Spray humic (F3)	87.10	94.98	102.41	94.83
50NPK+ Spray nano fertilizer (F4)	92.45	100.91	109.16	100.84
Spray humic acid + nano fertilizer (F5)	92.37	101.00	109.28	100.88
50NPK+ Spray nano fertilizer + humic (F6)	98.83	107.39	113.00	106.41
LSD 0.05	2.36			1.77
Mean	105.06	98.38	89.66	
LSD 0.05	0.89			

Table 3 : Effect of fertilization treatments and the distance between plants on percentage of nitrogen in the leaves for the two seasons.

2018				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
F0 (NPK)	2.27	2.42	2.53	2.41
Spray humic acid (F1)	1.85	1.98	2.19	2.01
Spray nano fertilizer (F2)	2.42	2.57	2.69	2.56
50NPK+ Spray humic (F3)	2.33	2.49	2.60	2.47
50NPK+ Spray nano fertilizer (F4)	2.59	2.80	3.07	2.82
Spray humic acid + nano fertilizer (F5)	2.56	2.73	3.01	2.77
50NPK+ Spray nano fertilizer + humic (F6)	2.75	3.08	3.23	3.02
LSD 0.05	0.11			0.07
Mean	2.40	2.58	2.76	
LSD 0.05	0.04			
2019				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
NPK (F0)	2.43	2.59	2.73	2.58
Spray humic acid (F1)	2.05	2.34	2.50	2.30
Spray nano fertilizer (F2)	2.58	2.74	2.87	2.73
50NPK+ Spray humic (F3)	2.44	2.61	2.73	2.59
50NPK+ Spray nano fertilizer (F4)	2.75	2.90	3.24	2.97
Spray humic acid + nano fertilizer (F5)	2.69	2.91	3.21	2.94
50NPK+ Spray nano fertilizer + humic (F6)	2.93	3.34	3.54	3.27
LSD 0.05				0.09
Mean	2.55	2.77	2.97	
LSD 0.05	0.05			

Table 4 : Effect of fertilization treatments and the distance between plants on percentage of phosphorus in the leaves for the two seasons.

2018				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
F0 (NPK)	0.42	0.45	0.47	0.45
Spray humic acid (F1)	0.36	0.40	0.44	0.40
Spray nano fertilizer (F2)	0.47	0.49	0.52	0.49
50NPK+ Spray humic (F3)	0.43	0.46	0.48	0.46
50NPK+ Spray nano fertilizer (F4)	0.50	0.54	0.59	0.54
Spray humic acid + nano fertilizer (F5)	0.49	0.53	0.58	0.53
50NPK+ Spray nano fertilizer + humic (F6)	0.53	0.60	0.65	0.59
LSD 0.05	0.03			0.02
Mean	0.46	0.50	0.53	
LSD 0.05	0.01			
2019				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
NPK (F0)	0.45	0.49	0.52	0.49
Spray humic acid (F1)	0.40	0.42	0.46	0.43
Spray nano fertilizer (F2)	0.47	0.50	0.53	0.50
50NPK+ Spray humic (F3)	0.48	0.52	0.54	0.51
50NPK+ Spray nano fertilizer (F4)	0.54	0.58	0.64	0.59
Spray humic acid + nano fertilizer (F5)	0.53	0.57	0.63	0.57
50NPK+ Spray nano fertilizer + humic (F6)	0.57	0.65	0.71	0.64
LSD 0.05	0.03			0.02
Mean	0.49	0.53	0.57	
LSD 0.05	0.01			

Table 5 : Effect of fertilization treatments and the distance between plants on dry weight of leaves for the two seasons.

2018				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
F0 (NPK)	32.19	32.66	33.31	32.72
Spray humic acid (F1)	30.59	31.10	32.23	31.31
Spray nano fertilizer (F2)	33.35	33.97	34.68	34.00
50NPK+ Spray humic (F3)	32.22	32.75	33.43	32.80
50NPK+ Spray nano fertilizer (F4)	33.89	34.90	34.96	34.58
Spray humic acid + nano fertilizer (F5)	33.81	34.87	35.00	34.56
50NPK+ Spray nano fertilizer + humic (F6)	34.94	35.98	36.76	35.89
LSD 0.05	0.44			0.36
Mean	33.00	33.75	34.34	
LSD 0.05	0.17			
2019				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
NPK (F0)	34.10	35.28	36.34	35.24
Spray humic acid (F1)	33.41	33.69	34.78	33.96
Spray nano fertilizer (F2)	36.58	37.48	38.16	37.41
50NPK+ Spray humic (F3)	34.17	35.31	36.45	35.31
50NPK+ Spray nano fertilizer (F4)	36.78	37.94	38.87	37.86
Spray humic acid + nano fertilizer (F5)	36.73	37.91	38.92	37.85
50NPK+ Spray nano fertilizer + humic (F6)	37.85	38.82	40.00	38.89
LSD 0.05	0.41			0.38
Mean	35.66	36.63	37.65	
LSD 0.05	0.16			

Table 6 : Effect of fertilization treatments and the distance between plants on yield leaves for the two seasons.

2018				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
F0 (NPK)	858.38	725.77	629.47	737.87
Spray humic acid (F1)	815.71	691.10	612.37	706.39
Spray nano fertilizer (F2)	889.31	754.88	658.91	767.70
50NPK+ Spray humic (F3)	859.17	727.77	635.17	740.70
50NPK+ Spray nano fertilizer (F4)	903.71	775.55	664.24	781.16
Spray humic acid + nano fertilizer (F5)	901.57	774.88	665.00	780.48
50NPK+ Spray nano fertilizer + humic (F6)	931.71	799.55	698.44	809.90
LSD 0.05	16.11			12.73
Mean	879.94	749.93	651.94	
LSD 0.05	5.04			
2019				
Fertilization treatment	**The distance between plants**			**Mean**
	D1	**D2**	**D3**	
NPK (F0)	909.31	783.99	690.46	794.59
Spray humic acid (F1)	890.91	748.65	660.82	766.79
Spray nano fertilizer (F2)	975.44	832.88	725.04	844.45
50NPK+ Spray humic (F3)	911.17	784.66	692.55	796.13
50NPK+ Spray nano fertilizer (F4)	980.77	843.10	738.53	854.13
Spray humic acid + nano fertilizer (F5)	979.44	842.43	739.48	853.78
50NPK+ Spray nano fertilizer + humic (F6)	1.009.31	862.65	760.00	877.32
LSD 0.05				9.80
Mean	950.90	814.05	715.26	
LSD 0.05	5.17			

Table 7 : Effect of fertilization treatments and the distance between plants on percentage of in the alkaloids in the leaves for the two seasons.

Fertilization treatment	The distance between plants			Mean
2018				
	D1	D2	D3	
F0 (NPK)	4.01	4.28	4.52	4.27
Spray humic acid (F1)	3.41	3.88	4.14	3.81
Spray nano fertilizer (F2)	4.28	4.53	4.75	4.52
50NPK+ Spray humic (F3)	4.04	4.31	4.51	4.29
50NPK+ Spray nano fertilizer (F4)	4.53	4.80	5.37	4.90
Spray humic acid + nano fertilizer (F5)	4.52	4.81	5.32	4.88
50NPK+ Spray nano fertilizer + humic (F6)	4.85	5.43	5.69	5.32
LSD 0.05	0.21			0.14
Mean	4.23	4.58	4.90	
LSD 0.05	0.08			
2019				
Fertilization treatment	The distance between plants			Mean
	D1	D2	D3	
NPK (F0)	4.23	4.51	4.77	4.50
Spray humic acid (F1)	3.58	4.09	4.37	4.02
Spray nano fertilizer (F2)	4.51	4.78	5.01	4.77
50NPK+ Spray humic (F3)	4.26	4.55	4.76	4.52
50NPK+ Spray nano fertilizer (F4)	4.81	5.06	5.66	5.18
Spray humic acid + nano fertilizer (F5)	4.77	5.08	5.61	5.15
50NPK+ Spray nano fertilizer + humic (F6)	5.12	5.82	6.12	5.69
LSD 0.05	0.25			0.16
Mean	4.47	4.84	5.19	
LSD 0.05	0.09			

Conclusion

The spraying of liquid nano-fertilization for nitrogen, phosphorus and potassium on the vegetative system of the datura plant has given good results than adding the elements to the soil according to the previous recommendations and this is due to increased absorption by the plant and less loss of soil or volatilization, which was reflected in the improvement of growth indicators and increase of materials effective. The addition of humic acid with half the amount of mineral fertilizer has given similar results to add the full fertilizer dose of mineral fertilizer according to the recommendations, which indicates the possibility of dispensing half of the amount of mineral fertilizer and save effort, money and reduce pollution, when the humic acid is available as an organic fertilizer and the liquid nano-fertilizer for nitrogen, phosphorus and potassium can be used with half of the recommended mineral fertilizer amount to increase the transport and absorption of the elements and thus be a substitute for the use of mineral fertilizer in the recommended amount to avoid pollution and save effort and money while increasing the growth and outcome indicators and the percentage active substances in leaves, the increase in the percentage of alkaloids at the wide distance means that the plant has benefited from the low of competition by increasing improve of the basic elements, especially nitrogen, and thus affecting its content of active substances.

References

Abu Zaid, Al-Shahat Nasr (2006). Alkaloids In Medicinal Plants and Their Pharmacological and Curative Importance. House of Books for Publishing and Distribution.

Al-Anbari, M.A.B. (1999). Study of the effect of distances between plant different on growth characteristics and active substance of two types of Datura spp. Master Thesis. Field Crops Section. College of Agriculture. Baghdad University.

Al-Hassan, I.I.S. (2016). Effect of plant density and potassium sulfate spraying on the growth and yield of anise plant *Pimpinella anisum* L. Basra Journal of Agricultural Sciences, 29(2): 561 – 573.

Al-Hatimi, K.; Khashan, T. and Al-Alwani, B.A.M. (2009). The combined effect of gibberellins GA_3 and temperature on germination rate and the development of feather and root growth in Datura metel Mill and *Dtura innoxia* Linn. types. Karbala University Journal for Scientific, 7(1) : 42 – 48.

Al-Humaid, A.I. (2003). Effect of compound fertilization on growth and alkaloids of datura (*Datura innoxia* Mill) plants. Journal of Agriculture and Rural Development in the Tropics and Subtropics. 104(2): 151–165.

Ali, Nour Al-Din Shawqi, Hayawi and Yawah Al-Jodhry (2017). Nanotechnology applications of micronutrients in agricultural production. Reference article. Iraqi Journal of Agricultural Sciences, 48(4): 984-990.

Al-Qaisi, Muhammad Abdul-Sattar Abdul-Jabbar Ja'ata (2015). The effect of adding humic acid and spraying some elements in physiological traits, seed yield and active substance in the leaves of *Datura stramonium* L. Master Thesis College of Agriculture. Tikrit University.

Al-Qaisi, Muhammad Abdul-Sattar Abdul-Jabbar Ja’atah and Al-Muhammadi, A.N. (2016). The effect of humic acid and spry of iron and zinc on the growth and yield of the *Datura stramonium* L. plant. Tikrit Journal of Agricultural Sciences, 16(3): 51 - 60.

Al-Mahdawi, A.Y.H. (2004). Effect of nitrogen levels on growth, yield and alkaloids of three types: *Datura stramonium L., Datura innoxia* M. and *Datura metel* L.

Master Thesis, faculty of Agriculture. Anbar University.

Boehm, A.L.; Martinon, I.; Zerrouk, R.; Rump, E. and Fessi, H. (2003). Nanoprecipitiation technique for the encapsulation of agro chemical active ingredients. J. Microencapsul. 20: 433- 441.

Chinnamuthu, C.R. and Boopati, P.M. (2010). Nanotechnology and agroeccosystem. Madras Agric. J. 96: 17 – 31.

Grover, M.; Singh, S. and Teswarlu, B. (2012). Nanotechnology : scope and limitations in agriculture. Int. J. Nanotech. Appl. 2(1) : 10-38.

Guru, T. *et al*. (2015). Crop nutrition management with nano fertilizers . International Journal of Environmental Science and Technology, 1(1): 4–6.

Harborne, J.B. (1973). Phytochemical methods: a guide to modern techniques of plant analysis. Chapman and Hall Ltd, London. 279.

Haynes, R.J. (1980). A comparison of two modified kijeldahl digestion techniques for multi- element plant analysis with conventional wet and dry ashing methods communication in soil science and plant analysis II : 459-467 (Cited From Al-Schaf. 1989).

Ijarotimi, O.S.; Fagbemi, T.N. and Osundahunsi, O.F. (2013). Comparative study of nutritional profiles and phytochemical components of raw, blanched and fermented flour from the leaves of *Moringa oleifera* Lam. Malays. J. Nutr. 19(3): 371–382.

Mondy, N.I. and Munshi, C.B. (1990). Effect of nitrogen fertilization on glycoalkaloid and nitrate content of potatoes. J. Agric. And Food Chem., 38: 565 – 567.

Nair, R.; Nair, B.G.; Yoshida, Y. and Kumar, D.S. (2010). Nanoparticulate material delivery to plant . Plant Sci., 179: 154-163.

Nasrallah, A.Y. (2012). Medicinal Plants. Ministry of Higher Education and Scientific Research. Baghdad University. Faculty of Agriculture, Department of Field Crops.

Nassar, R.M.A.; Boghdady, M.S. and Selim, D.A. (2015). Effect of mineral and biofertilizers on vegetative growth, mineral status, seed yield, tropane alkaloids and leaf anatomy of Thronapple plant (*Datura stramonium* L.) . Middle East Journal of Agriculture. 4(4): 754- 768.

Page, A.I.; Miller, H. and Keeneg, D.R. (1982). Methods of Soil Analysis part2 . Chemical and Microbiological Properties. American Soc. Agron. Midison. Wisconsin. USA. Pp: 732**.**

Qutb, F.T. (1979). Medicinal Plants. Its cultivation and components. Arab Book House. Libya.

Tashakori, H.; and Taghizadeh, M. (2011). Plantlet regeneration of *Datura inoxia* by IAA and improvement of tropane alkaloid content in regenerated plantlets in response to putrecine treatment. Iranian J. Biology. 24(3): 355–365.