Effect of nitrogenous and urea nano-hydroxyapatite fertilizer on growth and yield of two cultivars of broad bean (Vicia Faba L.)

Omer.A.Abd Alqader Saleh.M.Al-Jobouri Layth Mazin. H. Eshoaa
Department of Field Crops, College of Agriculture and Forestry, University of Mosul, Nineveh, Iraq.
edu3ab@uomosul.edu.iq Dr.salleh75@uomosul.edu.iq laythmazin96@uomosul.edu.iq

ABSTRACT

This study was conducted to know the effect of nitrogenous and urea nano-hydroxyapatite fertilizer on the growth and yield of two cultivars of broad bean (Vicia Faba L.) in the two autumn seasons (2018 and 2019). The Randomized Complete Block Design (RCBD) was used with a split plots system and three replicates, the experiment included two factors. The first (main) factor included the cultivars (Spanish Histal and Italian Aquadilge) and The second factor (secondary) included eight nitrogen fertilization treatments. The results showed: The cultivars differed significantly in some growth traits, yield traits, and its components, where the Histal cultivar has excelled in the trait of the weight of 100 seeds in the autumn season 2018 which amounted to (38.1 g), and in the number of seeds per pod, and the length of the pod in the autumn season 2019 amounted to (22.7 cm, 5.7 pods). While the Aguadulge cultivar has excelled in the trait of the chlorophyll content in leaves in the autumn season 2018 which amounted to (38.8 μg.cm^{2}), and in the trait of plant height, biological yield, number of pods in the plant, seed yield, and protein yield in the autumn season (2019) which amounted to (91.43 cm, 7.439 Mg.ha^{-1}, 15 pods.plant^{-1}, 2.331 Mg.ha^{-1}, 0.546 Mg.ha^{-}). The nitrogen fertilization caused a significant increase in some growth and yield traits and their components in the autumn season 2018, where the concentration of the nano-fertilizer (150 ppm) gave the highest averages for the trait of the leaf area and the chlorophyll content in the leaves which amounted to (8598.5 cm^{2}, 45.3 µg.cm^{-2}), while the concentration of the nano-fertilizer (75 ppm) gave the highest average in the traits of the biological yield, the number of pods per plant, and the seed yield amounted to (10.275 Mg.ha^{-1}, 19.6 pods.plant^{-1}, 2.825 Mg.ha^{-1}), while the concentration of nano-fertilizer (225 ppm) gave the highest average for the traits of the plant height and the number of Pod per seed, pod length, the weight of 100 seed, and protein yield amounted to (86.7 cm, 5.6 pods.seed^{-1}, 24.4 cm, 40.77 g, 0.655 Mg.ha^{-1}). In the autumn season (2019), the concentration of nano fertilizer (150 ppm) has excelled by giving it the highest averages of chlorine content in leaves, biological yield, number of pods per plant, number of seeds per pod, pod length, and seed yield which amounted to (445.0 µg.cm^{-2}, 7.815 Mg.ha^{-1}, 14.9 pods.plant^{-1}, 5.9 seed.pod^{-1}, 23.0 cm, 2.484 Mg.ha^{-1}). The concentration of nano-fertilizer (225 ppm) gave the highest average percentage of protein and the yield of protein amounted to (25.1%, 0.611 Mg.ha^{-1}). The interaction between nitrogen fertilization and cultivars was significant in some traits of growth and yield and its components for the autumn season (2018), where the interaction between Aguadulge cultivar and concentration of nitrogenous Nano-hydroxyapatite fertilizer (150 ppm) gave the highest average in the trait of leaf area and leaves the content of chlorophyll which amounted to (8909.3 cm^{2}, 46.6 µg.ha^{-1}). while the interaction between the Histal cultivar and a concentration of the urea nano-hydroxyapatite fertilizer (150 ppm) gave the highest average in the trait of plant height which amounted to (89.2 cm), and the interaction of the cultivar and a concentration of the nitrogenous nano-hydroxyapatite fertilizer (75 ppm) has excelled in the traits of the bio-yield and the number of pods per plant (19.9 pods.plant^{-1}). As for the weight of 100 seeds, the highest average of this trait was at the interaction between the Aguadulge cultivar and a concentration of nitrogenous nano-hydroxyapatite fertilizer (225 ppm) which amounted to (41.1 g). In the autumn season (2019), the interaction between the Aguadulge cultivar and a concentration of 150 ppm gave the nitrogenous Nano-hydroxyapatite fertilizer gave the highest

 ISSN 2072-3875

significant average in the trait of the leaves content of chlorophyll which amounted to (46.6 μg.ha^{-1}), while the highest average of leaf area has achieved at the interaction between the Aguadulge cultivar and the concentration of urea nano-hydroxyapatite fertilizer (150 ppm) which amounted to (9125.5 cm^{2}), and the highest significant average was achieved at the interaction between the Aguadulge cultivar and the concentration of nitrogenous nano-hydroxyapatite (225 ppm) in the traits of bio-yield and number of pods per plant, seed yield, and protein yield which amounted to (8.900 Mg.ha^{-1}, 16.6 pods.plants^{-1}, 2.689 Mg.ha^{-1}, 0.671 Mg.ha^{-1}), while the highest significant average was achieved for the number of seeds per pod at the interaction between the Histal cultivar and a concentration of nitrogenous nano-hydroxyapatite fertilizer (150 ppm) which amounted to (6.2 seeds.pod^{-1}), and the interaction between the Aguadulge cultivar and an adding level of urea nano-hydroxyapatite fertilizer (50 kg N.ha^{-1}) gave the highest average weight of 100 seeds which amounted to (47.0 g).

Keywords: Urea, Nitrogen, Nitrogenous nano-hydroxyapatite; cultivars of broad bean.

Research paper from MSc thesis for the third Author.

تأثير سماد النانو هيدروكسي اباتايت النيتروجيني واليوريا في نمو وحاصل صنفين من الباقلاء *Vicia Faba* L.

عمر عبد الموجود عبد القادر صالح محمد ابراهيم الجبوري ليث مازن هادي بطرس[1]

edu3ab@uomosul.edu.iq Dr.salleh75@uomosul.edu.iq laythmazin96@uomosul.edu.iq

قسم المحاصيل الحقلية، كلية الزراعة والغابات، جامعة الموصل، نينوى، العراق.

الخلاصة

أجريت هذه الدراسة لمعرفة تأثير التسميد النيتروجيني بالنانو هيدروكسي اباتايت واليوريا في نمو وحاصل ونوعية صنفين من الباقلاء *Vicia Faba* L في الموسمين الخريفيين 2018 و2019. استعمل تصميم القطاعات العشوائية الكاملة RCBD بنظام الألواح المنشقة وبثلاث مكررات، شملت التجربة عاملين ، الاول (الرئيس) تضمن الأصناف إسباني Histal و الإيطالي Aquadilge ، والعامل الثاني (الثانوي) شمل على ثمانية معاملات للتسميد النيتروجيني ، وأظهرت النتائج الآتي :- اختلفت الأصناف معنويا في بعض صفات النمو وصفات الحاصل ومكوناته ، اذ تفوق الصنف Histal في صفة وزن 100 بذرة في الموسم الخريفي 2018 بلغ 38.1غم وفي عدد البذور في القرنة وطول القرنة في الموسم الخريفي 2019 اذ بلغ 22.7سم، 5.7قرنة، بينما تفوق الصنف Aguadulge في صفة محتوى الكلوروفيل في الأوراق في الموسم الخريفي 2018 اذ بلغ 38.8 مايكروغرام.سم^{2} ، وفي صفة ارتفاع النبات و الحاصل الحيوي و عدد القرنات في النبات وحاصل البذور وحاصل البروتين في الموسم الخريفي2019 اذ بلغ (91.43سم،7.439ميكاغرام.ه$^{-1}$،15.4 قرنة نبات$^{-1}$، 2.331ميكاغرام.ه$^{-1}$،0.546 ميكاغرام.ه$^{-1}$). سبب التسميد النيتروجيني زيادة معنوية في بعض صفات النمو وصفات الحاصل ومكوناته في الموسم الخريفي 2018 فقد أعطى التركيز 150 ppm سماد النانو أعلى المتوسطات لصفات المساحة الورقية و محتوى الكلوروفيل في الأوراق (8598.5سم ^{2}، 45.3 مايكروغرام.سم^{2}) ،أما التركيز 75 ppm سماد النانو فقد اعطى اعلى متوسط في صفة الحاصل الحيوي وعدد القرنات في النبات وحاصل البذور(10.275ميكاغرام.ه$^{-1}$،19.6قرنة نبات$^{-1}$،2.825ميكاغرام.ه$^{-1}$) في حين اعطى التركيز 225 ppm سماد النانو أعلى متوسط لصفة ارتفاع النبات وعدد البذور.قرنة$^{-1}$ وطول القرنة، وزن 100 بذرة وحاصل البروتين (86.7سم،5.6بذرة قرنة$^{-1}$،24.4سم،40.77غم،0.655ميكاغرام.ه$^{-1}$ **.(**أما في الموسم الخريفي 2019 فقد تفوق التركيز 150 ppm سماد النانو بإعطائه أعلى المتوسطات لصفات محتوى الكلوروفيل في الاوراق والحاصل الحيوي وعدد القرنات في النبات وعدد البذورفي القرنة وطول القرنة وحاصل البذور(45.0مايكروغرام.سم^{2}،7.815ميكاغرام.ه$^{-1}$ ،14.9قرنةنبات$^{-1}$،5.9بذرةقرنة$^{-1}$،23.0سم،2.484ميكاغرام.ه$^{-1}$)، أما التركيز 225ppm سماد النانو فقد أعطى أعلى متوسط لصفة النسبة المئوية للبروتين وحاصل البروتين(25.1%،0.611ميكاغران.ه$^{-1}$). كان التداخل بين التسميد النتروجيني والأصناف معنوياً في بعض صفات النمو وصفات الحاصل ومكوناته للموسم الخريفي 2018 اذ أعطى التداخل بين الصنف Aguadulge والتركيز 150ppm سماد النانو هيدروكسي اباتايت النتروجيني أعلى معدل في صفة المساحة الورقية ومحتوى الكلوروفيل في الأوراق(8909.3سم^{2}،46.6مايكروغرام.ه$^{-1}$)، في حين أعطى تداخل الصنف Histal مع التركيز 150ppm سماد اليوريا أعلى متوسط في صفة ارتفاع النبات بلغ(89.2سم) وتفوق تداخل الصنف Aguadulge مع التركيز 75ppm سماد النانو هيدروكسي اباتايت النتروجيني في صفة الحاصل الحيوي ، عدد القرنات.نبات$^{-1}$ (10.696ميكاغرام.ه$^{-1}$،19.9قرنة نبات$^{-1}$)، أما صفة وزن100 بذرة فكان أعلى معدل لهذه الصفة من نصيب تداخل الصنف Aguadulge مع التركيز 225 ppmسماد النانو هيدروكسي اباتايت النتروجيني بلغ (41.1غم). اما في الموسم الخريفي 2019 فقد أعطى تداخل الصنف Aguadulge مع التركيز 150 ppm سماد النانو هيدروكسي

اباتايت النتروجيني أعلى معدل معنوي في صفة محتوى الكلوروفيل في الأوراق بلغ (46.6مايكروغرام.ه-1)، في حين تحقق أعلى معدل لصفة المساحة الورقية من تداخل الصنف Aguadulge مع التركيز 150ppm سماد اليوريا بلغ(9125.5سم2)، وتحقق أعلى معدل معنوي لتداخل الصنف Aguadulge مع التركيز 225ppm سماد النانو هيدروكسي اباتايت النتروجيني في صفة الحاصل الحيوي وعدد القرنات. نبات-1 وحاصل البذور وحاصل البروتين(8.900ميكاغرام.ه-1،16.6قرنةنبات-1،2.689ميكاغرام.ه-1 ،0.671ميكاغرام.ه-1)، في حين تحقق أعلى معدل معنوي لصفة عدد البذور. قرنة-1من تداخل الصنف Histal مع التركيز 150ppm سماد النانو هيدروكسي اباتايت النتروجيني بلغ(6.2بذرة قرنة-1) ، وأعطى تداخل الصنف Aguadulge مع مستوى اضافة 50 كغم N.ه-1 يوريا أعلى معدل لصفة وزن 100 بذرة بلغ (47.0غم)

الكلمات المفتاحية: اليوريا؛ النيتروجين؛ نانو هيدروكسي اباتايت النيتروجيني؛ أصناف الباقلاء.
البحث مستل من رسالة ماجستير للباحث الثالث.

1. INTRODUCTION

Broad bean (*Vicia faba* L.) is considered one of the economically important strategic leguminous crops, whose seeds contain a high percentage of protein, approximately 25-40%, as well as carbohydrates, mineral elements, fibers, oils, and vitamins, especially vitamin B, and a high percentage of phatic acid (15, 25, 29). Increasing the productivity of the legume crop depends on cultivating high-yielding cultivars and using effective field methods to obtain the potential energy of these cultivars and knowing the extent of their adaptation to the environmental conditions (4). The cultivars of broad bean vary in their morphological shape according to the nature of their growth, which varies in size, height, lengths of their stems and branches, this leads to a variation in the shape of the plant, as well as the variation in the size of the seeds, the seed content of nutrients and the percentage of protein. This variation is often due to the genetic nature of the cultivar and environmental conditions (16). Despite the fact that leguminous plants benefit from the atmospheric nitrogen fixed by the root nodule bacteria that coexist with the plant, but studies have shown that broad bean responds to the addition of nitrogenous fertilizers. The effect of fertilizer is commensurate with the type of soil, growth factors, method of adding fertilizer, and other factors, and foliar fertilization is one of the most important methods of effecting additional processing with nutrients for the plant and the foliar nutrition maintains the nutritional balance inside the plant, which may be disturbed for many reasons (26, 27). The period of filling seeds in legumes is the critical period for nutrients, where the seeds become the major repository of nutrients and the availability of restocking them in the vegetative parts or obtained from the nitrogen fixation may be insufficient in this period, which requires accelerating the preparation of nitrogen for the plant (26). One of the drawbacks of using nitrogenous fertilizers is that they quickly break down in wet soil and washing ammonia away, which creates huge environmental issues, where they lead to enriching watercourses with decomposing elements and It eventually enters the atmosphere in the form of carbon dioxide, and this rapid decomposition would also limit the amount of nitrogen absorbed by the crop roots, which leads farmers to apply more fertilizers to increase production, and here comes nanotechnology to solve the problem by making the urea breaking process slower to stay longer (slow-release) (7). Nanotechnology can provide solutions to increase the value of agricultural products and reduce environmental problems by using nanoparticles and nanopowders, and we can produce fertilizers that are controlled or delay their decomposition. The nanoparticles are characterized by high efficacy due to their having more surface area, or to increase the interaction of these areas on the surface of the particles and these features facilitate the absorption of fertilizers and pesticides that are produced with specific scales (13). Due to the lack of studies that dealt with nano fertilizer and its interaction with urea fertilizer that dissolves in water quickly, in addition to the main problem that accompanies ammonia volatilization, especially in Iraqi soils and in dry and semi-dry regions, this study was conducted to know the effect of nano-fertilizer, urea, and the interaction between them on the growth and yield of two cultivars of broad bean.

2. MATERIALS AND METHODS

This study was conducted during the autumn season of (2018 and 2019), in the Al-Rashidiya region north of the Mosul city, which far 13 km away from the city center of Mosul, in order to know the effect of nitrogenous and urea nano-hydroxyapatite fertilizer on growth and yield of two cultivars of broad bean (*Vicia Faba* L.). The experiment included two factors. The first (main) factor included the cultivars (Spanish Histal and Italian Aquadilge), obtained from 89Janbali company located in Zakho district, Duhok province. As for the second factor, it included eight levels of fertilization (without fertilization, adding 50 kg $N.ha^{-1}$ in the form of urea to the soil, and a dilute solution sprayed on plants until complete wetness of the nano-hydroxyapatite fertilizer (75, 150, 225 ppm), and a dilute solution of Urea fertilizer (75, 150, 225 ppm)), where urea fertilizer was manually added in the form of granules to the soil in two batches, the first (after a month of planting) and the second (at flowering) (8). As for the remaining levels of fertilization, it was added in the form of a dilute solution that was sprayed on the plants until complete wetness, as well as in two batches, the first (after a month of planting) and the second (at flowering). The cultivation was conducted at a distance of (75 cm) between one furrow and another, and 20 cm between one plant and another. the experimental unit consisted of (4 furrows), with a length of (3 m). The experimental unit was with an area of 9 m^2 (with dimensions of 3 × 4 m^2), and the treatments were randomly distributed to the experimental units, and the experimental units and replicates were separated from each other by a distance of (1 m). Dishwashing liquid (Al Zahi) was used with the amount of (1 $cm^3.L^{-1}$) as diffusion materials, the soil was analyzed for both seasons to find its physical and chemical properties by taking random samples of the soil with a depth of (0-30 cm) before planting in the laboratory of the Environment Department of Dohuk province as shown in Table (1). Climatic data were taken from the Meteorological Department in Ninawa province as shown in Table (2). The following traits were studied: plant height (cm), leaf area per plant (cm^2): The leaf area was measured with a ruler by measuring its maximum length and maximum width, the equation mentioned by (11) was then used :

$$(LA = 0.04 + 0.45\ (L \times W),$$

chlorophyll content ($\mu g.cm^{-2}$): it was measured by SPAD 502DL Plus Chlorophyll Meter With Data Logger RS-232, the measurements were then converted from the SPAD unit to ($\mu g.cm^{-2}$) with the equation mentioned by (19).

$$Y\ (\mu g.cm^{-2}) = -2.79 + 0.88 \times X,$$

In addition to studying the bio-yield ($Mg.ha^{-1}$), number of pods per plant, number of seeds per pod, pod length (cm), the weight of 100 seeds (g), seed yield ($Mg.ha^{-1}$), percentage of protein (%): The percentage of nitrogen in the seeds was estimated using the Micro Kjeldahl method according to the method mentioned in (12). The protein percentage was calculated according to the following equation:

The percentage of protein = the percentage of nitrogen x 6.25

The crude protein content ($Mg.ha^{-1}$): It was calculated according to the following equation:

Crude protein content ($Mg.ha^{-1}$) = seed yield ($Mg.ha^{-1}$) x percentage of protein in seeds.

The data of the studied traits were analyzed statistically by computer depending on the SAS / STAT program (2002) according to The Randomized Complete Block Design (RCBD), with split-plots for each season as mentioned by

(3). Duncan's new multiple range test was used to compare the averages of the treatments for each of the sources of variance with the significant effect (17). The averages followed by different letters indicate the existence of a significant difference between them.

Table 1: Physical and chemical traits of the soil of the experiment location for the two autumn seasons (2018 and 2019).

Measurement type	First season 2018	Second season 2019	Unit
Degree of soil reaction (pH)	7.7	7.4	----
Electrical conductivity	2.4	2.1	$dS.m^{-1}$
available nitrogen	45.0	39.2	$mg.kg^{-1}$
available phosphorous	115	102	$mg.kg^{-1}$
available Potassium	13.4	10.5	$mg.kg^{-1}$
Organic matter	0.4	0.9	$g.kg^{-1}$
Volumetric distribution of soil particles			
Clay	15.2		$g.kg^{-1}$
Silt	61.75		$g.kg^{-1}$
Sand	23.05		$g.kg^{-1}$
Soil texture	**Clay loam**		-----

Table 2: The amount of rainfall (mm) during the two study seasons received from the Nineveh Agriculture Directorate / Planning Department.

Month	November	December	January	February	March	April	May	Total
2018-2019	28.5	18.2	146.5	93	52.5	20.5	0	812.5
2019-2020	3.5	94	63.5	133.5	31	31	0	371

3. RESULTS AND DISCUSSION

Plant Height (cm):

Table (3) indicates that there was no significant effect of the cultivars on the trait of plant height for the autumn season 2018. while in the autumn season of 2019 there was a significant difference between the cultivars in the average plant height, where the Aguadulge cultivar has excelled by giving it the highest average for this trait which amounted to (91.43 cm), while the Histal cultivar gave the lowest average plant height amounted to (83.87 cm). The reason for the superiority of the Aguadulge cultivar in the trait of plant height may be due to the genetic nature of the cultivar, which influenced its response to environmental conditions better in the event of a decrease in the amount of rain in the second season as shown in Table (2), and then increasing the average of cell division and elongation, which positively affected the trait of plant height for this cultivar, this result agrees with (6). Nitrogen fertilization caused a significant increase in the plant height for the autumn season 2018, where the nano-hydroxyapatite fertilizer at a concentration of (150 ppm) gave the highest average amounted to (87.5 cm), which did not differ significantly from the concentration of (225 ppm), while the non-fertilization treatment gave the lowest average for this trait amounted to (82.1 cm). The reason for the superiority of high concentrations of nanoparticle fertilizer in increasing plant height may be due to the large permeability and high speed of nanoparticles, which means more ease in penetrating plant leaves that play an important role in promoting plant growth, where nitrogen has a positive role in increasing the activity of meristematic tissues and cell division and its importance In building amino acids such as Tryptophan, which is the basis for building Auxins that contribute to cell division and expansion (23). As for the autumn season (2019), nitrogen fertilization with its different levels did not have a significant effect on plant height. There was a significant interaction between cultivars and nitrogen fertilization in the trait of plant height for the autumn season (2018), the highest average for this trait amounted to (89.2 cm) at the interaction between the Histal cultivar and a concentration of urea fertilizer (150 ppm), while the lowest average for the trait amounted to (77.8 cm) at the interaction between the Aguadulge cultivar and a concentration of urea fertilizer (150 ppm). We observe that the response of the cultivar to the nitrogen fertilizer varies according to the cultivar with the used constant concentration. In the autumn season (2019), there was no significant interaction between cultivars and nitrogen fertilization in plant height.

Table 3: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of plant height (cm) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					**The autumn seasons (2019)**				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		86.0 a-d	hi78.2	82.1 b	Without nitrogen fertilization		84.10	92.13	88.12
Urea (50 kg.ha^{-1})		b-d 85.1	e-g81.5	83.3 b	Urea (50 kg.ha^{-1})		84.40	88.37	86.38
Urea nitrogen fertilization	75 PPM	d-f 83.2	84.6 c-e	83.9 b	Urea nitrogen fertilization	75 PPM	85.63	90.63	88.13
	150 PPM	a89.2	i 77.8	83.5 b		150 PPM	86.63	91.67	89.15
	225PPM	g-i78.4	88.0 ab	83.2 b		225PPM	80.97	92.63	86.80
Nano nitrogen fertilization	75 PPM	f- h 81.0	87.0 a-c	84.0 b	Nano nitrogen fertilization	75 PPM	83.57	96.97	90.27
	150 PPM	88.5 ab	a-d 86.5	87.5 a		150 PPM	84.0	89.50	86.75
	225 PPM	85.6 b-d	87.8 a-c	86.7 a		225 PPM	81.67	89.50	85.58
Effect of cultivars		**84.6**	**83.9**	**Overall average 84.3**	**Effect of cultivars**		**b 83.87**	**a 91.43**	**Overall average 87.6**

Plant Leaf area (cm^2):

The cultivars had no significant effect on the trait of leaf area for both seasons as shown in Table (4). While the levels of nitrogen fertilization significantly affected the trait of leaf area and for both seasons. In the autumn season (2018), the concentration of nano fertilizer (150 ppm) gave the highest average for this trait amounted to (8598.5 cm^2), while the lowest average for this trait which amounted to (6266.7 cm^2). The reason for excelling the concentration (150 ppm) may be attributed to the increase in the number of leaves in the plant (which was observed in the field) as well as the direct role of the nano-hydroxyapatite fertilizer in increasing cell division and expansion, especially the leaf cells, which was positively reflected in increasing the leaf area of the plant. Also, the significant decrease in the concentration of nano-fertilizer (225 ppm) may be due to the fact that the higher concentration affected the absorption of the sprayed fertilizer by the leaves. In the autumn season (2019), the concentration of nano-fertilizer (75 ppm) gave the highest average leaf area amounted to (8477.3 cm^2) compared to the non-fertilization treatment, which gave the lowest average for this trait amounted to (7138.1 cm^2) which did not significantly differ from the addition level (50 kg $N.ha^{-1}$) of urea and the concentration of Urea Fertilizer (75, 225 ppm). The reason for the difference in the effect of fertilization levels between the two seasons may be due to the difference in the amount and distribution of rain during the growing season as shown in Table (2), where it was more intense in the first season than it was in the second season and these results agree with (24). The interaction between the cultivars and the nitrogen fertilization of the autumn season (2018) had a significant effect. The interaction between the Aguadulge cultivar and the concentration of nano fertilizer (150 ppm) has excelled by giving it the highest average of leaf area amounted to (8909.3 cm^2). The lowest average of leaf area was at the interaction between the Histal cultivar and the concentration of urea fertilizer (225 ppm) which amounted to (5802.3 cm^2). in the autumn season (2019), the interaction between the Aguadulge cultivar and the concentration of urea fertilizer (150 ppm) gave the highest average for this trait amounted to (9125.5 cm^2) compared to the lowest significant average of leaf area was at the interaction between the Histal cultivar and the concentration of urea fertilizer (225 ppm) which amounted to (6436.2 cm^2). Through the results of the interaction, it is evident that the Aguadulge cultivar was the most responsive to spraying with nitrogenous nano-hydroxyapatite fertilizer and urea fertilizer than the Histal cultivar, where it achieved a high average of leaf area. This may be due to the genetic differences between them, which were reflected in their different response to nano-hydroxyapatite, nitrogen, and other growth factors.

The leaves content of Chlorophyll ($\mu g.cm^{-2}$):

Table (5) indicates that the cultivars had a significant effect on the trait of the leaves content of chlorophyll for the autumn season (2018), where the Aguadulge cultivar has excelled in this trait by giving it the highest average amounted to (38.8 $\mu g.cm^{-2}$) compared to the Histal cultivar which gave the lowest average for this trait amounted to (37.6 $\mu g.cm^{-2}$). While in the autumn season (2019), the differences between the cultivars did not reach the significant limit for this trait. The reason may be attributed to the difference in the genotypes of the cultivars in their genetic composition, the nature of their growth, their morphological shape, and their effect on the environmental factors, or it may be that the decrease in the number of leaves for the Aguadulge cultivar was reflected in increasing the concentration of this pigment in its leaves, this result agrees with (9). The effect of nitrogen fertilization was significant on the trait of the chlorophyll content, where the concentration nano fertilizer (150 ppm) has excelled in both seasons 2018 and 2019 by giving it the highest average for this trait amounted to (45.3, 45.0 $\mu g.cm^{-2}$), respectively, compared to the lowest average for this trait was at non-fertilization in both seasons which amounted to (32.7, 33.5 $\mu g.cm^{-2}$), respectively. This increase in the percentage of chlorophyll in the leaves may be attributed to the increase in the concentration of the nitrogen component in the leaves, which is essential in the formation of the chlorophyll

 ISSN 2072-3875

pigment, which was reflected positively in increasing its concentration in the leaves, and 70% of the nitrogen in the leaves enters in the formation of chlorophyll (14). The interaction between cultivars and nitrogen fertilization was significant in the trait of chlorophyll content in leaves for both seasons. In the autumn season (2018), the interaction between the Aguadulge cultivar and a concentration of nano fertilizer (150 ppm) has excelled by giving it the highest average for this trait amounted to (46.6 $\mu g.cm^{-2}$), and it did not significantly differ from the interaction between the Histal cultivar and a concentration of nan fertilizer (150 $\mu g.cm^{-2}$) which amounted to (44.0 $\mu g.cm^{-2}$), while the lowest average for this trait was at the concentration of urea fertilizer (75 ppm) gave the interaction between Histal cultivar and non-fertilization which amounted to (32.0 $\mu g.cm^{-2}$). In the autumn season (2019), the interaction between Aguadulge cultivar and a concentration of nano fertilizer (150 ppm) has excelled by giving it the highest average for this trait amounted to (46.6 $\mu g.cm^{-2}$), while the interaction between the Histal cultivar and the non-fertilization treatment gave the lowest average for this trait amounted to (33.5 $\mu g.cm^{-2}$).

Table 4: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of leaf area (cm^2) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					**The autumn seasons (2019)**				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		**bc**7380.7	**de** 6212.3	**bc** 6796.5	Without nitrogen fertilization		**hi** 6505.9	**d-f** 7770.2	**d** 7138.1
Urea (50 $kg.ha^{-1}$)		7073.2 **cd**	**c-e**6629.3	**bc** 6851.2	Urea (50 $kg.ha^{-1}$)		**fg** 7283.5	**e-g** 7428.2	**cd** 7355.9
Urea nitrogen fertilization	75 PPM	6425.3 **c-e**	**de** 6108.1	**c** 6266.7	Urea nitrogen fertilization	75 PPM	**hi** 6684.1	**bc** 8362.7	**cd** 7523.4
	150 PPM	8670.5 **a**	**de**6182.6	**b** 7426.6		150 PPM	**gh** 7063.0	**a** 9125.5	**b** 8094.3
	225PPM	5802.3 **e**	**ab** 8354.2	**b** 7078.2		225PPM	**i** 6436.2	**b-d** 8296.1	**cd** 7366.2
Nano nitrogen fertilization	75 PPM	6104.4 **de**	**ab** 8217.0	**b** 7160.7	Nano nitrogen fertilization	75 PPM	**c-e** 7969.8	**a** 8984.8	**a** 8477.3
	150 PPM	8287.6 **ab**	**a** 8909.3	**a** 8598.5		150 PPM	**hi** 6697.6	**ab** 8710.4	**c** 7704.0
	225 PPM	**bc**7455.1	**bc**7429.5	**b**7442.3		225 PPM	**g-i** 6958.5	**b-d** 8223.0	**c** 7590.8
Effect of cultivars		**7149.9**	**7255.3**	**Overall average 7202.6**	**Effect of cultivars**		**b 6949.8**	**a 8362.6**	**Overall average 7656.2**

Table 5: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the leaves content of Chlorophyll (μg.cm^{-2}) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					**The autumn seasons (2019)**				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		**i** 32.0	**hi** 33.5	**e** 32.7	Without nitrogen fertilization		**h** 33.5	**h** 33.5	**d** 33.5
Urea (50 kg.ha^{-1})		**g-i** 35.1	**f-h** 35.7	**d** 35.4	Urea (50 kg.ha^{-1})		**gh** 35.1	**gh** 35.3	**d** 35.2
Urea nitrogen fertilization	75 PPM	**g-i** 34.5	**f-h** 36.3	35.4 **d**	Urea nitrogen fertilization	75 PPM	**gh** 34.5	**gh** 35.3	**d** 34.9
	150 PPM	**e-h** 36.9	**c-f** 38.9	**c** 37.9		150 PPM	**fg** 36.9	**c-f** 39.0	**c** 37.9
	225PPM	**d-g** 38.0	**c-e** 40.4	**bc** 39.1		225PPM	**e-g** 37.7	**c-e** 40.3	**bc** 39.0
Nano nitrogen fertilization	75 PPM	**c-f** 39.1	**bc** 42.1	**b** 40.7	Nano nitrogen fertilization	75 PPM	**d-f** 38.7	**bc** 41.9	**b** 40.3
	150 PPM	**ab** 44.0	**a** 46.6	45.3 **a**		150 PPM	**b** 43.4	**a** 46.6	**a** 45.0
	225 PPM	**b-d**41.1	**f-h** 35.9	38.5 **bc**		225 PPM	**b-d** 40.9	**fg** 36.7	**bc** 38.8
Effect of cultivars		**b** 37.6	**a** 38.8	**Overall average 41.7**	**Effect of cultivars**		37.6	38.6	**Overall average 41.7**

Pod Length (cm):

Table (6) indicates that the cultivars did not significantly differ among them in the trait of pod length for the autumn season (2018). In the autumn season (2019), it differed significantly in this trait, where the Histal cultivar was excelled by giving it the highest average of pod length amounted to (22.7 cm) compared to Aguadulge cultivar which gave the lowest average for this trait amounted to (20.2 cm), and this result agrees with (2). The nitrogen fertilization has significantly affected the trait of pod length and for both seasons. In the autumn season (2018), the concentration of nano fertilizer (225 ppm) has excelled by giving it the highest average for the trait of pod length amounted to (24.4 cm), while the non-fertilization treatment gave the lowest average for this trait amounted to (20.0 cm). In the autumn season (2019), the concentration of nano fertilizer (150 ppm) gave the highest average of pod length amounted to (23.0 cm), while the lowest average for this trait amounted to (20.1 cm) at a concentration of urea fertilizer (75 ppm). The higher concentrations of nitrogen Nano-hydroxyapatite fertilizer in this trait for both seasons may be due to the increase in leaf area as shown in Table (4) and chlorophyll content in the leaves as shown in Table (5), and then an increase in the division and elongation of their cells, which was reflected in increasing the length of the pod. There was no significant interaction between cultivars and nitrogen fertilization in the trait of pod length for the two autumn seasons (2018 and 2019).

Table 6: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the Pod Length (cm) for the autumn seasons (2018 and 2019).

<table>
<tr><th colspan="5">The autumn seasons (2018)</th><th colspan="5">The autumn seasons (2019)</th></tr>
<tr><th colspan="2" rowspan="2">Nitrogen fertilization</th><th colspan="2">Cultivars</th><th rowspan="2">Effect of Nitrogen fertilization</th><th colspan="2" rowspan="2">Nitrogen fertilization</th><th colspan="2">Cultivars</th><th rowspan="2">Effect of Nitrogen fertilization</th></tr>
<tr><th>Histal</th><th>Aguadulge</th><th>Histal</th><th>Aguadulge</th></tr>
<tr><td colspan="2">Without nitrogen fertilization</td><td>21.7</td><td>18.2</td><td>d 20.0</td><td colspan="2">Without nitrogen fertilization</td><td>22.2</td><td>20.4</td><td>c 21.3</td></tr>
<tr><td colspan="2">Urea (50 kg.ha^{-1})</td><td>22.0</td><td>21.4</td><td>b-d 21.7</td><td colspan="2">Urea (50 kg.ha^{-1})</td><td>22.5</td><td>19.3</td><td>c 20.9</td></tr>
<tr><td rowspan="3">Urea nitrogen fertilization</td><td>75 PPM</td><td>21.5</td><td>19.7</td><td>cd 20.6</td><td rowspan="3">Urea nitrogen fertilization</td><td>75 PPM</td><td>21.6</td><td>18.5</td><td>c 20.1</td></tr>
<tr><td>150 PPM</td><td>23.6</td><td>20.1</td><td>b-d 21.8</td><td>150 PPM</td><td>22.7</td><td>19.0</td><td>c 20.9</td></tr>
<tr><td>225PPM</td><td>21.3</td><td>21.6</td><td>b-d 21.4</td><td>225PPM</td><td>21.6</td><td>20.6</td><td>bc 21.1</td></tr>
<tr><td rowspan="3">Nano nitrogen fertilization</td><td>75 PPM</td><td>22.7</td><td>23.5</td><td>ab 23.1</td><td rowspan="3">Nano nitrogen fertilization</td><td>75 PPM</td><td>23.4</td><td>19.6</td><td>a-c 21.5</td></tr>
<tr><td>150 PPM</td><td>23.8</td><td>21.2</td><td>a-c 22.5</td><td>150 PPM</td><td>23.9</td><td>22.1</td><td>a 23.0</td></tr>
<tr><td>225 PPM</td><td>25.2</td><td>23.7</td><td>a 24.4</td><td>225 PPM</td><td>23.3</td><td>22.1</td><td>ab 22.7</td></tr>
<tr><td colspan="2">Effect of cultivars</td><td>22.7</td><td>21.2</td><td>Overall average 21.9</td><td colspan="2">Effect of cultivars</td><td>a 22.7</td><td>b 20.2</td><td>Overall average 21.4</td></tr>
</table>

The number of pods per plant (pod.plant^{-1})

Table (7) shows that the cultivars did not significantly differ among them in the trait of the number of pods per plant for the autumn season (2018). While they differed significantly in this trait for the autumn season (2019), where the Aguadulge cultivar has excelled by giving it the highest average for this trait, which amounted to (15.4 pods.plant^{-1}) compared to the Histal cultivar which gave the lowest average amounted to (12.8 pods.plant^{-1}). The reason for the superiority of the Aguadulge cultivar may be due to its significant superiority in the trait of leaf area as shown in Table (4), as well as its superiority in the leaves content of chlorophyll as shown in Table (5). This means the high efficiency of the cultivar in converting photosynthesis products and nutrients from the vegetative part of the plant to the reproductive parts of the plant, especially the flowers, to increase the percentage of nodes in it and then increase the number of pods in the plant. In this context, researchers have concluded that there are significant differences between the cultivars of broad beans in the trait of the number of pods per plant (5, 9, 10). The nitrogen fertilization had a significant effect on the trait of the number of pods per plant for both seasons. In the autumn season (2018), the concentration of nano-fertilizer (75 ppm) by giving it the highest average for the trait which amounted to (19.6 pods.plant^{-1}), while the lowest average for this trait was achieved at the adding level of urea (50 kg $N.ha^{-1}$) which amounted to (14.2 $pods.plant^{-1}$). The reason may be due to the increase in the leaf area as shown in Table (4), which means increasing the surfaces of photosynthesis, increasing the manufactured nutrients that are transferred to the emerging pods to meet their needs of manufactured nutrients necessary for their growth and fullness, so decreases their abortion, this result agrees with (20). In the autumn season (2019), the concentration of nano fertilizer (150 ppm) has excelled by giving it the highest average of the number of pods per plant, which amounted to (14.9 $pods.plant^{-1}$) compared to the concentration of nano-fertilizer (75 ppm) which achieved an average amounted to (13.5 $pods.plant^{-1}$). It is possible that the reason for the superiority of the high concentration of nano-hydroxyapatite fertilizer is the increase in the leaf area as shown in Table (4) especially at the high level, making the leaf surface more vulnerable to spraying the fertilizer and then absorbing the element more by the leaves and this was reflected in the increase in the number of pods per plant, because it has a major role In increasing the flower nodes and the fertilization process through its role in increasing the speed of transport of sugars from their source to the places where they are needed in the plant during the reproductive phase, and this result agrees with (20). The interaction between cultivars and nitrogen fertilization was significant for the autumn season (2018), where the interaction between the Aguadulge cultivar and a concentration of 75 ppm achieved the highest average number of pods per plant amounted to (19.6 $pods.plant^{-1}$). The interaction between Aguadulge cultivar and a concentration of urea fertilizer (150 ppm) did not differ significantly from it, which gave an average for this trait amounted to (18.9 $pods.plant^{-1}$), and the lowest average for this trait was at the interaction between Aguadulge cultivar and the adding level of urea (50 kg $N.ha^{-1}$) which amounted to (13.3 $pods.plant^{-1}$). The significance of this interaction is due to the genetic differences between the two cultivars, which was reflected in their different response to different fertilizer concentrations. While in the autumn season (2019), the interaction between Aguadulge cultivar and a concentration of nano fertilizer (225 ppm) has excelled by giving it the highest average for this trait amounted to (16.6 $pods.plant^{-1}$) compared to the lowest average was at the interaction between the Histal cultivar and the adding level of urea (50 kg $N.ha^{-1}$) which amounted to (11.4 $Pod.plant^{-1}$).

The number of seeds per pods:

Table (8) indicates that the two cultivars (Histal and Aguadulge) were not significantly different in the trait of the number of seed per pod for the autumn season (2018). In the autumn season (2019), the cultivars differed significantly in this trait, where the Histal cultivar has excelled by giving it the highest average number of seeds per pod amounted to (5.7 $seeds.pod^{-1}$) compared to the Aguadulge cultivar which gave the lowest average for this trait amounted to (5.2 $seeds.pod^{-1}$). The reason may be attributed to the increase in the length of the pod as shown in Table (6), which was positively reflected in increasing the number of seeds per pod, in addition, to decrease the number of pods per plant as shown in Table (7), which leads to less competition, then reduce the chance of seed abortion and incomplete fertilization, and the result leads to an increase in the number of seeds, this result agrees with (5, 9, 10). The nitrogen fertilization caused a significant effect on the trait of the number of seeds per pod for both seasons, in the autumn season (2018), the highest average for this trait was at a concentration of nano fertilizer (225 ppm) which amounted to (5.6 $seeds.pod^{-1}$) without a significant difference at concentrations of (75 and 150 ppm), As for the lowest average for this trait was at a concentration of urea fertilizer (75 ppm) which amounted to (4.4 $seeds.pod^{-1}$). The higher concentrations of nano-hydroxyapatite fertilizer are due to the increase in the length of the pod as shown in Table (9), which leads to an increase in the number of seeds per pod. This result agrees with (24). In the autumn season (2019), the concentration of nano-fertilizer (150 ppm) has excelled in this trait by giving it the highest average amounted to (5.9 seeds.pod^{-1}), and the concentration of 225 ppm was not significantly different from it, while the concentration of urea fertilizer (75 ppm) gave the lowest average for this trait amounted to (4.9 seeds.pod^{-1}). Perhaps the positive effect of nitrogen in increasing the percentage of pod fertilization was reflected positively in increasing the number of seeds per pod. There was no significant interaction between nitrogen fertilization and cultivars for the trait of seed number per pod for the autumn season (2018). while in the autumn season (2019), there was a significant interaction between cultivars and nitrogen fertilization for the number of seeds per pod, the interaction between the Histal cultivar and a concentration of nano fertilizer (150 ppm) gave the highest average for this trait amounted to (6.2 seeds.pod^{-1}). It was not significantly different from it the interaction between Histal cultivar and a concentration of nano fertilizer (75 ppm) amounted to (5.9 seeds.pod^{-1}), while the interaction between Aguadulge cultivar and a concentration of urea fertilizer (75 ppm) which gave the lowest average for this trait amounted to (4.9 seeds.pod^{-1}).

Table 7: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the number of pods per plant (pod.plant^{-1}) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					**The autumn seasons (2019)**				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		15.8 **e-g**	16.8 **c-f**	16.3 **bc**	Without nitrogen fertilization		**g** 11.7	**bc** 15.3	**d** 13.5
Urea (50 kg.ha^{-1})		15.1 **f-h**	13.3 **h**	14.2 **d**	Urea (50 kg.ha^{-1})		**g**11.4	**b** 15.6	**d** 13.5
Urea nitrogen fertilization	75 PPM	14.5 **gh**	18.3 **a-c**	16.4 **bc**	Urea nitrogen fertilization	75 PPM	**f** 12.8	**b-d** 14.8	**cd** 13.8
	150 PPM	18.1 **a-d**	19.7 **a**	18.9 **a**		150 PPM	**de** 13.9	**cd** 14.4	**bc** 14.2
	225PPM	14.9 **f-h**	15.5 **e-g**	15.2 **cd**		225PPM	**ef** 13.1	**b** 15.4	**a-c** 14.3
Nano nitrogen fertilization	75 PPM	19.3 **ab**	19.9 **a**	19.6 **a**	Nano nitrogen fertilization	75 PPM	**g** 11.7	**bc** 15.2	**d** 13.5
	150 PPM	17.0 **c-f**	19.6 **ab**	18.3 **a**		150 PPM	**b-d** 14.7	**bc** 15.1	**a** 14.9
	225 PPM	17.5 **b-e**	16.1 **d-g**	16.8 **b**		225 PPM	**f** 12.7	**a** 16.6	**ab** 14.6
Effect of cultivars		16.5	17.4	**Overall average 17.0**	**Effect of cultivars**		**b** 12.8	**a** 15.4	**Overall average 14.0**

ISSN 2072-3875

Table 8: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the number of seeds per pods (seeds.pod^{-1}) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					The autumn seasons (2019)				
Nitrogen fertilization		**Cultivars: Histal**	**Cultivars: Aguadulge**	**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars: Histal**	**Cultivars: Aguadulge**	**Effect of Nitrogen fertilization**
Without nitrogen fertilization		4.6	4.7	b 4.6	Without nitrogen fertilization		**b-d** 5.5	**d-g** 5.1	**C** 5.3
Urea (50 kg.ha^{-1})		5.0	5.3	ab 5.2	Urea (50 kg.ha^{-1})		**bc** 5.8	**d-f** 5.2	**bc** 5.5
Urea nitrogen fertilization	75 PPM	4.6	4.2	b 4.4	Urea nitrogen fertilization	75 PPM	**e-g** 5.1	**g** 4.7	**d** 4.9
	150 PPM	5.4	4.7	ab 5.0		150 PPM	**bc** 5.8	**fg** 4.8	**C** 5.3
	225PPM	5.0	5.2	ab 5.1		225PPM	**d-f** 5.2	**de** 5.3	**C** 5.3
Nano nitrogen fertilization	75 PPM	5.5	5.5	a 5.5	Nano nitrogen fertilization	75 PPM	**ab** 5.9	**d-f** 5.2	**bc** 5.6
	150 PPM	6.0	5.0	a 5.5		150 PPM	**a** 6.2	**b-e** 5.5	**a** 5.9
	225 PPM	5.7	5.5	a 5.6		225 PPM	**b** 5.8	**d-e** 5.4	**ab** 5.7
Effect of cultivars		5.2	5.0	**Overall average 5.1**	**Effect of cultivars**		**a** 5.7	**b** 5.2	**Overall average 5.4**

Weight of 100 seeds (g):

Table (9) indicates that the weight of 100 seeds in the autumn season (2018) was affected by the different cultivars, where the Histal cultivar has excelled by giving it the highest average for this trait amounted to (38.1 g) compared to the Aguadulge cultivar, which gave the lowest average for this trait amounted to (37.3 g). This is due to the superiority of the Histal cultivar in the trait of leaf area as shown in Table (4) and the content of chlorophyll as shown in Table (5). These trait contributed to an increase in the photosynthesis process, which led to a lack of competition for nutrients at the stage of seed emergence and fullness, and this was reflected in increasing its efficiency in converting photosynthesis products to seeds. where the seed weight of any plant is a function for the average of photosynthesis and the transfer of its products to the developing seeds to increase their fullness instead of transferring to the division and elongation of stem cells (4). This result agrees with (9, 10). In the autumn season (2019), the differences between the cultivars did not reach the significant level in the weight of 100 seeds. The nitrogen fertilization was significantly affected on the weight of 100 seeds for the autumn season (2018), where the concentration of nano-fertilizer (225 ppm) achieved the highest average for this trait amounted to (40.77 g), while the concentration of urea fertilizer (225 ppm) gave the lowest average for this trait, which amounted to (36.25

g). This was attributed to the effect of nitrogenous nano-hydroxyapatite fertilizer in increasing the leaf area as shown in Table (4) and the leaves content of the chlorophyll as shown in Table (5), which was positively reflected in the efficiency of photosynthesis and increasing the nutrient storage in the plant, which is later transferred to the developing seeds, increasing their fullness and increasing their size. While in the autumn season (2019), the weight of 100 seeds was not significantly affected by the nitrogen fertilization factor. The interaction between the cultivars and nitrogen fertilization was significant in the weight of 100 seeds for both seasons. In the autumn season (2018), the interaction between the Aguadulge cultivar with a concentration of nano fertilizer (225 ppm) gave the highest average for this traitamounted to (41.1 g), while the lowest average for this trait amounted to (35.5 g) at the interaction between the Aguadulge cultivar and no fertilization treatment. In the autumn season (2019), the interaction between the Histal cultivar and the concentration of urea (75 ppm) has excelled by giving it the highest average for this trait amounted to (47.0 g), while the lowest average for this trait amounted to (42.0) at the interaction between the Histal cultivar and a concentration of 150 ppm.

Table 9: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the weight of 100 seeds (g) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					**The autumn seasons (2019)**				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		**c** 38.3	**f** 35.5	36.90 **de**	Without nitrogen fertilization		**ab** 46.3	**a-c** 43. 8	45.1
Urea (50 kg.ha^{-1})		38.2 **c**	36.5 **e**	37.37 **cd**	Urea (50 kg.ha^{-1})		**a-c** 45.3	**a** 47.0	46.2
Urea nitrogen fertilization	75 PPM	38.3 **c**	37.4 **d**	37.88 **c**	Urea nitrogen fertilization	75 PPM	**a** 47.0	**a-c** 4. 9	45.4
	150 PPM	36.9 **de**	38.7 **c**	37.78 **c**		150 PPM	**a-c** 44.0	**a-c** 45. 1	44.6
	225PPM	**de** 36.1	36.4 **e**	36.25 **e**		225PPM	**a** 46. 7	**c** 42. 1	44.4
Nano nitrogen fertilization	75 PPM	**b** 40.0	38.5 **c**	39.25 **b**	Nano nitrogen fertilization	75 PPM	**a-c** 45.1	**bc** 43.0	44.1
	150 PPM	36.4 **e**	36.9 **de**	36.68 **e**		150 PPM	**c** 42.0	**a-c** 43. 8	42.8
	225 PPM	**ab** 40.4	41.1 **a**	40.77 **a**		225 PPM	**a-c** 44.4	**a-c** 45.0	44.7
Effect of cultivars		**a** 38.1	**b** 37.7	**Overall average 37.9**	**Effect of cultivars**		45.09 7	44.208	**Overall average 44.7**

The seed yield:

Table (10) shows that the cultivars did not differ significantly in the trait of seed yield for the autumn season (2018). While it was significantly differ in this trait for the autumn season (2019), where the Aguadulge cultivar has excelled by giving it the highest average for this trait amounted to (2.331 $Mg.ha^{-1}$) compared to the Histal cultivar which gave the lowest average for this trait amounted to (2.162 $Mg.ha^{-1}$). The reason for the superiority of the Aguadulge cultivar in the trait of the seed yield in the second season is due to its superiority in the trait of the number of pods per plant as shown in Table (7), this result agrees with (5, 9). The nitrogen fertilization was significantly affected on the seed yield for both seasons. In the autumn season (2018), the concentration of ano-fertilizer (75 ppm) achieved the highest average for this trait, which amounted to (2.825 $Mg.ha^{-1}$), while the concentration of urea fertilizer (75 ppm) gave the lowest average for the trait which amounted to (1.815 $Mg.ha^{-1}$). The reason for the increase in the seed yield trait is due to the increase in the number of pods per plant as show in Table (7), as a result, there was an increase in the seed yield because it is a function of the yield components. This result agrees with the results of other studies that showed the positive effect of nitrogen on seed yield and for different legume crops (18, 19, 22, 28). In the autumn season (2019), the concentration of nano-fertilizer (150 ppm) gave the highest average for this trait, which amounted to (2.484 $Mg.ha^{-1}$), and the concentration of urea fertilizer (75 ppm) gave the lowest average for this trait, which amounted to (2.039 $Mg.ha^{-1}$). The reason was due to the increase in the number of pods per plant as shown in Table (7) and the number of seeds per pod as shown in Table (8), which was positively reflected in increasing seed yield. The interaction between cultivars and nitrogen fertilization was not significant in the trait of the seed yield for the autumn season (2018). while in the autumn season (2019), the interaction between cultivars and nitrogen fertilization was significant, where the interaction between Aguadulge cultivar and concentration of nano fertilizer (225 ppm) has excelled by giving it the highest seed yield amounted to (2.689 $Mg.ha^{-1}$). The interaction between Histal cultivar and the addition level of urea (50 kg $N.ha^{-1}$) gave the lowest average for this trait amounted to (1.977 $Mg.ha^{-1}$).

Bio-yield ($Mg.ha^{-1}$):

Table (11) indicates that the bio-yield was not significantly affected by the different cultivars in the autumn season (2018), while it was significantly differ between them in the autumn season. But it had a significant effect, where the Aguadulge cultivar has excelled by achieving the highest average for this trait, which amounted to (7.439 $Mg.ha^{-1}$) compared to the Histal cultivar, which gave the lowest average for this trait amounted to (6.846 $Mg.ha^{-1}$). The reason for the superiority of the Aguadulge cultivar may be due to the genetic difference, its response to the surrounding environmental conditions, and its superiority in the number of pods per plant as shown in Table (7). These results agree with (1, 10). As for nitrogen fertilization, it had a significant effect on the trait of bio-yield for both seasons, in the autumn season (2018), the concentration of nano fertilizer (75 ppm) has excelled by giving it the highest average of the bio-yield amounted to (10.275 $Mg.ha^{-1}$) compared to the lowest average for this trait was at the addition level of urea (50 kg $N.ha^{-1}$), which amounted to (6.397 $Mg.ha^{-1}$). The higher concentration of nitrogenous Nano-Hydroxyapatite fertilizer (75 ppm) in the trait of the number of pods per plant as shown in Table (7), the number of seeds per pod as shown Table (8) and the seed yield as shown in Table (10) were positively reflected in increasing the bio-yield. In the autumn season (2019), the concentration of nano-fertilizer (150 ppm) has excelled in this trait by giving it the highest average amounted to (7.815 $Mg.ha^{-1}$), while the non-fertilization treatment gave the lowest average for the trait amounted to (6.746 Mg.ha^{-1}), and it did not differ significantly from most other concentrations. This increase may be due to the significant increase in the seed yield traits as shown in Table (10), the weight of 100 seeds as shown in Table (9), and the leaf area as shown in Table (4). As for the interaction between the cultivars and the nitrogen fertilization, it was significant in the autumn season (2018), where the interaction between the Aguadulge cultivar and a concentration of 75 ppm achieved the highest average of biological yield amounted to (10.696 Mg.ha^{-1}). The lowest average for this trait amounted to (6.064 tons.ha^{-1}) was at the interaction between the Aguadulge cultivar and the addition level of urea (50 kg N.ha^{-1}). In the autumn season (2019), the interaction between the Aguadulge cultivar and the concentration of nano fertilizer (225 ppm) has excelled by giving it the highest average for this trait amounted to (8,900 Mg.ha^{-1}), while the lowest average was at the interaction between the Histal cultivar and the non-fertilization treatment amounted to (5.397 Mg.ha^{-1}).

Table 10: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the seed yield (Mg.ha^{-1}) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					**The autumn seasons (2019)**				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		1.860	1.856	1.858 **c**	Without nitrogen fertilization		**gh** 2.000	**d-g** 2.268	**bc** 2.134
Urea (50 kg.ha^{-1})		1.910	1.742	1.826 **c**	Urea (50 kg.ha^{-1})		**h** 1.977	**a-c** 2.546	**b** 2.261
Urea nitrogen fertilization	75 PPM	1.693	1.936	**c** 1.815	Urea nitrogen fertilization	75 PPM	**f-h** 2.032	**f-h** 2.059	**c** 2.039
	150 PPM	2.403	2.382	2.392 **b**		150 PPM	**b-e** 2.355	**e-h** 2.094	**b-c** 2.225
	225PPM	1.854	1.943	1.899 **c**		225PPM	**e-h** 2.125	**b-f** 2.309	**bc** 2.217
Nano nitrogen fertilization	75 PPM	2.828	2.823	2.825 **a**	Nano nitrogen fertilization	75 PPM	**f-h** 2.059	**c-f** 2.283	**bc** 2.171
	150 PPM	2.480	2.404	2.442 **ab**		150 PPM	**ab** 2.554	**b-d** 2.414	**a** 2.484
	225 PPM	2.694	2.423	2.558 **ab**		225 PPM	**d-h** 2.194	**a** 2.689	**a** 2.442
Effect of cultivars		2.215	2.189	**Overall average 2.2**	**Effect of cultivars**		**b** 2.162	**a** 2.331	**Overall average 2.2**

Table 11: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the bio-yield (Mg.ha^{-1}) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					The autumn seasons (2019)				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		**cd** 6.706	**a-c** 8.641	**cd** 7.674	Without nitrogen fertilization		**g** 5.397	**a-c** 8.094	**b** 6.746
Urea (50 kg.ha^{-1})		**cd** 6.730	**d** 6.064	**d** 6.397	Urea (50 kg.ha^{-1})		**ef** 6.454	**a-c** 8.055	**ab** 7.255
Urea nitrogen fertilization	75 PPM	**cd** 6.401	**cd** 6.823	**d** 6.612	Urea nitrogen fertilization	75 PPM	**b-d** 7.415	**fg** 6.078	**b** 6.747
	150 PPM	**ab** 9.200	**cd** 6.670	**b-d** 7.935		150 PPM	**b-d** 7.472	**d-f** 6.761	**b** 7.117
	225PPM	**cd** 6.545	**b-d** 7.159	**d** 6.852		225PPM	**b-d** 7.479	**ef** 6.368	**ab** 6.924
Nano nitrogen fertilization	75 PPM	**a** 9.854	**a** 10.696	**a** 10.275	Nano nitrogen fertilization	75 PPM	**c-e** 7.226	**de** 7.069	**b** 7.147
	150 PPM	**a** 10.007	**a-d** 8.373	**a-c** 9.189		150 PPM	**b-d** 7.447	**ab** 8.182	**a** 7.815
	225 PPM	**a** 9.571	**ab** 9.170	**ab** 9.371		225 PPM	**fg** 5.879	**a** 8.900	**ab** 7.389
Effect of cultivars		8.127	7.949	**Overall average 8.00**	**Effect of cultivars**		**b** 6.846	**a** 7.439	**Overall average 7.1**

The percentage of protein in the seeds (%):

Table (12) indicates that there was no significant effect of the cultivars and their interaction with nitrogen fertilization on the percentage of protein for both seasons (2018 and 2019). Nitrogen fertilization did not significantly affect the percentage of protein in the autumn season (2018). In the autumn season (2019), nitrogen fertilization caused a significant difference in the trait of the percentage of protein, where the concentration of nano-fertilizer (225 ppm) by giving it the highest average for this trait amounted to (25.1%), while the concentration of nano-fertilizer (75 ppm) gave the lowest average amounted to (21.7%). The superiority of high levels of nitrogen in this trait may be due to the increase in the trait of the leaf area as shown in Table (5) and the increase in nitrogen provision and its absorption by the plant, where the nitrogen component enters the composition of the amino acids that represent the basic

ISSN 2072-3875

component in building protein (21), which led to an increase in the percentage of protein in seeds.

Table 12: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the percentage of protein in the seeds (%) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					The autumn seasons (2019)				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		26.4	21.9	24.2	Without nitrogen fertilization		22.4	21.9	c 22.2
Urea (50 kg.ha^{-1})		24.4	24.9	24.6	Urea (50 kg.ha^{-1})		23.6	24.4	ab 24.0
Urea nitrogen fertilization	75 PPM	25.2	25.5	25.4	Urea nitrogen fertilization	75 PPM	25.0	24.9	a 25.0
	150 PPM	24.1	23.3	23.7		150 PPM	23.1	22.0	bc 22.5
	225PPM	24.2	25.4	24.8		225PPM	21.6	23.3	bc 22.4
Nano nitrogen fertilization	75 PPM	24.2	21.5	22.9	Nano nitrogen fertilization	75 PPM	21.8	21.7	c 21.7
	150 PPM	23.3	24.6	23.9		150 PPM	21.7	23.6	bc 22.7
	225 PPM	26.1	25.1	25.6		225 PPM	25.1	25.0	a 25.1
Effect of cultivars		24.7	24.0	**Overall average 27.6**	**Effect of cultivars**		23.1	23.4	**Overall average**

The protein yield (Mg.ha^{-1})

Table (13) shows that the cultivars did not significantly differ in their protein yield for the autumn season (2018). In the autumn season (2019), it differed significantly in this trait, where the Aguadulge cultivar has excelled by giving it the highest average for this trait, which amounted to (0.546 Mg.ha^{-1}), while the Histal cultivar gave the lowest average for this trait, which amounted to (0.498 Mg.ha^{-1}). The reason for the superiority of the Aguadulge cultivar in this trait may be due to its superiority in the seed yield as shown Table (10), the nitrogen fertilization has significantly affected in this trait for both seasons where the concentration of 225 ppm achieved the highest average for this trait which amounted to (0.655, 0.611 Mg.ha^{-1}), while, the lowest average for this trait was achieved in the season (2018) at the addition level of urea (50 kg N.ha^{-1}), which amounted to (0.449 Mg.ha^{-1}). While the concentration of nano fertilizer (75 ppm) gave the lowest average for this trait in the autumn season (2019), which amounted to (0.472 Mg.ha^{-1}). The increase in protein yield by increasing the concentration of nitrogen fertilizer is due to the positive effect of nitrogen in increasing the percentage of protein as shown in Table (12) and seed yield as shown in Table (10), which affected the increase in the trait of the protein yield. The interaction between cultivars and nitrogen fertilization was not significant for protein yield in the autumn season (2018). In the autumn season (2019), the

 ISSN 2072-3875

interaction between the Aguadulge cultivar and a concentration of nano fertilizer (225 ppm) has excelled by giving it the highest average for this trait amounted to (0.671 $Mg.ha^{-1}$), while the lowest average for this trait amounted to (0.448 $Mg.ha^{-1}$).

Table 13: The difference between cultivars and the effect of nitrogen fertilization and the interaction between them in the trait of the protein yield ($Mg.ha^{-1}$) for the autumn seasons (2018 and 2019).

The autumn seasons (2018)					**The autumn seasons (2019)**				
Nitrogen fertilization		**Cultivars**		**Effect of Nitrogen fertilization**	**Nitrogen fertilization**		**Cultivars**		**Effect of Nitrogen fertilization**
		Histal	**Aguadulge**				**Histal**	**Aguadulge**	
Without nitrogen fertilization		0.491	0.406	b 0.450	Without nitrogen fertilization		**f** 0.448	**c-f** 0.497	**d** 0.473
Urea (50 $kg.ha^{-1}$)		0.466	0.434	b 0.449	Urea (50 $kg.ha^{-1}$)		**d-f** 0.469	**ab** 0.622	**bc** 0.546
Urea nitrogen fertilization	75 PPM	0.427	0.494	b 0.461	Urea nitrogen fertilization	75 PPM	**c-f** 0.506	**c-f** 0.511	**b-d** 0.508
	150 PPM	0.579	0.555	ab 0.567		150 PPM	**b-e** 0.545	**ef** 0.460	**b-d** 0.502
	225PPM	0.449	0.494	b 0.471		225PPM	**ef** 0.458	**b-f** 0.538	**cd** 0.498
Nano nitrogen fertilization	75 PPM	0.684	0.607	a 0.647	Nano nitrogen fertilization	75 PPM	**f** 0.449	**c-f** 0.496	**d** 0.472
	150 PPM	0.578	0.591	ab 0.584		150 PPM	**b-d** 0.555	**bc** 0.571	**ab** 0.563
	225 PPM	0.703	0.608	a 0.655		225 PPM	**b-e** 0.551	**a** 0.671	**a** 0.611
Effect of cultivars		0.547	0.525	**Overall average 0.5**	**Effect of cultivars**		**b** 0.498	**a** 0.546	**Overall average 0.5**

CONCLUSIONS:

We conclude from this study: The possibility of using nitrogenous nano-hydroxyapatite fertilizer with the broad bean crop, where it had the best results in most traits of the growth, yield, and the quality of the seeds. The broad bean cultivars differed in their response to nitrogenous nano-hydroxyapatite fertilizer, where Aguadulge cultivar has excelled in most of the yield traits, its components and the qualitative traits.

REFERENCES

1. Al-Hamdani, Shamil Younis Hassan. 2012. Evaluation of performance, correlation, and expected genetic improvement of yield and its components in broad bean (Vicia faba L). Al-Rafidain Agriculture Journal. 40 (2): 67--55.

2. Al-Douri, Nourhan Ali Omar. 2013. Effect of spraying copper element on the field traits, yield and its components of three broad bean cultivars (Vicia faba L). Tikrit Journal of Agricultural Sciences. 13 (3): 232--239.

3. Al-Rawi, Khashi Mahmood and Abdulaziz Ibrahim Khalaf Allah. 2000. Design and Analysis of Agricultural Experiments, Ministry of Higher Education and Scientific Research, College of Agriculture and Forestry, University of Mosul.

4. Sahuki, Medhat Majeed. 2006. Plant Breeding with Partial Parameters. Iraqi Journal of Agricultural Sciences. 37 (4): 67--72.

5. Ayed, Qutaiba is pleased. 2012. Effect of foliar fertilizers on the growth and yield of two broad leguminous species (Vicia faba L) under the drip irrigation system. Tikrit University Journal of Agricultural Sciences. 12 (1): 131--137.

6. Al-Abadi, Ahmed Ibrahim Youssef and Al-Kamar, Majed Khalif. 2010. Evaluation performance and estimation of genetic parameters in faba bean (vicia faba L.) .Al-Rafidain Agricultural Journal .38)1 :(8.

7. Ali, Nour al-Din Shawqi, Hayawi, and Yawah Atiyah al-Jawzari. 2019. Nanoscience in soil and plant systems. Ministry of Higher Education and Scientific Research / Republic of Iraq. Al-Thaqalain Printing Press - Najaf Al-Ashraf: 499 pages.

8. Issa, Talib Ahmed. 1990. Crop plant physiology. Translator, Faculty of Agriculture - University of Baghdad, P.O.: 493.

9. Al-Fahdawi, Hussam Munif Obaid Mikhlif. 2013. Effect of humic acid on the growth and yield of four cultivars of pollutants, Vicia faba L., MA Thesis - Department of Field Crops - College of Agriculture - Anbar University.

10. Al-Fahdawi, Issam Kurdi Hammad. 2014. effect of plant density on the growth and yield of some cultivarsof broad bean (Vicia faba L.). Master Thesis . Field Crops Department - College of Agriculture - Anbar University.

11. Waly, Arol Mohsen Anwar. 2016. Improved methods for predicting leaf area for broad bean (Vicia faba L.). Tikrit Journal of Pure Sciences 21 (4): 1-5.

12. A.O.A.C. .(1980) official methods of analysis ,13th ed.Association of official analytical chemists Washington D.C.376-384.

13. Anonymouse (2009). Nano technology in agriculture. Journal of Agriculture and technology. (In Persian),114: 54-655.

14. Bozorgi.,H,R.Ebrahim.,A.and Moradi.,M. 2011. The effects of bio, mineral nitrogen fertilization and foliar zinc spraying on yield and yield components of faba bean. World Applied Sciences Journal .13(6):1409-1414.

15. Carmen, M. A., Zlatko.,S. Josefa., C, S. Salvador.,N. Diego.,R. Maria.,T. M. and Ana., M.T. 2005. Detection for Agronomic Traits in faba bean (Vicia faba L.). Agric. Conspec. Sci.,70 (3) ;pp17-20.

16. Daur,I ; H. Sepetoglu, K. B. Marwat, G. Hassan and I. A. Khan (2008) . Effect of different levels of nitrogen on dry matter and grain yield of Faba bean *Vicia faba* L.. Pak. J. Bot., 40(6): 2453-2459.

17. Duncan.,D. B. (1955). Multiple Range and Multiple F- test. Biometrics(11):1-42.

18. Drostkar., E. Talebi.R. and Kanouni .H.2016. Foliar application of Fe, Zn and NPK nano-fertilizers on seed yield and morphological traits in chickpea under rainfed condition. Journal of Research in Ecology. 4(2): 221-228.

19. Gomaa, M. A; E. E. Kandil1; A. A. Abuo Zeid and Bilkess M. A. (2016). Response of Some Faba Bean to Fertilizers Manufactured by Nanotechnology. J. Adv. Agric. Res. Vol. 21(3):384-397.

20. Hassan.,R.K.andLehmood.,A.M.2019.Eff ectofspraying time and concentration of liquid fertilizer on the growth and yield of broad bean

(Vicia faba L.).Research on crops.20(3):501-506.

21. Heldt,H.W.2005.PLANT BIOCHEMISTRY PUBLISHED BY ACADEMIC PRESS .THIRD EDITION.PP;657.

22. Jasim., A. H.and Obaid.,A. S. 2014. Effect foliar firtilizers spray boronand their interaction on broad bean (Vicia Faba L.) yield. Series B, Horticulture. Vol. LVIII. Online ISSN 1580-2286.

23. Loddo, S, and Gooding, M.J. (2012). Semi- dwarfing (Rht-B1b) Improves nitrogenuse efficiency in wheat, but not at economically optimal levels of nitrogen availability.Cereal. Res. Commun.

24. Mahmoud.,M.Shaaban.Abdalla.El-Sayed.,F.AbouEl- Nour.El-Zanaty., A.A. El-Saady. and Abdel Kareem., M.2006. Boron/Nitrogen Interaction Effect on Growth and Yield of Faba Bean Plants Grown under Sandy Soil .ConditionsInternational Journal of Agricultural Research, 1(4): 322-330.

25. Natalia.,G.Avila.,C.M.Moreno.,M.T.and Torres.,A.M.2008. Development of SCAR markers linked to zt-2, one of the genes controlling absence of tannins in Faba bean, Aust J of Agric. Res., 59 pp62- 68.

26. Salon.,C. Nathalie.,G. Gerard., D. Voisin., A. S. Larmure .,A. Emery.R.and Ney. B. 2001. Grain legume seed filling in relation to nitrogen acquisition: A review and prospects with particular with reference to pea. Agronomie 21: 539-552.

27. Su Fan. Lifang., H. Jin Hu and Zhong Li.1997. Improvement of root nodule nitrogen fixation and soil fertility by balanced fertilization of broad beans Better Crops International vol. 11 (2): 22-3.

28. Venkatesh.,M.S and Basu.,P.S.2011. Effect of foliar application of urea on growth ,yield and quality of chickpea under rainfed conditions.jornal of food legums.24(2):110-112.

29. Wasfi., Z. 2003. CULTIVATION OF FIELD CROPS. ALADDIN FOUNDATION FOR PRINTING AND PUBLISHING REPUBLIC MUSRARABN.PP2-30.