Effect of NPK Compound Fertilizer Normal and Nano on Mineral and Protein Content of Three Species of Apiaceae Plants

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Abstract

An experiment was conducted under the conditions of Al-Diwaniya governorate in a special nursery was specially constructed for the experiment during the autumn season (2016 - 2017) in order to determine the effect of adding the different levels of balanced NPK fertilizer (20-20-20) normal and nano to the soil of three species of Apiaceae (cumin, anise and sweet fennel) and their interference in mineral and protein content of seeds.

The factorial experiment that consist of two factor and with three replicates was designed by Randomized Complete Blocks Design (RCBD); the first factor consisted of three species of Apiaceae plant that above-mentioned, while second factor included seven levels of the NPK compound fertilizer balanced (control, normal NPK at recommended level, nano NPK at recommended level, normal NPK at double recommended level, nano NPK at double recommended level, Mixture NPK (Normal + Nano) at recommended level, Mixture NPK (Normal + Nano) at double recommended level). The means of the treatments was compared with a significant difference in the use of the least significant difference (LSD) at the probability level ($p \leq 0.05$). The results showed the superiority of sweet fennel plant in seeds content of total phosphorus and potassium versus the superiority of cumin plant in total seeds content of nitrogen and protein.

The significant effect of soil-additive fertilizers from normal and nano compound fertilizer in the increase of the majority of the studied traits and recording the highest mean in the NPK mixture at the double recommended or recommended level. The interference between factors gave the same significant effect to the superiority of the individual factors, as well as the improvement traits of more than double in some of them and the difference of response between plants depending on the type of fertilizer.

Keywords: NPK; nano; Apiaceae; mineral; protein.

Introduction

Apiaceae (formerly known as the Umbell Family: Umbelliferae) is one of the largest plant families in the world, with about 450 genera and 3700 species around the world [1, 2]. The members of this family are well known as vegetables, culinary and medicinal such as: *Anethum gravelolens* (dill), *Anthriscus cerefolium* (chervil), *Angelica* spp. (angelica), *Apium gravolence* (celery), *Carum carvi* (caraway), *Coriandrum sativum* (coriander), *Cumin cyminum* (cumin), *Foeniculum vulgare* (sweet fennel) and *Pimpinella anisum* (anise). The plants of this family usually have a pungent or distinctive aroma produced by the presence of essential oil called oleoresin [3]. It also has various compounds with several vital functions, as well as some of the main characteristics that characterize is the ability to cause apoptosis, antibacterial, hepatoprotective, vaso-relaxan, cyclooxygenase inhibitor (PTGS) and anti-tumor activity [3, 4].

Where the old chemical fertilizers are replaced with efficient and environmentally friendly nano fertilizers, the main use of fertilizers is rapid absorption of nutrients from the soil with best yield. Symbiotic exchange between soil and plant system is very effective when the application Itself, in a slow and efficient fertilizer. All the nutrients required by the plant that are supplied with the required energy and efficiency are taken, which will greatly increase when the fertilizers are encapsulated or surrounded by nanoparticles that increase their effectiveness and achieve the purpose of their use. In addition, the need for nitrogen as the main component of growth in terms of availability and absorption has caused many problems for plants [5].

The excessive use of different chemical fertilizers is one of the causes of degradation of the environment and soil, nano fertilizers are the most modern and technically advanced in the processing of crops with mineral nutrients, and compared with chemical fertilizers, nutrients that given plant

[1] The research is a part of M.Sc. Thesis in the case of the second researcher

needs reduce leaching, and improved fertilizer efficiency [6]. Fertilizer management is one of the most important factors in the successful cultivation of crops affecting the quality and quantity of the crop [7].

The aim of the study

Verification of the effect of the different levels of NPK compound fertilizer normal and nano, and their mixture in between them in mineral and protein content of seeds of the three species of Apiaceae (cumin, anise and sweet fennel), and determine the best level of fertilization according to increased target traits in plants.

Materials and methods

1. Design and experimental procedure of the study:

Randomized Completely Blocks Design (RCBD) was adopted to a factorial experiment consisting of two factors and three replicates ($3^{\text{plant}} \times 7^{\text{NPK}} \times 3^{\text{replicates}}$). The first factor of three species of Apiaceae (cumin, anise and sweet fennel) while the second factor included seven levels of the NPK compound fertilizer balanced (control, normal NPK $^{\text{at recommended level}}$, nano NPK $^{\text{at recommended level}}$, normal NPK $^{\text{at double recommended level}}$, nano NPK $^{\text{at double recommended level}}$, Mixture NPK (Normal + Nano) $^{\text{at recommended level}}$, Mixture NPK (Normal + Nano) $^{\text{at double recommended level}}$), and three replicates for each treatment distributed randomly in block and became the total units experimental were 63 ($3 \times 7 \times 3 = 63$).

The experiment was conducted in the autumn season (2016 - 2017) corresponding to 15/11/2016, with the aim of knowing the effect of adding the different levels of NPK fertilizer (20-20-20) normal and nano to three species of Apiaceae (cumin, anise, and sweet fennel), and their interaction in some growth traits and oil content of seeds. The seeds of the local plants were obtained from the approved agricultural offices in Al-Diwaniyah Governorate, while the normal compound fertilizers were produced by PRO-SOL Company by importing it by Dabbana Modern Agriculture Co. Ltd./ Baghdad, as well as pre-demand on Nano compound fertilizer from KHAZRA Co./ Iran.

The experiment was carried out by planting the seeds (5 seeds in each pot and was reduced after emergence to 4 only) for the plant species in pots (plastic pots) with dimensions (20 cm hieght × 15 cm width) and the capacity of 5 kg soil which filled it with mixture (1: 2) peatmoos and river's soil, and content it about 580 g. Kg^{-1} sand, 120 g. Kg^{-1} clay and 300 g. Kg^{-1} loam, with an average virtual density of 2.14 µg. M^{-3}, EC.= 7.6 ds. m^{-1}, sodium adsorption ratio (3.5 mmol. L^{-1}). According to the data below the experiment was executed:

a) Date of agriculture 15/11/2016.
b) The date of the emergence of seedlings fully 25/11/2016.
c) The continues of irrigation process at a rate of (3) days between irrigation and other, in addition to the continuation of the cultivation and control operations throughout the period of cultivation.
d) The date of the first addition of the Compound fertilizer by soil of both quality was done on 25/12/2016 according to the equivalent amount of the pot weight: 1 g. L^{-1}, (recommended) of normal compound fertilizer for each pot (5 kg soil) and 25 mg. 5 kg $soil^{-1}$ (recommended) of nano compound fertilizer.
e) Repeat the fertilizer additive of the plants according to the guidelines for each fertilizer until fruiting.

2- Studied characteristics:

a) Total Nitrogen: It was determined in seeds according to Cresser and Parsons [8] method (Kjeldahl method), and calculated by following equation:

$$N\% = \frac{1.401\,[(V1M1 - V2M2) - (V3M1 - V4M2)]}{W} \times df$$

where:

- $V1$ – millilitres of standard acid put in receiving flask for samples;
- $V2$ – millilitres of standard NaOH used in titration; $V3$ – millilitres of standard acid put in receiving flask for blank;
- $V4$ – millilitres of standard NaOH used in titrating blank;
- $M1$ – molarity of standard acid;
- $M2$ – molarity of standard NaOH;
- W – weight of sample taken (0.2 g);
- df – dilution factor of sample (if 1 g was taken for estimation, the dilution factor will be 100).

Note: 1 000 ml of 0.1M HCl or 0.05M H_2SO_4 corresponds to 1.401 g of N.

The following precautions should be observed:

- The material should not solidify after digestion.
- No NH_4 should be lost during distillation.
- If the indicator changes colour during distillation, determination must be repeated using either a smaller sample weight or a larger volume of standard acid.

b) Total phosphorus: It was determined in seeds according to Cresser and Parsons [8] method (Spectrophotometric vanadium phosphomolybdate method), and calculated by following equation: $P\% = \frac{C \times df \times 100}{1000000} = \frac{C \times 1000 \times 100}{1000000} = \frac{C}{10}$

where:

- *C* = concentration of P (µg/ml) as read from the standard curve;
- *df* = dilution factor, which is 100 × 10 = 1 000, as calculated below:
  - ✓ 1 g of sample made to 100 ml (100 times);
  - ✓ 5 ml of sample solution made to 50 ml (10 times).
- 1 000 000 = factor for converting µg to g.

c) Total potassium: Total phosphorus: It was determined in seeds according to Cresser and Parsons [8] method (AAS method), and calculated by following equation:

$$K\% = \frac{C \times df \times 100}{1000000} = \frac{C \times 2000 \times 100}{1000000} = \frac{C}{5}$$

where:

- *C* = concentration of K (µg/ml) as read from the standard curve;
- *df* = dilution factor, which is 100 × 20 = 2000, as calculated below:
  - ✓ 1 g of sample made to 100 ml (100 times);
  - ✓ 5 ml of sample solution made to 100 ml (20 times).
- 1 000 000 = factor for converting µg to g.

d) Total protein: The percentage of total protein in seeds was estimated according to A.O.A.C. [9] method, and calculated by following equation: $Total\ protein\ \% = N\% \times 6.25$

3- Statistical analysis:

All data for the results under study were classified by the Microsoft Office Excel (2013) and Randomized Complete Block Design (RCBD) According to factorial experiment consisting of two factors (3 × 7) and three replicates. The results were statistically analyzed by using the analysis of variance in the Analysis ToolPak included in the scheduling program add-ins [10]. The means of the treatments were compared when the differences were significant by using the least significant difference test (LSD) at the probability level ($P \leq 0.05$), as indicated by [11].

Results

1- Total nitrogen (%):

It is noted in Table (1) that cumin plant had the highest nitrogen content in the seeds was 2.9446% compared with 2,6489% anise and 2.3024% sweet fennel, respectively. The total nitrogen ratio of the plant at the levels of compound fertilizer was directly proportional to the increase in the level of fertilizer compared to the comparison plants with the lowest percentage of total nitrogen. On the other hand, the recommended level of nano fertilizer increased the total nitrogen ratio from 2.3904% in control plants to 2.5489% and 2.7415% by the effect of double recommended level of fertilizer was compared with same effect of normal fertilizer in both levels, where achieved 2.4601 and 2.5755% respectively. In addition, the treatment of the compound fertilizer at the doubled level recorded the highest percentage of total nitrogen (2.8776%), which significantly exceeded all other treatments, including the lowest level of 2.8298%, which showed the same moral superiority over the other fertilizer treatments under study.

Significant interference showed the same effect of the individual factors, and the significant superiority of combinations appeared to be clear and positive in comparison within each plant, as well as between plants. However, the combination of cumin with the mixture of compound fertilizer at the recommended and double it levels did not differ significantly between them, although recorded it high percentage of total nitrogen (3.1117 and 3.1276), respectively, as well as the combination of the compound fertilizer at the double recommended for anise and sweet fennel (2.8723 and 2.6330) %, respectively.

Table 1: Effect of different levels of NPK compound fertilizer normal and nano on total nitrogen of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
cumin	2.7670	2.8324	2.8755	2.9234	2.9744	3.1117	3.1276	2.9446
anise	2.3457	2.4734	2.6489	2.6808	2.7287	2.7925	2.8723	2.6489
sweet fennel	2.0585	2.0745	2.1223	2.1223	2.5213	2.5851	2.6330	2.3024
average of compound fertilizer effect	2.3904	2.4601	2.5489	2.5755	2.7415	2.8298	2.8776	
LSD $_{(P \leq 0.05)}$	Plant = 0.0047			NPK = 0.0113			Interaction = 0.0196	

2- Total phosphorus (%):

Phosphorus seed content of the three-plant species under study in Table (2) shows the significant superiority of sweet fennel plant on anise and cumin respectively, reaching 0.6073, 0.5854 and 0.5270%. In addition to the different levels of both fertilizers gave significant results in which to increased phosphorus content in seeds, the added application of different levels to both fertilizer significant results directly proportional to the increase in the level of fertilizer and up to the above when the mixture of compound fertilizer at doubled recommended level was 0.6190% compared with effect of other levels and control plants (0.5083%), and the nano compound fertilizer at the recommended level was significantly higher than its normal compound fertilizer (0.5638 and 0.5488%), respectively. The same applies on both fertilizers at double recommended level, were recorded (0.5896 and 0.5779) % respectively with significant superiority of nano fertilizer on normal fertilizer compared with comparison plants.

Interference between the levels of fertilizer and plants under study, it is noted from the table that the increase is steadily increasing with the increase of the level of fertilizer, whether normal or nano, with the highest content of phosphorus in the seeds and significantly superior to all other combinations and between them when the combination of compound fertilizer mixture at double recommend level with sweet fennel, anise and cumin, respectively (0.6788, 0.6257 and 0.5525%). As observed from the interaction data in table, the response of sweet fennel to the fertilizer treatments was the highest compared to the anise or cumin plants when comparing the content of the comparison treatment with the different fertilizer parameters of each plant.

Table 2: Effect of different levels of NPK compound fertilizer normal and nano on total phosphorus of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
Cumin	0.4983	0.5003	0.5134	0.5324	0.5434	0.5485	0.5525	0.5270
anise	0.5354	0.5625	0.5805	0.5836	0.5956	0.6146	0.6257	0.5854
Sweet fennel	0.4913	0.5836	0.5976	0.6176	0.6297	0.6527	0.6788	0.6073
average of compound fertilizer effect	0.5083	0.5488	0.5638	0.5779	0.5896	0.6053	0.6190	
LSD $_{(P \leq 0.05)}$	Plant = 0.0011			NPK = 0.0017			Interaction = 0.0031	

3- Total potassium (%):

Table (3) showed that the content of sweet fennel seeds from potassium was significantly higher than in anise and cumin, respectively. The average yield of these plants was 2.2433, 1.9307 and 1.8431%, respectively. It also shows that all levels of fertilizer added from the compound fertilizer have achieved a significant increase in the average content of potassium has reached in some of them than in comparison plants with a significantly lower average of 1.7470%, in addition to the effect of the nano compound fertilizer at the recommended level and the double recommended was significantly

higher than the normal fertilizer (1.8062 and 1.7673) for recommended level and (2.0692 and 1.9997) for double recommended, respectively. The highest content of potassium in the present study was recorded by the mixture treatments of compound fertilizer at recommended levels were recommended weakness and a significant difference for the latter. The percentage of potassium reached (2.2723 and 2.3783%), respectively, compared to all other treatments.

In the double interference of the study results, the superiority of the sweet fennel with the lowest potassium content in the comparison plants (1.6855%) compared to anise and cumin plants, as well as the increase in the levels of normal and plants (2.9721, 2.2251 and 1.9378%) were found when the combination of compound fertilizer at double recommended level with sweet fennel, anise and cumin plants, respectively.

It is worth mentioning that the two combinations of cumin and anise with normal compound fertilizer at the recommended level did not differ significantly with comparable plants. Moreover, the combinations of mixed fertilizers of both levels in all the plants under study were significantly higher among them, contained in the same table.

Table 3: Effect of different levels of NPK compound fertilizer normal and nano on total potassium of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
Cumin	1.7753	1.7872	1.8002	1.8371	1.8511	1.9129	1.9378	1.8431
anise	1.7802	1.7912	1.8052	1.8481	1.9069	2.1582	2.2251	1.9307
Sweet fennel	1.6855	1.7234	1.8132	2.3138	2.4495	2.7457	2.9721	2.2433
average of compound fertilizer effect	1.7470	1.7673	1.8062	1.9997	2.0692	2.2723	2.3783	
LSD $_{(P \leq 0.05)}$	Plant = 0.0078			NPK = 0.0120			Interaction = 0.0208	

4- Total protein (%):

Table (4) is observed that cumin plant had the highest total protein content in the seeds was 18.40% compared with 16.56% anise and 14.39% sweet fennel, respectively. The total protein ratio of the plant at the levels of compound fertilizer was directly proportional to the increase in the level of fertilizer compared to the comparison plants with the lowest percentage of total protein. On the other hand, the recommended level of nano fertilizer increased the total protein ratio from 14.94% in control plants to 15.93% and 17.13% by the effect of double recommended level of fertilizer was compared with same effect of normal fertilizer in both levels, where achieved 15.38 and 16.10% respectively. In addition, the treatment of the compound fertilizer at the doubled level recorded the highest percentage of total protein (17.99%), which significantly exceeded all other treatments, including the lowest level of 17.69%, which showed the same moral superiority over the other fertilizer treatments under study.

Significant interference showed the same effect of the individual factors, and the significant superiority of combinations appeared to be clear and positive in comparison within each plant, as well as between plants. However, the combination of cumin with the mixture of compound fertilizer at the recommended and double it levels did not differ significantly between them, although recorded it high percentage of total protein (19.45 and 19.55), respectively, as well as the combination of the compound fertilizer at the double recommended for anise and sweet fennel (17.95 and 16.46) %, respectively.

Table 4: Effect of different levels of NPK compound fertilizer normal and nano on total protein of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
Cumin	17.29	17.70	17.97	18.27	18.59	19.45	19.55	18.40
anise	14.66	15.46	16.56	16.76	17.05	17.45	17.95	16.56
Sweet fennel	12.87	12.97	13.26	13.26	15.76	16.16	16.46	14.39
average of compound fertilizer effect	14.94	15.38	15.93	16.10	17.13	17.69	17.99	
LSD $_{(P \leq 0.05)}$	Plant = 0.05			NPK = 0.07		Interaction = 0.12		

Discussion

Nutrition plays a key role in plant growth and development. In the case of medicinal plants, nutrient increases will stimulate plants to increase their yield and to synthesize essential oils and active substances [12 - 17]. On the other hand, unbalanced fertilization and low soil of organic matter have a negative impact on plant yield and chemical content, as well as the effect of the excessive additions of nitrogen and phosphorus fertilizers on plant structure and environment in terms of soil and irrigation water. The efficiency of conventional fertilizer use is about 20-50% for nitrogen and 10-25% for phosphorus, which means significant losses in the amount of fertilizer added versus low utilization by plants [18]. While the efficiency of using nano fertilizer from nitrogen and phosphorus is very high, rapid release and absorption by plants, which reduces the loss of unwanted nutrients in soil, water and air by direct absorption and avoids nutrient interaction with soil, microorganisms, water and air [19].

The results of the present study showed that when comparing the Apiaceae plants of cumin, anise and sweet fennel, and the last plant was significantly outweighed the cumin and anise plants in its total phosphorus and potassium that contained in tables 2 and 3, cumin is a significant effect on the sweet fennel and anise plant in seed content of total nitrogen and protein in tables 1 and 4. This is due to the genetic nature of each plant species, which in turn determines its phenotypic properties, its internal content, its growth, and its specific conditions [20].

For fertilizer treatments with NPK normal or nano, the growth and chemical content of the seeds other than the active substances were increased significantly with the increase of the fertilizer levels significantly higher in the mixed fertilizer at the recommended level or double recommended in some traits, as well as the nano fertilizer treatments are superior to those of normal fertilizer treatments; this is due to the fact that traditional nitrogen fertilizers containing particles of more than 100 nanometers in size, making them difficult to absorb by plants, which leads to low efficiency in the use of nitrogen utilization efficiency (NUE) by plants. Thus, the efficiency of fertilizer use by plants is carried out by nano fertilizer which are characterized as single-unit materials ranging from 1 to 100 nanometers in size in one dimension least [21], characterized by a high degree of interaction due to the more accurate surface area and the greater density of the interactive areas and increased interaction of these areas on the surfaces of the particles, making it easier for plants to absorb easily [22]. The difference between the multiplication of nano-fertilizers than the normal in terms of the effect on plant characteristics is that nanofertilizer cause increased nutrient efficiency, reduced soil toxicity and potential adverse effects associated with increased dose and reduced recurrence by providing a specific delivery organization and response [22] compared to traditional fertilizers that are washed or leached in the soil as a result of their rapid release, regardless of plant response to them [5, 22, 23].

The total protein content (Table 4) at the high fertilization level of cumin, anise and sweet fennel may be due to the effect of nitrogen on the structure of the ribosome and bio-synthesis of certain hormones involved in the synthesis of protein and the positive role in the increase of dry matter of the plant, which positively affected the increase of the mineral content of plants in tables (1-3) as a result of the combined action of additive elements in the increase rates growth and chemical components of plants [24, 25]. These results were consistent with the results of Khalid [26], which gave the same effect when adding the highest level of nitrogen fertilizer to the plants of Apiaceae family, and Hellal *et al.* [27] on dill plant and showed that the fertilizer added to the soil increased NPK The results of the studies are consistent with the results of the current study on different plants such as: Khalid [26] on

some medicinal plants of Apiaceae, and Sharafzadeh *et al.* [14], on sweet basil (*Ocimum basilicum* L.), Khalid and Shedeed [28] on the black bean plant. The role of nitrogen catalysts for biological processes in plants, such as protein synthesis, generates the need for energy translated by phosphorus uptake, which is positively reflected in the increase of plant content (phosphorus). In addition, the reason for the increase in potassium may be explained by the role of nitrogen in stimulating the activity of biological processes, which in turn increase the plant content of potassium with the role of regulating the balance of water and the movement of solubility as well as stimulating many of the enzymes associated with the process of representing carbohydrates, which increases the need for plant of potassium [29].

Conclusion

Apiaceae plants showed a significant superiority of each species in certain traits, as distinguished from their counterparts in other traits depending on the genetic factor and the specific conditions of each plant, as well as the significant effect of the normal or nano levels of fertilizer or the mixture between them in increasing the mineral content and protein of plant seeds increase the level of fertilizer, which achieved the significant superiority of nano fertilizers on normal fertilizers in addition to fertilizer mixture of the highest superiority of the studied qualities compared to individual species.

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Acceptance Letter **13 October 2017**

Dear Author (s)

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We would like to inform you that, your following paper was accepted and is selected for publication in: Vol. 10, No. (01-02), Upcoming Regular issues, and 2017-2018 of Journal of Global Pharma Technology /, (to get released on 11-19 Febreuary 2018)

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