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Effect of Nano Phosphorus and Potassium Fertilizers on Productivity and Mineral Content of Broad Bean in North Sinai

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ABSTRACT

A field experiment was carried out in winter season 2019 using broad bean. This study is to evaluate the effect of P and K as Nano fertilizes as foliar application at rate 0, 250 and 500 ppm for P, and 0, 150 and 300 ppm of K on the growth and the productivity of broad bean grown in sandy soil at Baloza Station-North Sinai of the Desert Research Center, Egypt, located at 31° 3′ 0" N32° 36′ 0" E. The treatments (P) and (K) were added as foliar spray after 25, 50 and 75 (DFS). Results indicated that the yield components of broad bean were improved with increasing P application. The K application took the same behavior of P where the spraying 500 and 300 ppm of P and K respectively, showed the higher effect on the yield parameters than the other levels. The nutrients concentration increased with increasing rates application of P and K which gave higher values than control treatment. Also N, P and K uptake had the same behavior as nutrients concentration where they affected significantly by spraying plants with P and K. The most efficient treatment was found when using the third rate of both nano P and K fertilizers which achieved 2.457, 1.470 and 3.927 ton fed^{-1} of straw, seeds and biological yield of broad bean, respectively. With increasing foliar application nano fertilizes of P and K single or in combination slightly increased the amount of N, P and K in soil after harvesting.

Keyword: Nano P, Nano K, Productivity, Sandy soil, North Sinai and Broad bean.

INTRODUCTION

Faba bean (*Vicia faba*, L.) is one of the most important leguminous harvests used as a human diet in many countries. Sandy soil encourages rapid loss of added fertilizers and hence, they are mostly poor in their nutrients content. Thus, careful and sufficient fertilization programs are required to increase the crop productivity.

Nanotechnology can put advents for increasing of agricultural products and decreasing environmental risks. With using Nano-particles and Nano powders, can control and/ or delaying releasing of fertilizers. Nano-particles have a big reactivity because of more specific surface area, more density of reactive areas, or increased reactivity of these areas on the particle surfaces. These features simplify the absorption of fertilizers and pesticides that produced in Nano standard (Anonymous, 2009). The use of nano fertilizers causes a growth their efficiency, decrease soil toxicity, reduce the potential negative effects associated with the over dosage and minimizes the frequency of addition. Nano fertilizers mainly delay the release of the nutrients and extend the fertilizer effect interval. Obviously, there is a chance for nanotechnology to have a significant effect on energy, the economy and the environment, by improving fertilizers. Hence, nanotechnology has a high capacity for achieving sustainable agriculture, especially in the developing countries. Naderi and Danesh-Shahraki, (2013) and Gomaa *et al.*, (2016), found that a significant increase was reading plant height, pod length, number of pods per plant, number of seeds per pod, 100 - seed weight, grain, straw and biological yield as well as harvest index percent with fertilizing “Nubaria two” cultivar by foliar nano - fertilizer (N P K + micro nutrients) at two or three stages (vegetative, flowering or filling) in both growing seasons.

Potassium is a substantial nutrient for plant growth and physiological functions, including organization of gas and water exchange in plants, carbohydrate translocation in plants, enzyme activation, and photosynthesis and protein synthesis. Potassium has positive effects on metabolism of nucleic acids, vitamins, proteins, and growth substances. Bednarz and Oosterhuis (1999) and Wang *et al.*, (2013), pointed out that K plays essential roles in enzyme activation, osmoregulation, photosynthesis, energy transfer, stomata movement, phloem transport, protein synthesis, stress resistance and cation-anion balance. The foliar additions with K can improve yield and quality, especially in heavy clay or in sandy soils, where K is not readily free for the plants. Marchand and Bourrie (1999) and Abbas *et al.*, (2018), revealed that sparing with potassium and calcium nanoparticle affected the plant height, pods number/ plant, branches number/ plant, seed weight, seed yield of broad bean, seeds number/ pod, where the effect was significant. Sahar *et al.*, (2020), showed that foliar addition with Nano-N fertilizer (400 mg N L-1), nano-P fertilizer (600 mg P L-1) and nano-K fertilizer (500 mg K L-1) using 200 L fed-1 of mixture of them throughout 3 periods after 21, 45 and 65 days after sowing (DAS) increased plant properties and weight of seeds yield.

Phosphorus is a very useful nutrient for plant growth and ensures big yield with high quality. It plays a key role in the formidable metabolic processes such as the conversion of sugar into starch and cellulose. As a result,

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phosphorus deficiency causes delayed maturity, stunting, and shriveled seeds Abou Hussien *et al.*, (2002). Several researchers reported that height of plant, number of pods and seeds per plant as well as weight of pods and seeds per plant, straw, biological yield per fed and seed protein content were increased as a result of phosphorus fertilizer application. Ruiqiang Liu and Rattan Lal (2014), showed that addition of the nanoparticles increased the yield of seed and growth rate by 32.6 and 20.4%, respectively, compared to those of soybeans treated by a regular P fertilizer Ca (H2PO4)2.

Eman Abd AlKader *et al.*, (2017), studied the effect of phosphorus fertilization rates (0, 37 and 74 kg P2O5 / ha), potassium fertilization rates (0, 57 and 114 kg K2O ha-1) and faba bean variety (Libyan landrace, Giza 843, Nubariah 3, Giza 716 and Sakha 1) on growth rate, crop productivity and yield components of the mentioned broad bean plants grown in sandy loam soil. They found that potassium and phosphorus fertilization rates, significant effects on growth rate , crop productivity and yield components of broad bean in both the studied seasons.

The present investigation aimed to study the effect of phosphorus and potassium nano fertilizers added as foliar application on yield and yield component as well as the chemical composition of shoots and seeds of broad bean grown in sandy soil under drip irrigation system in Baloza station.

MATERIALS AND METHODS

A field experiment was achieved at Baloza Research Station of the Desert Research Center, Egypt, located at 31° 3′ 0" N32° 36′ 0" E. Broad bean crop was grown in winter season 2019. The objective of this study was to evaluate the effect of P and K as foliar application at rats of 0, 250 and 500 ppm for nano P and 0, 150 and 300 ppm for nano K on the growth and the productivity of broad bean grown in sandy soil at Baloza station, North Sinai. The treatments (P) and (K) were sprayed after 25, 50 and 75 days from sowing (DAS). Broad bean cv. (Asbany) seeds were sown at the first of November 2019, in rows spacing 70 cm width and 20 cm between seeds / hills (30,000 plant fed-1). All plots received 75 kg N/fed as ammonium sulfate (20.5% N). Compost as organic manure at the rate of 20 m3fed-1 was added during soil preparation. While nitrogen fertilizer was added in three similar doses, *i.e.*, at sown, 45 & 60 days from planting.

The experiment was carried out in a split–plot design with 3 replicates, where the main factor was the foliar application with P and sub main was K rates. The experiment was irrigated by drip irrigation system from El-Salam canal water. Some physical and chemical properties of the studied site were determined acceding to Page *et al*., (1982) and Klute (1986) as presented in Table (1).

El-Salam Canal water was used for irrigation the grown plants and chemical analysis of the irrigation water was recorded in Table (2).

Table 1. Some physical and chemical properties of the experimental soil.

soil depth (cm)	OM %	pH	E.C (dS /m)	Soluble Cations (me/l)				Soluble Anions (me/l)			Texture class
				Ca++	Mg++	Na+	K+	HCO3-	SO4=	Cl-	
0-30	0.23	7.89	1.46	3.95	3.32	6.03	0.59	5.75	3.79	4.35	Sand
Available nutrients (ppm)		N		P		K		Fe	Mn	Zn	Cu
		35.00		2.82		39.00		5.52	2.18	0.97	0.28

pH: Acidity, soil extract (1 :2.5) , E.C: Electrical conductivity me/ l: mille equivalent per liter.

Table 2. Chemical analysis of the used irrigation water

Parameters	pH	E.C (dSm-1)	Soluble Cations(me/l)				Soluble Anions(me/l)			SAR
			Ca++	Mg++	Na+	K+	HCO3-	SO4=	Cl-	
Values	7.08	2.27	14.01	0.45	8.36	4.11	5.73	4.0	17.2	3.12

PH: Acidity, E.C: Electrical conductivity me/ l: mille equivalent per liter.

At the maturity stage 150 (DAS), the plants were harvested. The following determinations were carried, *i.e.* number of pods/ plant, number of seeds/ pod, 100 seeds weight and the yield of seeds and straw (kg/ fed).The seeds and straw samples were ground and wet digested using mixture of H2SO4 and HClO4 as recommended by Peterburgski (1968) and the following chemical analyses were carried out:

- Total nitrogen was determined using Microkjeldahl method, Phosphorus was calorimetrically determined using ascorbic acid and ammonium Molybdate, Potassium was determined by flame Photometer. All were determined according to the methods described by Chapman and Pratt (1961).
- Protein content was calculated by multiplying the N concentration by 6.25. Available P and K in soil at the end of experiment were determined according to the methods described by (Soltanpour *et al.,* 1979) and N was determined according to Jackson (1973).

Characterization of Nano composite:

To identify the presence of functional groups, Fourier transforms Infrared spectra (FTIR) study was performed with a resolution of 1 cm-1 in the wavelength range 500–4000 cm-1. Debye-Scherer equation was used to calculate the size of different nanoparticles while their surface Morphology was investigated by scanning electronic microscope (SEM).

A NEXUS 670 FT-IR spectrometer:

A NEXUS 670 FT-IR spectrometer (Thermo Nicolet, Madison, WI)

Was used to record the infrared spectra of the nano powders. The powders were mixed well with IR quality KBr at a mass ratio of 1 : 400 and the mixture was then pressed into a pellet in a 13 mm diameter evacuated die. The absorbance spectra were acquired over the range of 400 per cm to 4000 per cm using a DTGS detector and KBr beam splitter, with a resolution of 2 cm–1. Each spectrum was scanned 32 times to increase the signal to noise ratio. The estimated standard uncertainty of wavelength was ± 4 cm–1.

Fourier Transform Infrared Spectrometer (FTIR) Analysis

The functional groups present in the formulated fertilizer and the alginate-chitosan carrier were analyzed using a Fourier Transform Infrared Spectrometer. FT- IR spectra were analyzed using Spectra-Gryph® software and Know It All® Informatics System software.

Figure (1) shows the FTIR spectrum of the original SSP fertilizer. The infrared spectroscopy was used to confirm the coexistence of two mineral phases, monocalcium phosphate and gypsum, in the majority of phosphate fertilizers. The corresponding vibration bands (OH–, SO4-2 and PO2– chemical groups) have been presented in Table (3), (Fábio Plotegher & Caue Riberio, 2016, Takahashi *et al.*, 1983 and Anbalagan *et al.*, 2009).

All spectra of monocalcium phosphate exhibit bands indicative of the OH- vibration of hydrogen phosphate between 3600 and 2500 cm-1. Below 2000 cm-1, there are characteristic bands for the phosphate anion at 550, 1065 and 1620 cm-1.The spectra of apatite exhibit characteristic bands of PO4-3 at 560, 1050, and 1642 cm-1. The spectra also show broad bands attributed to OH- of hydroxyapatite and adsorbed water at 3450 cm-1, Andriy Shkilnyy *et al.* (2008).

The FT-IR spectra, shown in Figure (2) showed slight shift in the characteristic absorption peaks of 1613 cm-1 (–CO) and 1417 cm-1 (-COOH) to 1557 cm-1 and 1407 cm-1, respectively; and 1646 cm-1 (amide) and 1601 cm-1 (-NH) to 1557 cm-1 and 1407 cm-1 The FT-IR spectra show shift in the absorbance peak from 1613 cm-1 (-CO) and 1417 cm-1 (-COOH) to 1560 cm-1 and 1410 cm-1, respectively, Lim and Ahmad (2017) and Princess *et al. (*2019). Peaks at 825, 827 and 884 wave numbers respected aromatic C-C bond, 1082, 1090 and 1072 wave numbers represented aromatic C-O bonds and 1372, 1349, 1343, 3026 and 3045 wave numbers respected aromatic C-H group, Djamaan *et al.* (2018).

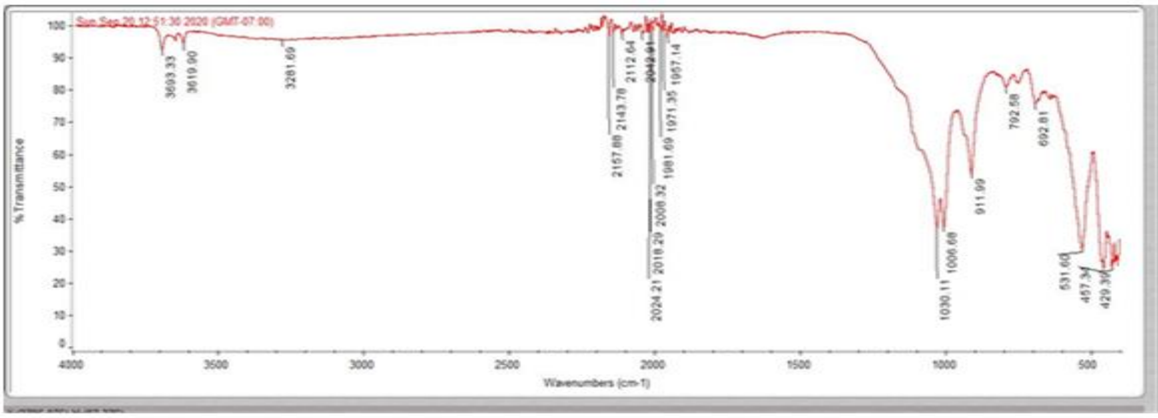

Fig .1. FTIR of nano calcium phosphates with (Ca/ P).

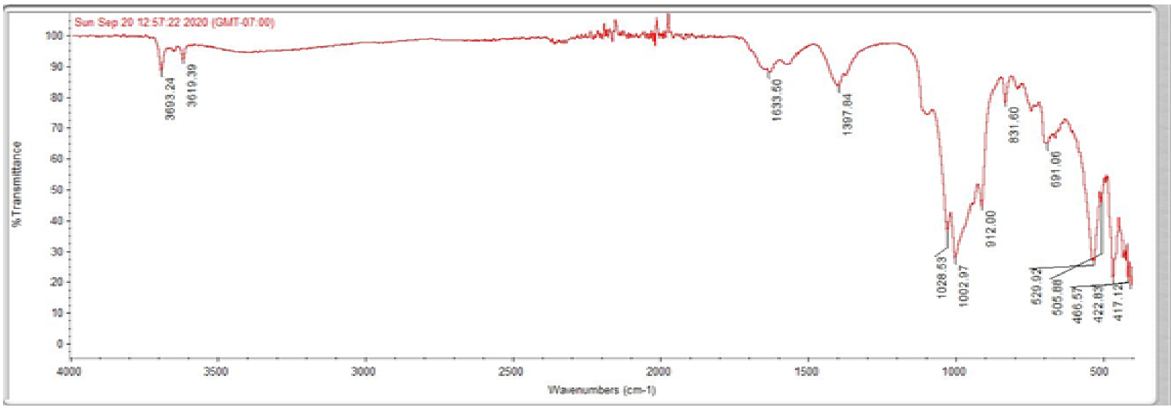

Fig .2. FTIR of nano Potassium Sulphat with SO4/ K

Table 3. IR band assignment for gypsum and monocalcium phosphate.

Wave Number (cm-1)	Assignment
1642	ν2, νOH of H2O
1240	δoH- in plane deformation
1158	PO2- asymmetric stretching
1126	PO2- symmetric stretching
1010	V̇3- (SO4)
980	P(OH)2- asymmetric stretching
960	P(OH)2- asymmetric stretching
912	P(OH)2- symmetric stretching
890	P(OH)2- symmetric stretching
862	γOH- deformation out of plane
678	VL, - H2O vibration mode
662	V4-(SO4)
612	V4-(SO4)
572	PO2- bending mode
546	PO2- bending mode
508	PO2- symmetric deformation in plan
454	V̇2- (SO4)
442	P(OH)2- bending mode

Scanning Electron Microscope (SEM) Analysis

The surface morphology and shape of the formulated fertilizer were determined through Hitachi Model SU3500 Scanning Electron Microscope. Sample preparation was done by attaching a small amount of formulated fertilizer on a carbon-coated tape, pressing it to flatten the sample, and placing it on the sample stage. The particle size distribution of the nCaP powders were determined by dynamic light scattering (DLS) (90 Plus particle sizer, Brookhaven Instruments, Holtsville, NY) at a wavelength of 532 nm at 25 Cº. Samples were prepared by dispersing small amounts of powder in 100 % ethanol followed by sonication for 10 min. A viscosity of 1.19 cP and refractive index of 1.36 were used for the calculation SEM (Figure 3 in Supporting Information) shows that the particles are highly agglomerated and the particles have an average diameter of 70 to 80 nm.

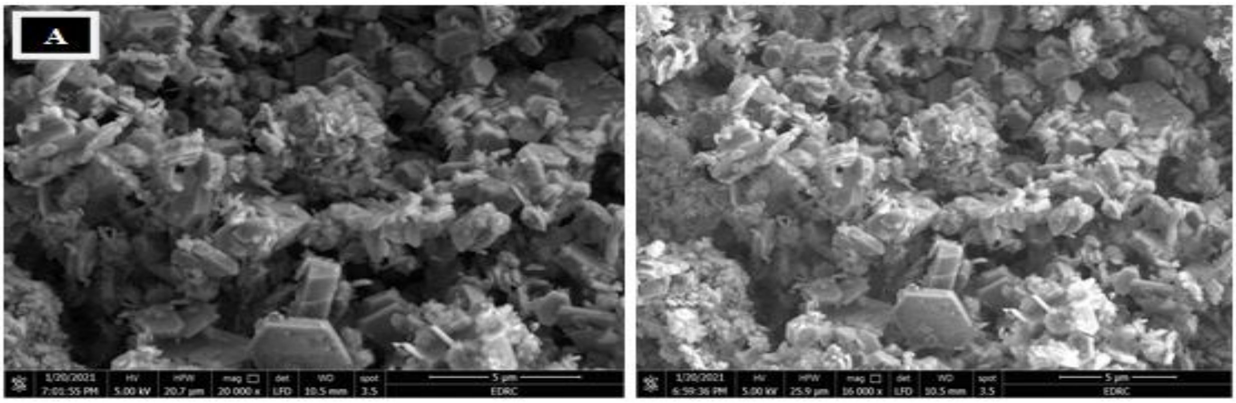

Fig. 3. FEG-SEM micrographs of simple superphosphate (SSP) fertilizer.

The appearance of dark fibrous or flat leaves of the ALG-CHI conveyor is formed during drying air like the ALG-CHI polymer backbone collapses after moisture. It evaporates leaving flat, compact polymer piles Conzatti, *et al.*, (2017). The white crystals are assumed to be K ion an integral part of ALG-CHI may be due to static electricity Interaction. The sizes and distribution of these are uneven Crystals on ALG-CHI may be agglomeration Particulate matter during synthesis and drying Azevedo, *et al.*, (2014) and Conzatti, *et al.*, (2017). Raw an estimate of the crystalline particle size based on Figure (4) is shown the smallest particle size are nano. The shape of the surface and the shape of the composition.

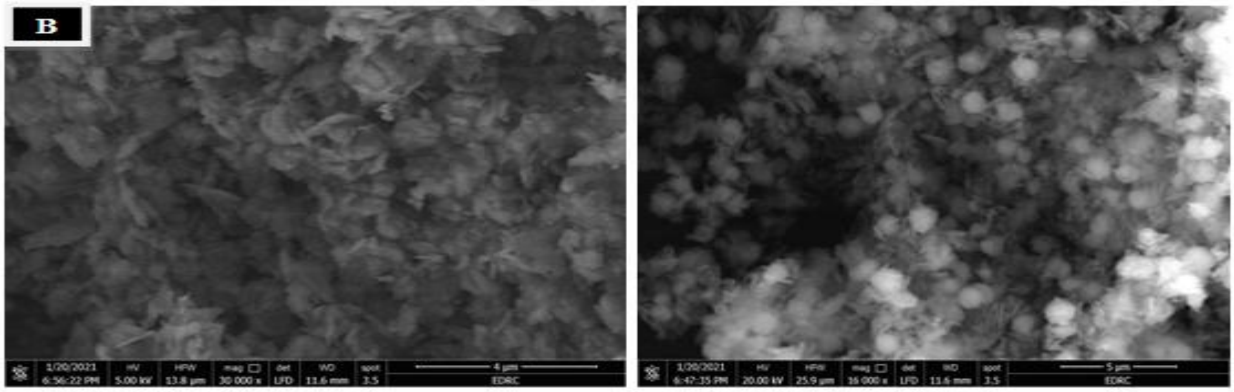

Fig. 4. SEM of nano Potassium Sulphat with (SO4/ K).

Statistical Analysis:.

All data were statistically analyzed according to **Snedecor and Cochran (1982),** where treatment means was compared using LSD test at 0.05 probability level.

RESULTS AND DISCUSSION

1. Effect of Phosphorus and potassium Nano fertilizers on the yield and yield parameters of broad bean:

Yield:

Regarding the effect of nano phosphorus fertilizer on the yield of broad bean straw and seeds, results in Table (4) showed that increasing application of nano phosphorus fertilizer increased significantly the yield of both straw and seeds. The increases of straw reached to about 84.8 and 136% by addition of 250 and 500 ppm (P nano)/ fed relative to control treatment (0+0), respectively. The corresponding increase of seeds yield were 146.6 and 200%, while the increases of biological yield recorded about 132.3 and 158%, respectively.

Also it is noticed that, results showed that increasing application of nano potassium fertilizers significantly increased the yield of both straw and seeds. The increases of straw reached about 80 and 119% by addition of 150 and 300 ppm (K nano/ fed), respectively. Where the increases of seeds yield were 161.4 and 177%, and increases of biological yield were 107.6 and 138.7%, respectively compared with control treatment.

With respect to the double interactions effect between, (P×K) results showed a significant effect on straw and seeds yields. The increases of straw, seeds and biological yields were reached to about 181.7, 230.6 and 198.2%, respectively with addition the highest rate of nano

P and K compared with the control treatment. These results agreement with the finding of Naderi & Danesh-Shahraki (2013) and Gomaa *et al.*, (2016), who found a significant increase in grains, straw, and biological yields with fertilizing "Nubaria 2" cultivar by foliar nano- fertilizers (NPK + micro nutrient) at 2 or 3 stages (vegetative, flowering or filling) in both growing seasons. Marchand and Bourrie (1999) and Abbas *et al.* (2018) revealed that, spraying with potassium and G power calcium nanoparticle showed a significant effect on height of plant, branch number/ plant, pod number/ plant, seeds number/ pod, 100 seeds weight and seeds yield of broad bean.

Table 4. Effect of the studied treatments on yield and yield parameters of broad bean plants

Nano P (ppm)	Nano K (ppm)	No of Pods/ plant	No of seeds/ pod	W. 100 Seeds (g)	Straw yield (Kg/ fed)	Seeds yield (Kg/ fed)	Biological yield kg/ fed
	0	3.0	3.33	115.0	872.3	444.7	1317.0
0	150	3.67	3.67	128.3	1058.7	967.7	2026.4
	300	4.33	4.33	134.3	1439	1005.0	2444.0
Means		3.67	3.78	125.9	1123.3	805.8	1929.1
	0	3.67	4.33	133.3	1173.0	887.3	2060.3
250	150	5.67	4.67	147.3	1564.7	1179.0	2743.7
	300	6.67	5.0	161.3	1835.7	1223.7	3059.4
Means		5.33	4.67	147.3	1524.5	1096.7	2621.1
	0	5.33	4.33	136.3	1631.3	1199.7	2831
500	150	7.33	5.33	153.3	2091.0	1340.3	3431.3
	300	8.67	6.33	164.0	2457.3	1470.0	3927.3
Means		7.11	5.33	151.2	2059.9	1336.7	3396.5
Means of (K) treatments							
	0	4	4	128.2	1225.5	843.9	2069.4
	150	5.56	4.56	143	1571.5	1162.3	2733.8
	300	6.56	5.22	153.2	1910.7	1232.9	3143.6
Means		5.37	4.59	141.5	1569.2	1079.7	2648.9
LSD(0.05)							
	A	0.79	1.05	4.07	100.9	31.13	73.80
LSD(0.05)	B	0.58	0.58	3.41	47.01	13.82	17.10
	AB	0.99	0.99	5.91	81.42	23.92	29.60

Yield parameters:

The effect of nano phosphorus fertilizer on some parameters of broad bean, *i.e*., number of bods/ plant & No. of seeds per pod and weight of 100 seeds. Results shown in Table (4) showed that increasing application rate of nano phosphorus fertilizer increased significantly No. of bods/ plant, No. of seeds per pod and the weight of 100 seeds. These increases reached to about 77, 189 & 40, 60 and 28, 31% by addition of 250 and 500 ppm (nano P/ fed), respectively compared to control treatment.

It is noticed that, increasing application of nano potassium fertilizer increased significantly the number of bods/ plant, number of seeds per pod and the weight of 100 seeds. Sush increases reached about 85, 118 & 36, 56.8 and 24, 33 % by addition of 150 and 300 ppm (nano K/ fed), respectively.

With respect to the double interaction effect between (P×K), results showed a significant effects on No. of bods/ plant & seeds/pod and the weight of 100 seeds. It gaves the increases reached to about 189, 90 and 42.6%, respectively over control treatment. This agreed with Naderi and Danesh-Shahraki (2013) and Gomaa *et al.*, (2016) who found a significant increases of plant height, pod length, number of pods per plant, number of seeds per pod, 100 - seed weight with fertilizing "Nubaria 2" cultivar by foliar nano- fertilizers (NPK + micro nutrient) at two or three stages (vegetative, flowering or filling) in both growing seasons. Sahar *et al.* (2020) showed that foliar addition with Nano-nitrogen fertilizer 400 mg N L-1, nano-phosphorus fertilizer 600 mg P L-1 and nano-potassium fertilizer 500 mg K L-1 using 200 L fed-1 of mixture of them throughout 3 period (after 21, 45 and 65 days after sowing), increased the plant characters and weight of seeds yield.

2- Effect of Phosphorus and potassium Nano fertilizers on nutrients content of broad bean:

Regarding to the effect of nano phosphorus fertilizer on nutrients content of broad bean straw and seeds, results in Tables (5 and 6) and fig. (5-7) showed that increasing application of phosphorus fertilizer increased significantly nutrients content of both straw and seeds. The highest mean values of N concentration and uptake of straw and seeds were obtained at addition the highest rate (500 ppm P) which gave the highest mean values 1.71 & 3.50% for (N %) and 35.52 & 47.03 (kg/ fed) for N uptake, respectively. Where the highest mean values of P concentration and uptake (fig 6) of straw and seeds with application the highest rate of P (500 ppm P/ fed) reached to about 0.32 & 0.39% for P% and 6.7 & 5.24 (kg/ fed) for P uptake, respectively.

Furthermore, the highest mean values of K concentration and uptake (fig 7) of straw and seeds were obtained at addition the higher rate of P (500 ppm/fed) which recoded 2.60 & 1.59% for K% and 53.98 & 21.32 for K uptake (kg fed-1), respectively.

Moreover, results showed that increasing application of nano potassium fertilizer increased significantly nutrients content of both straw and seeds. The highest values of N concentration and uptake of straw and seeds were obtained under addition the highest rate of K (300 ppmfed-1) which recorded 1.67 & 3.33% for (N %) and 32.46 & 41.7 for N uptake (kg/

fed), respectively. Where the highest mean values of P concentration and uptake (fig. 6) of straw and seeds were recorded with application the highest rate of P (300 ppm fed-1) and reached to about 0.26 & 0.35% for P% and 5.38 & 4.46 for P uptake (kg fed-1), respectively. Furthermore, the highest mean values of K concentration and uptake (fig. 7) of straw and seeds were obtained at addition the highest rate of K (300 ppm/fed) which recoded 2.31 & 1.59% for K% and 45.84 & 19.73 for K uptake (kgfed-1), respectively.

With respect to the double interaction between (P×K), results showed a significant effect on nutrients content of both straw and seeds. It is noticed that nano phosphorus and K fertilizers (500 ppm P + 300 ppm K)/ fed revealed the highest values were 1.83 & 37.1% for (N%) and 44.9 & 54.5 for N uptake (kg fed-1). The spraying plants with (500 ppm P + 300 ppm K) fed-1 gave the highest values 0.38, 0.42% for (P%) and 9.34, 6.18 for P uptake. Also, gave the highest values 2.69, 1.66% for (K%) and 66.1, 24.4 (kg fed-1) for K uptake of straw and seeds, respectively. The increases of nutrients under the studied treatments in seeds and straw may due to the role of spraying nano fertilizers on broad bean plants which affected the neuromas of vital processes inside plant organs, which affected positively the growth of plant and increased the absorption nutrients from soil. These results agreed with the finding of **Anonymous (2009).**

3- Effect of Phosphorus and potassium Nano fertilizers on protein content of broad bean:

Regarding to the effect of nano phosphorus fertilizer on protein content of broad bean seeds, results in fig. (8) Showed that increasing application of phosphorus fertilizer increased significantly the protein content of seeds. The highest mean values of seeds protein content were obtained at addition the highest rate of treatments (500 P +300 K ppm).

Table 5. Effect of the studied treatments on nutrients concentration in straw and seeds of broad bean plants

Nano P (ppm)	Nano K (ppm)	N (%)		P (%)		K (%)	
		Straw	Seeds	Straw	Seeds	Straw	Seeds
	0	0.94	1.30	0.16	0.22	0.95	0.71
0	150	1.40	2.68	0.18	0.27	1.55	1.44
	300	1.41	2.88	0.18	0.27	1.57	1.51
Means		1.25	2.29	0.17	0.26	1.36	1.22
	0	1.44	2.96	0.19	0.30	2.30	1.22
250	150	1.46	3.11	0.22	0.34	2.61	1.57
	300	1.75	3.41	0.23	0.36	2.66	1.61
Means		1.55	3.16	0.21	0.34	2.52	1.47
	0	1.57	3.29	0.25	0.36	2.44	1.49
500	150	1.72	3.51	0.32	0.39	2.68	1.62
	300	1.83	3.71	0.38	0.42	2.69	1.66
Means		1.71	3.50	0.32	0.39	2.60	1.59
Means of (K) treatments							
	0	1.32	2.51	0.20	0.300	1.90	1.14
	150	1.53	3.10	0.24	0.33	2.28	1.55
	300	1.67	3.33	0.26	0.35	2.31	1.59
Means		1.50	2.98	0.23	0.33	2.16	1.43
LSD(0.05)							
	A	0.016	0.032	46.05	2.52	0.016	0.016
LSD(0.05)	B	8.62	0.019	36.14	8.51	0.010	0.014
	AB	0.015	0.033	0.004	0.013	0.018	0.024

Table 6. Effect of the studied treatments on nutrients uptake of straw and seeds (kg/ fed) of broad bean plants

Nano P (ppm)	Nano K (ppm)	N (kg/fed)		P (kg/fed)		K (kg/fed)	
		Straw	Seeds	Straw	Seeds	Straw	Seeds
	0	8.23	5.77	1.38	0.993	8.31	3.17
0	150	14.82	26.00	1.91	2.65	16.41	14
	300	20.29	29.00	2.59	2.75	22.59	15.1
Means		14.45	20.26	1.96	2.13	15.77	10.76
	0	16.89	26.2	2.23	2.69	26.98	10.8
250	150	22.84	36.6	3.44	4.05	40.84	18.5
	300	32.12	41.7	4.22	4.45	48.83	19.7
Means		23.95	34.83	3.30	3.73	38.88	16.33
	0	25.61	39.5	4.08	4.36	39.80	17.8
500	150	35.97	47.1	6.69	5.18	56.04	21.8
	300	44.97	54.5	9.34	6.18	66.10	24.4
Means		35.52	47.03	6.70	5.24	53.98	21.33
Means of (K) treatments							
	0	16.91	23.82	2.56	2.68	25.03	10.59
	150	24.54	36.57	4.01	3.96	37.76	18.10
	300	32.46	41.73	5.38	4.46	45.84	19.73
Means		24.64	34.04	3.99	3.70	36.21	16.14
LSD(0.05)							
	A	1.59	1.64	0.23	0.19	1.89	0.66
LSD(0.05)	B	0.76	0.83	0.12	0.10	1.01	0.43
	AB	1.31	1.44	0.21	0.18	1.74	0.75

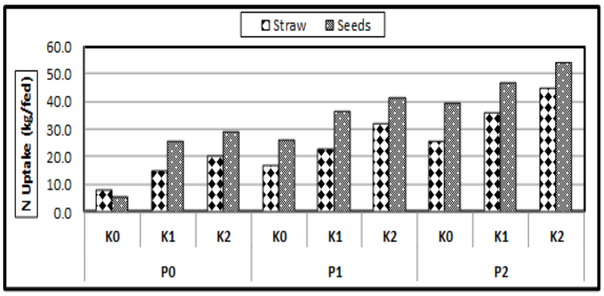

Fig. 5. Effect of the studied treatments on nitrogen uptake (kg /fed) of straw and seeds of broad bean plants.

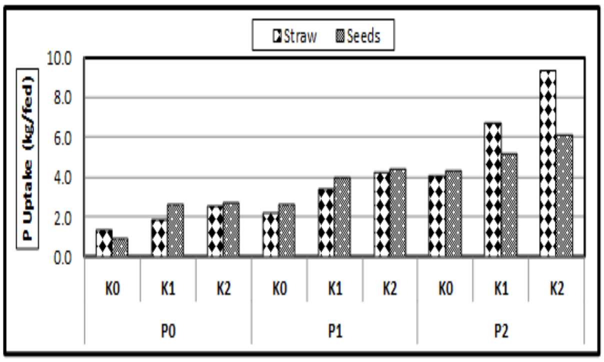

Fig. 6. Effect of the studied treatments on phosphorus uptake of straw and seeds of broad bean plants.

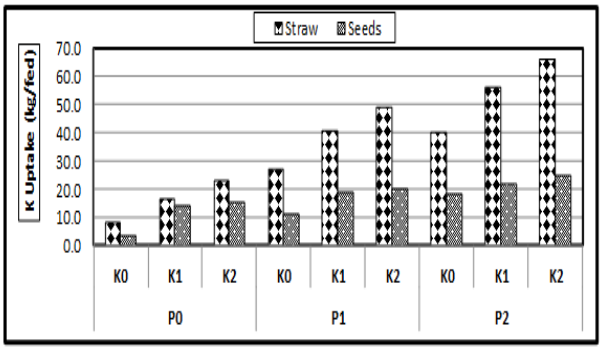

Fig. 7. Effect of the studied treatments on potassium uptake of straw and seeds of broad bean plants.

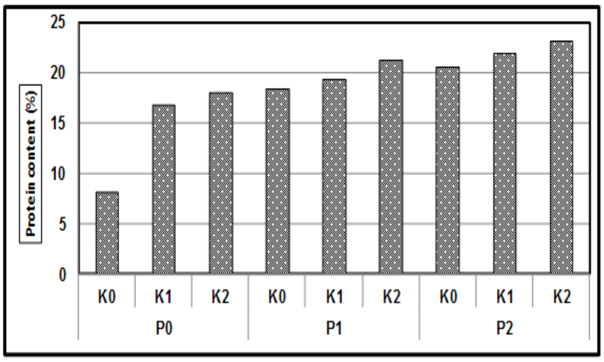

Fig. 8. Effect of the studied treatments on seeds protein of broad bean plants.

3- Available amounts of elements in soil after harvesting:

The sandy soil had a much lower exchange capacity and concentration of elements, such as N, P and K than heavier soils. They suffer from loss of elements by leaching. Data in Tables (8) showed that the studied available elements after harvesting reveal the flowing: addition of nano K+P fertilizers increased the extractable amounts of N, P and K through the studied season. Although, these increases had no arrived to adequate elements of Nitrogen, Phosphorus and potassium in soil after harvesting. So, it is important to fertilization with N , P and K at using the soils in cultivation, whereas Table (7) give an interpretation of the index values for P and K extracted by the AB- DTPA soil test (Soltanpour *et al.* 1979) and N by Jackson (1973).

Table 7. Index values of N, P and K according to (Soltanpour *et al.* 1979) and Jackson (1973).

Category	N (mg/kg soil)	P (mg/kg soil)	K (mg/kg soil)
Low	0 - 40	0 - 4	0 - 60
Marginal	40 -80	4 -7	60-120
Adequate	>80	>7	>120

The highest extractable amounts of Nitrogen, Phosphorus and potassium in soil after harvesting were 42.8 ppm for N, 4.5 ppm for P and 43.5 ppm for K at addition of highest level of P and K. With increasing foliar application of nano fertilizers of P and k, single or in combination increased the amount of Nitrogen, Phosphorus and potassium in soil after harvesting but not arrived to the adequate level to the following grown plants. In another words may be increase the nodules root which affected positively the fixing of atmospheric N in soil.

Table 8. Effect of the studied treatments on the available amount of N, P and K (ppm) after harvesting broad bean plants.

P rates (ppm)	K rates (ppm)	N	P	K
			(ppm)	
0	0	35.4	3.1	40.2
	150	35.8	3.2	41.3
	300	36.1	3.2	42.4
	Mean	35.77	3.2	41.3
250	0	36.1	3.5	40.1
	150	36.2	3.5	41.5
	300	36.7	4.1	41.6
	Mean	36.33	3.7	41.4
500	0	38.2	4.1	43.1
	150	40.6	4.3	43.3
	300	42.8	4.5	43.5
	Mean	40.53	4.3	43.3

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تأثير التسميد بالفوسفور والبوتاسيوم النانوى على الإنتاجية والمحتوى المعدنى للفول الرومى بشمال سيناء

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أقيمت تجربة حقلية على محصول الفول الرومى في فصل الشتاء 2019 وكان الهدف من التجربة هو دراسة تأثير رش الفوسفور والبوتاسيوم النانوى على نمو وإنتاجية الفول الرومى في الارض الرملية بمحطة بحوث بالوظه- شمال سيناء ، وكانت الاضافات بمعدل (صفر، 250، 500) ملجم فوسفور/ لتر والبوتاسيوم (صفر ، 150 ، 300) ملجم بوتاسيوم / لتر وتم الرش بعد 25 و50 و75 يوم من الزراعة. أظهرت النتائج ان هناك زيادة معنوية فى محصول الحبوب والقش وكذلك مكونات المحصول بزيادة معدل رش الفوسفور. كما تأخذ معدلات البوتاسيوم المضافة نفس السلوك حيث أعطى التركيز الثالث من الفوسفور والبوتاسيوم المضافين أعلى تأثير على الإنتاجية من التركيزات الاخرى. ولخصت النتائج أن أكثر المعاملات فاعلية في هذه الدراسة كانت إضافة 500 ملجم /لتر من الفوسفور مع 300 ملجم /لتر من البوتاسيوم النانوى، حيث أعطت تلك المعاملة 1,470 طن بذور/فدان من الفول و 2,457 طن من القش مقارنة بالمعاملات الاخرى. كما لوحظ أن أعلى تاثير للسماد الفوسفاتى والبوتاسى بالرش على محتوى القش والبذور كان مع اعلى معدل اضافه حيث أعطت أعلى قيم لتركيز عناصر النتروجين والفوسفور والبوتاسيوم وكذلك كانت الاكثر تاثيرا على قيم الممتص من تلك العناصر فى كل من القش والبذور. أدت زيادة الاضافة رشا من الفوسفور والبوتاسيوم النانوى سواء منفردة أو مجتمعة الى زيادة الميسرمن النتروجين والفوسفور والبوتاسيوم بعد الحصاد فى التربة ولكن لم يصل الى حد الكفاية للنباتات النامية لاحقا.