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THE EFFECT OF FOLIAR FERTILIZATION WITH NITROFOSKA AND SEED INOCULATION WITH SOME BIO-FERTILIZERS ON GREEN POD YIELD OF PEA (*Pisum sativum* L.)

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ABSTRACT:

Two field experiments were carried out in winter seasons of 2012/2013 and 2013/ 2014 to study the effect of foliar fertilizer with nitrofoska and treating seeds with bio-fertilizers , i.e. nitrobein and potassiomag on plant growth, chemical composition and green pod yield and its components, as well as, pod quality (pod physical characters and nutritive value of seeds) of pea cv. Lincoln.

The results showed that *foliar fertilization with nitrofoska and bio-fertilization with nitrobein increased most of plant growth traits, minerals content of shoots (N,P and K as a concentration), yield and its components, as well as physical pod characters and nutritive value of seeds (N, P, K contents, protein, ascorbic acid, TSS and total carbohydrates), followed by nitofoska + potassiomag, then nitofoska + nitrobein+potassiomag, respectively, in most cases.*

Conclusively, it could be concluded that the combination treatment between nitrofoska and nitrobein, followed by nitrofoska and potassiomag , as well as, nitrofoska + nitrobein + potassiomag, respectively, enhancing the most studied characters of peas.

Key words: Nitrofoska , nitrobein, potassiomag, pea (*Pisum sativum* L.).

INTRODUCTION

Pea (*Pisum sativum* L.) is a favorable vegetable crop owing to its richness in nutritional protein.

During the last few years, many workers have tried to improve the productivity of green peas without NPK application to the soil. So, attempts were done for solving problems of chemical fertilizers when added to the soil, by using foliar application with complete Fertilization and some bio fertilizers.

Some investigators reported that foliar fertilization increased plant growth, chemical composition and green pod yield and its quality of legumes

crops (Ghanem, 1989 on soybean; Mohamed *et al*., 1999 on pea; Hassan *et al.*, 2002 and Ahmed *et al.*, 2003 on snap bean).

In addition, the growth of leguminous plants, dry matter content , chemical composition and pod yield and its quality increased by bio- fertilizers soil application (Abo El-Nour *et al.*, 1996 using phosphorein on faba bean; Abou El-Salehein *et al.*, 2004 using rhizobacterein + phosphorein on peas; Abou El-Salehein *et al.*, 2005 using rhizobacterein +phosphorein + dry yeast on pea. Also, Abou El-Salehein *et al*., 2009 using (okadein containing of rhizobium) + dry yeast on peas.

Therefore, the aim of the present study was to obtain the highest pea yield with less soil pollution resulting from chemical fertilizers by foliar application of nitrofoska and inoculation the seeds with nitrobein and potassiomag as a bio-fertilizers.

MATERIALS AND METHODS:

The experiment of this study was carried out during the two success-sive winter seasons of 2012/2013 and 2013/2014 at private farm in Zawia zone, Libya. The soil was sandy in texture. The soil and water irrigation chemical constituents are presented in Tables, 1 and 2.

Table (1): Soil chemical analysis of the experimental soil.

Characters	Values
Available nitrogen	86 ppm
Available potassium	112 ppm
Available phosphorus	20 ppm
Organic matter	0.07 %
pH	7.4
CEC (Cation exchange Capacity)	21.0 (mg/ 100g.soil)

Table (2) : Chemical constituents of irrigation water.

Characters		Values
Total salts	(ppm)	1550
Sodium	(%)	60
Ca^{++}	meg/l	17.0
Mg^{++}	meg/l	18.0
Na^{+}	meg/l	17.5
K^{+}	meg/l	2.1
SO_4^{--}	meg/l	4.4
Cl^{-}	meg/l	8.1
HCO_3^{-}	meg/l	3.2
B^{---}	meg/l	3.2
EC	(dS/m)	6.0

The soil was prepared and pea seeds cv. Lincoln were inoculated with nitrobein and potassiomag.

Inoculated pea seeds were sown on the 2nd of November on the two sides of the rows in both growing seasons; 2012 and 2013, respectively.

The plot area in the experiment was 5.4 m^2 (3 ridges with 3 meters length and 60 cm width). The distance between plants was 20cm. One ridge was left between each two plots as a guard ridge.

The experiment included 8 treatments as follows:

1- control (without any addition).
2- Foliar spray with nitrofoska fertilizer at 1% (5kg/hectare).
3- Nitrobein (400g./hectare): as a source of nitrogen fixing bacteria, i.e. *Azolobacter* spp + *Azospirillium* spp.
4- Potassiomag (600g/hectare): as a source of potassium dissolving bacteria, i.e *Pseudomonas* spp.
5- Nitrofoska + nitrobein.
6- Nitrofoska + potassiomag.
7- Nitrobein + potassiomag.
8- Nitrofoska + nitrobein + potassiomag.

These treatments were arranged in a randomized complete blocks design system (RCBD) with three replicates. Nitrofoska fertilizer was used as foliar spray and applied at 15 and 25 days after sowing.

The analysis of nitrafoska fertilizer (COMPO Iberia Company, Barcelona, Spain) is shown in Table (3).

Table (3) : The chemical analysis of nitrafoska fertilizer

Elements	**Values (%)**
Total Nitrogen	15
Phosphorus (P_2O_5)	30
Potassium (k_20)	15
Boron (B)	0.036
Cupper (cu) EDTA	0.03
Iron (Fe)EDTA	0.08
Manganese (Mn)EDTA	0.08
Molybdenum (Mo)	0.002
Zinc (Zn) EDTA	0.03

Nitrobein and potassiomag, were obtained from the Department of Microbiology, Agricultural Research Centre , Giza, Egypt. The recommended dose was added as shown in enclosed sheet. The normal treatment of growing pea were practiced as usually followed in the commercial production of green pod yield. Sprinkler irrigation system was used.

Collected data of this experiment were recorded as follows:

I- Plant growth parameters:

Sample of 5 plants were randomly taken from every experimental unit at 45 days from sowing. Plant height, number of branches, number of leaves, fresh and dry weight of branches, leaves and whole plant were determined.

II- Chemical composition of pea plants:

The concentration of N, P and K were determined in random sample from pea shoots at 45 days from sowing after digestion. Nitrogen and phosphorus were determined according to A. O. A. C. (1999), and potassium was determined using the method described by Jackson (1967).

III- Green pod yield and its components:

At harvest time (75 days from sowing);number of pod/plant, average pod weight (g) and total green pod yield/hectare (ton) were measured.

IV- Pod and seed quality:

a- **Pod quality**: pod length (cm), pod width (cm) and pod diameter (cm) were measured at the final harvest(75 days from sowing).

b- **Seed quality**: average fresh weight of seeds/pod (g), dry weight of seeds/pod (g), number of seeds/ pod and 100 seed weight(g). As well as, the nutritional value of the seeds: N, P, K concentrations were determined by the same methods as previously mentioned in chemical composition of shoots, protein % was determined by multiplying N-values by 6.25, acorbic acid (mg/100g. F.W.) was determind by the method described by Mattk (1970), TSS (total soluble solids) was determined with Carl Zeiss hand refractometer, and total carbohydrates % in dry weight was determined by Michel *et al.* (1956).

Statistical analysis:

Collected data were subjected to statistical analysis of variance according to Snedecor and Cochaan (1980), and treatments means were compared using LSD (least significant difference at 0.05 level of probability.

RESULTS AND DISCUSSION:

Vegetative growth:

Data in Tables (4 and 5) indicate that all the studied treatments had different significant effect on most studied of vegetative growth characters of pea plants expressed as plant height, number of branches, number of leaves, fresh weight of both branches and leaves, and dry weight of both branches and leaves, as will as, total dry weight compared to control.

Table 4. Effect of nitrofoska, nitrobein and potassiomag, and its combinations on vegetative growth of pea plant.

Treatments	Plant height (cm)		Number of branches/plant		Number of leaves/plant	
	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
Control	33.0	36.0	1.7	1.6	13	14
Nitrofoska	35.1	39.0	2.4	2.5	15	15
Nitrobein	34.1	36.9	2.2	2.2	13.9	13.8
Potassiomag	33.9	36.3	2.0	2.1	13.5	14.2
Nitrofoska + Nitrobein	38.0	42.0	2.9	3.0	19	18
Nitrofoska + Potassiomag	36.0	41.0	2.7	2.8	18	17
Nitrobein + Potassiomag	44.5	37.0	2.3	2.4	14	14.6
Nitrofoska + Nitrobein + Potassiomag	35.7	40.0	2.5	2.7	17	16
LSD (0.05)	**1.02**	**1.01**	**0.1**	**0.1**	**1.2**	**1.4**

Application of nitrofoska + nitrobein and nitrofoska + potassiomag and/or nitrofoska +nitrobein + potassiomg, respectively, were the most effective treatments in this respect in the two growing seasons.

As the role of nitrofoska fertilizer in pea plant which contains macro and micro elements, i.e. N, P, K, B, Cu, Fc, Mn, Mo and Zn , Edmond *et al.*, 1981, concluded that nitrogen is an indispensable elementary constituent of numerous organic compounds of general importance (amino acids, protein, nucleic acids) and it is needed in the formation of protoplasm and new cells . Moreover, Bidwell (1979) illustrated that phosphorus plays a vital role in the enzyme system for the energy transform in photosynthesis and respiration. It is also a constituent of cell nucleus and essential for cell division and for the development of meristem tissues.

Concerning the role of potassium, Edmond *et al.*, (1981) stated that potassium is the prevalent cation in plant and may be involved in maintenance of ionic balance in cells and it bounds ionically to the enzyme pyruvate kinase, which is essential in respiration and carbohydrates metabolism. Moreover, it has a beneficial effect of water consumption.

As the role of microelements in plants, Mengel and Kirkby (1982) concluded that iron, promotes green color; manganese, promotes plant maturity; zinc, regulates plant growth, and sons umplion of sugar; copper, important for reproductive growth; boron, essential for root to absorption

the other nutrients and molybdenum, helps with reduction of nitrates for protein synthesis.

Regarding the effect of bio-fertilizers, *i.e.*, nitrobein and potassiomag on increasing growth plant, Subba Rao (1993) reported that nitrobein can be defined as preparations containing live cells of efficient strains of nitrogen fixing, i.e. *Azotobacter* and *Azospirillum* which accelerating certain microbial process to augment the extent of form can be easily assimilated by plants. As well as, potassiomag that contains *Pseudomonas* sp. which have the ability to dissolve the K nutrient and supply the grown plants with K many microelements and phytohormones that increase the plant growth.

Obtained results are conifirmed with the results obtained by Ghanem, 1989 ; Mohamed., 1999 and Ahmed *et al.,* 2003 using foliar fertilization on soybean, broad bean, pea and snap bean, respectively. As well as, Abo El-Nour *et al.,* 1996; Abou El-Salehein *et al.,* 2004, 2005 and 2009 and Sharaf *et al.,* 2013 on faba bean, pea and onion, respectively.

Chemical composition of pea plants :

All tested treatments had an effect on N, P and K contents in pea plants (Table 6). In this respect, the highest values of N, P and K content % were obtained with the combination between nitrofoska and nitrobein, followed by the combination between nitrofoska and potassomag, then nitrofoska + nitrobein + potassomag , respectively in most cases in both growing seasons.

The application of nitrofoska, which containing many elements may increase the accumulation of these elements in the cells of plant, and consequently, the bioactive of nutrients increases (Mengel and Kirkby, 1978).

The bio fertilizers, i.e. nitrobein and potassiomag containing micro organisms which have the ability to dissolve of fix air N_2 and supply the grown plants with N , P and K macro elements and phytohormones that increase the dry matter accumulation and in turn these elements concentration in plant tissues (Abd-Alla *et al*.,2000).

Similarly results were obtained by Mohamed *et al.,* 1999 and Ahmed *et al.,* 2003, using foliar fertilization on pea and snap bean, respectively and Abou El-Salehein *et al.,* 2009 and Sharaf *et al.,* 2013 using biofertilizaers on pea and onion, respectively.

Green pod yield and its components :

Data in Table (7) revealed that all the studied treatments significantly increased pod yield and its components of pea in both growing seasons compared with the control treatment. The combination treatment of nitrofoska and nitrobein, being the most effective on pod yield and its components, *i.e.* number of pods/plant, average pod weight , and total green

Table (6). Effect of nitrofoska, nitrobein and potassiomag, and its combinations on chemical composition of pea plants.

Treatments	N %		P %		K %	
	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
Control	3.17	3.75	0.273	0.279	1.53	1.57
Nitrofoska	3.96	4.03	0.287	0.301	1.77	1.31
Nitrobein	3.87	3.89	0.281	0.289	1.67	1.69
Potassiomag	3.75	3.81	0.279	0.281	1.63	1.65
Nitrofoska + Nitrobein	4.10	4.15	0.310	0.315	1.91	1.93
Nitrofoska + Potassiomag	4.07	4.12	0.303	0.311	1.85	1.87
Nitrobein + Potassiomag	3.90	3.97	0.281	0.288	1.70	1.75
Nitrofoska + Nitrobein + Potassiomag	4.01	4.10	0.291	0.307	1.80	1.83
LSD (0.05)	**0.03**	**0.02**	**0.003**	**0.003**	**0.03**	**0.04**

Table (7) : Effect of nitrofoska, nitrobein and potassiomag and its combination on yield and its components of peas.

Treatments	Number of pods/plant		Average pod weight (g)		Total green pod yield (ton)/ha	
	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
Control	5.10	5.17	15.22	15.19	10.55	10.49
Nitrofoska	6.47	7.12	17.39	17.49	16.45	15.86
Nitrobein	6.37	6.74	16.29	17.14	13.49	13.35
Potassiomag	6.25	6.39	16.17	17.10	12.63	11.79
Nitrofoska + Nitrobein	8.11	7.96	18.81	18.75	20.53	19.83
Nitrofoska + Potassiomag	7.87	7.86	18.76	18.66	18.35	18.03
Nitrobein + Potassiomag	6.41	6.85	16.21	17.45	14.37	14.35
Nitrofoska + Nitrobein + Potassiomag	7.63	7.74	18.57	17.57	17.59	17.50
LSD (0.05)	**0.83**	**0.75**	**0.03**	**0.02**	**0.87**	**0.83**

pod yield/hectare, as well as, pod quality , *i.e.* pod length, pod width and pod diameter. This effective treatment in its effect on yield and yield components, followed by the combination between nitrofoska and potassiomag, in most cases, in both growing seasons. On the other hand, the control treatment was recorded the lowest values in green pod yield and its quality.

The superiority in green pod yield of pea and quality by application of Nitrofoska + nitrobein + potassiomag treatment directly owing to the increase in number of pod/plant and average pod weight (Table 7), and also, this might be due to the favourable effect of such treatment on vegetative growth (Table 4) dry weight (Table 5)and total nutrients contents (Table 6), which may increase the efficiency of photosynthetic capacity and this in turn resulted in more number of pods/plant and accumulation of stored food in pea pods.

These results are coincided with those of Ghanem, 1989, Hassan *et al.*, 2002, who using fertilizers on soybean and snap bean, respectively, and , Abou El-Salehein *et al.,* 2004 and 2009, who using biofertilizers on pea.

Seed quality and the nutritional value of pea seeds:

a) Seed quality

Data given in Tables (8 and 9) revealed that, seed quality of pea, i.e. fresh weight of seeds/ pod, dry weight of seeds/ pod, number of seeds/pod responded significantly to nitrofoska and nitrobein as well as, nitrofoska and potassiomag and also to the triple combination treatment of nitrofoska, nitrobein and potassiomag. It is worthy to notice that similar trend was observed during both growing seasons of the experiment.

These results were agreed with those obtained by Mohamed *et al.,* 1999 and Ahmed *et al.,* 2003 on pea and snap bean using the foliar fertilizers also, Abou El-Salehein *et al.,* 2009 came to similar results with biofertilizers on pea.

***b) The nutritive values of pea seeds*:**

Data presented in Tables (9 and 10) reveal that the nutritive values of pea seeds, i.e. N , P , K , protein, ascorbic acids, TSS and total carbohydrates were significantly affected by nitrofoska and nitrobein as well as, nitrofoska and potassiomag and also to the triple combination treatment of nitrofoska, nitrobein and potassiomag , respectively. compared with control treatment.

Such results may be due to the favorable effect of the combination treatment of nitrofoska and nitrobein on vegetative growth (Tables 4 and 5) , higher N, P and K content of shoots (Table 6) and resulted in the highest green pod (Table 7).

Table (8) : Effect of nitrofoska, nitrobein and potassiomag and its combination on dry weight of seeds and pea pod quality.

Treatments	Fresh weight of seeds/pod (g)		Dry weight of seeds/pod (g)		Pod length (cm)		Pod width (cm)	
	2012/ 2013	2012/ 2013	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
Control	5.07	5.10	0.81	0.82	8.19	8.10	1.26	1.34
Nitrofoska	6.37	7.10	1.12	1.07	9.27	9.25	1.51	1.54
Nitrobein	6.15	6.75	1.01	1.00	9.10	9.05	1.39	1.38
Potassiomag	6.07	6.57	0.99	0.89	8.87	8.90	1.36	1.38
Nitrofoska + Nitrobein	7.70	7.66	1.25	1.22	9.53	9.44	1.71	1.69
Nitrofoska + Potassiomag	7.67	7.53	1.22	1.17	9.44	9.37	1.66	1.67
Nitrobein + Potassiomag	6.05	7.01	1.09	1.05	9.12	9.15	1.45	1.45
Nitrofoska + Nitrobein + Potassiomag	7.51	7.39	1.15	1.13	9.31	9.30	1.59	1.60
LSD (0.05)	**0.02**	**0.06**	**0.03**	**0.03**	**0.01**	**0.02**	**0.01**	**0.01**

Table (9): Effect of nitrofoska, nitrobein and potassiomag and its combination on seed quality and nutritive valueof pea seeds.

Treatments	Number of seeds/pod		N % in seeds		Protein in seeds %	
	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014	2012/ 2013	2013/ 2014
Control	6.75	6.71	3.17	3.22	19.81	20.25
Nitrofoska	7.87	8.10	3.36	3.40	21.00	21.25
Nitrobein	7.46	7.22	3.30	3.32	20.63	20.75
Potassiomag	7.15	7.10	3.28	3.30	20.50	20.63
Nitrofoska + Nitrobein	8.57	8.47	3.48	3.46	21.75	21.63
Nitrofoska + Potassiomag	8.43	8.36	3.45	3.43	21.56	21.44
Nitrobein + Potassiomag	7.69	7.59	3.33	3.37	20.81	21.06
Nitrofoska + Nitrobein + Potassiomag	8.17	8.11	3.40	3.42	21.25	21.38
LSD (0.05)	**0.29**	**0.10**	**0.05**	**0.02**	**0.11**	**0.09**

Obtained results are in harmony with those reported by Hassan *et al.*, 2002 and Ahmed *et al.*, 2003 on snap bean using foliar spray of fertilizer and Abou El-Salehein *et al.*, 2005 using bio fertilizer on pea.

Conclusively, it could be concluded that the combination treatment between nitrofoska and nitrobein, followed by nitrofoska and potassiomag , as well as, nitrofoska + nitrobein + potassiomag, respectively, enhancing the most studied characters of peas.

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تأثير التسميد بالرش بالنتروفوسكا ومعاملة البذور ببعض الأسمدة الحيوية على محصول القرون الخضراء للبسلة.

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الملخص :

أجريت تجربتان حقليتان خلال موسمي شتاء 2013/2012، 2014/2013 لدراسة تأثير التسميد بالرش بالنتروفوسكا ومعاملة البذور بالسمادين الحيويين النتروبين والبوتاسوماج على نمو النبات ، المحتوى الكيميائي ، ومحصول قرون البسلة ومكوناته، وكذلك جودة المحصول (صفات القرون الفسيولوجية والقيمة الغذائية للبذور) لصنف البسلة لنكولن .

أوضحت النتائج أن التسميد بالرش بالنتروفوسكا مع معاملة البذور بالسماد الحيوي النتروبين قد أعطوا زيادة فى معظم صفات النمو الخضرى ، المحتوى الكيماوى للأوراق من النتروجين ، الفوسفور ، البوتاسيوم كنسب مئوية ، محصول القرون ومكوناته ، وكذلك الصفات الفسيولوجية للقرون والقيمة الغذائية للبذور والمتمثلة فى محتوى البذور من النتروجين ، الفسفور ، البوتاسيوم ، البروتين ، حمض الاسكوربيك ، المواد الذائبة الكلية والكربوهيدرات الكلية ، متبوعة بمعاملتي النتروفوسكا + البوتاسيوماج ؛ النتروفوسكا + النتروبين + البوتاسيوماج ، علي الترتيب في معظم الحالات.

التوصية: يوصي باستخدام سماد النتروفوسكا مع معاملة البذور بالسماد الحيوي النتروبين أو البوتاسيوماج ، أو كلاهما معا للحصول علي أعلي القيم في معظم صفات البسلة.