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Effect of Inoculation with Phosphate and Potassium Dissolving Bacteria on Growth, Yield, and Seed Quality of Pea (*Pisum Sativum* L.)

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TWO FIELD experiments were conducted during winter seasons of 2006/2007 and 2007/2008 at Kaha (Kalyiobia Governorate) Horticulture Research Station, Egypt. The present investigation was initiated to study the effect of two types of bio-fertilizers *i.e.*, Phosphorin and Potassiumag (used as phosphorus and potassium releasing bacteria, respectively) when applied along with different rates of mineral phosphorus and potassium on vegetative growth, yield, yield components and seed quality of pea plants. This work aims to find out the appropriate application of P and K fertilizers with bio-fertilizers to minimize the abuse of chemicals on the environment. All the studied traits of seed yield and its components were affected by the fertilization treatments except of pod length and no. of seeds / pod in both seasons. Generally, it was found that effect of fertilization treatments on vegetative growth, yield, yield components and seed quality differed as fertilizer levels differ. The inoculation of pea seeds with both bio-fertilizers; phosphorin and potassiumag and application of P and K mineral fertilizers at 30 kg P_2O_5/fed and 34 kg K/fed (⅔ of the recommended dose), was found to be the best fertilization treatment respectively. This treatment surpassed the other fertilization treatments for the most studied traits of vegetative growth, yield, yield components and seed quality of pea plants in both seasons. Therefore, it could save ⅓ of the recommended dose of P and K mineral fertilizers (about 15 Kg P_2O_5/fed and 17 kg K/fed) by using the bio-fertilizers; phosphorin and potassiumag.

The application of biofertilizers to the cereal and legume plants has been a subject for comprehensive discussions and studies in the recent years. This is mainly due to increased prices of mineral fertilizers which also considered injurious to the environment. These findings revived the interests of microbiologists for manipulating phosphorus and potassium (silicate) dissolving and/ or releasing bacteria to enhance their uptake by plants. These microorganisms are known to play an essential role in mobilizing nutrients (fertilizers) from non-available sources and hence reduce the application of mineral fertilizers. To achieve these benefits, there is a need for more field trials to gain the desired impact of biofertilizer application. In this investigation, we selected pea as a module plant to emphasis the positive effect of biofertilizers

application because peas constitute a highly nutritious article of diet due to its richness in large quantity of nitrogenous materials in addition to starch, protein, fiber and sugar. Peas are cultivated for the fresh green seeds, tender green pods, dried seeds and foliage (Duke, 1981). Green peas are eaten cooked as a vegetable, and are marketed fresh, canned, or frozen while ripe dried peas are used whole, split, or made into flour (Davies *et al.*, 1985).

Several authors showed high performance of legume plants after application of phosphorin (commercial name of phosphate dissolving bacteria) application as a biofertilizer. Concerning this matter, a field experiment was conducted by Ahmed *et al.* (2003) to study the effect of phosphorin and other mineral or organic fertilizer on the growth and yield of faba bean, chickpea and lupine. They found that treatment with biofertilizer (as phosphorin) and chemical fertilizer resulted in the highest increases in weight of pods per plant, weight of seeds per plant, weight of straw per plant, 100-seed weight, seed yield, straw yield and seed protein yield. In addition, inoculation of soybean with phosphate solubilizing microorganisms resulted in significant increases in plant height, dry matter, nodulation, N and P uptake, and grain yield in comparison to the uninoculated treatment (Paratey and Wani, 2005). Youssef (2007) found that inoculation of pea seed with phosphate solubilizing bacteria *i.e.*, pdosphorin either alone or in combination with other biofertilizers gave the highest vegetative growth expressed as plant height, number of leaves, fresh and dry weight / plant as compared to untreated plants.

Soil potassium sometimes exist in non-exchangeable or bounded form and is released slowly, thus it is usually unavailable for uptake by plants. This finding emphasized the need to work on certain types of microorganisms (bacteria) which can release it in an available form. In Egypt, some studies were conducted on this group of bacteria (potassium dissolving bacteria, potassiumag as a commercial name) which were mainly concentrated on their K releasing capacity along with their effects on growth and K uptake of the treated plants. In a trial conducted by Balabel (1997) there were positive responses of broad bean to inoculation with some species of *Bacillus* (K releasing bacteria). These positive responses were observed in growth (dry weight of shoot and root, number and dry weight of nodules), nitrogenase activity, N, P, K contents of leaves, number as well as dry weight of pods, seed and straw yield. Moreover, some selected *Bacillus* species can be used as bio-accelerator for compost production to be applied in the field to enhance plant growth. Application of this kind of compost gave highly significant effect on all growth parameters tested on potato or broccoli (Mohamed 2006). This positive value refers as: weight of

tubers or fruits/ plant, total weight of tubers or fruits and NPK contents of potato tuber and broccoli fruits.

The present investigation was initiated to study the effect of two types of bio-fertilizers *i.e.*, phosphorin and potassiumag (used as phosphorus and potassium releasing bacteria, respectively) when accompanied with different rates of mineral phosphorus and potassium fertilizers on growth, yield, and seed quality of pea plants and its components to find out the best rate of mineral P and K fertilizers along with bio-fertilizers to minimize the injurious effects when minerals P and K are used.

Material and Methods

Pure lot of pea seeds (*Pisum sativum* L.) variety Master pea was obtained from the Vegetable Crops Seed Production and Technology Department, Horticulture Research Institute, Agriculture Research Center, Egypt. Two field experiments were conducted during winter seasons of 2006/2007 and 2007/2008 at Kaha (Kalyiobia govemorate) Horticulture Research Station, Egypt. The physical and chemical properties of the soil are presented in Table 1.

TABLE 1. Some physical and chemical analyses of the experimental soil.

Soil properties	2006/2007	2007/2008
Soil texture	Clay loamy	Clay loamy
pH	8.9	8.4
E.C. (dS/m)	0.7	1.0
Available N (mg/l)	120	195
Available P (mg/l)	5.0	5.9
Available K (mg/l)	521	435
Organic matter (%)	0.49	0.60

The experiments were laid out in a randomized complete block design with three replications. Ten fertilizer treatments of mineral P and K fertilizers and two types of bio-fertilizers *i.e.*, phosphorin and potassiumag (used as phosphorus and potassium releasing bacteria, respectively) were as follows:

1)Phosphorin + Potassiumag only, without mineral fertilizer
2) Phosphorin + Potassiumag + 15 kg P/fed + 17 kg K/fed.
3) Phosphorin + Potassiumag + 30 kg P/fed + 17 kg K/fed.

4) Phosphorin + Potassiumag + 15 kg P/fed + 34 kg K/fed.
5) Phosphorin + Potassiumag + 30 kg P/fed + 34 kg K/fed.
6) No Phosphorin + Potassiumag + 45 kg P/fed + 17 kg K/fed.
7) No Phosphorin + Potassiumag + 45 kg P/fed + 34 kg K/fed.
8) Phosphorin + no Potassiumag + 15 kg P/fed + 51 kg K/fed.
9) Phosphorin + no Potassiumag + 30 kg P/fed + 51 kg K/fed.
10) 45 kg P/fed + 51 kg K/fed without bio-fertilizers.

Phosphorin and potassiumag were produced by general organization for Agricultural Equalization Fund, Ministry of agriculture, Egypt. The carriers used were peatmoss, charcoal and vermiculite. Mineral fertilizers of both phosphorus and potassium were added as ⅓ (15 kg P/fed, 17 kg K/fed) or ⅔ (30 kg P/fed, 34 kg K/fed) or all (45 kg P/fed, 51 kg K/fed) of recommended dose.

Pea seeds were inoculated just before sowing with bio-fertilizers. Phosphorus was added as super phosphate (15.5% P_2O_5) during seedbed preparation. Potassium was added as potassium sulphate (48% K_2O) and nitrogen, at a rate of 30 kg N/fed., was added as ammonium sulphate (20.6% N). Both of fertilizers were divided into two equal doses, the first dose was applied after 21 days from sowing and the second one was added at the beginning of flowering stage. Sowing was done on 15th October during the two successive seasons of the present work. The seeds were planted 15 cm apart in a single row. Each row was 3 m long and 0.6 m wide. Each plot contains 5 rows. Thus, the area of each plot was 9 m^2. Other cultural practices were carried out as recommended for the conventional pea planting.

Measurements

Vegetative growth characters

The following growth attributes were measured at the end of flowering stage, using ten random plants from each treatment: plant height (cm), number of branches/plant, number of leaves/plant, plant fresh weight (g) and plant dry weight (g).

Seed yield and its components

At harvest, samples of ten random plants from each treatment were used to record the following characters: pod length (cm), number of pods/plant, number of seeds/pod, pods weight/plant (g), seeds weight/plant (g), and total seed yield (kg/plot).

Chemical contents

At the end of flowering stage, top fourth leaf from 10 random plants were picked up and washed by distilled water for the quantitative determination of chlorophyll and carotenoids according to Metzner *et al.* (1965) colorimeterically. Mineral and sugars concentrations were determined as mg/100 g in dry seeds. Total nitrogen was determined according the method described by Pregl (1945) using micro-Keldahl apparatus. Phosphorus was estimated colorimetrically according to the method described by Murghy and Riley (1962) as modified by John (1970). Potassium was determined flame-photometrically as described by Brown and Lilleland (1946). The method used for the quantitative determination of soluble reducing, non-reducing, and total sugars was that of Blakeney and Mutton (1980).

Seed quality

Three random samples (100 seeds each) were used from each treatment for calculating the following records; weight of 100 seeds (g), germination percentage (%), germination rate, seedling and root length (cm), and fresh and dry weight of seedling (g). Germination rate was calculated according to Edmond and Drapala (1958) as following;

$$\text{Germination rate} = \frac{(G1 \times N1) + (G2 \times N2) + \ldots\ldots\ldots\ldots (Gn \times Nn)}{G1 + G2 + \ldots\ldots\ldots\ldots Gn}$$

Where: G = Number of germinated seeds in certain day, N = Number of this certain day

Statistical analysis

All the collected data were tabulated and statistically analyzed using the analyses of variance method as reported by Snedecor and Cochran (1980). Duncan's multiple range at 5% level of probability was calculated to compare between means, as shown by Dospekhov (1984).

Results and Discussion

Effects of mineral and bio-fertilizers levels on vegetative growth characters of pea

The highest means values of vegetative growth characters of pea were observed for the fertilizer treatment no. (5), which consists of 30 kg P/fed, 34 kg K/fed. and the bio-fertilizers; phosphorin and potassiumag, in both seasons (Table 2). There were no significant differences between treatment no. (5) and the fertilization treatment no. (7) for all characters, and fertilization treatments no. (9) and (10) for plant height, number of branches/plant, and foliage dry weight / plant in 2006/2007 season. But, in 2007/2008 season, there were no

These results are in agreement with those obtained by El-Beheidi *et al.* (2005), Soubeih (2005) and Youssef (2007) during their investigation of growth and uptake of nutrients in pea.

Effects of mineral and bio-fertilizers levels on the chemical contents of pea

The fertilization treatment no. (5) surpassed the other fertilization treatments and gave the highest mean values for all the evaluated chemical contents in both seasons (Table 4). However, there were no significant differences between this fertilization treatment and fertilization treatments no. (7), (9), and (10) in the first season and fertilization treatments no. (3), (7), (8), (9), and (10) in the second season for N content in pea seeds. These results suggested that inoculation of pea seeds with both bio-fertilizers; phosphorin and potassiumag and application of P and K mineral fertilizers at 30 kg P_2O_5/fed. and 34 kg K/fed., respectively (fertilization treatment no. 5) was the best fertilization treatment in both seasons. The promotive effect of P on photosynthetic pigments could be due to its importance in enzymatic system necessary for energy transformation in photosynthesis as well as its role in developing meristematic tissues (Bielesky, 1973). This positive effect of biofertilizer application on the formation and content of photosynthetic pigments of pea leaves are similar to those reported by of Soubeih (2005), El-Beheidi *et al.* (2005), Mansour (2006) and Youssef (2007). They recorded that the inoculation of pea seeds with biofertilizer significantly increased photosynthetic pigment content of leaves. Also, they reported that addition of biofertilizers significantly increased sugars and NPK contents of pea seeds. Moreover, potassium has many essential functions in the nutrition of plant. It is specifically important for many vital processes in the plant like photosynthesis, protein synthesis and translocation of sugars (Balabel, 1997).

Effects of mineral and bio-fertilizers levels on quality of pea seeds

The fertilization treatments no. (5), (7) and (9) had the same effect on 100 seeds weight, germination rate, root length, and dry seedling weight, and surpassed the other fertilization treatments in the first season (Table 5). However, in the second season, the fertilization treatment no. (5) compensated to the fertilization treatment no. (7) and gave the highest means values for germination rate, root length, fresh and dry seedling weights. Generally, the fertilization treatment no. (5) was the best and gave the highest means values for all seed quality characteristics in both seasons. These findings resulted from the favorable effect of bio-fertilizers on growth attributes (Table 2) and seed yield and its components (Table 3). These effects may be attributed to; 1) the role of bio-fertilizer in increasing uptake of N, P, K and Mg as reported by Ragab (1998), 2) the role of bio-fertilizer in increasing the promotive plant growth substances like IAA, GA_3, and CKs which promote plant growth, cell division, encourage the photosynthesis and assimilates accumulation (Said, 1998), 3) the effect of bio-fertilizer in releasing phosphorus which plays an important role in plant growth improvement.

TABLE 3. Effects of mineral and bio-fertilizers levels on seed yield and its components of pea during 2006/2007 and 2007/2008 winter seasons.

TABLE 3. Effects of mineral and bio-fertilizers levels on seed yield and its components of pea during 2006/2007 and 2007/2008 winter seasons.

Fertilizers levels	Pod length (cm)	No. of pods / plant	No. of seeds / pod	Pods weight / plant (g)	Seeds weight / plant (g)	Seed yield / plot (kg)
2006/2007 season						
1) Phosphorin (Ph) + potassiumag (Po)	9.2 a	7.3 b	9.0 a	11.95 c	7.97 c	9.74 bc
2) Ph + Po + 15 kg P + 17 kg K / fed	9.6 a	7.3 b	9.0 a	12.07 c	8.83 bc	10.79 c
3) Ph + Po + 15 kg P + 34 kg K / fed	9.7 a	7.6 b	9.0 a	12.08 c	9.11 bc	11.14 c
4) Ph + Po + 30 kg P + 17 kg K / fed	9.9 a	8.3 a	9.2 a	12.12 c	9.30 b	11.37 bc
5) Ph + Po + 30 kg P + 34 kg K / fed	9.9 a	8.7 a	9.7 a	14.13 a	11.95 a	14.61 a
6) Po + 45 kg P + 17 kg K / fed	9.2 a	7.3 b	9.2 a	12.16 c	9.49 b	11.60 bc
7) Po + 45 kg P + 34 kg K / fed	9.9 a	8.4 a	9.5 a	12.29 c	11.76 a	14.38 a
8) Ph + 15 kg P + 51 kg K / fed	9.9 a	8.3 a	9.2 a	12.31 c	9.40 b	11.48 bc
9) Ph + 30 kg P + 51 kg K / fed	9.9 a	8.4 a	9.3 a	12.45 c	10.82 a	13.23 ab
10) 45 kg P + 51 kg K / fed	9.9 a	8.5 a	9.3 a	13.38 b	10.73 a	13.11 ab
2007/2008 season						
1) Phosphorin (Ph) + potassiumag (Po)	9.2 a	6.8 e	9.0 a	14.25 e	7.38 d	8.12 c
2) Ph + Po + 15 kg P + 17 kg K / fed	9.2 a	7.6 de	9.0 a	15.98 d	7.89 d	8.68 c
3) Ph + Po + 15 kg P + 34 kg K / fed	9.5 a	9.2 c	9.5 a	16.41 c	10.29 c	11.31 b
4) Ph + Po + 30 kg P + 17 kg K / fed	9.5 a	10.4 b	9.1 a	16.59 c	10.79 b	11.87 b
5) Ph + Po + 30 kg P + 34 kg K / fed	10.1 a	11.6 a	9.9 a	18.21 a	13.59 a	14.95 a
6) Po + 45 kg P + 17 kg K / fed	9.3 a	10.2 b	9.7 a	16.62 c	10.89 b	11.97 b
7) Po + 45 kg P + 34 kg K / fed	9.7 a	11.0 ab	9.7 a	16.92 bc	12.91 a	14.20 a
8) Ph + 15 kg P + 51 kg K / fed	9.5 a	8.0 d	9.5 a	17.04 b	10.18 c	11.20 b
9) Ph + 30 kg P + 51 kg K / fed	10.0 a	11.4 a	9.9 a	17.50 b	11.58 ab	12.73 ab
10) 45 kg P + 51 kg K / fed	9.7 a	11.0 ab	9.9 a	17.60 b	11.79 ab	12.97 ab

Values within the same column followed by the same letters are not significantly different at 5% level (Duncan's multiple range test).

TABLE 4. Effects of mineral and bio-fertilizers levels on the chemical contents of pea during 2006/2007 and 2007/2008 winter seasons.

Fertilizers levels	Pigments in leaves (mg/100 g F.Wt.)		Sugars and mineral concentrations in seeds (mg/100 g D. Wt.)					
	Chlorophyll	Carotenoids	Reducing sugars	Non-reducing sugars	Total sugars	N	P	K
2006/2007 season								
1) Phosphorin (Ph) + potassiumag (Po)	6.66 h	1.12 cd	58.33 e	40.65 i	97.27 h	3.80 c	0.515 d	3.35 h
2) Ph + Po + 15 kg P + 17 kg K / fed	8.00 f	1.04 e	58.33 e	46.39 f	96.20 i	3.85 bc	0.544 cd	3.26 i
3) Ph + Po + 15 kg P + 34 kg K / fed	6.39 h	0.96 f	55.55 f	53.00 d	104.72 f	3.90 b	0.549 c	3.55 g
4) Ph + Po + 30 kg P + 17 kg K / fed	8.44 e	1.06 e	52.77 g	44.50 g	111.33 d	3.95 b	0.585 c	4.13 f
5) Ph + Po + 30 kg P + 34 kg K / fed	10.65 a	1.39 a	63.72 a	68.39 a	132.10 a	4.15 a	0.702 a	4.78 a
6) Po + 45 kg P + 17 kg K / fed	7.55 g	1.07 de	59.00 d	48.39 e	107.39 e	3.90 b	0.554 c	4.17 e
7) Po + 45 kg P + 34 kg K / fed	9.44 c	1.22 b	61.33 b	59.17 b	120.50 b	4.05 ab	0.639 b	4.66 b
8) Ph + 15 kg P + 51 kg K / fed	7.66 g	1.13 cd	58.33 e	41.39 h	100.99 g	3.85 bc	0.602 bc	4.19 de
9) Ph + 30 kg P + 51 kg K / fed	8.83 d	1.16 c	59.61 c	54.00 c	112.88 c	4.05 ab	0.613 b	4.21 d
10) 45 kg P + 51 kg K / fed	9.77 b	1.24 b	59.61 c	53.28 d	112.33 c	4.10 ab	0.629 b	4.33 c
2007/2008 season								
1) Phosphorin (Ph) + potassiumag (Po)	6.69 i	0.98 d	53.38 g	44.92 i	99.21 i	3.40 c	0.394 d	3.42 h
2) Ph + Po + 15 kg P + 17 kg K / fed	6.62 j	0.99 d	54.00 f	41.12 j	95.61 j	3.40 c	0.432 d	4.12 g
3) Ph + Po + 15 kg P + 34 kg K / fed	8.28 g	1.02 d	54.30 e	54.92 e	104.00 g	3.65 abc	0.432 d	4.40 e
4) Ph + Po + 30 kg P + 17 kg K / fed	8.79 e	1.10 c	54.30 e	50.00 g	108.67 f	3.45 bc	0.493 c	4.44 d
5) Ph + Po + 30 kg P + 34 kg K / fed	11.08 a	1.48 a	61.19 a	61.00 a	121.68 a	3.75 a	0.598 a	4.77 a
6) Po + 45 kg P + 17 kg K / fed	6.98 h	1.11 c	54.49 de	54.42 f	111.79 e	3.40 c	0.483 c	4.40 e
7) Po + 45 kg P + 34 kg K / fed	9.32 c	1.22 b	57.38 c	58.42 b	113.09 d	3.70 ab	0.510 bc	4.44 d
8) Ph + 15 kg P + 51 kg K / fed	8.41 f	1.11 c	54.68 d	45.21 h	99.50 h	3.50 abc	0.498 c	4.16 f
9) Ph + 30 kg P + 51 kg K / fed	8.98 d	1.21 b	60.72 b	55.30 d	115.64 c	3.70 ab	0.522 bc	4.61 b
10) 45 kg P + 51 kg K / fed	9.49b	1.21 b	60.68 b	58.38 c	119.57 b	3.70 ab	0.554 b	4.53 c

Values within the same column followed by the same letters are not significantly different at 5% level (Duncan's multiple range test).

TABLE 5.Effects of mineral and bio-fertilizers levels on quality of pea seeds during 2006/2007 and 2007/2008 winter seasons.

Fertilizers levels	100 seeds weight (g)	Seed germination (%)	Germination rate	Seedling length (cm)	Root length (cm)	Fresh seedling weight (g)	Dry seedling weight
2006/2007 season							
1) Phosphorin (Ph) + potassiumag (Po)	14.40 e	90.0h	3.37c	26.4 g	14.1 d	1.25h	0.129c
2) Ph + Po + 15 kg P + 17 kg K / fed	14.50 e	90.4g	3.41b	27.8 f	14.1 d	1.26g	0.132c
3) Ph + Po + 15 kg P + 34 kg K / fed	15.00 de	91.4e	3.45b	29.2 e	14.6 d	1.35e	0.132c
4) Ph + Po + 30 kg P + 17 kg K / fed	15.55 cd	91.4d	3.46b	29.2 e	14.4 d	1.37d	0.132c
5) Ph + Po + 30 kg P + 34 kg K / fed	17.55 a	94.5a	3.55a	31.9 a	16.0 a	1.48a	0.150a
6) Po + 45 kg P + 17 kg K / fed	15.28 de	91.5c	3.46b	29.5 d	15.4 bc	1.35e	0.138b
7) Po + 45 kg P + 34 kg K / fed	16.44 abc	91.5c	3.54a	30.7 b	15.9 ab	1.45b	0.148a
8) Ph + 15 kg P + 51 kg K / fed	15.94 bcd	91.3f	3.44b	29.2 e	15.3 c	1.33f	0.132c
9) Ph + 30 kg P + 51 kg K / fed	16.72 ab	93.4b	3.54a	29.8 c	15.7 abc	1.43c	0.149a
10) 45 kg P + 51 kg K / fed	16.50 bc	93.4b	3.47b	29.8 c	15.4 bc	1.43c	0.139b
2007/2008 season							
1) Phosphorin (Ph) + potassiumag (Po)	15.20 g	96.0d	3.48d	25.8 j	13.0d	1.22f	0.134b
2) Ph + Po + 15 kg P + 17 kg K / fed	15.65 f	94.0e	3.51cd	26.4 i	13.8c	1.27ef	0.122c
3) Ph + Po + 15 kg P + 34 kg K / fed	15.97 e	97.3c	3.69bc	26.6 h	14.2bc	1.32de	0.137b
4) Ph + Po + 30 kg P + 17 kg K / fed	16.38 d	96.0d	3.56cd	27.2 g	14.1bc	1.36cd	0.137b
5) Ph + Po + 30 kg P + 34 kg K / fed	17.99 a	98.7a	4.10a	29.1 a	15.5a	1.48a	0.153a
6) Po + 45 kg P + 17 kg K / fed	14.91 h	96.0d	3.63c	27.6 f	13.9c	1.36cd	0.137b
7) Po + 45 kg P + 34 kg K / fed	16.51 c	98.0b	3.93ab	28.6 c	15.2a	1.47ab	0.152a
8) Ph + 15 kg P + 51 kg K / fed	15.90 e	97.3c	3.55cd	27.7 e	14.2bc	1.34d	0.136b
9) Ph + 30 kg P + 51 kg K / fed	16.40 d	98.0b	3.89b	28.1 d	14.6b	1.42bc	0.138b
10) 45 kg P + 51 kg K / fed	17.50 b	98.0b	3.71bc	28.8 b	14.5b	1.41bc	0.142b

Values within the same column followed by the same letters are not significantly different at 5% level (Duncan's multiple range test).

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تأثير التلقيح بالبكتيريا المذيبة للفوسفور والبوتاسيوم على النمو والمحصول وجودة البذور فى البسلة

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أجريت تجربتان حقليتان فى المزرعة البحثية بقها – محافظة القليوبية – التابعة لمعهد بحوث البساتين ، خلال موسمى الزراعة الشتويين ٢٠٠٦/٢٠٠٧ و٢٠٠٧/٢٠٠٨ ، لدراسة تأثير الأسمدة الحيوية التجارية "الفوسفورين" و" البوتاسيوماج " مع إضافة مستويات مختلفة من السماد الفوسفورى والبوتاسى على النمو ، والمحصول ومكوّناته، وجودة بذور البسلة لإيجاد أفضل نسبةٍ من الأسمدة المعدنية الفوسفورية والبوتاسية مع المخصّباتِ الحيويةِ لتقليل التلوث البيئى الناتج عن إستعمال الأسمدة الكيمياوية.

تأثرت كل الصفات النباتية بالمعاملات السمادية المختبرة فيما عدا صفتى طول القرن وعدد البذور فى القرن ؛ حيث أنهما من الصفات المميزة للصنف والثابتة وراثيا . وقد اختلف تأثير المعاملات السمادية على النمو ، والمحصول ومكوّناته، وجودة بذور البسلة باختلاف مستويات الأسمدة. وكانت أفضل معاملة سمادية هى تلقيح تقاوى البسلة بكلا المخصّبين الحيويين "الفوسفورين" و " البوتاسيوماج " مع إضافة الأسمدة المعدنية الفوسفورية والبوتاسية بمعدل ٣٠ وحدة فوسفور/ الفدان و٣٤ وحدة بوتاسيوم / الفدان (⅔ الكمية الموصّى بها)، على التوالي ؛ حيث أنها تفوقت على المعاملات السمادية الأخرى لمعظم الصفات المدروسة للنمو ، والمحصول ومكوّناته، وجودة بذور البسلة في كلا الموسمين. لذا، يُمْكِنُ توفير ⅓ الكمية الموصّى بها من الفوسفور والبوتاسيوم (حوالي ١٥ وحدة فوسفور/ الفدان و١٧ وحدة بوتاسيوم / الفدان) بإستعمال المخصّباتِ الحيويةِ "الفوسفورين" و " البوتاسيوماج ".