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Quality Parameters of Snap Bean Plant as affected by Compost Town Refuse, K-Levels and *Bacillus cerculans*

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ABSTRACT

Field experiment was conducted out during season of 2017 as a randomized complete block with 9 treatments and replicated three times. The experiment location is located in the Experimental Farm of the Faculty of Agric. El-Mansoura Univ. to study the effect of compost town refuse and K-levels in presence of *Bacillus cerculans* on the growth, yield and pods quality snap bean plant. The obtained results could be summarized as average values of vegetative growth parameters, chemical content, yield and its component, quality of snap bean seeds and available K were realized with using CTR+ 75%K +BS. While concentrations of heavy metals in seeds, available N,P, K, DTPA-extractable Pb, Ni and Cd mg.kg^{-1} were recorded with using CTR as source of organic manure all comparing with control.

***Keywords**:* compost town refuse, K-fertilization, potassium dissolving bacteria and beans.

INTRODUCTION

Snap bean considered one of the main important food crops in Egypt and consumed as a cooked vegetable either as green pods or dry seeds belongs to the family Leguminosae. It assumes a significant part in human nutrition as easy source for protein, vitamins, carbohydrates and minerals, which make it one of the most remarkable vegetable crops, cultivated in Egypt for local market also, for exportation as well (Ahmed, 2015). Increasing yield of snap bean in Egypt is highly energetically prescribed to satisfy the expanding need (Abdel Hakim *et al.* 2012).

Now, confirmed types of microorganisms are known to serve as a decent option to chemical fertilizers. A bio-fertilizer is a substance which contains some beneficial living microorganisms possessing the rhizosphere of the plant and advance growth by increasing the supply or availability of primary nutrients to the host plant (Gaur, 2010). The utilization of plant nutrients advancing rhizobacteria, including potassium solubilizing bacteria (KSB) as bio-fertilizers.

KSB can solubilize rock K mineral powder, as illite, micas, and orthoclases, through creation and excretion of organic acids (Ullman *et al*., 1996). It has been demonstrated that KSB, such as *Bacillus cerculans* increased K availability in soils and rised mineral content in plant. Application of K materials combined with co -inoculation of bacteria that solubilize them may be provide a faster and persistent supply of potassium for ideal plant development. Anyway, little is thought about the effects of materials combined with co-inoculation of KSB on mineral availability in soils, mineral content and growth of plant.

The potassium is the 3rd most important essential nutrient after nitrogen and phosphorus. It is considered one of the guideline plant nutrients and assumes a crucial part as macronutrient in plant development and sustainable crop production, usually absorbed by plants in larger quantities (Pettigrew, 2008 and Bukhsh *et al*., 2009). While implicated in many physiological processes, potassium is effect on photosynthesis, water relations, assimilate transport and enzyme activation can have direct consequences on crop productivity. It keeps up turgor pressure of cell which is basic for cell expansion (Bukhsh *et al*., 2010).

Organic wastes increasing progressively exerting environmental problem in Egypt. On the other hand, excessive chemical fertilizers bring about severe contamination to soil. Using organic manure fertilizers such as compost town refuse can serve as an alternative practice to use N mineral fertilizers (Naeem *et al*., 2006), Which play an important role in enhancing the physical properties of the soil (Bougnom *et al*., 2010). Town refuse compost can also play a significant role in the development and maintenance of soil organic matter content (Salama *et al*., 2017). It contributes to the increasing the organic soil carbon content and raising the productivity of the soil, by increasing the beneficial microorganisms in the soil Activity (Hepperly *et al.*, 2009). Converting forms of organic nutrient's to mineral forms, which become available to plants, such as slow -release fertilizers (Murphy, 2014). Another study demonstrated that organic fertilizer increased macro-elements and micro-elements compared to non - organic fertilizer treatment (Shaddad, 2009). However, Evanylo *et al.*, (2008) illustrated that use compost affected in porosity, bulk density and water-holding capacity of the soil such that losses of N and P.

Therefore, this work was established to furnish knowledge and to have some understood about kind of organic manure such as (compost town refuse) and K-levels in presence of *Bacillus cerculans* to improve quantity and quality of snap bean production.

MATERIALS AND METHODS

Field experiment was conducted out during season of 2017 as a randomized complete block with 9 treatments and

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replicated three times. The experiment location is located in the Experimental Farm of the Faculty of Agric. El-Mansoura Univ. to study the effect of compost town refuse and K-levels in presence of *Bacillus cerculans* on the growth, yield and pods quality snap bean plant. Some chemical and physical properties of the soil are presented in Table 1

Table 1. Physical and chemical properties of the experimental soil.

Particle size distribution (%)				Textural class	EC dSm^{-1}, (1:5)	pH (1:2.5)	$CaCO_3$ (%)	O.M (%)	SP (%)
C. Sand	**F. Sand**	**Silt**	**Clay**						
3.96	27.05	40.87	28.12	Silt clay loam	0.98	7.96	4.66	1.12	58.5

Available element, $mg.kg^{-1}$					
N	P	K Mn	Pb	Ni	Cd
56.5	5.65	105.4	5.17	2.88	0.08

Particle size distribution was determined according to the method of Haluschak, (2006). Available N, P and K were determined according to Reeuwijk, (2002). Pb, Ni and Cd were extracted and determined according to Mathieu and Pieltain (2003).

Treatments were as follows:

1.Control.
2.Compost town refuse (CTR) at rate 15 m^3fed^{-1}.
3.CTR + *Bacillus cerculans* (BS).
4.CTR + 50% K fertilization (recommended dose).
5.CTR + 50% K+ BS.
6.CTR + 75% K.
7.CTR + 75% K + BS.
8.CTR + 100% K.
9.CTR + 100% K + Bs.

Compost town refuse was taken from Mansoura manufactory for organic manure and mixed with field soil then irrigated up to saturation percentages. Failed soil was left for two weeks to elucidate the damage effect on seedlings and their roots resulted from the heat of decomposition. Some chemical analyses of compost town refuse used in this study are shown in Table 2.

Table 2. Chemical composition of the applied compost town refuse.

pH (1:10)	EC, dSm^{-1} (1:10)	SP%	%						Extract elements, mg kg^{-1}		
			OM	**OC%**	**T.N**	**C/N**	**T.P**	**T.K**	**Pb**	**Ni**	**Cd**
7.66	4.13	94.7	20.05	11.66	0.59	19.8	0.39	0.74	7.87	1.92	0.71

NPK fertilizer i.e. ammonium sulphate (20.6%N), calcium super phosphate (16% P_2O_5) and potassium sulphate (48% K_2O) were added at rates of 150, 100 and 50 kg/fed., respectively. The P fertilizer was added during soil preparation and before seed sowing. The N and K fertilizers, were split into two equal parts and the first addition added after the first irrigation and the second one added 25 days after seed sowing.

Seeds snap bean seeds (Giza 6) were sown on the first week of October, 2017. Experimental plot area was 10.5 m^2. Each plot consisted of (5 dripper lines 3 m in length and 0.7 m in width). Seeds were planted in hills (20 cm apart) on one side of dripper lines and two seeds per hill. The snap bean seeds were mixed with *bacillus cerculans* bacteria before planting.

Data recorded:

Growth parameters: after 45 days from planting, ten plant samples randomly were taken from every plot for measuring the growth parameters of snap bean plants expressed as follows: plant height, number of leaves and branches, fresh and dry weights, g/plant.

Total yield and its components: At harvesting stage (60 days from seeds sowing), the total green pods from each treatment were collected along the harvesting season and 15 of snap bean plants from each treatment were randomly taken to study the yield and its components including: pods (length, diameter, no./plant and weight) and yield (tons/fed.).

Chemical and quality analysis: chlorophyll content was determined as the method described by Gavrilenko and Zigalova (2003) in fresh leaves of snap bean plants then dried for chemical analysis. Samples powder were digested using mixture of sulphoric and perchloric acids (1:1). Nitrogen was determined using Kjeldal method. Phosphorus was determined using spectrophotometer, while potassium was determined using flam photometer. Total protein content was calculated as follows (N%×6.25) according to the method described in the (A.O.A.C 2000). Total carbohydrates were determined according Sadasivam and Manickam, (1996), T. sugar%, TSS%, fiber and VC mg/100g were determined according to (A.O.A.C 2000).

After harvesting, sample of soil was taken to determine available N, P and K according to Reeuwijk, (2002) as well as DTPA extractable Pb, Ni and Cd were extracted and determined as mentioned by Mathieu and Pieltain (2003).
The obtained data of experiments were subjected to the statistically analysis of variance procedure and means were compared using the Duncan's and LSD method at 5% level of significance according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1.Vegetative growth parameters:

Plant growth parameters of sanp bean plant as affected by compost town refuse, K-fertilization and BS in individual way or interaction were presented in Table (3). All treatments significantly increased plant growth as plant height, No. of leaves/plant, No. of branches/plant, fresh and dry weight comparing with control. Using treatment of C.T.R+K 75%+BS recorded the highest mean values of parameters than control which were 30.82, 32.28, 31.10, 31.22 and 31.25% for plant growth as plant height, No. of leaves/plant, No. of branches/plant, fresh and dry weight, respectively.

These results indicated that using BS as biofertilizer with K-fertilizers under organic compost interaction provide plant with nutrients and supplied better growing conditions which helped for getting proper vegetative growth.

This increment might be due to remains returned as compost supplies a superior soil environment and an abundant carbohydrate and nitrogen fertilizer source that benefits the growth of beneficial microorganisms (Zayed and Abdel-Motaal, 2005). Hence, remains returned as compost results in promoted soil enzyme activity by increasing the amount of enzymes and their substrates in the soil (Ros *et al*., 2006). These results were in agreement with the findings of Luna Zendejas *et al*. (2011) who showed that (*Phaseolus* *vulgaris* L.) grown with the application of compost recorded the highest growth of control treatment.

As for the effect of K-fertilization because of the potassium role in metabolism and many processes needed to support and advance plant vegetative growth and development. Additionally, K plays a significant function in many biochemical and physiological processes such as elongation, cell division and metabolism of protein and carbohydrates compounds These results could be supported with those obtained by Motaghi and Nejad (2014), Shokoohfar, (2015) and Taha *et al*., (2016).

The increase in vegetative growth as a result of *B. circulans* cells could be due to the ability of BS dissolve K in soil and be available to the plant. These results were emphasized by Han and Lee (2005) and Afifi *et al.* (2008)who found an increase in K-uptake when inoculated soil with K solubilizing bacteria and reported that the production of organic acids (oxalic, citric, α - ketogluconic and tartaric) by the bacterial strains led to mobilization of K and chelating it from K containing minerals.

Table 3. Effect of CTR, K-fertilization and *Bacillus cerculans* on vegetative growth parameters of snap bean plants.

Treatments	plant height (cm)	No. of leaves/plant	No. of branches/plant	fresh weight (g)	dry weight (g)
Control	39.71i	11.40h	6.27i	93.52i	16.83i
C.T.R	41.40h	11.92g	6.50h	97.22h	17.50h
C.T.R+BS	42.74g	12.49f	6.76g	100.83g	18.15g
C.T.R+K 50%	44.68f	12.85f	7.02f	104.85f	18.87f
C.T.R+ K 50%+ BS	48.91c	14.17c	7.75c	115.10c	20.72c
C.T.R+K 75%	46.00e	13.30e	7.27e	108.25e	19.49e
C.T.R+K 75%+BS	51.95a	15.08a	8.22a	122.72a	22.09a
C.T.R+K 100%	47.52d	13.72d	7.50d	111.81d	20.13d
C.T.R+K 100%+BS	50.55b	14.58b	7.97b	118.90b	21.40b
LSD at 5%	0.85	0.35	0.15	1.67	0.30

2.Chemical composition:-

Data presented in Table (4) showed the interaction effect of soil addition of K-fertilization and BS inoculation under compost town refuse on chlorophyll content, N, P and K concentration of snap bean plant comparing with the untreated plants. All present treatments significantly affected chlorophyll content, N, P and K concentration. Using K fertilization and CTR increased traits with increasing K fertilization. Adding BS + 75% RD with CTR increased chlorophyll content, N, P and K% followed by BS + 100% RD + CTR. It means that the highest values of chlorophyll content a, b, total, N, P and K% of snap bean leaves were associated with the plants received 75%K+ BS+CTR.

Effect of CTR may be return to the capacity of soil organic matter to influence a range of functional soil chemical, physical and biological properties and to assumes a benificial role in nutrient cycling (Murphy, 2014) . An expanding in mineral elements may be due to the part of K in nutritional balance and nutrients uptake, which increase the biosynthesis of photosynthesis, also could be as a result of potassium sulphate in the soil which attributed to the role of sulphate in acidic component for minimizing the values of soil pH, so subsequently facilitate the absorption of nutrients by the beans plant roots. Similar, results were observed by Kherawat *et al.* (2013), Biswash *et al.* (2014) and Taha *et al.* (2016). Also, K solubilize bacteria combined with the rock K materials amendment can improve uptake of mineral nutrient by crops grown under nutrient-deficient soils leading to more plant growth.

Table 4. Effect of CTR, K-fertilization and *Bacillus cerculans* on chemical composition of snap bean plants.

Treatments	Chlorophyll a	Chlorophyll b	Total chlorophyll	N	P	K
	(mg/g FW)			(%)		
Control	0.783i	0.547i	1.330i	2.82i	0.339h	1.65i
C.T.R	0.793h	0.556h	1.349h	2.93h	0.352g	1.76h
C.T.R+BS	0.803g	0.566g	1.369g	3.04g	0.358g	1.83g
C.T.R+K 50%	0.815f	0.574f	1.388f	3.16f	0.373f	1.96f
C.T.R+ K 50%+ BS	0.849c	0.602c	1.451c	3.49c	0.406c	2.09c
C.T.R+K 75%	0.826e	0.582e	1.408e	3.28e	0.383e	2.22e
C.T.R+K 75%+BS	0.871a	0.621a	1.492a	3.70a	0.430a	2.36a
C.T.R+K 100%	0.839d	0.592d	1.432d	3.38d	0.394d	2.48d
C.T.R+K 100%+BS	0.859b	0.609b	1.468b	3.59b	0.417b	2.66b
LSD at 5%	0.007	0.006	0.008	0.07	0.006	0.07

3.Yield and its components:

The results in Table (5) revealed that the effect of all treatments under this study significantly affected yield and it component. Pod length, diameter, pod weight and yield ton/fed. recorded a good significant positive correlation with application of all treatments comparing with control except number of pods/plant had no significant effect.

Table 5. Effect of CTR, K-fertilization and *Bacillus cerculans* on yield and its components of snap bean plant.

Treatments	Pod length (cm)	Pod diameter(cm)	No. of pod/plant	Pod weight	yield ton/fed
Control	11.13h	8.60i	49.15bc	5.34i	3.84g
C.T.R	11.64g	8.94h	36.18c	5.52h	3.99f
C.T.R+BS	11.91g	9.23g	53.05ab	5.72g	4.14e
C.T.R+K 50%	12.46f	9.62f	55.25ab	5.97f	4.30d
C.T.R+ K 50%+ BS	13.75c	10.62c	60.74ab	6.55c	4.74b
C.T.R+K 75%	12.89e	9.96e	57.09ab	6.14e	4.45c
C.T.R+K 75%+BS	14.59a	11.26a	64.40a	6.95d	4.98a
C.T.R+K 100%	13.32d	10.28d	58.94ab	6.33a	4.56c
C.T.R+K 100%+BS	14.16b	10.93b	62.77ab	6.74b	4.90a
LSD at 5%	0.30	0.18	n.s	0.16	0.13

The highest mean values of traits were connected with using CTR+K 75%+BS. These results might be discussed by the results of Salama *et al.* (2017) who showed that the organic matter content of the planting medium has a profound effect on its biological, chemical and physical characteristics. Through the decomposition of organic matter many elements become available to the plants. In another study was done by Mahmoud et *al.* (2013) who indicated that the green pods yield and pod quality of pea plant were enhanced to a great extent through increasing the level of added compost. In addition, using KSB in a good agreement with findings of Han and Lee (2005) and Chavoshi *et al.* (2017). As for the effect of K-fertilization may be due to that potassium is very remarkable in overall metabolism of plant enzymes activity, because its serve a necessary part in photosynthesis by direct increasing in growth and total yield. Also, potassium has a useful impact on water consumption (Taha *et al*., 2016). The obtained results are in a good accordance with those recorded by Rosa, (2012) and Shokoohfar, (2015).

4. Quality of snap bean seeds:

A. Heavy mineral on seeds:

Data in Table (6), revealed the effect of CTR, BS and K-fertilization on Pb, Cd and Ni (mg.Kg^{-1}) in snap bean seeds. All mentioned treatments significantly affected Pb, Cd and Ni content in seeds, also all treatments increased the heavy mineral content compared the control. Moreover,the highest mean values of increase were realized with using CTR as source of organic manure over the control which were 31.06, 69.04 & 36.60% for Pb, Cd and Ni, respectively. This is attributed to the fact that compost town refuse is containing high content of heavy metals and the compost town refuse fractions contributing the most amount of heavy metals in soil which reflected on the plant (Awokunmi *et al.*, 2015).

Table 6. Effect of CTR, K-fertilization and *Bacillus cerculans* on heavy metals of snap bean seeds.

Treatments	Pb mg.kg^{-1}	Cd, mg.kg^{-1}	Ni, mg.kg^{-1}
Control	5.44f	1.97h	3.06h
C.T.R	7.13a	3.33a	4.18a
C.T.R+BS	6.91ab	3.17b	3.97b
C.T.R+K 50%	6.70bc	2.98c	3.81c
C.T.R+ K 50%+ BS	6.41cd	2.47f	3.54e
C.T.R+K 75%	6.26d	2.63e	3.68cd
C.T.R+K 75%+BS	5.85e	2.32f	3.36f
C.T.R+K 100%	6.48cd	2.83d	3.65de
C.T.R+K 100%+BS	5.64ef	2.14g	3.21g
LSD at 5%	0.32	0.15	0.15

B. Quality of seeds:

Quality parameters of snap bean seeds in expression of crud protein, total carbohydrates, crud fibers, total sugar, TSS and VC are presented in Table (7). Obtained data stated that, the values of all previous traits were increased significantly due to using all treatments comparing with control. The highest mean values were recorded with using mixture of treatments as CTR + 75% K + BS comparing with control which increased by 29.10, 51.05, 15.40, 36.68, 18.49 and 40.77% for crud protein, total carbohydrates, crud fiber, total sugar, TSS and VC, respectively.

The useful impact of organic manure on chemical and physical biological characteristics of soil, which in turn influences the growth and increases plant dry production (Murphy, 2014). Similar results were recorded by (Salama *et al*., 2017). Adding of the K-fertilization investigated in the present study and the beneficial micro organisms stimulated (BS), the chlorophyll and protein synthesis, preventing protein break down, activating photosynthesis and respiration rates in plants and, consequently increased the accumulation of bio-products in snap bean seeds, Shaban *et al*., (2008), Ayub *et al*., (2012) and Mokoena, (2013).

Table 7. Effect of CTR, K-fertilization and *Bacillus cerculans* on quality of snap bean seeds.

Treatments	C.protien %	T.carbohydrate%	C.fibers %	T.sugar%	T.S.S%	VC, mg/100gFW
Control	16.39i	28.21i	13.96g	7.85i	6.87g	6.45e
C.T.R	16.98h	38.77h	14.23f	8.21h	7.06f	6.77e
C.T.R+BS	17.57g	39.35g	14.52e	8.56g	7.20f	7.14d
C.T.R+K 50%	18.18f	39.84f	14.74e	8.93f	7.37e	7.43cd
C.T.R+ K 50%+ BS	19.98c	41.51c	15.55c	10.07c	7.85b	8.43b
C.T.R+K 75%	18.81e	40.36e	14.97d	9.28e	7.53d	7.75c
C.T.R+K 75%+BS	21.16a	42.61a	16.11a	10.73a	8.14a	9.08a
C.T.R+K 100%	19.41d	41.04d	15.33c	9.65d	7.68c	8.42b
C.T.R+K 100%+BS	20.58b	42.04b	15.85b	10.35b	7.99b	8.74b
LSD at 5%	0.32	0.31	0.23	0.24	0.14	0.33

5.Available N, P and K as well as DTPA-extractable heavy metals in soil after cropping:-

Concentration of available N, P, K as well as DTPA-extractable Pb, Ni and Cd (mg.kg^{-1}) in the experimental soil after cropping with snap bean are shown in Figures (1 and 2).

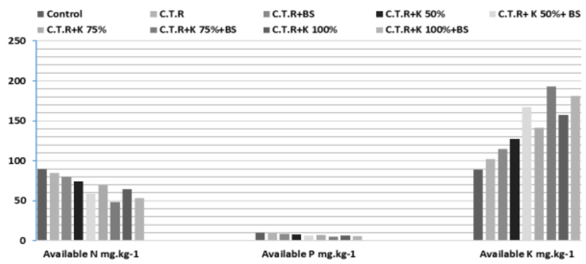

Fig 1: Effect of CTR, K-fertilization and *Bacillus cerculans* on available N, P, K

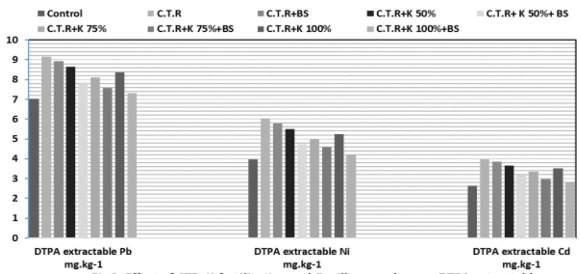

Fig 2: Effect of CTR, K-fertilization and *Bacillus cerculans* on DTPA extractable Pb, Ni and Cd mg.kg^{-1}

Concentrations of N and P in the soil after cropping as indicated in Figure (1) were generally decreased less than the control as affected by the adding treatments. Using CTR as a source of organic manure followed by control recorded the highest values of N and P. as for concentration of K which recorded the highest values with CTR+ 75%K +BS treatment.

In Figure (2), the effects of different treatments on concentration of Pb, Ni and Cd were significantly on these elements as affected by adding CTR, K-fertilization and BS comparing with control. The concentrations of Pb, Ni and Cd in the soil after cropping were generally slightly increased than that obtained from this soil before cropping, this result may be due to the roots activity affects greatly the soil pH and consequently increases the availability of these elements. Data of the same Table indicated that the concentrations of all heavy metals were significantly affected due to the addition of the organic manure under investigation; which already contained moderately amount of these elements and recorded the highest values for the treatment of compost town refuse, also K-fertilization and potassium dissolving bacteria.

These results may be due to the effect of roots activity on decreasing soil pH, consequently increases the availability of these metals. On the other hand, the contents of heavy metals increased with adding of the studied organic manure, which already contained moderately amount of these metals. But the average values of heavy metals in the soil tended to be less than that obtained for the control treatment. In this respect Kara *et al.*, (2004) indicated that the addition of organic manures to the soil could be enriched soil if it is found feasible and applicable. So, heavy metals will choose the form of chelates resulting from organic compounds. By this way, concentrations of extractable heavy metals will be minimized by using organic material. Also, the application of 75 kg K_2O rate and BS caused an increase in K availability in the soil and their contents were maximized with increasing the applied rates as found by Gani *et a*l., (2001); Han and Lee (2005); Hellal *et al*., (2009); Awokunmi *et al*., (2015) and Przygocka-Cyna *et al.*, (2018).

CONCLUSION

Using the compost town refuse with *Bacillus cerculans* in the presence of K-fertilization resulted in increasing the utilization of nutritional elements and organic acids as a result of the activity of potassium dissolving bacteria and the effect of K-fertilization. This effect was reflected on increasing yield and its quality parameters of snap bean crop.

Thus, it could be recommended that inoculation of snap bean seeds with the mixture of *Bacillus cerculans* inoculants combined with compost town refuse at rate of 15 m^3 fed^{-1} and the soil addition of K-fertilization at rate of 75% of recommended dose are considered as the most suitable treatment for realizing the highest economic and safe yield of snap bean plants with high quality.

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جودة محصول الفاصوليا المتأثرة بسماد قمامه المدن، مستويات التسميد البوتاسى والبكتريا المذيبة للبوتاسيوم

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نفذت تجربه حقليه في مزرعة كليه الزراعة جامعه المنصورة خلال ٢٠١٧ لدراسة تأثير سماد قمامه المدن ومستويات التسميد البوتاسيى والبكتريا المذيبة للبوتاسيوم على نمو والمحصول وصفات الجودة لنبات الفاصوليا. صممت التجربة في قطاعات كامله العشوائية لـ ٩ معاملات كررت ثلاث مرات. فوجد ان اعلى معدل لصفات النمو والمحصول ومكوناته وكذلك المحتوى الكيميائي وصفات الجودة لحبوب الفاصوليا بالإضافة الى محتوى التربة من البوتاسيوم قد تحققت مع استخدام سماد قمامه المدن بمعدل ١٥ م٣ للفدان + ٧٥% من التسميد البوتاسيى الموصي به في وجود البكتريا المذيبة للبوتاسيوم. أما بالنسبة لمحتوى الحبوب من المعادن الثقيلة ومحتوى التربة من النيتروجين والفوسفور والبوتاسيوم والرصاص والنيكل والكادميوم كانت في اعلى المستويات عند إضافة سماد قمامه المدن وذلك مقارنه بالنباتات الغير معامله بسماد قمامة المدن (كونترول).