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The Utilize of Vermicomposting Outputs in Substrate Culture for Producing Snap Bean

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Abstract

The need for increasing the agricultural area to secure food production and the sustainability under the climate change impacts and current conditions of Egypt, especially the shortage of available water and soil were the driving forces for developing ecology substrate culture via using vermicomposting outputs. The study was carried out at Central Laboratory for Agricultural Climate (CLAC), Giza, Egypt under unheated double span plastic house during two successive autumn seasons of 2012/2013 and 2013/2014 for investigating the effect of vermicompost as substrate amendment mixed with perlite or sand in different proportions 0, 10, 20 and 30 % of substrate combined with three sources of nutrient solutions (compost tea, vermi-liquid and chemical) on the growth and yield of snap bean *cv.* Alhamma in split plot design with four replicates.

Data revealed that increasing vermicompost rate from 0 to 20 % had positive significant effects on vegetative growth, yield and quality of snap bean pods while increasing the rate up to 30 % had no subsequent effect. Sand + vermicompost (80: 20 *v/v*) followed by perlite + vermicompost (80: 20 *v/v*) recorded the highest results of the vegetative growth characteristics during the two successive seasons compared to other treatments. The highest values of early and total yield / m^2 were recorded by sand + vermicompost (80: 20 *v/v*) 1494 and 6947 g / m^2 during the first season, respectively. In addition, it recorded the highest early yield on the second season (1552 g / m^2). While treatment of sand + vermicompost (70: 30 *v/v*) recorded the highest total yield (7035 g/ m^2). Otherwise, obtained results of the effect of nutrient solution sources indicated that the chemical nutrient solution recorded the highest vegetative growth traits and yield characteristics. Perlite + vermicompost (70: 30 *v/v*) combined with chemical nutrient solution had the highest results of early (1605) and total yield (7734) (g / m^2).

The study supports the use of vermicompost as substrate amendment and compost tea and vermi-liquid as a source of nutrient solution in ecology soilless production of snap bean plants. The environmental impacts of vermicomposting could create sustainable source of organic substrate and fertilizer besides mitigating CO_2 emission.

Keywords: Vermicompost, Vermi-Liquid, Compost Tea, Nutrient Solution, Substrate Culture, Perlite, Sand, Vegetative Growth, Yield and Snap Bean.

Introduction

Snap bean (*Phaseolus vulgaris L.*) is one of the most important pulse and fresh market crop in the world and it is also one of the most important legume crops in Egypt cultivated for local consumption as well as exportation especially during the period from December to May. However, it is highly sensitive to environmental conditions (climate, salinity, irrigation, fertilization etc…). It is an important source of proteins, calories, dietary fibers, minerals and vitamins for millions of people in both developing and developed countries worldwide. The acreage of snap bean in Egypt was 57873 fed. in 2012, and produced 251279 tons according to the Statistics of Ministry of Agriculture 2013.

Widely used substrate components include peat moss, pine bark, perlite, vermiculite, sand; etc. The need to produce local substrate instead of imported substrates drives many researchers to develop different substrate to play the role of peat moss. Several studies revealed that peat can be substituted by various compost types without any negative effects on a variety of crops raised in these substrates (**Hashemimajd *et al.*, 2004**). On the other hand, the commercial soilless culture progress slowly while it's expected to grow so fast through the next years according to the increase demands for food security. The expected future of climate change impacts and water shortage will be the driving forces to pay more attention for soilless culture. In this respect, **Surrage *et al*., (2010)** reported that Forterra Royal GRO1 (coconut coir/vermicompost) and Forterra Royal GRO2 (aged pine bark/coconut coir/vermicompost) attained signifiantly higher marketable yields per tomato plant compared with the plants grown in rockwool.

Vermicomposting has been discussed as a key step in sustainable Organic Solid Wastes (OSW) management, in many countries like Germany (**Ernst *et al*., 2008**), Spain (**Monroy *et al*., 2009**), USA (**Arancon *et al*., 2008**) and Vietnam (**Yadav *et al*., 2010**).

Vermicompost could be used as a natural fertilizer having a number of advantages over chemical fertilizers, possibly due to better physical properties, higher microbial and enzymatic activity and higher content of available nutrients. Producer acceptance of vermicompost is greater than that of compost **(Venugopal *et al*., 2010 and Abul-Soud *et al*., 2014b). Quaik *et al*., 2012b** indicated that, vermicomposting has been getting attention due to its environmental friendly approach. Beside the compost produced, recent interest has been brought up due to the possible use of the liquid by products from this green technology. Different organic wastes can be used in vermicompost production by different species of earthworms which include horse waste (**Garg and Kaushik, 2005**); cattle dung (**Quaik *et al*, 2012a**); urban solid waste (**Singh *et al*, 2010**); city leaf litter and food wastes (**Nath *et al*, 2009**); paper waste and residues of plant decomposition **(Abul-Soud *et al*., 2009)**. Vermicompost has a significant positive influence on seed germination and seedling vigor, plant growth, flowering, fruiting, tuberization, root development, colour, shelf-life and quality of vegetables (**Suthar 2009 and Chanda *et al*. 2011**).

Several studies assessed the effect of vermicompost amendments in potting substrates on seedling emergence and growth of a wide range of marketable fruits cultivated in greenhouses, as well as on growth, yields of green gram (*Phaseolus aurus Roxb*) (**Kamergam *et al*., 1999)**. Providing that all nutrients are supplied by mineral fertilization, studies show greatest plant growth responses when vermicompost constituted a relatively small proportion (10 to 20%) of the total volume of the substrate mixture, with higher proportions of vermicomposts in the mixture not always improving plant growth (**Atiyeh *et al*., 2000b**).

Extract from vermicompost is known as vermicompost extract. Vermicomposting derived liquids contain valuable nutrients that promote plant growth. Substrates that have been used in these liquids production are mainly animal and agricultural waste. **(Gutiérrez-Miceli *et al*, 2011 and Pant *et al*, 2009).** Available plant nutrients that present in these liquids are valuable and have the potential to be used as nutrients solution in hydroponics culture. **Quaik *et al*, 2012b** reported that vermicomposting leachate, this biofertilizer showing promising results in various dilutions on Radish (*Raphanus sativus* L.) germination(%), number of leaves, plant height and shoot dry weight are highest in leachate of 10% dilution, whereas root dry weight is highest in leachate of 15% dilution **(Gutiérrez-Miceli *et al*, 2011)**.

Compost tea is liquid extracted or leached from compost. It will contain soluble nutrients, both organic and inorganic, and microorganisms, including bacteria, fungi, protozoa, and nematodes. The benefit of tea supplies depends on what can be extracted from the compost (**Scheuerell and Mahaffee, 2002**). **Diver (2002)** indicated that compost teas and herbal teas are tools that can be made on the farm to enhance crop fertility and to inoculate the phyllosphere and rhizosphere with soluble nutrients, beneficial microbes, and the beneficial metabolites of microbes. **Abou-El-Hassan *et al.* (2008)** reported that compost tea as organic nutrient solution can substitute the inorganic nutrient solution to cantaloupe production in nutrient film technique.

The main objectives of the current study were to assess ecology soilless culture under Egyptian condition, to investigate the use of vermicomposting outputs on snap bean production and to minimize the environmental impacts of soilless culture inputs (peat moss and chemical fertilizers and to mitigate CO_2 emission).

Material and Methods

This experiment was conducted in the experimental station at the Central Laboratory for Agricultural Climate (CLAC), Agriculture Research Center (ARC), Egypt, during the autumn seasons of 2012/2013 and 2013/2014 under unheated double span plastic house (18 x 60 x 4.5m).

Plant material:

Snap bean seeds *cv.* Alhamma were sown on 4th week of September in both cultivated seasons. Three seeds of snap bean were planted directly in pots.

The vermicomposting process:

Epigiec earthworms imported from Australia, *Lumbriscus rubellus* (Red Worm), *Eisenia fetida* (Tiger Worm), *Perionyx excavatus* (Indian Blue) and *Eudrilus eugeniae* (African Night Crawler) were used in the vermicomposting beds system under this study. According to (**Ernst *et al*., 2008; Abul-Soud *et al*., 2009 and Venugopal *et al*., 2010**) fife kg of epigiec earthworms were taken and placed in each bed system. Worm diameter: 0.5 – 5 mm and worm length: 10 – 120 mm. Bed system of vermicomposting was used in this investigation for producing the vermicompost and vermi-liquid. Eight Beds were established under black net house by digging the soil and mulched with black polyethylene plastic sheet 0.5 mm to perform a bed with length 2.5 m, width 1.2 m and depth 50 cm. A slope 1.5 % had been done to collect the vermin-liquid through water bucket. Mixing the different raw materials: cattle manure (C. M) + vegetable and fruit wastes (V. F. W) + shredded paper (Sh. P) in the rate of 2: 2: 1 (v/v) respectively was done by using turning machine and pre-composting of different raw materials for 7 to 10 days before feed it to worms to avoid the thermophilic stage (increase temperature above 35^{o} C cause the death of earthworms in vermicompost systems). After pre-composting done, The final mix soaked in water for 1/2 to 1 hour to make sure it is not drier and put it in lines along the bed. The compositions of the different organic wastes are presented in Table 1. The feeding of earthworm done every two days and every 21 days the earthworms were fasting for 7 days to give them the opportunities to re-eat the cast and to avoid non composted wastes. Moisture content was in the range of 60 – 70 %.

The study treatments:

Four different rates of vermicompost (V) mixed with sand (S) or perlite (P) in different proportions as follows: 0, 10, 20 and 30 % (*v/v*) combined with chemical nutrient solution (control), compost tea and vermi-liquid as sources of nutrient solution to present 24 treatments.

The experimental design was a spilt-plot design with 4 replicates. The sources of nutrient solutions were assigned as main plots and vermicompost rates as subplots.

System materials:

Plastic pots 8 L (25 cm diameter x 30 cm height) were used, the pots were filled by different substrate mixes and placed in two rows in open substrate system. The pots arranged in two rows per bed. The final plant spacing was 50 cm in the row, 40 cm between the rows, and 90 cm in between the double rows.

The stock nutrient solutions of compost teas were prepared by soaking 4 l from compost in 20 l of water (1:5 by volume), the brewing of the compost occurring after 24 hours to get the concentrated compost tea. The concentrated compost tea was filtrated to get the clear solution, and then used to prepare the nutrient solution by diluting this stock up to 120 l water in solution tank. According to **Abou-El-Hassan *et al*., (2008)**.

The vermi-liquid was collected through vermicomposting process. The vermi-liquid filtered by using nets to remove any residues or dust that could cause blocking of drippers before diluted to the desire EC.

Different nutrient solutions pumped via submersible pump (110 watt). Water tanks 120 L were used in open system of substrate pots culture. The nutrient solution used in the experiment was adapted from **Cooper, (1979)** depending on the analysis of the local water by **El-Behairy, (1994)**. Plants were irrigated by using drippers of 4 l/hr capacity. The fertigation was programmed to work 8 times / day and the duration of irrigation time depended upon the season. The EC of the different nutrient solutions were adjusted by using EC meter to the required level (2.5 $mmhos^{-1}$). The chemical compositions of vermi-liquid and chemical nutrient solution were illustrated in **Table 3.** Substrate physical properties i.e. bulk density (B.D), total pore space (T.P.S), water hold capacity % (W.H.C) and air porosity % (A.P) were estimated according to **Wilson (1983)** and **Raul (1996).** The pH of the potting mixtures were determined using a double distilled water suspension of each potting mixture in the ratio of 1:10 (w: v) **(Inbar *et al*., 1993)** that had been agitated mechanically for 2 h and filtered through Whatman no.1 filter paper. The same solution was measured for electrical conductivity with a conductance meter that had been standardized with 0.01 and 0.1M KCl.

Samples of three plants of each experimental plot were taken to determine growth parameters at 120 days from the sowing as follows: Plant height, Total leaf area/plant was recorded using a digital leaf area meter (LI-300 portable area meter produced by LI-COR, Lincoln, Nebraska, USA) , Total plant fresh and dry weight (Total dry weight was determined after oven-drying the samples at 70 ºC for 48 hours), Yield measurements: early and total yield, physical properties for pods i.e., average pod length, diameter and weight. For mineral analysis of samples (N, P and K), three plant leaves samples of each plot were dried at 70^{o} C in an air forced oven for 48 h. and dried leaves were digested in H_2SO_4 according to the method described by **Allen (1974)** and N, P and K contents were estimated in the acid digested solution. Total nitrogen was determined by Kjeldahl method according to the procedure described by **FAO (1980).** Phosphorus content was determined using spectrophotometer according to **Watanabe and Olsen (1965).**

Table 1. The chemical composition (%) of the different agricultural wastes

Raw material	C/N ratio	Macro elements %				
		N	P	k	Ca	Mg
C. M	22.00	1.83	0.56	1.38	1.13	1.06
V. F. W	62.60	0.34	0.19	0.64	0.81	0.43
Sh. P	166.81	0.016	0.01	0.00	0.20	0.01
The mix	67.26	0.90	0.31	0.73	0.81	0.59

Table 2. The physical and chemical properties of vermicompost

Analysis	*UNITS*	*T.P.S %*	*Analysis*	*UNITS*	*T.P.S %*
B.D	Kg/m^3	715	P	%	1.27
O. M	%	33.22	K	%	0.59
C/N ratio		1:12.27	Fe	ppm	802
pH		8.17	Mn	ppm	143
EC	dS/m	6.67	Zn	ppm	37.0
N	%	1.57	Cu	ppm	14.0
N-NH4	ppm	65	Pb	ppm	9.0
N-NO3	ppm	81	Cd	ppm	n.d.

Table 3. The chemical composition of different sources of nutrient solutions

Nutrient source	Macro nutrients ppm					Micro nutrients ppm						
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Pb	Cd
Compost tea	162	187	275	99	38	0.68	0.02	0.02	0.02	0.27	0.012	n.d
Vermi-liquid	128	181	322	111	48.6	0.25	0.04	0.01	0.04	0.21	0.047	n.d
Chemical	250	45	350	180	50	3.0	1	0.06	0.10	0.25	0.157	0.014

Potassium content was determined photo-metrically using Flame photometer as described by **Chapman and Pratt (1961).** The obtained data were statistically analyzed using the analysis of variance method according to **Snedecor and Cocharn (1980)**. Duncan's multiple range tests at the 5% level of probability was used to compare means of treatments.

Results and Discussion

3.3 The effect of vermicompost rate and nutrient solution source on:

3.3.1The physical and chemical properties of different substrate mixtures:

The physical and chemical properties of different substrates mixtures for experiments are illustrated in Table 4. The obtained data indicated that increasing the rate of vermicompost from 0 to 30 % led to decrease the B.D and A.P of sand mixtures while T.P.S and W.H.C were increased. On the other hand, B.D and W.H.C were increased and T.P.S and A.P were decreased by increasing the vermicompost rate from 0 to 30 % in perlite mixtures.

The results of physical properties of sand and perlite mixtures presented clear contrast as a result of different rate of vermicompost application. The lowest B.D of perlite as well as W.H.C of sand are undesirable properties due to the vertical growth of snap bean that need to more stability and support with optimum moisture content respectively.

the bulk density of vermicompost is usually higher and the particle size lower than in some of the most commonly used peat-based substrates**,** mixing of these two substrates produces a significant increase in the bulk density and water holding capacity, while decreasing particle size and total porosity **Atiyeh *et al*, (2001); Bachman and Metzger, (2007). Hidalgo *et al*, (2006)** reported a significant increase in T.P.S and WHC after addition of vermicompost to a greenhouse potting medium comprising a mixture of sand, pine bark and peat. Limited studies on vermicompost indicated that it increases macropore space ranging from 50 to 500 µm, resulting in improved air-water relationship in the soil which favorably affects plant growth; the application of organic matter including vermicompost favorably affects soil pH, microbial population and soil enzyme activities (**Karuna *et al*., 2011**). **Veerabhadraiah *et al*, (2006)** showed improved soil properties due to application of vermicompost.

As a result of increasing vermicompost rate in both of sand and perlite from 0 to 30 %, E.C and O.M were increased regarding to the increase of organic compounds and high nutrient contents. The highest values of E.C and O.M were given by apply 30 % vermicompost rate in both of sand and perlite mixture as illustrated in Table 4. These results agreed with **Atiyeh *et al*., (2001)**. While the increase in vermicompost rate led to a slight increase in pH, especially with the perlite. Most of these results regarding physical and chemical properties are consistent with (**Gutie´rrez-Miceli *et al*., 2007 and Manivannan *et al*., 2007).** Regarding to the chemical properties (EC and pH), the obtained data indicated that increasing the rate of vermicompost led to increase EC and pH of different mixtures as a result of high contents of nutrients of vermicompost **(Venugopal *et al*., 2010 and Abul-Soud *et al*., 2014b).** The current study focus on the organic soil matter content as a strong indicator while much of the research on vermicompost has focused on studying plant available nutrients and changes in soil structure via soil porosity, aeration, and moisture holding capacity. (**Hashemimajd *et al*., 2004 and Tejada *et al*., 2010)**

Table 4. The physical and chemical properties of different substrates mix of study.

	Physical				*Chemical*		
Substrate	***B.D Kg/l***	***T.P.S %***	***W.H.C %***	***A.P %***	***E.C mmhos-1***	***pH***	***O.M%***
Sand 100%	1.67	26.0	17.8	8.2	0.4	7.6	0.20
S 90%:VC10	1.60	32.7	26.4	6.3	0.61	7.7	1.188
S 80%:VC20	1.56	37.2	33.1	4.1	0.90	7.8	2.436
S 70%:VC30	1.52	43.1	39.5	3.6	1.07	7.8	3.750
perlite 100%	0.125	90.0	30.5	59.5	0.34	7.4	0.00
P 90%:VC10	0.239	85.7	36.8	48.9	0.76	7.6	7.951
P 80%:VC20	0.341	78.6	43.3	35.3	1.05	7.8	11.145
P 70%:VC30	0.430	74.5	48.5	26.0	1.21	7.9	13.257

3.3.2 Vegetative growth parameters and production of snap bean:

Table 5 presented the effect of nutrient solution sources and substrate mixtures on the vegetative growth of snap bean. Regarding to the effect of nutrient solution source, chemical nutrient solution (N.S) was gave the highest values of plant height, leaf area, number of shoot, fresh and dry weight per plant, while the lowest values was gaven by compost tea (T.C), with no significant different between vermi-liquid (V.L) and compost tea in both seasons of study.

Application of vermicompost to sand and perlite mixtures resulted in promotion vegetative growth parameters in general. Adding vermicompost at 20% tended to increase the plant height, leaf area, fresh and dry weight per plant as well as number of shoot meanwhile, increasing the rate at 30% vermicompost was ineffective in both seasons with either sand or perlite mixtures as well.

As for the interaction effect between nutrient solution source and substrate mixture, data in Table 5 show that sand + vermicompost (80 +20 *v/v*) combined with chemical nutrient solution gave the highest significant results of plant height, fresh and dry weight per plant. The highest value of leaf area was recorded by sand and perlite with vermicompost rate (80 +20 *v/v*). On the other hand, the lowest values were recorded by 0 % vermicompost with slight significant differences between sand and perlite mixtures with all nutrient sources in both two seasons of growth. While the interaction effect on number of shoot was not clear through increasing vermicompost rates from 10 to 30 % combined with all nutrient sources solutions.

These results are in agreement with those mentioned by **Singh and Chauhan, 2009; Roy *et al.*, (2010) and Fernández-Luqueño F *et al.*, (2010)** on common bean (*Phaseolus vulgaris.*L) plants. As affirmed by **Rasool *et al.*, 2009** on cucumber (*Cucumis sativus* L.). **Senthilkumar *et al.*, (2004)** found that vermicompost ± NPK fertilizers significantly enhanced rose growth, yield and quality over the untreated control, especially when used in combination.

3.3.3 Chemical composition of snap bean leaves:

The presented data in Table 6 indicate the effect of nutrient solution sources and substrate mixtures as well as their interaction on the chemical composition of snap bean leaves.

As the result of Table 6 illustrate that the different tested nutrient solution i.e., chemical nutrient solution, compost tea and vermi-liquid had no significant effect on the K content during the two seasons of study. While, data show that using chemical solution reflected the highest values in N and P content. On the contrary, vermi-liquid as a nutrient solution led to the lowest results of P during the two seasons of growth.

Increasing the vermicompost rate from 10 to 30 % with sand did not affect the N content, while, applied 10 % vermicompost rate in perlite mixtures led to the highest value of N content in leaves. But increasing vermicompost rate up to 20 or 30 % tend to decrease the content of N. The highest values of both P and K content were recorded by perlite + vermicompost (90+10 *v/v*), and the lowest value was recorded by sand plus 30% vermicompost in both mixtures with significant difference. Concerning, the combination between different nutrient solution and substrates, the same data show that chemical nutrient solution with perlite mixtures with vermicompost rate (90+10 *v/v*) gave the highest values in N and P content **(Datt *et al.*, 2013)**. While the same substrate mixture with vermi-liquid reflected the highest potassium content. Similar resulted were reported by **Sharma *et al.*, 2008**. The lowest N content values were by vermicompost rate (80+20 *v/v*) and vermicompost rate (70+30 *v/v*) combined with vermi-liquid in first and second season respectively with no significant different, but, the lowest value of P content was recorded by sand + vermicompost (70+30 *v/v*) combined with vermi-liquid. While, the highest value of K content was recorded by vermi-liquid combined with perlite + vermicompost (90+10 *v/v*) in first season but sand 100% and perlite + vermicompost (90+10 *v/v*) in the second one, respectively. These results agree with **Abul-Soud *et al.*, (2014a)** on peas.

Table 5. Effect of different nutrient solution and different substrates and their interaction on growth characteristics of snap beans plants during 2012 / 2013 and 2013 / 2014 seasons.

	Treatment	First season					Second season				
		Plant height (cm)	Leaf area (cm^2) / plant	No. of Shoot /plant	Fresh weight / plant	Dry weight / plant	Plant height (cm)	Leaf area (cm^2) / plant	No. of Shoot/ plant	Fresh weight / plant	Dry weight / plant
	N.S	324.0	13610	2.81	469.4	98.92	311.4	13390	2.84	472.5	96.02
	C.T	272.9	12010	2.35	362.9	74.38	262.6	11680	2.50	365.0	84.28
	V.L	282.9	11650	2.48	368.2	74.70	274.2	11500	2.53	367.9	81.50
	L.S.D $_{at\ 0.05}$	10.5	815	0.72	6.28	4.30	7.042	710.5	0.53	13.85	2.129
	Sand	173.7	8090	2.41	282.3	54.20	179.7	8941	2.47	287.3	61.16
	S.90%+V 10%	331.3	1024	2.50	314.6	65.42	320.9	9931	2.61	323.9	68.66
	S 80%+ V 20%	355.3	16570	2.72	522.4	106.9	347.3	16050	2.69	521.3	108.2
	S 70% + V 30%	337.7	15130	2.62	502.9	107.1	325.9	14940	2.69	512.4	111.9
	Perlite	201.5	8019	2.29	244.3	43.36	186.9	8296	2.36	246.4	51.32
	P.90%+V 10%	300.7	10350	2.55	325.4	69.61	288.3	10370	2.71	335.1	73.31
	P 80%+ V 20%	329.5	15930	2.62	508.1	111.4	315.2	15120	2.72	501.0	115.1
	P 70% + V 30%	316.5	15040	2.70	501.4	103.4	297.6	13870	2.72	487.1	108.6
	L.S.D $_{at\ 0.05}$	11.1	692	0.28	8.78	4.68	5.379	762.2	0.374	14.01	3.054
N.S	Sand	177.9	7945	2.68	350.8	70.18	186.7	8941	2.58	360.9	73.49
N.S	S.90%+V 10%	366.4	11500	2.85	384.3	86.35	352.6	9931	2.92	388.3	83.23
N.S	S 80%+ V 20%	453.3	17610	3.08	644.0	140.3	440.8	16050	3.25	635.8	126.9
N.S	S 70% + V 30%	366.4	17320	2.93	563.8	124.0	353.0	14940	2.84	585.2	119.7
N.S	Perlite	197.3	8127	2.23	283.3	44.63	174.7	8296	2.42	284.5	52.95
N.S	P.90%+V 10%	335.1	10130	2.85	339.8	69.97	318.3	10370	2.89	354.7	70.93
N.S	P 80%+ V 20%	357.7	18420	2.83	613.5	135.8	339.7	15120	2.84	617.8	130.3
N.S	P 70% + V 30%	338.3	17790	3.08	575.8	120.3	325.4	13870	3.00	552.9	110.7
C.T	Sand	168.4	8380	2.30	251.5	47.00	175.6	227.9	2.50	253.0	53.50
C.T	S.90%+V 10%	309.5	10320	2.33	279.8	56.75	296.3	11110	2.42	291.3	66.50
C.T	S 80%+ V 20%	308.0	17330	2.40	436.8	85.75	301.2	16650	2.50	444.5	103.8
C.T	S 70% + V 30%	316.7	13390	2.33	476.3	96.50	302.5	17350	2.58	482.5	111.8
C.T	Perlite	200.6	8107	2.30	225.0	44.75	188.9	9063	2.34	237.0	55.75
C.T	P.90%+V 10%	275.1	9964	2.40	309.8	72.75	262.8	10020	2.67	314.0	72.75
C.T	P 80%+ V 20%	301.9	15430	2.43	438.8	94.50	289.7	17680	2.59	431.3	100.3
C.T	P 70% + V 30%	303.0	13140	2.35	485.8	97.00	283.7	16350	2.42	466.5	110.0
V.L	Sand	175.0	7945	2.25	244.5	45.43	176.8	8916	2.33	248.0	56.50
V.L	S.90%+V 10%	317.8	8904	2.33	279.7	53.16	313.8	10450	2.50	292.0	56.25
V.L	S 80%+ V 20%	304.6	14760	2.68	486.5	94.66	299.8	17270	2.33	483.5	93.75
V.L	S 70% + V 30%	330.2	14680	2.60	468.8	100.7	322.1	13140	2.67	469.5	104.3
V.L	Perlite	206.7	7823	2.35	224.6	40.70	197.3	8463	2.33	217.8	45.25
V.L	P.90%+V 10%	291.8	10970	2.40	326.7	66.09	283.8	9806	2.59	336.5	76.25
V.L	P 80%+ V 20%	328.8	13930	2.60	472.0	103.9	316.3	13920	2.75	454.0	114.8
V.L	P 70% + V 30%	308.3	14190	2.68	442.8	92.99	283.6	11470	2.75	441.8	105.0
	L.S.D $_{at\ 0.05}$	16.26	1013	0.40	12.86	6.85	7.873	1116	0.5473	20.51	4.47

Sand 90 %: vermicompost 10 %, sand 80 %: vermicompost 20 %, sand 70 %: vermicompost 30 %, perlite 90 %: vermicompost 10%, perlite 80 %: vermicompost 20 %, perlite 70%: vermicompost 30%.

Table 6. Effect of different nutrient solution and different substrates and their interaction on chemical composition of snap bean leaves during 2012-2013 and 2013-2014 seasons.

	Treatment	First season			second season		
		N	P	K	N	P	K
	N.S	2.96	0.458	2.23	2.84	0.456	2.18
	C.T	2.54	0.417	2.26	2.54	0.416	2.18
	V.L	2.71	0.353	2.22	2.63	0.357	2.14
	L.S.D at 0.05	0.163	0.048	n.s	0.083	0.340	n.s
	Sand	2.70	0.377	2.37	2.64	0.372	2.31
	S.90%+V 10%	2.46	0.341	2.22	2.22	0.349	2.13
	S 80%+ V 20%	2.46	0.370	2.39	2.42	0.366	2.28
	S 70% + V 30%	2.41	0.305	1.99	2.38	0.315	1.90
	Perlite	2.86	0.455	2.25	2.82	0.459	2.22
	P.90%+V 10%	3.25	0.534	2.52	3.22	0.520	2.34
	P 80%+ V 20%	2.94	0.488	2.38	2.96	0.491	2.34
	P 70% + V 30%	2.81	0.404	1.77	2.70	0.405	1.85
	L.S.D at 0.05	0.183	0.031	0.374	0.146	0.031	0.053
N.S	Sand	2.35	0.300	2.54	2.43	0.308	2.46
	S.90%+V 10%	2.55	0.318	2.30	2.32	0.326	2.15
	S 80%+ V 20%	2.53	0.445	2.43	2.37	0.431	2.35
	S 70% + V 30%	2.43	0.283	1.91	2.47	0.316	1.96
	Perlite	2.94	0.556	2.24	2.81	0.543	2.19
	P.90%+V 10%	3.84	0.773	2.32	3.62	0.707	2.25
	P 80%+ V 20%	3.58	0.536	2.39	3.43	0.553	2.34
	P 70% + V 30%	3.45	0.456	1.74	3.28	0.466	1.77
C.T	Sand	3.14	0.531	2.40	3.16	0.502	2.38
	S.90%+V 10%	2.47	0.411	2.27	2.10	0.420	2.16
	S 80%+ V 20%	2.49	0.364	2.39	2.59	0.374	2.29
	S 70% + V 30%	2.49	0.399	1.83	2.48	0.383	1.84
	Perlite	2.68	0.453	2.33	2.65	0.463	2.24
	P.90%+V 10%	2.65	0.350	2.61	2.71	0.362	2.34
	P 80%+ V 20%	2.21	0.440	2.48	2.48	0.446	2.41
	P 70% + V 30%	2.21	0.386	1.76	2.14	0.379	1.83
V.L	Sand	2.60	0.301	2.18	2.33	0.308	2.08
	S.90%+V 10%	2.38	0.294	2.09	2.25	0.301	2.07
	S 80%+ V 20%	2.37	0.302	2.37	2.29	0.293	2.20
	S 70% + V 30%	2.31	0.232	2.25	2.18	0.246	1.92
	Perlite	2.97	0.358	2.19	3.00	0.370	2.22
	P.90%+V 10%	3.26	0.481	2.63	3.32	0.491	2.44
	P 80%+ V 20%	3.04	0.488	2.27	2.98	0.474	2.27
	P 70% + V 30%	2.78	0.369	1.83	2.66	0.372	1.96
	L.S.D at 0.05	0.268	0.0448	0.547	0.214	0.0447	0.0774

Sand 90 %: vermicompost 10 %, sand 80 %: vermicompost 20 %, sand 70 %: vermicompost 30 %, perlite 90 %: vermicompost 10%, perlite 80 %: vermicompost 20 %, perlite 70%: vermicompost 30%.

Moreover**, (Kumari and Ushakumari, 2002** and **Quaik *et al*., 2012a)** found that treatment with enriched vermicompost was superior to other treatments for the uptake of N, P, K, Ca and Mg by cowpea. Vermicompost contain nutrients in forms that are readily taken up by the plants such as nitrates, exchangeable phosphorus, and soluble potassium, calcium, and magnesium.

Data in Table (7) indicate the effect of different studied nutrient solution and substrates as well as their interaction on green pods yield and its physical traits expressed as average pod weight, length and diameter during both season of growth.

Concerning the effect on nutrient solution, the same data in Table 7 show that there were significant differences in all determined yield parameters i.e., early and total pods yield / m^2 and produced pods quality (average pod weight, length and diameter) as a result of tested nutrient solution sources (chemical nutrient solution, compost tea and vermi-liquid) during both seasons of growth. In this concern, using chemical nutrient solution reflected the highest values in early and total yield as well as pods physical quality traits followed by using compost tea and vermi-liquid in descending order during the two seasons of growth.

Table 7. Effect of different nutrient solution and different substrates and their interaction on yield quality characteristics of snap beans plants during 2012 / 2013 and 2013 / 2014 seasons**.**

	Treatment	First season									
		Early yield g/m^2	Total yield g/m^2	Pod length (cm)	Pod diameter (cm)	Pod weight (g)	Early yield g/m^2	Total yield g/m^2	Pod length (cm)	Pod diameter (cm)	Pod weight (g)
	N.S	**1306**	**6270**	**14.00**	**0.78**	**5.68**	**1390**	**6371**	**13.81**	**0.77**	**6.09**
	C.T	**1212**	**5444**	**13.59**	**0.73**	**5.33**	**1232**	**5487**	**13.41**	**0.73**	**5.53**
	V.L	**1145**	**5625**	**13.69**	**0.73**	**5.28**	**1154**	**5824**	**13.50**	**0.73**	**5.37**
	L.S.D at 0.05	**68**	**194**	**0.35**	**0.06**	**0.12**	**184**	**261**	**0.36**	**0.03**	**0.123**
	Sand	**728.0**	**3872**	**13.79**	**0.72**	**4.96**	**748.7**	**4155**	**13.31**	**0.74**	**5.08**
	S.90%+V 10%	**1421**	**6368**	**13.42**	**0.75**	**5.59**	**1477**	**6570**	**13.32**	**0.77**	**5.73**
	S 80%+ V 20%	**1494**	**6947**	**13.52**	**0.76**	**5.48**	**1552**	**6897**	**13.55**	**0.74**	**6.01**
	S 70% + V 30%	**1461**	**6935**	**13.76**	**0.77**	**5.65**	**1501**	**7035**	**13.49**	**0.74**	**5.71**
	Perlite	**708**	**3709**	**13.51**	**0.74**	**5.38**	**711**	**3685**	**13.42**	**0.72**	**5.46**
	P.90%+V 10%	**1152**	**5250**	**13.83**	**0.76**	**5.43**	**1176**	**5406**	**13.74**	**0.75**	**5.79**
	P 80%+ V 20%	**1346**	**6500**	**14.00**	**0.74**	**5.44**	**1418**	**6625**	**13.74**	**0.75**	**5.78**
	P 70% + V 30%	**1458**	**6656**	**14.27**	**0.73**	**5.46**	**1485**	**6778**	**14.00**	**0.74**	**5.77**
	L.S.D at 0.05	**91.6**	**282**	**0.34**	**n.s**	**0.13**	**118**	**421**	**0.314**	**n.s**	**0.114**
N.S	**Sand**	**728.0**	**3631**	**14.00**	**0.75**	**5.33**	**734**	**4016**	**13.50**	**0.78**	**5.53**
	S.90%+V 10%	**1347**	**6877**	**14.00**	**0.78**	**6.23**	**1487**	**7304**	**13.75**	**0.80**	**6.48**
	S 80%+ V 20%	**1446**	**7347**	**13.75**	**0.80**	**5.53**	**1594**	**7259**	**14.00**	**0.75**	**6.45**
	S 70% + V 30%	**1605**	**7684**	**14.00**	**0.80**	**6.45**	**1675**	**7573**	**13.75**	**0.80**	**6.18**
	Perlite	**784.0**	**3984**	**14.00**	**0.80**	**5.40**	**813**	**3920**	**14.00**	**0.73**	**5.50**
	P.90%+V 10%	**1320**	**6119**	**14.25**	**0.80**	**5.63**	**1382**	**6359**	**14.00**	**0.80**	**6.15**
	P 80%+ V 20%	**1515**	**6834**	**14.00**	**0.78**	**5.25**	**1671**	**7019**	**13.50**	**0.78**	**6.23**
	P 70% + V 30%	**1702**	**7683**	**14.00**	**0.78**	**5.63**	**1765**	**7517**	**14.00**	**0.75**	**6.25**
C.T	**Sand**	**617.0**	**3374**	**13.75**	**0.70**	**4.55**	**607**	**3285**	**13.00**	**0.75**	**5.15**
	S.90%+V 10%	**1504**	**6375**	**13.00**	**0.75**	**5.28**	**1540**	**6469**	**13.00**	**0.75**	**5.20**
	S 80%+ V 20%	**1592**	**6599**	**13.50**	**0.75**	**5.45**	**1581**	**6438**	**13.50**	**0.73**	**6.23**
	S 70% + V 30%	**1372**	**6250**	**13.50**	**0.75**	**5.28**	**1424**	**6268**	**13.25**	**0.73**	**5.45**
	Perlite	**648.0**	**3451**	**13.25**	**0.68**	**5.48**	**652**	**3516**	**13.00**	**0.73**	**5.35**
	P.90%+V 10%	**1196**	**5536**	**13.25**	**0.73**	**5.50**	**1223**	**5597**	**13.50**	**0.70**	**5.63**
	P 80%+ V 20%	**1373**	**5972**	**14.00**	**0.73**	**5.50**	**1428**	**5816**	**14.00**	**0.75**	**5.63**
	P 70% + V 30%	**1393**	**5993**	**14.50**	**0.73**	**5.48**	**1401**	**6509**	**14.00**	**0.73**	**5.60**
V.L	**Sand**	**839.0**	**4610**	**13.63**	**0.72**	**5.01**	**905**	**5164**	**13.42**	**0.71**	**4.55**
	S.90%+V 10%	**1413**	**5852**	**13.25**	**0.73**	**5.28**	**1403**	**5937**	**13.23**	**0.75**	**5.51**
	S 80%+ V 20%	**1443**	**6895**	**13.30**	**0.74**	**5.45**	**1480**	**6995**	**13.15**	**0.74**	**5.34**
	S 70% + V 30%	**1407**	**6872**	**13.77**	**0.77**	**5.22**	**1403**	**7265**	**13.48**	**0.71**	**5.52**
	Perlite	**692.0**	**3692**	**13.28**	**0.75**	**5.25**	**669**	**3621**	**13.25**	**0.72**	**5.53**
	P.90%+V 10%	**940.0**	**4094**	**14.00**	**0.74**	**5.15**	**924**	**4261**	**13.73**	**0.75**	**5.59**
	P 80%+ V 20%	**1150**	**6695**	**14.00**	**0.71**	**5.58**	**1155**	**7041**	**13.73**	**0.72**	**5.48**
	P 70% + V 30%	**1278**	**6292**	**14.30**	**0.70**	**5.27**	**1289**	**6308**	**13.99**	**0.75**	**5.47**
	L.S.D at 0.05	**110**	**413**	**0.50**	**0.077**	**0.18**	**110**	**616.3**	**0.163**	**0.0774**	**0.167**

Sand 90 %: vermicompost 10 %, sand 80 %: vermicompost 20 %, sand 70 %: vermicompost 30 %, perlite 90 %: vermicompost 10%, perlite 80 %: vermicompost 20 %, perlite 70%: vermicompost 30%.

Such increments in produced pods yield and its quality as a result of the application of chemical nutrient solution may be attributed to the presence of nutrient elements in balanced and mineral form more available to absorb by plants. Obtained results are in agreement with those reported by **George *et al*., 2007**, **Gutiérrez-Miceli *et al*., 2008**, **Abou-El-Hassan *et al*., 2008.**

As for the effect of different tested substrates, the same data in Table 7 indicate that addition of vermicompost at different used ratios to both sand and perlite significantly increased all measured yield and its traits compared with using sand and perlite alone without addition (control).

In this respect, adding vermicompost to both sand and perlite at rate of 20 or 30 % reflected the highest values in all determined pods yield and its quality traits. In addition, using the mixture of sand with vermicompost was more superior compared with the substrate mixture of perlite plus vermicompost. Obtained results are similar to those reported by **Ramachandra *et al*., (1998)** on peas, **Arancon *et al*., (2002)** on tomato and **(Arancon *et al*., 2004)** on strawberry**.**

In addition, there is evidence that vermicompost added to plant media increases growth, flowering and fruiting of vegetables; **Atiyeh *et al*., 2000a** showed the highest yield on tomatoes when Metro-Mix 360 was mixed with 20% pig manure vermicompost and some field crops also show an increase in vegetable growth at low application rates of vermicompost (20 or 30%) reverse that using higher rate from 40: 100%. Mentioned by **Arancon *et al*., 2008, Amir and Fouzia, 2011** on *Pisum sativum* and **Abul-Soud *et al*., (2014a)** on peas. With regard to the effect of the interaction, the same data reveal that using chemical nutrient solution combined with substrate of perlite or sand with the addition of vermicompost at the highest used rate of 20% or 30% exhibited the highest values in all determined yield parameters during both seasons of study. These results are in agreement with **Senthilkumar *et al*., 2004** on rose.

Conclusion

The sustainment management of organic urban wastes could be performed sustainable source of substrate amendment and nutrient solution as a worm compost and vermi-liquid respectively. The further objective of mitigate greenhouse gases (GHG) save environment, nutrient resource and essential nutrients, Achieving by vermicomposting technique implementation. The recommended under these study could be summarized in using sand was more economical effusion than perlite and the best rate of applied vermicompost was 20 %, (sand+ vermicompost (80+20 v/v)) with nutrient solution.

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استخدام مخرجات الكمر بدودة الأرض فى مزارع البيئات لإنتاج الفاصوليا

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تم اجراء التجربة خلال الموسم النيلى 2012–2013 / 2013– 2014بموقع الزراعة المحمية بالدقى المعمل المركزى للمناخ الزراعى – مركز البحوث الزراعية – الجيزة – مصر تحت صوبة بلاستيكية غير مدفئة مزدوجة الأقبية لدراسة امكانية استخدام مكمورة دود الأرض كمحسن للبيئات المستخدمة فى زراعة البيئات بإضافة مكمورة كمبوست الدود بمستويات مختلفة (10،20،30%) مع بيئات الرمل أوالبرليت (حجم / حجم) مقارنة بالكنترول (بدون اضافة) وكذلك تاثير استخدام سائل دود الأرض و شاى الكمبوست كمحاليل مغذيه بالمقارنة بالمحلول المغذى المعدنى وكذلك التفاعل بينهما على النمو و الأنتاجية وصفات الجودة للمحصول لنباتات الفاصوليا وتم استخدام صنف الهاما وتم زراعة البذور فى 25سبتمبر فى الموسمين وقد اظهرت النتائج ان زيادة نسبة الأضافة من المكمورة من صفر الى 20 او 30% كان لها اثر ايجابى على زيادة النمو و المحصول فى الفاصوليا بينما لم يكن هناك اختلافات معنوية بين المعاملاتتن. اظهرت النتائج ان الخلط بين الرمل + مكموره الدود (20+80%) و البرليت + مكموره الدود (20+80%) سجلت اعلى النتائج من حيث صفات النمو الخضرى فى الموسمين على التوالى مقارنة بباقى المعاملات وقد تفوقت المعاملة المحتوية على الرمل + مكموره الدود (20:80%) فى المحصول المبكر والكلى فى الموسم الأول حيث اعطت 1494– 6947 جم / م ^{2} على التوالى وايضا تفوقت فى الموسم الثانى فى المحصول المبكر 1552 جم/ م^2 بينما قد تفوقت معاملة الرمل + مكموره الدود (30+70%) فى الموسم الثانى فى المحصول الكلى 7035 جم / م ^{2}. وقد اظهر التسميد بالمحلول المعدنى تفوق على بقية المعاملات فى صفات النمو و خصائص المحصول , كما اعطت معاملة البرليت + مكموره الدود (30:70%) بالتفاعل مع المحلول المعدنى اعلى امحصول مبكر (1605) وكلى (7734) (جم/ م ^{2}) على التوالى.