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INFLUENCE OF VERMICOMPOST AND PLANT DENSITY ON SUSTAINABLE PRODUCTION OF PEAS

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ABSTRACT

The need to increase the organic soil matter for sustainable production to match food security under semi-arid Egyptian conditions (high temperature, low preception, shortage of organic fertilizer etc..) led to looking for new sources of oragnic materials such as modern composting technologies and increase the effeiency of recycling. The field experiment was carried out during the two winter successive seasons of 2011 and 2012 under open field conditions in protected cultivation site, Central Laboratory for Agriculture Climate (CLAC), Agriculture Research Centre, Giza, Egypt. Peas (*Pisum sativum*), cv. Lincolin was used in this study. The study aimed to investigate the use of vermicompost as alternative organic fertilizer by different rates (15, 20 and 25 m^3/feddan) compared to cattle manure (20 m^3/feddan as a control) combained with two plant distances (30 and 50 cm) which performed in split plot design. The obtained results indicate that increasing the rate of vermicompost from 15 to 25 m^3/feddan led to increase the values of physical and chemical properties of both pea plants and yield characteristics. The highest vegetative growth characteristics were recorded by application rate of 25 m^3/feddan combined with 50 cm plant distance followed by 20 m^3/feddan combined with 30 cm compared to the other treatments. The application rate of vermicompost 25 m^3/feddan combined with plant distance 30 cm gave the highest yield of peas per feddan. Concerning, the highest fruit quality parameters were estimated under application rate of vermicompost 20 m^3/feddan combined with 50 cm. The recommended treatment under this study conditions was the use of vermicompost 25 m^3/feddan combined with 30 cm followed by 20 m^3/feddan combined with 30 cm of plant distance. The vermicomposting of organic wastes and applied it to the soil as an organic fertilizer instead of burial or inceneration led to store CO_2 in the soil and decrease its emission.

1. INTRODUCTION

Environmental degradation is a major threat confronting the world and the rampant use of chemical fertilizers contributes largely to the deterioration of environment, less agricultural productivity, loss of soil fertility and soil degradation (**Inbar *et al* 1993**). Semi-arid soils are deficient in all the necessary plant nutrients and at the same time large quantities of such nutrients found in domestic wastes and agricultural byproducts which are negligible and wasted. It is estimated that in cities and rural areas of Egypt nearly 80 million tones of organic wastes are generated annually creating disposal problems on environment, gas emessions and public health which are either burned or land filled. These wastes can be converted into valuable compost by applying vermi-composting technology. Different organic wastes can be used in vermicompost production by different species of earthworms which include horse waste (**Edwards *et al* 1998; Garg and Kaushik, 2005**); cattle dung (**Edwards *et al* 1985, 1998; Bansal and Kapoor, 2000; Kaushik and Garg, 2003**) cow slurry (**Hand *et al* 1988**); urban solid waste (**Alves and Passoni, 1997**); city leaf litter and food wastes (**Logsdon, 1994; Singh and Sharma, 2002**); paper waste and residues of plant decomposition. However, **Kamergam *et al* (1999**) mentioned that integrated effect of all the nutrients present in vermicompost increased growth of *Pisum sativum* plants in a very short period of time and gave rise to high crop

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yield as compared to pit compost and garden soil (control).

Plant density is a major factor in affecting the productivity of the yield, and is particularly important in large-seeded species such as field pea where the cost of sowing large quantities of seed become a significant issue compared to cereals (**Adisarwanto and Knight 1997; Armstrong *et al* 2008; Marcellos and Constable 1986; Matthews *et al* 2001, McMurray, 2004, McRae *et al* 2008**). Plant density can affect early ground cover (**Jettner *et al* 1998b**), competitive ability with weeds (**Lemerle *et al* 2004; Lemerle *et al* 2006**), soil surface evaporation, light interception (**Jettner *et al* 1998b**) and development of an optimum number of fruiting sites in a crop canopy to maximize grain yield (**Jettner *et al* 1998a and b**). In this regard, considerable attention has been paid by some workers on pea showed that out of the three rows spacing 20, 30 and 40 cm adopted with a constant plant spacing of 7.5 cm proved that, the closest spacing of 20×7.5 cm recorded the highest plant height. On cowpeas spacing significantly influenced the growth and yield where the maximum grain yield and net returns were obtained with 45 cm spacing. Seed rate generally influenced the plant height, number of pods/plant, number of grains/pod, and 100 grain weight and grain yield **(Sharma, 2002; Kumari and Ushakumari, 2002).** On the same crop, peas, testing four row spacing 40, 60, 80 and 100 cm exhibited that pods yield linearly decreased with the increase in row spacing showing that the least row spacing of 40 cm resulted in the highest yield (**Sajid *et al* 2012)**.

Sustainable agriculture needs sustained support of organic fertilizers and good practices of organic wastes. Vermicomposting secures friendly environment and the recycling of organic wastes creates the base for offering high nutrients value compost for sustainable agriculture. The main objectives of this study are the transferring and localize the know-how of vermicomposting besides establishing scientific base for the uses of vermicomposting in Egypt while sustained supply of organic fertilizer to soil and increase the productivity of peas take in high consider beside the investigating the effect of plant spacing on crop yield.

2. MATERIALS AND METHODS

This study was conducted out at the Protected Cultivation Site, Central Laboratory for Agriculture Climate (CLAC), Agriculture Research Centre, Giza, Egypt. The vermicomposting process was done during the summer seasons of 2011 and 2012 and the open field experiments on peas were established during the following winter seasons.

2.1. The vermicomposting proccess

The system of vermicomposting was established in 10 bins form on concrete base by using bricks banded together with cement 1.25 x 4 x 0.75 m diamensions. Each system contained 10 kg of the epigiec earthworms *Lumbriscus Rubellus* (Red Worm), *Eisenia Fetida* (Tiger Worm), *Perionyx Excavatus* (Indian Blue) and *Eudrilus Eugeniae* (African Night Crawler) which were used in the vermicomposting bins. The average worm diameter ranged btween 0.5–5 mm and the worm length between 10 to 120 mm. The epigiec earthworm consume as much as their weight of the different organic wastes.

Every day during the hot summer season, the growing beds turned and watering carefully to offer the aeration and prevent the anaropic condition. Shreded newspaper was used to cover the bins so as to minmize drying during hot summer weather and keep moisture content in the range of 60-70%. Every 21 days, the growing beds were fasting for 7 days to give the earthworms the opportunity to re-eat the cast and to avoid non composted wastes.

Mixing the different raw materials which were cattle manure + kitchen wastes + newspaper at the ratio 2 : 2 : 1 by using turning machine and pre-composting the materials for 7 to 10 days to avoid the thermphilic stage (the increase in temperature) of composting which cause the death of earthworms in vermicompost systems. The use of newspapers, cardboard and any fiber material used as a bulk material and water agent should not over than 20% of proccessing waste. The final mix were soaked in water for half to one hour to make sure that there was no any more dry parts, then put it in lines along the bed with the soaked water. The chemical composition of the different agricultural wastes is prsesnted in **Table (1)**.

2.2. The field experiment

After vermicompost isolation, the field experiment was carried out under open field conditions to investigate the effect of the three rates of vermicompost 15, 20 and 25 m^3/feddan beside the cattle manure at 20 m^3/feddan as a control for comparison. Two plant distances in the row at 30 and 50 cm were applied. The different rates of vermicompost and cattle manure added to the soil 2 weeks before the cultivation of winter peas through the preparation of soil to avoid any damage or burning of the plants.

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

Raw material	C/N ratio	Macro elements %				
		N	P	k	Ca	Mg
Cattle manure (CM)	22.00	1.83	0.56	1.38	1.13	1.06
Kitchen wastes (KW)	62.60	0.34	0.19	0.64	0.81	0.43
Newspaper (N)	166.81	0.016	0.01	0.00	0.20	0.01
CM + KW + N	67.26	0.90	0.31	0.73	0.81	0.59

Table 2. Chemical and physical analyses of the soil at Dokki site

Soil depth	Chemical properties							
	ECe mmohs	**pH**	**Ca^{++}** meg/L	**Mg^{++}** meg/L	**Na^{+}** meg/L	**K^{+}** meg/L	**Hco_{3-}** meg/L	**CL_{-}** meg/L
0 – 30 Cm	2.63	7.6	5.05	1.8	9.0	4.15	2.9	10.8
	Physical properties							
	Sand %	**Clay** %	**Silt** %	**Texture**	**SP** %	**FC** %	**WP** %	**BD** g/cm^3
	15.9	76.6	7.5	Clay	22.5	32.0	16.0	1.25

The chemical **(Chapman and Pratt 1961**) and physical properties of the clay experimental soil were determined before cultivation and vermicompost applications **(Table 2)**. The saturation point % (SP), field capacity % (FC), wilting point % (WP) and bulk density g/cm^3 (BD) of the soil were determined according to **Israelsen & Hansen (1962).** The organic soil matter of the experiment was determined before vermicompost application and after two months from harvesting the peas in both the first and second seasons. The remain canopy of peas was chopped and turned over with the soil for increasing the organic soil matter.

Peas (*Pisum sativum, L*), cv. Lincolin was used in this study. Sowing was done at the first of October for the two seasons. Pea seeds soaked overnight in water and treated by *Rhizobium* inoculation (microbin) to encourage both germination and microbial nodules. Two seeds were placed at 30 and 50 cm in the row where the distance between the rows was 60 cm (2 rows/bed) and between the beds was 70 cm. Pea plants were irrigated by using drippers of 4 l/hr capacity. The chemical fertilizers were injected within irrigation water system. The fertigation was programmed to work 2 times / day and the duration of irrigation time depended upon the season. All the other agriculture practices of peas cultivation were in accordance with the standard recommendations for commercial growers by Agriculture Research center (ARC). Ministry of Agriculture, Egypt.

Plant height (cm), number of branches / plant, dry weight (g / plant), total leaves area (cm^2) estimated by using leaf area meter, leaf area index, total chlorophyll content (mg/g) determined by using spectrophotometer (**Wettstein, 1957)**. Total yield of green pods (tone/feddan), No. of pods / plant, yield of dry seed (kg/feddan), weight of 100 dry seeds (g), No. of dry seeds/plant, protein content (%) and total carbohydrate (%) of dry seeds were determined at the harvesting stages acording to **Smith *et al* (1956).**

For mineral analysis of leaves and dry seeds (N, P and K %) determinations take place at the beginning of fruiting stage and at the end of harvesting, Three samples of the plant and seeds from each plot were dried at 70ºC in an air forced oven for 48 h. Dried leaves and seeds were digested in H_2SO_4 according to the method described by **Allen (1974)** and N, P and K contents were determined in the acid digested solution by colorimetric method (ammonium molybdate) using spectrophotometer and flame photometer **Chapman and Pratt, (1961**). Total nitrogen was determined by Kjeldahl method according to the procedure described by **FAO (1980).** Phosphorus content was determined by using spectrophotometer according to **Watanabe and Olsen (1965).** Potassium content was determined photo-metrically using the Flame photometer as described by **Chapman and Pratt (1961)**.

The calculations of sequestrate CO_2 and save the nutrients in the soil were calculated as follows:

Sequestrate CO_2 (Kg/tone) = C% (raw material) x 10
Nutrient save (Kg/tone) = Nutrient % (after composting) x 10

The experimental design was split plot with 3 replicates where vermicompost rates and control were assigned as main plots and plant distances as subplots. Analysis of the data was done by computer, using SAS program for statistical analysis and the differences among means for all traits were tested for significance at 5 % level **(Waller and Duncan 1969).**

3. RESULTS AND DISCUSSION

3.1. The effect of vermicomposting proccess on raw materials

The results in **Table (3)** showed that the vermicomposting proccess increased the total N, P, K, Ca and Mg % of the vermicompost as compared to that of the raw materials while C/N ratio decreased as a result of N fixation, concentrated the nutrients and bulk reduction.

The vermicomposting proccess through using *Lumbriscus Rubellus* (Red Worm), *Eisenia Fetida* (Tiger Worm), *Perionyx Excavatus* (Indian Blue) and *Eudrilus Eugeniae* (African Night Crawler) led to produce rich, dark, earth-smelling soil conditioner from neglectable sources of raw materials and offer organic fertilizer for sustainable agriculture. It should be realized that vermicomposting allows obtaining organic sources of nutrients for the crops in relatively less time, which are physically, nutritionally and biochemically improved in the obtained composts. Never the less, vermicomposting is defined as a low cost technology system for processing organic wastes (**Hand *et al* 1988**). More information proved that earthworms act as mechanical blenders besides fragmenting the organic matter which modify its physical and chemical status by gradually reducing the ratio of C:N and increasing the surface area exposed to microorganisms inducing much more favorable media for microbial activity and further decomposition **(Domínguez *et al* 2010)**. In addition, the nutrient save (Kg/tone) via using vermicomposting proccess from nonsignificant organic sources such as kitchen wastes and newspapers gave good evidences on recycling the urban organic wastes and the application of the output. Needless to say that the most important point of utilizing vermicomposting was mitigating the CO_2 emission through sequestration of the organic carbon into the soil. However, the determined calaculation measured the organic carbon of organic wastes used in this study that treated by vermicomposting and stored in the soil was estimated by 605.3 Kg per each tone.

3.2. The effect of organic application on organic soil matter

The data in **Fig. (1)** show the organic soil matter content (%) of the soil's experiment which was meseaured before the first season application of vermicompost and after 1.5 months from harvesting peas in both seasons. The obtained results presented that the increase of vermicompost rate from 15 to 25 m^3/feddan consequantly increased the organic soil matter content (%). On the other hand, the application of in-row plant space of 30 cm recorded the higher value of organic soil matter content (%) compared to 50 cm. The increase in organic soil matter content (%) induced gradual increases during the management of organic fertilizer and the recycling of peas canopy into the soil. The sustainable production was affected to great extend by the increase of organic soil matter content (%) which in turn increased the soil fertility. However, the highest value of organic soil matter content (%) resulted from addition of vermicompost rate at 25 m^3/feddan that compined with 30 cm plant distance followed by 20 m^3/feddan compined with 30 cm. It is reasonable to say that adding of vermicompost increased the surface area, provides strong absorbability, retained more nutrients for a longer period of time, had significantly greater soil bulk density and less compactness (**Lunt and Jacobson, 1994**).

The recycling of organic wastes for maintenance of soil health by hygienic methods is vital for increasing crop production and welfare of mankind. The incorporation of organic matter remain in the form of compost, farmyard manure, cereal residue and green manure which influence favorably the physical, chemical and biological properties of the soil. It was reported that composting is the most important and rewarding method for increasing agricultural output by raising the level of soil fertility through improving the long-term structural stability, moisture retention of the soil and the supply of plant nutrients **(Dalzell *et al* 1987)**. The current study focus on the organic soil matter content as a strong indicator while much of the research work on vermicompost has focused on studying plant

Table 3. The chemical composition (%) of the raw material before and after vermicomposting and nutrient save (Kg / tone)

Vermicomposting	C/N ratio	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Before	67.26	0.90	0.31	0.73	0.81	0.59
After	12.8	1.46	0.59	1.06	1.08	0.89
Nutrient Save (Kg/tone)	605.3	14.6	5.9	10.6	10.8	8.9

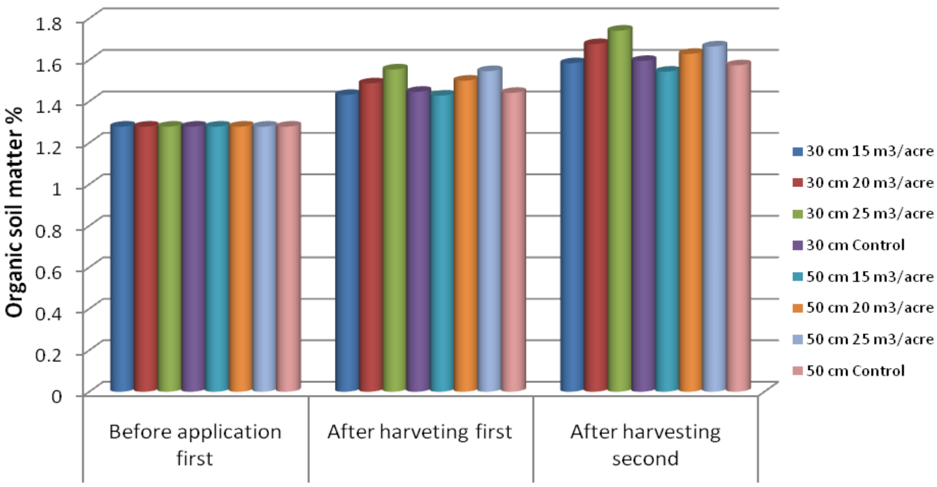

Fig. 1. The effect of vermicompost applications and plant spacing on average of organic soil matter content of the soil's experiment

available nutrients and changes in soil structure via soil porosity, aeration, and moisture holding capacity. (**Hashemimajd *et al* 2004** and **Tejada *et al* 2010**). From another point of view, aging of vermicompost has been studied focusing on microbiological or physical/chemical changes for up to 60 days duration (**Aira *et al* 2007**).

3.3. The effect of vermicompost and plant distances on properties of peas plant

The results in **Table (4)** illustrate the effects of vermicompost rates, planting distances and their interaction on some physical and chemical propertis of pea plant. Regarding the effect of vermicompost rate, the data of plant height, No. of branches / plant, dry weight, total leaves area, leaf area index, total chlorophyll content, N, P and K leaves content are presented in **Table (4)**. The results indicate that the increase of the vermicompost rate from 15 to 25 m^3/feddan led to significant increase in the above mentioned data except P content. This tendency of the increase in the previous characteristics may be due to the increase in the soil organic matter and the mineral content. However, there was no significant difference between 20 and 25 m^3/feddan of vermicompost. The treatment of cattle manure 20 m^3/feddan (control) recorded significantly the second level after the treatments of 20 and 25 m^3/feddan of vermicompost.

The in-row plant distance of 50 cm gave the highest figures of physical and chemical properties of pea plant exept leaf P content (%) as compared to 30 cm. Increasing in-row plant distance led to enhence the vegetative growth and the contents of N and K in leaves. Significant differences between treatments were true during both seasons.

The interaction between the vermicompost at 25 m^3/feddan combined with in-row distance 50 cm followed by 20 m^3/feddan combined with in-row space 50 cm recorded the highest results of plant height, No. of branches / plant, dry weight, total leaves area, leaf area index and the contents of total chlorophyll, N and K in leaves. These results

Table 4. Effect of vermicomposting %, planting Spaces and their interaction on some physical and chemical properties of pea plant

Treatment Vermicompost rate (A)	Plant height cm	No. of bran./ plant	Dry weight g/plant	Leaf area cm^2/plant	Leaf area index cm^2	Chlorophyll (mg/g fresh weight)	N % leaves	P % leaves	K % leaves
First season									
15 m^3/feddan	75.8 C	2.7 C	17.3 B	1208 C	3.9 C	0.51 B	4.1 B	0.5 A	3.7 B
20 m^3/feddan	91.2 A	4.4 A	24.3 A	1812 A	6.4 A	0.61 A	4.4 A	0.4 B	5.0 A
25 m^3/feddan	92.5 A	4.7 A	24.7 A	1842 A	6.2 A	0.62 A	4.3 A	0.4 B	5.0 A
Control	80.5 B	4.1 B	19.8 B	1572 B	5.7 B	0.55 B	4.0 B	0.5 A	4.1 B
Planting Space (B)									
30 cm	79.8 B	3.7 B	19.4 B	1417 B	5.3 B	0.50 B	4.1 B	0.5 A	4.2 B
50 cm	90.3 A	4.3 A	23.7 A	1800 A	5.8 A	0.59 A	4.4 A	0.4 B	4.7 A
Interaction A*B									
15 m^3 * 30 cm	77.5 d	2.5 d	15.0 d	1017 e	3.5 d	0.45 b	3.8 c	0.6 a	3.5 d
20 m^3 * 30 cm	92.8 c	3.7 bc	20.7 b	1383 d	5.9 b	0.56 b	4.1 bc	0.5 b	4.5 b
25 m^3 * 30 cm	95.0 b	4.5 a	22.7 b	1833 b	6.2 a	0.66 a	4.4 ab	0.4 c	4.9 b
Control * 30 cm	86.7 d	3.9 b	19.1 c	1533 cd	5.5 b	0.48 b	3.9 c	0.5 b	4.0 c
15 m^3 *50 cm	4.9 cd	2.9 cd	19.7 c	1400 d	4.2 c	0.49 b	4.2 b	0.5 ab	3.8 d
20 m^3 * 50 cm	82.4 a	5.1 a	28.0 a	2240 a	6.8 a	0.65 a	4.7 a	0.4 c	5.5 a
25 m^3 * 50 cm	93.6 a	4.9 a	26.7 a	1900 b	6.3 a	0.59 ab	4.5 a	0.4 c	5.2 ab
Control * 50 cm	8.0 b	4.2 ab	20.4 bc	1610 c	5.9 b	0.53 b	4.1 b	0.4 bc	4.1 c
Second season									
Vermicompost rate (A)									
15 m^3/feddan	77.5 C	2.8 B	13.8 C	758 D	2.6 B	0.44 C	3.6 B	0.5 A	2.4 B
20 m^3/feddan	92.8 A	4.4 A	23.3 B	1183 B	5.8 A	0.54 B	4.1 AB	0.4 B	2.7 A
25 m^3/feddan	95.0 A	5.0 A	32.5 A	2221 A	6.4 A	0.60 A	4.6 A	0.4 B	2.8 A
Control	86.7 B	3.2 B	20.7 B	1008 C	3.5 B	0.53 B	3.7 B	0.5 A	2.5 B
Planting Space (B)									
30 cm	82.4 B	3.6 B	20.1 B	1201 B	3.9 B	0.50 B	3.8 B	0.5 A	2.5 B
50 cm	93.6 A	4.1 A	25.1 A	1383 A	5.2 A	0.57 A	4.3 A	0.4 B	2.7 A
Interaction A*B									
15 m^3 * 30 cm	75.0 c	2.7 b	10.3 d	695 f	2.1 b	0.42 b	3.5 b	0.6 a	2.3 b
20 m^3 * 30 cm	80.0 b	3.9 ab	21.8 bc	1195 c	5.3 a	0.48 b	3.8 ab	0.4 a	2.6 a
25 m^3 * 30 cm	90.0 b	4.6 a	30.0 a	1170 c	5.6 a	0.59 a	4.2 a	0.4 ab	2.6 a
Control * 30 cm	84.7 b	3.0 b	18.3 c	945 e	2.7 b	0.49 b	3.6 b	0.5 a	2.4 b
15 m^3 *50 cm	80.0 b	2.8 b	17.3 c	820 e	3.1 b	0.46 b	3.7 b	0.5 a	2.6 ab
20 m^3 * 50 cm	105.7 a	4.9 a	35.1 a	2471 a	6.3 a	0.57 a	4.5 a	0.4 b	2.7 a
25 m^3 * 50 cm	100.0 a	5.3 a	24.9 b	1971 b	7.2 a	0.62 a	5.0 a	0.4 b	2.9 a
Control * 50 cm	88.7 b	3.3 b	23.0 b	1070 d	4.3 ab	0.56 a	3.9 a	0.5 a	2.5 b

* Similar letters indicate non-significant at 0.05 levels.
** Control = 20 m^3 cattle manure / feddan.

coincided with that recommended on vermicompost application for encourging plant growth and quality through increase the available forms of nutrients (nitrates, exchangeable P, K, Ca and Mg) for plant uptake of red clover and cucumber **(Sainz *et al* 1998),** cowpea **Kumari and Ushakumari (2002**), straw berry (**Arancon *et al* 2004)** and rose **(Senthilkumar *et al* 2004),** Vermicomposts are comprised of large amounts of humic substances which release nutrients relatively slowly in the soil that improve its physical and biological properties of soil and in turn rise to much better plant quality (**Muscolo *et al* 1999).**

3.3.2. The effect of vermicompost and plant distances on the properties of yield

The results of using the vermicompost on the green pods total yield, No. of pods / plant, yield of dry seed, weight of 100 dry seeds, No. of dry seeds/plant and the dry seed content of N, P, K, protein and total carbohydrate are presented in **Table (5)**. The results indicated that increasing the

Table 5. Effect of vermicomposting %, planting spaces and their interaction on some chemical properties, yield and yield quality of pea green and dry seeds

Treatment / Vermicompost rate (A)	N % dry seed		P % dry seed		K % dry seed		Protein % dry seed		Total Carboh. %		No. of pods/plant		Green pods yield ton/Fed		Yield of dry seed Kg/fed		Weight of 100 dry seed (g)	
First season																		
15 m^3/feddan	3.4	B	0.52	A	2.5	C	23	C	35.9	A	10.5	C	3.4	C	808	B	20.1	C
20 m^3/feddan	4.0	A	0.38	C	2.8	A	25	A	33.1	C	18.1	A	6.8	A	988	A	23.8	A
25 m^3/feddan	4.0	A	0.38	C	2.7	A	25	A	33.1	C	18.2	A	7.1	A	1104	A	22.6	B
Control**	3.5	B	0.45	B	2.6	B	24	B	34.6	B	16.3	B	5.9	B	843	B	22.4	B
Planting Space (B)																		
30 cm	3.5	B	0.46	A	2.6	B	24	B	34.6	A	14.2	B	5.8	A	1020	A	20.9	B
50 cm	3.9	A	0.40	B	2.7	A	25	A	33.7	B	17.4	A	5.0	B	898	B	23.0	A
Interaction A*B																		
15 m^3 * 30 cm	3.2	c	0.55	a	2.4	d	22	c	36.2	a	9.0	d	3.4	c	863	bc	19.7	d
20 m^3 * 30 cm	3.6	bc	0.45	b	2.7	b	24	ab	33.7	cd	15.0	c	6.7	a	917	b	21.6	c
25 m^3 * 30 cm	4.0	ab	0.39	bc	2.7	ab	25	a	33.3	d	17.8	bc	6.9	a	1000	b	21.2	c
Control * 30 cm	3.3	c	0.47	ab	2.5	c	24	b	35.2	b	15.3	c	6.1	b	933	b	21.3	c
15 m^3 *50 cm	3.6	b	0.50	a	2.5	c	24	b	35.5	b	12.0	cd	3.4	c	733	c	20.6	cd
20 m^3 * 50 cm	4.3	a	0.31	c	2.8	a	25	a	32.4	e	20.8	a	6.8	a	1000	b	25.9	a
25 m^3 * 50 cm	4.1	a	0.36	c	2.7	b	25	a	32.9	e	21.1	a	7.2	a	1183	a	23.3	b
Control * 50 cm	3.6	b	0.43	b	2.7	bc	24	a	34.1	c	17.3	b	5.7	b	833	c	22.8	bc
Second season																		
Vermicompost rate (A)																		
15 m^3/feddan	3.5	B	0.53	A	2.4	B	22	C	37.0	A	9.0	C	3.3	C	626	C	22.1	C
20 m^3/feddan	3.7	AB	0.43	B	2.7	A	23	B	35.5	A	15.9	B	4.4	B	850	B	24.7	A
25 m^3/feddan	4.0	A	0.37	B	2.8	A	24	A	34.1	B	21.4	A	5.6	A	1040	A	24.1	A
Control	3.6	B	0.52	A	2.5	B	22	B	37.0	A	15.5	B	4.0	B	793	B	22.9	B
Planting Space (B)																		
30 cm	3.6	B	0.49	A	2.5	B	23	B	36.4	A	17.0	A	4.7	A	926	A	23.0	B
50 cm	3.8	A	0.44	B	2.7	A	23	A	35.4	B	13.8	B	3.9	B	711	B	24.5	A
Interaction A*B																		
15 m^3 * 30 cm	3.3	b	0.55	a	2.3	b	21	d	37.5	a	7.0	f	3.8	bc	750	c	21.7	c
20 m^3 * 30 cm	3.7	b	0.45	a	2.6	a	23	c	35.9	bc	14.2	d	4.7	b	917	b	23.1	c
25 m^3 * 30 cm	3.9	a	0.41	b	2.6	a	23	bc	34.6	de	19.6	bc	6.2	a	1339	a	24.7	b
Control * 30 cm	3.6	b	0.53	a	2.4	b	22	cd	37.5	a	14.5	cd	4.3	b	807	bc	22.6	c
15 m^3 *50 cm	3.7	ab	0.50	a	2.6	ab	22	c	36.4	ab	11.1	e	3.8	bc	502	d	22.5	c
20 m^3 * 50 cm	3.8	a	0.41	b	2.7	a	24	ab	35.0	cd	17.4	c	4.1	b	783	c	25.2	ab
25 m^3 * 50 cm	4.1	a	0.43	b	2.9	a	25	a	33.6	e	23.2	a	5.0	ab	850	b	26.6	a
Control * 50 cm	3.7	ab	0.51	a	2.5	b	23	c	36.5	a	16.4	c	3.8	bc	710	c	23.7	bc

* Similar letters indicate non-significant at 0.05 levels.
** Control = 20 m^3 cattle manure / feddan

vermicompost rates from 15 to 25 m^3/feddan increased total yield, No. of pods / plant, yield of dry seed, weight of 100 dry seeds, No. of dry seeds/plant, the contents of N and K and protein. On the other hand, the increase in vermicompost rate led to decrease P content in dry seed and total carbohydrates.

The data in **Table (5)** illustrate that applying in-row plant distance 50 cm presenteded the higher values of No. of pods / plant, weight of 100 dry seeds, No. of dry seeds/plant, the contents of dry seed N and K and protein while the higher values of total green pods yield, dry seed yield, the content of P in dry seed and total carbohydrate were recorded by the application of in-row plant space 30 cm.

The application of vermicompost 25 m^3/feddan combined with in-row distance 30 cm gave rise to the highest green pods total yield, No. of pods / plant and dry seed yield. On the other hand, the treatment of 25 m^3/feddan combined with in-row distance of 50 cm gave the highest values of 100 dry seeds weight, the contents of dry seed N, K and protein.

Evidances cuaght up from the literature focusing on vermicompost application support our previous results on different crop such as tomato (**Patil *et al* (1998)** and **Arancon *et al* (2003),** peas **(Ramachandra *et al* (1998) and** strawberry **(Arancon *et al* 2004)** which showed that the application of vermicompost enhanced soil fertility and improved soil properties beside increased growth and yield of *Pisum sativum* **(Amir and Fouzia, 2011).**

CONCLUSION

Mitigating CO_2 emission and sequestrate organic matter into the soil, which increase soil fertility and sustainability, recycling neglectable organic sources led to the increase of pea plants production, utilize of vermicomposting proccess.

Much of the research on vermicompost has focused on studying plant available nutrients and changes in soil structure and fertility. But the most viable indicator should be the organic soil matter content and its monitoring which are absent in most of studies. A high value compost could be obtained through the proper management of organic wastes (vegetables, fruits and newspaper wastes, etc) beside the animal manures via vermicomposting technology. From our results, it can be recommended that the vermicompost rate of 20 m^3/feddan combined with in-row plant distance of 50 cm is the most obvious in yielding the highest peas production.

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