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UTILIZATION OF RICE STRAW AND VERMICOMPOST IN VEGETABLE PRODUCTION VIA SOILLESS CULTURE

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ABSTRACT

The need to recycle organic agricultural and urban wastes is not just for environmental issues but also for economical and sustainable advantages. The current studies were conducted during winter and summer seasons on lettuce and egg plant respectively of 2011/2012 and 2012/2013 at Central Laboratory for Agricultural Climate (CLAC), Dokki, Agricultural Research Center (ARC), Giza governorate, Egypt. The main objectives were investigating the ability of use rice straw and vermicompost as a substrate instead of peat moss or perlite in substrate culture and to determine the effect of treatments on vegetative growth, nutrients content (nitrogen, phosphors, potassium), as well as total yield of lettuce and egg plant. Different sizes of chopped rice straw (8-10, 6-8, 4-6 and less than 2 mm) combined with three vermicompost levels (5%,10% and 15% v/v) were applied in horizontal bags of substrate culture. Lettuce plant (*Lactuca sativa* L.) iceberg was transplanted in October and eggplant (*Solanum melongena* L.) was transplanted in February, both crops were cultivated in horizontal bags of substrate culture. The experiment design was a split- plot with three replications.

The obtained results indicated that, using rice straw in a small size less than 2 mm significantly increased plant height, number of leaves per plant, plant dry weight and increased yield for both crops lettuce and eggplant. Vermicompost at 15% gave the highest vegetative growth and yield compared with the other treatments. The smallest size of rice straw less than 2 mm combined with vermicompost 15% increased significantly vegetative growth and total yield of lettuce and eggplant. The physical and chemical properties of different mixtures varied from the first and second year. The use of rice straw and vermicompost as a substrate instead of burial or incineration led to decrease CO_2 emission, save the environmental and nutrients and at the same time introduce new method for recycling rice straw.

Keywords

Lettuce, Eggplant, Vermicompost, Chopped rice straw, Rice Straw WHC, Substrate culture, Recycle agricultural and urban wastes, Vermicomposting.

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1. INTRODUCTION

Rice is one of the most important field crops in Egypt. The agricultural sector has been producing about 4.5 million tons of rice annually; the total amount of rice straw in Egypt is about 2,978,578 tons annually. Economic Affairs Sector (EAS 2012), MALR. Most of farmer's burn rice straw in the field causing a great environmental problem that known as black clouds phenomenon each year in October. The reasons of rice straw incineration mainly regarding to the farmer's desire in vacate the land from the rice residues for planting new crop in suitable time of season and the same time the farmers face optional shortage for recycle and benefit of rice straw. Burning rice straw cause air pollution, one feddan produce 5.4 tons of carbon dioxide. Suspended particles of ashes harm the lungs and cause respiratory disease. In addition, incomplete and inefficient combustion will produce carbon monoxide and carcinogenic hydrocarbons that can cause cancer. Meanwhile, rice straw contain high nutrient value nitrogen (N), phosphorus (P), sulfur (S) and potassium (K), given the very high nutrient value. The nutrient economics, it is a big loss if the agricultural residue is not being exploited and utilized to the optimum (Rosmiza et al., 2012). There are some uses for rice straw in agriculture sector, chopped rice straw bales could be used as a growing media for vegetable cultivation instead of soil and can improve the production of pepper under greenhouse conditions for export (El-Marzoky and Abdel-Sattar, 2008).

Vermicomposting is a simple-technology, environmentally-friendly process used to treat organic waste; the effects of vermicompost on plant-soil systems are not yet fully understood (Lazcano and Dominguez, 2011). Vermicomposts contain nutrients in forms that are available to be absorbed or uptake by the plants such as nitrates, exchangeable phosphorus, soluble potassium, calcium, and magnesium. Vermicomposts have a great potential in the horticultural and agricultural industries as media for plant growth. Vermicomposts, whether used as soil additives or as components of horticultural media also, improve seeds germination and enhance rates of seedling growth and development (Medany, 2011). Vermicompost is rich in organic matter resources that have the unique ability to improve the chemical, physical, and biological characteristics of soils or growing media (Kamal et. al., 2013)

The application of vermicompost significantly increase nitrate concentration at harvest of lettuce plant Brisa cv. whereas; Marketable yield was not affected by vermicompost application (Leon et. al., 2012). Vermicompost provides strong absorbability and retention of nutrients as well and retain more nutrients for a longer period of time (Mamta et. al., 2012). Vermicompost enhance the nutrient uptake by the plants by increasing the permeability of root cell membrane, stimulating root growth and increase proliferation of root hairs (Pramanik et al., 2007). Plant height, number of leaves and fruit weight ware higher in the vermicompost treated field as compared to control and no disease incidence was observed in the fruits of vermicompost treated plot (Mamta et. al., 2012). Vermicompost increase plant heights significantly, but had no significant effect on the numbers of Leaves, but Yields of tomatoes were significantly higher when the relationship vermicompost and soil were mixed 1:1, 1:2 or 1:3, after 100 days of transplanting (Gutie´rrez-Miceli et. al., 2007)

The tomato yields in all vermicompost-treated plots were consistently greater than yields from the inorganic fertilizer-treated plots. Also there were significant increases in shoot weights, leaf areas and total fruit yields of pepper, plants from plots treated with vermicomposts compared to those from plots treated with inorganic fertilizer only. (Arancon et. al., 2003). Different studies have suggested that the use of vermicompost as part of the plant growth media can provide nutrients and retain moisture while promoting the development of crops. The vermicompost was able to satisfy the nutrient demand of tomato plants and reduces the volume of water required by this crop (Reséndez et. al., 2013).

Therefore, the study aimed to use rice straw and vermicompost in sustainable production of vegetables, mitigate CO2 emission, introduce new option for recycling rice straw through determine the most appropriate rice straw size and vermicompost rate to get the best for both vegetative and yield characters for lettuce, as leafy crop, but for eggplant to obtain high quality fruits and high yield per unit area. In addition, the study aimed also to convert the rice straw from agriculture waste product to an organic compost by the end of planting seasons.

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2. DATA AND METHODOLOGY

The experiments were carried out in the two successive seasons at (2011-2012) and (2012-2013) at Central Laboratory for Agricultural Climate (CLAC), Dokki, Giza governorate, Egypt.

Rice Straw material

Rice straw material was preparing by chopper machine (TM- E1) then milling by hammer mill (TM-1500), followed by screening into different size . Physical properties were estimated by using laboratory procedure as followed 3 samples of different Rice straw materials size were examined to evaluate physical properties included initial moisture content, water holding capacity (WHC),water releasing capacity (WRC), bulk density after determining initial moisture content, were dried for 24 h at room temperature and all of the examinations were performed on dried samples. Moisture content of the materials was measured using 10 g of sample at 105ºC for 24 h(AOAC, 1994). For determine water holding capacity (WHC), first each sample material was dried and 20 g of sample placed in plastic pans at a depth of approximately 4 cm. Then, the pans filled with water and left them to stand at room temperature (22–24°C) for 60 min. After draining excess water for 3 min, the samples were weighed to determine the percentage of water absorbed on a dry matter basis. To determine water releasing capacity (WRC), in 2 and24 h intervals after draining the excess water, the samples weighed again and amount of moisture losses in each time period was calculated based on the percentage of moisture released on a dry matter basis . The physical properties of chopped rice straw were illustrated in Table (1).

Table (1): The physical properties of chopped rice straw

Size mm	Volume CM3	Weight G	bulk density G/CM3	WHC% AFTER 2 HOUR	WRC% AFTER 24HOUR
>2	250	60	0.240	490	23
4-6	250	44	0.176	350	36
6-8	250	34	0.136	290	42
8-10	250	30	0.120	220	52

Plant material

Seeds of lettuce (Lactuca sativa L. cv. Iceberg) and eggplant (Solanum melongena L.) were grown in media composed of 70% peat-moss and 30 %vermiculite (v/v). Dates of seeding were October 20, 2011and October 29, 2012, for the first and the second seasons, for lettuce. Whereas, dates of seeding were February 25, 2012 and February 24, 2013, for the first and second seasons, for eggplant.The transplanting date was November, 15, 2011 and November, 29, 2012, for the 1st and the 2nd seasons for lettuce. The eggplant transplanting date was March, 26, 2012 and March, 24, 2013 for the 1st and the 2nd seasons. The seedlings were transplanting in the polyethylene bags as six plants of lettuce, but for eggplant were two plants for each bag.

System materials:

Horizontal polyethylene bags (90 x 25 cm with 30 L volume) were filled by different substrate mixes and placed in two rows in open substrate system. The bags were holed in the bottom to allow for drainage and laid on polyethylene plastic sheet (200 micron) to collect the drainage.

The nutrient solutions pumped via submersible pump (400 watt). Water tanks 1 m3 were used in open system of soilless culture. 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 nutrient solutions were adjusted by using EC meter to the required level (1.5 and 2.5 mmhos-1 for lettuce and egg plant respectively). The chemical compositions of chemical nutrient solution were illustrated in Table (2).

Table (2): The chemical composition of different sources of nutrient solutions

Nutrient Solution	nutrients (ppm)									
	N	P	K	Ca	Mg	Fe	Mn	Zn	B	Cu
Egg plant	200	45	300	150	60	6	0.8	0.25	0.25	0.15
Lettuce	120	25	180	90	40	6	0.8	0.25	0.25	0.15

Treatments

The experiments investigated two factors different chopped rice straw sizes and vermicompost rates. The first, four chopped rice straw cutting size (8-10, 6-8, 4-6, less than 2 mm). The second, three vermicompost rates were investigating (5%, 10%, 15% v/v). The combination of two factors presented 12 substrate mixtures treatments as follows :

A. Chopped rice straw size 8 – 10 + Vermicompost 5 %
B. Chopped rice straw size 8 – 10 + Vermicompost 10 %
C. Chopped rice straw size 8 – 10 + Vermicompost 15 %
D. Chopped rice straw size 6 – 8 + Vermicompost 5 %
E. Chopped rice straw size 6 – 8+ Vermicompost 10 %
F. Chopped rice straw size 6 – 8+ Vermicompost 15 %
G. Chopped rice straw size 4 – 6 + Vermicompost 5 %
H. Chopped rice straw size 4 – 6 + Vermicompost 10 %
I. Chopped rice straw size 4 – 6 + Vermicompost 15 %
J. Chopped rice straw size less than 2 + Vermicompost 5 %
K. Chopped rice straw size less than 2 + Vermicompost 10 %
L. Chopped rice straw size less than 2 + Vermicompost 15 %

Two different types of machines were used for cutting rice straw into different sizes. The first machine designed to chop rice straw between (10-15 cm) and the machine capacity was one ton/h. The second machine equipped with hammer mill drum and fixed knife, the machine capacity was 250kg / h, chopped rice straw size after grinding between (2mm -10mm). Rice straw was sizing into four sizes by using three different sieves 1 mm, 2mm, and 5 mm screens. After chopping and sieved the rice straw, each size mixed with different vermicompost level carefully and filled the horizontal polyethylene bags.

The chemical composition of rice straw has been determined before was used in the experiment, rice straw elements, moisture, ash, protein, (total nitrogen content x 5.7), the chemical analysis according to the (A.O.A.C., 2005) the analysis show in Table (3).

Table (3): Chemical composition of rice straw before was used as growing media.

Component	(%)
Moisture	8.4
Ash	19.3
Protein	5.3
Nitrogen	0.8
Cellulose	35
Lignin	12.2
Organic Carbon	48.1
C/N ratio	1 : 90.8

The vermicomposting proccess

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The system of vermicomposting contained 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 between 0.5 – 5 mm and the worm length between 10 to 120 mm. 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 thermophilic 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 processing waste. The final mix were soaked in water for half to one hour to make sure that there was no anymore dry parts, then put it in lines along the bed with the soaked water. The Vermicompost chemical analysis was measured before applied to treatments as presented in Table (4).

Table (4): 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

A sample of 3 plants of each plastic bag were collected after 45 days to determine number of leaves, fresh and dry head weight, lettuce head density and lettuce head volume. A sample of 2 eggplant plants of each plastic bag were collected after 60 days to determine plant height, number of leaves, total leaves area, fruits number and fruits weight. The N, P, K content was determined in leaf samples after dried at 70 oC in an air forced oven for 48 h . Dried leaves were digested in H2SO4, the fallowing mineral contents were estimated (phosphorous, potassium in the acid digested solution by colorimetric method; ammonium molybdate by spectrophotometer and flame photometer) Chapman and Pratt, 1961) .Total nitrogen was determined by Kjeldahl method according to the procedure described by (FAO 1980).

The experiment was designed in a split plot arrangement with three replicates. Rice straw cutting sizes were in the main plots, different vermicompost rates were applied in the sub plots. Analysis of data was done by computer, using SAS program for statistical analysis. The differences among means for all traits were tested for significance at 5 % level according to Waller and Duncan (1969).

3. RESULTS AND DISCUSION

3.1 The changes in substrate mixtures properties

Through the cultivation seasons of lettuce and egg plant, the volume of substrate mixtures had a real change especially in the volume and their mineral contents as a result of rice straw decomposition, N fixation and the fertigation program. The most important issue is the disposal of used substrate mixtures. Table (4) presented the chemical composition of different substrate mixtures after ending seasons that indicated; the different substrate mixtures of rice straw + vermicompost turn to mature compost. The results showed that the disposal of different substrate mixtures will be very useful to use as compost.

Increasing the rate of vermicompost led to increase the mineral contents of N, P and K while led to decrease the C/N ratio. Decreasing the size of chopped rice straw gave the same results as presented in Table (5).

The most issues of utilizing rice straw and vermicompost was mitigating the CO2 emission from the different used of organic wastes through sequestration of the organic carbon into substrate that could be utilize in ecology soilless culture of different vegetables led to more mitigation of CO2 emission that would be generated through the incineration

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of rice straw or urban wastes beside save the nutrients and restored in the soil. The results showed also that the disposal of different substrate mixtures will be very useful to use as compost.

Table (5): The physical and chemical property of different substrates mixes of first study.

		%		
Substrate	***N***	***P***	***K***	**C/N Ratio**
A	0.58	0.50	0.61	1 : 18.2
B	0.65	0.65	0.63	1 : 17.4
C	0.81	0.66	0.64	1 : 17.2
D	0.57	0.54	0.67	1 : 17.8
E	0.66	0.71	0.67	1 : 17.2
F	0.82	0.74	0.69	1: 16.9
G	0.71	0.70	0.66	1 : 14.6
H	0.78	0.71	0.69	1 : 14.3
I	0.97	0.75	0.74	1 : 13.9
J	0.81	0.78	0.75	1 : 13.4
K	0.88	0.78	0.86	1 : 12.7
L	1.03	0.91	0.97	1 : 11.8

3.2 Growth pattern

The effect of different chopped rice straw sizes and vermicompost rates on growth characters of lettuce and eggplant was presented in Tables (6 & 7). In regard to the effect of different rice straw sizes, data showed that using chopped rice straw size less than 2 mm increased number of leaves, head volume, head density and dry weight of lettuce significantly, the second rank was using (4-6 mm) chopped rice straw size. The lowest values of growth pattern were obtained by using (8-10 mm) size during the two studied seasons. The same effect was obtained in eggplant growth, the data showed that the media of chopped rice straw size less than 2 mm increased eggplant plant height, number of leaves, total leaf area, number of fruits and total fruits weight. The second rank was (4-6 mm) chopped rice straw treatment. The lowest growth pattern was obtained by (8-10 mm) size chopped rice straw treatment during the two studied seasons. The effect of rice straw size due to the change of water holding capacity of different size of rice straw as shown in (table 1)decreasing size increasing water holding capacity which effect the plant growth.

The vermicompost treatments followed the same effects on growth pattern. Data indicated that, application of vermicompost 15% obtained the highest values of growth pattern for lettuce and eggplant followed by vermicompost 10% treatment. The lowest values of growth pattern were obtained by vermicompost 5% treatment with significant differences between them during the two studied seasons.

The effect of interaction between different chopped rice straw sizes and vermicompost rates on lettuce and eggplant, data illustrated that the highest values of growth pattern were obtained by using rice straw less than 2 mm size combined with vermicompost 15% followed by (4-6 mm) chopped rice straw size with vermicompost 10%. On the other hand, the lowest growth pattern of lettuce and eggplant were obtained by using (8-10 mm) chopped rice straw size treatment with vermicompost 5% in both studied seasons.

Obtained results are in agreement with Rosmiza et al., (2012) who reported that chopped rice straw consists of high nutritional value. El-Marzoky and Abdel-Sattar (2008) mentioned that, rice straw bales could be used as a growing media for cultivation vegetable crops instead of soil. These results may be due to the ability of small size straw media to save the water and nutrient solution for plant uptake for long period than the big size of straw. However, these results in agreement with Medany (2011) and Kamal et. al. (2013), whom reported that, vermicompost is rich in organic matter resources and improves the chemical and physical characteristics of growing media and enhance the rate of seedling growth, because vermicompost is activate substance for plant growth especially in straw media, so the increase of growth characters values for lettuce and eggplant may be due to the increase of vermicompost rates.

Table (6): The effect of chopped rice straw sizes and vermicompost application rates on plant growth pattern and yield of lettuce.

Vermicompost ratio (B)	Chopped rice straw size (A) (mm) 2011 (8-10)	(6-8)	(4-6)	Less than 2	Mean(B)	2012 (8-10)	(6-8)	(4-6)	Less than 2	Mean(B)
	No. of leaves									
5%	28.9 g	28.9 g	31.1 f	33.4 d	30.6 C	27.7 h	28.3 g	29.2 f	31.7 c	29.2 C
10%	28.9 g	31.1 f	33.3 e	33.6 b	31.7 B	29.2 f	29.6 e	31.6 c	33.9 b	31.1 B
15%	33.5 c	33.3 e	35.5 a	33.3 e	33.9 A	29.8 e	30.5 d	33.6 b	34.8 a	32.2 A
Mean (A)	30.4 C	31.1 B	33.3 A	33.4 A		28.9 C	29.5 C	31.5 B	33.5 A	
	Fresh head weight (g/plant)									
5%	190 g	225 f	270 e	280 e	241 C	192 h	221 g	257 f	283 e	238 C
10%	195 g	285 c	320 d	385 c	296 B	191 h	288 e	285 e	366 c	282 B
15%	330 d	420 b	430 b	580 a	440 A	294 d	421 b	424 b	516 a	414 A
Mean (A)	238 D	310 C	340 B	415 A		226 D	310 C	322 B	388 A	
	Lettuce head volume (mml)									
5%	161 i	250 g	213 h	225 h	212 C	143 i	200 g	209 g	253 f	201 C
10%	170 i	280 f	270 f	325 d	261 B	172 h	257 f	274 e	328 c	258 B
15%	300 e	375 c	425 b	450 a	388 A	294 d	379 b	378 b	428 a	370 A
Mean (A)	210 C	302 B	303 B	333 A		203 D	279 C	287 B	336 A	
	Lettuce head density (g/cm^3)									
5%	0.90 h	0.99 g	1.01 fg	1.10 d	1.0 C	0.88 g	0.90 g	1.00 f	1.05 e	0.96 C
10%	1.02 f	1.12 ed	1.20 d	1.29 c	1.16 B	0.91 g	1.13 d	1.15 d	1.18 c	1.09 B
15%	1.12 e	1.21 d	1.32 b	1.43 a	1.27 A	1.13 d	1.19 c	1.25 b	1.44 a	1.25 A
Mean (A)	1.01 C	1.10 B	1.18 B	1.27 A		0.97 C	1.07 B	1.13 B	1.22 A	
	Lettuce dry weight (g/plant)									
5%	15.1 f	15.6 e	15.7 e	20.2 f	16.7 C	13.4 g	15.8 g	15.4 g	18.0 f	15.6 C
10%	17.1 h	18.8 g	23.4 e	26.4 c	21.4 B	16.8 g	19.0 f	20.8 e	25.1 d	20.4 B
15%	24.7 d	27.0 c	30.5 b	32.3 a	28.6 A	24.9 d	26.5 c	29.0 b	32.6 a	28.3 A
Mean (A)	19.0 C	20.5 C	23.2 B	26.3 A		18.4 D	20.4 C	21.7 B	25.2 A	

Table (7): The effect of chopped rice straw sizes and vermicompost application rates on growth pattern and yield of eggplant

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Vermicompost ratio (B)	Chopped rice straw Size (A) (mm)									
	2011					2012				
	(8-10)	(6-8)	(4-6)	Less than 2	Mean(B)	(8-10)	(6-8)	(4-6)	Less than 2	Mean(B)
	Plant height									
5%	77 i	109 g	116 f	123 e	106 C	75	112	110	124	105 C
10%	99 h	122 e	124 e	129 d	118 B	97	126	125	131	120 B
15%	113 fg	137 c	143 b	149 a	136 A	115	130	140	146	133 A
Mean (A)	96 C	123 B	128 B	134 A		96 C	123 B	125 B	134 A	
	Number of leaves									
5%	27.0 i	33.1 h	39.9 f	44.2 e	36 B	26.5	34.1	37.9	44.7	35.8 C
10%	36.6 g	40.2 f	48.8 d	50.5 c	44 A	34.8	40.6	43.4	51	42.5 B
15%	43.4 e	49.2 cd	51.0 b	56.3 a	50 A	44.3	46.7	50	55.2	49.0 A
Mean (A)	35.7 C	40.8 B	46.5 A	50.3 A		35.2 D	40.5 C	43.8 B	50.3 A	
	Total leaf area									
5%	2788 h	3423 g	4123 e	4563 d	3724 C	2844	3252	4041	4472	3652 C
10%	3780 f	4154 e	5043 c	5213 b	4547 B	3704	4279	4791	5276	4512 B
15%	4489 d	5077 c	5265 b	5820 a	5163 A	4265	5128	4686	5878	4989 A
Mean (A)	3686 D	4218 C	4810 B	5198 A		3604 D	4219 C	4506 B	5208 A	
	Number of fruits									
5%	8.60 h	9.70 g	11.2 ef	11.8 e	10.3 B	8.4	10	10.6	11.9	10.3 C
10%	10.6 f	14.8 d	16.4 c	19.1 b	15.2 A	10.1	14.9	14.6	19.3	14.7 B
15%	12.1 e	14.9 d	21.2 a	21.8 a	17.5 A	12.3	14.2	20.8	21.4	17.2 A
Mean (A)	10.4 C	13.2 B	16.3 A	17.6 A		10.3 D	13.0 C	15.3 B	17.5 A	
	Total fruit weight (g/plant)									
5%	1619 j	1835 i	2119 g	2235 f	1952 C	1538	1853	1886	2257	1884 C
10%	2279 f	2800 e	3100 d	3608 c	2947 B	2325	2660	3038	3536	2890 B
15%	2002 h	2823 e	4003 b	4110 a	3235 A	1962	2908	3803	4159	3208 A
Mean (A)	1967 D	2486 C	3074 B	3318 A		1942 D	2474 C	2909 B	3318 A	

3.3 Mineral contents

According to the effect of chopped rice straw size, data in Tables (8&9) showed that using chopped rice straw size less than 2 mm lead to increase N, P and K % significantly in lettuce and eggplant leaves followed by chopped rice straw size (4-6 mm) with significant difference between them. The lowest N, P and K % were obtained by using chopped rice straw size (8-10 mm).

The effect of applied vermicompost levels on N, P and K in lettuce and eggplant leaves. The highest N, P and K % were observed by using vermicompost 15% followed by vermicompost 10% with significant difference between them. The lowest N, P and K % was obtained by using vermicompost 5% rate.

The interaction effect between chopped rice straw sizes and vermicompost rates, data showed that using chopped rice straw size less than 2 mm combined with vermicompost 15% increased N, P and K percentage in lettuce and eggplant as well. The lowest N, P and K % obtained by using chopped rice straw size (8-10 mm) with vermicompost 5% in both of lettuce and eggplant during two studied seasons.

The obtained results are in agreement with Souza et al., (2005) reported that the protein, phosphorus, potassium, calcium and magnesium contents in lettuce leaves increased with the rates of organic compost. Pramanik et al., (2007) reported that vermicompost enhance the nutrient uptake by the plants by increasing the permeability of root cell membrane, stimulating root growth and increasing proliferation of root hairs. These results can be related to higher water holding capacity of rice straw with high rate of vermicompost compared to rice straw with low vermicompost rate.

3.4 Yield parameters

Data Presented in Tables (5&6) and Figures (1, 2, 3 and 4) showed that, the chopped rice straw sizes and vermicompost rates affected head fresh weight per plant in lettuce and total fruit weight per plant for eggplant in both studied seasons. The effect of chopped rice straw treatments chopped rice straw size less than 2 mm., showed the highest lettuce head fresh weight and fruit weight in eggplant as well, followed by chopped rice straw size (4-6 mm) and the lowest yield of lettuce and eggplant were obtained by using chopped rice straw size (8-10 mm).

Concerning vermicompost 15% treatment lead to highest yield in lettuce and eggplant in both seasons, followed by vermicompost 10% treatment. In contrary, vermicompost 5% application produced the lowest yields in lettuce and eggplant in both studied seasons.

The interaction effect between different chopped rice straw sizes and vermicompost rates treatments, data showed that using chopped rice straw size less than 2 mm., combined with vermicompost 15% increased plant fresh weight of lettuce head and average fruit weight of eggplant, followed by chopped rice straw size (6-8 mm) combined with vermicompost 10%. The lowest yield was obtained by using chopped rice straw size (8-10 mm) and vermicompost 5% for lettuce and eggplant in both studied seasons.

The increases in yield of lettuce and eggplant may be due to the increased utilization of nutrient minerals which is stimulating meristimatic activities. The accumulation of synthesized metabolites resulted in high dry matter accumulation and produce high yield. Meanwhile, increasing vermicompost rate up to 15% in rice straw media, lead to increase the yield in lettuce as well as eggplant. The obtained results were matching with those reported by (Leon et al., 2012 and Mamta et al., 2012). While, chopped rice straw media is poor for water holding capacity, this lead to decrease the humidity in root zone and decrease plant water and nutrient absorption.

Applying vermicompost into chopped rice straw has improved plant growth and yield, due to the increase water and nutrient uptake, these results are in agreement obtained by Resendez et al., (2013), he mentioned that, vermicompost was able to satisfy the nutrient demand and reduces the amount of water required by tomato plants.

4. CONCLUSION

The integrated use of chopped rice straw and vermicompost via soilless culture as a substrate presented good method for friendly recycling the organic wastes (agricultural – rural – urban), offer input materials for sustainable production of vegetable crops instead of incineration and increase CO_2 emission plus the economic added value. Chopped rice straws in different sizes plus vermicompost are friendly disposal by using as compost. The smallest size of chopped rice straw (less than 2 mm) generates more effect as growing substrate. The disposal of substrate mixtures could be used as compost in soil for increasing the soil organic matter.

Table (8): The effect of chopped rice straw sizes and vermicompost application rates on lettuce leaves content of N, P and K in 2011 and 2012 seasons.

Vermicompost ratio (B)	Chopped rice straw Size (mm)									
	2011					2012				
	(8-10)	(6-8)	(4-6)	Less than 2	Mean(B)	(8-10)	(6-8)	(4-6)	Less than 2	Mean(B)
	N %									
5%	2.04 h	2.58 f	2.63 f	3.12 c	2.08 C	2.10 h	2.39 g	2.64 f	3.16 b	2.07 C
10%	2.21 g	2.86 d	2.73 e	3.32 b	2.24 B	2.09 h	2.88 d	2.80 e	2.88 d	2.15 B
15%	2.48 f	2.97 d	2.98 d	3.56 a	2.43 A	2.60 f	2.79 e	3.09 c	3.44 a	2.41 A
Mean (A)	2.25 C	2.80 B	2.78 B	3.33 A		2.26 D	2.69 C	2.84 B	3.16 A	
	P %									
5%	0.35 f	0.37 f	0.38 f	0.41 e	0.31 C	0.36 f	0.36 f	0.39 e	0.42 d	0.32 B
10%	0.36 f	0.48 c	0.45 d	0.55 b	0.39 B	0.35 f	0.45 c	0.45 c	0.45 c	0.36 B
15%	0.53 b	0.55 b	0.57 b	0.66	0.49 A	0.49 c	0.47 c	0.55 b	0.60 a	0.45 A
Mean (A)	0.41 C	0.47 B	0.47 B	0.54 A		0.40 B	0.42 B	0.46 A	0.49 A	
	K %									
5%	0.25 g	0.29 f	0.29 f	0.33 e	0.24 B	0.36 f	0.36 f	0.39 e	0.42 d	0.32 B
10%	0.35 e	0.41 d	0.39 d	0.44 c	0.34 B	0.35 f	0.45 c	0.45 c	0.45 c	0.36 B
15%	0.45 c	0.46 c	0.48 b	0.53 a	0.41 A	0.49 c	0.47 c	0.55 b	0.60 a	0.45 A
Mean (A)	0.35 C	0.38 B	0.39 B	0.43 A		0.40 B	0.42 B	0.46 A	0.49 A	

Table (9): The effect of chopped rice straw sizes and vermicompost application rates on eggplant leaves content of N, P and K in 2011 and 2012 seasons.

Vermicompost ratio (B)	Chopped rice straw Size (A) (mm)									
	2012					2013				
	(8-10)	(6-8)	(4-6)	Less than 2	Mean(B)	(8-10)	(6-8)	(4-6)	Less than 2	Mean(B)

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					N					
5%	2.26 g	2.85 e	3.09 d	3.43 b	2.91 B	2.32 g	2.93 e	3.19 d	3.53 b	2.99 B
10%	2.30 g	3.02 d	3.26 c	3.64 a	3.06 A	2.37 f	3.10 d	3.36 c	3.75 a	3.15 A
15%	2.49 f	2.89 e	3.25 c	3.56 a	3.05 A	2.57 f	2.98 e	3.35 c	3.68 a	3.14 A
Mean (A)	2.35 D	2.92 C	3.2O B	3.55 A		2.42 C	3.00 B	3.30 B	3.65 A	
					P					
5%	0.30 f	0.45 c	0.50 b	0.55 a	0.45 B	0.38 f	0.45 e	0.57 a	0.57 a	0.49 A
10%	0.37 e	0.46 c	0.51 b	0.55 a	0.48 A	0.37 f	0.46 e	0.49 d	0.55 b	0.47 A
15%	0.43 d	0.49 b	0.50 b	0.54 a	0.49 A	0.44 e	0.48 d	0.50 d	0.53 c	0.49 A
Mean (A)	0.37 C	0.47 C	0.50 B	0.54 A		0.40 C	0.46 B	0.52 A	0.55 A	
					K					
5%	2.09 h	2.24 f	2.49 c	2.63 a	2.36 C	2.18 g	2.25 f	2.61 c	2.74 a	2.45 C
10%	2.15 g	2.37 d	2.51 c	2.60 b	2.41 B	2.25 f	2.48 d	2.62 c	2.70 b	2.51 B
15%	2.30 e	2.40 d	2.49 c	2.61 b	2.45 A	2.39 e	2.51 c	2.61 c	2.71 b	2.55 A
Mean (A)	2.18 D	2.34 C	2.50 B	2.61 A		2.27 D	2.41 C	2.61 B	2.72 A	

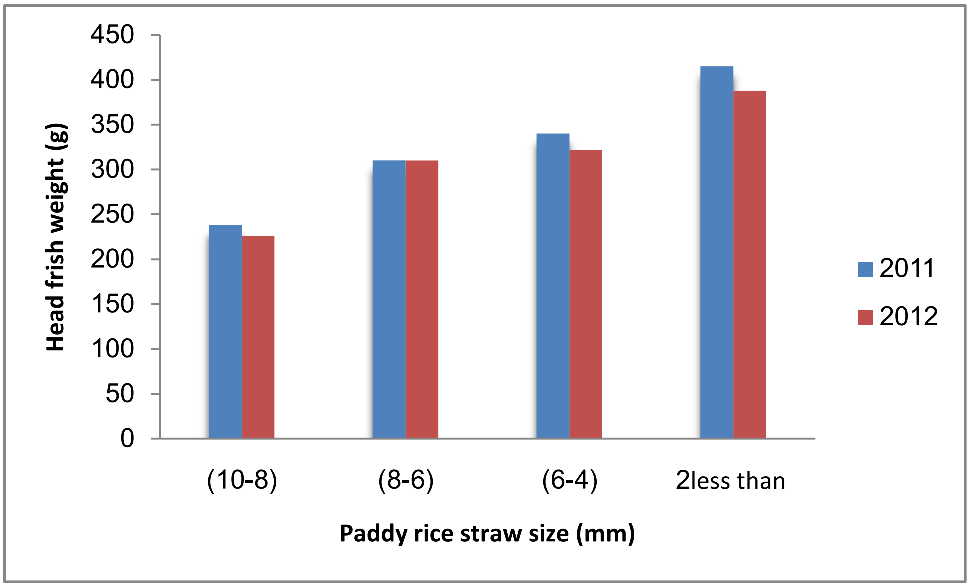

Fig 1: The effect of different chopped rice straw sizes on fresh weight of lettuce head

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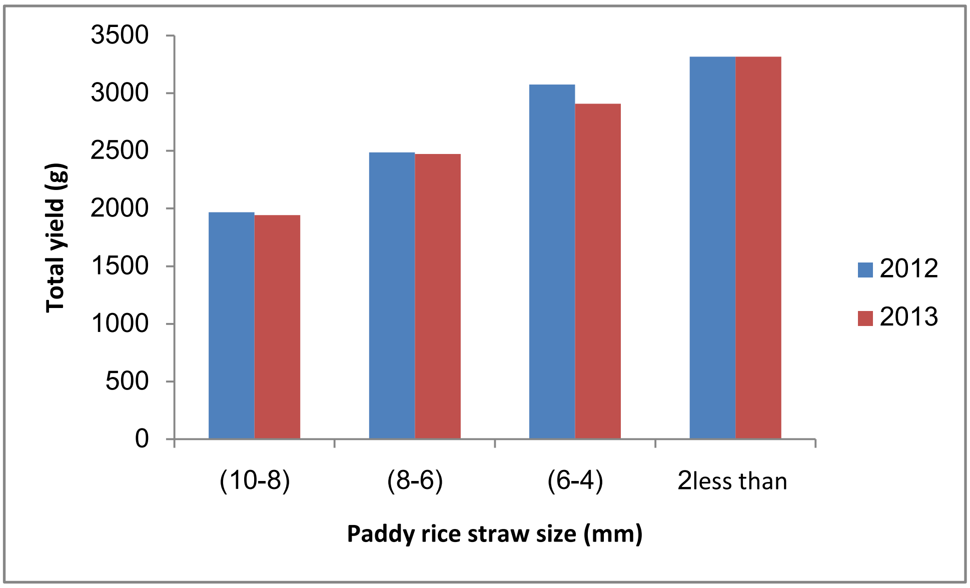

Fig 2: The effect of different chopped rice straw sizes on total yield per plant of eggplant

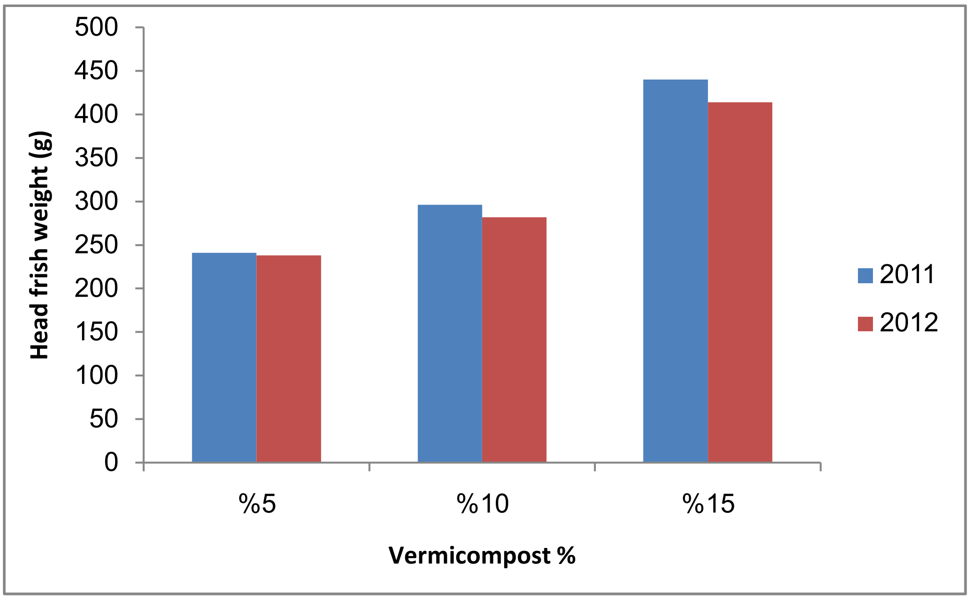

Fig 3: The effect of different vermicompost rates on head fresh weight of lettuce

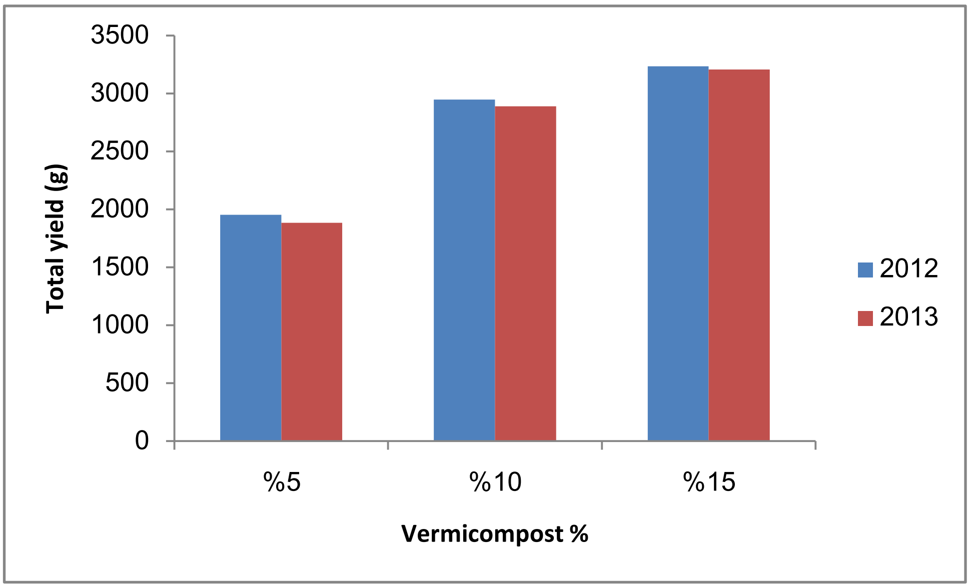

Fig 4: The effect of different vermicompost rates on total yield per plant of eggplant

5. AKNOWLEGMENTS

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