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Assess Yield and Physiological Parameters of Lettuce Affected Different Types and Amounts of Some Organic Wastes

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ABSTRACT

BACKGROUND: The use of agricultural waste as organic fertilizers is important for soil fertility and plants health production.

OBJECTIVES: The aims of this study were to examine the effects of different types and rates of vermicompost on physiological and morphological properties of lettuce.

METHODS: Present study was conducted according factorial experiment based on complete randomized design with three replication at green house condition. Treatment included different type of vermicompost (1-Carrot vermicompost 2-Sugar beet vermicompost and 3- date fruit composts) and different application rate of vermicompost (Zero or control, 2, 4 and 6 percent of medium dry weight).

RESULT: The results showed that, the type and amount of organic wastes had significant effects on fresh and dry weight, leaf area, plant height, marketability, carotenoid and chlorophyll b content of lettuce. Sugar beet and carrot vermicompost was more effective on most lettuce properties than date fruit waste. The organic compost rate had a sigmoid trend effects on most lettuce properties. The highest and lowest lettuce dry weight was observed respectively in 2% carrot vermin compost (500% more than control) and in date fruit compost (50% lower than control). The highest amount of carotenoid (0.49 $mg.gr^{-1}$ fresh weight) was in sugar beet vermicompost (6%), which increased by 40% with respect to control. The highest marketable index was observed at (2% and 4%) both in sugar beet, which were increased by 400 and 380 present respectively in compared to control.

CONCLUSION: Sugar beet and then carrot vermicompost were evaluated as the best raw materials for vermicompost production; also 4 and 6 percent had the greatest effect on the growth and yield of lettuce.

KEYWORDS: *Carotenoid, Chlorophyll, Dry weight, Organic fertilizers.*

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1. BACKGROUND

In developing countries, different agricultural organic wastes are created after harvest, which can be converted to vermicompost or compost and applied to the soil as organic fertilizers to increase soil fertility and reduce the application of chemical fertilizer. This not only helps to reduce environmental pollution but also better nutrient cycling and sustainability of agricultural systems. Compost and vermicompost are organic fertilizers containing various plant nutrients that become available to plants after microbial decomposition. The nutritional value of these organic fertilizers depends to a large extent on the type and nature of the raw materials used to produce those (Atiyeh *et al*., 2000a). Worms Composting of organic wastes would increase the availability of nutrients within the organic wastes, will increases photosynthesis (chlorophyll and pigments) and plant biomass. In an experiment the application of vermicompost increased the amounts of anthocyanin and flavonoids in plants (Joshi *et al*., 2014). In several studies, the importance of organic wastes in the preparation of compost and vermicompost and the role of these organic fertilizers in sustainable agriculture and the growth, yield and macro- and micronutrient content of plants have been discussed (Hernandez *et al*., 2015). The high humic acid content of the vermicompost causes plants to produce more phenolic compounds which make them as a nutrient chelator (Bevacqual *et al*., 1993). According to the results of Stanchova and Mitova (2002), also vermicompost had a significant effect on the number of leaves per plant and leaf area index. The effect of vermicompost on plant growth depends on the source of organic materials used for vermicompost preparation and its nutrient content (Nadi and Golchin, 2011). In another experiment on onion, lettuce, antirrhinum and grass by the application of 0.37 and 74 tons of sewage sludge compost per hectare, the growth of the plants increased significantly (Chang *et al*., 2008). Vermicompost increased fresh weight, plant size, number of leaf, 9%, 8% and 9% respectively more than control. Also it caused to an increase in plant height, length and width of leaf for each plant 8% and 12% respectively (Muhammad *et al*., 2007). Vermicomposting technology involves the bioconversion of organic waste into vermicasts and vermiwash utilizing earthworms (Jadia and Fulekar, 2008). These earthworms feed on the waste and their gut act as the bioreactor where the vermicasts are produced. These vermicasts are also termed vermicompost and are rich in nitrogen, phosphorous, potassium and micronutrients (Ansari and Sukhraj, 2010). Effect of these vermicompost on plant growth is well reported but mostly it used as a main source of nitrogen. Increasing the vermicompost quantity also promoted plant growth as well as growth of the cob webs by increasing the zinc and phosphorous like nutrients. Zinc enhances plant growth regulation whilst phosphorous promotes plant growth (Manyuchi *et al*., 2013a; Manyuchi *et al.,* 2013b). Increasing the level of phosphorous content in the soils also promoted plant growth, high resistance and quality of seed. Furthermore, it was well documented that increasing the application time of both the vermicompost and vermiwash also increased the soil copper, iron and phosphorous content (Manyuchi *et al*., 2013c; Nath and Singh, 2012). This increase in soil nutrient content promoted plant growth and chlorophyll production; hence boost the overall corn growth. In addition, microbial activities was also reported higher in the soil treated by vermicompost and this higher microbial activity also affected the production of plant growth regulators such as cytokinins as well as humic acid which promote plant growth (Gopal *et al.,* 2010; Manyuchi *et al.,* 2013d). The effect of vermicompost on plant growth is significant and increases the growth potential, yield and yield components of different plants (Atiyeh *et al.,* 2000b). Vermicompost, along with chemical fertilizers, improves the usefulness of low-energy elements and their absorption in plants compared with the use of chemical fertilizers alone (Jabin and Ahmad, 2017). In an experiment on lettuce Results showed that plant biomass production was optimal with a 20/80 (v/v) compost/soil, and more leaf chlorophyll content, growth and increased N content were achieved (Lee *et al*., 2013). Lee *et al*. (2013) reported effect of bio-fertilizer on (*Bacillus subtilus*) improved plant growth more than control, and also observed an increase in the leaf number, leaf length, and leaf mass, 128%, 122%, and 153% respectively more than the control. Recommendations on the application rate of compost depend on the type of compost, soil and environmental conditions. Unfortunately, there is no professional advice on the application rate of compost due to the lack of research on the production of organic fertilizers from organic wastes (Hunt, 1982).

2. OBJECTIVES

Generally different chemical and nutritional properties of various types of vermicompost and compost, have depends on the source of organic wastes used to prepare them, so the aims of this study were to evaluate the effects of different types and rates of vermicompost on physiological and morphological properties of lettuce.

3. MATERIALS AND METHODS

3.1. Field and Treatment Information

To assess the effects of vermicomposts of carrot and sugar beet wastes and compost of date waste on yield, growth and physiologic parameters of lettuce, current research was carried out in greenhouse condition according factorial experiment based on complete randomized design in three replications. Treatment included different type of vermicompost (Carrot, sugar beet and date fruit) and different application rate of vermicompost (Zero or control, 2, 4 and 6 percent of medium dry weight). The soil properties were mentioned in table 1.

Table 1. Soil sample for routine analysis of plant-available soil elements

Sand (%)	**Lime (%)**	**Clay (%)**	**pH**	**Electrical conductivity (ds.m^{-1})**	**T.N.V**	**Mn (ppm)**
46	36	18	7.72	3.20	11.20	4.55
P (ppm)	**K (ppm)**	**B (ppm)**	**Zn (ppm)**	**Organic carbon (%)**	**Fe (ppm)**	**Cu (ppm)**
31	146	1.85	2.20	0.75	3.27	2.18

3.2. Greenhouse Management

Sandy loam texture soil with low organic carbon was mixed with different amounts of vermicomposts (according to treatments) and then was filled in a 3 Kg pots. Each experimental unit consisted of 6 plants in three replication. After that lettuce seedlings were planted in each experimental unit. During the growth period, Irrigation water was on the basis of 50% depletion of available water. Lettuce plants according different type of vermicompost shown in figures 1 to 3.

Fig. 1. Lettuce plants one month after transplanting, grown with various rates of carrot vermin compost (0% ; A, 6%; B, 2%; C and 4%; D).

3.3. Measured Traits

Growth indices such as relative growth rate (RGR), fresh and dry weights of each plant, the number of leaves per plant, marketability, leaf surface area and the plant height were measured. For assessing the lettuce marketability they were classified and graded from one to 20 in comparison to the control treatment.

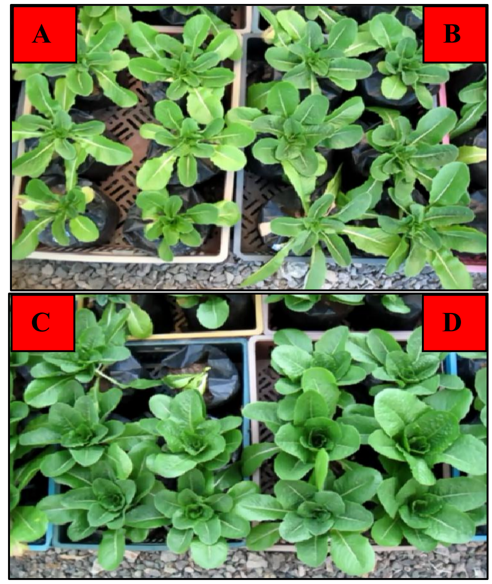

Fig. 2. Lettuce plants one month after transplanting, grown with various rates of sugar beet vermicompost (0, 2, 4 and 6%; A, B, C, D respectively).

The surface area of 10^{th} leaf was measured by leaf area meter. To measure fresh and dry weights, the bush were cut at the soil surface and weighted and then dried at 60˚C in an oven for 72 hr and weighted again. The chlorophyll and carotenoids were measured by spectrophotometer. RGR, were measured by the method (Hunt, 1982), Chlorophyll a, Chlorophyll b and Carotenoids (Khosravi *et al*., 2018).

3.4. Statistical Analysis

ANOVA was done by SAS software and mean comparison was compared by LSD test at 5% probability level.

4. RESULTS AND DISCUSSION

4.1. Relative Growth Rate (*RGR*)

The ANOVA showed that the effects of type and amount of organic fertilizer on the RGR, leaf area, fresh and dry weights, contents of chlorophyll b and carotenoids were significant ($p < 0.01$) but interaction effects of the experimental factors and the number of leaves per plant were not significant (Table 2).

Fig. 3. Lettuce plants, 80 days old, grown with various rates of date compost (0%; A, 2%; B, 4%; C and 6%; D).

In study effects of vermicompost on growth of grape showed that use of 20% of vermicompost had best result on growth parameters (10% increase) (Nadi and Golchin, 2011). Mean comparison interaction effect of treatment revealed maximum amount of RGR belonged to sugar beet vermicompost at 6% (2.62 $g.g.day^{-1}$) (Table 3).

In another to study the use of 2% vermicompost increase the growth of seedlings by 200% (Sallaku *et al*., 2009). Vermicompost can increase relative growth rate 16% more than control (Yusof *et al*., 2018). In a study on Effects of vermicompost on growth and nutrients uptake by lettuce in a calcareous soil, Biological fertilizers significantly increased shoot dry matter and some nutrients uptake (Durak *et al*., 2017). In experiment by vermicompost application the Lettuce yield were increased 34% more than control (Hernandez-Rodríguez *et al*., 2017). The vermicompost impacts positively on the nutrient available for uptake by the lettuce due to the presence of living organisms in vermicompost thereby stimulating growth (Alidadi *et al*., 2017). Vermicompost has considerable potential for improving plant growth when used as amendment to soil.

4.2. Plant Height

The effects of all treatments on plant height were significant (α= 0.01) (Table 2). The highest and lowest plant height (49.1 and 24.8 cm) was obtained from application of sugar beet vermicompost and control respectively (Table 3). The highest values of plant height were obtained from application of 6% of sugar beet vermicompost. This increase in height was 98% more than control. Height parameter was improved 25% by vermicompost use when compared to control and conventional fertilization (Hernandez-Rodríguez *et al*., 2017).

4.3. Leaf Number

The effects of vermicompost types on number of leaves were significant (α= 0.01), (Table 2). The highest and lowest number of leaves (7.44 and 5.66) was obtained from the application of 6% carrot vermicompost and 2% date compost respectively (Table 3).

With using carrot vermicompost, leaf number increased 30% with respect to date compost. In a study Asghari *et al.* (2016) showed that the effect of urban waste compost and vermicompost on the number of lemon leaves was significant. Application of vermicompost did not have a significant effect on the number of leaves per plant (Huerta *et al.*, 2018). Vermicompost caused an increase Number of Leave per plant 49% more than control (Weerasinghe and De Silva, 2017).

4.4. Leaf Area Index

The effects of vermicompost types, application rates and their interaction on lettuce leaf area were significant (α= 0.01), (Table 2). The highest and lowest leaf area (116 and 58.3) was obtained from the application of 4% carrot vermicompost and control respectively. With using carrot vermicompost, leaf area increased 98% with respect to control (Table 3). Nadi and Golchin (2011) in a study showed that, the leaf area due to the use of 10% vermicompost of animal manure increased significantly. Semi compost and vermicompost mixed with peat moss enhance development of lettuce and leaf area (94.5%), (Azarmi *et al.*, 2008). It is understood the lettuce planted in date compost has lower height than the plants planted in a carrot and sugar beet vermicompost and having the lowest leaf number, had the lowest leaf area. In fact, small leaves were produced probably due to insufficient development of roots in the experimental pots and then resulted in less photosynthesis, less fresh and dry weight and, finally, a decrease in relative growth rate of experimental plants.

4.5. Dry and Fresh Weights

The effects of vermicompost types, application rates and their interaction were significant for both Dry and Fresh weights per plant (α= 0.01), (Table 2). The highest and lowest fresh weights (108 and 12.2) were obtained from the application of 2% carrot vermicompost and 4% date compost respectively (Table 3). With using carrot vermicompost, fresh weights increased 885% with respect to date compost. The highest and lowest dry weights (10.7 and 1.05) were obtained from the application of 2% carrot vermicompost and 4% date compost respectively (Table 3). With using carrot vermicompost the Dry weights increased 1000% with respect to date compost (Table 3). Asghari *et al.* (2016) reported that the effect of urban waste compost and vermicompost on dry weight of the Lemon Verbena was significant (Mohsen *et al.*, 2016).

Table 2. The analysis of variance of effects of types and application rates of organic fertilizer on morphological traits

S.O.V	df	RGR	Plant height	Leaf number	Leaf area index	Fresh weight	Dry weight
Block	2	0.0058	18.11	0.09070	100.19	5.65	0.0919
Different type of Vermicompost (A)	2	0.165^{**}	1316^{**}	4.18^{**}	1221^{**}	4304^{**}	59.2^{**}
Different application rate (B)	3	0.113^{**}	35.2^{**}	0.169^{ns}	1084^{**}	975^{**}	16.6^{**}
A × B	6	0.050^{ns}	11.4^{**}	0.219^{ns}	1861^{**}	1979^{**}	19.3^{**}
Error	22	0.022	35.8	0.182	173	47.9	0.444
CV (%)	-	6.62	17.67	6.48	15.0	13.6	13.31

$^{ns,\ *}$ and ** are respectively not significant and significant at 0.05 and 0.01 probability levels

Porter *et al*. (1999) reported use of vermicompost/compost in a ratio of 4:1 respectively caused more growth and development of the roots and biomass of tested lettuce. Vermicompost, in addition to its direct role in the plant nutrition, also helps absorb more nutrients by developing a root system. Probably increased access to nutrients has increased amount of pigments and photosynthesis, resulting increased carbon fixation, plant growth and yield (Baca *et al*., 1992). Vermicompost with rate of 15 t ha^{-1} increased fruit dry matter up to (24%), (Adiloglu *et al*., 2018).

4.6. Biomass and Yield

The effects of vermicompost types, application rates and their interaction were significant on biomass and yield traits was significant at 1% probability level (Table 4). The highest and lowest biomass (36.2 and 1.55 $g.plot^{-1}$) was obtained from the application of 6% sugar beet vermicompost and 4% date compost respectively (Table 5). The highest and lowest yield (410 and 18.9 $g.plot^{-1}$) was obtained from the application of 4% sugar beet vermicompost and 2% date compost respectively (Table 5).

Table 3. Mean comparison of interaction effect of treatment on morphological traits

Type	Application rate (%)	RGR ($g.g.day^{-1}$)	Plant height (cm)	Leaf number
Carrot Vermicompost	0	2.01 *e	24.8 c	5.94 cd
	2	2.37 abc	31.5 bc	7.11 ab
	4	2.31 bcd	30.5 bc	6.61 b
	6	2.39 ab	44.9 ab	7.44 a
Sugar Beet Vermicompost	0	2.01 e	24.8 c	5.94 cd
	2	2.26 b-e	46.3 ab	7.05 ab
	4	2.29 bcd	47.1 ab	6.77 b
	6	2.62 a	49.1 a	6.55 bc
Date Compost	0	2.01 e	24.8 c	5.94 cd
	2	2.11 cde	29.1 bc	5.66 d
	4	2.22 b-e	28.2 bc	5.83 d
	6	2.07 de	26.8 c	5.88 d
LSD	-	0.260	7.56	0.631

*The treatments with the same letter are not significant at (0.05) probability level

Continue Table 3.

Type	Application rate (%)	Leaf area (cm^2)	Fresh weight ($g.plant^{-1}$)	Dry weight ($g.plant^{-1}$)
Carrot Vermicompost	0	58.3 *f	27.9 d	2.13 d
	2	81.3 cde	108 a	10.7 a
	4	116 a	61.8 b	8.12 b
	6	105 ab	56.0 bc	6.12 c
Sugar Beet Vermicompost	0	58.3 f	27.9 d	2.13 d
	2	107 ab	63.9 b	6.07 c
	4	95.6 bc	65.9 b	5.72 c
	6	63.1 ef	47.4 c	6.23 c
Date Compost	0	58.3 f	27.9 d	2.13 d
	2	69.9 def	18.9 de	1.56 d
	4	68.7 def	12.2 e	1.05 d
	6	70 def	57.3 bc	5.16 c
LSD	-	18.7	11.7	1.12

*The treatments with the same letter are not significant at (0.05) probability level

4.7. Leaf Chlorophyll Index

The effects of vermicompost types, application rates and their interaction were significant on leaf chlorophyll index (α= 0.01) (Table 4). The highest and lowest leaf chlorophyll index (44.2 and 35.5) was obtained from the application of 4% sugar beet vermicompost and 4% carrot compost respectively (Table 5).

4.8. Chlorophyll a

The effects of vermicompost types on chlorophyll a were not significant but effects of application rates and their interaction effect were significant for chlorophyll a (α= 0.01), (Table 4). The highest and lowest counts of chlorophyll a (1.03 and 0.77) were obtained from the application of 2% carrot vermicompost and control respectively (Table 5). With using carrot vermicompost, counts of Chlorophyll a increased 33% with respect to control. Chlorophyll content was improved in a ratio of 1:5 and 1:3 vermicompost treatments (Alhajhoj, 2017).

Table 4. The analysis of variance of effects of types and application rates of organic fertilizer on plant biomass, yield, chlorophyll, carotenoid contents and marketability of lettuce

S.O.V	df	Biomass	Yield	Leaf chlorophyll index	Chlorophyll a
Block	2	13.87	1166	8.1370	0.00164
Different type of vermicompost (A)	2	2692.9**	260212**	35.1**	0.002^{ns}
Different application rate (B)	3	192.4**	6151**	23.3**	0.028**
A × B	6	148.7 **	16953**	26.9**	0.011**
Error	22	9.67	1074	4.27	0.002
CV (%)	-	14.4	14.5	5.31	5.18

$^{ns, *}$ and ** is not significant and significant at the 0.05 and 0.01 levels respectively

Continue Table 4.

S.O.V	df	Chlorophyll b	Carotenoid	Marketability
Block	2	0.01312	0.00008	0.516
Different type of vermicompost (A)	2	0.184**	0.006**	354**
Different application rate (B)	3	0.038*	0.007**	8.59**
A × B	6	0.057**	0.002*	5.12**
Error	22	0.009	0.0005	0.984
CV (%)	-	15.3	5.71	8.46

$^{ns, *}$ and ** are respectively not significant and significant at 0.05 and 0.01 probability levels

4.9. Chlorophyll b

Result of analysis of variance revealed the effects of vermicompost types, application rates and interaction effect of treatments were significant on chlorophyll b at 1% probability level (Table 4). The highest amount of chlorophyll b (0.77) were obtained in 6% sugar Beet vermicompost and, date compost and the lowest one (0.34) belonged to control treatment (Table 5). With using carrot vermicompost and date compost, chlorophyll b increased 226% with respect to control.

Nadi and Golchin (2011) showed that the leaf chlorophyll content of plants treated with iron-enriched vermicompost was higher than that in control treatment.

4. 10. Carotenoids

Result of analysis of variance indicated the effects of vermicompost types, application rates and interaction effect of treatments were significant for carotenoids at 1% and 5% probability level, respectively (Table 4). The highest and lowest Carotenoids (0.49 and 0.35) were obtained from the application of both 6% sugar beet vermicompost and control respectively (Table 5). By using the sugar beet vermicompost, Chlorophyll b increased 40%, with respect to the control treatment. The studies have shown that the content of the carotenoids and chlorophylls depends on the plant growth conditions.

Table 5. Mean comparison of treatment means for the interaction effects of treatments on plant biomass, yield, chlorophyll and carotenoid contents and marketability of lettuce

Type	Application rate (%)	Biomass ($g.plot^{-1}$)	Yield ($g.plot^{-1}$)	Leaf chlorophyll index	Chlorophyll a ($ml.gr^{-1}$)
Carrot Vermicompost	0	9.15 *cd	163 ef	36.6 d	0.78 f
	2	21.2 b	216 de	36.7 d	1.03 a
	4	32.6 ab	327 b	35.5 e	0.97 a-d
	6	34.1 ab	318 bc	42.2 ab	1.01 abc
Sugar Beet Vermicompost	0	9.15 cd	163 ef	36.6 d	0.77 f
	2	35.8 ab	360 ab	43.5 ab	1.02 ab
	4	33.1 ab	410 a	44.2 a	1.01 abc
	6	36.2 a	264 cd	38.2 cd	1.01 abc
Date Compost	0	9.15 cd	163 ef	36.6 d	0.77 f
	2	1.55 e	18.9 i	38.7 cd	0.94 def
	4	1.38 f	28.9 hi	36.9 d	0.96 cd
	6	12.3 c	134 fg	40.6 bc	0.98 a-d
LSD	-	5.26	55.4	3.13	0.058

*The treatments with the same letter are not significant at (0.05) probability level

Continue Table 5.

Type	Application rate (%)	Chlorophyll b ($ml.gr^{-1}$)	Carotenoid ($ml.gr^{-1}$)	Marketability
Carrot Vermicompost	0	0.34 g	0.35 g	4.23 e
	2	0.40 fg	0.41 de	12.7 bc
	4	0.48 def	0.39 ef	12.7 bc
	6	0.570 df	0.43 d	13.7 b
Sugar Beet Vermicompost	0	0.34 g	0.35 g	4.23 e
	2	0.70 bc	0.46 ab	17.4 a
	4	0.59 cd	0.46 bc	16.4 ab
	6	0.77 ab	0.49 a	16.3 ab
Date Compost	0	0.34 g	0.35 g	4.23 e
	2	0.54 ab	0.43 cd	4.57 e
	4	0.78 ab	0.43 d	5.83 e
	6	0.77 ab	0.44 bcd	9.05 e
LSD	-	0.11	0.028	1.67

*The treatments with the same letter are not significant at (0.05) probability level

Cruz *et al*. (2012) in the study showed that the enrichment of 0 to 20% fresh coffee waste showed that less than 10% of the waste in the planting ground could increase the amount of xanthophyll, β-carotene, chlorophyll of lettuce leaf and biomass. In the similar study on coriander, vermicompost treatments were superior in terms of the plant height, leaf length and width, dry weight, biomass yield, and total chlorophyll a and b and total carotenoids to the control treatment, and the treatment of 200 grams of vermicompost in the pot had the highest values of these parameters compared to levels of 0, 100 and 150 grams of vermicompost in the pot (Zaidi *et al*., 1999).

4.11. Market-friendly (*marketability*)

The effects of vermicompost types, application rates and their interaction were significant for marketability (α= 0.01), (Table 4). The highest and lowest marketability (16.4 and 4.23) were obtained from the application of both 2% and 4%sugerbeet vermicompost and control respectively (Table 5). With using sugar beet vermicompost, marketability increased by 400 and 380 percent respectively in compared to control. In the present experiment, the different types and levels of organic fertilizer had different effects on the tested plant. So that, among different types of organic fertilizers, vermicompost of sugar beet had the greatest effect on the growth and yield of lettuce, and date compost had a smaller share in this regard. These effects were due to an increase in traits such as the relative growth rate, dry biomass, head yield, leaf chlorophyll index and its effect on lettuces market-friendly compared to carrot vermicompost and date compost. Sharifian *et al*. (2014) showed that the effects of organic fertilizer on leaf area, carotenoids and plant height in calendula were significant. Photosynthesis activity and the concentration of materials within the tissues can be related to osmotic potential (Valadabadi and Farahani, 2011). Vermicompost increase chlorophyll a, chlorophyll b, total chlorophyll, and carotenoids content 73%, 62%, 66% and 26% respectively (Alhajhoj, 2017). Despite the fact that due to the plant's effort to survive with sufficient light in the environment, chlorophyll b levels are high, but, because of the disturbance in osmotic potential due to high amounts of date compost treatment, the root absorption is not enough so there is no sufficient energy in the cells, and the plant's yield will not increase (Tables 4 and 5). In a similar study in evaluating the effect of solid vermicompost on *Nigella sativa* L., chlorophyll a, b, total, and carotenoid content of three-month plants was significantly increased**,** compared to the control, but high concentrations of organic matter and essential oil reduced these parameters (Cruz *et al*., 2012).

5. CONCLUSION

It is concluded that the sugar beet vermicompost increased the plant growth by increasing chlorophyll content, or possibly due to having pigments thereby enhancing photosynthesis and providing nutrients. Sugar beet and the carrot vermicompost were more effective on the most lettuce properties with respect to date fruit waste. The organic compost rate had sigmoid trend effects on most lettuce properties. The highest and lowest lettuce dry weight was observed respectively in carrot vermicompost and in date fruit compost. The highest amounts of carotenoids were in sugar beet vermicompost with respect to the control treatment. The highest marketable indices were observed in sugar beet and date fruit compost.

Therefore, the sugar beet and then the carrot vermicompost were evaluated as the best raw materials for application as a vermicompost production. Also, the results of current experiment showed that by increasing the amount of organic fertilizer use, its effect were increased too; so that at different levels of application of organic fertilizers, 4 and 6 percent had the greatest effect on the growth and yield of lettuce plant. In reaching the goals of sustainable agriculture and food safety, the present achievement-organic production based on the theory of wealth of vegetable wastes-will is helpful for producers and consumers of organic lettuce. The innovation of this research is that, as in the developing countries, the best carbon cycle will be done in ecosystem for increasing the soil fertility when we apply the plant residues as the soil carbon source, finally this matter lead to the improve of poorly cultivated soils because the lost nutrients will be returned to the soil texture.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

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