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Effect of Using Vermicompost on Some Soil Physicochemical Properties and Cabbage Growth and Yield under Different Levels of Sprayed Zinc

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Abstract: Two field experiments were carried out at the Agricultural Production and Research Station, National Research Centre (NRC), Nubaria, Egypt during the successive winter seasons of 2020 and 2021. The experiment was designed to investigate the response of cabbage plants to different levels of vermicompost and foliar application of zinc (zinc sulfate) on growth, yield and nutrients uptake of cabbage plants, as well as studying the effect of vermicompost on some physico-chemical properties (bulk density, total porosity, available water, field capacity, wilting point, hydraulic conductivity, organic matter, CEC and EC)of the soil. Results indicated that spraying cabbage plants with different rates of zinc (zinc sulfate)greatly improved the growth, yield and nutritional value of cabbage plants under different levels of vermicompost in both seasons. The effect was more significant and positive when zinc (zinc sulfate) was sprayed at a rate of 100 ppm with vermicompost fertilization at a rate of 6 ton/ fed. It can be said that spraying plants with zinc (zinc sulfate)greatly improved the growth, yield and nutritional status of the cabbage plants grown in sandy soil in combination with organic fertilization. In summary the foliar application of zinc to cabbage plants combined with the addition of vermicompost increased the yield from (12.9, 12.7 ton/fed) in case of the control treatment to (18.3, 18 ton/fed) in case of 100 ppm of zinc + 6 ton/fed of vermicompost for the first and the second respectively. Moreover, this treatment produced the cabbage with high minerals content and nutritional value compared with the control treatment. Regarding the effect of vermicompost on soil physico-chemical properties, results showed that a significant positive effects of the application of different rates of vermicompost on physical soil properties where, Increasing the addition of vermicompost to sandy soil from 0 to 6 ton /fed led to a significant decrease in the bulk density and hydraulic conductivity While there was a significant increase in the total porosity, available water, field capacity, wilting point, of the sandy soil. Also results indicated that significantly increased in soil organic matter, CEC and EC with increasing the addition of vermicompost of the sandy soil especially at 6 ton /fed.

Key words: Cabbage plants · Growth · Yield · Nutrient's uptake · Zinc · Vermicompost · Soil physicochemical properties · Sandy soil

INTRODUCTION

Cabbage (*Brassica oleraceae*) is one of the common vegetables in Egypt. Cabbage is one of the most important and widely cultivated winter cruciferous leafy vegetables in Egypt [1]. The original home of cabbage is Europe and it is a plant that can be grown in any season. The area of cabbage planted in Egypt is about 35, 000 feddans every year. It is grown for its compact heads, which have high nutritional amount and hold organo-sulphur phytochemicals that increase their antioxidant capacity, which may have anti-carcinogenic effects [2]. Based a detailed review of diet and cancer, cruciferous vegetables are the richest sources of glucosenolates and rich in vitamins C and E and β-carotene [3, 4]. Cabbage plants are among the crops that require high fertilization, whether organic or mineral fertilization to obtain a high yield [5].

Vermicompost technology is a simple biotechnological method that characterized by the safe recycling of organic waste through certain types of soil worms and it produces an organic fertilizer with high-value characteristics that is suitable for sustainable agriculture [6]. The production process of the

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vermicompost is faster than production of traditional compost; as vermicompost is formed as a result of the material rushing into earthworm gut, which soon turns into organic materials that are more decomposed and richer in microbes and growth regulators [7]. The implementation of vermicompost in the field enhances the goodness of soils by superior in influencing the soil physical, chemical and biological properties such as bulk density, organic matter, available nutrients, beneficial bacterial and fungal population. Vermicompost plays an important role in improving the growth and productivity of all kinds of different crops [8].

Vermicomposting has many economically and environmentally benefits [9]. It enhances plant growth and development directly and indirectly through the improvement of soil physical and chemical properties such as porosity and water holding capacity [10, 11].

Zinc is an important micronutrient for all crops, which is an important component of different enzyme catalyzing many metabolic reactions in plants [12]. Zinc also plays a significant role in plant resistance against disease, photosynthesis, protein synthesis and enhance the levels of antioxidant enzymes and chlorophyll within plant tissues [13, 14, 15].

The aim of the research was to study the effect of adding vermicompost on the physico-chemical properties of the soil and its effect on the growth and yield of cabbage under spraying different concentrations of zinc.

MATERIALS AND METHODS

This study was carried out in the experimental station of the National Research Centre, El-Nubaria, Beheira Governorate, Egypt (latitude 30°8/ N and longitude 30°16/ E and mean altitude 21 m above sea level), during the two winter season of 2020 and 2021, to investigate the response of cabbage plants to different levels of vermicompost and foliar application of Zn on growth and yield of cabbage plants, as well as studying the effect of vermicompost on physico-chemical properties of the sandy soil. The planting date was 1st January 2020 and 3rd January 2021. The soil of the area is a newly reclaimed sandy in texture; physical and chemical analysis of the experiment soil is described in (Table 1).

The experimental design was the random split design with two factors (vermicompost + Zn). Vermicompost was added by 4 different levels (0, 2, 4 and 6 ton/fed) while Zn was sprayed at 3 different concentrations (0, 50 and 100 ppm). This resulted in 12 different treatments with three replicates for each treatment.

Seeds of cabbage were sown in the nursery in foam trays filled with a mixture of peat moss and vermiculite (1:1 volume). Seedlings were transplanted in the open field at 45 days age. Ditches of 20 cm depth and 20 cm width were ditched 75 cm apart and 10 m length. Nitrogenous fertilizer (80 units/fed.) and calcium superphosphate ($P_2O_5$90 units/fed were carefully mixed and spread through the ditches and covered with sand. Drip irrigation lines were established over the ditches. Irrigation system started three days before transplanting for washing planting beds. Healthy cabbage transplants were selected and planted on the eastern side of the irrigation line, one beside each dripper (50 cm apart). Potassium sulphate as recommended (80 kg/ fed.) was added in two equal portions every two weeks beginning one month after transplanting.

Four rates of vermicompost (0, 2, 4 and 6 ton/fed) were added before planting cabbage seedlings. Vermicompost physical and chemical properties were determined using the standard procedures outlined by Cottenie [16] as illustrated in Table (2).

Three concentrations of zinc (zinc sulfate), which are 0, 50, 100 ppm, which began spraying a month after planting cabbage seedlings; the spraying was repeated three times and the spraying was once every two weeks

Analytical Methods of Soil Properties: The surface soil samples were collected at 0 - 15 cm depth from the treated experimental plots inside the range of drippers to monitor the changes in soil physico-chemical properties and the nutrients status, Particle size distribution was determined according to [17], soil bulk density, total porosity, available water, field capacity, wilting point according to Klute [18], hydraulic conductivity according to Klute and Dirksen [19], pH, EC, cations and anions, organic matter, $CaCO_3$, total nitrogen and available P, K, Fe and Mn were determined according to Page *et al*., [20].

Measurement of Vegetative Growth: All growth parameters of cabbage plants such as plant height, plant diameter number of leaves per plant as well as fresh weight per plant were recorded according to FAO [21].

Measurement of Yield: Cabbage yield parameters such as head height, head diameter, head weight and marketable yield were recorded according to Gabal *et al.* [22].

Measurement of Chemical Constituents: Total nitrogen was determined in cabbage leaves using the micro-Kjeldahl method; P was assayed using molybdenum blue method and determined by spectrophotometer,

Table 1: Soil physical and chemical properties of the experimental field at the beginning of the experiment

Soil physical properties		Soil chemical properties			
Particle size distribution (%)		Soluble cations (meq. L^{-1})		Available nutrients (mg kg^{-1})	
Sand	86.6	Ca^{2+}	1.15	N	25.5
Silt	8.76	Mg^{2+}	0.74	P	3.9
Clay	4.69	Na^{+}	1	K	140
Soil texture	Sandy	K+	0.21	Fe	4.11
		Soluble anions (meq. L^{-1})		Mn	0.97
	CO_3^{2-}	-		Zn	1.2
	HCO_3^{-}	0.1	Calcium carbonate (%)		2.11
	Cl^{-}	1.2	pH		8.35
	SO_4^{2-}	1.8	EC (dS m^{-1})		0.31

Table 2: Some Physico-chemical properties of vermicompost used:

Analyses	Vermicompost
pH	6.9
EC (dS m-1)	2
Moisture content (%)	15
Organic matter (%)	50.3
Organic carbon (%)	29.2
Ash (%)	49.7
C/N ratio	01:24.3
N (%)	1.2
P (%)	0.5
K (%)	0.8

as well as K was determined by Flame Photometer [23], total proteins, total carbohydrates and total soluble sugars as well as vitamin "C" of cabbage leaves were determined according to A.O.A.C [24].

Statistical Analysis: The obtained data were subjected to the statistical analysis, where the Least Significant Difference test (LSD) at 0.05 level was used to verify the differences between treatments as mentioned by Snedccor and Cochran [25].

RESULTS AND DISCUSSION

Effect of Vermicompost on Soil Physico-Chemical Properties: Data illustrated in Table (3) shows the effect of different additions of vermicompost on some of the physico-chemical properties of sandy soil. The results showed that the application of different rates of vermicompost showed significant positive effects on the physical soil properties (bulk density, total porosity, available water, field capacity, wilting point and hydraulic conductivity) in the two growing seasons. Increasing the addition of vermicompost to sandy soil from 0 to 6 ton/fed led to a significant decrease in the bulk density of the sandy soil, while the total porosity of the soil was significantly increased. The available water, field capacity and wilting point were increased and improved significantly with the increase in the addition of vermicompost, especially at 6 ton/fed. Also, the high rates of vermicompost led to a decrease and improving in the hydraulic conductivity values of sandy soil.

Data in Table (3) also shows that, applying vermicompost affected on some chemical properties of the sandy soil at the two seasons. The increase in the rates of vermicompost added to the soil from 0 to 6 ton/fed significantly increased soil organic matter, as well as soil cation exchange capacity (CEC) and this was evident at the highest rate of vermicompost addition (6 ton/fed). As a result of the high value of the electrical conductivity (EC) in vermicompost, this of course led to an increase in the electrical conductivity content of the soil with an increase in the addition of vermicompost to the sandy soil.

According to Arancon *et al*. [26], successive and regular addition of vermicompost improved soil physical properties, as it improved soil texture and bulk density and also increased the soil ability to drain water. Manivannan *et al*. [27] confirmed the positive role of vermicompost addition to the soil leading to a decreased soil bulk density and increased soil porosity. Girde *et al*. [6] explained that, vermicompost addition to the soil increased the number of earthworms in the soil leading to a significant enhancement in the soil physical and chemical properties such as formation of tunnels and holes in the soil making the soil more loose and increased the micro pores of the soil, which improved water absorption and increased plant roots ventilation. Moreover, the drilling carried out by the worms contributed greatly to improving the water permeability of the soil. Earthworm secreted gelatinous substances that coat and stabilize the soil minerals; vermicompost is usually more water stable than aggregates of identical soils [28]. The high porosity and moisture holding capacity characteristic feature of vermicompost increased the growth of pathogen free plants [29].

Table 3: Effect of vermicompost on soil physicochemical properties

	Physical properties						Chemical properties		
Vermicompost ton fed^{-1}	Bulk density g cm^{-3}	Total Porosity %	Available water	Field capacity	Wilting point	Hydraulic conductivity cm hr^{-1}	Organic matter %	CEC me/100 g soil	EC dS/m
			----------%----------						
					Season (1)				
0	1.65	39.0	6.28	10.6	4.28	15.9	0.16	4.19	1.20
2	1.63	41.8	6.87	11.1	5.09	14.2	0.23	4.96	1.32
4	1.61	42.1	6.90	11.4	5.68	12.9	0.26	5.53	1.42
6	1.59	42.1	7.71	12.4	6.15	12.3	0.28	5.67	1.50
$LSD_{0.05}$	0.014	0.65	0.65	1.32	0.48	0.83	0.02	0.41	0.10
					Season (2)				
0	1.65	39.2	6.26	10.5	4.46	15.7	0.15	4.22	1.10
2	1.64	41.6	6.88	11.2	5.07	14.3	0.22	4.99	1.30
4	1.62	42.3	6.89	11.3	5.66	12.8	0.25	5.60	1.39
6	1.58	42.2	7.70	12.1	6.11	12.4	0.28	5.70	1.48
$LSD_{0.05}$	0.014	0.65	0.65	1.32	0.48	0.83	0.02	0.41	0.10

The results of the study are agreement with those obtained by Azarmi *et al*. [30] they studied the effect of adding vermicompost on some physical soil characteristics in soil cultivated with tomato plants and found that when adding vermicompost to the soil, this led to improved soil porosity and decreased bulk density values. Significant reduction in bulk density (1.69 to 1.56 g cm^{-3}) was observed in the treatment that received vermicompost 6 ton fed^{-1} treatment than treatment without vermicompost application. Alfred and Tom [31] reported that application of worm-compost caused significant reduction in bulk density of soil. The decreasing in bulk density due to the action of gum compounds polysaccharides and humic substances of vermicompost on the soil structure. The high organic matter in vermicompost increases soil fertility and enhances soil aerations which improve soil water holding capacity [32].

The improvement of hydraulic conductivity of sandy soils may be attributed to the effects of released organic acids, that occupy soil larger pores and encouraged the creation of medium and micro pores between the soil particles, consequently inhibiting the rapid velocity of down-movement of water in saturation conditions [33].

The EC of vermicompost depends on the raw materials used for vermicomposting and their ion concentration [34]. Adding vermicompost to the soils increased the soil EC compared to the untreated soils. Increasing the rates of adding vermicompost leads to a significant increase in the soil organic matter content and an increase in the cation exchange value in it [35, 36].

Effect of Vermicompost Rates and Foliar Concentration of Zn on Cabbage Growth: Data illustrated in Table (4) showed the effect of different rates of vermicompost under various concentrations of Zn on cabbage plants grown in sandy soil. Cabbage vegetative parameters such as plant weight, diameter and height positively responded to the increasing rates of vermicompost addition and zinc concentrations spray. Increasing the addition rates of vermicompost to the sandy soil led to a significant improvement in head weight, head diameter, plant height and number of leaves with an increase in the spraying concentration of zinc during the two successive seasons. The superior treatment, which gave the highest values for growth characteristics of cabbage plants, was 6 ton/fed of vermicompost with 100 ppm of $ZnSO_4$ solution spray.

Vermicompost is an organic fertilizer rich in nutrients needed by plants. vermicompost contains beneficial soil microbes and mycorrhizal fungi and thus it acts as a growth stimulator [7]. Manivannan *et al*., [27] and Ananthavalli *et al*. [37] reported a significant enhancement in plant growth in response to vermicompost addition to the soil. They attributed this effect to the stimulatory role of vermicompost as an organic substance which is rich in minerals and humic materials. Moreover, Zn as an essential element for plant growth, it is, involved in many enzymatic reactions and it is necessary for plant growth and development [38]. El-Khawaga, [39] reported the effectiveness of Zn foliar spray compared to the addition to the soil as it was found that Zn uptake was faster in the first case.

The effect of vermicompost different doses on lettuce plant length, number of leaves, fresh weight, dry weight was reported by Frasetya *et al.* [40] where he reported that 5 ton ha^{-1} vermicompost was the best dose to support growth, efficiency and improves plant growth. Moreover, Alper Durak *et al.* [41] reported the same results and attributed the effect of vermicompost by increasing soil humic acid content and consequently increases plant growth hormones and other beneficial symbiotic microorganisms. Besides, it helps availability

Table 4: Effect of vermicompost rates and foliar concentration of Zn on cabbage growth

Vermicompost ton fed^{-1}	Zn ppm	Plant weight kg	Plant diameter cm	Plant height cm	No. of leaves	Plant weight kg	Plant diameter cm	Plant height cm	No. of leaves
			Season (1)				Season (2)		
0	0	3.69	36.5	15.3	83.73	3.66	36.0	15.3	83.70
	50	3.80	38.7	16.0	90.1	3.82	37.9	15.9	89.5
	100	3.81	39.2	16.1	92.2	3.85	38.8	16.0	91.9
2	0	4.43	45.2	19.3	88.5	4.44	44.6	19.4	88.5
	50	5.26	46.5	19.8	95.5	5.21	45.5	19.9	94.5
	100	5.38	47.8	20.0	98.1	5.40	46.7	20.2	97.2
4	0	5.40	47.9	20.2	98.2	5.51	47.8	20.3	98.1
	50	5.75	48.2	20.6	99.4	5.80	48.1	20.5	99.1
	100	6.20	49.1	21.4	100.2	6.12	49.0	21.2	100.1
6	0	6.21	49.0	21.5	102.4	6.23	49.1	21.5	101.2
	50	6.50	50.2	22.4	106.8	6.49	49.9	21.9	105.9
	100	7.00	50.5	23.0	110.2	6.99	50.1	22.8	108.9
$LSD_{0.05}$		0.15	1.60	0.03	4.20	0.15	1.60	0.03	4.20

Table 5: Effect of vermicompost application on cabbage yield under different concentrations of zinc

Vermicompost ton fed^{-1}	Zn ppm	Head weight g	Head diameter cm	Head height cm	Yield ton fed^{-1}	Head weight g	Head diameter cm	Head height cm	Yield ton fed^{-1}
			Season (1)				Season (2)		
0	0	46.53	2.92	4.90	12.90	47.42	2.91	4.91	12.7
	50	47.32	3.44	4.92	13.05	48.21	3.45	4.92	13.02
	100	48.11	3.65	4.99	13.42	49.02	3.66	4.97	13.39
2	0	62.41	3.82	5.32	14.11	61.30	3.82	5.31	14.01
	50	66.85	3.92	5.66	14.53	65.94	3.91	5.56	14.43
	100	69.64	4.00	5.86	14.60	69.63	4.01	5.78	14.50
4	0	74.62	4.20	6.22	15.33	73.51	4.30	6.21	15.23
	50	77.90	4.34	6.35	15.65	77.00	4.23	6.33	15.54
	100	86.60	4.52	6.81	16.31	84.22	4.42	6.74	16.29
6	0	96.30	4.66	7.11	17.00	95.22	4.56	7.08	16.90
	50	100.4	5.00	7.38	17.62	100.2	4.99	7.40	17.55
	100	105.7	5.11	7.45	18.30	104.6	5.01	7.50	18.00
$LSD_{0.05}$		4.420	0.300	0.01	1.20	4.420	0.300	0.01	1.20

of plant nutrients by improving soil structure and microorganism activity and also this way increases plant growth. Rakesh *et al.* [42] reported the superiority of vermicompost enhancing plant physical and chemical characteristics and encouraging the use of organic fertilizers. The role of vermicompost of enhancing the soil physical, chemical properties and enhances nutrients availability in the soil solution and nutrients use efficiency [43].

Effect of Vermicompost Application on Cabbage Yield under Different Concentrations of Zinc: Through the data in Table (5), it became clear the effect of using vermicompost on cabbage yield under different levels of zinc is positive. As the increase in adding vermicompost to the soil significantly increased the cabbage yield characteristics compared to the control treatment (in which vermicompost was not added), this positive effect of vermicompost increased and became more effective with the boost in the concentration of zinc which sprayed on cabbage plants. The best experimental treatments, which gave the highest values for cabbage yield and different yield characteristics (weigh, height and diameter of head), was the treatment in which vermicompost was added at a rate of 6 ton fed^{-1} with zinc spraying at a concentration of 100 ppm.

Many authors reported the promotive effect of vermicompost as a source of plant required nutrients and humic materials, such as nitrogen, phosphorous and potassium [26]. Vermicompost is a host environment for several types of beneficial bacteria such as nitrogen-fixing and phosphorous-dissolving bacteria [44] and various growth regulators enzymes [45] and [46]. Moreover, Zn is one of the important micronutrients that are required by plants. It is either a constituent element of enzymes or a regulatory factor of many enzymes [47].

Table 6: Effect of vermicompost application on cabbage yield nutritional value under different concentrations of zinc

Vermicompost ton fed^{-1}	Zn ppm	Total protein	Total carbohydrate	Total soluble sugars	Vitamin C	Total protein	Total carbohydrate	Total soluble sugars	Vitamin C
		----------%----------			mg/100 g FW	----------%----------			mg/100 g FW
		Season (1)				Season (2)			
0	0	4.22	13.3	7.67	35.6	4.21	13.1	7.66	35.5
	50	4.52	13.4	7.70	35.6	4.52	13.2	7.71	35.6
	100	4.60	13.5	7.77	35.8	4.59	13.4	7.79	35.8
2	0	5.00	14.0	8.20	36.0	4.99	13.9	8.19	36.1
	50	5.23	14.2	8.47	36.8	5.22	14.2	8.46	36.7
	100	5.38	14.6	8.60	37.0	5.37	14.5	8.58	37.1
4	0	5.88	15.1	9.00	37.6	5.79	15.0	8.99	37.5
	50	6.02	15.5	9.25	37.8	6.00	15.4	9.24	37.7
	100	6.10	15.6	9.35	37.9	6.09	15.6	9.34	37.8
6	0	6.36	16.1	9.60	38.2	6.28	16.0	9.58	38.1
	50	6.45	16.4	9.62	38.4	6.36	16.3	9.61	38.4
	100	6.93	16.5	9.66	38.6	6.84	16.5	9.68	38.5
$LSD_{0.05}$		0.23	0.15	0.07	0.23	0.23	0.15	0.07	0.23

Chaplin and Westwood, [48] reported that, Zinc sulphate ($ZnSO_4$) has a significant role on tryptophan biosynthesis which induces pollen tube growth. In addition, Barker and Pilbeam [49] attributed the increase in fruits number and fruit quality due to the foliar application of $ZnSO_4$ to auxiliary role Zn in auxin synthesis which is potentially useful as plant growth promotor. Moreover, Jnana *et al*. [50] found that Zinc is an essential element for plants and increasing of yield.

Abou El- Hassan *et al*. [51], Sevinç *et al*. [52] and Yassen *et al*. [53] reported the increasing dose of vermi-compost increased growth, yield and quality of plants.

Effect of Vermicompost Application on Cabbage Yield Nutritional Value under Different Concentrations of Zinc: The obtained data in Table (6) showed that, the increase in the concentration of foliar spraying with zinc solution on cabbage plants led to an improvement in the quality of the cabbage crop, especially when combined with the addition of vermicompost at increasing rates added to the sandy soil, during the two growing seasons. The addition of high rates of vermicompost (6 ton/fed) with zinc spraying at a concentration of 100 ppm gave the highest content of protein, carbohydrates, vitamin C and soluble sugars in cabbage leaves, which increases its quality and improves its nutritional value.

This may be attributed to the role of Zn as it is a component of many enzymes such as dehydrogenase, proteinase, peptidases and phosphohydrolases important for metabolism of carbohydrate, protein and phosphate [54]. Zinc has also proven to have an important role in photosynthesis and related enzymes, resulting in increasing sugar and decreasing acidity [55]. Abdollah *et al*. [56] found that the highest number of fruits, TSS and vitamin C in fruit of strawberry was obtained through application of $ZnSO_4$ at 200 ppm. When vermicompost was applied in combination with integrated plant nutrient system along with recommended doses chemical fertilizers, the effect showed better performance on yield rather than applying chemical fertilizers alone. Thus, vermicompost can be used in combination with fertilizers for satisfactory yield of cabbage [57].

Effect of Vermicompost Application on Minerals Content of Cabbage Leaves under Different Concentrations of Zinc: Date presented in Table (7) illustrates that, the N, P and K content of the cabbage leaves increased by increasing the addition rate of vermicompost from zero to 6 ton/fed, while spraying zinc had a slight and insignificant effect on the content of cabbage leaves of nitrogen, phosphorous and potassium, during the two growing seasons. This improvement in the nutritional value of cabbage leaves is more evident when adding a higher rate of vermicompost with spraying Zn at a highest concentration. Vermicompost releases nutrients gradually in the soil during crop development compared to the chemical fertilizers which have cracking effect resulting in immediate release of nutrients in the soil [58]. The nutrient contents of different plant components such as roots, shoots and fruits also were improved when vermicompost was added to the soil.

These results are in harmony with those reported by Beyk Khurmizi *et al*. [59, 52, 60] on lettuce. Where they reported the increase in leaf mineral (N, P and K) contents in case of the application of vermicompost at 5 ton/fadden. Vermicompost promotes minerals uptake [61, 62, 63, 64], which led to total N (%) increase in spinach [65], P content in the leaves of maize [66].

Table 7: Effect of vermicompost application on nutritional status of cabbage leaves under different concentrations of zinc

Vermicompost ton fed^{-1}	Zn ppm	N	P	K	N	P	K
		---------- % ----------			---------- % ----------		
		Season (1)			Season (2)		
0	0	0.78	0.33	0.97	0.78	0.32	0.99
	50	0.81	0.34	0.99	0.79	0.33	1.01
	100	0.81	0.34	1.02	0.79	0.34	1.02
2	0	0.85	0.36	1.11	0.86	0.35	1.12
	50	0.89	0.38	1.14	0.88	0.36	1.18
	100	0.90	0.39	1.17	0.89	0.37	1.18
4	0	0.94	0.39	1.33	0.94	0.37	1.32
	50	0.97	0.41	1.39	0.97	0.39	1.40
	100	1.01	0.42	1.40	1.00	0.40	1.41
6	0	1.04	0.42	1.41	1.02	0.41	1.47
	50	1.05	0.43	1.52	1.04	0.42	1.55
	100	1.07	0.44	1.60	1.06	0.43	1.62
$LSD_{0.05}$		0.01	0.002	0.02	0.01	0.002	0.02

CONCLUSION

The results of this study have confirmed the ability of vermicompost when used alone to improve the sandy soils a result to its effect on improving the physical and chemical properties of this soils. Moreover, when the cabbage plants are treated with zinc the yield and plant nutritional value enhanced significantly especially with 100 ppm of zinc sprayed to the plant leaves. The result of the experiment indicated that the highest growth and yield of cabbage was obtained by using eco-friendly organic fertilizer (vermicompost). Hence, it is imperative to popularize the use of organic fertilizers, to reduce the dependence on inorganic fertilizers and contribute to a pollution-free atmosphere. From the obtained results it can be concluded that organic fertilizers are recommended for improving soil physicochemical properties and cabbage plant growth and yield

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