Impact of Vermicompost on Lettuce Cultivated Soil

M. M. Manyuchi, T. Mudamburi, A. Phiri, P. Muredzi

Abstract*— Vermicomposting is an environmentally friendly technique that is used for organic solid waste management. Waste corn pulp blended with cow dung and office paper was vermicomposted over 30 days to produce vermicompost which is a bio-fertilizer. The vermicompost was applied to soil cultivated with lettuce at the planting and after every four weeks. The impact of vermicompost on the soil was quantified. Application of vermicompost resulted in a 5%, 21.7%, 16.9% and 4.92% increase in soil pH, nitrogen, phosphorous and manganese content respectively. Application of the vermicompost also resulted in a 9.41% and 3.77% decrease in soil electrical conductivity and potassium content respectively. However, application of vermicompost did not alter the copper and zinc content of the lettuce cultivated soil. The lettuce showed vigor and vitality during the period of growth. Vermicompost can be used for sustainable agriculture practices.

***Key Words*— Bio-fertilizer, lettuce, soil properties, vermicompost**

I. INTRODUCTION

Vermicomposting is widely being used as a solid waste management technology [1]-[2]. During vermicomposting, earthworms ingest the organic wastes and are expelled as vermicasts after a bioconversion process in the earthworms' gut [3]-[5]. These vermicasts are termed vermicompost and are rich with the fertilizer macro and micronutrients [2] and [5]. Vermicompost also contain living microorganisms and have a high content of humus like material [2] and [5]. This vermicompost can be utilized as a bio-fertilizer which is environmentally friendly [6]-[9]. Vermicompost has been used in sustainable agriculture and was found to stimulate plant growth [1]. Vermicompost has been applied to several plants including strawberries, tomato, rice and maize [1], [3], [5], [8], [10]-[16]. Furthermore, the effect of metals found in the vermicompost on lettuce has been quantified [17]. The objective of this study focused on quantifying the impact of vermicompost on lettuce cultivated's soil physicochemical properties. Lettuce (*Lactuca sativa L.*) is a salad vegetable crop which can be grown in 2-3 months. Lettuce thrives best in temperature conditions of 10-20 ◦C, pH 6-6.5 and electrical conductivity of ≤ 1.3 ds/m [18]. The fertilizer nutrient requirement of lettuce is indicated in Table 1 [18].

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TABLE 1: LETTUCE NUTRIENT REQUIREMENTS

Nutrient	Required range	Target level
N (%)	2.5-4.0	3.5
P (%)	0.4-0.6	0.45
K (%)	4.0-7.5	5
Ca (%)	0.9-2.0	1.0
Mg (%)	0.3-0.7	0.35
S (%)	0.1-0.3	0.1
Fe (ppm)	50-150	130
Zn (ppm)	25-50	40
Mn (ppm)	30-55	50
Cu (ppm)	5-10	8
B	15-30	20
Mo	NA	0.03

II. MATERIALS AND METHODS

A. Materials

Waste corn pulp blended with cow dung manure and office paper was vermicomposted for 30 days using *Eisenia fetida*. Vermicompost with a nutrient com position indicated in Table 2 was applied [2]. The nutrient composition of the vermicompost met the fertilizer requirements needed for lettuce indicated in Table 1.

TABLE 2: VERMICOMPOST FROM WASTE CORN PULP COMPOSITION

Nutrient	Vermicompost composition
N (%)	4.19
P (%)	1.15
K (%)	6.18
Na (ppm)	4.85
Mg (ppm)	6.58
Cu (ppm)	0.57
Zn (ppm)	1.35
Fe (ppm)	162.30
Mn (ppm)	1.62

Methods

The soil pH and electrical conductivity were determined by a Hanna HI 9810 Instrument. 5g of the soil was dissolved in 10ml of water and allowed to settle before taking measurements. The nitrogen and phosphorous content were determined by a Shimadzu *uv-vis* spectrophotometer. The potassium content in the soil was determined by a Cary Model AAS spectrophotometer. The lettuce seeds were planted 6cm deep in loam-clay soils. The lettuce beds were 3m long by 1m wide and were regularly watered to maintained adequate moisture content. The lettuce seeds were 98% germinated at day 4-5. The lettuce was allowed to grow for 2 months and vermicompost was applied upon planting and after 4 weeks of planting.

The lettuce was planted at the Faith and Hope Children's home.

III. RESULTS AND DISCUSSION

The lettuce planted using the vermicompost is indicated in Figs 1a and 1b.

Fig 1a: Lettuce grown using vermicompost as bio-fertilizer

Fig 1b: Lettuce grown using vermicompost as bio-fertilizer

A. Impact on soil pH and conductivity

The raw soil had a pH of 5.7 and electrical conductivity of 10 121 µS/cm. Addition of vermicompost increased the soil pH of lettuce cultivated soil by 5% compared to the raw soil. This was also affirmed by the 9.41% decrease in the lettuce cultivated soil upon addition of vermicompost. However, the change in the pH and electrical conductivity were still in line with the requirements for optimum lettuce growth (see Table 1).

B. Impact on soil nitrogen, phosphorous and potassium content

Nitrogen exists as ammonium nitrate ions, NH_4^+ and NO_3^- in the soil for ready uptake by plants. Addition of vermicompost increased the nitrogen available in the soil by 21.7% in the lettuce cultivated soil compared to the virgin soil (see Fig 2). This was because of addition of extra ammonium nitrates from the vermicompost due to mineralization [10]-[14]. Phosphorous exists as phosphates $H_2PO_4^-$ and HPO_4^{2-} in the soil. Addition of vermicompost in the lettuce cultivated soil resulted in increased phosphorous content by 16.9% (see Fig 2). This was because of addition of extra slow release phosphates from the vermicompost [1], [10] and [15]. Potassium exists as K^+ in the soil. Addition of vermicompost in the lettuce cultivated soil, resulted in 7.75% decrease of the potassium content (see Fig 2). This was possibly because the potassium available from the vermicompost was not enough such that the lettuce extracted some of the potassium from the soil.

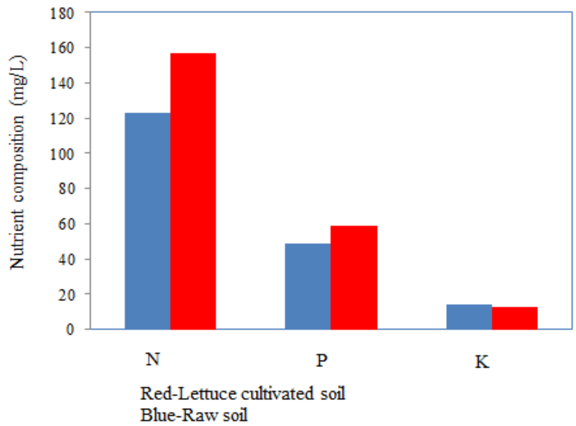

Fig 2: Comparison of soil NPK in raw soil and lettuce cultivated soil

C. Impact on soil Zn, Cu, Mn and Fe content

Zinc and copper exist in the soil as Zn^{2+} and Cu^{2+}. Addition of vermicompost on lettuce cultivated soil did not result in any change in the zinc and copper content (see Fig 3). The zinc and copper ions from the vermicompost were all taken up by the lettuce and did not alter the soil composition. The insignificant change in zinc was attributed to the slight increase in soil pH [14]. Manganese exists in the soil as Mn_2O_3. Addition of vermicompost in the lettuce cultivated soil resulted in a 4.92% increase in the manganese content (see Fig 3). This was because of addition of extra manganese to the soil from the vermicompost. Iron exists in the soil as Fe^{2+} and Fe^{3+} in the soil. Addition of vermicompost in the lettuce cultivated soil resulted in a 3.77% decrease in the iron content (see Fig 3). This was possibly because the iron available from the vermicompost was not enough such that the lettuce extracted some of the iron from the soil.

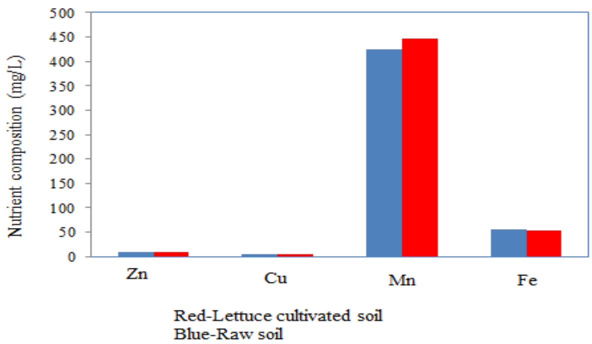

Fig 3: Comparison of soil micronutrients in raw soil and lettuce cultivated soil

IV. CONCLUSION

Vermicompost can be successfully used as a bio-fertilizer for the growth of lettuce.

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The vermicompost impacts positively on the nutrient available for uptake by the lettuce due to the presence of living organisms in the vermicompost thereby stimulating growth. Vermicomposting technology can be used for sustainable agriculture practices.

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