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Research Article

Effects of Various Feed Sources Vermicompost on Lettuce (*Lactuca Sativa L*) Growth Performance at Hawassa

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Abstract

The research was conducted to study the effects of vermicompost produced from various biodegradable wastes on lettuce growth performance. The experiment was conducted at Hawassa University, College of Agriculture during 2022 cropping season. The experiment consisted of 8 treatments, 7 treatments were using vermicomposts produced from agro-industrial wastes such as avocado and coffee husk and agricultural waste (cow dung and enset produced at Hawassa University, College of Agriculture and negative control (without vermicompost amendment) was included as check. The treatments were arranged in RCBD with 3 replications. The plot size was 1.5 m*1.5m. The spacing between plants and rows were 0.25 m and 0.3 m respectively. 8 t/ha vermicompost was added to each plot. The data were analyzed using SAS software version 9.3. vermicompost prepared from all feeding materials had significantly ($p < 0.05$) higher lettuce yield, dry weight, plant height, root length, and leaf area than the negative control. However, the highest lettuce yield (20.25 t/ha) was recorded from vermicompost produced from organic materials such as coffee husk+ avocado waste + enset waste + cow dung followed by vermicompost produced from coffee husk + cow dung. Similarly, the highest dry weight (10.09 %) was found from vermicompost produced from mixed biowaste of coffee husk + cow dung. Therefore, from the present study, it could be concluded that vermicompost prepared from coffee husk + cow dung and coffee husk + avocado waste + enset waste + cow dung are suitable biowaste for lettuce production in Sidama area.

Keywords

Vermicompost, Lettuce, Growth Performance

1. Introduction

Lettuce (*Lactuca sativa* L.) is an annual leafy herb, belongs to the family compositae and it is one of the most popular salad crops and occupies the largest production area among salad crops in the world [12]. It is extensively grown in most parts of Ethiopia on diverse ecology. In many parts of Ethiopia, lettuce is an important cash and food security crop for smallholder farmers and fresh salad retailers [3]. Vegetables need substantial amounts of nitrogen (N) fertilizer, and crop yields might be significantly decreased if crops do not receive enough N [10]. Therefore, it is crucial that farmers use the most N fertilizer possible [10]. Likewise, P nutrition, root development, and lettuce output all depend on optimal phosphorus (P) administration [17]. Water-soluble inorganic N and P fertilizers can easily release these nutrients for plant uptake, promoting plant development and yield. However, the utilization of organic matter in the form of composted goods is

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growing due to rising fertilizer costs and worries about the environmental effects of excessive fertilizer use. However, Although some studies on vermicomposting using Coffee husk and Enset waste were conducted in some parts of Ethiopia [4, 7], detailed study of vermicomposting for valorizing of coffee husk, avocado, and enset waste into value-added product for crop production is lacking in the SNNPRS in general and around the Sidama region in particular. Therefore, the aim of the study was to determine the effects of vermicompost produced from agro-industrial wastes such as avocado and coffee husk and agricultural waste (cow dung and enset) on lettuce growth performance.

2. Materials and Methods

The experiment was conducted at Hawassa University, College of Agriculture during 2022 cropping season. The experimental field was conducted within the College of Agriculture at Hawassa City (Figure 1). Hawassa is the capital City of Sidama Region, located 275 km far from Addis Ababa, capital city of Ethiopia. The site lies 7°4′N latitude and 38°31' E longitudes, at an elevation of 1669 m.a.s. The mean annual rainfall is 1,761.36 mm.

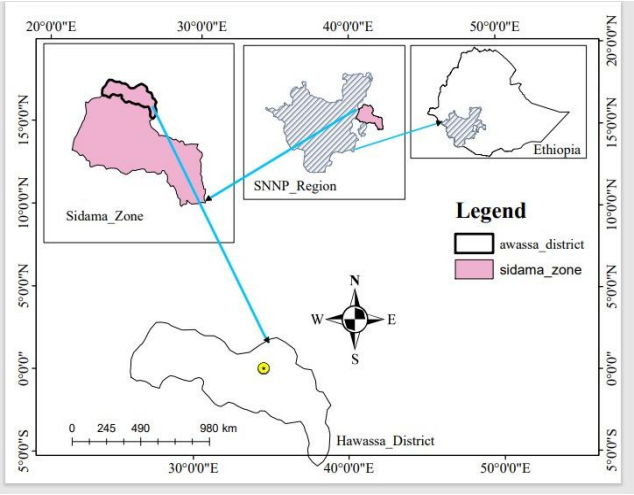

Figure 1. Map of study area.

2.1. Experimental Materials

Great lake lettuce seed was used as a test crop and vermicompost prepared from locally available industrial wastes such as avocado and coffee husk and agricultural waste (cow dung and enset) produced at Hawassa University, College of Agriculture Vermiculture Center was used as treatment.

Table 1. Selected physicochemical properties of initial soil sample.

Soil properties	
Sand (%)	59
Silt (%)	28
Clay (%)	13
Textural class (%)	Sandy loam
OM (%)	1.94
TN (%)	0.213
Available P (ppm)	4.44
K (cmol/kg)	0.26
Na (cmol/kg)	0.21
CEC (cmol/kg)	24.5
pH (H_2O)	6.2

2.2. Treatments and Experimental Design

The experiment comprised of 8 treatments and which was laid out in randomized complete block design (RCBD) with 3 replications. The plants were separated at spacing of 0.25 m and rows were separated at 0.3 m. the recommended spacing between plots and blocks were maintained as 0.5m and 0.8 m respectively. There were 5 rows per plot and 6 plants per row. The plot size was 1.5 m × 1.5 m. = 2.25 m^2 and 17.5 m × 8.1 m was the total experimental area. For each plot, 8 t ha^{-1} of vermicompost [1]. was applied. The applied vermicompost was broadcasted uniformly and incorporated in to the soil then the lettuce seedlings, which were sown on seed bed for seedling preparation and stayed for 30 days until they rich 3-4 leafs were transplanted.

Table 2. Treatments set up of the experiment.

No	Treatments	Amount of vermicompost added (kg) /2.25m^2
T1	Vermicompost produced from coffee husk + cow dung	1.8
T2	Vcermicompost produced from avocado waste+ cow dung	1.8
T3	Vermicompost produced from enset waste + cow dung	1.8

No	Treatments	Amount of vermicompost added (kg) /2.25m^2
T4	Vermicompost produced from coffee husk+ avocado waste + cow dung	1.8
T5	Vermicompost produced from coffee husk +enset waste + cow dung	1.8
T6	Vermicompost produced from avocado waste + enset waste + cow dung	1.8
T7	Vermicompost produced from coffee husk + avocado waste + enset waste + cow dung	1.8
T8	Negative Control	

Table 3. Some initial chemical properties of Vermicompost.

Treatment	OC (%)	N (%)	C:N	P (ppm)	K (Cmol/kg)
CH + CD	37.54	2.45	15.33	173.84	35.9
AW + CD	37.54	2.24	16.73	114.82	29.44
EW + CD	39.22	1.003	39.08	120.62	28.053
CH + AW + CD	37.8	1.26	29.90	169.24	28.65
CH + EW + CD	40.46	1.82	22.19	103.88	28.52
AW + EW + CD	38.1	1.96	19.45	116.85	21.19
CH + AW + EW + CD	42.36	2.1	19.55	103.86	27.253

Note: CH + CD= coffee husk + cow dung; AW + CD = Avocado waste + cow dung; EW + CD= Enset waste + cow dung

2.3. Data Collected

Lettuce yield and growth data such as plant height, leave number per plant, leaf area, root length, fresh weight per plant, and dry weight per plant were recorded.

Yield (t/ha): Ten plants were randomly selected from middle rows of the plot. After uprooting the plant, the biomass was cut (separated) from the root. Then it was measured immediately by using sensitive balance.

Dry Weight (g): Samples from lettuce leaves (500 g fresh weight) were placed in paper bags. And then, the samples were dried in an oven at 75 ℃ overnight. Then, the dry weight was measured by using sensitive balance.

Fresh Weight per plant (g): Ten plants were randomly selected from middle rows of the plot. After uprooting the plant, the biomass was cut (separated) from the root. Then it was measured immediately by using sensitive balance.

Plant height (cm): Ten plants were randomly selected from the three middle rows to avoid border effect and plant height was measured to take the average. It was measured from the ground level to the topmost growth point above the ground after by using a ruler.

Leaf number per plant: Visual counting of leaf on 10 randomly taken plants from the 3 middle rows was recorded for each plant. Every visible leaf on the plant counted.

Root Length per plant (cm). It was measured from middle rows of the plot, after uprooting the lettuce and removing the attached growing media from the root carefully to avoid root damage of the plant by elongating the tape to measure the length. The length was measured in centimeter by using the ruler.

Leaf area per plant (cm$^{2)}$: Leaf areaX was measured by randomly selecting 3 plants from middle rows of the plot. The leaf area was measured by using the material LI- 3100C Area meter (precision Square cms), LI-COR after distracting the samples.

2.4. Data Analysis

All the recorded data were subjected to analysis of variance (ANOVA) using SAS computer software version 9.3 (SAS, 2002) and the least significant difference between means (LSD) used to separate the treatment means at statistical significance level of $p \leq 0.05$.

3. Results and Discussion

3.1. Plant Height

The analysis of variance indicated that the application of vermicompost produced from different sources significantly

(P < 0.0001) affected plant height (Table 5). The maximum plant height (25.13 cm) was recorded from the application of vermicompost prepared from coffee husk + avocado waste + enset waste + cow dung, while, the lowest plant height cm) was recorded from control. The application of vermicompost increased the plant height by 27.25% over the control. The increment of plant height after application of vermicompost may be due to the presence of high total nitrogen, organic carbon and other plant nutrients that were released from the applied vermicompost. Similar findings reported that the application of vermicompost increased lettuce plant height over the control [18].

3.2. Fresh Weight of Lettuce

The highest fresh weight (155.00 g per plant) was observed from the vermicopost produced from the coffee husk+ avocado waste + enset waste + cow dung, whereas the lowest fresh weight (105.05 g per plant) was measured from the control. The application of vermicompost produced from coffee husk+ avocado waste + enset waste + cow dung increased the fresh weight by 32.22% over the control. This could be due to the positive influences of vermicompost that contain essential plant nutrients on physical, chemical and biological properties of the soil (Tables 3).

Similarly, the findings of [5]; [18] reported the highest fresh weight over the control due to the fact that it improves soil microbial activity and properties, such as porosity and water infiltration rate of soil. In addition, it increases soil oxygen availability and maintains the temperature of soil and helps in achieving high yield of crop.

Table 4. *Effects of various feed sources vermicompost on growth and yield of lettuce.*

Treatment	Dry Weight (%)	Leaf Number	Fresh Weight (g)	Yield (t/ha)	Root Length (cm)
CH + CD	10.09^{a}	23.73	151.86^{a}	20.25a	11.33^{bc}
AW + CD	6.13^{b}	25.13	145.72^{a}	19.43a	12.70^{a}
EW + CD	6.07^{b}	26.63	126.60^{b}	16.89b	11.56^{abc}
CH + AW + CD	6.34^{b}	27.13	121.45^{b}	16.19b	11.00^{c}
CH + EW + CD	6.83^{b}	23.67	151.63^{a}	20.23a	11.56^{abc}
AW + EW + CD	6.13^{b}	22.47	151.72^{a}	20.23a	11.33^{bc}
CH + AW + EW + CD	9.72^{b}	21.45	155.00^{a}	20.67a	12.53^{ab}
Control	4.54^{c}	16.4	105.05^{c}	14.1c	9.73^{d}
LSD (0.05)	1.25***	NS	15.92***	2.12***	1.26*
CV (%)	10.21	15.72	6.56	2.14	6.27

Note: Mean values followed by different letter(s) are significantly different from each other using LSD test (NS = P > 0.05; ***= P < 0.0001; **= P < 0.001; *= P < 0.05). LSD = least significant difference; CV = coefficient of variance: CH + CD= coffee husk + cow dung; AW + CD = Avocado waste + cow dung; EW + CD= Enset waste + cow dung

3.3. Root Length of Lettuce

The analysis of variance showed that root length of lettuce had significantly (P < 0.05) increased due to vermicompost application (Table 4). The longest root length (12.70 cm) was recorded from the vermicompost feeding materials of avocado waste + cow dung, while the shortest root length of lettuce (9.73 cm) was measured from the control (Table 4). The plant root length was increased by 23.24% with the application of vermicompost produced from the feedstock materials avocado waste + cow dung, as compared to the control. This could be due to the presence of abundant plant nutrients in the vermicompost produced from different feeding materials as compared to the control. The root growth was also due to Vermicompost is a finely-divided peat-like material. Because of this fine structure, the addition of vermicompost to the soil causes significant changes in the physical properties, altering water and air availability in the substrates and conditioning root growth [11]. The effect of humic substances in vermicompost is more prominent in stimulating root respiration, formation and growth [2]. Similarly, [14] also reported the elongation of root length on sunflower plant from vermicompost application.

Table 5. Effects of various feed sources vermicompost on Plant Height and Leaf Area of lettuce.

Treatment	Plant Height (cm)	Leaf Area (cm^2)
CH + CD	23.5^{b}	2311.2^{b}
AW + CD	21.73^{c}	2677.3^{ab}
EW + CD	19.57^{d}	2577.4^{b}
CH + AW + CD	19.02^{de}	2507.0^{b}
CH + EW + CD	20.13^{d}	2857.1^{ab}
AW + EW + CD	19.95^{d}	2733.8^{ab}
CH + AW + EW + CD	25.13^{a}	3313.3^{a}
Control	18.28^{e}	1151.2^{c}
LSD (0.05)	1.224***	718.49**
CV (%)	3.34	16.31

Note: Mean values followed by different letter(s) are significantly different from each other using LSD test (***= P < 0.0001; **= P < 0.001). LSD = least significant difference; CV = coefficient of variance: CH + CD= coffee husk + cow dung; AW + CD = Avocado waste + cow dung; EW + CD= Enset waste + cow dung

3.4. Leaf Area (cm^2)

The applied vermicompost significantly (P < 0.0001) increased leaf area of the plant over the control (Table 5). The application of coffee husk + avocado waste + enset waste + cow dung resulted the highest leaf area (3313.3 cm^2), while the negative control had the lowest leaf area (1151.2 cm^2) (Table 5). The applied vermicompost produced from the mixed biowastes of coffee husk + avocado waste + enset waste + cow dung increased the leaf area by 65.27% over the control. This may be attributed to the supply of plant growth promoting substances (PGRs) from the vermicompost applied. In addition to this, the nutrient supply and improvements of the physical conditions of soil by vermicompost improved plant development such as increased leaf area, root volume and root branching [11]). Similar result also reported by [15] who reported leaf area of cucumber was increased due to the application of vermicompost. Thus, 40 day after transplanting the application of vermicomost showed significant increment of leaf area [13].

3.5. Dry Weight of Lettuce

Dry weight of lettuce was significantly (P < 0.0001) affected by the application of vermicompost (Table 4). The highest dry weight (10.09 %) was recorded from vermicompost produced from coffee husk + cow dung, while the lowest dry weight (4.54 %) was recorded from the control. Application of vermicompost increased the dry weight of lettuce by 55.04% over the control. This could be due to the fact that vermicompost contains plant nutrients, microbes and organic carbon. Similarly, [13] found significant increment of dry weight of lettuce from application of vermicompost.

3.6. Yield of Lettuce

The highest lettuce yield (20.25 t/ha) was observed from the vermicopost produced from the substrates of coffee husk+ avocado waste + enset waste + cow dung. Whereas the lowest fresh weight (14.1 t/ha) was measured from control. The application of vermicompost produced from the substrates of coffee husk+ avocado waste + enset waste + cow dung increased the fresh weight by 31.78 % over the control. Similarly, [6] also reported the application of vermicompost increased lettuce yield over the control.

4. Conclusion and Recommendation

The present study indicated that the effects of vermicompost on growth and yield of lettuce indicated that, the highest fresh weight (20.25 t/ha) was observed from the vermicopost produced from the bedding materials of coffee husk+ avocado waste + enset waste + cow dung and followed by the vermicompost produced from coffee husk+ cow dung substrates. Whereas, the lowest lettuce yield was (14.1 t/ha) measured from control. Similarly, the highest dry weight (10.09 %) was recorded from vermicompost produced from the mixed feeding materials of coffee husk + cow dung and followed by coffee husk+ avocado waste + enset waste + cow dung. While, the lowest dry weight (4.54 %) was recorded from the control. Therefore, we recommend the biowaste consisted of coffee husk + cow dung and coffee husk + avocado waste + enset waste + cow dung that have high dry weight and Yield for lettuce production in Sidama Region. However, since the experiment was conducted only for one season and one site, repeating the trial at different sites as well as in the same trial site would be important in order to draw sound recommendation.

Abbreviations

ANOVA	Analysis of Variance
CV	Coefficient of Variance

Author Contributions

Malefia Demerew: read, conceptualize and approved the final manuscript

Girma Abera: participated on resource facilitating, project administration and Methodology part of the research

Conflicts of Interest

The authors declare no conflicts of interest.

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