Nutrient Concentrations of Conventional Compost and Its Effects on Teff Yield and Vermicompost of Different Crop Residue, Bedding and Feed Wastes in Ambo District

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Abstract: Currently use of conventional compost and vermicompost for crop production is common in the country but their nutrient concentrations were not known. Therefore, there is a need to determine the nutrient concentrations to know the quality of conventional compost and conventional compost for crop production. Consequently, an experiment was conducted to determine the nutrient concentrations of conventional compost and vermicompost prepared from different crop residue, bedding and feed wastes at Ambo in 2017 and 2018 cropping season. The decomposed conventional compost and vermicompost were prepared following laboratory procedures and analyzed for different nutrient concentration at Holetta Research Soil and Plant Laboratory. Higher total nitrogen (0.696 %) was obtained with compost produced from ratio of 15:5 kg of wheat residue with farmyard manure followed by 15:7.5: 2.5 kg wheat residue: faba bean residue and farmyard manure combinations with total nitrogen concentration of 0.610 %. Significantly higher mean panicle length, plant height, dry biomass and grain yield of teff were obtained from application of recommended NP fertilizer rate as compared compost indicting integrated use of compost with NP fertilizer is advisable for sustainable teff production as compared to sole compost for smallholder farmers. Higher total nitrogen concentration of 1.32% was obtained from vermicompost prepared using fruit wastes followed by that of barley straw 1.28 %. Higher total nitrogen concentration of 1.32% was obtained from vermicompost prepared using fruit wastes followed by that of barley straw 1.28 %. Therefore, the use of wheat residue with farmyard manure and wheat and faba bean residue with farmyard manure combinations was selected for better total nitrogen concentration and recommended in pure and integrated with inorganic fertilizer for sustainable crop production. Use of vermicompost prepared from fruit waste, barley straw and faba bean straw was for better production of vermicompost for better total nitrogen production and further use for crop production.

Key words: Compost • Vermicompost • Nutrient

INTRODUCTION

Conventional compost and vermicompost are prepared from organic materials containing low amounts of nutrient, but they slowly release available essential elements which can improve the physical condition of the soil. The use of organic wastes through conventional compost and vermicompost as alternative solution to the difficulties of organic waste disposal [1]. Composting converts biologically unstable organic matter into more stable humus like product that can be used as a soil conditioner or organic fertilizer. Composting is an aerobic method (meaning that it requires the presence of air) of decomposing organic solid wastes [2]. Zakarya et al. [3] reported that large quantities of bioresidues are potentially nutritious and may be utilized for the production of valued compost. Composting is a process in which organic substances are reduced from large volumes of rapidly decomposable materials to small volumes of materials which continue to decompose slowly. Compost is primarily a soil-amending product that may improve soil quality and the productivity of organic...
and conventional vegetable crops [4]. Conventional aerobic composting where biological aerobic transformation of an organic by product takes place and results into different organic product that can be added to the soil without detrimental effects of crop growth [5]. Additional benefits of composting of organic wastes include prevention of odors from rotting wastes, destruction of pathogens and parasites (especially in thermophilic composting) and retention of nutrients in the end products. Conventional composts provide all nutrients in readily available forms and also enhances uptake of nutrients by plants and plays a major role in improving growth and yield of different field crops[6]. Efficient composting will overcome the cost of chemical fertilizers with economic and environmental profits [7].

Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product [8]. Vermicompost is a nutrient-rich, microbiologically-active organic amendment that results from the interactions between earthworms and microorganisms during the breakdown of the organic matter [9]. Vermicomposting using earthworms as natural bioreactors for effective recycling of organic wastes is an environmentally acceptable which defined also as a low-cost technology system [10]. Vermicompost has been enriched by beneficial microbes to increase the fertilizer value and reduce the dose of application [8]. Vermicomposts are finely divided, peat-like materials produced through a non-thermophilic process involving the biodegradation and stabilization of organic materials through interactions between earthworms and microorganisms [11]. Vermicomposting, which is the biodegradation of organic wastes using earthworms and microorganisms [12-14], has been reported as an effective and relatively inexpensive cattle manure management technology [14, 15]. Vermicomposting convert waste to wealth in a safe and healthy way, because it is done by biopotential of earthworm [9]. He further stated that it contains plant growth hormones, enzymes, microbial population and free of small animals and harmful pathogens. Vermicompost increased nitrogen and phosphorous availability by enhancing biological nitrogen fixation and phosphorous solubilization [16].

Higher nutrient concentrations Mg, Ca, P and Na in vermicompost as compared to conventional aerobic compost [8]. Vermicompost has a potential source of plant nutrients for sustainable tomato production can reduce health and environmental problems [9]. Organic fertilizers had positive impacts on soil fertility, crop yield and quality has been proved in different findings [17]. Application of farmyard manures to crop fields is a broadly used method of increasing soil organic matter and fertility [18-20]. Dutta [21] reported that to produce a good crop, macronutrients available in the soil should be in the range of N (0.1 to 0.5%), P (0.08 to 0.5%), K (1.5 to 3.0%). Hence, knowing the nutrient concentrations of conventional compost and vermicompost prepared from different crop residue, bedding and feed wastes have a paramount importance to calculate the amount of compost and vermicompost applied for crop production. Therefore, the objective was to determine the nutrient composition of conventional composts and its optimum rates for teff production and to determine the nutrient composition of vermicompost prepared from different crop residue, bedding and feed wastes for identifying quality vermicompost for sustainable crop production.

**MATERIALS AND METHODS**

**Description of the Study Area:** The experiment was conducted in Ambo Agricultural Research Center in 2016 and 2017 cropping season. Geographically, it is located at 8°57"N latitude, 38°07"E longitude and at an altitude of 2185 meters above sea level. It receives a mean annual rainfall of 1100 mm [22]. The minimum, maximum and mean temperatures of the area are 11, 26 and 18.5°C, respectively [22]. The soil type is Vertisol consisting of 67% clay, 18% silt and 15% sand dominated by the clay fraction, with a pH of 7.5. The soil type is Vertisol consisting of 67% clay, 18% silt and 15% sand dominated by the clay fraction, with a pH of 7.5. The area was predominantly found to have clay textural class with a swelling and cracking nature of black colored Pellic Vertisol weakly acid to neutral in reaction with a montmorillonitic clay content in excess of 50% [23, 24].

**Experimental Materials:** The conventional compost was prepared from bulking agents of various crop residue. The conventional compost heap was prepared from different mixtures of crop residue of faba bean, wheat straw and farmyard manure. Five ratio of composting materials were: 1. 10:10 kg wheat straw: faba bean straw, 2. 15:5 kg wheat straw: faba bean straw, 3. 15:7:5: 2.5 kg wheat straw: faba bean straw farmyard manure, 4. 15:5 kg wheat straw :farmyard manure, 5. 15: 2.5: 2.5 kg wheat straw: faba bean straw: farmyard manure. The decomposed compost obtained after decomposition of the crop residues were analyzed for different nutrient concentration to know the stability indices and quality of compost.
Three earth worms (Esenia fetida, Esenia anderi and local) will be produced used as main factor combined with the same cow dung, Soil and Maize stock and five crop residue and feed wastes (Maize stalk, Barley straw, Faba bean straw, Niger seed straw and Fruit peels /fruit wastes). Total of 15 bedding for the vermicomposting and bulking in the composting process was properly mixed, watered and used. Prepare moistened bedding at least 2 days prior to adding worms, as it may heat initially and harm the worms. Bedding of (cow dung + soil + maize stock) and feed materials (maize stalk, barley straw, faba bean, Niger seed and fruit peels/wastes) were used. The vermicompost produced was collected from fifteen treatments and analyzed for different nutrient concentrations.

The collected conventional compost and vermicompost samples were prepared following standard procedures and analyzed at Holetta Agricultural Research Center Soil and Plant Analysis Laboratory. The conventional compost and vermicompost samples were analyzed for total nitrogen, available phosphorus, organic carbon and organic matter concentrations. The organic carbon was determined following wet digestion method as described by Walkley and Black [25] and organic matter was determined with conversion. Total nitrogen was determined following Kjeldahl procedure as described by Bremner and Mulvaney [26]. The available phosphorus was determined following Bray-II procedure as described by Bray and Kurtz [27].

Based on total nitrogen concentration result quality of conventional composts obtained with different bulking agents was identified and its optimum rate determination for teff production undertaken on farmers field at Ambo. The conventional composts with higher total nitrogen concentrations was used for rate determination. Three conventional composts rates (3, 6, 12 t ha⁻¹) and recommended nitrogen rate was used for teff production. The recommended nitrogen rate was 69 kg N ha⁻¹. Recommended rate of phosphorus (64 kg p ha⁻¹) was applied uniformly for each plot. All other agronomic practices were applied as per research recommendation for teff production. The experiment was laid out in randomized complete block design. The plot size was 3m X3m = 9m². The data was collected for plant height, panicle length, dry biomass and grain yield of teff. The collected data was analyzed using SAS software [28]. The mean separation was done using Least Significance Difference at 5 % probability level [29].

RESULTS AND DISCUSSION

Nutrient Concentrations of Conventional Compost: The nutrient concentrations of different decomposed conventional compost made of various ratio of crop residues and farmyard manure are indicated in Table 1. The total phosphorus was ranged from 0.239 to 0.310 ppm obtained from 10:10 kg wheat: faba bean straw and 15:7.5: 2.5 kg wheat: faba bean straw: Farmyard manure ratio. The total phosphorus contents obtained from matured conventional compost found in better range [30], optimum range [4, 31]. The total nitrogen concentration was ranged between 0.472 to 0.696 % produced from 10:10 kg wheat: faba bean straw and 15:5 kg wheat straw: Farmyard manure ratio followed by 15:7.5: 2.5 kg wheat: faba bean straw: Farmyard manure ratio producing 0.610 % total nitrogen. Higher total nitrogen was obtained from decomposed wheat straw mixed with farm yard manure followed by mixture of wheat and faba bean straw with farm yard manure. The total nitrogen contents obtained from matured conventional compost was found in ideal range of matured compost [32]; optimum range [4, 31]. The total nitrogen and organic matter contents of conventional compost were ranged between 7.01 to 10.29 and 12.085 to 17.74 %, respectively obtained from 10:10 kg wheat: faba bean straw and 15:5 kg wheat straw: Farmyard manure ratio. Higher organic carbon and organic matter were obtained from conventional compost prepared from different ratio of crop residue and farmyard manure. Similarly, Bagari and Biradar [33] found higher organic carbon was from conventional compost produced of all organic wastes. The organic matter contents of matured conventional compost obtained was found in better range [32]. Thus, the conventional compost produced have good quality compost and better to be use for crop production. Therefore, after knowing the total nitrogen contents of different conventional compost from Table 1, 15:5 kg wheat straw: Farmyard manure ratio compost was selected for the next teff production based on quantity rate.

Effects of Conventional Compost Rate and Recommended NP on Teff: The mean panicle length, plant height, dry biomass and grain yield of teff due to compost rate and recommended NP application are indicated in Table 2. Mean panicle length, plant height, dry biomass and grain yield of teff were significantly (P<0.05) affected by application of conventional compost rate and
Table 1: Nutrient concentrations of different decomposed conventional compost made of various ratio of crop residues at Ambo

<table>
<thead>
<tr>
<th>Ratio of crop residues</th>
<th>Total phosphorous (mg kg⁻¹)</th>
<th>Organic carbon %</th>
<th>Organic matter (%)</th>
<th>Total nitrogen (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:10 kg wheat: Faba bean straw</td>
<td>0.239</td>
<td>7.01</td>
<td>12.085</td>
<td>0.472</td>
</tr>
<tr>
<td>15:5 kg wheat: Faba straw</td>
<td>0.245</td>
<td>8.11</td>
<td>13.982</td>
<td>0.502</td>
</tr>
<tr>
<td>15:7.5: 2.5 kg wheat: Faba bean straw: Farmyard manure</td>
<td>0.301</td>
<td>9.04</td>
<td>15.585</td>
<td>0.610</td>
</tr>
<tr>
<td>15:5 kg wheat straw: Farmyard manure</td>
<td>0.310</td>
<td>10.29</td>
<td>17.740</td>
<td>0.696</td>
</tr>
<tr>
<td>15:2:5: 2.5 kg wheat: Faba bean straw: Farmyard manure</td>
<td>0.296</td>
<td>8.26</td>
<td>14.240</td>
<td>0.596</td>
</tr>
</tbody>
</table>

Table 2: Effect compost rate and recommended NP fertilizer on plant height, panicle length, dry biomass and grain yield of teff on farmers field around Ambo

<table>
<thead>
<tr>
<th>Compost rate (t ha⁻¹)</th>
<th>Panicle length (cm)</th>
<th>Plant height (cm)</th>
<th>Dry biomass (kg ha⁻¹)</th>
<th>Grain yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>30b</td>
<td>74.55b</td>
<td>1785b</td>
<td>574b</td>
</tr>
<tr>
<td>6</td>
<td>32ab</td>
<td>75.35b</td>
<td>2252b</td>
<td>667b</td>
</tr>
<tr>
<td>12</td>
<td>32ab</td>
<td>77.80ab</td>
<td>1874b</td>
<td>670b</td>
</tr>
<tr>
<td>Recommended N (69 kg N ha⁻¹)</td>
<td>34a</td>
<td>79.9a</td>
<td>3933a</td>
<td>1237a</td>
</tr>
</tbody>
</table>

LSD (5%) 3.3 6.1 605.7 236.3
CV (%) 5.9 4.5 15.1 18.4

Means followed by different letter(s) in a column and rows are significant at 5% level of probability

Table 3: Nutrient concentrations of different decomposed vermicompost made of various earth worms, bedding materials, crop residue and feed waste in Ambo

<table>
<thead>
<tr>
<th>No.</th>
<th>Earth worms + bedding material + feed sources</th>
<th>pH 1:2.5 H₂O</th>
<th>Total nitrogen (%)</th>
<th>Available phosphorus (mg kg⁻¹)</th>
<th>Available potassium (meq 100g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Esenia fetida + Cow dung + Soil + Maize stock</td>
<td>8.23</td>
<td>0.98</td>
<td>0.347</td>
<td>3.50</td>
</tr>
<tr>
<td>2</td>
<td>Esenia fetida + Cow dung + Soil + Barley straw</td>
<td>7.36</td>
<td>1.28</td>
<td>0.328</td>
<td>2.58</td>
</tr>
<tr>
<td>3</td>
<td>Esenia fetida + Cow dung + Soil + Faba bean straw</td>
<td>7.92</td>
<td>1.22</td>
<td>0.325</td>
<td>3.12</td>
</tr>
<tr>
<td>4</td>
<td>Esenia fetida + Cow dung + Soil + Niger seed straw</td>
<td>8.07</td>
<td>1.11</td>
<td>0.349</td>
<td>3.09</td>
</tr>
<tr>
<td>5</td>
<td>Esenia fetida + Cow dung + Soil + Fruit peels /fruit wastes</td>
<td>7.53</td>
<td>1.09</td>
<td>0.364</td>
<td>2.97</td>
</tr>
<tr>
<td>6</td>
<td>Local EW+ Cow dung + Soil + Maize stock</td>
<td>8.64</td>
<td>1.09</td>
<td>0.367</td>
<td>3.67</td>
</tr>
<tr>
<td>7</td>
<td>Local EW+ Cow dung + Soil + Barley straw</td>
<td>7.66</td>
<td>1.13</td>
<td>0.325</td>
<td>2.95</td>
</tr>
<tr>
<td>8</td>
<td>Local EW + Cow dung + Soil + Faba bean straw</td>
<td>7.78</td>
<td>0.92</td>
<td>0.281</td>
<td>1.82</td>
</tr>
<tr>
<td>9</td>
<td>Local EW+ Cow dung + Soil + Niger seed straw</td>
<td>7.68</td>
<td>0.86</td>
<td>0.370</td>
<td>3.60</td>
</tr>
<tr>
<td>10</td>
<td>Local EW+ Cow dung + Soil + Fruit peels /fruit wastes</td>
<td>7.08</td>
<td>1.13</td>
<td>0.300</td>
<td>2.18</td>
</tr>
<tr>
<td>11</td>
<td>Esenia Andrei + Cow dung + Soil + Maize stock</td>
<td>7.91</td>
<td>1.21</td>
<td>0.372</td>
<td>3.69</td>
</tr>
<tr>
<td>12</td>
<td>Esenia Andrei + Cow dung + Soil + Barley straw</td>
<td>6.99</td>
<td>1.27</td>
<td>0.340</td>
<td>2.34</td>
</tr>
<tr>
<td>13</td>
<td>Esenia Andrei+ Cow dung + Soil + Faba bean straw</td>
<td>7.20</td>
<td>1.26</td>
<td>0.291</td>
<td>1.88</td>
</tr>
<tr>
<td>14</td>
<td>Esenia Andrei+ Cow dung + Soil + Niger seed straw</td>
<td>8.01</td>
<td>1.13</td>
<td>0.316</td>
<td>3.09</td>
</tr>
<tr>
<td>15</td>
<td>Esenia Andrei+ Cow dung + Soil + Fruit peels /fruit wastes</td>
<td>7.19</td>
<td>1.32</td>
<td>0.256</td>
<td>1.92</td>
</tr>
</tbody>
</table>

Organic inputs have remarkable potential for providing nutrients which can reduce the chemical fertilizer dose by 25 to 50 percent [34]. Senthilkumar et al. [35] found that vermicompost ± NPK fertilizers significantly enhanced Rose sp growth, yield and quality over the control, especially when used in combination. The application of inorganic fertilizers with organic manure would have a better effect on soil health, soil organic matter and related soil properties than the application of inorganic fertilizers [7]. Plant available N, P and K were higher in plots supplied with both vermicompost and NPK fertilizers [35]. Theunissen et al. [36] reported vermicompost application along with fertilizer N gave higher dry matter and grain yield of wheat. Tariku et al. [37], Tolera et al. [38] found that integrated use of inorganic and organic fertilizers improved yield and yield components of barley.
Reddy *et al.* [39] reported that higher yield of field pea with combined application of vermicompost and with recommended N, P and K as compared sole fertilizer application. Kumari and Ushakumari [40] reported that enriched vermicompost was superior for the uptake of N, P, K, Ca and Mg by cowpea. Sainz *et al.* [41] also reported that addition of vermicompost to soil resulted in increased mineral contents in the substrate and higher concentrations of P, Ca, Mg, Cu, Zn and Mn in shoot tissues of red clover and cucumber. Therefore, application of integrated use of chemical fertilizer with compost is for most importance for better yield and yield components of teff rather than sole application of compost in the area.

**Nutrient Concentrations of Vermicompost:** The nutrient concentrations of different decomposed vermicompost made of various earth worms, bedding materials, crop residue and feed wastes are indicated in Table 3. The pH of vermicompost ranged from 6.99 to 8.94 obtained from decomposed with *Esenia Andrei* from cow dung + soil + barley straw and local earth worm from cow dung + soil + maize stock (Table 3). All vermicompost made with three earth worms from different bedding materials, crop residue and feed wastes were neutral to alkaline range (Table 3). Similarly, Hernandez *et al.* [42] observed higher pH of (7.3) for vermicompost. Also, Tesfaye [1] found that pH of (7.1). for vermicompost. Bahrampour and Ziveh [43], Kmetova and Kovacik [44] reported that higher pH of 7.7 and 7.4. Vellaikkannu *et al.* [45] reported that matured vermicompost have pH contents of 7.

Bagari and Biradar [33] found that towards alkaline in all vermicompost made of all the waste foods, this might be due to the production of CO₂ and organic acids by microbial metabolism during decomposition process [46-48]. Similar results in pH shift towards alkaline after processing of cattle manure, fruit and vegetable wastes have been reported by Barker and Gunadi and Edwards [49, 50]. Barker [51] have also noticed higher pH values in vermicompost indicating to free availability of ions and minerals generated during ingestion and excretion by the earthworms in the vermicompost [33].

The total nitrogen concentration was ranged from 0.86 to 1.32 % obtained from vermicompost decomposed with local earth worm from cow dung + soil + Niger seed straw and *Esenia Andrei* from cow dung + soil + fruit peels (fruit wastes) (Table 3). Higher total nitrogen was produced from all vermicompost. Likewise, Parkin and Berry [52] reported that vermicompost contains 5 times high N than the first 15 cm top soil. Similarly, Tesfaye [1] found that vermicompost is higher with organic matter and total N content. Likewise, Bagari and Biradar [33] found that higher nitrogen content in all vermicompost. The total nitrogen content was varied across all earth worms, bedding materials, crop residue and feed wastes. Kaushik and Garg [53] also reported that increased nitrogen contents in vermicompost of textile mill sludge along with cattle dung and agricultural residues. This might be due to accumulation of mucus, nitrogenous excretory substances, growth stimulating hormones and enzymes secreted by the earthworms [33, 54]. Atiyeh *et al.* [55] have stated earthworms make a great impact on nitrogen transformation by enhancing nitrogen mineralization so that mineral nitrogen may be retained in the form of nitrate. Kavian and Ghatnekar [56], Whiston and Seal [57] also argued that earthworm gives shelter for microflora and also releases gut enzymes in their intestine, both are involved in biodegradation process. The available phosphorus was ranged from 0.281 to 0.372 ppm produced from vermicompost decomposed with local earth worm from cow dung + soil + faba bean straw and *Esenia andrei* from cow dung + soil + maize stock (Table 3).

The vermicompost produced from various earth worms, bedding materials, crop residue and feed wastes were higher in available phosphorus. Mansell *et al.* [58] also observed that plant litter was found to hold more available phosphorus after ingestion by the earthworms. Higher available phosphorous during vermicomposting is probably because of mineralization process and mobilization of phosphorus through bacterial and faecal phosphatase activity of earthworms [59]. The available potassium was ranged from 1.82 to 3.69 meq 100g⁻¹ obtained with local earth worm from cow dung + soil + faba bean straw and *Esenia Andrei* from cow dung + soil + maize stock. Likewise, Bagari and Biradar [33] found available phosphorus and potassium contents were also more in the vermicompost. Delgado *et al.* [60]; Jambhekar [61] also reported higher content of available N, P, K and micronutrients in vermicompost. Vellaikkannu *et al.* [45] found that vermicompost converts tea leaves wastes into compost reduces the C:N ratio and retains more N, P and K.

The average 7.82, 1.14 %, 0.343 ppm and 3.052 meq 100g⁻¹ of pH, total nitrogen, available phosphorus and available potassium nutrient concentrations were obtained with *Esenia fetida* from made of various earth worms, bedding materials, crop residue and feed wastes. Aira *et al.* [62] reported that vermicompost produced by the joint action of earthworms and microbes, contains nutrients in available form with increased microbial
activity. The average 7.77, 1.03 %, 0.329 ppm and 2.84 meq 100g⁻¹ of pH, total nitrogen, available phosphorus and available potassium nutrient concentrations were obtained with local earthworm from made of various earth worms, bedding materials, crop residue and feed waste. The average 7.46, 1.24 %, 0.315 ppm and 2.58 meq 100g⁻¹ of pH, total nitrogen, available phosphorus and available potassium nutrient concentrations were obtained with Esenia Andrei from made of various earth worms, bedding materials, crop residue and feed waste.

Higher total nitrogen concentrations were obtained from vermicompost made with Esenia Andrei from various bedding materials, crop residue and feed waste followed by Esenia fetida and local earth worm. Similarly, Kumari [63] reported that difference in quality of vermicompost production from various earthworms. Vermicompost contain higher levels of nitrogen, phosphorous and potassium in available form, micronutrients, microflora, enzymes and growth regulators [64, 65]. This indicate that Esenia Andrei was more effective as compared to Esenia fetida and local earth worm. All physicochemical properties were higher in all combinations of various earth worms, bedding materials, crop residue and feed wastes. Likewise, Bagari and Biradar [33] found that increasing level of physicochemical parameters such as pH, EC, both macro nutrients (N, P, K, S, Ca and Mg) and micronutrients (Cu, Zn, Fe and Mn) in vermicompost. He further stated that because of more biodegradation process by the action of earthworms and mineralization of degraded organic wastes by the action of saprophytic microorganisms present in the gut of earthworm, E.eugeniae. Likewise, Parvaresh et al. [66]. reported the level of the organic matter, nitrogen, phosphorus, pH and the ratio of the carbon to nitrogen in produced vermicompost from sewage’s sludge respectively 36.4, 1.04, 0.112, 7.5 and 22.6%. Vermicompost produced from household’s waste have better quality than sewage’s sludge [67]. Theunissen et al. [37]. reported that vermicompost contains plant nutrients (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B), the uptake of which has a positive effect on plant nutrition, photosynthesis, the chlorophyll content of the leaves and improves the nutrient content of the different plant components.

The use of earthworms for production of vermicompost could help to reduce dumping of huge quantity of organic wastes from different sources which cause serious environmental pollution and economic problems. Vermicompost higher different nutrient concentration which makes it to provide balance of nutrient in smaller quantity as compared to chemical fertilizer. Vermicompost is considered as a supplement to soil as it releases different plant nutrients slowly with significant decrease in the organic carbon, thus improving physicochemical properties of soil and synchronizing the requirement of plants [68, 69]. Proper use of organic wastes could promote recycling of plant nutrients and improved soil health and environmental quality[70, 71].

The soil enriched with vermicompost provides additional substances that are not found in soils with chemical fertilizers [72]. Vermicompost are materials characterized by high porosity, aeration, drainage, water holding capacity and microbial activity [11, 55, 65]. The nutrient content of vermicompost and composts mainly depends on the raw materials used, the processed materials usually contains higher levels of most of the mineral elements, which are in available forms than that of parent material [73]. Vermicompost has contain between 40 to 60% higher levels of humic substances and are superior in quality as compared to farm yard manure and conventional composts [74]. Golchin et al. [75] reported that vermicomposted animal manures tend to have a higher nutritional status, compared with that derived from organic municipal waste. Atiye et al. [76]; Carpenter-Boggs et al. [77]; Muscolo et al. [78]; Pern e et al. [79] reported that soils amended with vermicompost have the ability to retain moisture, improve soil structure and cation exchange capacity, have a higher rate of plant growth hormones and humic acids, higher microbial population and activity and less root pathogens or soil borne diseases and overall improvement in plant growth and yield [80, 81].

Higher percentage of humic acids in vermicompost contributes to plant health, as it promotes the synthesis of phenolic compounds such as anthocyanins and flavonoids which may improve the plant quality and act as a deterrent to pests and diseases [36]. Nagavaleemma et al. [14] stated that vermicompost contains a high proportion of humic substances (i.e. humic acids, fulvic acids and humin) which provide numerous sites for chemical reaction; microbial components known to enhance plant growth and disease suppression through the activities of bacteria (Bacillus), yeasts (Sporobolomyces and Cryptococcus) and fungi (Trichoderma), as well as chemical antagonists such as phenols and amino acids. The vermicompost produced out of different organic wastes have all the physicochemical nutrients necessary for plant growth and to maintain the fertility of soil [33]. Wang et al. [82] concluded that vermicompost can be recommended as a fertilizer to improve tomato fruit quality and yield and soil quality, particularly for soils with no
tomato planting history. Therefore, knowing the vermicompost sources is very important for harvesting quality compost for soil health management. Thus, in conclusion production vermicompost is depends on the nature of raw organic wastes used and multiplication and capacities of the microorganisms and earthworm species in biodegradation and mineralization process and overall favorable environmental conditions.

CONCLUSION

Conventional compost and vermicompost are prepared from organic materials contain higher quantity of macronutrients suitable for crop production. The quality of compost with macronutrient contents was varied with different ratio of wheat and faba bean straw combined with farmyard manure. Growth, yield and yield components of teff were significantly improved with application of recommended NP fertilizer rate as compared sole compost. Application of compost did not give better grain yield of teff as compared to recommended NP fertilizer rate. Thus, integrated use of compost with NP fertilizer is advisable for sustainable teff production by reducing the use of sole inorganic fertilizer and maintaining good-quality soil. Lower pH achieved from vermicompost could be a better recommendation for soils amendments. The use of earthworms for production of vermicompost could help to reduce dumping of huge quantity of organic wastes from different sources which cause serious environmental pollution and economic problems, improved nutrient contents of produced vermicompost used for crop production. Therefore, compost and vermicomposting can be used an alternate technology for the management bedding materials, crop residue and feed waste suitable for sustainable soil fertility management for improved yield of crops.

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