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Integration of tea waste with bottom ash for growth promotion of cowpea

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Abstract
Composting of organic wastes could convert them into a value-added product. A pot experiment was conducted to evaluate the integrated use of composted and uncomposted tea waste with coal ash (bottom ash) for improving growth of cowpea plants. All treatments promoted physical characteristics and biochemical contents of cowpea plants as compared to control. Composted tea waste in combination with coal ash showed better results as compared to other treatments. Results revealed that utilization of enriched compost with coal ash as mineral fertilizer gave best results.

Keywords: Integration, organic waste, bottom ash, compost, cowpea.

1. Introduction
Integrated plant nutrient management is the use of inorganic fertilizer in grouping with organic fertilizer to retain soil fertility and to balance nutrient source in order to improve the crop yield per unit area (Arif *et al.*, 2014, Aulakh *et al.*, 2008, Mahajan *et al.*, 2008, Roberts 2010) [1-4]. Integrated use of organic with mineral fertilizers outcomes into higher crop yield than mineral fertilizers alone (Shah *et al.*, 2013) [5]. Integrated use of chemical fertilizers and recycled organic waste may be a methodology for sustainable production of crops. Integrated use of organic and inorganic fertilizers can progress crop productivity and sustain soil health and fertility (Asghar *et al*., 2006) [6]. Soil modifications could provide supplementary benefits for plant growth (Rizvi *et al.,* 2015) [7]. Application of compost along with chemical fertilizers has been described to give utmost yield and maximum profit. The application of organic amendments can possibly stimulate crop growth and progress through the actions of plant growth-promoting hormones, including cytokinins, auxins, and gibberellins (Quilty and Cattle 2011) [8].
Land application of composted material as a fertilizer source not only make available essential nutrients to plants, it also increases soil quality and effectively disposes of wastes (Arumugam, 2012) [9]. Biocomposts have gained importance since the fertilizers and pesticides cause a lot of environmental complications and health risks and soil degradation. Organic matter is essential for sustainable crop production (Soomro *et al., 2013*) [10]. Compost teas are a sustainable, cost-effective, and reasonable way to efficiently consume nutrients from pre and post-consumer food waste and vegetative wastes from modern agriculture. For example a compost tea can be specifically prepared for use as a soil organic matter producer, a disease suppressant, or a nutrient source (Ingham 2002) [11]. They also increase soil biological features (Lee *et al.*, 2004) [12].
Coal combustion products (CCP) has been presented to have potential for repair of degraded land when mixed with biosolids (Robinson *et al.* 2003) [13]. Benefits could include better water infiltration and storage and more plant root proliferation, which should outcome in higher dry matter and grain yield. The concentration of heavy metals in plants must be evaluated against established safety standards in USEPA (1995) [14], NH&MRC (1999) [15] over an extended period. Minute quantitative assessment of the possibility to environmental protection or accumulation of heavy metals in plants is evident from earlier research (Adriano *et al*. 2002) [16]. Bottom ash is a relatively coarse, gritty material.

It has particle sizes usually within a range of. 1 to 10mm.Bottom ash can be used for soil development. Main constituents include calcium, aluminum, iron, magnesium, potassium, silicone, sodium and titanium. Of these materials Ca, Fe, Mg, K and Si are essential plant nutrients (Kim *et al.*, 2011) [17]. Insam *et al.*, (2009) [18] found a progressive effect of ashes on soil texture, aeration, water holding capacity and cation exchange capacity. According to several authors (Aronsson and Akelund, 2004; Demeyer *et al.*, 2001; Zimmermann and Frey, 2002) [19-21] ash amendment rises soil microbial activity and biomass.

Cowpea (*Vigna unguiculata* (Linn. Walp.) is a summer season crop(Imran *et al.*, 2012) [22]. Cowpea is the most significant grain legume and fodder crop of the semiarid warm tropics and subtropics (Huynh *et al.*, 2013) [23]. Moreover being an outstanding fodder legume crop, it increases nitrogen status of the soil. Cowpea fodder is also a amusing source of crude protein (Sebetha *et al.*, 2010) [24]. The grain contains between 20 - 25 per cent of protein, about twice the protein content of most cereals (Nwofia *et al.*, 2015) [25]. Keeping this in view, the present study was conducted to evaluate the potential of integrated use of recycled organic waste and chemical fertilizers for improving growth and yield of radish.

2. Material and methods

The present research work conducted in net house of department of botany, Jinnah University for Women in complete randomized block design. Tea waste used as organic material, composted aerobically with Trichoderma harzianum for one month. Coal ash (bottom ash) collected from Bar-BQ shop used as inorganic source of nutrients. Four treatments were used as experimental setup. Treatments are as follows, T1= control, T2= Coal ash 2g, T3= composted tea waste 10 g with coal ash 2 g, T4= uncomposted tea waste 10g with coal ash 2 g. Each treatment has three replicates. Cowpea was used as experimental plants. 4 seeds of cowpea were planted in each pot. Plants were irrigated with tap water to maintain soil moisture. After 15 days plants were harvested for physical and biochemical analysis. Root & shoot lengths (cm), root & shoot fresh and dry weights (g), leaf area (cm^2) were measured as physical parameters while % carbohydrate (Yemm and Willis, 1954) [26], % protein (Bradford Method,1976) [27] and total chlorophyll (mg/g fresh weight, Arnon method 1949) [28] as biochemical parameters.

Results are expressed as mean ± standard deviation (SD). The data was analyzed by using *One-way* ANOVA followed by LSD (least significant difference) test through SPSS 16 (version 4). The differences were considered significant at $p<0.05$ when treatments' mean compared with control.

3. Results

The data analysis present in figures (1 & 2) revealed that all three treatments increased root and shoot lengths of experimental plants as compared to control. Composted tea waste integrated with bottom ash showed maximum improvement in root length non-significantly and shoot lengths significantly.

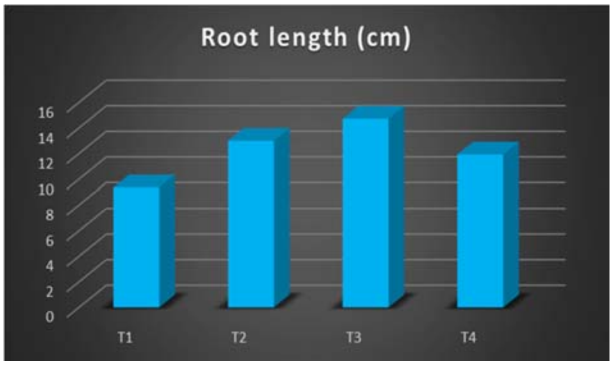

Fig 1: Effect of integrated use of tea waste with bottom ash on root length of cowpea. Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at $p<0.05$(LSD).

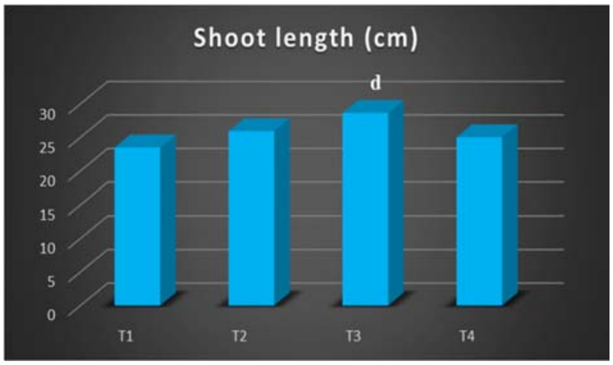

Fig 2: Effect of integrated use of tea waste with bottom ash on shoot length of cowpea. Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at $p<0.05$(LSD).

All three treatments (fig 3& 4) showed enhancement in fresh and dry weights of cowpea plants. Bottom ash (in the amount of 2tons/ha) alone and in combination with composted tea waste (10 tons/ha) significantly improved fresh weights of plants.

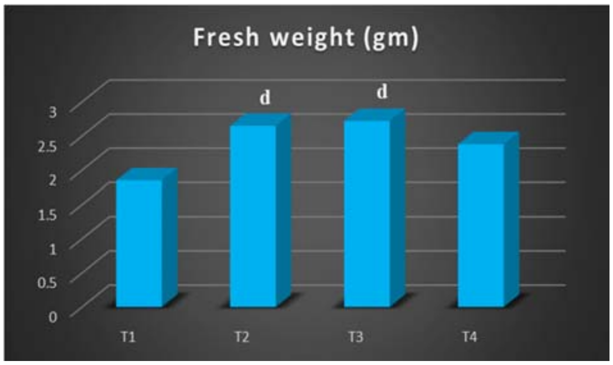

Fig 3: Effect of integrated use of tea waste with bottom ash on fresh weight of cowpea. Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at $p<0.05$(LSD).

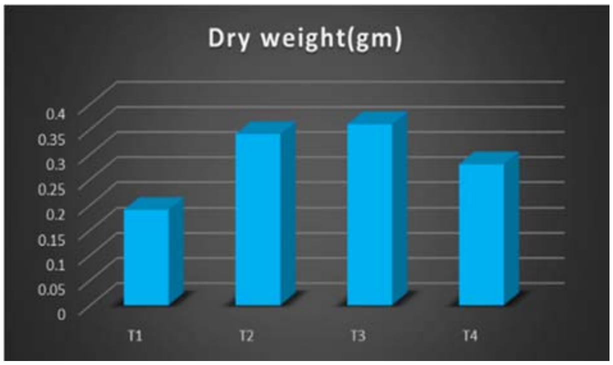

Fig 4: Effect of integrated use of tea waste with bottom ash on dry weight of cowpea. Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at *p*<0.05(LSD).

Biochemical constituents of experimental plants such as % carbohydrate, % protein and total chlorophyll contents were also increased non-significantly by all treatments, except treatment with composted tea waste with bottom ash significantly improved total chlorophyll content of cow pea plants (table 1).

Table 1: Effect of integrated use of tea waste with bottom ash on biochemical parameters of cowpea.

S. No	Treatments	Carbohydrate (%)	Protein (%)	Total Chl. (mg/gm fresh wt.)
1	T1=Control	0.18±.02	0.12±.09	0.86±.74
2	T2= Bottom ash 2g	0.24±.07	0.17±.02	2.08±.82
3	T3= Composted tea waste 10g + Bottom ash 2g	0.31±.11	0.23±.11	2.61^{d}±.50
4	T4=Uncomposted tea waste 10g + Bottom ash 2g	0.19±.08	0.15±.3	2.03±.54

Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at
p<0.05(LSD).

4. Discussions

Integrated consumption of organic with mineral fertilizers results into greater crop yield than mineral fertilizers alone (Lamps, 2000) [29]. Besides, the environmental risks related with the nonstop applications of mineral fertilizers can simply be alleviated by optimizing fertilizer use efficiency through integrated management of organic manure/residues and mineral fertilizers (Shah *et al.*, 2013) [5]. Application of organic matter increases the physical and chemical conditions of the soil (Ali and Azam, 2000) [30]. Application of compost beside with chemical fertilizers has been described to give highest profit and maximum yield. This treatment may also support to improve certain nutritional difficulties that result in deprived health and individual productivity (Asghar *et al.*, 2006) [6].

Results revealed an increase in the growth parameters in response to the application of organic waste both in composted and uncomposted form along with bottom ash as compared to control. Integrated use of recycled organic wastes and chemical fertilizers was useful in improving the growth of plants (Asghar *et al.*, 2006) [6]. When we apply enriched compost along with chemical fertilizers, compost not only gradually releases nutrients from itself but also inhibits the losses of chemical fertilizers through denitrification, volatilization and leaching by binding the nutrients and releasing with the passage of time. Thus compost stops nutrients losses (Arshad *et al*., 2004) [31].

These results go similar to those of Aminuddin (1995) [32] that application of compost along with chemical fertilizers has been found to give maximum yield and highest return in many vegetables including radish. These results are also in agreement with the results of several researchers like
Jayathilake *et al*., (2002) [33] who found that onion plant height and number of leaves per plant were maximum upon treatment with organic manures + 50% N and 100% PK through chemical fertilizers.

Organic manures in combination with inorganic fertilizers influenced the root length non significantly and significantly improved shoot length over control (Fig: 1, 2). Increase in root and shoot length in response to combined use of organic and inorganic fertilizers is might be due to additional availability of macro as well as micro nutrients (Arif *et al.*, 2014) [1]. Bottom ash alone also enhanced the physical and biochemical parameters of chickpea plants. Wang *et al.*, in 2006 [34] stated that bottom ash used mostly as an amendment to increase the physical and chemical properties of soil, as a source of liming material to enhance soil acidity and as a nutrient source to supply calcium and sulphur. The CCPs in general have a significant content of K, Ca, Mg, S and P (Seshadri *et al.*, 2010) [35], which support in increasing plant growth and nutrient uptake.

5. Conclusion

It could be concluded from these results that the integration of composted organic wastes with mineral fertilizers augments growth of plants.

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