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# Comparative effect of fly ash fortified crop residue and municipal waste based vermicomposts on quality parameters of mulberry leaves

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**Abstract**
Comparative effect of fly ash fortified crop residue and municipal waste vermicomposts on biochemical composition of mulberry leaves *viz*., nitrogen, phosphorous, potassium, chlorophyll a, chlorophyll b and total chlorophyll of mulberry leaves of V-1 hybrid was assessed. The pooled data of two crops revealed that mulberry raised with Vermicompost produced from mixed crop residues along with fly ash fortification @ 10% + recommended dose of chemical fertilizers ($T_2$) recorded significantly higher chemical composition of leaf *viz.,* leaf nitrogen (3.88%), phosphorous (0.84%), potassium (2.03%), chlorophyll a (1.61 mg/g), Chlorophyll b (0.66 mg/g) and total chlorophyll (2.26 mg/g) followed by Vermicomposts produced from mixed crop residues along with fly ash fortification @ 5% + recommended dose of chemical fertilizers ($T_1$). Significantly lower chemical compositions were recorded in control ($T_9$). The enhanced quality parameters of mulberry leaves were attributed to the improved mineralization resulting in enhanced production of plant growth substances and enzyme activity in mulberry. Increased nitrogen, phosphorus and potassium contents in leaves might be due to increased availability of nutrients in soil due to application of fly ash fortified vermicompost. This might be an indication that there was proper uptake of plant nutrients those were available due to the addition of organic manures in the form of fly ash fortified vermicomposts along with recommended dose of chemical fertilizers.

**Keywords:** fly ash, vermicompost, mulberry, biochemical parameters

## Introduction

Mulberry (*Morus* spp.) is a perennial and high biomass producing plant, continues to grow throughout the year in tropics. The continuous production of mulberry for a long time results in gradual reduction in leaf yield and quality. The silkworm, *Bombyx mori* L. being monophagous insect, derives almost all the nutrients for growth and development from the mulberry leaf. It has been estimated that, nearly 70% of the silk proteins are derived from mulberry leaves. Hence, silkworms should be fed with good quality mulberry leaves in abundant quantity for the successful cocoon production.

The leaf yield and quality of mulberry depends on the soil type, plant variety, and availability of plant nutrients and agro-ecological conditions, which reflects on the quality of silk production. In India, mulberry is largely cultivated for leaf production and contributes to an extent of 38.20 per cent for successful cocoon crop production (Miyashita, 1986) [4]. Application of organic manures to the soil either in the form of organic or inorganic inputs are to supply nutrients to the plants. Organic manures such as vermicompost, FYM, compost, green manures, oil cakes and biofertilizers, etc., contain comparatively smaller quantities of plant nutrients apart from being bulky in nature (Shivaprakash and Narayanagowda, 2006). Mulberry leaf productivity is highly dependent on plant nutrients like NPK and is known to respond well to the addition of organic manures. The chemical fertilizers are becoming costlier day by day due to escalating costs and scarce availability of commodities. Further, intensive mulberry cropping system causes depletion of nutrients in soil and excess usages of inorganic fertilizers and pesticides caused deleterious effect on soil health (Shashidhar *et al*., 2009) [12].

Industrialization and urbanization at a rapid rate has led to an increase in dependence on coal based thermal power plants for power generation in most of the developing countries. In India, about 79% of the entire electricity is met by these coal fired power plants (Singh and Siddiqui 2003) [15]. India is a large consumer of non-coking coal having a high ash content of about

30-40% (Senapati, 2011) [9]. Fly ash a residue of burning of coal / lignite in thermal power plant has traditionally been considered as a waste product. It's generation in the country has increased fly ash year by year. If not utilized, it would demand large area of land for ash ponds and would pose a threat for air and water pollution. FA contains silica, aluminium and oxides of iron, calcium, magnesium, arsenic, chromium, lead, zinc and other toxic metals. It has been regarded as a problematic solid waste all over the world.

Disposal, management and proper utilization of FA has been a major concern for the scientists and environmentalists. Engineers nowadays are making efforts to take advantage of these coal by products. Use of FA in agriculture is also being explored by researchers, mainly because it contains essential plant nutrients except N, P and K. FA maintains pH, better aeration and percolation of the soil, provides nutrients to the soil and enhances the growth and yield of crops as biofertilizers. In India, only 2% of FA generated is being utilized in the agricultural sector (Kumar *et al.* 2005) [3]. FA has certain limitations regarding its use in agricultural ecosystems because of the low availability of most of the nutrient elements and lower rate of degradation after application in soils. The presence of heavy metals in their soluble forms in FA is the major constraint in its utilization for agricultural purposes (Pandey *et al.* 2009; Pandey and Singh, 2010) [6, 5]. The treatment of FA polluted sites and the reduction of heavy metal exposure by conventional procedures is expensive and time-consuming.

Vermicomposting is one of the most promising techniques to dispose the wastes like FA and also remediate and amend the soil. The prime benefits of vermicomposting of FA are (a) capable of handling very low to very high quantities of FA, (b) simple and cost-effective process effective both in case of small scale and large scale utilization, (c) the vermicasts provide popular and ready markets as enrichers of soil. Earthworms form an important part of soil fauna in most global soils and comprises a significant proportion of the soil biomass, thus serving as a useful indicator of soil health and quality. Earthworms enhance the fertility of soil treated with coal FA by increasing availability of mineral nutrients such as nitrogen (N), phosphorus (P) and potassium (K) in the ash and minimizing the toxic heavy metal contents from FA by this metal accumulation in their gut. These fly ash fortified vermicompost major as well as micro nutrients for plant growth and improves the quality status in mulberry leaves.

## Materials and methods

A field experiment was conducted to know the effect of fly ash fortified municipal waste and crop residue based vermicomposts for quality parameters mulberry. The study was initiated at Sericulture unit, Department of Entomology, College of Agriculture, Raichur during *kharif* 2018-19.

## Preparation of vermicompost

Vermicompost preparation was done in cement pit of size 2 ½ feet cube for each of fly ash fortification level.

Municipal waste, bio degradable farm wastes (crop residues) and fly ash were collected from thermal power station, Raichur. Farm waste was passed through shredder (Whenever necessary) along with dung and 100 kg each of mixed crop residue waste were taken and different crop residues were equally distributed for all eight types of vermicompost preparation fortified with fly ash at rate of 5, 10 and 15 per cent separately. Based on the final weight of the substrate 20 per cent cow dung was added and allowed for pre decomposition with thorough mixing and regular watering. Similarly, 100 Kg each municipal waste was taken and fortified with fly ash at the rate of 5, 10 and 15 per cent. Cow dung was added to the municipal waste at the rate 20 per cent of substrate weight and thoroughly mixed and regularly watered. Mixed crop residue (100 kg) alone and municipal waste (100 kg) alone without fortification of fly ash was kept and 20 per cent dung was added and allowed for decomposition with regular watering. For all the substrates 12 kg each mulch cover was placed on the top to avoid drying of substrate.

Later, earthworms, *Eudrillus eugienae* was released at the rate of 2 kg/tonne of substrate below the mulch layer and watered on regular basis once in 2-3 days. The vermi-pits were regularly monitored for activity of earthworm. At the time of pit filling samples of mixed crop residue, fly ash and municipal waste were collected for initial nutrient analysis. When the vermicompost was ready for harvest, earthworms and vermicompost was separated; vermicompost yield and earthworm biomass was recorded treatment wise. Vermicompost samples were collected treatment wise for final nutrient assay.

## Treatment details

$T_1$: Vermicompost (produced from mixed crop residues along with fly ash fortification @ 5%) + recommended dose of chemical fertilizers (CRVC5 + RDF).

$T_2$: Vermicompost (produced from mixed crop residues along with fly ash fortification @ 10%) + recommended dose of chemical fertilizers (CRVC10 + RDF).

$T_3$: Vermicompost (produced from mixed crop residues along with fly ash fortification @ 15%) + recommended dose of chemical fertilizers (CRVC15 + RDF).

$T_4$: Vermicompost produced from mixed crop residues alone without fortification (CRVC + RDF).

$T_5$: Vermicompost (produced from municipal waste along with fly ash fortification @ 5%) + recommended dose of chemical fertilizers (MWVC5 + RDF).

$T_6$: Vermicompost (produced from municipal waste along with fly ash fortification @ 10%) + recommended dose of chemical fertilizers (MWVC10 + RDF).

$T_7$: Vermicompost (produced from municipal waste along with fly ash fortification @ 15%) + recommended dose of chemical fertilizers (MWVC15 + RDF).

$T_8$: Vermicompost (produced from municipal waste alone without fortification (MWCV + RDF).

$T_9$: Recommended dose of chemical fertilizers (RDF) (300: 120: 120 kg NPK/ha/year).

In this experiment RCBD statistical design is fallowed with nine treatments and three replication. Mulberry garden with V-1 (Victory -1) hybrid for the study consisted three year old plants planted in paired row system with spacing of (3' x 2') × 5' and number of plants per replication was twenty four. Treatment wise vermicompost was produced for application to mulberry @ 7.5 t /ha along with recommended dose of chemical fertilizer. Initial nutrient assay of mulberry soils were carried out before start of the experiment. Treatment wise vermicompost was applied to mulberry garden 10 days after pruning and incorporated into soil and mulberry crop was raised for about 65 days and leaf sample were taken from five plants in each replication to estimate quality parameters like nitrogen, phosphorous, potash, chlorophyll a, chlorophyll b and total chlorophyll.

## Results and discussion

Crop residues and municipal wastes were fortified with different levels of fly ash and subjected to vermicomposting has yielded vermicomposts of varied quantities of nutrients. In general vermicomposts from crop residues fortified with fly ash displayed higher quantities of nutrients of both major (NPK) and micronutrients (Copper, Iron, Manganese and Zinc) when compared to municipal waste fortified with fly ash. Increased supply of nutrients through nutrient rich vermicompost known to enhance growth, development, yield and quality of mulberry by supplying essential nutrients required by the plant. The utilization of fly ash fortified crop residues for vermicomposting or combined application of fly ash with organic manures will not only sustain the soil fertility but also improve the mulberry productivity, nutrient use efficiency and leaf quality. If such mulberry leaves are fed to silkworms the silkworms put up better growth and development leading to higher cocoon production both qualitatively and quantitatively.

Total nitrogen content in mulberry leaf was significantly higher in application of CRVC10 (3.85, 3.92 and 3.88%) followed by CRVC5 (3.72, 3.83 and 3.78%) and CRVC15 (3.66, 3.78 and 3.72%) during first, second crop and pooled data respectively in order. The results of soil application of fly ash fortified based vermicomposts indicated that the treatment CRVC10 exhibited significantly higher total phosphorous content (0.82, 0.87 and 0.84%) followed by CRVC5 (0.77, 0.78 and 0.77%) and CRVC15 (0.73, 0.74 and 0.74%) during first, second crop and pooled data. Significantly higher total potassium content in mulberry leaves was recorded in CRVC10 (1.92, 2.14 and 2.03%) followed by CRVC5 (1.81, 2.06 and 1.94%) and CRVC15 (1.76, 1.95 and 1.85%) during first, second crop and pooled data. Significantly lower total nitrogen, phosphorous and potassium content was noticed in control (Table 1). Total chlorophyll content in mulberry was found to be significantly higher in CRVC10 (2.21, 2.32 and 2.26 mg/g) followed by CRVC5 (2.02, 2.14 and 2.08 mg/g) and CRVC15 (2.21, 2.06 and 2.00 mg/g) during first, second crop and pooled data respectively. Significantly lower chlorophyll content was noticed in control (Table 2).

Beneficial effects of fly ash fortified vermicomposts obtained in the present study have also been noticed by earlier workers *viz.*, Das *et al.* (2000) [1] who observed that the application of 10 MT of vermicompost along with 150:60:60 NPK kg/ha/year could maintain the good leaf quality parameters like chlorophyll, total sugars, nitrogen, crude protein, leaf moisture percentage and organic carbon content in mulberry. Sumedha (2011) [17] observed that *Jatropha curcus* grown in different amendments of soil with fly ash @ 20 per cent showed increased chlorophyll content and this may due to presence of high concentration of nitrogen in plants. Jadhav and Patil (2001) [2] recorded significantly higher carbohydrate, crude protein content in mulberry leaves in *in-situ* vermiculture plots followed by vermicompost applied plots compared to control. Setua *et al.* (2002) [10] revealed that vermicompost in combination with 150:50:50 kg N, P and K / ha per year in mulberry resulted to higher content of quality parameters like leaf moisture, chlorophyll a, b and total chlorophyll, total sugar, organic carbon, crude protein, nitrogen. Reddy *et al.* (2003) [8] observed that significant improvement leaf moisture content, moisture retention capacity, nitrogen and protein content and chlorophyll content in mulberry when applied with sericulture waste vermicompost. Shrivastava *et al.* (2007) [14] recorded increased moisture content, chlorophyll a and b and carotenoids at 60 days by 10 per cent fly ash incorporation into soil in *Andrographis paniculata.* Ray *et al*. (2012) [7] reported that total chlorophyll content, carotenoids and ascorbic acid were more in fly ash amended soils which clearly indicated that a mix of fly ash and diluted distillery effluent plays a significant role in the vegetative growth and in the synthesis of photosynthetic pigments in ornamental plants. Umesha and Sannappa (2014) [18] studied the biochemical parameters like moisture content, total nitrogen content, chlorophyll, total sugars, crude protein, phosphorous, potash in mulberry leaves and the results indicated that there was significant improvement of these parameters when mulberry plots were supplied with vermicompost. Shashidhar *et al.* (2018) [11] recorded significantly higher chemical constituents in mulberry leaves *viz.*, leaf nitrogen, phosphorous, potassium, calcium, magnesium and sulphur by the combined application of vermicompost and recommended nitrogen in mulberry. The improvement in chlorophyll content indicated that there is improved photosynthetic efficiency in plants accordingly Singhal *et al*. (2000) [16] opined that leaf nitrogen plays a vital role in chlorophyll synthesis. The enhanced quality parametrs content in mulberry leaf were attributed to the improved mineralization resulting in enhanced production of plant growth substances and enzyme activity in mulberry. Increased nitrogen, phosphorus and potassium contents in leaves might be due to increased availability of nutrients in soil due to application of fly ash fortified vermicompost.

**Table 1:** Comparative effect of fly ash fortified crop residue and municipal waste based vermicomposts on Total nitrogen, phosphorus and potassium content of mulberry leaves.

| Treatment details | Total nitrogen (%) | | | Total phosphorus (%) | | | Total potassium (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1st crop | 2nd crop | Pooled | 1st crop | 2nd crop | Pooled | 1st crop | 2nd crop | Pooled |
| $T_1$: CRVC5 + RDF | 3.72 (11.12)$^{ab}$ | 3.83 (11.28)$^{b}$ | 3.78 (11.20)$^{ab}$ | 0.77 (5.02)$^{b}$ | 0.78 (5.06)$^{b}$ | 0.77 (5.05)$^{ab}$ | 1.81 (7.73)$^{ab}$ | 2.06 (8.25)$^{ab}$ | 1.94 (8.00)$^{ab}$ |
| $T_2$: CRVC10 + RDF | 3.85 (11.31)$^{a}$ | 3.92 (11.41)$^{a}$ | 3.88 (11.36)$^{a}$ | 0.82 (5.18)$^{a}$ | 0.87 (5.35)$^{a}$ | 0.84 (5.27)$^{a}$ | 1.92 (7.96)$^{a}$ | 2.14 (8.42)$^{a}$ | 2.03 (8.18)$^{a}$ |
| $T_3$: CRVC15 + RDF | 3.66 (11.02)$^{ab}$ | 3.78 (11.21)$^{b}$ | 3.72 (11.12)$^{bc}$ | 0.73 (4.91)$^{bc}$ | 0.74 (4.94)$^{bc}$ | 0.74 (4.93)$^{b}$ | 1.76 (7.61)$^{bc}$ | 1.95 (8.01)$^{bc}$ | 1.85 (7.82)$^{bc}$ |
| $T_4$: CRVC + RDF | 3.28 (10.43)$^{c}$ | 3.38 (10.58)$^{e}$ | 3.33 (10.51)$^{e}$ | 0.57 (4.31)$^{e}$ | 0.62 (4.50)$^{d}$ | 0.59 (4.41)$^{de}$ | 1.56d (7.16)$^{ef}$ | 1.69 (7.47)$^{de}$ | 1.63 (7.33)$^{ef}$ |
| $T_5$: MWVC5 + RDF | 3.20 (10.31)$^{d}$ | 3.30 (10.46)$^{f}$ | 3.25 (10.38)$^{e}$ | 0.53 (4.17)$^{ef}$ | 0.54 (4.22)$^{e}$ | 0.54 (4.21)$^{ef}$ | 1.52 (7.08)$^{ef}$ | 1.64 (7.35)$^{ef}$ | 1.58 (7.22)$^{efg}$ |
| $T_6$: MWVC10 + RDF | 3.56 (10.87)$^{b}$ | 3.65(11.01)$^{c}$ | 3.61 (10.95)$^{cd}$ | 0.66 (4.67)$^{cd}$ | 0.69 (4.76)$^{cd}$ | 0.68 (4.73)$^{c}$ | 1.68 (7.44)$^{cd}$ | 1.83 (7.76)$^{cd}$ | 1.75 (7.61)$^{cd}$ |
| $T_7$: MWVC15 + RDF | 3.49 (10.76)$^{b}$ | 3.55 (10.85)$^{d}$ | 3.52 (10.81)$^{d}$ | 0.60 (4.45)$^{de}$ | 0.64 (4.60)$^{d}$ | 0.62 (4.54)$^{d}$ | 1.63 (7.32)$^{de}$ | 1.72 (7.52)$^{de}$ | 1.67 (7.43)$^{de}$ |
| $T_8$: MWVC + RDF | 2.95 (9.89)$^{d}$ | 3.23 (10.35)$^{f}$ | 3.09 (10.13)$^{f}$ | 0.47 (3.93)$^{fg}$ | 0.54 (4.20)$^{e}$ | 0.50 (4.08)$^{fg}$ | 1.51 (7.05)$^{ef}$ | 1.60 (7.27)$^{ef}$ | 1.56 (7.17)$^{fg}$ |
| $T_9$: RDF | 2.51 (9.10)$^{e}$ | 3.09 (10.11)$^{g}$ | 2.80 (9.63)$^{g}$ | 0.42 (3.70)$^{g}$ | 0.49 (4.02)$^{e}$ | 0.46 (3.87)$^{g}$ | 1.49 (7.01)$^{f}$ | 1.54 (7.12)$^{f}$ | 1.52 (7.07)$^{g}$ |
| CV (%) | 3.18 | 0.78 | 1.49 | 4.87 | 4.67 | 3.39 | 2.99 | 3.34 | 2.47 |
| S.Em (±) | 0.06 | 0.02 | 0.03 | 0.02 | 0.02 | 0.01 | 0.03 | 0.03 | 0.02 |
| CD @ 1% | 0.26 | 0.07 | 0.12 | 0.07 | 0.07 | 0.05 | 0.12 | 0.14 | 0.10 |

**Table 2:** Comparative effect of fly ash fortified crop residue and municipal waste based vermicomposts on Chlorophyll 'a', Chlorophyll 'b' and total chlorophyll content of mulberry leaves

| Treatment details | Chlorophyll 'a' (mg/g) | | | Chlorophyll 'b' (mg/g) | | | Total chlorophyll (mg/g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1st crop | 2nd crop | Pooled | 1st crop | 2nd crop | Pooled | 1st crop | 2nd crop | Pooled |
| $T_1$: CRVC5 + RDF | 1.43ab | 1.53ab | 1.48b | 0.59b | 0.60b | 0.60b | 2.02b | 2.14b | 2.08b |
| $T_2$: CRVC10 + RDF | 1.57a | 1.64a | 1.61a | 0.64a | 0.68a | 0.66a | 2.21a | 2.32a | 2.26a |
| $T_3$: CRVC15 + RDF | 1.41bc | 1.48b | 1.44bc | 0.53c | 0.58b | 0.55c | 1.94bc | 2.06b | 2.00b |
| $T_4$: CRVC + RDF | 1.26cde | 1.27de | 1.27ef | 0.40e | 0.45de | 0.42e | 1.66e | 1.72de | 1.69d |
| $T_5$: MWVC5 + RDF | 1.24def | 1.22ef | 1.23fg | 0.38e | 0.41ef | 0.40e | 1.62ef | 1.63ef | 1.63d |
| $T_6$: MWVC10 + RDF | 1.36bcd | 1.39c | 1.37cd | 0.49cd | 0.52c | 0.51cd | 1.85cd | 1.91c | 1.88c |
| $T_7$: MWVC15 + RDF | 1.32bcd | 1.33cd | 1.33d | 0.45d | 0.49cd | 0.47d | 1.76de | 1.82cd | 1.79c |
| $T_8$: MWVC + RDF | 1.15ef | 1.20fg | 1.18gi | 0.33f | 0.37fg | 0.35f | 1.48fg | 1.57fg | 1.53e |
| $T_9$: RDF | 1.09f | 1.14g | 1.11i | 0.27f | 0.33g | 0.30g | 1.36g | 1.47g | 1.41f |
| CV (%) | 4.70 | 1.85 | 2.56 | 3.94 | 4.68 | 3.78 | 3.62 | 2.17 | 2.13 |
| S.Em (±) | 0.04 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.04 | 0.02 | 0.02 |
| CD @ 1% | 0.15 | 0.06 | 0.08 | 0.04 | 0.05 | 0.04 | 0.15 | 0.10 | 0.09 |

## Conclusion

The pooled data of two crops revealed that mulberry raised with Vermicompost produced from mixed crop residues along with fly ash fortification @ 10% + recommended dose of chemical fertilizers ($T_2$) recorded significantly higher chemical composition of leaf *viz.*, leaf nitrogen (3.88%), phosphorous (0.84%), potassium (2.03%), chlorophyll a (1.61 mg/g), Chlorophyll b (0.66 mg/g) and total chlorophyll (2.26 mg/g) followed by Vermicomposts produced from mixed crop residues along with fly ash fortification @ 5% + recommended dose of chemical fertilizers ($T_1$). This might be an indication that there was proper uptake of plant nutrients those were available due to the addition of organic manures in the form of fly ash fortified vermicomposts along with recommended dose of chemical fertilizers.

## References


1. Das PK, Bhogesha K, Theerthaprasad BM, Katiyar RS, Vijayakumari KM, Madhava rao YR *et al*. Vermicomposting of sericultural wastes and its impact on mulberry production. Natl. Conf. Strategies Seric. Res. Dev., CSR&TI, Mysore. 2000; 39:16-18.
2. Jadhav SN, Patil GM. Effect of In-situ vermiculture, vermicompost and inorganic fertilizers on nutritional value of S-41 mulberry. Karnataka J. Agric. Sci. 2001; 14(3):822-825.
3. Kumar V, Singh G, Rai R. Fly ash another material for green revolution. Fly Ash Utilization Programme (FAUP), TIFAC, DST, New Delhi, 2005-2012.
4. Miyashita Y. A report on mulberry cultivation and training methods suitable to bivoltine rearing in Karnataka, 1986, 1-7.
5. Pandey VC, Singh N. Impact of fly ash incorporation in soil systems. Agric. Ecosyst. Environ. 2010; 136:16-27.
6. Pandey VC, Abhilash PC, Upadhyay N, Tewari DD. Application of fly ash on the growth performance, translocation of toxic heavy metals within *Cajanus cajan* L., implication for safe utilization of fly ash for agricultural production. J. Hazard. Mater. 2009; 166:255-259.
7. Ray SNC, Ranjan N, Kumari K, Sinha RC. Potential use of a mix of fly ash and diluted distillery effluent in agriculture: A case study on the vegetative growth and photosynthetic pigments of the ornamental plant, Calendula Officinalis. Centre for Environment and Nature Conservation. 2012; 2(5):193-203.
8. Reddy BK, Ramarao DM, Reddy MP, Suryanarayana N. Studies on the effect of farmyard manure and vermicompost on quantitative and qualitative characters of mulberry under semi-arid conditions of Andhra Pradesh. Advance Plant Sci. 2003; 16 (1):177-182.
9. Senapati MR. Fly ash from thermal power plants-waste management and overview. Curr. Sci., 2011; 100(12):1791-1794.
10. Setua GC, Banerjee ND, Sengupta T, Das NK, Ghosh JK, Saratchandra B. Comparative efficacy of different composts in S-1 mulberry (*Morus alba*) under rainfed condition. Indian J Agri. Sci. 2002; 72(7):389-392.
11. Shashidhar KR, Narayanaswamy TK, Sudhakar SN, Bhaskar RN. Impact of different sources of organic nutrients on chemical composition of S-36 mulberry and soil under irrigated condition. Int. J. Curr. Microbiol. App. Sci. 2018; 7(1):2233-2238.
12. Shashidhar KR, Narayanaswamy TK, Bhaskar RN, Jagadish BR, Mahesh M, Krishna KS. Influence of organic based nutrients on soil health and mulberry (*Morus indica* L.) production. J Biol. Sci. 2009; 1(1):94-100.
13. Shivaprakash RM, Narayanagowda SN. Organic manures for mulberry cultivation-A review. Sericologia, 2006; 46(3):241-249.
14. Shrivastava SK, Prasad SVK, Kanungo VK. Impact of coal fly ash on the growth of *Andrographis paniculata*. Nat. Environ. Poll. Technol, 2007; 6(4):709-714.
15. Singh LP, Siddiqui ZA. Effects of fly ash and *Helminthosporium oryzae* on growth and yield of three cultivators of rice. Bioresour. Technol., 2003; 86:73-78.
16. Singhal BK, Chakraborti S, Mala VR, Sarkar A, Datta RK. Photosynthesis for crop improvement in mulberry (*Morus* spp.). Sericologia. 2000; 40:27-55.
17. Sumedha M. Growth of biodiesel plant in fly ash: A sustainable approach Response of *Jatropha curcus*, a biodiesel plant in fly ash amended soil with respect to pigment content and photosynthetic rate. Proce. Environmental Sci. 2011; 8:421-425.
18. Umesha A, Sannappa B. Bio-chemical and mineral constituents of mulberry leaf raised through organic based nutrients in red loamy soil. Intl. J Advanced Res. 2014; 2(9):348-355.