Original Research Article

Effect of Fly Ash Based Organic Application on Plant Biomass and Bio Concentration of Major and Micro Nutrients in Nursery Seedlings of Simarouba glauca

L. Rajashekhar*, N.A. Yeledhalli and S.J. Patil

Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Dharwad -58005, Karnataka, India

*Corresponding author

ABSTRACT

Fly ash was mixed with FYM, Vermicompost and soil in different ratios on a w/w was used for growing nursery seedlings of Simarouba glauca with object of response of pot mixture on biomass production and bioconcentration N, P, K and Zn, Fe, Cu and Mn in stems and leaves. Fly ash based organic substrate application of FA+FYM/VC in 1:3 ratio (w/w) followed by 1:2 ratio. Was found to be optimum for preparing potting mix for Simarouba glauca Biomass accumulation in the stems and roots increased with increase in the ratio of fly ash to FYM/VC application. Up to 1:3 ratio. Whereas the biomass accumulation in leaves as well as total biomass accumulation in the Simarouba saplings. Bioconcentration concentration N, P, K, S and micronutrients Zn, Fe, Cu, Mn and in stem and leaves of Simarouba glauca displayed higher values in all the pot mixture treatment combinations. However, Variations in the concentration of nutrient elements in the plants and uptake by the leaves and stem of nursery seedling of Simarouba glauca was observed for major N.P.K nutrients which varied as N=K>P, secondary nutrients varied as Ca>S>Mg and micro nutrients varied as Fe>Mn>Zn>Cu. The study indicates that the Simarouba glauca had high potential for nutrient uptake due to high biomass production during seedling growth besides fast growth. Fly ash based organic substrates pot mixtures when added to the soil in different ratios benefits biomass production and increase in plant growth which in turn attains significance from the point of view of eco-friendly disposal of fly ash.

Keywords
Fly ash, FYM, Vermicompost, Bioconcentration, Biomass accumulation and nutrient uptake.

Article Info
Accepted: 26 September 2017
Available Online: 10 October 2017

Introduction

Fly ash is a repository of nutrients which can benefit plant growth and increase biomass production. Fly ash has been reported to contain low amounts of C and N, medium amounts of available K and high concentration of available P (Sharma and Kalra, 2006). Species belonging to Simarouba (Simarouba glauca) is an ecfriendly tree with well-developed root system and with evergreen dense canopy efficiently checks soil erosion, recharges ground water supports soil microbial life, and improves soil fertility. The addition of biomass to waste land @ 10-15 tonnes/ha/year helps in the improvement of soil fertility. Plant species achieve a chemical equilibrium with respect to a particular medium or pot mixture exposure (Mountouris et al., 2002). Distribution of any element in environment is dependent on continuous exchange between air, water, soil/sediment and biota (Agoramoorthy et al., 2008). In the present study, fly ash was used...
as a soil amendment along with FYM, VC with and without soil for nursery seedlings of *Simarouba glauca*. To know its response on biomass production and uptake of major and micro nutrients in the stems and leaves.

**Materials and methods**

Fly ash was collected West Coast Paper Mills Dandeli, Karnataka state. India was air-dried prior to analysis. Soil for the experiment was collected from Agro forestry division, MARS, Dharwad.0-30 cm depth and spread on polythene sheets, air-dried and sieved through a 2 mm sieve for chemical analysis. The pH of fly ash and soil used in the study was 6.97 and 7.41 and electrical conductivity was 0.20 and 0.40 (dSm⁻¹) respectively. The chemical properties of fly ash and soil used in the study are presented in the Table 1. Pot mixtures were prepared with fly ash, FYM, VC and soil. With fly ash was mixed with FYM, VC and soil on w/w basis in different proportions. FA+FYM and FA+VC in 1:1, 1:1, 1:2, 1:3, 0:1, 2:1, 3:1 ratios and FA+FYM+SOIL and FA+VC +SOIL in 1:0:1, 1:1:1, 1:2:1, 1:3:1, 0:1:1, 2:1:1, 3:1:1 ratios as per treatment details. The physico-chemical properties are presented Table 2. The different fly ash-soil mixtures were placed in polythene bags perforated at the bottom. Shoot cuttings for the nursery trial were taken from full grown trees of *Simarouba glauca*. The bags were placed in a nursery watering and weeding was carried out regularly. The nursery was grown over a period 150 days. After 150 days the representative plants Simarouba glauca were gently uprooted and washed with water to remove any adhering soil particles. Thereafter the plants were dried with blotting sheets and weighed for fresh weight. The plants were then kept overnight in an oven at 65 °C and weighed again for dry weight. To measure the bioconcentration major and micro nutrients in stems and leaves, the dried leaves and stems were ground followed by sieving with a 0.2 mm sieve to obtain a fine powder and analyzed for N, P, K, S and Zn, Fe, Cu, Mn and uptake was calculated.

**Results and Discussion**

**Dry biomass production**

**Without soil**

The dry biomass of *Simarouba glauca* (3.12 g plant⁻¹) recorded in treatment T8 containing 1:1:1 was 3.12 g plant⁻¹ which increased significantly to 6.71 g plant⁻¹ in the treatment T4 with pot mixture FA+FYM, in 1:3:1 ratio. The dry biomass of *Simarouba* was 3.21 g plant⁻¹ in treatment T8 containing FA+FYM/VC+SOIL in (1:1:1) ratio which increased to 7.15 g plant⁻¹ in the treatment T4 pot mixture containing FA+VC. In general higher dry biomass (shoot + leaf) was recorded in the treatments containing FA+VC as compared to pot mixture containing FA+FYM (Table 2).

**With soil**

It was observed that the dry biomass of nursery seedling was positively influenced due to treatment effect. The dry biomass in control treatment T₈-C₁ was 3.21 g plant⁻¹ which significantly increased to 8.87 g plant⁻¹ due to treatment T₄ pot mixture containing FA+VC+SOIL in 1:3:1 ratio.

Marcer et al., (1995) observed that increase in the number of branches and leaves of *Simarouba glauca* due to pot mixtures containing fly ash and sewage sludge. The biomass production of nursery seedling of *Simarouba glauca* was generally higher in pot mixtures containing fly ash and organic substrates. The reasons may be attributed to improved available nutrient in the pot mixtures (Pryor, 1976). Incorporation of fly ash as a pot mixture with organic substrates.
and soil had significant effect as compared to the control. Improved seedling growth and biomass production would depend on the uptake of nutrients by the plants (Cavaleri et al., 2004).

**Major nutrients (N, P, K)**

The data presented in Table 3 indicates that the uptake of nutrient elements was measured generally in the order K=N>P. The maximum uptake of major nutrients was recorded in treatment T_4 (1:3) containing either fly ash, FYM and vermicompost.

However, the treatment T_2 and T_3, receiving fly ash, FYM in (1:1) and (1:2) ratios were on par with each other. The treatment receiving only fly ash in the pot mixture showed the lowest N, P and K uptake by the plant.

**Table 1** Initial physico-chemical properties of soil, fly ash, vermicompost and farmyard manure used for pot mixture

| Sl. No. | Properties          | Soil  | Fly ash | Vermicompost | Farmyard Manure |
|--------|---------------------|-------|---------|--------------|-----------------|
|        |                     | Sand (%) | Silt (%) | Clay (%)    | Sand (%) | Silt (%) | Clay (%) | Sand (%) | Silt (%) | Clay (%) | Sand (%) | Silt (%) | Clay (%) |
| 1      | Particle            | 65.0   | 15.1    | 20.2        |飞灰 | 36.50    | -        | -        | -        | -       | -       | -       | -       |
| 2      | Texture             | Sandy clay loam | Silty loam | - | -       | -       | -       | -       | -       | -       | -       | -       | -       |
| 3      | Bulk density (Mg m^{-3}) | 1.40 | 0.98    | 0.43        | 0.41   | 14.00    | 28.90    | 65.9     | 58.35    |
| 4      | Water holding capacity (%) | 0.39 | 0.10    | 1.21        | 0.50   | 0.39     | 0.10     | 1.21     | 0.50     |

**Physical**

| Sl. No. | Reaction (pH) | Electrical Conductivity (dSm^{-1}) | Organic carbon (g kg^{-1}) | Total N (%) | Total P (%) | Total K (%) | Total S (%) | Total Ca (%) | Total Mg (%) | Zinc (%) | Copper (%) | Iron (%) | Manganese (mg kg^{-1}) | Available N (kg ha^{-1}) | Available P (kg ha^{-1}) | Available K (kg ha^{-1}) | Zinc (mg kg^{-1}) | Copper (mg kg^{-1}) | Iron (mg kg^{-1}) | Manganese (mg kg^{-1}) |
|---------|---------------|-----------------------------------|---------------------------|-------------|-------------|-------------|-------------|--------------|-------------|----------|-------------|----------|------------------------|------------------------|------------------------|------------------------|----------------|----------------|----------------|----------------|
| 5       | 7.41          | 6.97                              | 7.20                      | 7.60        |
| 6       | 0.20          | 0.40                              | 0.82                      | 0.65        |
| 7       | 8.30          | 1.20                              | 14.21                     | 12.31       |
| 8       | -             | 0.39                              | 1.21                      | 0.50        |
| 9       | -             | 0.10                              | 0.86                      | 0.26        |
| 10      | -             | 0.94                              | 1.01                      | 0.55        |
| 11      | -             | 0.77                              | 0.37                      | 0.28        |
| 12      | -             | 1.12                              | 1.32                      | 1.50        |
| 13      | -             | 0.18                              | 0.94                      | 0.98        |
| 14      | -             | 0.16                              | 0.40                      | 0.33        |
| 15      | -             | 0.13                              | 0.32                      | 0.30        |
| 16      | -             | 1.27                              | 1.63                      | 1.55        |
| 17      | -             | 1.31                              | 1.09                      | 0.40        |
| 18      | 204.34        | -                                 | -                         | -           |
| 19      | 20.36         | -                                 | -                         | -           |
| 20      | 220.07        | -                                 | -                         | -           |
| 21      | 0.94          | -                                 | -                         | -           |
| 22      | 1.80          | -                                 | -                         | -           |
| 23      | 6.02          | -                                 | -                         | -           |
| 24      | 11.21         | -                                 | -                         | -           |
### Table 2: Effect of Fly ash, FYM and VC pot mixtures on dry biomass (g plant⁻¹) of *Simarouba glauca*

| Treatments | Shoot/Leaf biomass (g plant⁻¹) | Root biomass (g plant⁻¹) |
|------------|-------------------------------|--------------------------|
|            | Without soil                  | With soil                 | Without soil                  | With soil                 |
|            | FA+FYM | FA+VC | Treatment with soil | FA+FYM+SOIL | FA+VC+SOIL | Treatment with soil | FA+FYM+SOIL | FA+VC+SOIL |
| T1(1:0)    | 4.27   | 4.87  | T1(1:0:1)          | 5.48        | 5.66        | T1(1:0)           | 2.86        | 2.86        | T1(1:0:1)         | 2.67        | 3.41        |
| T2(1:1)    | 6.02   | 6.90  | T2(1:1:1)          | 7.04        | 7.73        | T2(1:1)           | 3.03        | 3.03        | T2(1:1:1)         | 3.50        | 4.16        |
| T3(1:2)    | 6.58   | 7.04  | T3(1:2:1)          | 7.29        | 7.57        | T3(1:2)           | 3.44        | 3.44        | T3(1:2:1)         | 4.57        | 4.73        |
| T4(1:3)    | 6.71   | 7.15  | T4(1:3:1)          | 7.57        | 8.87        | T4(1:3)           | 3.55        | 3.55        | T4(1:3:1)         | 5.03        | 5.15        |
| T5(0:1)    | 6.01   | 6.34  | T5(0:1:1)          | 7.34        | 8.44        | T5(0:1)           | 2.81        | 2.81        | T5(0:1:1)         | 4.34        | 4.27        |
| T6(2:1)    | 4.61   | 5.70  | T6(2:1:1)          | 6.58        | 7.80        | T6(2:1)           | 2.53        | 2.53        | T6(2:1:1)         | 3.35        | 4.19        |
| T7(3:1)    | 3.85   | 4.32  | T7(3:1:1)          | 5.72        | 6.88        | T7(3:1)           | 2.27        | 2.27        | T7(3:1:1)         | 3.15        | 3.67        |
| T8 C1 (1:1:1) | 3.12  | 3.12  | T8 C1 (1:1:1)     | 3.12        | 3.12        | T8 C1 (1:1:1)     | 3.31        | 3.31        | T8 C1 (1:1:1)     | 3.31        | 3.31        |
| T9 C2(1:1:1) | 5.69  | 5.69  | T9 C2(1:1:1)      | 5.69        | 5.69        | T9 C2(1:1:1)      | 2.32        | 2.32        | T9 C2(1:1:1)      | 2.32        | 2.32        |
| MEAN       | 5.32   | 5.79  | MEAN               | 6.32        | 6.86        | MEAN              | 3.58        | 3.91        |
| SEm⁺       | 0.073  | 0.074 | SEm⁺               | 0.07        | 0.11        | SEm⁺              | 0.079       | 0.087       |
| CD (P = 0.01) | 0.292 | 0.294 | CD (P = 0.01)      | 0.30        | 0.44        | CD (P = 0.01)     | 0.313       | 0.349       |

### Table 3: Effect of Fly ash, FYM, and VC pot mixtures on plant uptake of major nutrients (mg plant⁻¹) by *Simarouba glauca*

| Treatments without soil | FA+FYM | FA+VC | Treatments with soil | FA+FYM | FA+VC | FA+FYM+SOIL | FA+VC | FA+VC+SOIL |
|-------------------------|--------|-------|----------------------|--------|-------|------------|--------|------------|
| T1(1:0)                 | 23.91  | 5.12  | 29.89                | 25.32  | 5.84  | 26.30       | 25.32  | 5.84       |
| T2(1:1)                 | 46.96  | 10.84 | 51.17                | 59.34  | 13.11 | 58.65       | 59.34  | 13.11      |
| T3(1:2)                 | 57.90  | 12.86 | 63.17                | 66.18  | 15.49 | 66.18       | 66.18  | 15.49      |
| T4(1:3)                 | 64.17  | 16.96 | 84.81                | 69.99  | 19.56 | 90.47       | 69.99  | 19.56      |
| T5(0:1)                 | 36.92  | 10.82 | 37.26                | 41.21  | 11.41 | 35.93       | 41.21  | 11.41      |
| T6(2:1)                 | 36.42  | 9.22  | 38.19                | 52.78  | 11.40 | 52.44       | 52.78  | 11.40      |
| T7(3:1)                 | 27.72  | 6.93  | 33.88                | 44.96  | 7.69  | 42.34       | 44.96  | 7.69       |
| T8 C1(1:1:1)            | 24.65  | 4.99  | 22.46                | 25.88  | 4.99  | 22.46       | 25.88  | 4.99       |
| T9 C2(1:1:1)            | 47.23  | 10.24 | 39.83                | 50.07  | 10.24 | 39.83       | 50.07  | 10.24      |
| MEAN                    | 44.32  | 9.78  | 44.52                | 51.38  | 11.08 | 48.29       | 51.38  | 11.08      |
| SEm⁺                    | 0.11   | 0.10  | 0.33                 | 0.16   | 0.16  | 0.28        | 0.16   | 0.16       |
| CD (P = 0.01)           | 0.45   | 0.40  | 1.32                 | 0.62   | 0.63  | 1.12        | 0.62   | 0.63       |
Table 4 Effect of Fly ash, FYM, and VC pot mixtures on plant uptake micronutrient (mg plant⁻¹) *Simarouba glauca*

| Treatments without soil | FA+FYM | FA+VC | Treatments with soil | FA+FYM+SOIL | FA+VC+SOIL |
|-------------------------|--------|-------|----------------------|-------------|------------|
|                         | Zn     | Cu    | Fe       | Mn | Zn | Cu | Fe | Mn | Zn | Cu | Fe | Mn | Zn | Cu | Fe | Mn |
| T1(1:0)                 | 0.18   | 0.09  | 3.42     | 0.65 | 0.23 | 0.12 | 3.94 | 0.80 | 0.28 | 0.16 | 5.49 | 0.98 | 0.31 | 0.16 | 8.54 | 1.18 |
| T2(1:1)                 | 0.35   | 0.16  | 6.02     | 1.13 | 0.43 | 0.19 | 7.94 | 1.38 | 0.42 | 0.23 | 8.32 | 1.25 | 0.43 | 0.26 | 10.65 | 1.74 |
| T3(1:2)                 | 0.42   | 0.21  | 7.89     | 1.37 | 0.48 | 0.23 | 9.75 | 1.88 | 0.51 | 0.25 | 9.48 | 1.16 | 0.53 | 0.26 | 10.27 | 2.08 |
| T4(1:3)                 | 0.54   | 0.26  | 10.73    | 1.96 | 0.60 | 0.31 | 11.42 | 2.35 | 0.68 | 0.32 | 12.88 | 2.36 | 0.61 | 0.33 | 11.97 | 2.46 |
| T5(0:1)                 | 0.28   | 0.17  | 4.82     | 1.04 | 0.32 | 0.22 | 6.30 | 1.35 | 0.53 | 0.25 | 10.66 | 1.73 | 0.64 | 0.31 | 12.61 | 2.42 |
| T6(2:1)                 | 0.27   | 0.15  | 5.06     | 1.08 | 0.35 | 0.20 | 6.85 | 1.35 | 0.51 | 0.26 | 9.84 | 1.58 | 0.63 | 0.28 | 11.84 | 2.38 |
| T7(3:1)                 | 0.24   | 0.15  | 4.62     | 0.96 | 0.28 | 0.19 | 5.27 | 1.04 | 0.44 | 0.22 | 8.92 | 1.50 | 0.58 | 0.27 | 10.52 | 2.21 |
| T8 (control 1:1:1)     | 0.10   | 0.36  | 1.88     | 0.47 | 0.11 | 0.05 | 1.89 | 0.43 | 0.14 | 0.05 | 1.88 | 0.43 | 0.14 | 0.05 | 1.89 | 0.37 |
| T9 (control 1:1:1)     | 0.20   | 0.63  | 4.12     | 0.79 | 0.20 | 0.36 | 4.13 | 0.78 | 0.25 | 0.37 | 4.11 | 0.78 | 0.26 | 0.12 | 4.11 | 0.79 |
| MEAN                    | 0.29   | 0.21  | 5.40     | 1.05 | 0.33 | 0.21 | 6.39 | 1.26 | 0.42 | 0.23 | 7.95 | 0.95 | 0.46 | 0.23 | 9.16 | 1.74 |
| SEm+                    | 0.005  | 0.09  | 0.034    | 0.004 | 0.005 | 0.039 | 0.017 | 0.005 | 0.0048 | 0.089 | 0.040 | 0.011 | 0.0056 | 0.005 | 0.030 | 0.006 |
| CD (P = 0.01)           | 0.021  | 0.35  | 0.135    | 0.017 | 0.020 | 0.124 | 0.069 | 0.021 | 0.0192 | 0.354 | 0.161 | 0.045 | 0.0223 | 0.021 | 0.118 | 0.025 |
The uptake of nitrogen varied from 23.91 to 97.17 mg plant\(^{-1}\) due to treatment effect of fly ash and farmyard manure in different proportions. Similar uptake pattern was also observed with pot mixture containing fly ash, vermicompost and soil. The most effective pot mixture treatment which influenced the uptake of nitrogen are 1:1 and 1:2 ratios with fly ash, farmyard manure and vermicompost pot mixture.

Phosphorus uptake values ranged from 4.99 to 19.56 mg plant\(^{-1}\) in the pot mixture containing fly ash, FYM/VC in different proportions. However, the measured phosphorous uptake values differed marginally. In general, all the pot mixture containing FA, VC and FYM positively enhanced the uptake of phosphorus.

Similarly the uptake of potassium differed due to treatment effects. The pot mixture in 1:1, 1:2 and 1:3 ratio containing fly ash and farmyard manure or vermicompost had significantly influenced increased uptake of potassium compared to other treatment combinations.

**Micronutrients (Zn, Cu, Fe, Mn)**

The data presented in Table 4 indicates uptake of nutrient elements from pot mixture results in their differential bio accumulation influenced by many factors. The uptake of micronutrients by *Simarouba glauca* which varied as Fe>Mn>Zn>Cu and corresponding nutrient concentration in pot mixture containing fly ash, farmyard manure, vermicompost and soil in different proportions were ranged from 1.88 to 12.88, 0.43 to 2.36, 0.14 to 0.68 and 0.05 to 0.37 mg plant\(^{-1}\) respectively.

The nutrient uptake in pot mixture containing fly ash, vermicompost and soil in different ratios ranged from 1.89 to 12.61 then 0.32 to 2.41, then 0.14 to 0.64 and 0.005 to 0.33 mg plant\(^{-1}\) respectively.

The deferential bio accumulation of micronutrients by the forest species *Populas deltoids* and *Cajurina* was influenced by seasonal physiology and species was influenced by specific capacity for uptake forest species was recorded (Demidchick et al., 2000).

Increased biomass accumulation was observed in the pot mixture receiving fly ash, FYM and VC in 1:2 and 1:3 ratio (w/w). Further, it was improved in the pot mixture fly ash, FYM and VC and soil 1:2:1 and 1:3:1 ratio (w/w) in various plant parts of *Simarouba glauca* fly ash proportion in the potting mixture with organic substrates and soil accounted for up to 84 per cent over the control.

Fly ash incorporation FYM/VC and soil enrich the pot mixture with major and micro simultaneously led to a relative improvement of the stem and leaves.

A relative up take a greater up take of major and micronutrients was observed when pot mixture with soil as compared to without soil thus *Simarouba glauca* cultivation Simaroba seedling cultivation may be explored as an environmentally sound and cost effective technology for proper disposal and utilization of solid wastes.
References

Agoramoorthy, G., Chen Fu-An. Hsu MJ, 2008. Threats of heavy metal pollution in halophytic and mangrove plants of Tamil Nadu, India. *Environmental Pollution* 155, 320-326.

Cavaleri, M. A., Gilmore, D. W., Mozaffari, M., Rosen, C. T. and Hallbach, T. R., 2004. Hybrid poplar and forest soil response to municipal and industrial by-products; a greenhouse study. *J. Environ. Qual.*, 33(3): 1055-1061.

Demidchick, V., Davenport, R. J., Tester, I. 2000. Non-selective cation channels in plants. *Ann. Rev. Pint. Rio*. 53:67-107.

Mountouris, A., Voutsas E, Tassios, D., 2002. Bioconcentrations of heavy metals in aquatic environments: the importance of bioavailability. *Marine Pollution Bulletin*. 44, 1136-1141.

Pryor, L. D., 1976. Biology of Eucalypts. Edward Arnold, London, pp 51-58.

Sharma, S. K., Kalra, N., 2006. Effect of fly ash incorporation on soil properties and productivity of crops: A review. *Journal of Scientific and Industrial Research*. 65, 383-390.

How to cite this article:

Rajashekar, L., N.A. Yeledhalli and Patil, S.J. 2017. Effect of Fly Ash Based Organic Application on Plant Biomass and Bio Concentration of Major and Micro Nutrients in Nursery Seedlings of *Simarouba glauca*. *Int.J.Curr.Microbiol.App.Sci*. 6(10): 3366-3372.
doi: [https://doi.org/10.20546/ijcmas.2017.610.394](https://doi.org/10.20546/ijcmas.2017.610.394)