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# Effect of fly ash added pot mixture on growth and development of nursery seedlings of *Simarouba glauca*

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**Abstract**
Fly ash was mixed with FYM, Vermicompst 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 growth and development of nursery seedlings of *Simarouba glauca***.** The study indicates that the *Simarouba glauca*, positive influence of pot mixtures in enhancesing different growth parameters in general the treatment $T_4$ (1:3) and fly ash: vermicompost: soil in 1:3:1 ratio receiving either farmyard manure, vermicompost, soil as recorded the higehest germination percentage maximum number leaves, number branches, root length and stem girth. Fly ash based organic substrates pot mixtures when added to the soil in different ratios benefits increase in plant growth which in turn attains significance from the point of view of eco-friendly disposal of fly ash.
The germination percentage was enhanced. With vermicompost pot mixture with or without soil. It was maximum at 88.84 and 90.68 per cent in the treatment $T_4$ receiving fly ash: farmyard manure in 1:3 ratio and fly ash:vermicompost:soil in 1:3:1 ratio respectively.

**Keywords:** Fly ash, FYM, Vermicompost, Bioconcentration, biomass accumulation and nutrient uptake.

## 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 ecofreindly 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) [2]. In the present study, fly ash was used as a soil amendment along with FYM, VC with and with out soil for nursery seedlings of *Simarouba glauca*, to know its response on growth and development of nursery seedlings of *Simarouba glauca*.

## 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 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 reprsentive 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 ºC 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.

**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 |
|---|---|---|---|---|---|
| **Physical** | | | | | |
| 1 | Particle<br>Sand (%)<br>Silt (%)<br>Clay (%) | <br>65.0<br>15.1<br>20.2 | <br>36.50<br>47.40<br>16.10 | <br>-<br>-<br>- | <br>-<br>-<br>- |
| 2 | Texture | Sandy clay loam | Silty loam | - | - |
| 3 | Bulk density (Mg m-3) | 1.40 | 0.98 | 0.43 | 0.41 |
| 4 | Water holding capacity (%) | 14.00 | 28.90 | 65.9 | 58.35 |
| **Chemical** | | | | | |
| 5 | Reaction(pH) | 7.41 | 6.97 | 7.20 | 7.60 |
| 6 | Electrical Conductivity ($dSm^{-1}$) | 0.20 | 0.40 | 0.82 | 0.65 |
| 7 | Organic carbon($g\ kg^{-1}$) | 8.30 | 1.20 | 14.21 | 12.31 |
| 8 | Total N (%) | - | 0.39 | 1.21 | 0.50 |
| 9 | Total P (%) | - | 0.10 | 0.86 | 0.26 |
| 10 | Total K (%) | - | 0.94 | 1.01 | 0.55 |
| 11 | Total S (%) | - | 0.77 | 0.37 | 0.28 |
| 12 | Total Ca (%) | - | 1.12 | 1.32 | 1.50 |
| 13 | Total Mg (%) | - | 0.18 | 0.94 | 0.98 |
| 14 | Zinc (%) | - | 0.16 | 0.40 | 0.33 |
| 15 | Copper (%) | - | 0.13 | 0.32 | 0.30 |
| 16 | Iron (%) | - | 1.27 | 1.63 | 1.55 |
| 17 | Manganese (%) | - | 1.31 | 1.09 | 0.40 |
| 18 | Available N ($kg\ ha^{-1}$) | 204.34 | - | - | - |
| 19 | Available P ($kg\ ha^{-1}$) | 20.36 | - | - | - |
| 20 | Available K ($kg\ ha^{-1}$) | 220.07 | - | - | - |
| 21 | Zinc ( $mg\ kg^{-1}$) | 0.94 | - | - | - |
| 22 | Copper ( $mg\ kg^{-1}$) | 1.80 | - | - | - |
| 23 | Iron ( $mg\ kg^{-1}$) | 6.02 | - | - | - |
| 24 | Manganese ($mg\ kg^{-1}$) | 11.21 | - | - | - |

## Results and discussion

### Effect of pot mixture on germination percentage of *Simarouba glauca*.

The results showed that there was significant effect on germination percentage due to treatment effect containing different combination pot mixtures containing fly ash+farmyard manure and fly ash +vermicompost in different proportions. The higher germination was recorded in the $T_4$ treatment receiving fly ash and farmyard manure in 1:3 ratios with or without basis and it was lowest (69.20%) the treatment $T_1$ receiving only fly ash. Further, the similar trend of germination percentage was observed due to fly ash based pot mixture containing vermicompost in different ratios with or without soil. The germination percentage was enhanced. With vermicompost pot mixture with or without soil. It was maximum at 88.84 and 90.68 per cent in the treatment $T_4$ receiving fly ash: farmyard manure in 1:3 ratio and fly ash: vermicompost: soil in 1:3:1 ratio respectively. The variation and enhanced germination of the *Simarouba glua* seeds was mainly attributed to the good aerations and water. Treatments proportions rendered by the pot mixture containing fly ash, farmyard manure and Vermicompost and soil in different proportions.

### Effect of fly ash based pot mixture on plant height at different growth stages of *Simarouba glauca*.

The results showed that Fly ash based pot mixture containing farmyard manure and vermicompost with or without soil influenced the plant height of Simarouba nursery seedlings significantly (10.18 cm). The plant height was maximum in the treatment $T_4$ receiving (1:3) fly ash and farmyard manure, however the treatments does not varied at early stage of 30 and 60 days after sowing the plant height increased to 32.87 cm in the treatment $T_4$ and it was on par with $T_3$ treatment receiving (1:2) fly ash farmyard manure, further the plant height was maximum 38.29 cm in treatment $T_4$ due to pot mixture containing fly ash and vermicompost and the treatment this is clearly indicates then higher positive influence of vermicompost over the farmyard manure.

The similar positive significant response on plant height was noticed due to variation plant height of *Simarouba glauca* in pot mixture containing fly ash, farmyard manure or vermicompost along with soil in different proportions. However, higher plant height was recorded in all pot mixture containing fly ash than the control treatment.

### Effect fly ash based pot mixture on number leaves per plant, number branches, root length and stem girth

The results indicates that the bio metric observation on number of leaves and number of branches per plant, root length, stem girth significantly differed due to treatment combination involving fly ash, farmyard manure, vermicompost with and without soil in different proportion. The data clearly indicates the positive influence of pot mixtures in enhance sing different growth parameters in general the treatment $T_4$ (1:3) receiving either farmyard manure, vermicompost, soil as recorded the maximum number leaves, number branches, root length and stem girth, which was on par with treatment $T_2$ (1:1), $T_3$ (1:1), were on par with each other the positive influence on enhancement

growth parameters may be attributed to improved water transformation properties aeration. Increased availability of nutrients including micro nutrients. The results are in collaborate with the findings of (Chang *et el* 1977, 1989, Aitken and bell, 1985 and Sharma et el, 1990) [4]. The increased nutrient availability due to enrichment with fly ash, farmyard manure and varmicompost and soil. Which composed of various easoily available cations and anions (Wang and Wang,1989) [18] organic carbon content in the pot mixture was also enhanced due to organic substations in different proportion (Fung *et el*,1988).The maximum number of leaves recorded in the treatment $T_4$(1:3) ratio fly ash and farmyard manure was 203.66. And it was 2586.26 with fly ash and vermicompost (1:3) and DAS, further the number of leaves enhanced marginally with the pot mixture containing fly ash, farmyard manure, vermicompost and soil. However, the number of leaves was on par with $T_2$, $T_3$ treatments. Similar observation of enhanced the number of branches and root length, stem girth parameters were observed.

**Table 2:** Effect of Fly ash, FYM and VC pot mixtures on germination percentage of *Simarouba glauca*

| Treatments | Simarouba | | | | |
|---|---|---|---|---|---|
| | Without soil | | | With soil | |
| | FA+FYM | FA+VC | Treatments | FA+FYM+SOIL | FA+VC+SOIL |
| T1(1:0) | 69.20 | 71.86 | T1(1:0:1) | 82.67 | 84.49 |
| T2(1:1) | 79.19 | 84.27 | T2(1:1:1) | 85.91 | 88.59 |
| T3(1:2) | 80.18 | 83.37 | T3(1:2:1) | 87.74 | 90.00 |
| T4(1:3) | 82.27 | 84.85 | T4(1:3:1) | 88.84 | 90.68 |
| T5(0:1) | 81.18 | 84.28 | T5(0:1:1) | 88.65 | 89.39 |
| T6(2:1) | 76.59 | 81.67 | T6(2:1:1) | 86.43 | 88.92 |
| T7(3:1) | 74.49 | 81.77 | T7(3:1:1) | 82.19 | 83.94 |
| T8 C1 (1:1:1) | 75..69 | 73.75 | T8 C1 (1:1:1) | 79.49 | 79.49 |
| T9 C2(1:1:1) | 76.47 | 78.93 | T9 C2(1:1:1) | 80.93 | 80.93 |
| MEAN | 76.64 | 81.31 | MEAN | 84.76 | 86.27 |
| SEm± | 1.55 | 1.32 | SEm± | 0.46 | 0.39 |
| CD (P = 0.01) | 6.17 | 5.26 | CD (P = 0.01) | 1.85 | 1.57 |

**Table 3:** Effect of Fly ash, FYM and VC pot mixtures on plant height (cm) different growth stages in *Simarouba glauca*

| Treatments without soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC |
| T1(1:0) | 9.08 | 10.63 | 13.16 | 14.22 | 14.67 | 15.59 | 18.16 | 22.18 | 24.43 | 29.37 |
| T2(1:1) | 9.44 | 10.84 | 12.79 | 14.21 | 16.67 | 17.56 | 21.21 | 24.34 | 30.49 | 36.22 |
| T3(1:2) | 9.77 | 10.95 | 13.16 | 15.00 | 21.33 | 20.92 | 22.13 | 25.71 | 32.39 | 37.24 |
| T4(1:3) | 10.18 | 10.90 | 13.87 | 15.55 | 22.30 | 22.23 | 25.78 | 25.97 | 32.87 | 38.29 |
| T5(0:1) | 9.88 | 10.68 | 12.87 | 14.89 | 20.33 | 21.28 | 23.88 | 24.39 | 30.22 | 36.89 |
| T6(2:1) | 9.39 | 10.47 | 12.48 | 14.21 | 18.67 | 19.31 | 22.46 | 23.62 | 27.49 | 34.89 |
| T7(3:1) | 9.26 | 10.52 | 12.41 | 13.89 | 17.33 | 18.10 | 21.55 | 22.77 | 26.34 | 31.92 |
| T8 C1 (1:1:1) | 9.23 | 10.63 | 11.80 | 13.81 | 14.67 | 16.27 | 19.18 | 24.30 | 23.94 | 26.87 |
| T9 C2 (1:1:1) | 9.11 | 10.52 | 11.79 | 13.52 | 13.33 | 17.11 | 19.98 | 28.21 | 23.74 | 29.97 |
| MEAN | 9.48 | 10.68 | 12.70 | 14.37 | 17.70 | 18.71 | 21.59 | 24.61 | 27.99 | 33.52 |
| SEm± | 0.52 | 0.45 | 0.76 | 0.64 | 0.42 | 0.44 | 0.20 | 0.11 | 0.31 | 0.30 |
| CD (P = 0.01) | N.S | N.S | N.S | N.S | 1.66 | 1.74 | 0.81 | 0.44 | 1.24 | 1.18 |

| Treatments without soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC |
| T1(1:0) | 10.67 | 11.22 | 18.22 | 18.78 | 35.37 | 36.38 | 61.30 | 89.98 | 100.21 | 125.33 |
| T2(1:1) | 12.31 | 12.91 | 21.36 | 23.49 | 38.18 | 40.10 | 77.88 | 131.86 | 140.28 | 160.15 |
| T3(1:2) | 13.24 | 14.22 | 23.27 | 23.70 | 40.27 | 50.57 | 85.76 | 162.95 | 189.85 | 230.46 |
| T4(1:3) | 14.25 | 16.27 | 25.38 | 26.57 | 43.39 | 64.91 | 102.31 | 193.66 | 203.66 | 286.26 |
| T5(0:1) | 12.30 | 14.17 | 24.52 | 28.36 | 41.16 | 55.04 | 96.12 | 152.56 | 185.83 | 189.26 |
| T6(2:1) | 11.03 | 13.25 | 22.38 | 24.41 | 38.96 | 45.16 | 86.53 | 130.22 | 139.32 | 146.28 |
| T7(3:1) | 9.29 | 11.85 | 21.15 | 22.43 | 36.41 | 42.13 | 84.36 | 110.22 | 134.24 | 145.95 |
| T8 C1 (1:1:1) | 8.19 | 10.49 | 19.64 | 18.53 | 22.15 | 28.61 | 79.32 | 99.06 | 116.31 | 130.21 |
| T9 C2(1:1:1) | 9.09 | 12.32 | 17.62 | 16.37 | 21.12 | 30.19 | 81.21 | 101.88 | 120.27 | 135.56 |
| MEAN | 11.15 | 12.97 | 21.50 | 22.52 | 35.22 | 43.68 | 83.87 | 130.27 | 158.00 | 172.16 |
| SEm± | 0.14 | 0.17 | 0.15 | 0.22 | 0.21 | 0.28 | 0.59 | 1.56 | 0.77 | 1.13 |
| CD (P = 0.01) | 0.58 | 0.67 | 0.58 | 0.86 | 0.85 | 1.10 | 2.36 | 6.23 | 3.07 | 4.49 |

**Table 4:** Effect of Fly ash, FYM and VC pot mixtures on plant height (cm) different growth stages in *Simarouba glauca*

| Treatments without soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC |
| T1(1:0) | 9.08 | 10.63 | 13.16 | 14.22 | 14.67 | 15.59 | 18.16 | 22.18 | 24.43 | 29.37 |
| T2(1:1) | 9.44 | 10.84 | 12.79 | 14.21 | 16.67 | 17.56 | 21.21 | 24.34 | 30.49 | 36.22 |
| T3(1:2) | 9.77 | 10.95 | 13.16 | 15.00 | 21.33 | 20.92 | 22.13 | 25.71 | 32.39 | 37.24 |
| T4(1:3) | 10.18 | 10.90 | 13.87 | 15.55 | 22.30 | 22.23 | 25.78 | 25.97 | 32.87 | 38.29 |
| T5(0:1) | 9.88 | 10.68 | 12.87 | 14.89 | 20.33 | 21.28 | 23.88 | 24.39 | 30.22 | 36.89 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| T6(2:1) | 9.39 | 10.47 | 12.48 | 14.21 | 18.67 | 19.31 | 22.46 | 23.62 | 27.49 | 34.89 |
| T7(3:1) | 9.26 | 10.52 | 12.41 | 13.89 | 17.33 | 18.10 | 21.55 | 22.77 | 26.34 | 31.92 |
| T8 C1 (1:1:1) | 9.23 | 10.63 | 11.80 | 13.81 | 14.67 | 16.27 | 19.18 | 24.30 | 23.94 | 26.87 |
| T9 C2 (1:1:1) | 9.11 | 10.52 | 11.79 | 13.52 | 13.33 | 17.11 | 19.98 | 28.21 | 23.74 | 29.97 |
| MEAN | 9.48 | 10.68 | 12.70 | 14.37 | 17.70 | 18.71 | 21.59 | 24.61 | 27.99 | 33.52 |
| SEm± | 0.52 | 0.45 | 0.76 | 0.64 | 0.42 | 0.44 | 0.20 | 0.11 | 0.31 | 0.30 |
| CD (P = 0.01) | N.S | N.S | N.S | N.S | 1.66 | 1.74 | 0.81 | 0.44 | 1.24 | 1.18 |

| Treatments without soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC |
| T1(1:0) | 10.67 | 11.22 | 18.22 | 18.78 | 35.37 | 36.38 | 61.30 | 89.98 | 100.21 | 125.33 |
| T2(1:1) | 12.31 | 12.91 | 21.36 | 23.49 | 38.18 | 40.10 | 77.88 | 131.86 | 140.28 | 160.15 |
| T3(1:2) | 13.24 | 14.22 | 23.27 | 23.70 | 40.27 | 50.57 | 85.76 | 162.95 | 189.85 | 230.46 |
| T4(1:3) | 14.25 | 16.27 | 25.38 | 26.57 | 43.39 | 64.91 | 102.31 | 193.66 | 203.66 | 286.26 |
| T5(0:1) | 12.30 | 14.17 | 24.52 | 28.36 | 41.16 | 55.04 | 96.12 | 152.56 | 185.83 | 189.26 |
| T6(2:1) | 11.03 | 13.25 | 22.38 | 24.41 | 38.96 | 45.16 | 86.53 | 130.22 | 139.32 | 146.28 |
| T7(3:1) | 9.29 | 11.85 | 21.15 | 22.43 | 36.41 | 42.13 | 84.36 | 110.22 | 134.24 | 145.95 |
| T8 C1 (1:1:1) | 8.19 | 10.49 | 19.64 | 18.53 | 22.15 | 28.61 | 79.32 | 99.06 | 116.31 | 130.21 |
| T9 C2(1:1:1) | 9.09 | 12.32 | 17.62 | 16.37 | 21.12 | 30.19 | 81.21 | 101.88 | 120.27 | 135.56 |
| MEAN | 11.15 | 12.97 | 21.50 | 22.52 | 35.22 | 43.68 | 83.87 | 130.27 | 158.00 | 172.16 |
| SEm± | 0.14 | 0.17 | 0.15 | 0.22 | 0.21 | 0.28 | 0.59 | 1.56 | 0.77 | 1.13 |
| CD (P = 0.01) | 0.58 | 0.67 | 0.58 | 0.86 | 0.85 | 1.10 | 2.36 | 6.23 | 3.07 | 4.49 |

**Table 5:** Effect of Fly ash, FYM and VC pot mixtures on number of leaves per plant at different growth stages of *Simarouba glauca*

| Treatments with soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC+ SOIL |
| T1(1:0:1) | 10.40 | 11.59 | 15.35 | 5.47 | 18.16 | 18.19 | 16.92 | 23.22 | 31.36 | 32.18 |
| T2(1:1:1) | 10.42 | 11.50 | 15.52 | 6.16 | 21.21 | 20.34 | 27.13 | 25.34 | 32.32 | 34.21 |
| T3(1:2:1) | 10.61 | 11.64 | 16.19 | 6.47 | 21.87 | 22.27 | 27.70 | 26.20 | 32.88 | 35.24 |
| T4(1:3:1) | 10.68 | 11.70 | 17.22 | 6.79 | 21.96 | 22.97 | 28.96 | 26.42 | 33.15 | 35.97 |
| T5(0:1:1) | 10.86 | 11.68 | 16.86 | 6.16 | 19.19 | 21.38 | 26.32 | 23.99 | 31.55 | 34.47 |
| T6(2:1:1) | 10.33 | 11.60 | 15.86 | 5.81 | 18.91 | 19.44 | 24.25 | 23.45 | 29.67 | 28.45 |
| T7(3:1:1) | 10.22 | 11.56 | 15.59 | 6.04 | 18.46 | 18.60 | 22.22 | 22.08 | 27.98 | 29.09 |
| T8 C1 (1:1:1) | 10.07 | 11.50 | 14.22 | 6.13 | 19.18 | 17.28 | 19.54 | 23.32 | 23.12 | 27.13 |
| T9 C2(1:1:1) | 10.11 | 11.23 | 14.53 | 5.50 | 19.98 | 18.33 | 21.32 | 24.37 | 26.32 | 29.13 |
| MEAN | 10.41 | 11.56 | 15.71 | 6.06 | 19.88 | 19.87 | 23.82 | 24.27 | 29.82 | 31.76 |
| SEm± | 0.47 | 0.35 | 1.04 | 1.00 | 0.14 | 0.08 | 0.22 | 0.23 | 0.31 | 0.29 |
| CD (P = 0.01) | N.S | N.S | N.S | N.S | 0.54 | 0.31 | 0.88 | 0.90 | 1.23 | 1.14 |

| Treatments with soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC+ SOIL | FA+FYM +SOIL | FA+VC +SOIL |
| T1(1:0:1) | 11.21 | 11.97 | 20.53 | 21.04 | 38.53 | 44.15 | 94.12 | 96.57 | 130.24 | 141.58 |
| T2(1:1:1) | 12.37 | 12.32 | 24.63 | 25.43 | 41.06 | 56.19 | 138.57 | 140.23 | 173.14 | 172.88 |
| T3(1:2:1) | 13.11 | 13.25 | 25.34 | 26.69 | 55.21 | 72.50 | 170.24 | 172.31 | 286.34 | 190.13 |
| T4(1:3:1) | 14.21 | 14.57 | 27.71 | 28.96 | 79.57 | 93.46 | 210.24 | 220.90 | 294.31 | 221.92 |
| T5(0:1:1) | 13.10 | 13.51 | 24.57 | 25.77 | 60.94 | 61.18 | 190.24 | 201.88 | 190.24 | 201.25 |
| T6(2:1:1) | 12.24 | 12.13 | 23.56 | 24.14 | 46.64 | 58.47 | 140.59 | 166.48 | 164.24 | 166.86 |
| T7(3:1:1) | 11.03 | 11.93 | 23.12 | 23.68 | 40.11 | 54.51 | 132.03 | 140.23 | 154.31 | 167.29 |
| T8 C1 (1:1:1) | 9.14 | 10.43 | 19.25 | 20.13 | 33.24 | 53.48 | 100.27 | 110.20 | 140.22 | 93.14 |
| T9 C2(1:1:1) | 9.84 | 9.50 | 17.36 | 18.56 | 43.19 | 55.16 | 108.27 | 112.36 | 139.21 | 112.25 |
| MEAN | 11.81 | 12.18 | 22.90 | 23.82 | 48.72 | 61.01 | 142.73 | 151.24 | 185.81 | 163.03 |
| SEm± | 0.15 | 0.14 | 0.14 | 0.15 | 0.25 | 0.81 | 0.25 | 0.66 | 0.747 | 1.48 |
| CD (P = 0.01) | 0.61 | 0.55 | 0.55 | 0.59 | 1.02 | 3.23 | 1.01 | 2.65 | 2.978 | 5.92 |

**Table 6:** Effect of Fly ash, FYM and VC pot mixtures on number of branches at different growth stages of *Simarouba glauca*

| Treatments without soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC |
| T1(1:0) | 3.25 | 4.13 | 6.26 | 6.97 | 14.67 | 15.59 | 18.16 | 22.00 | 24.42 | 27.28 |
| T2(1:1) | 4.29 | 4.11 | 7.45 | 7.53 | 16.67 | 17.56 | 21.21 | 26.71 | 25.44 | 28.93 |
| T3(1:2) | 4.25 | 4.95 | 8.37 | 8.87 | 21.33 | 20.92 | 22.13 | 30.85 | 30.14 | 32.13 |
| T4(1:3) | 4.41 | 5.35 | 9.10 | 9.33 | 21.67 | 22.58 | 25.78 | 31.85 | 32.25 | 34.14 |
| T5(0:1) | 4.25 | 5.21 | 7.56 | 8.19 | 20.33 | 21.28 | 23.88 | 37.87 | 30.14 | 33.36 |
| T6(2:1) | 3.15 | 3.85 | 7.25 | 6.95 | 18.67 | 19.31 | 22.46 | 29.25 | 29.51 | 31.47 |
| T7(3:1) | 4.13 | 3.83 | 6.05 | 6.05 | 17.33 | 18.10 | 21.55 | 25.58 | 27.17 | 29.18 |
| T8 C1 (1:1:1) | 2.41 | 4.13 | 6.40 | 6.40 | 14.67 | 16.27 | 19.18 | 24.30 | 25.15 | 26.47 |
| T9 C2(1:1:1) | 3.31 | 3.21 | 6.75 | 6.75 | 13.33 | 17.11 | 19.98 | 28.05 | 23.55 | 25.14 |
| MEAN | 3.72 | 4.31 | 7.24 | 7.45 | 17.85 | 18.97 | 21.59 | 23.12 | 27.53 | 29.79 |
| SEm± | 0.11 | 0.15 | 0.19 | 0.20 | 0.43 | 0.50 | 0.20 | 0.44 | 0.18 | 0.19 |
| CD (P = 0.01) | 0.43 | 0.61 | 0.75 | 0.80 | 1.72 | 1.99 | 0.81 | 1.74 | 0.72 | 0.74 |

| Treatments with soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL |
| T1(1:0:1) | 3.26 | 5.29 | 7.24 | 7.89 | 18.19 | 19.23 | 24.29 | 23.22 | 28.93 | 30.24 |
| T2(1:1:1) | 3.78 | 6.27 | 8.62 | 9.16 | 20.34 | 21.52 | 25.22 | 25.34 | 29.73 | 32.34 |
| T3(1:2:1) | 4.16 | 7.75 | 9.45 | 9.70 | 25.24 | 27.27 | 28.57 | 28.59 | 33.46 | 35.86 |
| T4(1:3:1) | 4.75 | 8.12 | 9.50 | 10.04 | 26.16 | 27.79 | 29.41 | 35.53 | 33.48 | 36.15 |
| T5(0:1:1) | 4.15 | 7.48 | 8.63 | 9.10 | 24.10 | 26.24 | 27.34 | 31.11 | 33.14 | 35.39 |
| T6(2:1:1) | 3.05 | 6.86 | 7.46 | 8.32 | 22.11 | 24.16 | 25.64 | 29.34 | 32.60 | 34.24 |
| T7(3:1:1) | 3.83 | 6.51 | 6.86 | 7.23 | 20.14 | 23.09 | 24.22 | 27.86 | 30.14 | 32.07 |
| T8 C1 (1:1:1) | 3.04 | 5.79 | 7.12 | 7.18 | 19.57 | 20.16 | 21.33 | 25.92 | 29.63 | 30.13 |
| T9 C2(1:1:1) | 4.14 | 5.11 | 7.34 | 7.76 | 21.10 | 21.11 | 21.90 | 26.47 | 26.43 | 27.55 |
| MEAN | 3.80 | 6.58 | 8.02 | 8.49 | 22.23 | 23.73 | 23.96 | 28.12 | 31.06 | 32.77 |
| SEm± | 0.16 | 0.13 | 0.16 | 0.13 | 0.31 | 0.31 | 0.21 | 0.47 | 0.22 | 0.24 |
| CD (P = 0.01) | 0.63 | 0.53 | 0.66 | 0.51 | 1.24 | 1.28 | 0.84 | 1.88 | 0.88 | 0.94 |

**Table 7:** Effect of Fly ash, FYM and VC pot mixtures on root length (cm) at different growth stages of *Simarouba glauca*

| Treatments without soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC |
| T1(1:0) | 5.43 | 5.96 | 7.09 | 7.52 | 10.67 | 12.50 | 13.16 | 13.87 | 14.25 | 14.27 |
| T2(1:1) | 6.21 | 6.81 | 7.98 | 8.02 | 12.33 | 13.17 | 16.82 | 17.68 | 18.29 | 18.35 |
| T3(1:2) | 7.15 | 7.33 | 8.96 | 9.39 | 13.33 | 14.50 | 18.77 | 19.97 | 20.90 | 22.19 |
| T4(1:3) | 7.17 | 8.13 | 9.10 | 9.48 | 14.17 | 15.54 | 19.86 | 20.14 | 21.91 | 23.86 |
| T5(0:1) | 6.79 | 7.10 | 8.45 | 9.18 | 12.33 | 12.83 | 19.73 | 21.03 | 22.24 | 22.13 |
| T6(2:1) | 6.13 | 7.40 | 6.96 | 8.55 | 10.67 | 16.00 | 19.65 | 20.18 | 21.21 | 22.11 |
| T7(3:1) | 5.20 | 6.14 | 5.58 | 7.02 | 10.33 | 15.14 | 18.71 | 18.84 | 19.25 | 19.49 |
| T8 C1 (1:1:1) | 4.12 | 4.94 | 4.36 | 5.02 | 9.33 | 14.33 | 16.57 | 16.62 | 18.27 | 18.34 |
| T9 C2(1:1:1) | 4.55 | 4.83 | 4.78 | 5.86 | 10.00 | 16.67 | 15.25 | 16.21 | 17.19 | 18.18 |
| MEAN | 5.97 | 5.63 | 7.22 | 7.95 | 11.63 | 14.63 | 17.72 | 17.97 | 19.50 | 19.89 |
| SEm± | 0.09 | 0.14 | 0.06 | 0.07 | 0.31 | 0.34 | 0.35 | 0.20 | 0.35 | 0.25 |
| CD (P = 0.01) | 0.37 | 0.57 | 0.22 | 0.26 | 1.25 | 1.34 | 1.38 | 0.78 | 1.41 | 1.00 |

| Treatments with soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL |
| T1(1:0:1) | 6.13 | 6.91 | 8.28 | 9.13 | 8.67 | 11.52 | 14.20 | 16.35 | 15.32 | 15.72 |
| T2(1:1:1) | 7.18 | 7.92 | 8.52 | 9.98 | 11.76 | 16.67 | 15.78 | 18.53 | 19.21 | 21.22 |
| T3(1:2:1) | 8.36 | 8.39 | 10.04 | 10.85 | 15.33 | 21.33 | 19.35 | 21.20 | 22.56 | 23.56 |
| T4(1:3:1) | 9.02 | 10.15 | 11.22 | 11.86 | 19.33 | 23.14 | 22.23 | 22.27 | 23.94 | 24.59 |
| T5(0:1:1) | 7.68 | 8.09 | 10.24 | 10.57 | 15.67 | 20.33 | 21.32 | 21.45 | 22.23 | 22.56 |
| T6(2:1:1) | 6.32 | 7.28 | 9.22 | 9.87 | 14.67 | 20.04 | 20.13 | 21.52 | 22.14 | 22.50 |
| T7(3:1:1) | 5.13 | 6.57 | 8.27 | 8.46 | 14.33 | 18.33 | 20.50 | 20.96 | 22.84 | 22.89 |
| T8 C1 (1:1:1) | 4.11 | 5.42 | 6.13 | 7.88 | 13.33 | 17.33 | 14.58 | 17.20 | 17.23 | 17.33 |
| T9 C2(1:1:1) | 4.40 | 4.82 | 6.53 | 6.97 | 13.67 | 16.33 | 15.37 | 15.97 | 19.91 | 19.98 |
| MEAN | 6.48 | 7.28 | 8.72 | 9.51 | 14.08 | 18.34 | 18.16 | 19.19 | 20.78 | 20.89 |
| SEm± | 0.10 | 0.10 | 0.10 | 0.04 | 0.34 | 0.29 | 0.21 | 0.17 | 0.26 | 0.30 |
| CD (P = 0.01) | 0.41 | 0.41 | 0.41 | 0.16 | 1.35 | 1.15 | 0.85 | 0.68 | 1.04 | 1.18 |

**Table 8:** Effect of Fly ash, FYM and VC pot mixtures on stem girth (cm) at different stages in *Simarouba glauca*

| Treatments without soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC | FA+FYM | FA+VC |
| T1(1:0) | 0.15 | 0.16 | 0.26 | 0.28 | 0.30 | 0.31 | 0.35 | 0.34 | 0.40 | 0.55 |
| T2(1:1) | 0.15 | 0.18 | 0.27 | 0.29 | 0.33 | 0.39 | 0.42 | 0.42 | 0.46 | 0.69 |
| T3(1:2) | 0.16 | 0.18 | 0.28 | 0.30 | 0.35 | 0.41 | 0.47 | 0.49 | 0.53 | 0.79 |
| T4(1:3) | 0.18 | 0.20 | 0.29 | 0.30 | 0.39 | 0.45 | 0.49 | 0.54 | 0.60 | 0.81 |
| T5(0:1) | 0.17 | 0.19 | 0.29 | 0.30 | 0.37 | 0.40 | 0.45 | 0.44 | 0.50 | 0.75 |
| T6(2:1) | 0.15 | 0.18 | 0.28 | 0.29 | 0.35 | 0.40 | 0.43 | 0.45 | 0.53 | 0.66 |
| T7(3:1) | 0.16 | 0.17 | 0.27 | 0.29 | 0.33 | 0.40 | 0.42 | 0.44 | 0.70 | 0.69 |
| T8 C1 (1:1:1) | 0.16 | 0.19 | 0.25 | 0.28 | 0.29 | 0.34 | 0.36 | 0.38 | 0.57 | 0.53 |
| T9 C2(1:1:1) | 0.14 | 0.17 | 0.25 | 0.28 | 0.28 | 0.29 | 0.31 | 0.36 | 0.45 | 0.63 |
| MEAN | 0.16 | 0.18 | 0.27 | 0.29 | 0.33 | 0.38 | 0.41 | 0.43 | 0.53 | 0.68 |
| SEm± | 0.02 | 0.02 | 0.02 | 0.01 | 0.00 | 0.01 | 0.002 | 0.0031 | 0.01 | 0.02 |
| CD (P = 0.01) | N.S | N.S | N.S | N.S | 0.01 | 0.03 | 0.008 | 0.013 | 0.06 | 0.07 |

| Treatments with soil | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | 150 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL | FA+FYM+SOIL | FA+VC+SOIL |
| T1(1:0:1) | 0.19 | 0.24 | 0.29 | 0.31 | 0.35 | 0.41 | 0.43 | 0.47 | 0.55 | 0.58 |
| T2(1:1:1) | 0.19 | 0.26 | 0.30 | 0.32 | 0.39 | 0.44 | 0.47 | 0.49 | 0.83 | 0.75 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| T3(1:2:1) | 0.21 | 0.26 | 0.32 | 0.33 | 0.44 | 0.48 | 0.49 | 0.52 | 0.91 | 0.79 |
| T4(1:3:1) | 0.22 | 0.27 | 0.32 | 0.34 | 0.52 | 0.53 | 0.55 | 0.58 | 0.97 | 4.95 |
| T5(0:1:1) | 0.21 | 0.24 | 0.32 | 0.33 | 0.48 | 0.49 | 0.50 | 0.53 | 0.87 | 0.89 |
| T6(2:1:1) | 0.21 | 0.25 | 0.32 | 0.33 | 0.45 | 0.46 | 0.48 | 0.51 | 0.86 | 0.80 |
| T7(3:1:1) | 0.20 | 0.24 | 0.30 | 0.33 | 0.41 | 0.46 | 0.48 | 0.49 | 0.86 | 0.85 |
| T8 C1 (1:1:1) | 0.17 | 0.22 | 0.29 | 0.31 | 0.37 | 0.37 | 0.39 | 0.45 | 0.51 | 0.70 |
| T9 C2(1:1:1) | 0.17 | 0.22 | 0.28 | 0.31 | 0.38 | 0.35 | 0.37 | 0.43 | 0.60 | 0.77 |
| MEAN | 0.20 | 0.24 | 0.30 | 0.32 | 0.42 | 0.44 | 0.46 | 0.50 | 0.79 | 0.79 |
| SEm± | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | 0.002 | 0.01 | 0.00 | 0.02 | 0.01 |
| CD (P = 0.01) | N.S | N.S | N.S | N.S | 0.01 | 0.01 | 0.02 | 0.01 | 0.08 | 0.02 |

## Conclusions

The study indicates the positive role of fly ash as on alternative to soil for pot mixture alone or co mixed with farmyard manure or vermicompost and soil act synergistically towards growth and biomass production. The germination percentage was enhanced with vermicompost pot mixture with or without soil. It was maximum at 88.84 and 90.68 per cent in the treatment $T_4$ receiving fly ash: farmyard manure in 1:3 ratio and fly ash:vermicompost:soil in 1:3:1 ratio respectively**,** fly ash based pot mixture containing farmyard manure and vermicompost with or without soil influenced the plant height of Simarouba nursery seedlings significantly (10.18 cm). The plant height was maximum in the treatment $T_4$ receiving (1:3) fly ash and farmyard manure,pot mixtures in enhance sing different growth parameters in general the treatment $T_4$ (1:3) receiving either farmyard manure, vermicompost, soil as recorded the maximum number leaves, number branches, root length and stem girth.

A relative plant growtth and developent was observed when pot mixture with soil as compared to with out 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.

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