

## GROWTH BEHAVIOR OF *Gmelina arborea* IN DIFFERENT FERTILITY LEVELS OF AGROFORESTRY SYSTEM

Ajay Kumar Shah\* and R. Bajpai

Department of Forestry, College of Agriculture, JNKVV, Jabalpur, 482004, India

Email: [shahajay.1209@hotmail.com](mailto:shahajay.1209@hotmail.com)

Received-02.06.2022, Revised-16.06.2022, Accepted-29.06.2022

**Abstract:** A field experiment was conducted at a research farm, department of forestry, JNKVV, Jabalpur during the *rabi* season 2020-21 and 2021-22 to find out the growth of *Gmelina* trees at different fertilizer levels under agroforestry systems. The experiment was laid out in a factorial randomized block design (FRBD) with 4 replications and 2 factors and 3 fertilizer treatments consisting of F<sub>1</sub> (75%NPK@ 45:30:30 kg ha<sup>-1</sup>), F<sub>2</sub> (100%NPK@ 60:40:40 kg ha<sup>-1</sup>), and F<sub>3</sub> (125%NPK@ 75:50:50 kg ha<sup>-1</sup>) the nutrient utilization have to influence the growth of *Gmelina* tree different fertilizer levels. The result revealed that the growth of dbh and height was found highest in F<sub>3</sub> (8.04, 8.3 and 8.17 cm) and (3.84, 3.94 and 3.80 m) respectively, first, second year and pooled data. This parameter directly impacts on derived parameters like basal area and volume, thus maximum fertilizer levels found in basal area and volume in F<sub>3</sub> (2.6, 2.75 and 2.67 m<sup>2</sup> ha<sup>-1</sup>) and (10.8, 11.7 and 11.3 m<sup>3</sup> ha<sup>-1</sup>) respectively in both year and pooled data.

**Keywords:** Agroforestry system, Plantation, Timber, Tree

### INTRODUCTION

India is estimated to have between 14,224 million and 24,602 76 million trees outside forests, spread over an equivalent area of 17 million 77 hectares, supplying 49% of the 201 million tons of fuel wood and 48% of the 64 million m<sup>3</sup> of timber consumed annually by the country (Rai and Chakrabarti 2001; Pandey 2007). The productivity of timber in India is 0.7 m<sup>3</sup> ha<sup>-1</sup> year<sup>-1</sup> compared to the world average of 2.1 m<sup>3</sup> ha<sup>-1</sup> year<sup>-1</sup>. Smallholder farmers in India an important role producing timber in their farm systems as well as agroforestry, in particular in supplying to national local markets to fulfill construction material for low-cost housing.

Agroforestry is a land-use system and technology whereby woody perennials are deliberately used on the same land management unit as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence. In an agroforestry system there are both ecological and economical interactions between the various components (Long *et al.*, 2013).

The *Gmelina arborea* has a very high timber rate on the market and the characteristics of fastgrowing timber reduce early production and utilization by local people and reduce the burden of forest timber. It is also deciduous in nature, so the competition between trees and crops is reduced. The agroforestry trees have an immense quantity and great quality of timber produce.

*G. arborea* is a tree which has been widely used in reforestation programs in tropical and subtropical regions of the world and as a source of commercial timber and cellulose (Dvorak, 2004; Silva *et al.*, 2005). This species produces large numbers of fertile fruits that are easily dispersed by birds and bats, spreading seedlings quite far from the parent tree (Orwa *et al.*, 2009). In this way, *G. arborea* has

escaped from plantations and entered wild habitats where it is now replacing native trees and becoming invasive (IUCN, 2013).

Application of fertilizer has influenced the growth and development of tree crops. The growth and development of plants is negatively affected by lack of any of these nutrients during the life cycle. Nitrogen plays a key role in chlorophyll synthesis and subsequently in photosynthesis (Duarah *et al.*, 2011) Nitrogen plays an important role in vegetative growth of plants. Thus, it should remain available during it vegetative stage (Venkatesh *et al.*, 2017) The P increases cell division and stimulates root growth and flowering (Khan *et al.*, 2012). P is found in the plant parts having high metabolism and rapid cell division; therefore, it plays a role in the storage and transfer of energy released during photosynthesis and its deficiency delays plant maturity (Savoy 1999).

### MATERIALS AND METHODS

The field experiment was conducted during the winter (*rabi*) seasons of 2020-21 at College of Agriculture, Jabalpur, JNKVV, (Madhya Pradesh). The soil was sandy loam, slightly acidic in nature to find out the growth and developments of *Gmelina arborea* crops under Agroforestry systems. The experiment was laid out in a Factorial Randomized Complete Block Design (RCBD) with 4 replications and 3 fertilizer level with 2 factor (systems) treatments consisted F<sub>1</sub>(75%NPK@ 45:30:30 kg ha<sup>-1</sup>), F<sub>2</sub>(100%NPK@ 60:40:40 kg ha<sup>-1</sup>), and F<sub>3</sub>(125%NPK@ 75:50:50 kg ha<sup>-1</sup>). The soil of the experimental field was silty clay loam in texture, low and high rating for available nitrogen (293.63 kg N ha<sup>-1</sup>), phosphorus (2.85 P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and potassium

\*Corresponding Author

(250.5 K<sub>2</sub>O ha<sup>-1</sup>) under *Gmelina arborea*. The soil was found slightly acidic that is pH 6.5.

#### Growth estimation of trees

The growth estimation of *Gmelina arborea* through two main parameters, i.e. dbh at 137cm and the height of the tree were calculated by a derived formula of basal area and volume they are:

$$\text{Basal area (m}^2\text{ha}^{-1}\text{)} = \pi/4 \times (\text{dbh})^2$$

$$\text{Volume of standing tree (m}^3\text{ha}^{-1}\text{)} = \text{Basal area of main stems} \times \text{Tree height}$$

## RESULTS AND DISCUSSION

The result was described in the form of derived data, i.e., estimated in two progressive years, 2020-21 and 2021-22 respectively. The following parameters are shown in Table 1 and Fig.1.

#### Diameter at Breast Height (dbh<sub>1.37m</sub>) of *Gmelina arborea*

*Gmelina* was estimated in diameter at breast height fertilizer levels. F<sub>3</sub> (8.04, 8.3 and 8.17 cm) was found maximum and minimum on F<sub>2</sub> (7.19, 7.53 and 7.36 cm) followed by F<sub>1</sub> (6.64, 6.85 and 6.75 cm) thus, increase the fertilizer dose the diameter at breast height into *Gmelina* both the year and pooled data respectively. Plants exploit nutrient acquisition to persist in different habitats and higher acquisition of nutrients results in better growth (Duarah *et al.*, 2011, Gioria *et al.*, 2014).

#### Height of Tree

*Gmelina*, it was estimated that in the height of trees, fertilizer levels F<sub>3</sub> (3.84, 3.94 and 3.80 m) was found higher and minimum on F<sub>2</sub> (2.98, 3.32 and 3.15 m) followed by F<sub>1</sub> (3.32, 3.62 and 3.47 m) thus increase the fertilizer dose the diameter at breast height into *Gmelina* both the year and pooled data respectively. Nitrogen plays an important role in vegetative growth of plants; thus, should remain available

throughout this stage (Rumeu *et al.*, 2011). Similar results in *Juniperus procera* individual and interactive effects of soil types and NPK concentrations significantly altered tree height, number of leaves per plant, stem and root fresh and dry weights and relative water contents (Khalofah *et al.*, 2022, Gioria *et al.*, 2014).

#### Basal area and Volume of standing tree

Basal area of trees was found in different fertility levels where the maximum was estimated in F<sub>3</sub> (2.6, 2.75 and 2.67 m<sup>2</sup> ha<sup>-1</sup>) followed by F<sub>2</sub> (2.03, 2.24 and 2.14 m<sup>2</sup> ha<sup>-1</sup>) and minimum was found in F<sub>1</sub> (1.73, 1.85 and 1.79 m<sup>2</sup> ha<sup>-1</sup>) in first and second year as well as pooled data respectively. Volume of tree was varying due to different fertility levels was estimated maximum production of volume in F<sub>3</sub> (10.8, 11.7 and 11.3 m<sup>3</sup> ha<sup>-1</sup>) followed by F<sub>2</sub> (6.00, 7.4 and 6.7 m<sup>3</sup> ha<sup>-1</sup>) and list volume found under F<sub>1</sub> (5.7, 6.6 and 6.2 m<sup>3</sup> ha<sup>-1</sup>) fertility levels. Similar result obtained under Basal-area and volume growth per tree were significantly greater with the SCU treatment than with the control (C), Urea (U), or U + NS (urea treated with N-Serve [nitrapyrin, 2-chloro-6-(trichloromethyl) pyridine]) treatments. Beneficial effects of SCU seemed to be mostly due to the slow release of N from the fertilizer, (Radwan *et al.*, 1989) and significant differences for fertilization and species effects in growth variables and nutrient additions enhanced the growth of fertilized plants (Jaquetti and Gonçalves, 2021).

## CONCLUSION

Application of different fertilizer level treatment the F<sub>3</sub> (125% NPK @ 75:50:50 kg ha<sup>-1</sup>) was estimated highest basal area, height of *Gmelina*, basal area as well as volume of tree estimated maximum followed by F<sub>2</sub> and F<sub>1</sub> fertilizer levels.

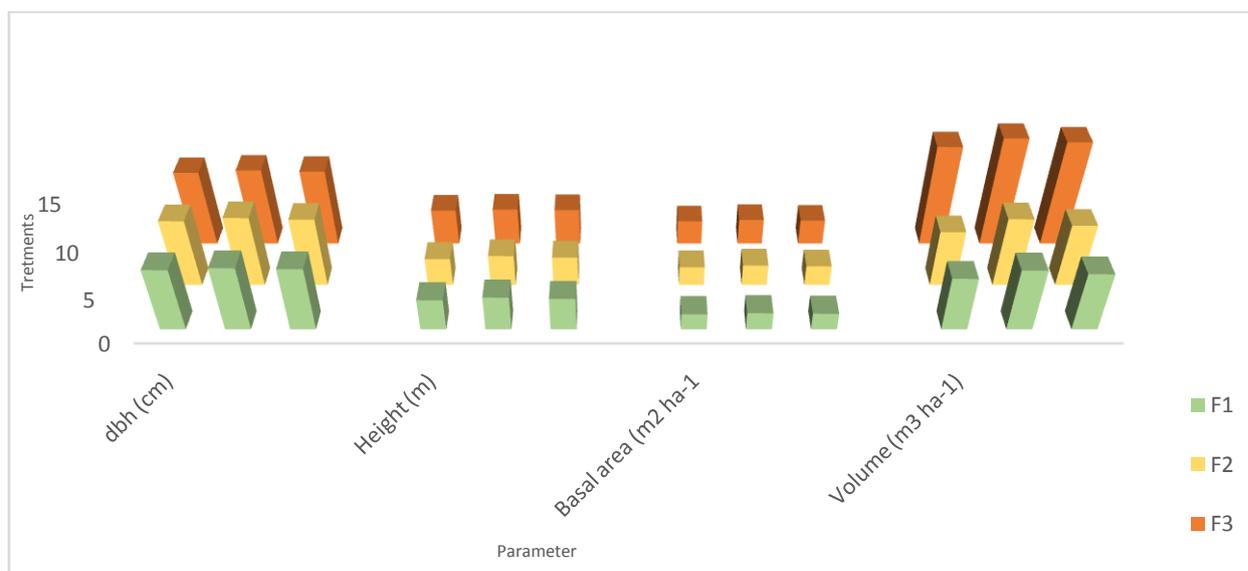


Fig. 1. Effect of fertility levels on different parameters of trees

**Table 1.** Effect of fertility levels on *Gmelina arborea* at different parameters in 2020-21, 2021-22 and pooled respectively

| Parameter              | dbh (cm)    |             |             | Height (m)  |             |             | Basal area (m <sup>2</sup> ha <sup>-1</sup> ) |             |             | Volume (m <sup>3</sup> ha <sup>-1</sup> ) |             |             |
|------------------------|-------------|-------------|-------------|-------------|-------------|-------------|---|-------------|-------------|---|-------------|-------------|
|                        | 2020-21     | 2021-22     | Pooled      | 2020-21     | 2021-22     | Pooled      | 2020-21                                       | 2021-22     | POOLED      | 2020-21                                   | 2021-22     | Pooled      |
| <b>Treatment</b>       |             |             |             |             |             |             |   |             |             |   |             |             |
| <b>F1</b><br>(75%RDF)  | 6.64        | 6.85        | 6.75        | 3.32        | 3.62        | 3.47        | 1.73  | 1.85        | 1.79        | 5.7                                       | 6.6         | 6.2         |
| <b>F2</b><br>(100%RDF) | 7.19        | 7.53        | 7.36        | 2.98        | 3.32        | 3.15        | 2.03  | 2.24        | 2.14        | 6.0                                       | 7.4         | 6.7         |
| <b>F3</b><br>(125%RDF) | <b>8.04</b> | <b>8.30</b> | <b>8.17</b> | <b>3.84</b> | <b>3.94</b> | <b>3.89</b> | <b>2.60</b>                                   | <b>2.75</b> | <b>2.67</b> | <b>10.8</b>                               | <b>11.7</b> | <b>11.3</b> |
| <b>Mean</b>            | 7.29        | 7.56        | 7.43        | 3.38        | 3.63        | 3.50        | 2.12  | 2.28        | 2.20        | 7.5                                       | 8.6         | 8.1         |
| SEm±                   | 0.42        | 0.76        | 0.74        | 0.55        | 0.57        | 0.56        | 1.04  | 1.11        | 1.07        | 18.6                                      | 19.1        | 18.8        |
| CD (5%)                | <b>2.19</b> | <b>2.29</b> | <b>2.14</b> | <b>1.66</b> | <b>1.73</b> | <b>1.62</b> | <b>3.10</b>                                   | <b>3.36</b> | <b>3.10</b> | <b>56.0</b>                               | <b>57.5</b> | <b>54.4</b> |

## REFERENCES

Duarah, I., Deka, M., Saikia, N. and Deka Boruah, H.P. (2011). Phosphate solubilizers enhance NPK fertilizer use efficiency in rice and legume cultivation. *3 Biotech.*, **1**: 227–238.

[Google Scholar](#)

Dvorak, W.S. (2004). World view of *Gmelina arborea*: opportunities and challenges. *New Forests*, **28**, 111-126.

[Google Scholar](#)

Gioria, M. and Osborne, B.A. (2014). Resource competition in plant invasions: emerging patterns and research needs. *Front Plant Sci.* **5**.

[Google Scholar](#)

IUCN(2013). Invasive plants affecting protected areas of West Africa. Management for reduction of risk for biodiversity.

[Google Scholar](#)

Jaquetti, R.K. and Gonçalves, J.F.C. (2021). Data on the effects of fertilization on growth rates, biomass allocation, carbohydrates and nutrients of nitrogen-fixing and non-nitrogen-fixing tree legumes during tropical forest restoration. *BMC Res Notes*, **14**: 153.

[Google Scholar](#)

Khalofah, A., Ghramh, H.A., Al-Qthanin, R.N. and L'taief, B. (2022). The impact of NPK fertilizer on growth and nutrient accumulation in juniper (*Juniperus procera*) trees grown on fire-damaged and intact soils.

[Google Scholar](#)

Khan, M.B., Rafiq, R., Hussain, M., Farooq, M. and Jabran, K. (2012). Ridge sowing improves root system, phosphorus uptake, growth and yield of Maize (*Zea Mays L.*) Hybrids. *J. Anim. Plant Sci.*; **22**: 309–317.

[Google Scholar](#)

Long, Li and Zhang, F. (2013). Crop Mixtures and the Mechanisms of Overyielding. *Encyclopedia of Biodiversity (Second Edition)*.

[Google Scholar](#)

Orwa, C., Mutua, A., Kindt, R., Jamnadass, R. and Anthony, S. (2009). Agroforestry Database: a tree reference and selection guide version 4.0.

[Google Scholar](#)

Pandey, D.N. (2007). Multifunctional agroforestry system in India. *Curr Sci.*, **92**: 455–463.

[Google Scholar](#)

Radwan, M.A. and DeBell, D.S. (1989). Effects of Different Urea Fertilizers on Soil and Trees in a Young Thinned Stand of Western Hemlock. *SOIL SCI. SOc.AM. J.*, **53**: 941-946.

[Google Scholar](#)

Rai, S.N. and Chakrabarti, S.K. (2001). Demand and supply of fuelwood and timber in India. *Indian Forester*, **127**(3):263-279.

[Google Scholar](#)

Rumeu, B., Caujapé-Castells, J., Blanco-Pastor, J.L., Jaén-Molina, R., Nogales, M., Elias, R.B. (2011). The colonization history of *Juniperus brevifolia* (Cupressaceae) in the Azores islands.

[Google Scholar](#)

Savoy, H. (1999). Fertilizers and their use. PB-1637, Agric Ext Serv Univ Tennessee, Knoxville.

[Google Scholar](#)

Silva, AMF, Barbosa, MAG, Menezes, M. and Camara, M.P. (2005). Parapyriculariabrasiliensis, a new dematiaceous hyphomycete on *Gmelina arborea* from Brazil. *Mycotaxon*, **92**:43-48.

[Google Scholar](#)

Venkatesh, M.S., Hazra, K.K., Ghosh, P.K., Khuswah, B.L., Ganeshamurthy, A.N. and Ali, M. (2017). Long-term effect of crop rotation and nutrient management on soil-plant nutrient cycling and nutrient budgeting in Indo-Gangetic plains of India. *Arch Agron Soil Sci.*, **63**: 2007–2022.

[Google Scholar](#)

