Print : ISSN 0970-7662

Journal of Tree Sciences
online available at www.ists.in

Volume 30 No.1&2 June & December, 2011

Growth Characteristics, Protein and Chlorophyll Content in Multipurpose Trees at Early Stage in *Tarai* Region of Uttarakhand-II

Sandhya Goswami[a]* and Salil K Tewari

Department of Genetics and Plant Breeding, Agroforestry Section, GBPUAT Pantnagar, Uttarakhand a Present address: Department of Forestry, Dolphin (PG) Institute of Biomedical and Natural Sciences Manduwala, Dehradun-28007, Uttarakhand

*Corresponding author: sandhya.goswami@gmail.com

Keywords:

MPTs, height, collar diameter, clean bole length, protein content, early growth.

ABSTRACT

Fodder and fuelwood deficiency in India is well recognized. Exploitation of forest for these daily necessities by rural population leads to severe deforestation. Tree outside forest are potential solution of such demands. Aim of this study was to identify the fast growing MPTs of *tarai* region of Uttarakhand (India) at an early age.. Among twenty seven tree species evaluated in field conditions, *Melia azedarach*, *Calistemon lanceolatus*, *Kigelia pinnata*, *Bauhinia variegata* and *Acer oblongum*, recorded maximum plant height while collar diameter was maximum in *Sarraca indica*, *K. pinnata*, *M. azedarach*, *Oroxylum indicum* and *Delonix regia*. Higher crown length was also recorded in *B.variegata*, *M. azedarach*, *K. pinnata*, *C. lanceolatus*, *S. indica* and *A. oblongum*. Highest nitrogen and protein content in leavers was observed in *Cinnamomum zeylanicum*, *D. regia* and *B. variegata* among all the tree species. Highest chlorophyll content was also recorded in *M.azedarch*, *C.lanceolatus* and *K.pinnata* along with *O. indicum* and *Dillenia indica*. In the light of results, it may be concluded that *M.azedarach*, *C.lanceolatus*, *K.pinnata*, *B.variegata*, *A.oblongam*, *D. regia* and *S.indica* showed higher performance at early stage and can be recommended as promising MPTs for tree outside forest plantations.

INTRODUCTION

India is among the low wood producing countries of the world with an average of 0.7 cubic meter per hectare per year (FAO 2002). Forests play a vital amicable role in ecological and economical sustainability of nature. Forest resource of our country is under tremendous pressure. In order to maintain productivity of wood and ecological balance on sustainable basis it is necessary to promote tree outside forest in form of social forestry, community forestry and agroforestry on large scale. Under different situation, inclusion of suitable multipurpose tree species in farming system not only provide fodder, fuel, timber and cash to farmer, it also improves soil fertility through addition of organic matter in soil and controlling soil erosion. The foliage of tree is the key source of green fodder during dry months as the major areas is rain fed and usually no green fodder is grown in

agricultural fields. In any agroforestry system, output depends primarily on selection of the component species. Selection of suitable tree species is utmost importance with respect to growth rate and survival in any agroforestry system. The dynamics of growth of different tree species is one of the main deciding factor for crop rotation period. Identification and selection of MPTs that are suited for being raised under different agroforestry systems in various climatic and altitude zones is need of hour. Growth characteristics and photosynthetic efficiency or chlorophyll fluorescence have been used to select high-quality seedlings or clones for a particular environment (Husen et al. 2004a; Husen 2004b). The ratio of maximum variable florescence is linearly correlated with the quantum yield of net photosynthesis and thus may be a good measure of seedling vigour. There is no report available on screening of fast growing indigenous fodder and fuel wood tree species growing at nursery stage, considering the growth, and physiological characteristic features. Therefore, this research paper focuses on these parameters to identify the best and fast growing multipurpose tree species with higher relevance and great potential for afforestation programmes as well as for agroforestry potential.

MATERIALS AND METHODS

The study was conducted at new site of Agroforestry Research Center, Haldi, Pantnagar, District U S Nagar, Uttarakhand. The center is located as 29^{o} latitude, 79.3^{o} E longitude and at an altitude 243.84 meter amsl in the *Tarai* belt of Shivalik range of the Himalayan foothills. It falls in the subhumid and subtropic climate zone. The maximum and minimum temperature during the period of investigation ranged from 14.0 ^{o}C to 40.62 ^{o}C and 6.9 ^{o}C to 26.98^{o}C, respectively. The seedlings of twenty seven tree species mentioned in Table 1 were raised in the field in the year 2003 at a spacing of 4x4m as block plantation. In each block 12 numbers of trees were accommodated. Observation on five randomly selected plants was recorded at nine month age for growth parameters, nitrogen, protein and chlorophyll content. Height of the plant was measured in centimetre from base to the apical shoot with measuring tape. Collar diameter on stem was measured in millimetres at the height of six centimetres from the ground with the help of calliper. Clear bole length was measured as a distance between the ground to the first crown forming branch. For crown width measurement data was taken in two direction i.e. North-South and East-West direction. The mean of these measurements expressed in centimetres as crown width. The distance between the first crown forming branch and the tip of the plant was taken as crown depth. Number of primary branches from the tree's main stem counted on each of the five replications. To determine chlorophyll content SPAD chlorophyll meter (Minolta Company, Japan) was used, which was relative to greenness of leaf. The observations taken randomly from trees of each species by inserting the leaves individually in the instrument and then the data obtained averaged to report chlorophyll content of the species. The nitrogen content of the leaves was obtained by using the modified Micro-Kjeldhal method (Jackson 1973). The nitrogen content percentage was multiplied by a conversion factor, 6.25, to get protein content in leaves. The data of each species were subjected to analysis of variance (ANOVA) using one tree as single replication. For the comparison of different means in different treatments, the critical differences (CD) were calculated based on the Student t -test at the $p < 0.05$ level.

RESULTS AND DISCUSSION

The variation on plant height is presented in Figure1. *M. azedarach* was recorded with the maximum height (100.00 cm) and followed by *C. lanceolatus, K. Pinnata*, B. *variegata* and *A. oblongum*, whereas *M. azedarach* was at par with *C. lanceolatus*. Lowest height increment was found in *D. Indica* (23.60cm) which was found to be at par with *B. ceiba, T. chebula* and *A. excelsa*. Results are in line with the result obtained by Thakur (2000). Maximum collar diameter was recorded in *S. indica* (21.44 mm). It was followed by *K. pinnata* (20.03 mm), *M. azedarach, O. indicum* and *D. regia*. And also found at par with each other (Figure 2). *Shorea robusta* has showed minimum collar diameter of 6.13 mm and followed by *T. chebula, D. embryopteris*, *C. zeylanicum* and *C. tamala*.

Table 1: Nitrogen, Protein and Chlorophyll content in MPTs at the age of nine month.

Tree species	Nitrogen content (%)	Protein content (%)	Chlorophyll content SPAD value
Saraca indica (Si)	1.16	7.29	30.39
Pongamia pinnata (Pp)	1.38	8.62	44.06
Tamarindus indica (Ti)	1.10	6.92	39.06
Mangifera indica (Mi)	0.67	4.18	45.11
Bambax ceiba (Bc)	0.80	5.00	42.19
Cinnamomum camphora (Cc)	0.81	5.07	38.77
Terminalia bellerica (Tb)	0.86	5.38	44.08
Shorea robusta (Sr)	0.64	4.05	22.30
Delonix regia (Dr)	2.75	17.29	27.38
Diospyros embryopteris (De)	0.84	5.27	55.87
Haplophragma adenophyllum (Ha)	1.14	7.12	38.03
Oroxylum indicum (Oi)	0.74	4.62	60.72
Melia azedarach (Ma)	1.12	7.01	49.76
Koelreuteria species (Ks)	0.77	4.83	54.51
Cinnamomum tamala (Ct)	1.74	10.91	35.51
Cinnamomum zeylanicum (Cz)	3.44	21.51	37.67
Terminalia chebula (Tc)	0.83	5.21	40.10
Kigelia pinnata (Kp)	1.33	8.36	45.58
Bauhinia variegate (Bv)	1.93	12.06	35.62
Dillenia indica (Di)	1.14	7.15	57.37
Sapindus indica (Sai)	1.18	7.41	33.00
Acer oblongum (Ao)	0.65	4.10	40.58
Quercus leucotricophora (Ql)	0.98	6.12	39.96
Callistemon lanceolatus (Cl)	1.01	6.34	47.20
Taxodium mucronatum (Tm)	0.76	4.78	18.28
Ailanthus excels (Ae)	0.63	3.96	34.33
Gmelina arborea (Ga)	0.78	4.92	36.00
CD (5%)	0.03	0.22	4.31

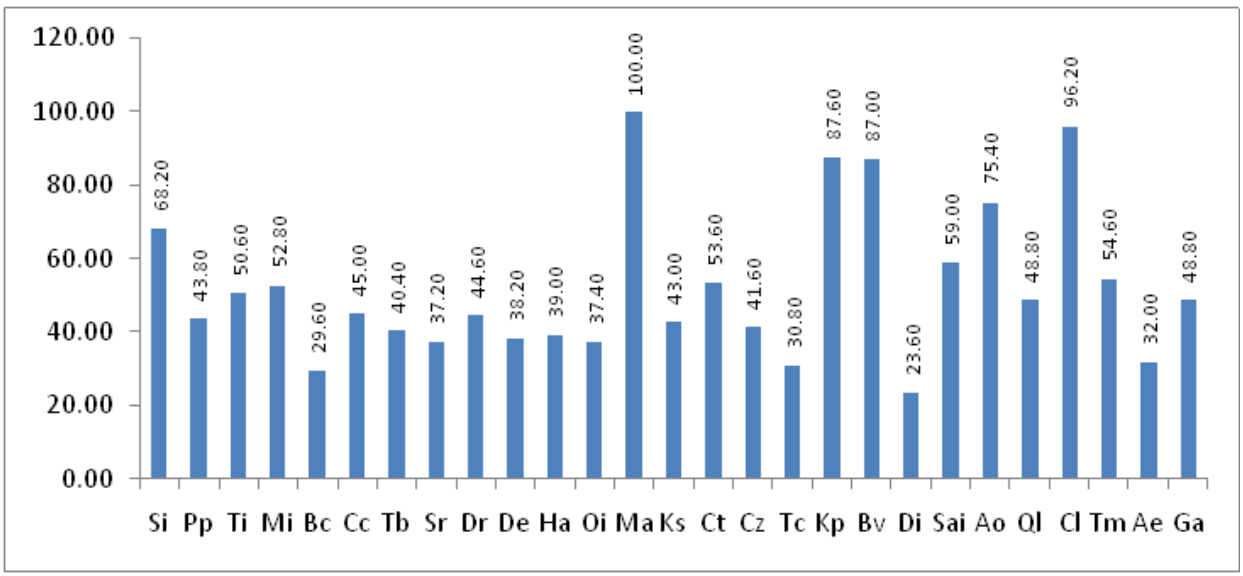

Fig.1. Variation in tree height (cm)

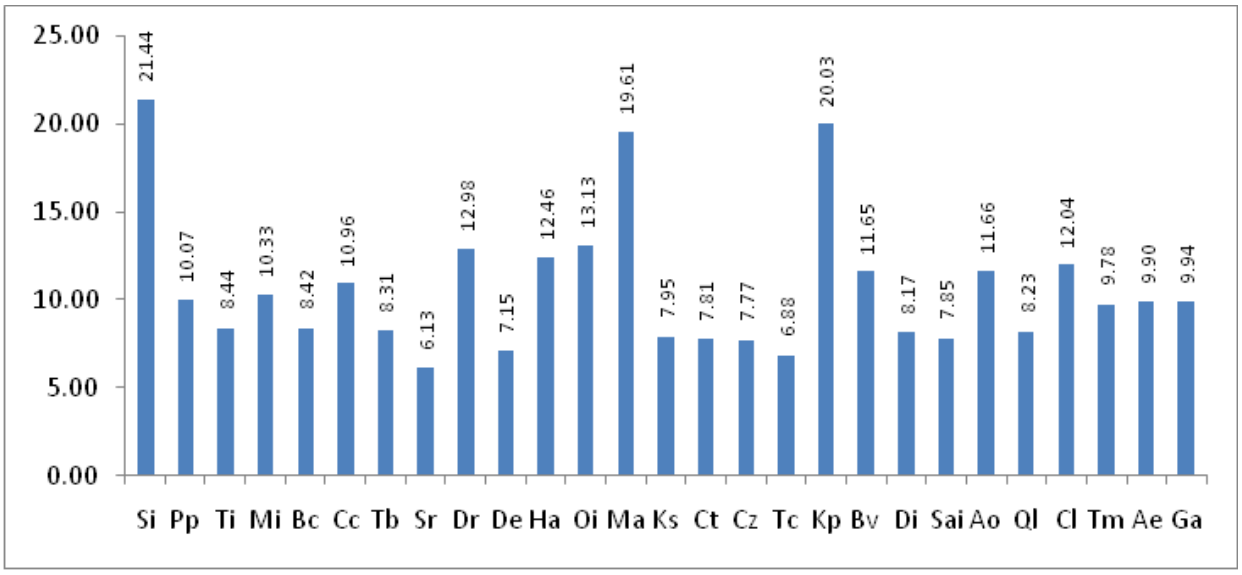

Fig. 2. Variation in collar diameter (mm)

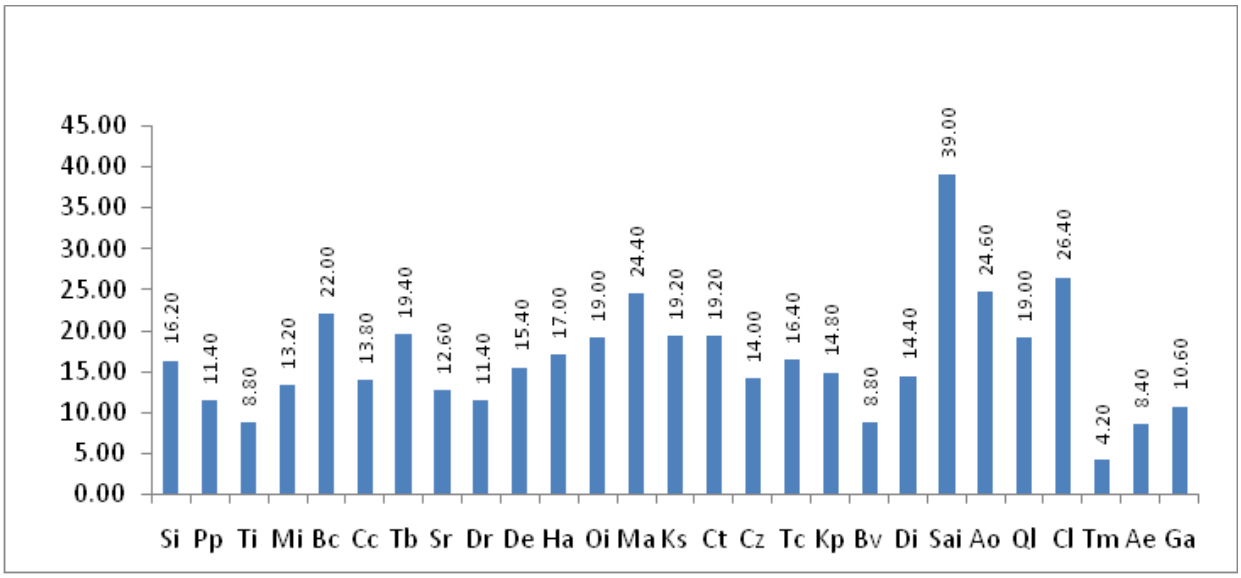

Fig. 3. Variation in clearbole legth (cm)

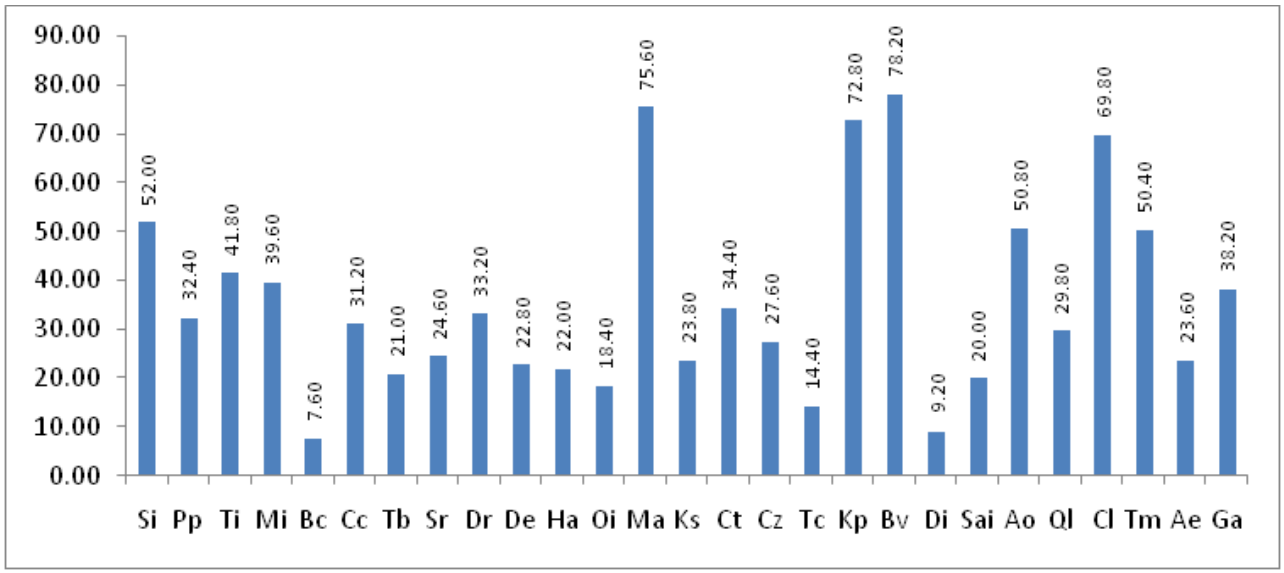

Fig.4. Variation in crown length (cm)

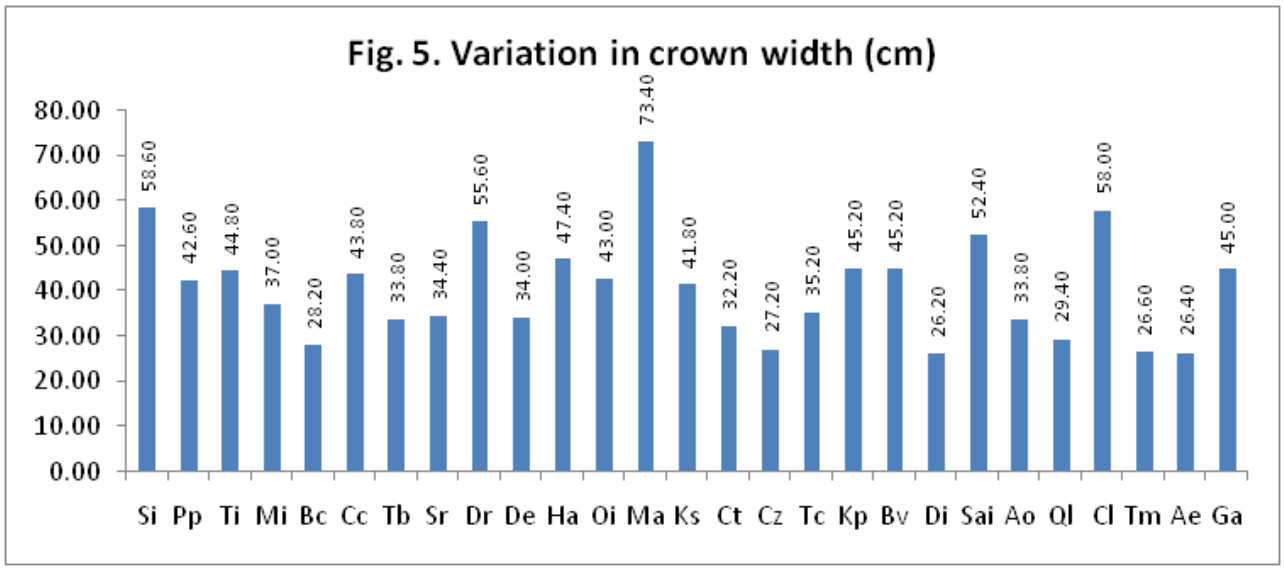
Fig. 5. Variation in crown width (cm)
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
58.60
42.60
44.80
37.00
28.20
43.80
33.80
34.40
55.60
34.00
47.40
43.00
73.40
41.80
32.20
27.20
35.20
45.20
45.20
26.20
52.40
33.80
29.40
58.00
26.60
26.40
45.00
Si Pp Ti Mi Bc Cc Tb Sr Dr De Ha Oi Ma Ks Ct Cz Tc Kp Bv Di Sai Ao Ql Cl Tm Ae Ga

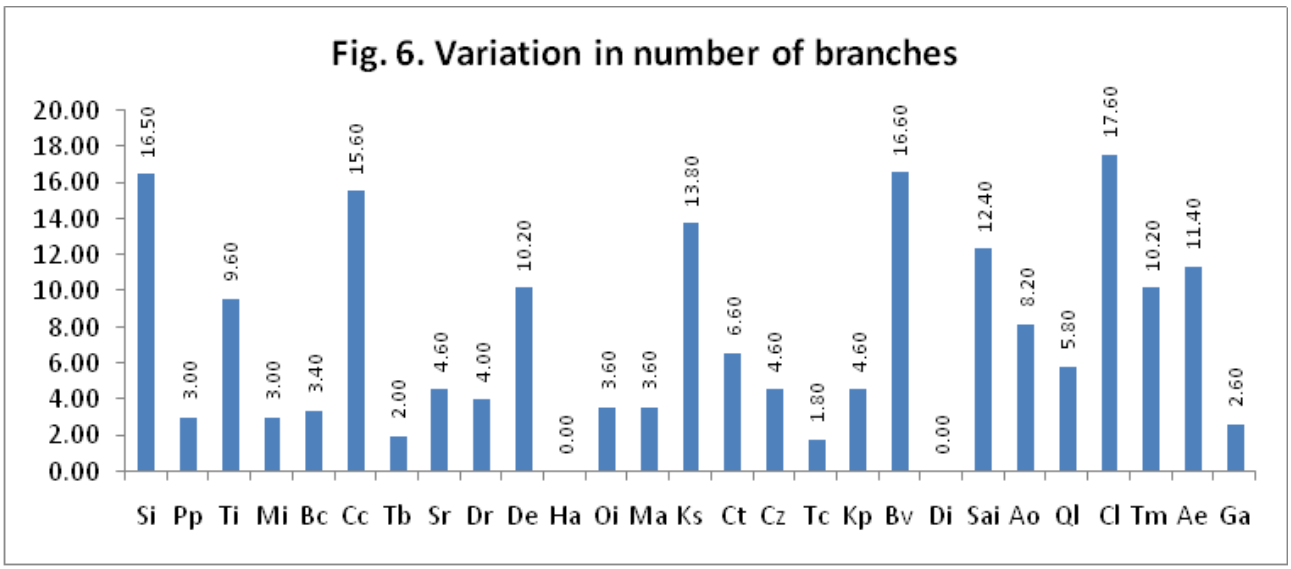
Fig. 6. Variation in number of branches
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
16.50
3.00
9.60
3.00
3.40
15.60
2.00
4.60
4.00
10.20
0.00
3.60
3.60
13.80
6.60
4.60
1.80
4.60
16.60
0.00
12.40
8.20
5.80
17.60
10.20
11.40
2.60
Si Pp Ti Mi Bc Cc Tb Sr Dr De Ha Oi Ma Ks Ct Cz Tc Kp Bv Di Sai Ao Ql Cl Tm Ae Ga

Where later four tree species were at par with each other. The variation in clearbole length is presented in Figure 3. Significantly higher clearbole length was found in *Sapindus indica* (39.00 cm). It was followed by *C. lenceolatus*, *A. oblongum, M. azedarach* and *B. ceiba*, these were found at par with each other. *T. mucronatum* (4.20 cm) was recorded with lowest clearbole length. It was followed by *A. excelsa*, *B. variegata* and *T. indica*, they were also found at par with each other. Crown length variation is presented in Figure4. *B. variegata* (78.20 cm) has recorded with maximum crown length. It was followed by *M. azedarach, K. pinnata, C. lanceolatus, S. indica* and *A. oblongum*. Where, *M. azedarach, K. pinnata* and *C. lanceolatus* were at par with *B. variegata*. Minimum crown length was showed by *B. ceiba* (7.60 cm), which was at par with *D. indica* and *T. chebula*. It was also followed by *O. indicum*, *Sa. indica* and *T. bellerica* and were at par with each other. Findings are in line with Bahuguna and Dhawan (1990) and Thakur (2000). Crown width measurement showed that *M. azedarach* (73.40cm) had maximum spread (Figure 5) and was followed by *S. indica*, *C. lanceolatus*, *D. regia* and *Sapindus indica*. Minimum spread was recorded in *D. indica* (26.20 cm) which was followed by *A. excelsa*, *T. mucronatum*, *C. zeylanicum*, *B. ceiba* and *Q .leucotricophora*. all the species were found at par with each other. Data on number of branches (Figure 6) showed that *C. lanceolatus* (17.60) had maximum branches. It was found at par with *B. variegata* and *S. indica* and then followed by *C. camphora* and *K. pinnata*. *D. indica* and *H. adenophyllum* has not shown any branch till 9month age. They were followed by *T. chebula*, *T. bellerica*, *G. arborea*, *M. indica* and *P. pinnata* which were found at par with each other. Variability in growth character increment may be explained on the basis of favourable conditions (Naidu and Swomy, 1995). The species sequence based on radial growth was different that based on height. These finding corroborate with the earlier findings of Patel and Singh (1996) and Toky and Khosla (1984). Clear bole length depends upon the increment in number of branches and height of plant. It did not show any particular pattern of increase or decrease.

The result in chlorophyll, nitrogen and protein content presented in Table1. *O. indicum* (60.72) showed highest chlorophyll content which was found at par with *D. indica.* Sgnificantly lower chlorophyll content was recorded in *T. mucronatum* (18.28) which was found at par with *S. robusta* when compared with rest of the species. Several explanation have been given for variation in chlorophyll fluorescence, such as it might be due to low temperature (Hardacre and Greer 1989), low irradiance (Janssen et al. 1995) and/or other environmental conditions (Parker and Mohammed 2000; Husen et al. 2004 a, 2004 b) were observed by several researchers.

The range of nitrogen content and protein content varied from 0.63 to 3.44 per cent and 3.96 to 21.51 per cent, respectively. Significantly higher nitrogen and protein content was observed in *C. zeylanicum* and followed by *D. regia*, *B. variegata* and *C. tamala* which were significantly different with each other. *A. excelsa* showed lowest value with tree species *S. robusta* and *A. oblongum* where it was found at par. The magnitude of concentration of nitrogen and hence protein from one to another species differed significantly owing to N-fixing capacity of each tree (Sreemannarayana et al. 1994).

The study showed that among the 27 species studied, *M. azedarach, C. lanceolatus, K. pinnata, B. variegata, A. oblongum* and *S. indica* showed higher performance. *M. azedarach*, *C. lanceolatus* and *K. pinnata* has also shown higher chlorophyll content. Higher protein content was recorded in *B. variegata* and *D. regia*. Hence, it can be concluded that these species can be given preference over rest of the studied species for plantation as tree outside forest with various objectives.

REFERENCES

Bahuguna VK, and Dhawan VK 1990 Growth performance of *Dalbergia sissoo, Eucalyptus grandis, Michalea champaca, Grevillea robusta, Bauhinia variegata* and *Bauhinia purpurea* for planting under social forestry programmes. *Indian Forester* **116(8)**: 609-617.

Food and Agriculture Organisation of the United

Nations 2002 Forests and the Forestry Sector: India.

Hardacre AK, and Greer DH 1989 Differences in growth in response to temperature of maize hybrids varying in low temperature tolerance. *Australian Journal of Plant Physiology* **16:**181-187.

Husen A, Khali R, and Nautiyal S 2004a Altitudinal variation in chlorophyll fluorescence/ photosynthetic efficiency in seedlings of some indigenous fodder species. *Indian Forester* **130:** 89-94.

Husen A, Khali R, and Nautiyal S 2004b Chlorophyll fluorescence in relation to diurnal changes of three *Ficus* species. *Indian Forester* **130:**811-818.

Jackson ML 1973 Soil Chemical Analysis, Prentice Hall Pvt. Ltd., New Delhi, India. 498 p.

Janssen LHJ, Von Overen JC, Van Hassett PR, and Kuiper PJC 1995 Genotypic variation in chlorophyll fluorescence parameters, photosynthesis and growth of tomato grown at low temperature and low irradiance. *Photosynthetica* **31**:301-314.

Naidu CV, and Swomi PM 1995 Seasonal variation of growth characteristics in some selected tree saplings. *Indian Forester* **121(9)**:797-801.

Parker WC, and Mohammed GH 2000 Photosynthetic acclimation of shade grow red pine (*Pinus resinosa* Ait) seedlings to a high light environment. *New Forests* **19**:1-11.

Patel NL, and Singh SP 1996 Dynamics of growth in some agroforestry tree species under South Saurashtra region of Gujarat. *Indian Forester* **112(7):**570-576.

Sreemannarayana B, Giri Rao LG, and Joseph B 1994 Evaluation of multipurpose tree species and their influence on soil fertility improvement. *Range Management and Agroforestry* **15(2):** 199-202.

Thakur PS 2000 Comparative performance of MPTs growing at degraded site. *Indian Forester* **126**:895-900.

Toky OP, and Khosla PK 1984 Comparative growth of agroforestry trees (Indigenous vs. Exotic) in subtropical Western Himalaya. *Journal of Tree Sciences* **3(1&2):** 93-98.