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Growth Characteristics, Protein and Chlorophyll Content in Agroforestry Trees During Early Stage in *Tarai* Region of Uttarakhand – I

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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 tree species of *tarai* region of Uttarakhand (India) at an early age, as efficiency of trees varies as per the change in climatic conditions. Among sixteen tree species evaluated in field conditions, *Parkinsonia aculeata, Eucalyptus tereticornis, Cassia siamea* and *Acacia catechu* recorded the maximum plant height while collar diameter was maximum in *Cassia siamea, P. acculeata, Anthocephalus chinensis, Dalbergia sissoo* and *A. catechu*. Clean bole length was recorded in *E. tereticornis*, *Tectona grandis*, *A. catechu, C. siamea*. Highest nitrogen and protein content was observed in *Albizia lebbeck* among all the tree species. Highest chlorophyll content was also recorded in *A. lebbeck*. In the light of results, it may be concluded that *C. siamea, A. catechu, E. tereticornis, P. aculeate, A. lebbeck, D. sissoo and A. chinensis* showed superior growth and can be included in agroforestry or for bund plantations to meet the requirements of farmers.

INTRODUCTION

Forest meet nearly 40 percent of the energy and 30 per cent of the fodder needs of the country. It is estimated that about 270 million tonnes of fuelwood, 280 million tones of fodder, over 22 million cubic meter of timber and countless non-wood products are removed from forest annually (Tewari, 2002). India has a huge population living close to the forest with their livelihoods critically linked to the forest ecosystem. People living in these forest fringe villages depend upon forest for a variety of goods and services. India is the world's largest consumer of fuel-wood. India's consumption of fuel-wood is about five times higher than what can be sustainably removed from forests (FAO, 2002). In such situations tree outside forest can play significant role. Trees are grown by the framers to meet the requirement of small timber, fodder as well as for the conservation and soil improvement. Farmers are taking up agroforestry

for the reason. In all the terms multipurpose fast growing trees are considered more useful. Plant growth and development is influenced by many factors, one of them is age factor. However, the studies on growth pattern of tree species at an early age received less attention. Therefore in the present study was made to assess the growth characters, protein and chlorophyl content of sixteen tree species in *tarai* region to get their suitability for agroforetsry purpose.

MATERIALS AND METHODS

The experiment was conducted at new site of Agroforestry Research Center, Haldi, Pantnagar, District U S Nagar, Uttarakhand during December 2003 to May 2004. The center is located as 29^0 latitude, 79.3^0 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 ^{0}C to 40.6 ^{0}C and 6.9 ^{0}C to 26.9^{0}C, respectively. Seedlings of sixteen 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 30 days interval for growth parameters. Observation on nitogen, protein and chlorophyll content was recorded at the last month of investigation. 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. 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 plant height of different tree species differed significantly at all the observation (Table1). In the month of December at age of 10 month, maximum height was recorded in *P. aculeata* which was found significantly higher and was followed by *C. siamea, A. catechu, E. tereticornis and T. grandis*. Similar trend was obtained during 11 to 13 month age. *P. aculeate* was followed by *E. tereticornis, C. siamea, A. catechu, T. grandis, D. sissoo* and *E. officinalis* at 14 and 15 month age and all differed significantly with each other. Maximum height increment obtained between 10^{th} - 11^{th} month of growth and minimum was from 14^{th} to 15^{th} month growth, which was however found non-significant.

The data on collar diameter of different tree species presented in Table 2 indicate significant difference among different species. At an age of 10 month *T. grandis* showed maximum collar diameter which was found at par with *C. siamea* and *A. chinensis*. These were followed by *A. catechu*, *K. calycina*, *D. sissoo* and *P. aculeata* which were also found at par with each other. Similar trend of growth was obtained for the age of 11 month while during February and March at 12-13 month age *C. siamea* showed superior collar diameter and found at par with *A. catechu, A. chinensis* and *T. grandis*. At 15 month age *C. siamea* again showed significantly higher collar diameter. Monthly increment in collar diameter revealed that significant increment recorded in 10 to 11 month age and 13 to 14 month age in all species except *K. calycina*.

Clean bole length of different tree species is given in Table 3. *T. grandis* showed significantly higher clean bole length than other tree species during December to January month at an age of 10 to 12 month. This was followed by *C. siamea, A.chinensis, E. tereticornis, A. catechu* and *K.*

Table 1: Height of different tree species at an age of 10 to 15 month.

Tree Species	Height (cm)					
	10th month (Dec)	11th month (Jan)	12th Month (Feb)	13th month (Mar)	14th month (Apr)	15th month (May)
Acacia catechu	235.40	241.00	252.20	263.00	275.20	276.00
Adina cordifolia	86.00	92.80	97.40	97.80	99.80	101.00
Albizia lebbeck	88.40	126.60	129.40	135.80	145.00	184.40
Anthocephalus chinensis	138.40	152.00	161.20	163.60	169.80	174.80
Azadirachta indica	126.60	139.60	141.00	145.80	160.60	162.60
Cassia fistula	141.00	157.40	173.00	175.00	179.00	182.60
Cassia siamea	246.80	254.80	265.60	268.00	274.20	282.00
Dalbergia sissoo	176.60	190.80	192.60	194.40	197.40	207.00
Emblica officinalis	163.20	171.20	185.20	190.00	205.40	206.60
Eucalyptus teriticornis	235.00	244.80	255.80	269.00	307.20	319.80
Grevillea robusta	81.60	91.40	99.40	105.50	112.00	133.20
Kydia calycina	159.00	163.20	165.60	174.40	186.20	193.60
Murraya koenigii	21.60	23.40	25.00	26.60	30.00	54.20
Parkinsonia aculeata	329.60	347.00	358.80	372.40	389.20	389. 80
Pterospermum acerifolium	86.40	94.80	97.80	103.00	113.00	135.20
Tectona grandis	204.00	219.40	221.00	222.60	225.60	236.20
CD (5%)	22.40	22.42	21.66	13.25	26.74	26.82

Table 2: Collar diameter of different tree species at an age of 10 to 15 month.

Tree Species	Collar diameter (mm)					
	10th month (Dec)	11th month (Jan)	12th Month (Feb)	13th month (Mar)	14th month (Apr)	15th month (May)
Acacia catechu	37.92	47.64	51.18	52.26	53.10	54.05
Adina cordifolia	31.18	34.24	35.15	35.84	37.01	39.39
Albizia lebbeck	29.98	31.08	32.89	34.81	37.99	44.83
Anthocephalus chinensis	40.15	45.44	51.37	54.50	57.94	58.96
Azadirachta indica	20.09	25.09	25.60	26.74	29.07	32.11
Cassia fistula	29.88	39.04	40.34	41.06	42.19	43.56
Cassia siamea	45.87	50.53	56.11	57.15	57.39	66.31
Dalbergia sissoo	34.53	35.93	36.61	38.75	41.56	54.41
Emblica officinalis	33.75	39.06	40.25	40.86	41.88	46.43
Eucalyptus teriticornis	24.26	28.69	33.87	36.36	39.06	44.96
Grevillea robusta	13.56	15.22	16.10	17.50	19.10	22.88
Kydia calycina	36.55	41.82	43.80	44.76	45.80	48.00
Murraya koenigii	3.75	4.35	4.79	5.21	5.71	9.17
Parkinsonia aculeata	34.15	42.81	45.50	48.73	51.76	60.16
Pterospermum acerifolium	18.60	23.57	24.60	25.63	27.52	31.96
Tectona grandis	46.28	50.76	52.53	52.98	53.45	54.35
CD (5%)	6.19	5.11	5.63	4.64	6.09	4.34

Table 3: Clean bole length of different tree species at an age of 10 to 15 month.

Tree Species	Clear bole length (cm)					
	10th month (Dec)	11th month (Jan)	12th Month (Feb)	13th month (Mar)	14th month (Apr)	15th month (May)
Acacia catechu	96.20	90.20	98.40	88.80	81.00	79.40
Adina cordifolia	57.00	57.80	58.80	60.80	58.20	51.40
Albizia lebbeck	61.00	61.80	64.60	60.20	58.80	54.60
Anthocephalus chinensis	105.8	111.80	95.20	78.80	61.20	60.60
Azadirachta indica	68.80	87.00	88.20	57.20	29.00	19.40
Cassia fistula	76.60	78.00	81.00	70.60	35.80	28.20
Cassia siamea	117.40	112.40	107.20	103.60	92.60	76.00
Dalbergia sissoo	84.60	83.20	82.60	81.80	75.00	52.40
Emblica officinalis	68.80	54.20	51.20	37.80	26.00	25.40
Eucalyptus teriticornis	85.80	108.40	139.00	163.60	167.00	169.20
Grevillea robusta	41.80	48.60	53.60	54.60	56.40	59.60
Kydia calycina	95.80	970	97.60	78.60	55.60	28.60
Murraya koenigii	7.00	9.20	11.00	11.40	13.60	16.60
Parkinsonia aculeata	94.20	101.00	64.80	55.80	46.40	47.00
Pterospermum acerifolium	48.00	53.40	55.80	44.40	26.60	13.60
Tectona grandis	132.00	167.60	173.60	147.60	121.20	46.00
CD (5%)	11.85	17.02	18.59	18.75	21.24	19.11

Table 4: Mean Nitrogen content (%), Protein content (%) and chlorophyll content (SPAD value) for the Agroforestry tree Species at an age of 15 month.

Tree Species	Nitrogen Content (%)	Protein Content (%)	Chlorophyll content (SPAD value)
Acacia catechu	1.71	10.72	27.36
Adina cordifolia	1.73	10.85	39.96
Albizia lebbeck	3.02	18.88	69.85
Anthocephalus chinensis	2.74	17.17	39.78
Azadirachta indica	1.25	7.82	48.22
Cassia fistula	1.16	7.28	33.51
Cassia siamea	1.91	11.93	43.6
Dalbergia sissoo	0.93	5.86	37.39
Emblica officinalis	0.64	3.77	38.23
Eucalyptus tereticornis	0.87	5.48	39.41
Grevillea robusta	1.12	7.01	33.14
Kydia calycina	1.53	9.57	50.23
Murraya koenigii	0.88	5.52	37.42
Parkinsonia aculeata	0.60	3.76	19.09
Pterospermum acerifolium	1.40	8.75	37.17
Tectona grandis	1.32	8.27	40.48
CD (5%)	0.03	0.24	3.88

calycina which were found statistically at par with each other. During 13 to 15 month age *E. tereticornis* obtained significantly clean bole length which was at par with *T. grandis* during March at 13 month age and followed by *A. catechu, C. siamea* and *A. chinensis* during 14-15 months age which were found at par with each other.

Monthly variability in growth pattern might be due to differences in genetic makeup of different tree species which exhibited in plants particularly raised by seeds (Patel and Singh, 1996). Medium height growth in *E. tereticornis* is in conformity with earlier observations by Nath et al. (1991) and Patel and Singh (1996). The species sequence based on radial growth was quite 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 on foliage nitrogen content, protein content and chlorophyll content is depicted in Table 4. During May, at an age of 15 month foliage nitrogen content and protein varied from 0.60 to 3.02 per cent and 3.76 to 18.88 per cent, respectively. *A. lebbeck* showed significantly higher nitrogen and protein content than rest of the tree species. This was followed by *A. chinensis*. *P. aculeata* showed significantly lowest value except *E. officinalis* where it was found at par. The magnitude of concentration of nitrogen from one species to another species differed significantly owing to N-fixing capacity of each trees (Sreemannarayana et al. 1994)

Significantly higher chlorophyll content was recorded in *A. lebbeck* which was followed by *K. calycina and A. indica*. They were found at par with each other. 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. 2004a, 2004b) were observed by several researchers.

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