Assessment of Sal Seedlings and Herbaceous Flora in the Khairbar Plantation of Sarguja Forest Division, Chhattisgarh

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ABSTRACT

In the present study an attempt has been made to evaluate the growth performance of sal seedlings and also assess the diversity of herbaceous flora in the Khairbar plantation of Sarguja forest division during the year 2013-14. Study reveals that there are prominent variations in the height of the seedlings in Khairbar plantation. The root shoot ratio of seedlings ranged between 0.31 to 0.74. The total height of seedlings ranged from 24.00 to 90.00 cm. The girth of individual seedling ranged between 4.00 and 12.00 cm. The number of branches per seedling ranged between 4.00-17.00. The average collar diameter of sal seedling was 1.96 cm and the sturdiness ranged from 15.09-42.86. Total of 27 herbaceous species comprising 15 families were encountered in the study area. The total density of the herb species was 776000 individuals ha^{-1} and the maximum density was recorded for *Mellilotus alba* (64000 individuals ha^{-1}), while minimum for *Achyranthus aspera*, *Malvastrum coromandelicum* and *Rumex dentatus* (12000 individuals ha^{-1} for each, respectively). The Shannon index (H') of herbaceous species was 4.606, Simpson index (Cd) was 0.045, Species richness (d) was 1.917 and Equitability (e) was 1.397, respectively. It was observed that the growth performance of sal seedling in the Khairbar plantation site is quiet slow as compared to the other tropical species. It may also be due to the higher population of the herbaceous species. The herbaceous species compete with the sal species for the sharing of the resources for the growth and development. Microclimate and management aspects are the major concern for the good growth performance of the species in plantation sites.

Key words: Diversity, Herbaceous flora, Sal, Plantation, Shannon index.

INTRODUCTION

The herbaceous species varies greatly along with the different microclimate of the region [1,2,3]. Herb layer contributes substantial role and responds quickly to changes in the environmental conditions. In landscapes with significant topographic heterogeneity, herb layer composition and diversity vary with gradients of microclimate, soil moisture, soil fertility[4] and different kind of anthropogenic pressures[5,6,7]. Herbaceous community also alters by natural and anthropogenic disturbances. Disturbances at low severity, such as surface fires, usually cause minor damage to overstory trees but mainly affects to herb layer directly by killing aboveground parts and indirectly by altering the forest floor and the availability of light, water and nutrients[3,5,7,8].

In the present era, the scale of new forest establishment has increased considerably[9,10,11,12]. Herbaceous layer is essential component for increasing diversity of the region as well as it plays a substantial role in the nutrient cycling. On the other hand, the plantation of forest tree species are influenced mainly during the growth period initially by the invasion of undesirable species as well as luxuriant growth of weeds and/or herbaceous flora[11].

Therefore, it is essential to quantify the herbaceous flora and also to know about its impacts on growth parameter in the new plantation site. The findings of the present investigation will help the researcher, ecologist and foresters to work in the other region of plantation to evaluate the growth of new seedlings and associated herbaceous species. Therefore, the present study was undertaken to investigate growth performance of sal in plantation site and to assess the structure and diversity of herbaceous species.

MATERIALS AND METHODS

The present study was carried out at Khairbar plantation site (Fig. 1), Ambikapur in Sarguja forest division during the year 2013-2014. District Sarguja in the state of Chhattisgarh is very rich in natural vegetation and biological wealth[11]. It lies between $22^0 58'$ to $23^0 49'$ N latitude and $81^0 33'$ to $82^0 45'$ E longitude. The average elevation of the area varies from 600 meter and above. Geologically, the area is dominated by upper Gondwana rocks which are rich in coal deposits[11]. The highest mountain ranges of the region occupies the northern part of the district. The climate of the study area is dry tropical. The mean monthly temperature ranges between 15.34^0 C (January) and 31.54^0 C (May) and the mean annual temperature averages 23.31^0 C. The average annual rainfall is 1161.42 mm (Fig. 2).

Sal plantation was established in the Khairbar beat, Ambikapur (Compartment No. 2581 and Coupe No. IX, Area 10 ha, range Ambikapur) in the year 2012; which is located in the north side of district headquarter. Ten seedlings were selected randomly from each part of the plantation area (viz, north, south, west, east and centre part) for measuring various parameters viz., height, girth, total number of leaf, number of fresh leaf, number of defected leaf, leaf length and width, number of branch, collar diameter and sturdiness (the ratio of height to diameter). The growth parameters of sal seedlings was observed followed by Sinha *et al.*[11], Kumar *et al.*[9] and Bhagat *et al.*[12].

The herbaceous vegetation was measured randomly by laying ten quadrats of size 50 x 50 cm^2. Vegetational data were quantitatively analysed for frequency, density and abundance[13]. The importance value index was calculated followed Phillips[14]. A/F ratio (Abundance to Frequency) for different species was determined by eliciting the distribution pattern. This ratio has indicated regular (<0.025), random (0.025-0.05) and contagious (> 0.05) distribution[15,16]. Species diversity for herb layers were determined using the Shannon-Weaver[17] information function for species diversity. Concentration of dominance was measured following Simpson's[18] index. Herbaceous vegetations were also measured for species richness[19], equitability[20] and beta diversity[21]. The
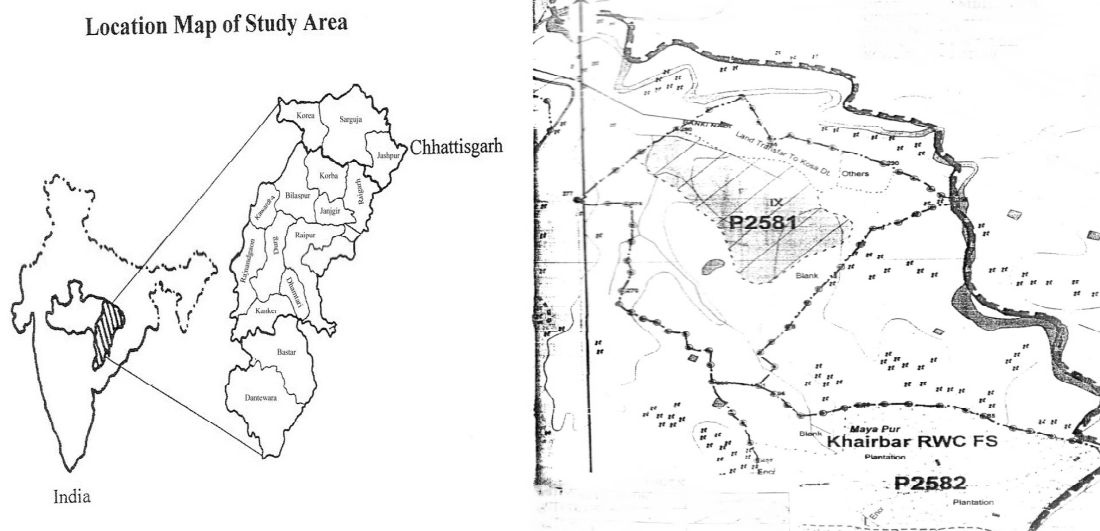

Fig. 1: Location map of the study area

different parameters were calculated by following formula:

Density = $\underline{\text{Total number of individuals of a species}}$
Total number of quadrats studied

Frequency (%) = $\underline{\text{No. of quadrats in which species occurred}} \times 100$
Total number of quadrats studied

Abundance= $\underline{\text{Total no of individuals of a species in all quadrats}}$
Number of quadrats in which the species occurred

The relative frequency, relative density and relative abundance, were calculated as following:

Relative frequency= $\underline{\text{Frequency of the individual species}}$ x 100
(RF)   Total frequency of all the species

Relative density (RD) = $\underline{\text{Density of the individual species}}$ x100
Total density of all species

Relative abundance= $\underline{\text{Abundance of the individual species}}$ x 100
(RA)   Total abundance of all species

The Importance Value Index (IVI) was determined as :

Importance Value Index (IVI) = RF + RD + RA.

Species diversity analysis

Species diversity was calculated as
$H' = - P_i \log_2 P_i$
Where,
P_i is the proportion of total stand basal cover represented by the i species.
$H' = 3.3219[\log_{10} N – (\Sigma N_i \log_{10} N_i/ N)]$

Where,
N_i was the total basal cover of species i and N was the total basal area of all the species. The factor 3.3219 was used to convert the index value to $\log_2$.

Concentration of dominance was measured as
$C_d = \Sigma(N_i/ N)^2$
N_i and N were same as explained above.
Equitability (e) was calculated as
$e = H' / \ln S.$
H' = Shannon index and S = the number of species.

Species richness was calculated as
$D = S-1 / \ln N.$

Where,
S =   total number of species,
N =   basal area of all species

Beta diversity was calculated as
$\beta d = Sc/\overline{S}$
Where,
$\overline{S}c$= total number of species in all sites and
S = average species per site.

RESULTS AND DISCUSSION

The different parameters of sal seedlings measured in Khairbar plantation site is given in table 1. The growth of sal seedlings was found slower and it was found that only 10% of the planted seedlings were converted into the saplings. The total height of seedlings ranged from 24.00 to 90.00 cm. The girth of individual seedlings ranged between 4.00 and 12.00 cm. The average number of leaf per seedling was 48.10, in which average defected leaf per seedling was 27.10, while the mean healthy leaf per seedling was 21.00, respectively. The infected leaf percent ranged from 38.14 to 90.91%. The average leaf width of large leaf was 9.69 cm whereas it was 4.46 cm for the small leaf. The average leaf length of large and small leaf was 18.10 cm and 7.71 cm, respectively. The number of branches per seedlings ranged from 4 to 17. The average collar diameter of sal seedling was 1.96 cm and the sturdiness ranged from 15.09-42.86.

In the present study the sal seedlings showed slower growth as compared to the other species grown in tropical regions[9,11,12]. The site conditions and silvicultural management aspects are the key factors defining the good growth performance of the species in plantation sites. The optimum growth of any species in the plantation depends upon the species adoption and the site conditions like soil physical environment, soil texture, soil moisture, humous; nutrient availability and presence of microorganism etc., which can influence the establishment as well as root and shoot growth of the species[9,11,12,22,23,24,25,26]. Since it is a departmental plantation carried out by the forest department, the management practices varied in

comparison to the commercial plantation which is related mainly to economics. In order to maximize the survival and growth it is essential that proper care and management option should be opted[11]. Some practices like water management, weeding[25] and silvicultural practices can boost up the growth of the seedlings.

Structure and diversity of herbaceous species

The data of herbaceous composition is given in table 2. A total of 27 herb species were recorded in the Khairbar plantation site. A total of 15 families were encountered in the Khairbar plantation

site (Fig. 3). The herbaceous species comprises of Amaranthaceae (1), Apiaceae (1), Lamiaceae (1), Malvaceae (1), Oxalidaceae (1), Polygonaceae (1), Sapindaceae (1), Tiliaceae (1), Verbenaceae (1), Convolvulaceae (2), Cyperaceae (2), Euphorbiaceae (2), Asteraceae (3), Fabaceae (4) and Poaceae (5) families.

The total density of the herb species was 776000 individuals ha^{-1} and the maximum density was recorded for *Mellilotus alba* (64000 individuals ha^{-1}), while the minimum for *Achyranthus aspera*, *Malvastrum coromandelicum* and *Rumex dentatus*
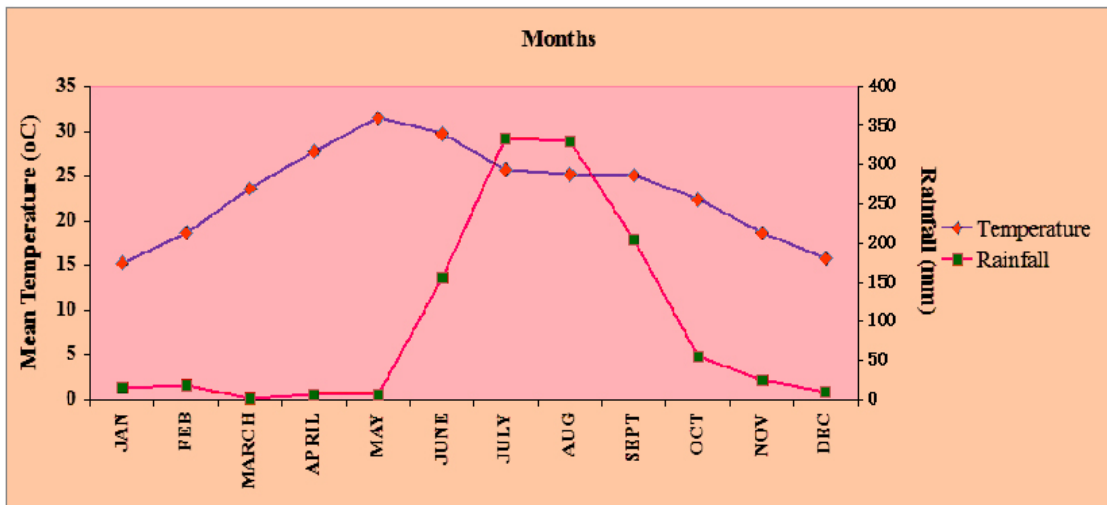

Fig. 2: Ombrothermic diagram for Sarguja district based on five years data (2009-2013)
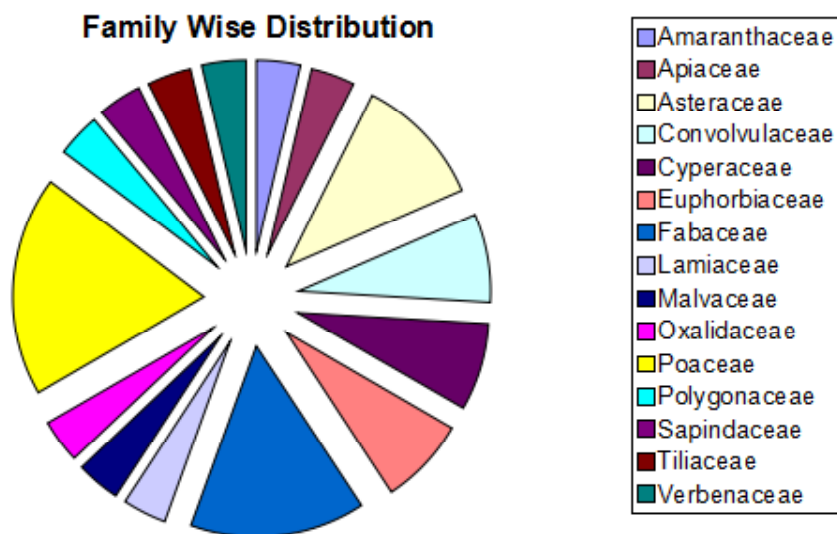

Fig. 3: Family wise distribution of herbaceous flora in Khairbar plantation site

(12000 individuals ha^{-1} for each, respectively). The frequency of individual herbaceous species varied from 30-70%. The Importance Value Index (IVI) of individual herb species ranged between 6.42-19.66, highest for *Mellilotus alba* and lowest for *Rumex dentatus*, respectively. A/F ratio (Abundance to Frequency) for different species was determined by eliciting the distribution pattern. This ratio of individual species ranged between 0.024 to 0.125. It is evident from the data presented in the table 2, that *Euphorbia hirta* is only species which is showing the regular distribution pattern (3.70% of the total) on the plantation site, whereas about 40.74% species were distributed randomly and about 55.56% of the recorded herbaceous species showing contagious type of distribution pattern. The diversity parameters of herbaceous species is presented in table 3. The diversity parameters in the present study reveals that the Shannon index (H') was 4.606, Simpson index (Cd) was 0.045, species richness (d) was 1.917, equitability (e) was 1.397 and beta diversity (βd) was 1.00, respectively.

The present study reveals higher number of herbaceous species as well as density in the plantation site. A total of 39 and 5-20 herbaceous species were reported by Oraon *et al.*[27] and Jhariya *et al.*[5] in different sites of Kawardha forest division of Chhattisgarh. The reason for their maximum

occurrence could be due to the availability of resources and other environmental factors[5]. Alhassan *et al.*[28] reported the environmental factors as well as moisture level at site are responsible for the variation in species number, density and diversity. In the line of agreement in the present findings, Joshi and Bharti[29] reported that plants may facilitate other plants directly by ameliorating harsh environmental conditions, altering substrate characteristics, or increasing the availability of a resource. Jhariya *et al.*[5] have analysed the herbaceous vegetation in Bhoramdeo wildlife sanctuary, Kawardha district (C.G.) and reported total density varied from 112000-668000 individuals ha^{-1}. Jhariya *et al.*[6] reported that the density of herbs across various sites ranged from 502000 to 724000 individuals ha^{-1} in Rowghat of Narayanpur district (C.G.).

The distribution pattern of species depends upon the environment conditions and on the biological peculiarities. Abundance to frequency ratio used to assess the distribution pattern of species. In the present study it is found that most of the species were distributed contagiously and randomly, whereas a few species is distributed regularly. Likewise, Oraon *et al.*[27], Jhariya *et al.*[5,6,], Kittur *et al.*[7] and Jhariya[3] described that most of the species recorded the contagious and random distribution pattern whereas the regular distribution was found almost negligible or insignificant. Shadangi and Nath[30] in his study also reported maximum species followed contagious distribution in the site. Odum[31] stated that the most common distribution is contagious in natural condition and were performed due to small but significant variation in environmental conditions while random distribution was found only in very uniform environment.

The knowledge about species diversity is the vital parameter which typically defines the ecosystems and its functioning[32]. The diversity parameters of herbaceous species were close to values presented by Jhariya and Oraon[2], which showed that the value of Shannon index in different sites ranged from 1.69-3.39, equitability 0.92 to 1.33, species richness 0.33 to 1.48, concentration of dominance 0.11 to 0.37 and beta diversity 1.50 to 3.80 of the herb layer in Kawardha. Jhariya *et al.*[6] have evaluated herbaceous vegetation in Rowghat (C.G.) and reported the Shannon index

Table 1: Performance of Sal species in Khairbar plantation site

Parameters	Max.	Min.	Avg.
Height (cm)	90.00	24.00	57.55±2.72
Girth (cm)	12.00	4.00	6.15±0.86
No. of Leaf	97.00	9.00	48.10±3.55
DF Leaf	50.00	6.00	27.10±2.54
Healthy Leaf	60.00	1.00	21.00±3.68
IF Leaf %	90.91	38.14	61.18±2.37
Leaf Width (cm)			
Large (cm)	13.00	4.00	9.69±0.74
Small (cm)	6.00	2.00	4.46±0.55
Leaf Length (cm)			
Large (cm)	22.00	13.00	18.10±0.74
Small (cm)	9.00	4.00	7.71±0.53
No. of Branches	17.00	4.00	8.90±1.47
Collar Dia. (cm)	3.82	1.27	1.96±0.49
Sturdiness	42.86	15.09	29.53±1.43

Table 2: Herbaceous composition in the Khairbar plantation site

Species	D/ha	F	A	A/F	IVI
Achyranthus aspera L.	12000	30	1.00	0.033	6.48
Apluda mutica L.	16000	30	1.33	0.044	7.63
Biophytum reinnardtii Zucc.	28000	30	2.33	0.078	11.07
Cassia tora L.	40000	40	2.50	0.063	13.95
Corchorus capsularis L.	20000	30	1.67	0.056	8.78
Coriandrum sativum L.	28000	30	2.33	0.078	11.07
Cynodon dactylon L.	56000	60	2.33	0.039	17.71
Cyperus rotundus L.	40000	40	2.50	0.063	13.95
Dactyloctenium aegyptium L.	44000	30	3.67	0.122	15.67
Desmodium pulchellum DC.	32000	50	1.60	0.032	12.22
Dodonoea viscosa Linn.	36000	50	1.80	0.036	13.11
Echinochloa crusgalli L.	20000	30	1.67	0.056	8.78
Eragrostis tenella L.	24000	30	2.00	0.067	9.93
Euphorbia geniculata Orteg.	20000	30	1.67	0.056	8.78
Euphorbia hirta L.	48000	70	1.71	0.024	16.52
Evolvulus nummularius L.	20000	20	2.50	0.125	9.35
Fimbritylis dichotoma L.	16000	30	1.33	0.044	7.63
Lantana camara Linn.	24000	40	1.50	0.038	9.98
Malvastrum coromandelicum L.	12000	30	1.00	0.033	6.48
Mellilotus alba Medikus	64000	70	2.29	0.033	19.66
Merremia emarginata Burm.F.	32000	40	2.00	0.050	11.97
Ocimum basilicum L.	20000	30	1.67	0.056	8.78
Parthenium hysterophorus L.	20000	20	2.50	0.125	9.35
Rumex dentatus L.	12000	20	1.50	0.075	6.42
Tridex procumbence L.	28000	30	2.33	0.078	11.07
Trifolium spp. L.	44000	50	2.20	0.044	14.90
Xanthium strumarium L.	20000	30	1.67	0.056	8.78
Total	776000	990	52.60	1.601	300

Table 3: Herbaceous diversity in the Khairbar plantation site

Diversity parameters	
Shannon index (H')	4.606
Simpson's index (Cd)	0.045
Species richness (d)	1.917
Equitability (e)	1.397
Beta diversity (βd)	1.00

values ranged from 2.66 to 3.17. The values of Simpson's index ranged from 0.14 and 0.23, species richness from 0.67 to 1.06 and the equitability value 1.09-1.33. The beta diversity values ranged from 2.40 to 3.60. Shameem *et al.*[33] reported the species diversity ranged between 1.80 to 3.03. Concerning the species richness, a high number of species results with in higher community stability or rather resilience[34]. This takes the advantage of heterogeneity and increases their diversity. The level of heterogeneity created, obliviously would depend on the height and architecture tree species[35.]. The species diversity range from 1.80 to 3.03 was also reported by Shameem *et al.*[33] which are found to be similar with present study. Kittur *et al.*[7] specified the diversity parameters of herb layer showed that Shannon index in different sites varied from 2.21-2.57, equitability from 1.02-1.24, species richness from 0.34-0.67, concentration of dominance from 0.21-0.31 and beta diversity from 1.81-3.33 which

are closer to the present study. These parameters were also supported by the findings made by Jhariya *et al.*[5,6].

CONCLUSION

In the present study it was found that the growth of sal is quiet slow as compared to the other tropical species. The locality factors and management aspects are the major concern for the good growth performance of the species in plantation sites. The optimum growth depends upon the adoption of the species and the site conditions. Soil physical environment, soil texture, soil moisture, humus, nutrient availability and presence of microorganism etc can also influence the establishment as well as development of the species. Artificial application of ectomycorrhizal fungus synthesise mycorrhiza and helpful during initial growth period and for establishment of sal seedlings. In the present study the growth of sal seedlings is also affected due to the higher population of the herbaceous species. The herbaceous species compete with the sal for the sharing of the resources for the growth and development. Proper management practices should be applied for the betterment of the plantation site.

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