Original Research Article

Impact of Edaphic Parameters on the Regeneration Status of *Terminalia chebula* Retz. Across Garhwal Himalaya

ABSTRACT

Terminalia chebula Retz is considered as “king of medicines”. Utilization of its fruit for multiple purposes is thought to have an impact on the natural regeneration status of the species. The aim of the present study is to investigate the impacts of edaphic parameters in the regeneration status of *Terminalia chebula* Retz. The present study was conducted in the region of Garhwal Himalayas along the gradient in different altitudes. The information regarding selected species, such as altitudinal range, habitat (s), locality factors, and soil parameters, was recorded. Soil parameters were analysed by using standard procedures and measures of multiple coefficients of correlation have been done between the parameters and their impact on the seedling density. The pH level had been attributed to acidic, ranging between 5.2 to 6.52 in all the different altitudinal ranges between 900-1200m. According to findings of this study pH characteristics of different altitudinal gradients have a high degree of negative impact on the regeneration of the *Terminalia chebula* Retz.

Keywords: Correlation, Edaphic, Habitat, Regeneration status, Seedling

1. INTRODUCTION

The Himalayan region of India is a part of the Himalayan Biodiversity Hotspot. This region is rich in biodiversity and natural resources. The Uttarakhand Himalayan region is demarcated into two distinct regions, namely Garhwal region consisting of seven districts (i.e., Dehradun, Haridwar, Tehri Garhwal, Pauri Garhwal, Rudraprayag, Uttarkashi, and Chamoli) and Kumaon region consisting of six districts (i.e., Kotdwar, Pittoragarh, Almora, Bhageshwar, Champavat, and Uddham Singh Nagar). Garhwal Himalaya has diverse forms of plants that are of high medicinal value. A total of 33 genera and 39 species of growing medicinal trees have been noticed in the study area (P.S. Chauhan, 2017)[1].

Terminalia chebula Retz. Belong to the family Combretaceae, a moderate-sized to large deciduous tree with a rounded crown and usually short trunk. The species is distributed in India over the mixed deciduous forests extending to the drier areas (Troup, 1921)[2]. According to Troup, *T. Chebula* Retz. Ascends to 5000ft. in the outer Himalayas. In Uttarakhand, the flowering season lasts from April to June, and Fruiting is observed from January to March (Upreti et al., 2010)[3]. *Terminalia chebula* Retz. is a common species in sal and dry miscellaneous forests up to an altitude of 1400m. The structure and function of the forest ecosystem are determined by the plant component more than any other living component of the system (Richards, 1996)[4].

Terminalia chebula Retz. It is considered the "King of medicine" because it contains a large number of phytochemicals that are used for treating a variety of disorders (Gupta 2012)[5]. Composition and community are the vital forest attributes that influence and get influenced by the regional environment and edaphic and anthropogenic factors (Thammanu et al., 2021; Das et al., 2021)[6]. The pH of the soil in the natural environment has an enormous influence on soil biogeochemical processes; hence, soil pH is described as the "*master soil variable*" (Neina, 2019)[7]. Soil pH influences myriads of soil biological, chemical, and physical properties and processes that affect plant growth and biomass yield. The study focuses on the regeneration status of *Terminalia chebula* Retz. With respect to edaphological parameters in the different altitudinal zones of Garhwal Himalayas. Terminalia chebula Retz. Works as a multipurpose tree species and has utilization for many purposes, including the evident one, which is medicinal. The fruit is the main part utilized for medicinal purposes. Such as for

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practical purposes, the fruit of *Terminalia chebula* is of three types – actually, these are the different stages of maturity of fruits (D. Frawley,1986[8]; Varnick et al., 1996)[9]. The maturity stages are such as Small Myrobalan - the unripe fruit; Yellow Myrobalan - After the development of seed, the adult stage of the fruit; and Large Myrobalan - The fully matured fruit (Chattopadhyay and Bhattacharyya, 2007)[10]. Hence, utilization of the species is assumed to have an impact on natural regeneration. So, in natural systems where natural regeneration is taking place, the impact of edaphic parameters, which have direct effects/influences on the regeneration process, has been assessed. Assessment of different edaphic components has been done by multiple correlations to evaluate in which direction the change in parameters has been influencing the regeneration process.

2. MATERIAL AND METHODS

The present investigation has been carried out to analyze the impacts of edaphic parameters of the plots where the natural regeneration occurred. Requirements for the field assessment consist of a rope of a specific size and measuring tape for the tree data. Augur and zip lock bags have been used for soil collection sampling.

2.1 Selection of Sites

Due to the fact that the tract was hilly, every accessible site along the gradient in different altitudes has been studied for the information regarding selected species' altitudinal range, habitat (s), locality factors (*i.e.,* soil parameters), etc., was gathered. Each location, i.e., habitat, was identified based on the dominance of the vegetation along altitudinal gradient.

Table 1: Details of the sites along altitudinal gradient

Site	Latitude	Longitude	Aspect	Altitude (m A.S.L)
LUSI,Tehri Garhwal,Uttarakhand	30°17' 2.6016" N	78°43' 5.1996" E	SE	900
Jakhni road, Tehri Garhwal,Uttarakhand	30°17' 2.7488" N	78°43' 9.6924" E	NE	950
Pindula, Tehri Garhwal	30°17' 36.7476" N	78°42' 59.6124" E	NE	1000
Near Pindula,Tehri Garhwal	30°17' 15.5508" N	78°43' 7.9932" E	NE	1050
Jakhni, Tehri Garhwal	30°16' 54.894" N	78°43' 10.7544" E`	SE	1100
Kathela,Kotdwar	29°50' 59.4744" N	78°38' 18.8844" E	SW	1150
Deosal, Khanda,Pauri Garhwal	30°10' 44.3532" N	78°49' 10.2324" E	NW	>1200

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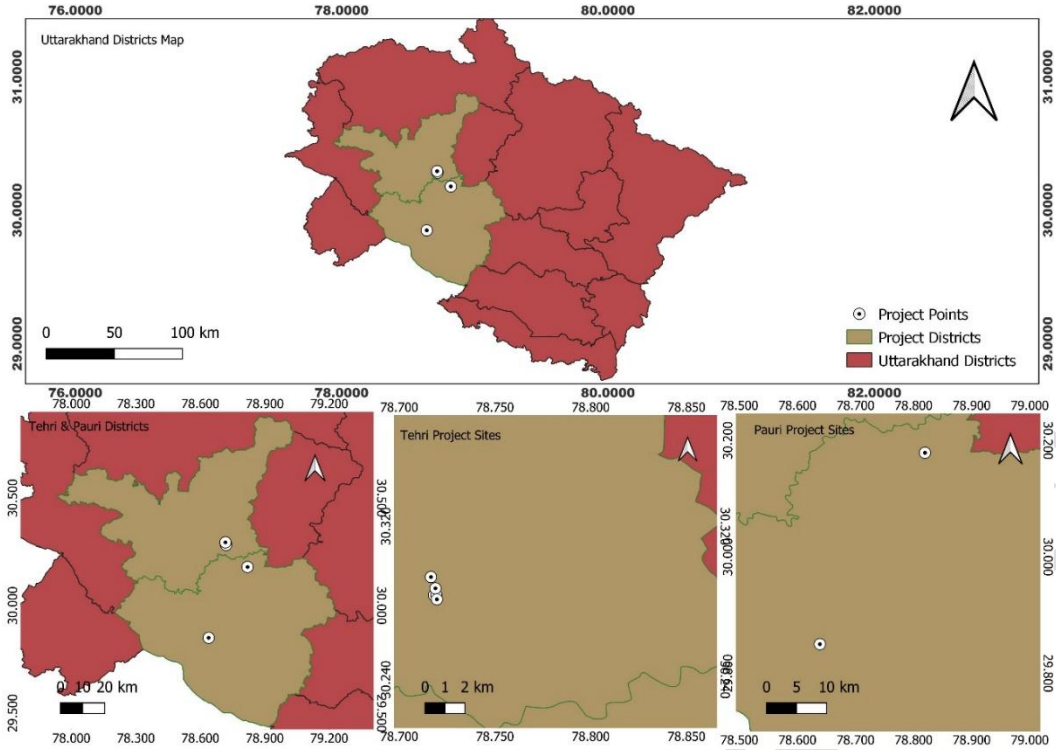

Figure 1: Project Location of Tehri and Pauri Districts

2.2 Sampling of the Natural Vegetation

In each selected site, a plot of 50m×50m (0.25 hectare) was laid. Trees, saplings, and seedlings were sampled sequentially. 10x10m quadrats (31 NOS) were placed inside five plots. Standard ecological sampling methods were followed for the data collection from the quadrats (Muller-Dombois and Ellenberge, 1974 [11]; Dhar et al., 1997 [12]; Samant and Joshi, 2004 [13].

2.3 Sampling of Soil

Standard three out of four soil testing steps have been obtained as described by Walworth, 2011[14]. For the collection of soil samples, all seven different sites of different altitudinal levels were sampled. Followed three steps include.

- Collection of a representative soil sample,
- Laboratory analyses of the soil sample,
- Interpretation of analytical results.

Seven quadrats of 50*50m were laid in the study area. Plots were then classified into seven altitudinal ranges of 900-950m, 950-1000m, 1000-1050m, 1050-1100m, 1100-1150m, and 1150-1200m, respectively. From each altitude, a composite sample was collected from each quadrat. Samples were collected from a depth of 20 cm. The samples were placed in clean polythene bags and marked properly. It was imperative to use clean sampling tools.

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2.4 Measurement of Plants

Significant considerations have been made during the measurement of plants. Considerations have been made according to the work of Chauhan et al., 2008. The considerations are as follows,
Stems measuring over 30 cm in diameter at DBH, i.e., 1.37m (Chaturvedi and Khanna, 2000)[15] and over 13 m in height, are considered '*Mature trees*.' Individuals over 10 cm to less than 30 cm diameter along with less than 2 m height have been considered as '*Poles*.' Individuals having over 1 cm to less than 10 cm collar diameter have been considered as '*Saplings*,' and with less than 1 cm collar diameter and up to 0.5 m height have been considered as '*Seedlings*' (Chauhan et al., 2008)[16].

2.5 Analysis of Soil Parameters

Soil Physical and Chemical properties were estimated using all standard procedures (**Table 2**) in the department laboratory.

Table 2: Methodology used for the analysis of different soil parameters.

S.No	Soil Parameter	Reference
1	Soil pH	Watson and Brown, 1998[17]
2	Soil Texture	Moreno Marato and Alanso- Azcarate, 2022[18]
3	Bulk density	Al Shammary et al., 2018[19]
4	Nitrogen content	Bremner, 1960[20]
5.	Soil organic carbon and organic content	Walkley and Black, 1934 & Mylavarapu, 2014[21]

2.6 Coefficient of Multiple Correlation

The coefficient of multiple correlations is a measure of how well the given variable natural regeneration status can be predicted using a linear function of a set of other variables, which are edaphic parameters (e.g., pH, Texture, Bulk Density, Nitrogen Content, SOC (%) and SOM (%). It is the correlation between the variable's values and the best predictions that have been computed linearly from the predictive variables. The coefficient multiple correlation has been computed with the help of MS Office for this study.

3. RESULTS AND DISCUSSION

The study assessed the impact of edaphic parameters on the regeneration and growth pattern of *Terminalia chebula* Retz in the plots of 50m*50m, the number of individuals belonging to the species. A total of 239 individuals were present in the seven quadrats. The individuals were composed of seedlings, saplings, and mature trees. The density of *Terminalia chebula* Retz. Seedlings in 7 different altitude gradients of 900m, 950m, 1000m, 1050m, 1100m, 1150m, and 1200m are subsequently 0.02, 0.03, 0.02, 0.03, 0.01, 0, and 0.04 per sq. meter (**Table 3**). The basal area of the seedlings varied from 0 to 65.46 cm^2.

Table 3: Table of different Edaphic Parameters

Plot No.	Plant Status	Seedling Density (Nos/m2)	pH	Nitrogen (Kg/acre)	SOC (%)	SOM (%)	Altitude	Bulk Density (%)
P-1	Seedling	0.02	5.2	155.54	1.63	2.81	900	0.81
P-2	Seedling	0.03	5.66	125.44	2.36	4.36	950	0.93
P-3	Seedling	0.02	5.8	100.35	2.07	3.57	1000	1.26
P-4	Seedling	0.03	6.22	120.42	1.32	2.28	1050	1.15
P-5	Seedling	0.01	5.72	95.33	2.01	3.47	1100	1.06
P-6	Seedling	0.00	6.52	105.36	1.42	2.44	1150	0.94

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P-7	Seedling	0.04	5.52	135.47	2.46	4.23	1200	1.13

The pH level had been attributed to acidic, ranging between 5.2 to 6.52 in all the altitudinal ranges. The standard deviation for different altitudinal gradients had been assessed such as the standard deviations of seedling density, pH, Nitrogen (Kg/Acre), SOC (%), SOM (%), and Bulk density are 0.58, 0.44, 21.37, 0.45, 0.83, and 0.15 respectively (**Table 3**).

Table 4: Table of Correlation

Parameter	Seedling Density (Nos/m2)	pH	Nitrogen (Kg/acre)	SOC (%)	SOM (%)	Altitude	Bulk Density (%)
Density (Nos/m2)	1	-	-	-	-	-	-
pH	-0.46	1.00		-	-	-	-
Nitrogen (Kg/acre)	0.53	-0.62	1.00	-	-	-	-
SOC (%)	0.51	-0.56	0.04	1.00		-	-
SOM (%)	0.52	-0.54	0.05	0.99	1.00	-	-
Altitude	-0.06	0.46	-0.38	0.09	0.03	1.00	-
Bulk Density (%)	0.30	0.24	-0.53	0.21	0.16	0.39	1

A correlation (**Table 4**) has been made between the parameters and their impact on the seedling density. Altitude has a low but negative impact on the natural regeneration of *T. chebula* Retz. This negative impact may be associated with the climatic parameters. However, climatic parameters have not been taken into account for this study. The study suggests that the altitudinal gradients have a moderately positive impact on the pH, a moderately negative impact on the soil nitrogen content, and almost no impact on SOC (%) and SOM (%). In the case of Individual parameters, the outcome concludes that pH characteristics of different altitudinal gradients have a high degree of negative impact on the regeneration of the *Terminalia chebula* Retz. Seedlings and if the pH of the soil in the sites goes up, then the regeneration will decline. This suggests that alkaline soil will reduce the regeneration of the species. The organic carbon content percentage and the organic matter percentage are highly correlated, and it must be because the organic carbon concentration depends on the organic matter present in the site and its decomposition rate. Microbial activity in the sites is very good in terms of altitude; hence the correlation is very strong between these parameters. High Nitrogen content in soils supports regeneration in a good way, and the bulk density of the soil has a very low but positive impact on regeneration. Nitrogen content has a high degree of negative impact on the bulk density of the soil at different altitudinal gradients. The study incorporates the edaphic drawbacks that suppress regeneration ability. compared to Samanpreet singh et al (2019)[22], reported However recruits of Harar were found in some agricultural fields of Naraina, unestablished and established regeneration was found in grassland of natural population in Pahlu (Plates 1 & 2). The reasons for poor regeneration of Harar in natural regeneration were found to be having hard seed coat, the species being a strong light demander, complete burning of seedlings due to forest fires during summer and intensive removal of fruits for sale in the local markets. The scanty/failure of natural regeneration of Terminalia chebula in Himachal Pradesh has also reported by sharma et al (2016)[23].

4. CONCLUSION

An overall conclusion can be drawn from the study that higher soil organic carbon and soil organic matter resulting in low pH (i.e., acidic soil) along with higher Nitrogen content has a net positive impact in the study sites of the Garhwal Himalayas along the altitudinal gradient . Thus, the regeneration status in these selected sites across the Garhwal Himalayas is classified as 'good.'

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CONSENT

I on behalf of all authors confirm that all authors have read the copy of this manuscript and approved for submission of this manuscript.

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