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Natural regeneration status of *Dhav* forests (*Anogeissus pendula* Edgew.) in Jhalawar forest division

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Abstract

A field experiment entitled "Natural regeneration studies of *Dhav* forests (*Anogeissus pendula* Edgew.) in Jhalawar forest division" was undertaken during the year 2016-17 in selected natural pure *Anogeissus pendula* stands under different sites viz. Bagher (S₁), Rata Devi (S₂), Mishroli (S₃) and Ghatoli (S₄). *Anogeissus pendula* has multiple uses as its timber is very hard, tough, strong, and durable which is equivalent to teak in terms of transverse strength and does not decay and discolor. Its timber has a great potential value; leaves are considered to be an excellent fodder. The tree yields the *Ghatti* or Indian Gum is edible in nature, has medicinal value and generally used as fuel or for making charcoal. Pattern of natural regeneration follows Rata Devi (S₂) > Bagher (S₁) > Ghatoli (S₄) > Mishroli (S₃) *ie.*, very low recruits/per hectare found in low dense, matured stand at S₃ where as Bagher (S₁) and Rata Devi (S₂) shows higher recruits per hectare. However, the same Bagher (S₁) fail to convert its recruits into un-established and established individuals due to posed threat of uncontrolled grazing and poor soil depth. Reported good regeneration success percent at Ghatoli (S₄) was attributed to higher un-established individuals, protection and topographical features than other sites relatively.

Keywords: *Anogeissus pendula*, natural regeneration, status and Jhalawar forest division

Introduction

Anogeissus pendula (Edgew) is one of the most important multi-purpose tree species belongs to the family Combretaceae and is distributed throughout the tropical Asia and Africa. It grows in dry, hot region of India, commonly occurring in the dry tropical forest and dry mixed deciduous forests of Rajasthan, part of Gujarat, Madhya Pradesh, Haryana and Uttar Pradesh. According to Champion and Seth's classification (1968) its forest corresponds to 5/E-1 *Anogeissus pendula* forest, which is an edaphic climax type of Tropical dry deciduous forest. In different parts of the country it is commonly known as *dhav*, *dhaunkra*, *kala dhaunkra*, *dhok*, *etc.*

Some of the noticed constraint with this species is its slow growth. It seldom reaches a height of 12 m and girth of 1.5m. As reported by Mathur (1961) [7] in 50 year of the growth of *A. pendula* in Rajasthan, it attained a maximum height of 9.39 m and dbh 12.22cm. More so, tree fruits abundantly every year but the germination capacity of the seed is very low, and the seedling have a tendency to die back probably due to prolonged drought. Therefore, seedling regeneration is not adequate and dependable. This could be a major factor responsible for the poor germination percentage of this species. However, the shoots dies back annually, but the deep roots survive and this process continues for 5-6 every year in the rains till the roots are sufficiently strong to give out of 60 cm height (Mathur, 1965) [9].

Recurring periods of drought in Rajasthan is a serious issue of normal life but also an ecological one with its consequences on disastrous changes in soil, moisture regime (chiefly water table) and incidence of pests and diseases of flora and fauna that results in large scale mortality of forest crop. Both young and old aged trees were the first victims, slowly followed by middle aged trees. From the forest type of *Anogeissus pendula* and *Anogeissus latifolia* large scale mortality was observed earlier in various part of the state. Trees mortality was first reported from Mandalgarh Range, Chittorgarh Forest Division during 1966 where about 1500 trees, and during 1967 in Manohar Thana Range of Jhalawar Forest Division (Verma, 1972) [15]. In addition a continuous grazing and forest fire further aggravates the problem. Thus, both climate and biotic factors play important role in the development process of *A. pendula stand* (Saxena, 1989) [12].

Anogeissus pendula Edgew. forms an important species in Jhalawar Forest Division with respect to its area, dominance and utility by the local users. Hitherto, very limited or no study has been carried out here on this species about its stand growth characters, regeneration level

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and site conditions.

Materials and Methods

The Jhalawar district falls under Humid South Eastern plain under Zone V of the Rajasthan and lies between 23.45° and 24.52° N and between 75.27° and 76.56° E. Altitude of Jhalawar plateauranges from 300-450 above msl. Jhalawar district is an expanse of fertile plain having rich black-cotton soil in general. The maximum temperature range in summer is 43^o- 48^oC and the minimum in winter is 1.0^o-2.6^oC. whereas the annual normal rainfall for the district was 100.47 cm which is highest in the state of Rajasthan. Current study was carried out during the year 2016-17 in selected natural pure *Anogeissus pendula* stands (Table 1) in different parts of Jhalawar Forest Division. By referring stock map & working

plan information, four locations, viz. Bagher (S₁), Rata Dievi (S₂), Misihroli (S₃) and Ghatoli (S₄) were select.

The sampling units of 50m × 20m each were selected. Each sampling unit had five regeneration units of 2m × 2m quadrate as per Cleark (1979). The survey was conducted for counting number of recruits (r), which may be defined as current year’s seedlings, unestablished regeneration (u) seedlings other than recruits which has not yet established and with height less than 2 meter and established regeneration (e) plants with height of more than 2 meter. Here four (4) unestablished plants were taken equivalent to one established regeneration for calculating the regeneration per cent. The height of unestablished plants was also measured for the assessment of regeneration.

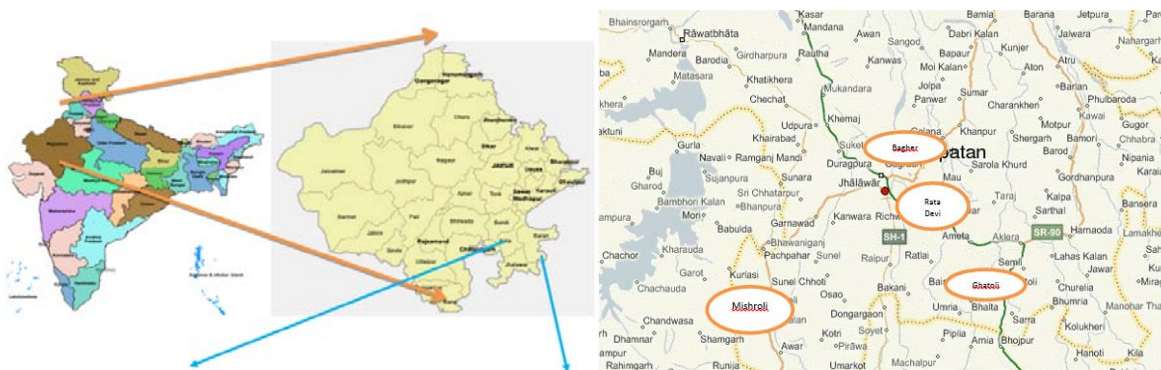


Fig 1: Location map of the study sites

Table 1: Location and details of the study sites

Locality	Forest Range	Altitude*(m)	Rainfall *(mm/yr)	Coordinates*
Bagher (S ₁)	Khanpur	309 m	830.7 mm	24.03°N 76.01°E
Rata Devi (S ₂)	Asnawar	361 m	943 mm	24.28°N 76.20°E
Mishroli (S ₃)	Jhalawar	312 m	910.4mm	24.6°N 76.15°E
Ghatoli (S ₄)	Aklera	289 m	943 mm	24.42°N 76.57°E.

Information at range level

Regeneration assessment

The survey was conducted for recruits (defined as current year’s seedlings), unestablished regeneration (seedling other than recruits which has not yet established and the height less than 2 m). Four unestablished plants has taken equivalent to one established plant and established regeneration having height of more than 2 m. The height of unestablished plants will be measured for the assessment of regeneration (Champion, 1935). The data thus collected will be analyzed using the formulae given by Chacko (1965) as follows:

$$\text{Recruits (r)/ha} = 2500 \sum_{i=1}^n r_i / m$$

$$\text{unestablished regeneration (u)/ha} = 2500 \sum_{i=1}^n u_i / m$$

$$\text{Established regeneration (e)/ha} = 2500 \sum_{i=1}^n e_i / m$$

Where,

n = Number of sampling units

m = Total number of recording units in survey

r_i = Total number of recruits in each sampling unit

u_i = Total number of unestablished plants in each sampling unit

e_i = Total number of established plants in each sampling unit

$$\text{Weighted Average height (cm)} = \frac{\text{Total height of unestablished regeneration} + (\text{Number of established Plants} \times \text{establishment height})}{\text{Total unestablished plants} + \text{Total established plants}}$$

On the basis of above estimates following indices were calculated

$$\text{Establishment Index (I}_1\text{)} = \frac{\text{Weighted Average Height}}{\text{Establishment height}}$$

$$\text{Regeneration Success \%} = \text{Stocking Index (I}_2\text{)} \times 100$$

$$\text{Stocking Index (I}_2\text{)} = \frac{1}{250} * \frac{\text{Un-established regeneration/ha}}{4} + \frac{\text{Established regeneration/ha}}{4}$$

$$\text{Establishment Stocking \%} = 100 * I_1 * I_2$$

Results and Discussion

The current investigation on restocking pattern of *Anogeissus pendula* stand attempted to assess the level of recruits, unestablished, established individuals on per hectare basis along with their regeneration success percent is shown in (Table 2) below.

Table 2: Status of natural regeneration of *Anogeissus pendula* in different sites

Site	r/ha	ue/ha	e/ha	total ue height	weighted average height (cm)	Est. index	stoking index	Est. stoking (%)	Regeneration success (%)
Bagher(S ₁)	21968	531	781	716.25	187.26	0.94	0.36	34.23	36.56
Rata Devi (S ₂)	39718	875	1000	1090	179.33	0.89	0.48	43.71	48.75
Mishroli (S ₃)	8031	656	875	667.5	168.77	0.84	0.41	35.07	41.56
Ghatoli (S ₄)	15968	1531	906	2037.5	178.84	0.89	0.51	46.10	51.56

The current investigation on restocking pattern of *Anogeissus pendula* forests to assess the level of recruits, un-established, established individuals on per hectare basis along with their regeneration success percent and the same is shown in Table 2. The performance of the recruits/ha follow the sequence Rata Devi (S₂) > Bagher (S₁) > Ghatoli (S₄) > Mishroli (S₃) with values 39718, 21968, 15968 and 8031 recruits/ha respectively. Difference between lowest and highest performance with respect to recruits/ha at site level was very high that indicates in-adequate regeneration (Figure 2). The reason could be the seed formation, dispersal, seed quality as noticed that germination of this species is very low (2 – 9 %) (Bhargava, 1951) [1] and ground conditions (Rikhari *et al.*, 2000) [11] such as insufficient moisture contents in the soil due to the thick layer of humus on the surface affect the process of natural regeneration (Jha *et al.*, (1984) [6].

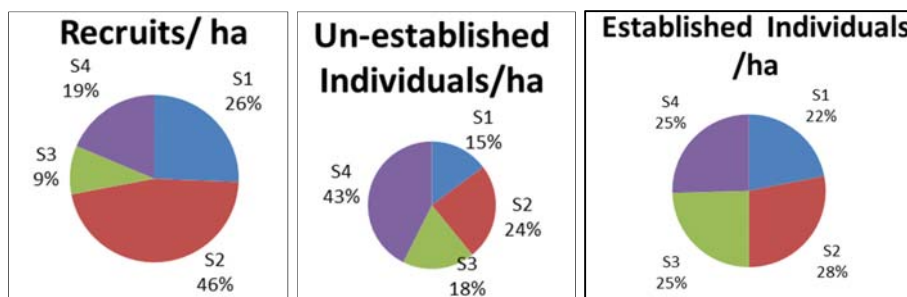
Though the seedling of this species were greatly affected with excessive browsing and trampling by animals, but the main cause of die back related to intensive drought condition of summer is serious one as reported by Tripathi and Saxena (1987) [13] and Working plan Jhalawar (2013-14 to 2023-24). The un-established seedlings/ha found maximum and minimum values of 1531/ha and 531/ha were recorded at Ghatoli (S₄) and Bagher (S₁) respectively. Similarly, the established individuals/ha 1000 at Rata Devi (S₂) showed highest and lowest 781 at Bagher (S₁). It is evident for low performance in reference to above parameters at site level that, seedlings and transplants survivorship of the *Anogeissus*

pendula were very much affected by dry periods in rainy season, overgrazing and browsing by wild herbivores, goats, sheep and cattle (Yadav and Gupta, 2009) that is observed in the field during current investigations. More so illicit felling, lopping and fodder collection in these sites were reported in working plan of Jhalawar Forest Division. Unfortunately, working plan admits its inability to follow the recommendation of silvicultural treatment and protection against grazing earlier in *dhav* forests in the forest division (Working plan Jhalawar 2013-14 to 2022-23).

The weighted average height 187.26 cm was found highest in Bagher (S₁) and lowest as 168.76 cm at Mishroli (S₃). The establishment Index varied from minimum 0.84 at Mishroli (S₃) to maximum 0.94 at Bagher (S₁). The maximum and minimum value for Stoking Index for Ghatoli (S₄) shows 0.51 and 0.36 at Bagher (S₁) as highest and lowest respectively.

As seedlings require protection against uncontrolled heavy grazing to put up their growth otherwise tree develops bushy form (Mathur, 1961) [7] may be the reason for variation in height of un-established individuals and lower establishment Index at site level.

The established stocking percent was reported to be in between lowest 34.23 and highest 46.10 at Bagher (S₁) and Ghatoli (S₄). Regeneration success percent of *Anogeissus pendula* from different sites showed highest values of 51.56 from Ghatoli (S₄) and lowest values of 36.56 from Bagher (S₁).

**Fig 2:** Regeneration pattern of *Anogeissus pendula* in different sites

The reason for highest performance of established stocking percent and Regeneration success percent at Ghatoli (S₄) due to the plane topography compared to other sites which are undulated hilly terrains relatively. This can be correlated with the earlier study where the maximum survival (3.9%) reported at the bottom of hillocks whereas none of the seedling survived at the top of hillocks in the natural forest of Sagar district of Madhya Pradesh (Tripathi *et al.*, 1986, Mathur, 1956) [8]. Also, that strong insulation, deep litter, competing lower vegetation create obstructions to seedlings survival and growth Gordon (1970) [4].

Other reason for variation in establishment of individuals in the current study at site levels due to difference in age as resistance and resilience capacity of the seedlings improves with the age of the seedling as observed in two year old

seedling which performed better establishment compared to one year old seedling (Mathur, 1961) [7]. Also variation in success of regeneration in *Anogeissus pendula* due to soil type where very good survival condition of 87.5% reported at five year of age on red gravely soil (Rai *et al.*, 1995) [10].

Conclusions

Very low recruits /per hectare found in low dense matured stand at Mishroli (S₃) where as Bagher (S₁) and Rata Devi(S₂) shows higher recruits per hectare follows the trend Rata Devi (S₂) > Bagher (S₁) > Ghatoli (S₄) > Mishroli (S₃). However, the same Bagher (S₁) fail to convert its recruits into un-established and established individuals due to posed threat of uncontrolled grazing and poor soil depth. However, the good regeneration success percent at Ghatoli (S₄) was attributed to

good un-established individuals, protection and topographical features than other sites relatively.

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