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Assessment of regeneration response of Silver Fir (*Abies pindrow)* to slope, aspect, and altitude in Miandam area in District Swat, Khyber-Pakhtunkhwa, Pakistan

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SUMMARY

Shade-bearing conifer species face a lot of problems in their regeneration, causing low density as compared to other vegetation communities. We investigated the effect of physiographic factors affecting *Abies pindrow* in the Miandam watershed area in District Swat. The parameters included slope, aspect, density, altitude, and canopy. The center of 5 x 5 size plots was traced through GPS located at steep slopes having gradients of 60% (27°) and above, moderate slopes having gradients of 40% to 60% (18°–27°), and gentle slopes having gradients of 40% (18°) or below. Slope was categorized as steep slope N. aspect, steep slope S. aspect, well-drained moderate slope, and moderate slope poorly drained. Similarly, the sampling units with various canopy covers (10% to 50% and 51% to above) were also separated. Three elevations along altitudinal gradients (1800–2100 m amsl (above mean sea level), 2100–2400 m amsl, and 2400–2700 m amsl) were identified. In each plot, the tree saplings (seedling below 31.5 cm, just above the ground) were investigated. The result indicated that a steep slope (60% (27°) and above) with a northern aspect supported the maximum number of fir regeneration (32) followed by a steep (southern) aspect (21). However, no significant variations were recorded in the number of regenerations between well-drained moderate slopes and poorly drained moderate slopes. Similarly, the closed canopy supported maximum regenerations (21) as compared to the open canopy (14). The highest number of regenerations was recorded at maximum altitude (2400–2700 m amsl).

Keywords: Aspect, Altitude, Density, Regeneration, Slope

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INTRODUCTION

The physiographic factors show a major impact on plant microhabitats, especially in hill slope form. Differences in insolation period may occur depending on the site aspect, thereby forming a range of microclimates in multifaceted landscapes. Consequently, microclimate is often linked to soil moisture and distribution of plant

communities (Holland and Steyn, 1975). Similarly, the climate and seed production play an important role in composition and distribution of Himalayan vegetation (Tiwari et al., 2020). However, studies on tree-growth responses to climatic variations in a subalpine ecoregion of the central Himalaya are limited (Shrestha and Bista, 2017). One of the most important ecological factors differentiating quantity and quality of fir regeneration is the proportion of fir in a stand (Dobrowolska, 1998). *Abies pindrow* of Himalayan moist temperate forest species is facing a problem of natural regeneration and the absence of adequate regeneration and suitable physiographic sites. Therefore, viable and healthy seed source can be most fruitful in propagation and regeneration techniques (Masoodi et. al., 2014).

According to (Quazi, and Redman 1969) regeneration is significantly more frequent on steeper slopes as compared to gentle and moderate slopes. This may be the consequences of high intensity grazing on the latter sites. Keeping in view the problem of regeneration of *Abies pindrow*, several experiments were conducted in Pakistan, to study seed production, distribution, viability, and losses of seed affecting natural regeneration of this species in the moist temperate forests of Pakistan (Haq, 1992).

Establishment of regeneration in natural conditions faces several problems and the resultant regeneration does not proportionate with the seed productions. The problem of silver fir regeneration was pointed out during the silver fir Silviculture conference held in 1957 wherein it was emphasizing to conduct studies and dig out solution for establishment of natural regeneration this tree. Unfortunately, no work was carried out on the subject except an experiment which was initiated in 1962 at Shogran (Mansehra) to determine the effect of grazing, humus, and adequacy of seed from natural seed fall. Further investigations were again recommended in the 2nd Silviculture conference in1966. Most of the studies thus conducted so far have highlighted the grazing effect and humus layer on silver fir regeneration. The present study has been conducted in Miandam valley, District Swat has investigated the aspect, soil, altitude and slope and canopy cover on silver fir regeneration and the result thus obtained may be generalized on all areas where silver fir in northern temperate forest of Pakistan. and the result may be applicable to whole Swat and northern areas of Pakistan.

MATRIALS AND METHODS

A preliminary survey was carried out to determine the variance in vegetation in the study region. A total of twelve 5 x 5 metre random quadrates (four in each slope and aspect) were chosen. The standard deviation and mean from the preliminary survey were determined in the excel sheet. The formula (Equation 1) was used to compute the co-efficient of variation from the standard deviation and mean. Equation 2 was used to compute sample size.

Co-efficient of variation= (standard deviation)/mean x100 (1)

From the above equation, sample sizes both for aspect and slope were calculated using the formula.

Sample size n= CV2 X t2 / E2 (2)

Whereas

t=1.96 for 95% Confidence Interval)

n=No. of sample plots,
CV=coefficient of variation, E=allowable Error 10% (Asrat and Tesfaye, 2013).

DESCRIPTION OF THE STUDY AREA

Miandam valley is located in the district of Swat's Tehsil Khwaza Khela. It is located on the eastern bank of the Swat River, approximately 54 kilometres from Mingora. Miandam. Miandam has a varying altitude of over 2000 metres in the centre. This altitude, however, fluctuates depending on where you are in the valley. In terms of climate, the region is classified as wet temperate. This indicates that the people own 80% of the stock and the government owns 20%. The forest is separated into 25 divisions, each of which has an average area of 160 hectares. As a result, the total area of the forest grows to 4000 hectares. The land is divided into two villages: Gujjar village and Swati village (Figure 1).

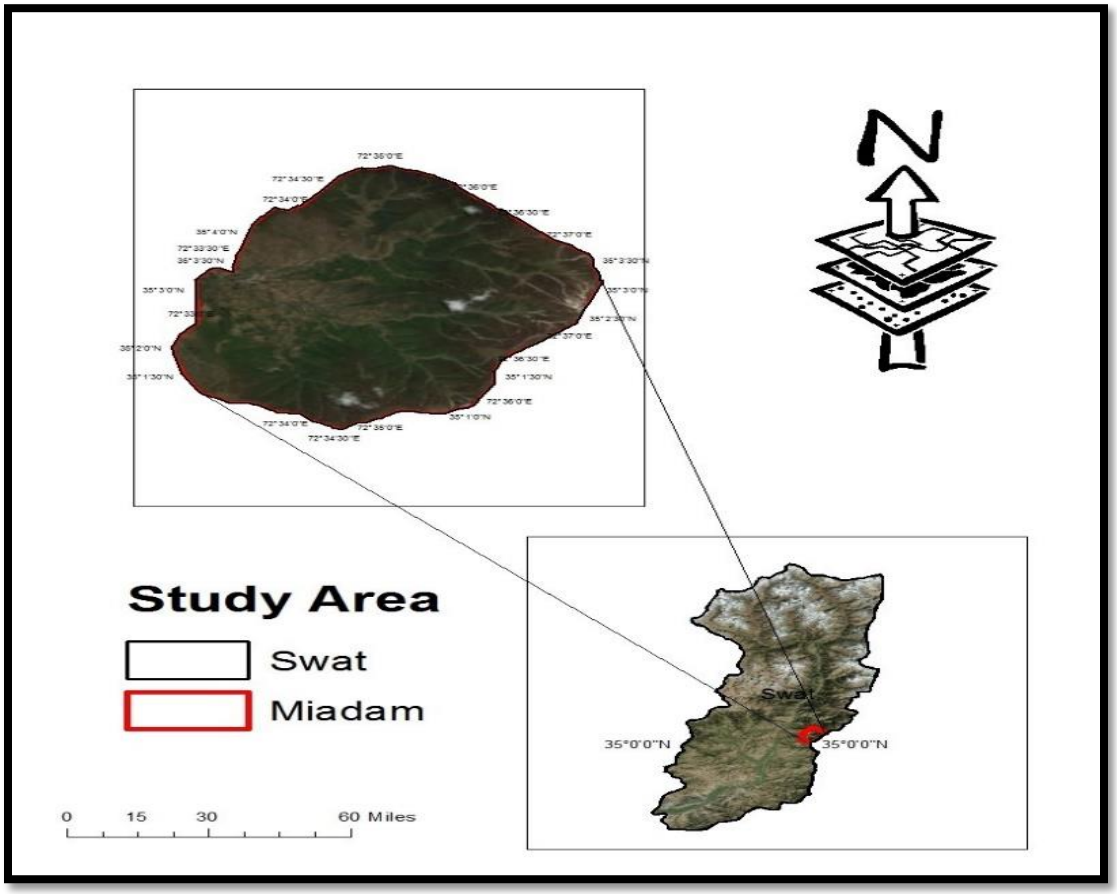


Figure 1: Map of Miandam valley (study area) Swat.

EXPERIMENTAL DESIGN

Based on the sample size calculated (150), the whole Miandam valley was divided into 150 grids to carry out systematic sampling. The center of each grid was traced by GPS. In each plot, 5 m × 5 m sized quadrats were laid out randomly to enumerate the tree saplings (Curtis and McIntosh, 1950). Seedling below 31.5 cm just above the ground were considered as regeneration (Knight, 1963) were counted as regeneration.

The aspect, slope and canopy cover of each sampling unit was also recorded. The sampling units with steep slopes gradient from 60% (27°) and above, the Moderate slope having gradient from 40% to 60% (18°-27°) and gentle slope having gradient 40% (18°) or below was separated and analyzed for the effect slope on regeneration (Sharma *et. al.*, 2010). Slope was categorized as steep slope N. aspect, Steep slope S. aspect, well drained moderate slope, and moderate slope poorly drained. Similarly, the sampling units with various canopy covers (10% to 50% and 51% to above) were also separated. Three elevations along altitudinal gradient (1800–2100 m amsl; 2100–2400 m amsl; 2400–2700 m amsl) were identified (Adil et. al., 2022). Normality was checked through Shapiro-Wilk and the data was analyzed in IBM SPSS 2 Through ANOVA with LSD at 0.05 probability.

RESULTS

The analysis indicated that our hypothesis of equality of regeneration in all treatments is rejected due to its significant value. Alternatively, it is concluded that significant variations exist among various treatments at α=0.5 probability level (Figure 2). The steep slope with a northern aspect supported a maximum number of fir regeneration (mean 32) followed by a steep southern aspect (21). No significant variations were recorded in the number of regenerations between the well-drained moderate slope and poor-drained moderate slope.

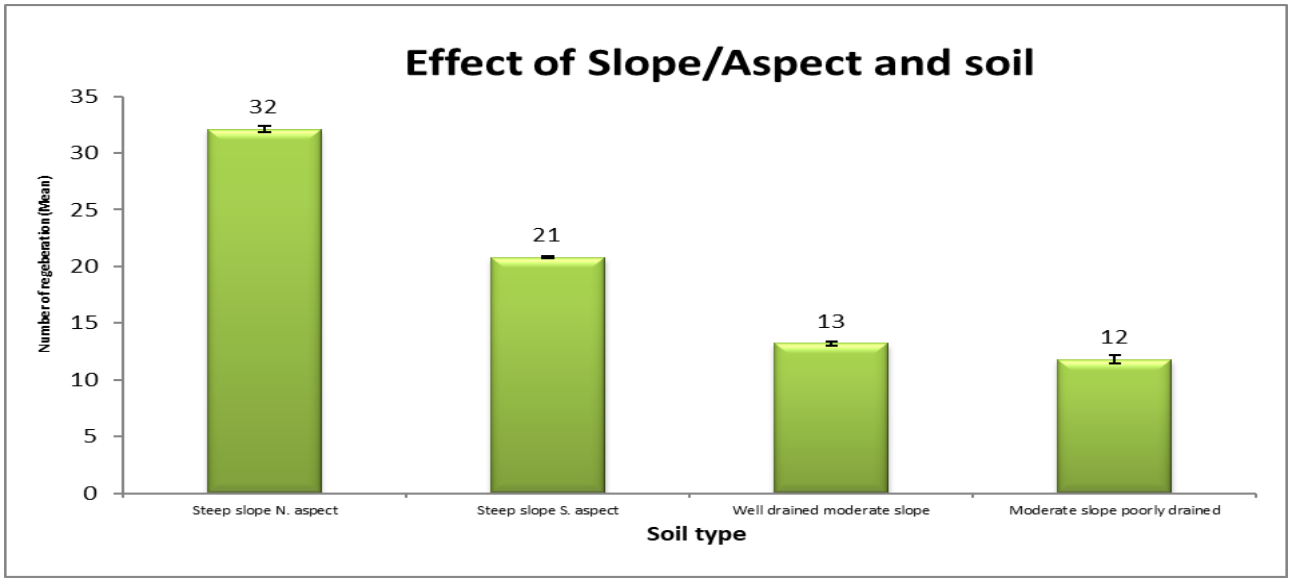


Figure 2: Variations of mean regeneration number on slope and aspect.

However, the lowest number of 13 and 12 regenerations on these two treatments (well drained moderate slope and poor drained moderate slope) respectively indicated unsuitability for *Abies pindrow* regenerations. Possible reasons for suitability of steep slope northern aspect are it inaccessibility to human interventions and grazing aided obviously by more moisture contents on the northern side as compared to southern aspect which is generally dry and cannot support regeneration. Similarly, the data for canopy cover indicated that closed canopy (51% and above) supported more regenerations as compared to open canopy (10% to 50%)

(Figure 3). The highest number of regenerations was recorded at maximum altitude (2400 – 2700 m amsl) (Figure 4).

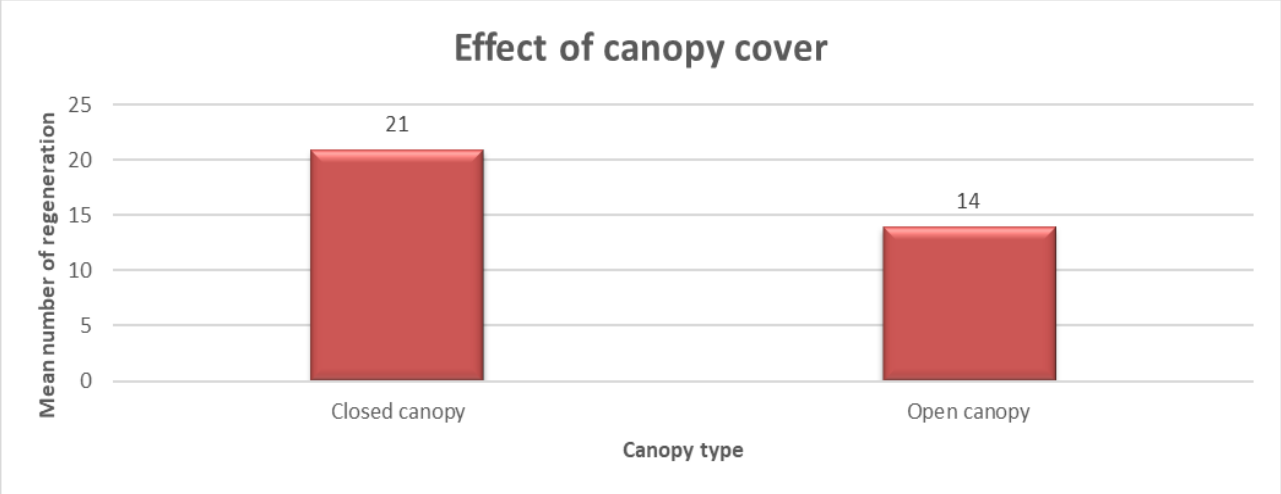


Figure 3: Variations of mean regeneration number in closed and open canopy.

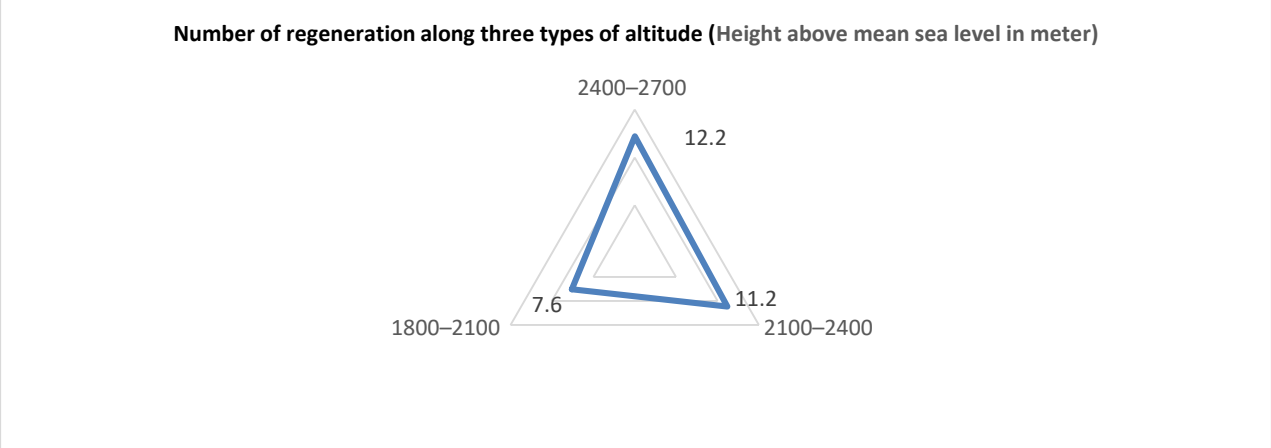


Figure 4: Number of regenerations along altitudes.

DISCUSSION

The analysis of regeneration data of *Abies pindrow* is strongly supported by the steep slope, northern aspect, and closed canopy over. The best possible reason According to (Quazi and Redman 1969) is that steep slope face lesser pressure of grazing and inaccessibility to anthropogenic activities which validated the result of this study. Our study also focused on aspect and canopy cover. Rich undergrowth is supported due to inaccessibility that favors fir regeneration. However, in thick humus layer areas, regeneration was not satisfactory because of low moisture conditions. The steep slope thus prevents accumulation of thick humus layer as compared to moderate slope. The abundance of regeneration also indicates well drained soil on steep slope. Conversely, moderate slope with well-drained soil was not suitable for fir regeneration. On steep slope the closed canopy supported more regeneration as compared to open canopy because *Abies pindrow* seed is shade bearer and produce best regeneration in shade

and shows better germination in the presence of thin humus layer. This result is aligned with the study conducted by (Grassi et. al., 2014).

According to this study Fir sapling are more represented in understory environments and less represented in gaps as compared with spruce thus validating the result of this study. This study is also in confirmation of the study carried out by (Hofmeister *et. al.,* 2008) who stated that Fir can find more favorable conditions under the crowns of spruce trees and the spruce under mature firs. On slopes with southern exposures, many fir seedlings did not reach heights above 30 cm and spruce developed due to dry conditions and browsing intensity (Heuze *et. al.,* 2005). However, the northern aspect is best for silver fire regeneration. It was also reported by (Dobrowolska, 1998) that one of the most important ecological factors differentiating quantity and quality of fir regeneration is the proportion of fir in a stand. According to (Adil *et al.,* 2022), maximum regeneration is found on higher altitude and their results are in coincidence with ours. The data demonstrated that the where the soil was directly exposed to soil showed a smaller number of regenerations. The presence of good mother trees also favored good regeneration in the sample area. The plots that were taken on the Northern side showed good regeneration as compared to Southern regeneration due to shade on the northern side.

CONCLUSION

The study concluded *Abies pindrow* regenerations depends upon slopes, aspect, and altitude. Regeneration is rich on steep slopes. The Northern aspect and well-drained soil support maximum regeneration as compared to moderate slope and southern aspect. Similarly, closed canopies on steep sleep and maximum altitude were also found suitable for regeneration establishment. Grazing limit the regeneration of fir through trampling effect and thus is main cause which is highly affects the regeneration of *Abies pindrow* Regeneration.

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