Sci., Tech. and Dev., 31 (4): 301-304, 2012

GROWTH-CLIMATE RESPONSE OF *PICEASMITHIANA* FROM AFGHANISTAN

MUHAMMAD USAMA ZAFAR[1]*, MOINUDDIN AHMED[2], M. AFZAL FAROOQ[1], MUHAMMAD AKBAR[2] AND ALAMDAR HUSSAIN[2]

[1]Department of Environmental Science, Federal Urdu University of Arts, Science and Technology, Gulshan-e-Iqbal Campus, Karachi, Pakistan.

[2]Department of Botany, Federal Urdu University of Arts, Science and Technology, Gulshan-e-Iqbal Campus, Karachi, Pakistan.

Abstract

Twenty eight cores were taken from fifteen *Piceasmithiana* trees and only twenty four cores were cross-dated. Various chronology statistics like EPS, SNR and Rbar were described having the values 0.89, 8.11 and 0.28, respectively. The standardised chronology was compared with temperature and precipitation of Dir meteorological and gridded data. Residual chronology was used to find out the correlation coefficients. No correlation was found between chronology and station data but previous October temperature was found to be negatively correlated and previous October and current January precipitation was found to be positively correlated with gridded data. Total variance explained was 17.19 percent with significant at 0.05 levels. It is suggested that a higher sample size would produce better results.

Keywords: *Piceasmithiana*, Residual chronology, ARSTAN.

Introduction

Piceasmithiana, also known as Morinda or Western Himalayan Spruce, is native to the Western Himalayan and adjacent mountains starting from northeast Afghanistan to the central Nepal. It usually grows at the elevation of 2400-3600m in forests with *Cedrusdeodara*. *Pinuswallichiana* and *Abiespindrow* in the middle limit whilst associated with *Betullautilis* in the upper limit (Ahmed et al., 2011). It is an evergreen tree that grows up to 40-55 m tall with the trunk diameter of 1-2 m. It has conical crown with usually pendulous branchlets.

Piceasmithiana has been widely used for dendroclimatic potential from North Pakistan, India and Nepal (Ahmed et al., 2011; Borgaonkar et al., 2009; Cook et al., 2003). Some dated chronology using *Piceasmithiana* from Afghanistan without describing EPS, SNR and Rbar were evaluated by Khan et al. (2008). Therefore, the aim of the present study is to explore growth-climate response of this species by comparing correlation and response coefficients using different chronology versions with Dir climate and gridded data.

Material and methods

Twenty one cores from fifteen trees were cross-dated independently showing no flags in COFECHA statistics followed by Holmes et al. (1986); Grissino-Mayer (2001). Non climatic signals were removed using negative exponential curve method by software ARSTAN developed by Cook (1985) and important chronology statistics were further discussed like EPS, SNR and Rbar. We acquired mean monthly temperature and precipitation from meteorological data in Dir and gridded data from CRU TS 2.1 (http//www.cru.uea.uk/). Data of temperature and precipitation from Dir station spanned 42 years (1967-2009) and gridded data spanned 101 years (1901-2002). The climate-growth relationship was estimated using Pearson's product moment correlation analysis between chronologies and the mean monthly temperature and total monthly precipitation of Dir station and gridded data in the program Correlation and Response Function (DPL) introduced by Fritts (1976). A set of thirteen months window from previous October to current October was used.

***Author for correspondence E-mail:muhammadusamazafar@gmail.com**

Results and Discussion

Important chronology statistics obtained from program ARSTAN are presented in Table 1. COFECHA statistics were described by Khan et al. (2008). They found average chronology correlation of 0.54 with mean sensitivity of 0.18 also satisfying our results. Master series was found to be 344 years, i.e. 1663-2006. Locally absent were not recorded in any series. According to Speer (2010), mean sensitivity around 0.2 is generally considered as acceptable enough to reconstruct past climate whereas mean sensitivity around 0.1 is considered that rings are complacent. Our mean sensitivity value is within the limits determined by Speer et al. (2010). Esper et al. (2001) worked on Western Central Asia including Karakorum and Tein Shan Mountains and initiated following pointer years: 1917, 1877, 1871, 1833, 1806, 1790, 1742, 1669, 1653, 1611, 1605, 1591, 1572, 1495, 1492 and 1483. This study explained pointer years 1948, 1921, 1912, 1871, 1835, 1815, 1795, 1790, 1785, 1776, 1774, 1763, 1741, 1732, 1729, 1728, 1705, 1703, 1699, 1698, 1697, 1689, 1670, which does not match with the findings made by Esper et al. (2001) except two years, i.e. 1871, 1790. Common years interval of 101 years from 1900-2000 were used to create important chronologies values, i.e. expressed population signal (eps), Signal-to-noise ratio (SNR) and rbar. SNR tells the climatic signal of trees (Fritts, 1976) and present study result explains that value of SNR is low.

Table 1. Dendrochronological characteristics of the ring-width chronology from *Piceasmithiana* of Afghanistan. COFECHA and ARSTAN statistics based on 50-years segments lagged 25 years. Critical level of correlation at 99% confidence level.

Mean sensitivity	**0.18**
Series intercorrelation	**0.54**
Years absent rings all series	**1948, 1921, 1912, 1871, 1835, 1815, 1795, 1790, 1785, 1776, 1775, 1774, 1763, 1741, 1732, 1729, 1728, 1705, 1703, 1699, 1698, 1697, 1689, 1670**
Common years interval	**1900-2000 (101 years)**
Expressed population signal	**0.89**
Signal to noise ratio	**8.9**
Rbar	**0.28**
Rbar within the trees	**0.425**
Rbar between the trees	**0.27**

Growth-climate correlation and response are presented in Figures 1-4. No significant correlation was explained between chronologies and Dir meteorological station data. This is due to the fact that data of climatic station of Afghanistan was not available therefore it was argued that nearby station data should be used for the better analysis. This was further supported by the direction of Pakistan-Afghanistan border and Dir meteorological station, therefore, it may be anticipated that Dir data has no effects on plants growing on other side of mountain in Afghanistan area and this Pak/Afghan border serve as a climate barrier. A weak correlation was also seen when comparison was made between chronologies and gridded data. The total variance explained was 17.19% significant at 0.05 levels. Correlation coefficients showed negative correlation with previous October temperature and positive correlation with previous October and current January precipitation. The response coefficients also showed negative response to previous and current temperature in October. It shows positive response with previous October, current January with precipitation and January temperature and similar response as indicated in correlation coefficients in most of the months.

According to NOAA (National Oceanic and Atmospheric Administration), Afghanistan is a dry country and experiences extreme of climate and weather. The climate consists of snowy and cold winters and hot and dry summers. The snow season occurs roughly from October to April in mountainous area. In these areas, plant growth normally starts in early spring (February-March). Here, in this study, negative significant correlations of tree-growth with temperature and positive significant correlation with precipitation make no sense. Current January showed positive significant correlation with both temperature and precipitation which anticipates that higher temperature will tend to melt the snow to provide water for early growing plants and the same time, precipitation during this period will also promote the process of photosynthesis.

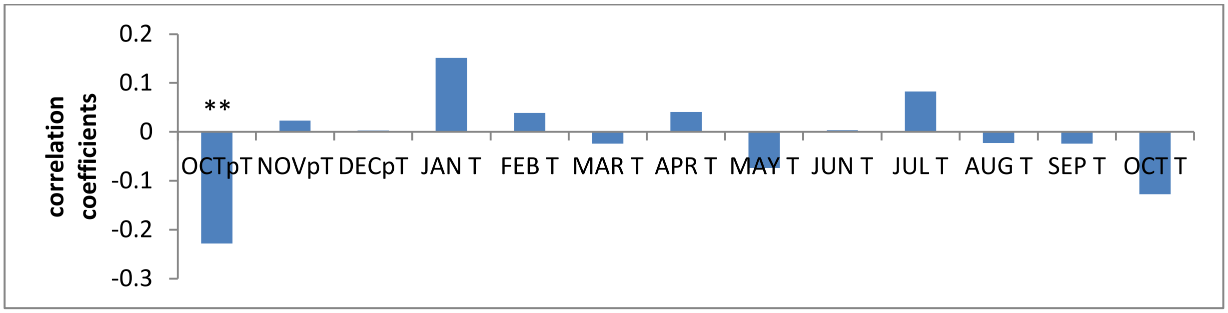

Fig. 1. Correlation function analysis between annual growth and gridded temperature data

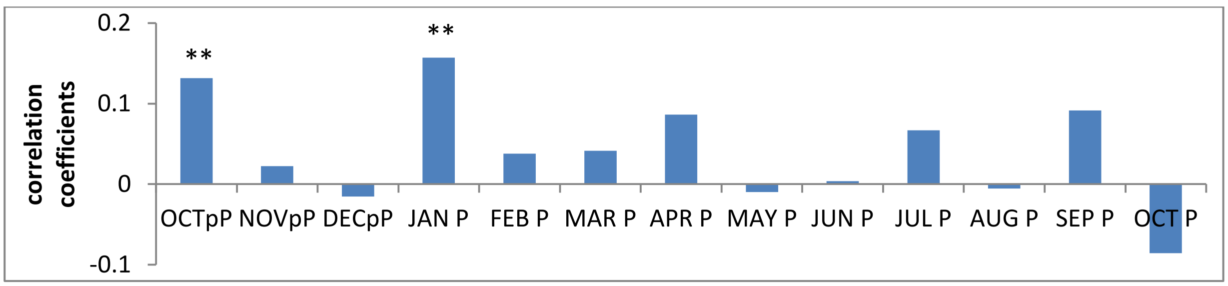

Fig. 2. Correlation function analysis between annual growth and gridded precipitation data

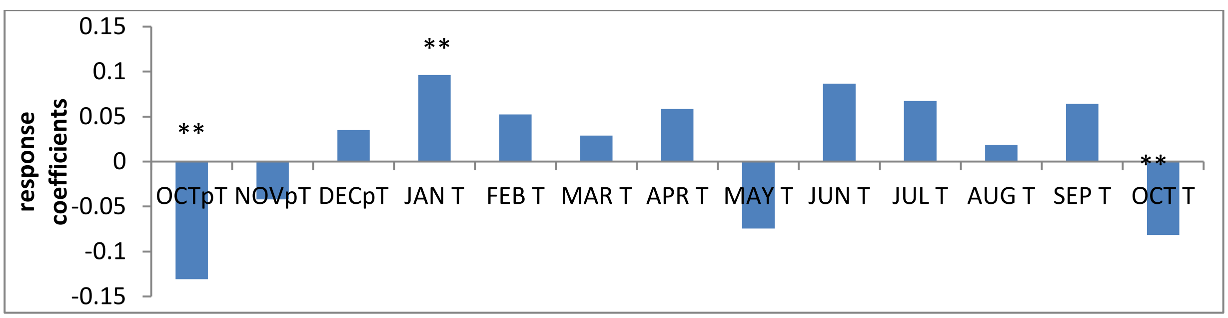

Fig. 3. Response function analysis between annual growth and gridded temperature data

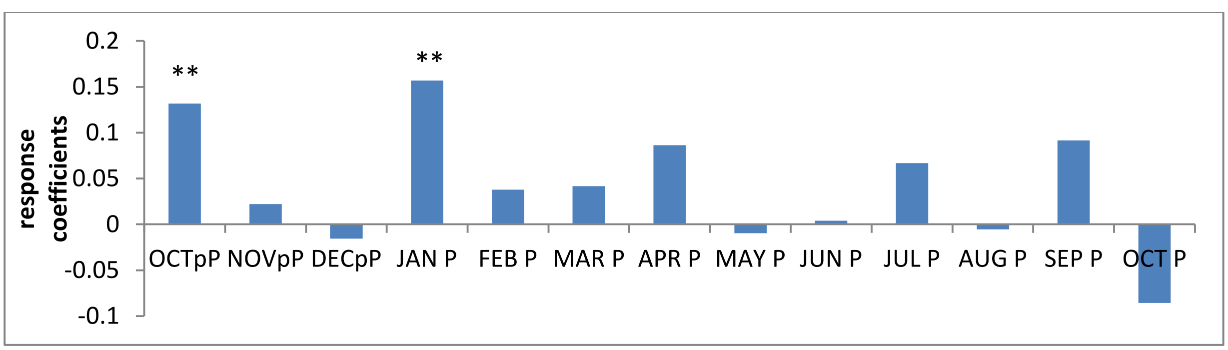

Fig. 4. Response function analysis between annual growth and gridded precipitation data.

Twenty eight sites were used to estimate the growth-climate response of temperature and precipitation by Ahmed et al. (2011). They explained significant positive response of tree ring indices with temperature in the months of previous November and pervious December. Our correlation and response function analysis also indicated same significant response (Figs. 1 and 3). They also showed significant negative response in the months of May and June 2012. In case of precipitation, their ring width indices showed positive response with March-May 2012 (spring).

Singh et al. (2006) reconstructed similar March-May precipitation using *Cedrusdeodara* of 13 sites in the Western Himalayas of India while our results do not show significant response in March and April. Ahmed et al. (2012) created growth-climate correlations by using four species including *Piceasmithiana*, *Juniperusexcelsa, Pinusgerardiana* and *Cedrusdeodara* from seven sites of upper Indus Basin where *Piceasmithiana* showing 43 to 64% of total variance. Our results are similar and significant in October 2011 and January 2012 for temperature and while October 2011 precipitation showed same positive trend for *Piceasmithiana*, however, in this study this species showed low variance.

The study also suggests that it is also possible to successfully cross-date and develop a site-specific ring-width chronology having potential to better recognise the role of *Piceasmithiana* succession in this area. Because temperature and precipitation are weakly negatively correlated, we suggest that it may be possible that mean monthly temperature is not the most limiting climate factor to growth in this area. It may be concluded that the climate-growth relationships illustrated in this study are uncertain until more wood samples are added and further dendroclimatological research of *Piceasmithiana* from Afghanistan is carried out.

References

Ahmed, M., J. Palmer, N. Khan, M. Wahab, P. Fenwick, J. Esper and E. Cook. 2011. The dendroclimatic potential of Conifers from Northern Pakistan. *Dendrochronologia,* 29(2): 77-88.

Ahmed, M., N. Khan, M.U. Zafar and J. Palmer. 2012. Climate growth correlations of tree species in the Indus Basin of Karakorum Range, North Pakistan. IAWA 33(1): 51-61.

Ahmed, M., T. Hussain, A.H. Shaikh, S. Hussain and M.F. Siddique. 2006. Phytosociology and structure of Himalayan Forests from different climatic zones of Pakistan. *Pak. J. Bot.*, 38(2): 361-383.

Borgaonkar, H.P., S. Ram and A.B. Sikdar. 2009. Assessment of tree-ring analysis of high elevation Cedrusdeodara D. Don from Western Himalaya (India) in relation to climate and glacier fluctuations. *Dendrochronologia*, 27: 59-69.

Cook, E.R., 1985. A time series analysis approach to tree ring standardization. PhD dissertation, University of Arizona, Tucson, A. Z.

Cook, E.R., P.J. Krusic and P.D. Jones. 2003. Dendroclimatic signals in long tree ring chronologies from the Himalayas of Nepal. *International Journal of Climatology*, 23(7): 707-732.

Esper, J., K. Treydte, H. Gartner and B. Neuwirth. 2001. A tree ring reconstruction of climatic extreme years since 1427AD for Western Central Asia. *Palaeobotanist*, 50 (2001): 141-152.

Fritts, H.C. 1976. *Tree Ring and Climate.* London: Academic Press.

Grissino-Mayer, H.D. 2001. Evaluating cross dating accuracy: A manual for the program COFECHA. *Tree Ring Research*, 57: 205-219.

Holmes, R.L., R.K. Adams and H.C. Fritts. 1986. Quality control of crossdating and measuring, a user manual for program COFECHA, in tree ring chronologies of Western North America: California, Eastern Oragon and North Great Basin. *Chronology Series* 6:41-49.

Khan, N., M. Ahmed and M. Wahab. 2008. Dendroclimatic investigation of *Piceasmithiana* Boiss., from Afghanistan. *Pak. J. Bot*., 40(3): 1063-1070.

Singh, J., W.K. Park and R.R. Yadav. 2006. Tree ring based hydrological records for Western Himalayan India since 1560 AD. *Climate Dynamics*, 26: 295-303.

Speer, J.H., 2010. *Fundamental of Tree Ring Research*. The University of Arizona Press Tucson.