# Exploring Biotechnological Insights into the Variability of Seed Germination in Platanus orientalis L. within the Kashmir Himalayas

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# Abstract

*Platanus orientalis*, commonly known as the Oriental plane tree, is a widely distributed and ecologically significant species with valuable insights for conservation practitioners, foresters, and plant breeders. Understanding the variability in seed germination within half-sib families is crucial for effective breeding programs, conservation efforts, and propagation techniques. This research paper investigates the patterns of seed germination variability in half-sib families of *Platanus orientalis*. Seeds from multiple half-sib families of *Platanus orientalis* were collected from a diverse range of parental trees across a natural population. The germination experiment was conducted under controlled environmental conditions, including temperature, moisture, and light. Germination rates, time to germination, and other related parameters were recorded for each seed within the half-sib families. The results demonstrated significant variability in seed germination within the half-sib families of *Platanus orientalis.* Germination rates ranged from 27.19–40.48%, indicating substantial differences in the reproductive success of individual parental trees. The time to germination also exhibited a wide range, with some seeds germinating within a few days while others took several weeks. Our findings demonstrate substantial variability in seed germination within half-sib families of *Platanus orientalis.* The study highlights the importance of considering genetic factors and environmental conditions in understanding and managing seed germination in tree populations. This research contributes to a broader understanding of plant floral biology and provides valuable information for conservation and breeding programs focused on *Platanus orientalis* and related species.


# 1. Introduction

Nestled amidst the majestic Himalayas, Jammu and Kashmir, a union territory, boasts a remarkable abundance of plant life. This can be attributed to the diverse topography of the region, which results in a wide range of flora. From arid plains characterized by thorny bushes to the temperate and alpine vegetation of the elevated areas, the botanical variety in this area is truly exceptional. Among the notable trees that thrive in Kashmir, the Chinar *(Platanus orientalis L.*) stands out as the most significant, with its presence spanning across the entire valley. *Platanus orientalis L.* is a tree species of the family Platanaceae. It is the only species of Platanaceae found in India. Its growth is limited to Jammu and Kashmir (Kozgar and Khan 2011). *Platanus orientalis* L., called 'Bouin' in Kashmiri (Fayaz et al. 2018). *Platanus orientalis*, commonly known as the Oriental plane tree, is a widely distributed deciduous tree species with ecological and economic importance (Aksoy 2022). It is known for its adaptability to a range of environmental conditions, including diverse soil types and climates (Wang et al. 2022). The germination behavior of *Platanus orientalis* seeds, especially within the context of half-sib families, has not received much attention from researchers, despite its ecological importance.

The evaluation of a batch of seeds' ability to germinate can be determined using three factors: the time it takes for germination to begin (lag), the speed at which germination occurs (rate), and the overall extent or percentage of germination achieved by the end of the testing period (cumulative germination). The composition of a seed batch can range from a mixture of seeds collected from various sources to a group derived from controlled pollination, known as a full-sib family. This genetic variation significantly influences the variability observed in the germination parameters of the seed batch (El-Kassaby et al. 2002). The estimation of seed-to-seedling conversion and the evaluation of seed lots for commercial seedling production rely on crucial germination parameters. These parameters play a significant role in determining the appropriate seed pre-treatment methods and nursery management practices required to achieve a desirable level of germination (Kolotelo et al. 2001).

Seed germination is a precarious transformation from the seed, which is the most adaptable to environmental conditions, to the seedling stage, which is the most delicate and susceptible to plant growth (Castro et al. 2005). Germination entails the development of a plant from a seed, leading to the formation of a seedling. It involves activating the seed's metabolic processes, leading to the emergence of the radicle and plumule. The germination process is influenced by both internal and external factors. Propagation through seeds (after stratification) is the first option. However, the rate of germination for *Platanus orientalis* species is poor (30–40%) (Anonymous 2003; Hartman et al. 2011).

Half-sib families, which result from controlled pollinations among different individuals within a population, provide a valuable framework for studying the genetic basis of seed germination variability (Norman et al. 2021). Investigating the germination patterns and variation within half-sib families can shed light on the heritability of germination traits and the potential for selection and breeding programs to improve seedling performance (Gupta et al. 2021). Seed germination is a crucial phase in the life cycle of plants, as it has a direct impact on the successful establishment and survival of individuals in natural populations. It is imperative to comprehend the elements that contribute to the variation in seed germination in order to develop effective conservation and management approaches for plant species. In the case of *Platanus orientalis*, a valuable tree species renowned for its ornamental and ecological significance (Rinaldi et al. 2019), investigating seed germination within half-sib families can provide insights into the genetic and environmental components underlying the observed variability. The germination process is influenced by a complex interplay of genetic and environmental factors (Salter 2019). In the context of half-sib families, genetic variability among seeds originating from the same parent can contribute to differences in germination rates and patterns. *Platanus orientalis* exhibits significant genetic diversity, making it an ideal species for studying the genetic basis of seed germination (Rinaldi et al. 2019). Besides genetic factors, environmental conditions play a crucial role in seed germination. Factors such as temperature, moisture availability, light intensity, and soil characteristics can significantly impact the germination success of *Platanus orientalis* seeds (Ahmed 2016). Investigating seed germination variability within half-sib families allows for a closer examination of how environmental cues interact with genetic variation to shape germination outcomes. Understanding the sources of variability in seed germination within half-sib families of *Platanus orientalis* can have practical implications for conservation and management efforts. By identifying genetic factors associated with high germination rates or improved tolerance to specific environmental conditions, targeted breeding programs can be developed to enhance seedling establishment and ensure the long-term viability of this valuable tree species (Wu et al. 2017).

The outcomes of this research will have practical implications for the management and conservation of *Platanus orientalis* as well as provide valuable insights into the broader understanding of seed germination variability in tree species. By identifying the genetic basis of germination traits, we can develop targeted strategies for enhancing seedling establishment and optimizing reforestation efforts. Moreover, our findings may contribute to the overall knowledge of seed germination processes and their ecological implications, thus benefiting the broader field of plant biology and seed science. Therefore, the objective of this study is to assess the variability in seed germination within half-sib families of *Platanus orientalis.* By quantifying the extent of germination variation and exploring the genetic factors contributing to it, we aim to provide valuable insights into the germination ecology and potential for genetic improvement of this important tree species. Studies on the seed germination of *Platanus orientalis* are limited, and the data collected are incomplete. Any conservation approach has to be based on a comprehensive study of the reproductive biology of flowering plants. In order to ascertain the barriers to fruit and seed sets and to understand seed germination that regulate the genetic structure of populations. Studies on seed germination also help in developing policies to preserve the genetic potential of this species. Which is crucial for its restoration and renewal. Keeping in view the above facts and to overcome the scarcity of data on seed germination of *Platanus orientalis* L., the present study was conducted with the aim of collecting baseline data regarding variability in seed germination of *Platanus orientalis* L. in the Kashmir Himalayas.

# 2. Materials and Methods

The current study was conducted in the research field at the Faculty of Forestry, SKUAST-Kashmir, Jammu and Kashmir. The study area is situated on the southern aspect at 34°16' 4" north latitude and 4°46' 31" east longitude. The research region is elevated at 1,783 metres (5850 feet) above mean sea level. The Sindh River spans the mountainous Ganderbal district. The district has every attribute of the Kashmir valley's climate on a general basis. The area has hot summers and extremely frigid winters due to its mid- to high-altitude elevation. From mid-March through June, there is a pre-monsoon / summer season with mild temperatures and a warm summer. The following season is the southwest monsoon, which lasts until September. Between the monsoon season and winter, there is a transitional month called October (Indian Meteorological Department). The majority of the annual precipitation, around 690 to 1150 millimetres, falls as snow and rain from December to April. The area experiences a large temperature fluctuation, with winter lows of -8$^{o}$C and summer highs of 33$^{o}$C. The study site's soil has a sandy loam texture, a high level of organic carbon, a pH that is essentially neutral, and typical electrical conductivity (Tahir 2015).

**2.1.** In order to study variability in seed germination in half-sib families of Chinar. Seeds collected in April were placed in the growth chamber in order to determine variability in germination at monthly intervals from May till December: (7 treatments x 3 replications x 100 seeds x 8 sets) 2100 seeds per set (per month).

### Sampling and method

| Design of Experiment | Factorial CRD |
|---|---|
| Number of factors | 02 |
| Months | 08 (eight) |
| Treatments | 07 |
| Replication | 21 |
| Seeds per replication | 100 |
| Total number of treatment combinations | 08 x 07 = 56 |
| Number of replications per treatment | 03 |

## 2. 2. Other germination parameters recorded

**a. Mean daily germination (MDG)**

MDG = FGP/d (Moghadam and Alaei 2014).

FGP stands for the viability percentage at the end of the germination process, while d represents the duration in days required to achieve the highest FGP.

**b. Germination Index (GI)**

GI: $(13\times N1) + (12\times N2) + \ldots\ldots + (1\times N13)$

N1, N2, and subsequent numbers represent the quantities of seeds that have sprouted on the initial day, subsequent day, and subsequent days. Meanwhile, 9, 10, and subsequent numbers indicate the corresponding weights assigned to the number of seeds germinated on the initial day, subsequent day, and subsequent days (Moghadam and Alaei 2014).

**c. Coefficient of Velocity of Germination (CVG)**

$CVG = 100x\Sigma Ni / \Sigma NiTi$, Ni represents the count of seeds that have started to sprout per day, while Ti indicates the number of days that have passed since the beginning of the experiment (Moghadam and Alaei 2014).

# 2.3. Statistical Analysis

The collected data underwent statistical analysis using both R software and SPSS software, which is a statistical package commonly used in the social sciences.

## 3. Results

The results of the present investigations, entitled “variability in seed germination of *Platanus orientalis* L. in Kashmir Himalayas,” have been described below:

**Variability in seed germination in half-sib families of chinar**

## 3.1 Seed germination

An inquisition of the data in Table 1 revealed that seed germination percent of *Platanus orientalis* increased from May, i.e., 27.19, up to July, i.e., 40.48; after that, it decreased gradually till December 6.38. Among trees, the maximum germination percent was observed in tree no. 6, i.e., 38.50, and the minimum in tree no. 4, i.e., 9.29. Seed germination in Table 1 revealed significant variation in both months and trees.

## 3.2 Mean daily germination (MDG)

The average daily germination rate of *Platanus orientalis* showed an increase from May, with a value of 1.50, to July, with a value of 5.64. After July, the germination rate gradually decreased until reaching 1.22 in December. Among the trees observed, the highest average daily germination rate was recorded in tree number 4, with a value of 4.29, while the lowest rate was observed in tree number 5, with a value of 0.94. This information is summarized in Table 2.

## 3.3 Germination Index (GI)

A thorough examination of the data in Table 3 showed that the Germination Index (GI) of *Platanus orientalis* exhibited an upward trend from May, reaching 310.28, and continued to increase until July, reaching its highest value of 593.286. After July, the GI gradually decreased and reached 182.24 by December. The analysis also indicated notable variations in seed germination among different months and trees. Tree number 1 displayed the highest GI at 490.21, while tree number 5 had the lowest GI at 234.58.

## 3.4 Coefficient of Velocity of Germination (CVG)

The analysis of Table 4 showed that the coefficient of velocity of germination (CVG) for *Platanus orientalis* increased from 11.88 in May to 14.82 in July. Afterward, it gradually decreased until it reached 10.43 in December. Among the trees, the highest CVG was observed in tree number 2, which was 13.18, while the lowest CVG was recorded in tree number 6, which was 11.54. The data demonstrates significant variations in seed germination across different months.

## 4. Discussion

The data presented in Table 1–4 highlight the complexity of seed germination and indicate that a single parameter is not enough to fully describe this process. The germination data in Figure Table 1 clearly demonstrate significant variation in both months and trees, emphasizing the multifactorial nature of germination. One important factor influencing germination is the physiological changes that occur in the seeds over time. As mentioned, certain unripened seeds undergo ripening from May to June, resulting in maximum germination in June. This suggests that the level of seed ripeness plays a crucial role in determining germination success. It is worth noting that seed ripeness can vary among individual trees, contributing to the observed variation in germination rates across different trees. Additionally, the decline in germination after June indicates a loss of seed viability. Viability refers to the ability of a seed to germinate and develop into a healthy plant. Over time, seeds naturally lose their viability due to various factors such as aging, exposure to adverse environmental conditions, or internal metabolic changes. This decline in viability explains the gradual decrease in germination observed in the later months. The findings from these tables highlight the need to consider multiple factors when studying and predicting seed germination. It is evident that both the ripeness of seeds and their viability are essential parameters to consider. Other factors such as environmental conditions (e.g., temperature, moisture) and genetic variations among tree populations may also influence germination and should be considered.

To fully understand and describe seed germination, a comprehensive approach that considers the interplay of various factors is required (Wolny et al. 2018). Future studies could focus on investigating the specific physiological and molecular changes occurring in seeds during ripening and the underlying mechanisms that contribute to the loss of viability over time. This would provide valuable insights for seed conservation efforts, agricultural practices, and the management of plant populations (Arif et al. 2022).

During a study by (Nakar and Jadeja 2014) on the germination of 20 different types of leguminous trees, it was observed that germination occurred more quickly and successfully at temperatures between 25 and 30 degrees Celsius. As a result, it was recommended that a temperature of 30 ± 2 degrees Celsius be considered the ideal condition for germination of leguminous tree species. Our results are consistent with the findings of (Gohil 2005), who observed a high rate of germination and viability shortly after collection in the dry season.

(Rokaya and Munzbergova 2012) suggested that an increase in temperature leads to a faster germination process. (Satyanarayana et al. 2011) discovered that in the case of Sterculi urens, there is a significant accumulation of protein content and reducing sugars during the initial phase of germination, up to 6 days, which promotes rapid germination. Previous studies by (Hall and Swine 1981; Whitemore 1978) concluded that rain forest seeds tend to germinate more quickly due to their short dormancy period. (Boter et al. 2019) argued that the germination value is a crucial physiological trait for assessing the performance and quality of seeds, making it a key aspect to consider.

The increased storage period under room conditions resulted in a decline in the ability of seeds to germinate. As reported by (Walter et al. 2005) the length of storage time is heavily influenced by environmental and genetic factors such as storage temperature and seed moisture content. When seeds degenerate during storage, they lose vigour, become more sensitive to stress during germination, and ultimately become unable to germinate, as reported by (Rajjou and Debeaujon 2008). It is also reported that genotype has a strong impact on vigour of the seed (Schmidt 2000).

The observed increase in MDG from May to July suggests a favorable germination period for *Platanus orientalis* during this time. This could be attributed to the combination of suitable environmental conditions, such as temperature, moisture, and light, which are essential for seed germination. The increase in MDG indicates that a higher number of seeds were able to successfully germinate on a daily basis during July compared to May. However, after July, the MDG gradually decreased until December, indicating a decline in the germination rate. This decline could be influenced by various factors, such as seasonal changes, reduced availability of favorable conditions for germination, or the completion of the germination process for a significant portion of the seeds (Nautiyal et al. 2023).

The focus of the Coefficient of Velocity of Germination (CVG) is not on the final percentage of germination but rather on the time it takes to achieve it. The specific details of when germination starts and ends, as well as the spread of time, are not considered as the time is averaged. Simply starting and ending germination at the same time is not sufficient to calculate an accurate and consistent CVG (Talska et al. 2020).

Additional investigation could be undertaken to determine the precise factors that contribute to the fluctuations in the Germination Index across different months and trees. This research would offer valuable insights into the ecological prerequisites and potential constraints for the successful germination and establishment of *Platanus orientalis.* It would also provide useful information for conservation initiatives or management strategies aimed at enhancing seed germination and fostering the growth of this species. The Germination Index (GI) seems to be the most comprehensive indicator, encompassing both the percentage of seeds that germinate and the rate at which germination occurs (Roman et al. 2022). This measure increases the diversity among seed batches in terms of germination by providing a numerical value that can be easily compared. The Germination Index (GI) gives the most importance to seeds that germinate on the first day and less importance to those that germinate later. Seeds that germinate on the 10th day are given the lowest weight. Hence, the Germination Index (GI) reflects both the percentage and speed of germination. A higher Germination Index (GI) indicates a higher percentage and rate of germination (Talska et al. 2020).

(Timson 1965) proposed the utilization of an index to give more weight to the majority of seeds and their impact on the parameters. The percentage of germination is measured every 24 hours, and the results are added up after a suitable period of time (usually two days). For example, if a batch of seeds achieved germination percentages of 40, 20, 0, 0, and 0 on days 1, 2, 3, 4, and 5 respectively, Timson's Index ($\sum 4$ in this case) would be calculated as 40 + 60 + 60 + 60 = 220. However, a challenge with this method was reported by (Heydecker 1966), where different germination percentages could result in the same index, making interpretation more complicated. For instance, if the aforementioned batch of seeds were compared to a second batch that had germination percentages of 10, 30, 30, 30, and 0 on days 1, 2, 3, 4, and 5 respectively, the Index would be 10 + 40 + 70 + 100 = 220, which is the same as the first batch despite their differences in germination percentage and time to ultimate germination. Therefore, it is recommended to use the Final Germination Percentage (FGP) in combination with the Mean Germination

Time (MGT) and Germination Index (GI) to depict both the germination percentage and its speed separately and together.

# 5. Conclusion

The current study found that using a single parameter is not enough to fully describe germination. The Final Germination Percentage (FGP) is a measure that only looks at whether seeds are able to germinate; it doesn't consider the speed, synchrony, or spread of germination. Analysis of the data showed that germination rates increased from May (27.19) to July (40.48), and then gradually decreased until December (6.38). The other germination parameters followed a similar pattern over the months. Statistically significant differences were observed in the germination parameters, including Mean Germination Time (MGT), Germination Index (GI), Germination Rate Index (GRI), Coefficient of Velocity of Germination (CVG), and Last Day of Germination (LDG), among different months. However, when it comes to the number of trees, these parameters vary among themselves.

Different germination parameters such as First Day of Germination (FDG), Germination Index (GI), Germination Rate Index (GRI), and Final Germination Percentage (FGP) exhibited statistically significant variations among trees. This suggests that the genotype of individuals in different half-sib families of *Platanus orientalis* plays a significant role in seed germination differences.

The research aimed to assess the variability in seed germination and identify potential factors influencing the process. The findings of the study indicate that there is a considerable degree of variability in the germination of *Platanus orientalis* seeds in the Kashmir Himalayas. The germination rates varied significantly among different seed batches, highlighting the importance of considering seed source variability when planning reforestation or restoration projects involving this species.

The results of this study have practical implications for forest management and conservation efforts in the Kashmir Himalayas. By recognizing the variability in seed germination, appropriate seed collection strategies and seedling production techniques can be implemented to ensure the success of reforestation initiatives. Moreover, the findings emphasize the need to consider site-specific environmental conditions when planning seed-based restoration activities for *Platanus orientalis* in the region.

In conclusion, this study enhances our knowledge of the seed germination dynamics of *Platanus orientalis* in the Kashmir Himalayas. It provides a foundation for further research and practical applications, contributing to the sustainable management and conservation of this important tree species in the area.

# Declarations

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# Tables

**Table-1: Variability in seed germination with respect to trees and months in half-sib families of chinar (*Platanus orientalis*)**

| **Months →** / **Tree No. ↓** | **May** | **June** | **July** | **August** | **September** | **October** | **November** | **December** | **Mean** |
|---|---|---|---|---|---|---|---|---|---|
| **$T_1$** | 14.67 | 39.00 | 54.67 | 45.00 | 26.67 | 63.00 | 28.00 | 18.00 | 36.12 |
| **$T_2$** | 17.00 | 23.33 | 34.00 | 7.67 | 23.33 | 14.67 | 6.67 | 4.33 | 16.37 |
| **$T_3$** | 21.67 | 32.00 | 27.67 | 27.33 | 15.67 | 14.33 | 6.33 | 6.33 | 18.92 |
| **$T_4$** | 16.00 | 6.67 | 15.67 | 6.67 | 13.67 | 8.33 | 4.33 | 3.00 | 9.29 |
| **$T_5$** | 14.67 | 12.33 | 52.00 | 92.67 | 27.00 | 9.00 | 23.33 | 4.33 | 29.42 |
| **$T_6$** | 56.00 | 45.00 | 85.00 | 31.67 | 47.67 | 24.33 | 13.67 | 4.67 | 38.50 |
| **$T_7$** | 50.33 | 41.00 | 14.33 | 66.00 | 13.67 | 22.00 | 16.67 | 4.00 | 28.50 |
| **Mean** | **27.19** | **28.48** | **40.48** | **39.57** | **23.95** | **22.24** | **14.14** | **6.38** | |
| **C.D. ($p \leq 0.05$)** | | | | | | | | | |
| **Months** | : | **1.61** | | | | | | | |
| **Trees** | : | **1.51** | | | | | | | |
| **Months x Trees** | : | **4.27** | | | | | | | |

**Table -2: Variability in Mean daily germination (MDG) with respect to trees and months in half-sib families of chinar (*Platanus orientalis*)**

| Months→ / Tree No.↓ | May | June | July | August | September | October | November | December | Mean |
|---|---|---|---|---|---|---|---|---|---|
| **$T_1$** | 2.32 | 2.59 | 0.04 | 0.27 | 2.93 | 3.77 | 0.52 | 0.59 | 1.63 |
| **$T_2$** | 1.49 | 0.94 | 6.67 | 15.60 | 0.25 | 0.68 | 0.15 | 0.87 | 3.33 |
| **$T_3$** | 2.77 | 1.18 | 0..19 | 2.50 | 14.67 | 0.50 | 1.55 | 0.78 | 3.02 |
| **$T_4$** | 0.57 | 1.49 | 27.99 | 0.93 | 0.63 | 1.34 | 0.92 | 0.39 | 4.28 |
| **$T_5$** | 0.37 | 0.79 | 0.70 | 1.18 | 0.65 | 0.54 | 1.35 | 1.91 | 0.94 |
| **$T_6$** | 1.92 | 0.10 | 1.32 | 0.80 | 0.72 | 2.49 | 3.59 | 0.69 | 1.46 |
| **$T_7$** | 1.08 | 3.88 | 2.58 | 0.31 | 1.28 | 2.95 | 2.49 | 3.32 | 2.24 |
| **Mean** | 1.50 | 1.57 | 5.64 | 3.09 | 3.02 | 1.75 | 1.51 | 1.22 | |
| **C.D. ($p \leq 0.05$)** | | | | | | | | | |
| Months | **: NS** | | | | | | | | |
| Trees | **: NS** | | | | | | | | |

**Table -3: Variability in Germination Index (GI) with respect to trees and months in half-sib families of chinar (*Platanus orientalis*)**

| Months → / Tree No. ↓ | May | June | July | August | September | October | November | December | Mean |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 340.00 | 88.67 | 881.00 | 1902.67 | 335.67 | 21.67 | 263.67 | 88.33 | 490.21 |
| $T_2$ | 392.00 | 98.00 | 836.33 | 199.67 | 39.33 | 165.00 | 387.33 | 89.67 | 275.92 |
| $T_3$ | 496.67 | 1080.67 | 1377.67 | 215.00 | 43.00 | 74.67 | 254.67 | 142.67 | 460.63 |
| $T_4$ | 791.33 | 379.00 | 269.00 | 123.67 | 384.00 | 64.00 | 145.67 | 178.67 | 291.92 |
| $T_5$ | 46.33 | 679.67 | 108.67 | 221.33 | 83.33 | 281.67 | 131.67 | 324.00 | 234.58 |
| $T_6$ | 46.33 | 166.33 | 205.33 | 85.00 | 1183.00 | 602.33 | 302.67 | 363.67 | 369.33 |
| $T_7$ | 59.33 | 103.00 | 475.00 | 855.67 | 1125.33 | 1302.0 | 94.00 | 88.67 | 512.88 |
| **Mean** | 310.28 | 370.76 | 593.28 | 514.72 | 456.24 | 358.76 | 225.67 | 182.24 | |

**C.D. ($p \leq 0.05$)**

| | |
|---|---|
| Months | **: 111.59** |
| Trees | **: 104.38** |
| Months x Trees | **: 295.24** |

**Table -4: Variability in Coefficient of Velocity of Germination (CVG) with respect to trees and months in half-sib families of chinar (*Platanus orientalis*)**

| Months→ / Tree No. ↓ | May | June | July | August | September | October | November | December | Mean |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 11.70 | 10.60 | 10.57 | 22.40 | 13.37 | 10.47 | 14.07 | 4.10 | 12.16 |
| $T_2$ | 9.67 | 8.77 | 17.23 | 18.50 | 20.43 | 7.10 | 12.87 | 10.90 | 13.18 |
| $T_3$ | 8.87 | 15.90 | 14.93 | 9.40 | 11.37 | 15.83 | 9.30 | 17.30 | 12.86 |
| $T_4$ | 10.67 | 10.70 | 17.33 | 13.47 | 7.23 | 15.47 | 10.07 | 12.43 | 12.17 |
| $T_5$ | 10.87 | 20.10 | 18.00 | 8.20 | 12.93 | 15.23 | 11.07 | 6.83 | 12.90 |
| $T_6$ | 15.73 | 7.23 | 15.77 | 13.00 | 8.30 | 9.00 | 10.77 | 12.57 | 11.54 |
| $T_7$ | 15.67 | 17.87 | 9.93 | 10.87 | 14.67 | 10.10 | 10.33 | 8.87 | 12.29 |
| **Mean** | 11.88 | 13.02 | 14.82 | 13.69 | 12.61 | 11.89 | 11.21 | 10.43 | |

**C.D. ($p \leq 0.05$)**

Months : **2.11**

Trees : **NS**

Months x Trees : **5.60**

# Figures

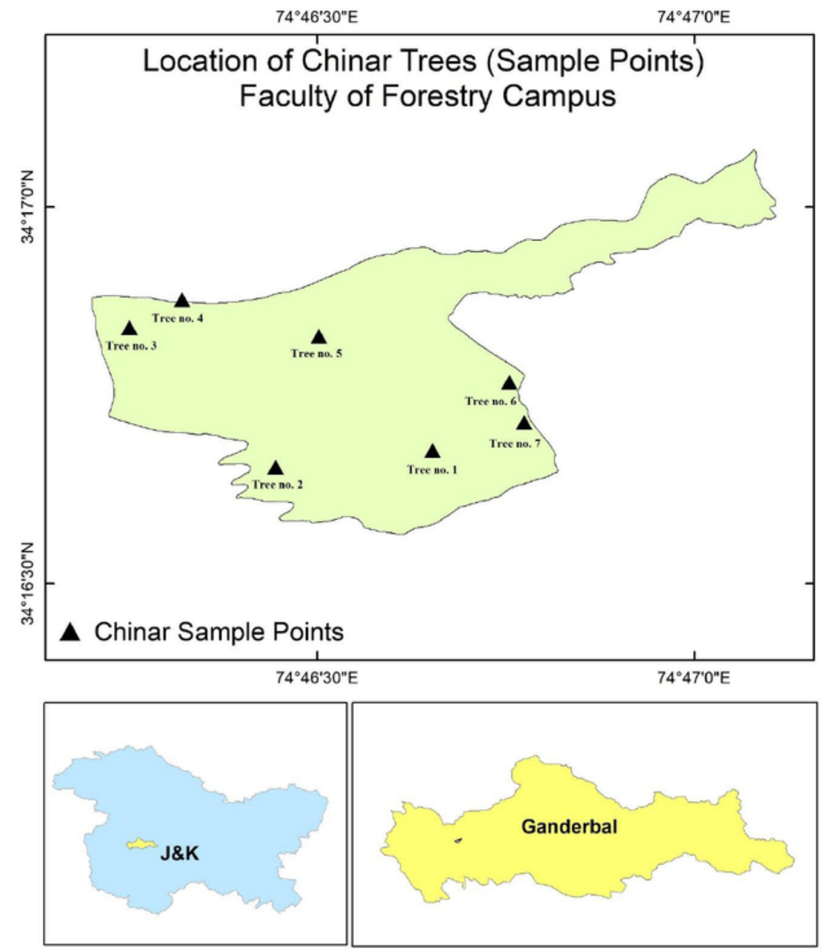


**Fig.1: Location of chinar (*Platanus orientalis*) trees (sample points) at Faculty of Forestry Benhama Ganderbal Kashmir, India.**

## Figure 1

See image above for figure legend.

**Figure 2**

**Germinated seeds of chinar (*Platanus orientalis*)**

# Supplementary Files

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- supplementarymaterial.docx