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Monitoring phenology to assess the response and adaptive potential of a Hellenic *Abies borisii regis* Mattf. population to inter-annual climate variability

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INTRODUCTION

Monitoring phenological traits may provide information of vital importance on the ability of individuals, populations, or species to adjust to climatic variations, by shifting the initiation and duration of biological events. Phenology could thus serve as an indicator of forest genetic material vulnerability in the face of climate change. The timing of phenological events, such as bud-break, flowering, etc. is dictated by environmental, physiological and genetic factors. Phases of phenological traits though, such as initiation of bud-burst or flowering has been proved to be under strong genetic control. In the current work the progress of bud burst phenophases is studied in adult and natural regeneration individuals growing in a Hellenic LIFEGENMON monitoring plot of *Abies borisii regis* for a period of four successive years. The results for the two generations under study are discussed in relation to the recorded interannual climate variability.

MATERIALS AND METHODS

The phenological trends of bud-break related to interannual climatic variability will be presented for two generations of a Hellenic *Abies borisii regis* population, based on the assessment performed on 40 adult fir trees and 200 individuals of natural regeneration, growing in a LifeGenMon monitoring plot (Fig. 1). The following four phenophases (1,2,3,4 as shown in the Fig. 2) were recorded at the same time for all adult and natural regeneration individuals of the monitoring plot. Daily recorded climatic data were used to assess the values of monthly mean temperatures and the monthly precipitation for the four successive years of the study (2016-2019).

Figure 1. Map indicating the location of *Abies borisii regis* monitoring plot.

Figure 2. Phases of *Abies borisii regis* bud break phenology.

RESULTS

Interannual variation of climatic conditions was notable (Fig. 3 & 4). Year 2019 was the most xerothermic one, as the site received 195 mm of precipitation in the period (Oct 2018-May 2019) while the mean temperatures exceeded the grand mean values across the whole period preceding the initiation of flushing, while the same was recorded also for year 2017 but to a less extend.

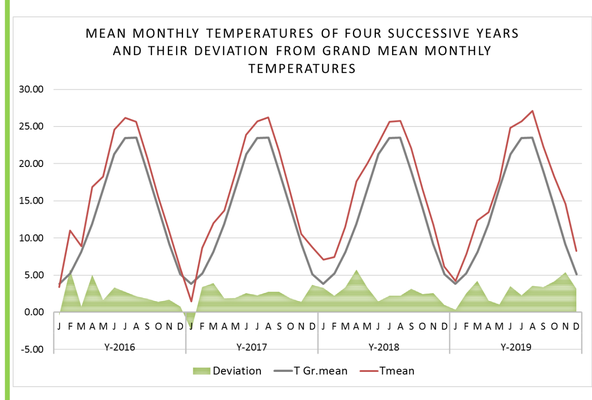

Figure 3. Interannual variation of mean monthly temperature values across the four years of the study and their deviation from the grand monthly average (30 years mean).

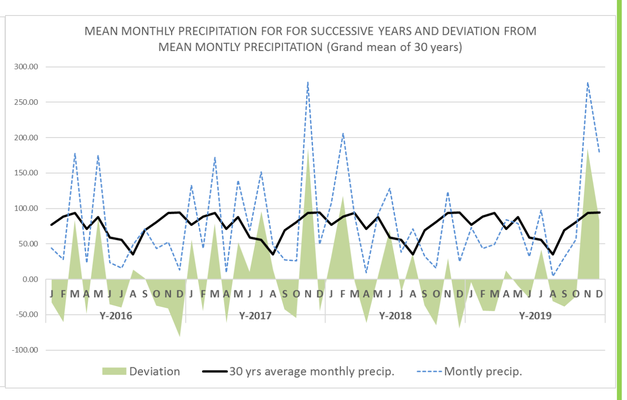

Figure 4. Interannual variation of monthly precipitation (mm) across the four years of the study and deviation from the grand monthly average (30 years mean).

RESULTS (Continued….)

Notable variation was recorded among years as well as among individuals for the initiation, termination and duration of the bud break period. Initiation of bud break occurred later during the year 2017 and especially during the year 2019. The above years were characterized by higher temperatures and reduced precipitation when compared to the climate of the site (30 years mean values), and especially for the whole period (fall-winter and spring) preceding initiation of bud break.

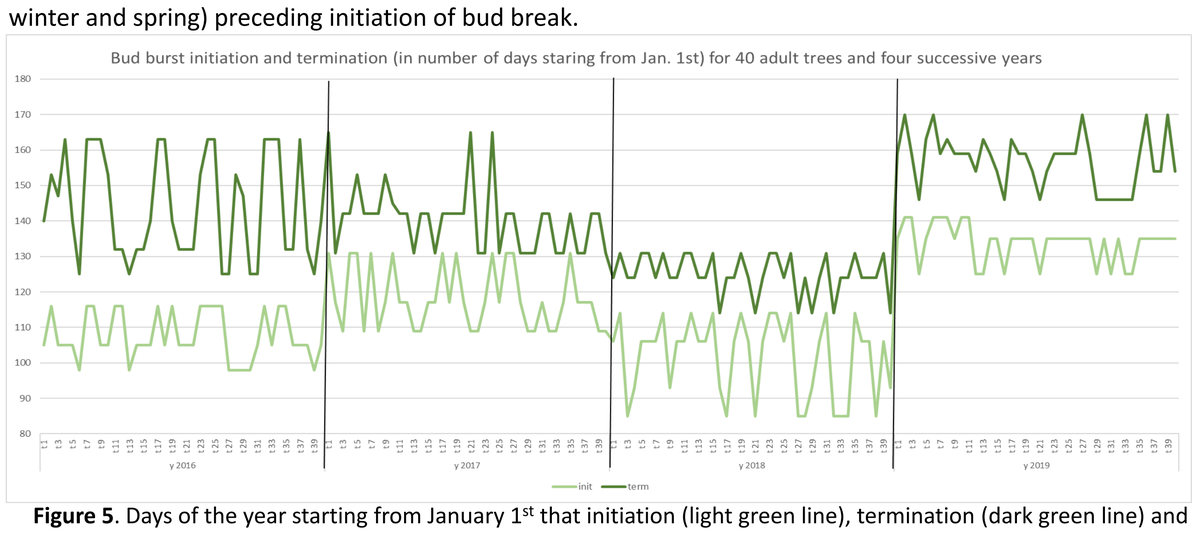

Figure 5. Days of the year starting from January 1st that initiation (light green line), termination (dark green line) and duration of the 40 adult trees has been recorded in the four successive years of the study. .

From Figure 6, and regarding the progress of the bud burst phenophases in the two different generations, it can be concluded that natural regeneration individuals initiated and terminated their budburst earlier than the adult trees, during all the four years of the study. This difference, and especially for earlier termination is very well expressed during the xerothermic year 2019.

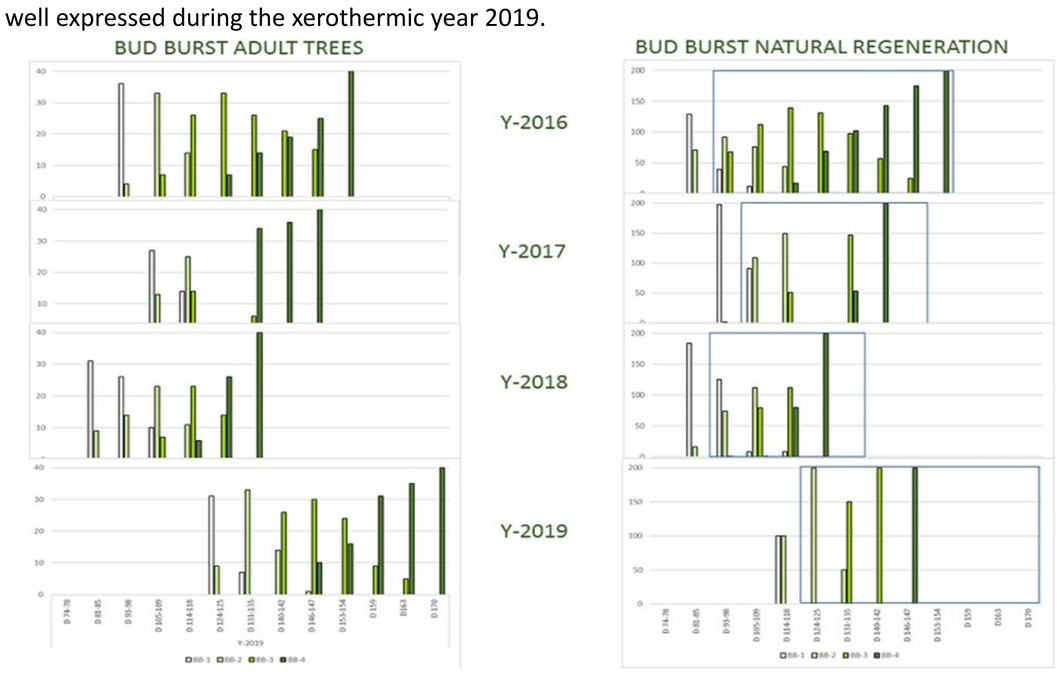

Figure 6. Bud burst phenophases for adult trees and natural regeneration (the boxes em in N.R. graphs indicate the bud burst period for adult trees).

CONCLUSIONS

Climate change, related in the Mediterranean region with intensification of xerothermic conditions, can result in notable delay of bud burst initiation due probably to induced stress to the plants. Adult trees expressed their plasticity to the interannual climatic variability by altering the time of bud burst initiation and its duration.

Comparison among different generations (adult trees vs natural regeneration) regarding the initiation of bud burst and its progress revealed that natural regeneration individuals initiated bud burst earlier than the adult trees of the stand, while the earlier termination was pronounced during all four years but especially in year 2019 which was the xerothermic one. This may indicate the adaptive and evolutionary potential of the population to climatic changes, as natural selection seems to be shaping the performance of younger generations.

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