Stem bursting as a consequence of winter injury on the young argan plants

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Abstract

The Argan tree (*Argania spinosa* (L.) Skeels) is an endemic species of Morocco, thriving in arid and semi-arid regions with a Mediterranean climate. It plays a crucial ecological, pharmaceutical, and socio-economic role in its native habitat. However, the Argan forest faces threats such as climate change, lack of rainfall, deforestation, overgrazing, and low natural regeneration. To address these challenges, artificial regeneration through seedling transplantation has been pursued, but many efforts have failed due to various constraints. In response, the Development of Argan Cultivation in Vulnerable Zones (DARED) project aims to enhance Argan tree transplantation techniques and overcome domestication of argan tree challenges. One such challenge observed is stem bursting in young plants. This study, conducted in Aguerdane village, Morocco, aimed to identify the causes of stem bursting and propose preventive measures. Field observations revealed the phenomenon of stem bursting predominantly at the basal part of young plants, followed by regrowth of shoots. Laboratory analyses ruled out rodent damage and pathogenic infections as causes, implicating climatic conditions, particularly cold temperatures, as the likely factor. Recommendations such as trunk wrapping to protect against extreme cold are proposed to mitigate stem bursting and promote successful Argan tree transplantation efforts.

Keywords: *Argania spinosa*, growth, climatic conditions, stem bursting

INTRODUCTION

The argan, scientifically known as *Argania spinosa* (L.) Skeels, is a forest species endemic to Morocco, grows naturally in arid and semi-arid regions with a Mediterranean climate (Emberger, 1939; Le Houérou, 1989; M'hirit *et al.*, 1998). Its distribution is mainly concentrated along the central west coast of Morocco, extending from north of Safi to south of Sidi Ifni (Baehni, 1948; Ehrig, 1974; Prendergast and Walker, 1992). thanks to its defoliation capacity, Argan tree has high adaptability to survive long periods of drought (Peltier, 1982; Ferradous *et al.*, 1996; M'hirit *et al.*, 1998). It can produce leaves, shoots and fruits even in low rainfall, not exceeding 100 mm (Emberger, 1939; Le Houérou, 1989; Ferradous *et al.*, 1996; M'hirit *et al.*, 1998). The Argan tree plays a crucial ecological, pharmaceutical and socio-economic role in its endemic area (Boudy, 1950); however, it is facing regression due to intense deforestation linked to the expansion of agroecosystem and urbanization (El Yousfi and Benchekroun, 1992). Excessive logging and overgrazing also contribute to the degradation of existing Argan forest. On the other hand, its natural regeneration is practically absent due to the low rainfall occurred for several years in the region, the excessive harvesting of the fruit and grazing by livestock of the few seedlings resulting from the germination of the few remaining kernels (Boudy, 1950; M'Hirit *et al.*, 1998; Bellefontaine *et al.*, 2010). In order to preserve this species, artificial regeneration by transplanting young Argan seedlings has become a necessary alternative. Several reforestation projects have been undertaken, but most have failed despite the efforts of the Water and Forestry Services (Khay, 1989; Alouani and Bani-Aameur, 1999; Harrouni *et al.*, 1999; Mokhtari and Zahri, 1999; Alouani, 2003; Bellefontaine *et al.*, 2010). These failures were partially attributed to the poor quality and low production of seedlings in the nursery, drying out and grazing. In the same context, a three-year project for the Development of Argan Cultivation in Vulnerable Zones (DARED) is currently being executed with GCF financing. This project is a part of the framework of the Green Morocco Plan and the program contract for the development of the Argan, while integrating national components and meeting Morocco's commitment to adapting to climate change. The Argan Cultivation program is part of the NAMAs (Nationally Determined Contributions) proposed by Morocco to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at reducing its greenhouse gas emissions by 42% by 2030. One of the aims of this project is to carry out argan tree transplant trials in different regions, using various techniques and treatments, in order to find the best methods and overcome the constraints linked to reforestation. Among these constraints, we observed the bursting of the stems and the drying out of some young Argan plants of 18-month-old. This study aims to identify the main factor of this phenomenon and formulate recommendations to prevent it.

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MATERIAL AND METHODS

Study site

The study was conducted in Aguerdane, a rural village in the Commune Territorial (CT) of Sidi Mzal, near Taroudant in Morocco. The local community of Douar Aguerdane is mainly engaged in agricultural activities, farming and livestock are the main practices for livelihood.

Field monitoring and observation

After replanting six-month-old argan plants in the Douar Aguerdane, we observed the desiccation of the aerial part of the young plants, followed by the recovery of the young shoots below the bursting point and the mortality of some of them during the cold period (end of November to February, 2021). The bark bursting was observed mainly in the basal part of the argan plants, a few centimeters from the collar, with simultaneous drying of the upper part and growth of the lower part of the shoot at the bursting point (Figure 1).

Several hypotheses have been proposed to explain the phenomenon, including damage caused by rodents, cryptogamic diseases, and the impact of climatic conditions. However, the first hypothesis is refuted as during our field observations, we found no traces of rodent bites on a sample of 30 plants displaying signs of bursting.

Laboratory sampling and analysis

To verify the second hypothesis, the plant protection team from the National Institute of Agronomic Research in Agadir collected samples of plants that showed bursting symptoms. The samples were then transported to the laboratory for microbiological analysis to detect the presence of any pathogens that may be responsible for these symptoms (Figure 2).

Figure 2: Sampling plants displaying the symptoms of bursting

At the laboratory, the roots and stems of the plants that showed bursting symptoms were disinfected by using a 5% sodium hypochlorite solution. The samples were rinsed three times with sterile distilled water and dried under aseptic conditions (Figure 3). The samples were then placed in Petri dishes with nutrient agar (NA) for bacterial detection and potato dextrose agar (PDA) for fungi. The dishes were incubated at specific temperatures, 25°C for PDA and 30°C for NA.

Figure 3: Pieces of roots and stems from argan tree plants displaying symptoms of cracking

Figure 1: Cracking of the stem and drying of young argan plants

Climate data in Taroudant region

To verify the hypothesis about the impact of climatic conditions on stem splitting, we analyzed the climate data history of the studied area from October 1, 2020 to February 28, 2021 (Figure 4). This period coincides with the onset of symptoms.

RESULTS AND DISCUSSION

The act of splitting did not result in plant death, but it did cause the upper part of the plants to become desiccated. During our field observations, we noted that bark cracks in all plants that exhibited splitting were primarily located in the lower part of the plants. Additionally, almost all young plants with affected lower parts exhibited bud regrowth (Figure 5).

At the laboratory level, a thorough diagnostic examination was conducted on the affected plant roots and stems. The hypothesis of rodent damage was rejected because no traces of mortality were found.

Incisions were made on both the roots and stems, and their quality was observed (Figure 6), indicating no signs of infection. Additionally, the microbiological test results validate the sample quality and demonstrate the absence of any pathogen (Figure 7). These findings refute the second hypothesis related to cryptogamic diseases.

Bark splitting, also referred to as "winter injury", commonly occurs during periods of intense cold when temperatures drop near or below freezing. Additionally, wrapping the tree trunks with insulating material can provide an extra layer of protection against extreme temperatures.

This phenomenon was observed in the Aguerdane region of Sidi Mzal in Taroudant in November 2020 when the temperature decreased to approximately 2°C. To mitigate the impacts of winter injury, it is recommended to choose tree species that are better adapted to the local

Figure 5: Regrowth of buds on the lower part of affected plants

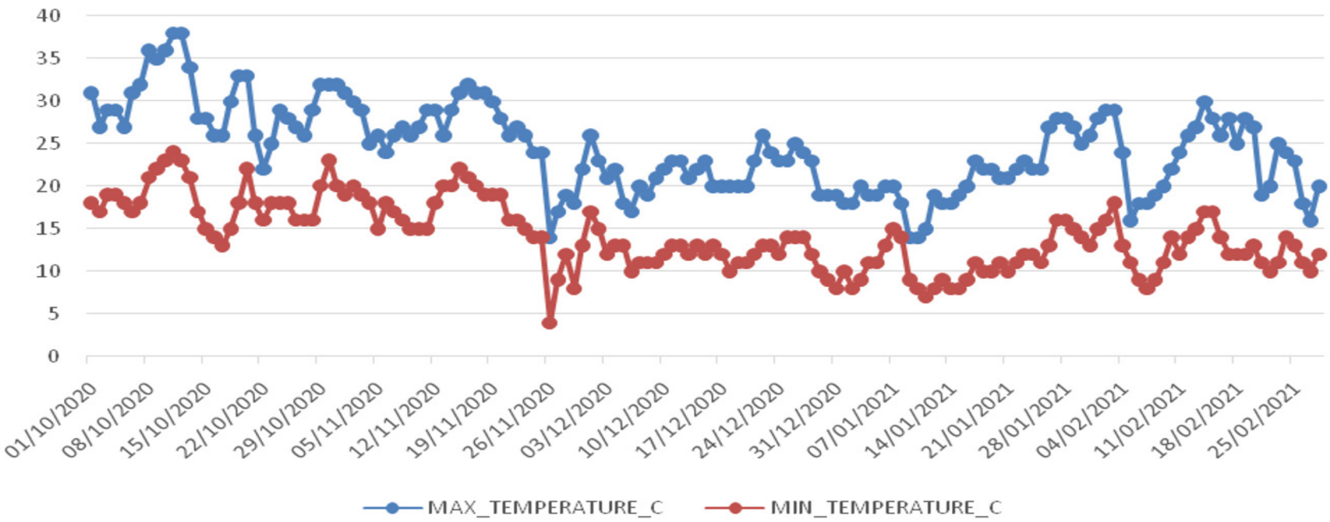

Figure 4: Climate Data for the Taroudant Region from October 2020 to February 2021

Figure 6: Cross-section illustrating root and stem quality

climate and to avoid over-fertilizing them which can result in weaker bark. When cold air infiltrates an arboreal tissue, a swift contraction occurs, leading to fissures of varied sizes and depths - from shallow cracks to larger ruptures. The immediate effects of bark rupturing due to cold include the desiccation of parts located above the fissures caused by the exposure to the tree's internal tissues to the cold and frost. Indirectly, this could allow for the entry of pathogens such as fungi or bacteria, leading to infections and illnesses. Several factors contribute to the splitting of bark in cold weather. Some trees are more susceptible than others, particularly those with thin bark. Studies have shown that some plant species have a limited ability to survive low temperatures, while others can develop tolerance to the cold (Boorse *et al.*, 1998; Wanner and Junttila, 1999). Trees previously subjected to stress, injuries, or fungal infections are more prone to bark splitting. According to Alouani (2003), the response of argan seedlings to cold conditions varies significantly depending on the genotypes of the parent plants. Some genotypes are more sensitive than others, allowing for the possibility of selecting cold-stress-resistant genotypes to improve plant growth and production.

Figure 7: Microbiological test results

CONCLUSION AND RECOMMENDATIONS

In conclusion, the natural phenomenon of bark splitting due to cold temperatures can cause damage to trees. However, preventive measures such as utilizing shade nets in the nursery, winter cover fabric, and proper irrigation can minimize risks and preserve the health of argan trees.

To prevent or reduce damage from cold, several measures can be taken:

- It is possible to use shading nets in nurseries for argan tree plant production, in order to protect young plants after germination, thereby creating a microclimate of temperatures higher than 10°C (Lamhamedi *et al.*, 2000).
- Applying straw bark or winter fabric around the tree can help to insulate the tissues and reduce the impact of the cold.
- Regular irrigation during cold periods can maintain adequate moisture in the tree tissues.
- Increasing the soil temperature by applying winter mulch at the beginning of the winter period can also be helpful.

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