Drought-induced tree mortality has been recently increasing and is expected to increase further under warming climate. Conversely, tree species that survive under arid conditions might provide vital information on successful drought resistance strategies. Although *Acacia*(*Vachellia*) species dominate many of the globe's deserts, little is known about their growth dynamics and water-use in situ. Stem diameter dynamics, leaf phenology, and sap flow were monitored during 3 consecutive years in five *Acacia raddiana* trees and five *Acacia tortilis*trees in the Arid Arava Valley, southern Israel (annual precipitation 20–70 mm, restricted to October–May). We hypothesized that stem growth and other tree activities are synchronized with, and limited to single rainfall or flashflood events. Unexpectedly, cambial growth of both *Acacia* species was arrested during the wet season, and occurred during most of the dry season, coinciding with maximum daily temperatures as high as 45 °C and vapor pressure deficit of up to 9 kPa. Summer growth was correlated with peak sap flow in June, with almost year-round activity and foliage cover. To the best of our knowledge, these are the harshest drought conditions ever documented permitting cambial growth. These findings point to the possibility that summer cambial growth in *Acacia* under hyper-arid conditions relies on concurrent leaf gas exchange, which is in turn permitted by access to deep soil water. Soil water can support low-density tree populations despite heat and drought, as long as recharge is kept above a minimum threshold.