Correlation of Germination capacity, Germination value, T-50, Peak Value, Mean Germination Time, and Germination Rate for *Melia volknesii*seed collected from Kibwezi seed orchard

Abstract

Melia volkensii is an important drought tolerant dryland species with drought tolerant characteristics that make it adoptable to harsh environments. The species is primarily propagated by seeds that are produced in fruits (drupes) that contain a single nut with each nut having two to five seeds. To collect data on the germination indecies of *M.volkensii,* fruits were collected from a seed orchard in Kibwezi and the nuts were extracted immediately. The nuts were stored in open containers for three months and seeds were extracted from the nuts. The extracted seeds were stored for two weeks prior to experimentation. The seeds were pretreated by soaking overnight in Ridomil solution made (4g of Ridomil per liter of water). The soaking solution was strained and the seeds rinsed with distilled water then carefully nicked by slitting along the longitudinal side of the seed using a sterilized razor blade. The nicked seeds were then placed in 500g plastic containers sterilized using 70% ethanol, and soaked in water for 30 minutes. The seeds were then sowed in four replicates of twenty five seeds each in the glasshouse and nursery, with the experiment laid out seven times by seven participants in both glasshouse and nursery. Onset germination was observed between day five and six with 77% germination in the glasshouse and 54% germination in the nursery. Peak germination was reached between day 19 and day 24, with germination rate highest between day 7 and day 19.From the current study, germination outcomes related positively with all other indices with the exception of T_{50}, the index whose increase corresponds with poor germination. Comparatively, Mean Daily Germination, Germination Value, and Peak Value (indices that indicate a fast germination rate) had a strong positive correlation to germination percentage.

Introduction

Kibwezi is located in the Eastern part of Kenya at an altitude of 861 meters above sea level and a longitude 37.9667. The area is considered as part of the Kenyan drylands, characterized by high mean temperatures of 26ºC and annual rainfall of 112.49 mm. The region is also characterized by bushed grassland to bushland vegetation (Njoki, 2006) and a tree cover that is dominated by Acacia, Balanites, Commiphora and Adansonia species (Gachambi, 1990; Njoki, 2006). With regard to *M. vokensii*, the area is considered as a natural habitat for the species with its adaptation to water deficient environments making it an important conservation and economical species for the region. Generally, propagation of the species is done by the use of seed, with the natural population as the main means for conservation and maintenance of genetic diversity. This diversity has provided materials for the establishment of seed orchards through use of high value individuals for seed production (Kariuki *et al*., 2021).

With regard to its characteristics, *Melia volknesii* is a drought tolerant deciduous species that grows to approximately 20 meters tall (Muok*et al.,* 2010; Orwa *et al.*, 2009). This feature provides capacity for production of high quality timber (Wekesa, *et al.,* 2012; Githae&Mutiga, 2021). In addition, due its capacity for drought tolerance, it has manageable water requirements and can be utilized as s source of fodder during harsh climatic conditions (Wekesa, *et al.,* 2012). This ability to thrive under harsh conditions therefore makes the species significantly important in environmental conservation and restoration efforts. Besides food, fodder and conservation, the species is also utilized as a source of bee forage and medicines (Omondi *et al.,* 2004; Muok*et al.,* 2010; Stewart &Blomley, 1994), as well as a potential pesticide source (Jaoko*et al.,* 2021).

This exceptional value has resulted in increased demand and utilization of quality seed (Kamondo *et al.,* 2021). However, forestry tree seeds have varied germination characteristics based on genetics as well as provenance (Gupta and Sehgal, 1999). This therefore necessitates detailed research on seed source related effects germination characteristics (Wani & Singh, 2016). Such results are important for large scale restoration programs as well as for tree improvement programs that depend on both seed germination and seedling survival. In addition, according to Zobel and Talbert (1984) such information is important in advising large scale forestry restorations programs on applicability of seed sources as a measure against seed quality related losses. This current study therefore seeks to assessthe correlation dynamics of seed germination of *Melia volknesii* seed from a seed orchard. The seeds for the study were sourced from Kibwezi seed orchardestablished and maintained on the principles outlined byMulawarman et al (2003) and Mbora et al (2009), as outlined by Kariuki et al (2021).

Objectives

- To compare the variations in germination of *Melia volkensii* seed under different germination environments.
- To assess the correlation dynamics of seed germination of *Melia volknesii* seed.

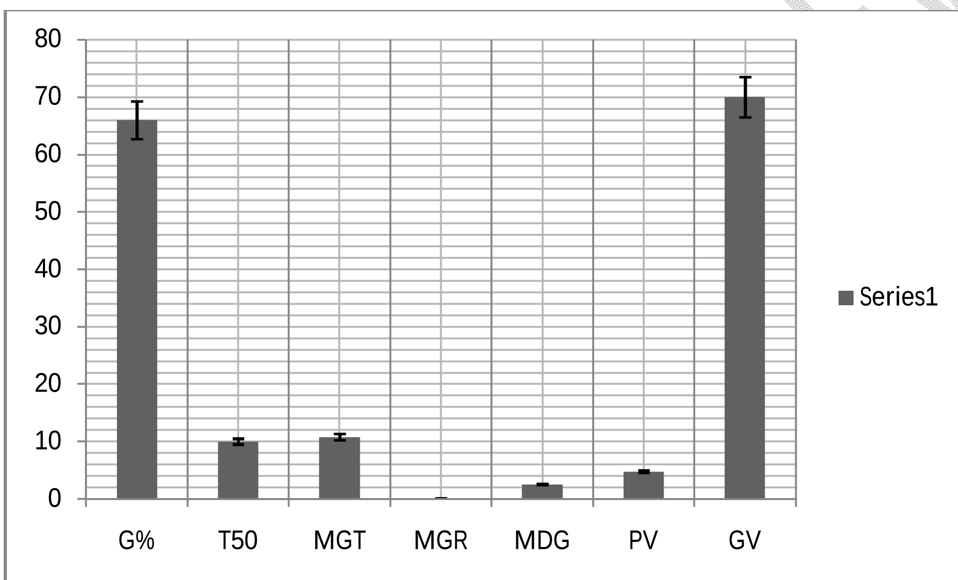
Methodology

*Melia volkensii*nuts collectedfrom Kibwezi orchard and seeds extracted and prepared for germination testing according to the procedure described by Olung'ati et al (2023).The seeds were then germinated in the glasshouse and nursery at KEFRI Seed Center Muguga using shallow drills and light covering. The sown experiments were then covered with a transparent polythene bag and observed for 25 days according to Njehu et al (2021) as described by Olung'ati et al (2023). Germination data was collected on daily basis for 25 daysand analyzed to generate germination indices values according based on the formulas as cited in Dastanpoor et al (2013), and Djavanshir&Pourbeik (1976), and edited by the author using Excel software. The output was subjected to ANNOVA using Genstat Version 14. Correlations were done and assed as described by Schober et al (2018).

Results

The overall germination capacity of the seeds varied statistically across the germination sites ($p<.001$). Germination capacityat the glasshouse had a general mean of 77% while germination capacity at the nursery had an overall mean of 54%. The seeds however had a general germination percentage of 66%. This percentage translated to a GV of 70%, indicating the potential for complete germination at optimal speeds for at least seven tenths of the material regardless of site. Between the two sites, GV was higher in the glasshouse at 92% as compared to in the 48% in the nursery. Comparatively, T_{50} for the two sites was not significantly different with a mean of 10 days across sites, 12 days in the glasshouse and 11.5 days in the nursery. This resulted in an MGT of between 10 to 11 days for both sites (Figure 1).

Figure 1: Germination indices for *M. volkensii* seeds germinated under different conditions.



Of all the germination indices, only T_{50} had a net negative correlation to germination percentage. This correlation was however weak at 9%. On the other hand, MDG and PV had a strong positive correlation to germination percentage at 97% and 92% respectively. Similarly, GV had a strong positive correlation to germination percentage at 81%, but the value was lower than that of MDG and PV. The weakest correlation to germination percentage was recorded from MGT and MGR. However, both MGT and MGR had a weak positive correlation to germination percentage at 10% and 19.6% respectively. For the other indices, T_{50} had negative correlations with all other indices with the exception of MGT (93%, strong) and GV (12%, weak). Comparatively, GV had positive correlations with all indices with the exception of MGR with a strong negative correlation of 77% (Table 2).

MGR also had strong negative correlation MGT at 98%. While the other indices had weak positive correlations to GV, MDG had a strong positive correlation to GV (77%). In addition, MDG had positive correlations with other indices with the exception of MGT and T_{50} that had negative correlation to MDG at 11% and9.1% respectively. MGT also had weak negative correlation PV at 28%, while PV also had a weak negative correlation to at T_{50} at 24% (Table 2).

	G%	T_{50}	MDG	MGR	MGT	PV	GV
G%	-						
T_{50}	-0.091	-					
MDG	0.972***	-0.091	-				
MGR	0.196	-0.917	0.169	-			
MGT	0.1	0.937***	-0.11	-0.981	-		
PV	0.927***	-0.243	0.92	0.363	-0.281	-	
GV	0.081	0.124	0.77	-0.77	0.126	0.043	-

Table 1: Correlation for germination indices for *M.volkensii* seeds germinated under different conditions.

Discussion

The negative correlation between T_{50} and germination percentage is indicative of the effect of slow germination times on the overall achieved germination. In addition, it indicates the possibility that fast germinating seeds, as a cause of higher germination outcomes, could indicate higher seed quality and vice versa. This relationship is however opposite to that that expressed by mean daily germination (MDG) and peak value (PV), where an increase in the MDG as well the PV corresponds to an increase in the overall germination. These results therefore quantify that higher daily germinations result in lower T_{50} and conversely higher PV and germination outcomes. According to Djavanshir&Pourbeik (1976), higher peak values are an expression of seed quality, and generally correlates positively with germination speed. According to Finch-Savage & Bassel (2016)a faster germination is an indication of vigour which subsequently affects field uniformity positively. In addition, a higher vigour of seedlings can likewise be provided as an indicator for seedling survival (Finch-Savage & Bassel, 2016; Khan *et al.,* 2012).

On the other hand, out of all evaluated indices, only MGT had a strong positive correlation with T_{50}. This indicates that seed lots with a longer germination time consequently will require a longer time period to achieve T_{50}, as increase in one index results in an increase in the other. On the other hand, all the other indices expressed a decrease with increase in $T_{50,}$ vice versa. While a longer time to T_{50} can be considered negative for species considered as having relatively fast germination, it may vary between forestry species depending on average germination time. On the other hand, MDG correlated positively with all other indices with the exception of T_{50} and MGT. This relationship indicates that an increase in daily germination lowers the overall germination time as well as time to T_{50}. Daily germination and germination time can be affected by seed physiology, seed germination environment (Tonguç*et al*.,2021), and for forestry seed the skill of germinating practitioners(Luna *et al.,* 1949;Olung'ati *et al.,* 2023; Omondi *et al.,* 2004).

Of all the Indies, germination value (GV) had a significant correlation with MDG and mean germination rate (MGR). While the relationship was positive for MDG it was negative for MGR. These results therefore quantify that seeds with a higher MDG have a higher GV, and that increase in the GV corresponds to a decrease in MGR. Comparatively, seed germination rate is higher at onset of germination and slows down as it approaches peak value, then plateaus. The highest GV is recorded after the plateau at the point when MGR is lowest, hence a negative correlation between GV and MGR. The relationship therefore has no implication on seed quality, only on the nature of seed germination over time.

Recommendations

From the current study, germination outcomes related positively with all other indices with the exception of T_{50}, the index whose increase corresponds with poor germination. Comparatively, Mean Daily Germination, Germination Value, and Peak Value(indices that indicate a fast germination rate) had a strong positive correlation to germination percentage. The relationship between germination indices provides an important means for understanding and apportioning effects of different factors that lead to germination issues. In addition, such relationships highlight the actual panting value of a seed lot with regard to seed germination as well as seedling survival. For *M. volkensii*, GV, PV, and MDG are the best indices for use in evaluating overall seed germination value in correlation to germination.

Research to determine the provenance related variations in such relationships should be pursued to build on information of seed germination and seed germination behavior. For the *M. volkensii* seeds tested the results indicate, high germination potential when for orchard sources seed when freshly extracted. Therefore, indices for stored seed should likewise be investigated.

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