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Effects of Seed Storage Time on Germination of Ancylobothrys Petersiana Seed

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Abstract

The propagation of wild plants is lagging even though rural communities are eager to be involved in the propagation and domestication of valued wild fruit trees. Erratic rainfall, dry spells are common in the areas where the fruit tree exist and together with the soil compaction making it difficult for seed to be buried in the soil to enable germination but remain on the surface. The objective was to evaluate the effects of the length of seed storage with natural dehydration on loss of seed viability and germination. The seeds were obtained and prepared from mature ripen fruits. The seeds were tested for viability prior to the experiment. The experiment was laid out in a complete randomized design (CRD) with eight treatments replicated four times. The seeds were sown at different storage periods from the first day of harvesting the fruits and seed preparation and then sown at fourteen days interval up to ninty eight days from seed preparation. The soil media was obtained from the fruit tree the original site where they occur naturally. The data collected include germination percentage and development into individual seedlings or plants that could be transplanted. The data was analysed for Analysis of Variance (ANOVA) using Genstat version 14. The least significant different was used to identify different means. Prolonging seed storage with dehydration had significant effect on seed viability and seed germination. The results show that there was significant difference ($p<0.001$) between treatments used. Prolonged seed storage owing to seed dehydration has significant effects ($P < 0.05$) on seed viability and germination. The study has shown that climbing wild apricot seed viability is lost due to longevity of seed storage with loss of moisture. Extreme seed dehydration of *A. petersiana* resulted in seed splitting and separation of cotyledons and this worsened the chances of reviving of the seed during hydration.

Key words: Seed Storage, Time, Germination, *A. Petersiana*, Masvingo

JEL classification: Q1, Q10, Q25

Paper Classification: Research Paper

Introduction

The propagation of wild plants is not well adopted in most smallholder farming areas of Zimbabwe even though most of the rural communities are willing to be involved in the propagation and domestication of wild fruit trees (Pye-Smith, 2010, p. 405) but the problem is due to the limited attention being paid to wild fruit trees. This may also be linked to edaphic factors in most wild environments such as compaction and dryness has owed poor germination of *A. petersiana* seed. Under these environments seed(s) are hardly buried in the soil and some usually remain in the soil without germinating due to limited conditions to promote germination (Bewley & Black, 1994, p.75). The limatic conditions in most smallholder farming communities in Zimbabwe do not favour the perpetuation of natural sexual propagation of climbing wild apricot seed due to the erratic rainfall, dry spells in areas where the fruit tree exists and high temperatures owing to the high seed dehydration. In natural region IV, for example, rainfall received is below 500 mm (Vincent and Thomas, 1960, p.3) accompanied with long dry spell and mean annual temperatures ranging from 21- 25 ^{0}C (Mugandani, Wuta, Makarau & Chipindu, 2012, p.364). These high mean annual temperatures cause high loss of water through evaporation leading to dehydration of seed. Plant competition, pest and diseases, edaphic factors and natural burying of seeds at planting are some of the factors that hinder natural sexual propagation of climbing wild apricot seed.

The wild apricot seeds are recalcitrant seeds which are easily affected by prolonged seed storage resulting in natural dehydration of moisture that may cause loss of seed viability (Bewley & Black, 1994 p80; Bewley, 1997, p.1058; Geneve, 2003, p.339). Loss of viability due to prolonged dehydration of recalcitrant seed is not uniform but varies between and within species (Copeland, and Mcdonald, 1995, p.34). The exposure of seeds to low moisture level environments may results in loss of seed viability as this causes seeds to rot (Copeland & Mcdonald, 1995, p.67, Geneve, 2003, p.338). Hydration of these affected seeds to reinstate them to their original seed structure is difficult to achieve. Barrie & Drennan (1970, p.137) reported that enzymes responsible for germination of recalcitrant seed are highly denatured due to loss of seed moisture. The dehydration results in hardening and deformation of cellular membranes which makes them stiff to rupture to allow the germination of the embryo. The dehydration also results in moisture impediment due to stiffened cellular membranes hence they will fail to absorb moisture for them to return to their original state (Bewley, 1997, p.1057). In extreme cases of seed dehydration, seed splitting and separation of cotyledons will occur especially in dicotyledonous seeds (Geneve, 1998, p.680). Dehydration also causes embryonic death, suppressing absorption of moisture hence germination will not be achieved (Geneve, 1998, p.700).

After the ripening of fruits, they will be consumed by animals, humans and some may decompose naturally releasing seeds on the ground. Poor deposition of seeds on ground by animals allows seeds to remain dormant for many years until it is buried in the soil properly. The seeds left on the soil surface are affected by high temperatures, windy conditions, low humidity and prolonged dry spells results in elevated seed dehydration (Bewley & Black, 1994, p.1060; Copeland & Mcdonald, 1995, p.37; Geneve, 2003, p.340).

Review of Literature

Description of *Ancylobothrys Petersiana*

Climbing wild apricot can grow up to six metres or more and it often climbs over other trees, rock outcrop or creeping on the ground. Climbing wild apricot has milky sap that oozes out of foliage and fruit whether ripe or unripe whenever damage is initiated. Young branches of this species appear brownish pubescent (Hyson, 2002, p.20) and older branches usually bear spotted noticeable pores (Hyde, Wursten & Ballings, 2013). Hyson (2002, p.24) reported that climbing wild apricot leaves are elliptic or obovate-elliptic in shape with apex rounded or obtuse and are thin or thick with a resemblance of leather. Wild apricot leaves has a dark green sparsely pubescence or glabrous on the upper leaf surface. According to Hyde *et al*. (2013, p. 14) climbing wild apricot leaf nerves are well spaced and curving towards the leaf apex forming a network of venation which is reticulating level. Ibrahim (2011, p.46) reported that the petiole of wild climbing apricot ranges from 3- 8mm in length and lamina ranges from 5–11·5 x 1·8–5 cm. The tree usually flowers from September to December (Hyde *et al*., 2013, p.12). Inflorescences of the tree stretch panicles with each lateral branch terminating into a dense flower-cluster (Ibrahim, 2011). Flowers have elongated branched panicles bearing petals which are approximately about 4 cm in diameter, white or creamy in colour, sweetly scented (Hyde *et al*., 2013, p.14). The flowers are pubescent in upper part inside, glabrous or sparsely puberulous outside and lobes elliptic to oblong. Iinflorescence-axes are soft; calyx is 2–3.5 mm long and pubescent outside, (Hyson, 2002, p.24). Stamens are inserted near base of petal-tube; anthers are approximately 1.5–2 mm long and cylindrical. Ovary is 1 mm in length and globular in shape with a dense ring of pale hairs round the apex. Stigma is approximately 1.5–2 mm. long (Ibrahim, 2011, p.48). Wild apricot fruits are spherical, fleshy and juice, 4.5-6 cm in diameter, green when unripe and yellow or orange in colour when ripe and velvety in textural appearance and edible**,** fleshy, juice and delicious (Hyde *et al*., 2013, p.13).

Effect of seed storage and dehydration on seed germination

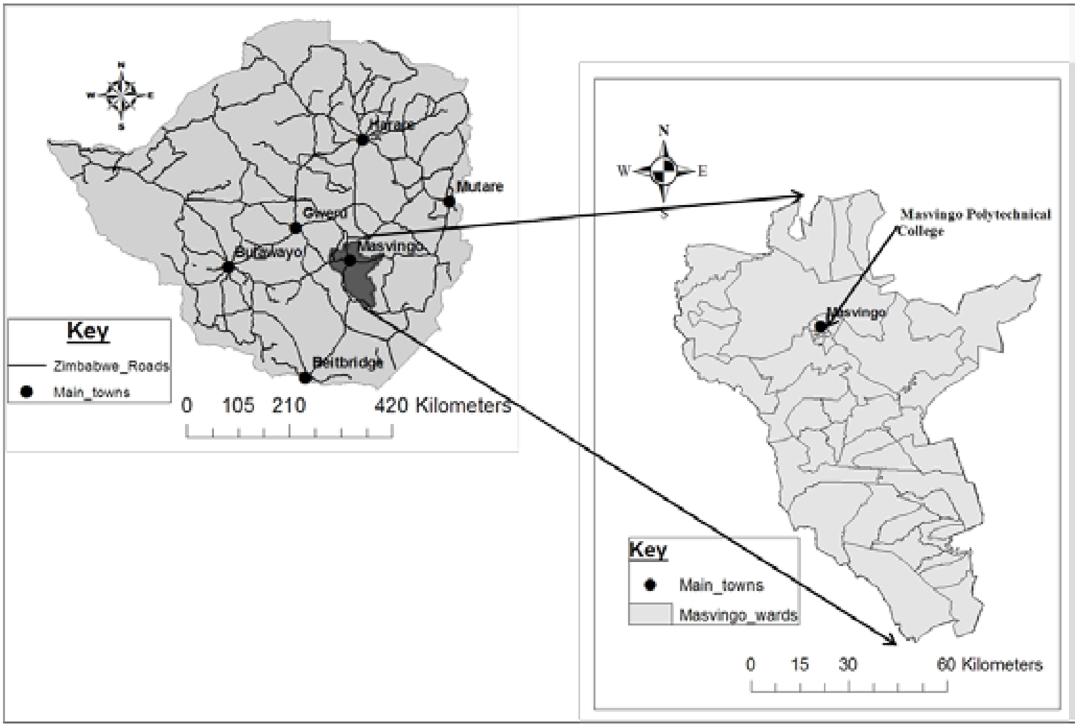
Simmon (1974, p.405) mentioned that seeds are divided into orthodox which are desiccation tolerant and recalcitrant which are desiccation sensitive. Seeds of some species do not survive dehydration as water is a major determinant of germination (Bewley & Black, 1994, p.78). Recalcitrant seeds do not accept loss of bound water without seed viability damage and display signs of dehydration stress caused by loss of bound (Bewley and Black, 1994, p.76, Copeland & Mcdonald, 1995, p.34; Bewley, 1997, p.1061; Geneve, 1998, p.702; Geneve, 2003, p.337). Copeland & Mcdonald (1995, p.34) reported that desiccation sensitive seeds must not be dried prior to planting and their storage must be done for a short period (few days or months depending on the plant species). Geneve (2003, p.336) reported that different varieties of the same species have different response to desiccation. Germination of desiccation-sensitive seeds declines rapidly as seed moisture content decreased due to dehydration induced loss of viability. In contrast orthodox seed can die prior to planting and seed storage can be done for a longer period of time with the seed losing moisture in storage but without loss of seed viability (Bewley & Black, 1994, p.75; Copeland & Mcdonald, 1995, p.37; Bewley, 1997, p.1059; Geneve, 1998, p.699; Geneve, 2003, p.340)**.** Water uptake by desiccation tolerant seeds after seed have dehydrated may restore seeds to their original structure, whereas dehydrated membranes of desiccation-sensitive seeds will not be able to restore structure leading to no germination.

Materials and Method

Study Area

The experiment was carried out at Masvingo Polytechnic College in Masvingo District in Masvingo Province of Zimbabwe. Masvingo Polytechnic College is located in Masvingo town and on the east side along Masvingo– Beitbridge road with the longitudes and latitudes of 20^{0} 5^{1} S and $30^{0}50^{1}$ E. The study site is on altitude of 1240 m above sea level. The study area is in agro-ecological region IV (Thomas & Vincent, 1961, p.5) and dominated by Savannah and Miombo woodlands. Mugandani *et al*. (2012, p.365) reported that the study area has a mean minimum temperature range of 11-20 ºC; mean maximum temperature range of 19-26ºC and a mean annual temperature range of 18-24ºC. Annual rainfall ranges from 450- 650 mm. Most of the rainfall is received in summer from October up to mid-March. The soil is of the fersiallistic group, brown sandy soil derived from granite. The terrain generally ranges from moderate to steep slopes with shallow soils in poor structure. Below is a map showing the location of Masvingo Polytechnic College in relation to Masvingo District.

Fig 1: Location of Masvingo Polytechnic College in Masvingo District in relation to Zimbabwe



Procedure

Preliminary experiments show that climbing wild apricot can be propagated through the use of seeds. In its natural environment climbing wild apricot can heavily multiply due to propagation by seed but fewer seed germinate and survive due to unavailability of moisture. Fig 2 below shows a climbing wild apricot seed germinated two weeks after sowing and a young seedling at six weeks after sowing.

Fig 2: Germinating seed (A) and young seedling 2 weeks after germination (B)

The experiment was used to determine if seed dehydration has effects on the germination of climbing wild apricot seeds. Seeds were dry and processed soon after harvesting with the removal of the pulp around the seed. A sample of 250 seeds forming mature harvested fruits were selected each year after seed viability test. Seeds which showed positive results of sinking at the bottom of a container where assumed to be viable and used in this experiment. Seeds were treated for storage pests and enclosed in a sack placed in a cardboard room. Seeds were later on planted in sterile growth media.

Experimental design

The experiment was laid out in a complete randomized design (CRD) with eight treatments replicated four times. Seeds were sown at eight different storage times from harvesting. These sowing times include planting seeds at day of harvesting, followed by 14 days, 28 days, 42 days, 56 days, 70 days, 84 days and 98 days after harvesting. Fifty seeds were planted at each interval and the experiment was replicated four times.

Data collection

Data collected was based on germination and survival percentage.

Data analysis

To achieve normal distribution, data of success germinated seeds was transformed using square roots. Analysis of variance (ANOVA) using GenStat statistical package version 14 was used to analyse the difference among the treatments (different dehydration periods). Least significant difference (LSD) was used to separate the means at five (5) per cent level of significance

Results

Effects of seed storage time on germination and success of *A. petersiana* seed into young plants

The results indicated high germination percentages of seeds when planted shortly after harvesting. The results also show that all seeds germinated when planted in less than 14 days from harvesting with no seed dehydration. Germination percentage gradually decreases to zero percent after 84 days due to high seed dehydration. Figure 3 below shows ninety eight per cent successes of seeds of *A. petersiana* sown fourteen days after seed harvesting and seed preparation

Fig 3: Ninety eight per cent success of seeds sown fourteen days after seed harvesting and seed preparation

Prolonged seed storage and dehydration has significant effects (P < 0.05) on seed viability and germination (Table 1). The results are shown in Table 1 below which shows that means followed by a different superscript letter were significantly different at (P < 0.05). Table 1 below shows effect of seed dehydration on seed germination.

Table 1: Effect of prolonged seed storage on seed germination

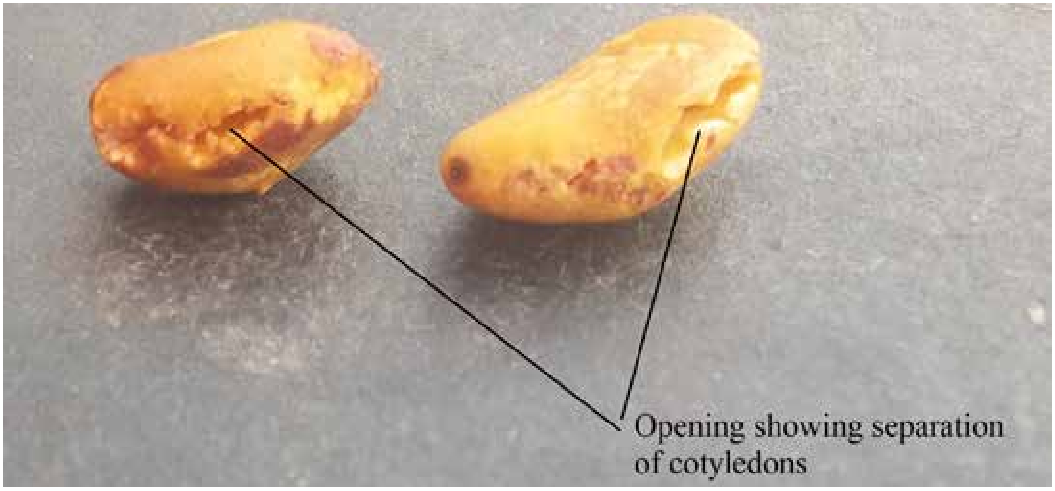
Treatment	Germination percentage
D1	98.25^{e}(9.91)
D14	98.00^{e}(9.91)
D28	90.00^{e}(9.49)
D42	60.00^{d}(7.73)
D56	12.75^{c} (3.53)
D70	0.75^{b}(0.60)
D84	0.00^{a}(0.00)
D98	0.00^{a}(0.00)
Grand mean	45.0 (5.15)
F prob	<0.001
l.s.d	0.5889
CV%	7.8

Means followed by different superscript letter were significantly different at (P< 0.05). Numbers in parenthesis were square root transformed hence the F prob. L.S.D and CV% values used were those of transformed data.

Discussion

The results show that seed viability of climbing wild apricot is lost due to longevity of seed storage and loss of moisture caused by dehydration. These results concurred with results by Bewely & Black (1994, p.75) who reported some species do not survive dehydration. Prolonged seed storage results in loss of seed viability which consequently decreased seed germination (Simon, 1974, p.379; Bramlage, Leopold & Parrish, 1978, p.527; Leopold, 1980, p.1097). Climbing wild apricot seed proved to be desiccation sensitive as prolonged seed storage resulted in loss of seed viability. The research failed to determine the real cause for the loss of seed viability. This also concurred with results by Copeland & Mcdonald, (1995), Geneve, (1998), Geneve, (2003) who reported that seeds viability lost in most seeds is not only related to moisture loss but to many factors which need to be investigated. Viability loss of seeds may be a failure of hydration to reinstate seeds to their original structure. This also concurred with results by Barrie *et al*. (1970, p.138) who indicated that dehydration denatures enzymes responsible for germination due to loss of seed moisture. Loss of seed viability can be due to dehydration causing hardening and deformation of cellular membranes such that they would be stiff to rupture to allow the germination of the embryo. Stiffening of cellular membranes may occur due to dehydration which causes failure of embryo to absorb water (Bewley, 1997, p.1058). Extreme seed dehydration of *A. petersiana* results in seed splitting and separation of cotyledons which worsens chances of reviving the seed during hydration (Geneve, 1998, p.338). Fig. 4 below shows *A. petersiana* seeds with cotyledons separating due to longer storage period and moisture loss. The picture was taken 90 days after fruit harvesting and seed preparation.

Fig 4: ***A. petersiana*** **seed cotyledons separating due to longer storage period**



Dehydration of *A. petersiana* was suspected to be the cause of embryonic death (Geneve, 1998, p.708). Addition of water failed to revive seed resulting in decreased germination percentage of seeds planted after fourteen days from harvesting. Becwar, Stanwood & Roos (1982, p.1133) indicated that after dehydration of desiccation-sensitive seeds, wet planting does not result in reformation of membranes.

Conclusion

Successful sexual propagation of climbing wild apricot can be done up to seventy days from harvesting and seed preparation day. Beyond seventy days from harvesting results in no germination of the seeds. Dehydration of climbing wild apricot seed causes loss of seed viability and poor germination hence they are referred to as recalcitrant seed. The use of fresh seed proved to achieve high germination percentage and developing into seedlings hence it is highly recommended.

Recommendation

Sexual propagation of climbing wild apricot seed must be done whilst the seed is fresh, most preferably the day of harvesting to attain maximum germination percentage. Research must be undertaken to find the specific cause of seed viability loss of *A. petersiana* and explain their association to seed physiology. Further research must be done to determine seed moisture level required for the seeds to germinate.

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