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Improvement of *Amaranthus hybridus* seed germination under greenhouse condition

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ABSTRACT

Amaranthus hybridus leafy vegetable is consumed by the African rural communities as pot vegetables gathered during rainy season. Various researchers are working on the domestication and cultivation of this plant species as means to reduce poverty and malnutrition in the rural communities. A study was conducted at the greenhouse of the University of Limpopo in South Africa with the aim to improve seed germination percentage of *A. hybridus*. Seeds were collected in the wild and dried under room conditions for one week. Dried seeds were submitted to four treatments, namely, untreated seeds, seeds soaked in cold water, seeds soaked in hot water and seeds soaked in effective micro-organisms solution and were arranged in a randomized complete block design with 10 replications. At 14 days after sowing, seed germination data were collected and submitted to an analysis of variance using SAS software (SAS Institute, Inc., Cary, NC, U. S. A., 2008. Seed germination was 43% with the untreated control, 44% seeds soaked in cold water, 77% seeds soaked in hot water and 94% seeds soaked in effective micro-organisms solution. Relative to the untreated control, seed germination was improved by 2.9, 78.3 and 117.4% by seeds soaked in water, seeds soaked in hot water and seeds soaked in effective micro-organisms solution, respectively. The study revealed that *A. caudatus* leafy vegetable seeds need to be treated in order to improve germination percentage.

Key words : *Amaranthus hybridus*, germination, seed, vegetable

INTRODUCTION

Amaranthus hybridus, belonging to the family Amaranthaceous (Olujide and Oladele, 2007), is a leafy vegetable much appreciated in parts of Africa which occurs naturally and is collected from the wild (FAO, 1988; Rensburg *et al.*, 2007). This nutritious and tasty pot herb is not extensively being planted in some parts of Africa as in other West African countries such as Nigeria and Sierra Leone (Olujide and Oladele, 2007; Department of Agriculture, 2010). Pelinganga and Mphosi (2019) managed to successfully determine the optimum NPK requirements for the cultivation of *A. hybridus* under greenhouse conditions. However, the commercial production of this pot herb depends much on the availability of viable seeds for a successful cultivation.

Seed germination is a chemical process which starts with imbibition of water and ends when the radicle raptures the seed coat (Campbell, 1990). After imbibition, the embryo releases gibberellic acid (GA), which diffuses through the endosperm to the aleurone layer, where it catalyses the synthesis of alpha-amylase enzyme. The enzyme then hydrolyses starch to sugars which are then absorbed by the cotyledons, resulting in growth of embryo (Starr and Taggart, 1987; Campbell, 1990; Hartmann *et al.*, 2010). Since the movement of GA from the embryo to the aleurone layer entails diffusion through the endosperm, any chemical that could inhibit release and/or movement of GA to reach the aleurone layer and/or synthesis of hydrolytic enzymes or their bio-activities and absorption of sugars by the cotyledons, would inherently inhibit germination (Campbell, 1990).

Physical seed dormancy occurs as a result of the hard testa, which inhibits imbibition of water and gaseous exchanges

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(Black *et al.*, 2006; Hartmann *et al.*, 2010). In cases where the two processes are allowed, the hard testa may prevent the emergence of the radicle after chemical processes are completed (Black *et al.*, 2006). In the Cucurbitaceae family, it appears that seed dormancy is due to both chemicals and impermeable testas (Mayer and Shain, 1994; Welbaum *et al.*, 1998). Generally, chemical and physical dormancies are eliminated through stratification and scarification, respectively (Hartmann *et al.*, 2010). The objective of this study was to improve the germination percentage of *A. hybridus* leafy vegetable.

MATERIALS AND METHODS

The study was conducted in the greenhouse at the Plant Protection Skills Centre, University of Limpopo, Limpopo Province, South Africa (23°53'10"S, 29°44'15"E). *A. hybridus* seeds were collected from the wild, dried under room condition for one week, treated and sown in a seedling tray containing Hygromix (Hygrotech, Pretoria North, South Africa) growing medium. 200 x 200 seedling tray was placed on a greenhouse bench and 16 seeds per hole. Ambient day/night temperatures averaged 28/21°C, with maximum temperatures controlled using thermostatiscally-activated fans.

Four treatments, namely, untreated seeds, seeds soaked in cold water, seeds soaked in hot water and seeds soaked in effective microorganism solution were arranged in a randomized complete block design with 10 replications. At 14 days after sowing, seed germination data were collected and submitted to an analysis of variance using SAS Software (SAS Institute, Inc., Cary, NC, U. S. A., 2008). Relative to untreated control, seed germination was improved by 71 and 114% by hot water and use of effective microorganisms, respectively.

At 14 days after seed sowing, germinated seeds were counted per treatment and germination data were subjected to analysis of variance (ANOVA) using SAS software (SAS Institute, Inc., Cary, NC, U. S. A., 2008). When treatments were significant at the probability level of 5%, mean separation was achieved using Waller-Duncan multiple-range test. Unless otherwise stated, only treatment means significant at the probability level of 5% were discussed.

RESULTS AND DISCUSSION

Treatments had a significant ($P \leq 0.05$) effect on *A. hybridus* seed germination. Relative to the untreated control, seeds soaked in cold water, soaked in hot water and soaked in effective micro-organisms solution improved seed germination by 2.9, 78.3 and 117.4%, respectively (Table 1). Untreated seeds had the lowest germination percentage (43), whereas seeds soaked in effective micro-organisms had the highest germination percentage (94), followed by seeds soaked in hot water (77%) and the ones soaked in cold water (44%) (Fig. 1.). The result of this experiment clearly shows that *A. hybridus* seeds need to be treated to improve germination percentage.

The law germination percentage of the untreated control is explained by the allelochemicals present in the seed which has autotoxic activity often present in outer parts of seeds (Evenari, 1949). Similar results were also obtained by Maila and Mashela (2013) who leached out seeds of *Cucumis* species, which greatly improved germination percentage. This means that seeds of naturally occurring plants need to be treated to leach out the allelochemical in order to induce the seed to

Table 1. Responses of *Amaranthus hybridus* seed germination to four treatments, namely, untreated seeds, seeds soaked in cold water, seeds soaked in hot water and seeds soaked in effective micro-organisms solution at 14 days under greenhouse conditions (n=40)

Treatment	Germination means	Impact (%)
Untreated seeds	6.9b	-
Seeds soaked in cold water	7.1b	2.9
Seeds soaked in hot water	12.3a	78.3
Seeds soaked in effective micro-organisms solution	15.0a	117.4
P-value	0.0000	-

Figures in a column followed by the same letter do not differ significantly according to the least significant difference test.
Impact (%) = [(Treatment/Control) -1)] x 100.

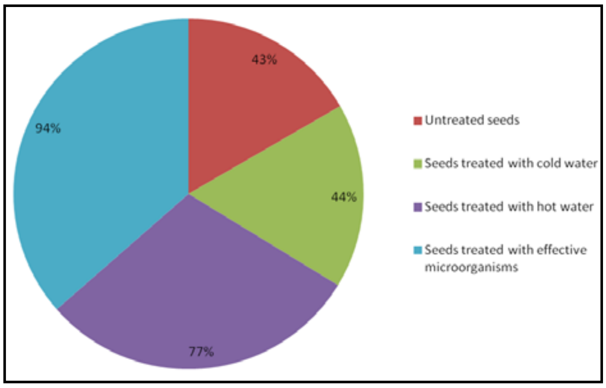

Fig. 1. *Amaranthus hybridus* seed germination percentage : Untreated seeds (43%), seeds soaked in cold water (44%), seeds soaked in hot water (77%) and seeds soaked in effective micro-organisms solution (94%) at 14 days under greenhouse condition (n=40).

germinate. A closer look into the natural environment suggests that germination does not occur in the natural environment until sufficient rainfall to leach out allelochemicals has occurred (Evenari, 1949).

Temperature and microbial activity were also another element observed in nature which greatly contribute to increase or decrease seed dormancy (Jah *et al.*, 2010). Several experiments conducted to improve seeds of *Amaranthus* species established as the optimum temperature for complete germination 30°C (Steckel *et al.*, 2004), other authors obtained 80% germination at temperatures above 16°C (Aufhammer *et al.*,1998). This may explain how the hot water may have increased seed temperature and reduced dormancy. In conclusion, seeds of *A. hybridus* need to be treated to overcome seed allelopathy and reduce dormancy, thus, improving germination percentage.

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