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Variation in seed germination response to water deficit stress in six baobab (*Adansonia digitata* L.) provenances

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Outline

- Introduction
- Objectives
- Methodology
- Results
- Conclusion and Policy recommendations

Introduction

Baobab botanical description and his its potentialities?

Adansonia digitata L: Malvaceae family

much-valued tree by numerous rural populations in the semi-arid lowlands of West Africa which has numerous medicinal properties and food uses (bark fibers, fruit pulp, seeds, leaves,…….)

crop plants diversification programs and for the development of agroforestry systems in semi-arid Africa

Tree priority species for domestication by the World Agroforestry Center

Recently, baobab fruit pulp approved for sale in the EU (2008/575/EC) and USA (GRAS Notice No. GRN 000273), and thus entered the formal, international food market, offering opportunities for income generation to millions of rural farmers

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Introduction

Where *baobab* grows?

Natural growth area of baobab is the tropical dry Africa where it grows typically in areas with 600 to 900 mm of rainfall, although it can survive as low as 200 to 400 mm of precipitation

A prospecting study: *A. digitata* is found in all the three agro-climatic zones in Senegal (the Sahel (250 to 500 mm), sudano-Sahel (500 to 900 mm) and sudan (900 to 1100 mm) and is very representative in sudano-sahelian and sudanian zone

Grow in a wide range of soils. In Senegal, it occurs mainly in chalky soils and sandy clay.

In Senegal Baobab is found associated with (*Tamarindus indica*, Acacias, *Butyrospermum paradoxum* (shea), *Parkia* spp. (locust bean), *Balanites aegyptiaca* (desert date) or *Acacia albida* etc….).

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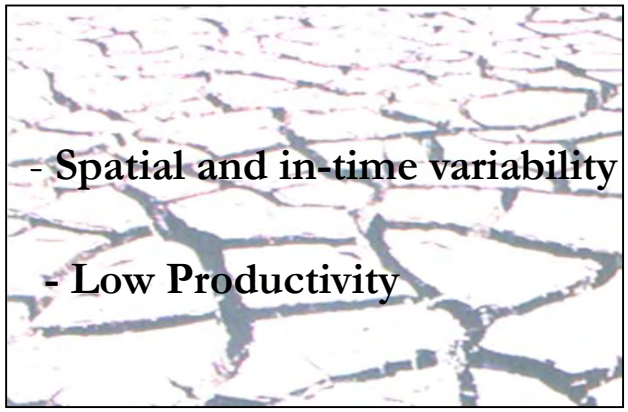
Rationale

✓ Baobab (*Adansonia digitata* L.) is an important multi-purpose forest tree in sub-Saharan Africa where water deficit stress is the most limiting factor to germination and seedling establishment in natural environments.

Water deficit



✓In the situation of global climate change, drought is predicted to increase in both frequency and intensity in the Sahel region and natural regeneration has been observed to be poor as a result of drought stress.

✓ Crucial to identify plant genotypes that can germinate and grow under limited soil moisture conditions.

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Objectives

The overall objective: Assess seed germination behavior of A. digitata under drought stress conditions for contributing to domestication of the baobab tree and selection of so-called plus trees.

Specific objectives

evaluate the variation of germination response to different water deficit stress levels in baobab seeds from different provenances

To identify baobab provenances more tolerant for further domestication

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Methodology

- **Plant material:**

Table 1. Geographic coordinates and climatic conditions (mean temperature, mean annual rainfall, altitude) of the sites where baobab fruits were collected

Agro-climatic zone	Site	Latitude (° ‘ “)	Longitude (° ‘ “)	Yearly rainfall (mm)**	Mean annual temperature (° C)*	Mean annual rainfall (mm)*	Altitude (m)*
Sahel (250-500 mm)	Thielle	14°52’020”	14°58’468”	300-450	27.9	495	52
	Cokki	15°30’724’’	15°59’496”		26	389	52
Sudano-Sahel (500-900 mm)	Gnibi	15° 38’237”	14° 26’159”	450-600	28.4	381	55
	Balla	13°58’021”	13°24’859”		28.4	762	50
Sudan (900-1100 mm)	Wélingara	12°29’158”	12°05’655”	600-900	28.1	1211	178
	Diana Malary	12°51’214”	15°15’117”		27.2	1072	10

* Data obtained from the Worldclim database (Hijmans *et al*., 2005);
** Source: Agence Nationale de la Météorologie du Sénégal, 2007

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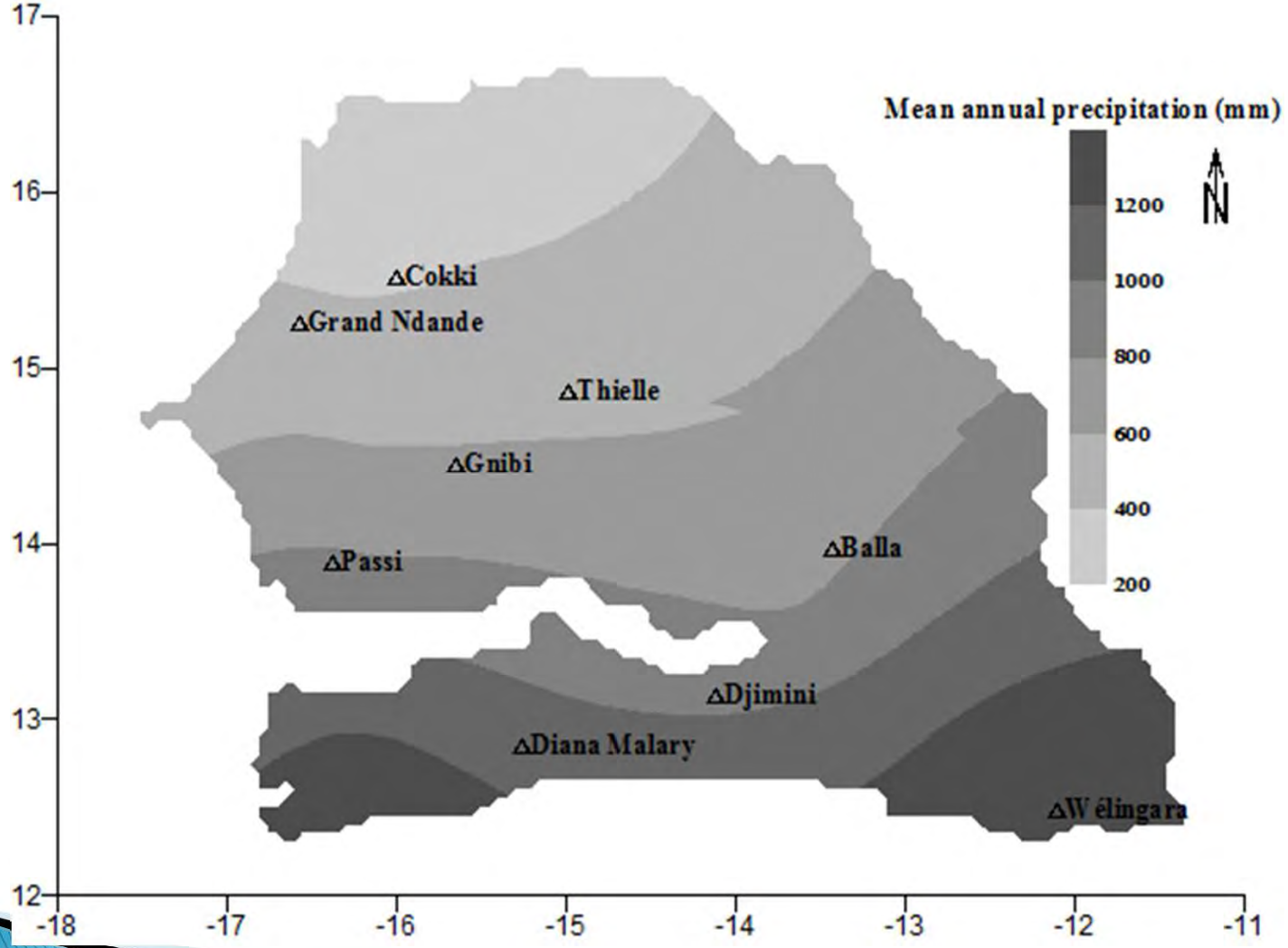
Methodology

Fig 1: Geographic coordinates and mean annual rainfall of the sites where baobab fruits were collected



Methodology (continue)

Experimental set-up

Seed germination of six baobab provenances were assessed under controlled water stress conditions using polyethylene glycol (PEG-6000)

Twenty pre-treated seeds per replication and treatment were placed on a wetted standard filter paper (15 cm diameter) in 16 cm diameter Petri dishes and were left to germinate in distilled water (control, 0 MPa) and in PEG solutions with increasing water potentials of -0.4, -0.8, -1.2 and -1.6 MPa.

Methodology (continue)

Trial set

The subsequent PEG solutions of the different potential osmotic levels were prepared by dissolving the required amount of PEG-6000 in distilled water as previously described by Michel and Kaufmann (1973).

The experiments were set up in a germination chamber at constant air temperature of 25 ± 2 °C) using a completely randomized design with two factors (provenance and drought level).

Drought stress levels used were chosen with respect to the soil water potential conditions of the areas where the seeds originate.

Ten ml of PEG-6000 solution was added to Petri dishes every 48 h; Petri dishes were covered to prevent water losses by evaporation.

Methodology (end)

Measured traits

The number of seeds germinated was counted daily.

A seed was considered germinated when the first radical pierced its integument.

Germination capacity (final germination rate (FGr (%)), germination speed (G50) and germination duration (GD) were calculated

FGr (%) = total number of germinated seeds between the first day and the last day of germination;

G50= number of days to which 50% of seeds have germinated;

GD= number of days between the first and the last seeds to germinate.

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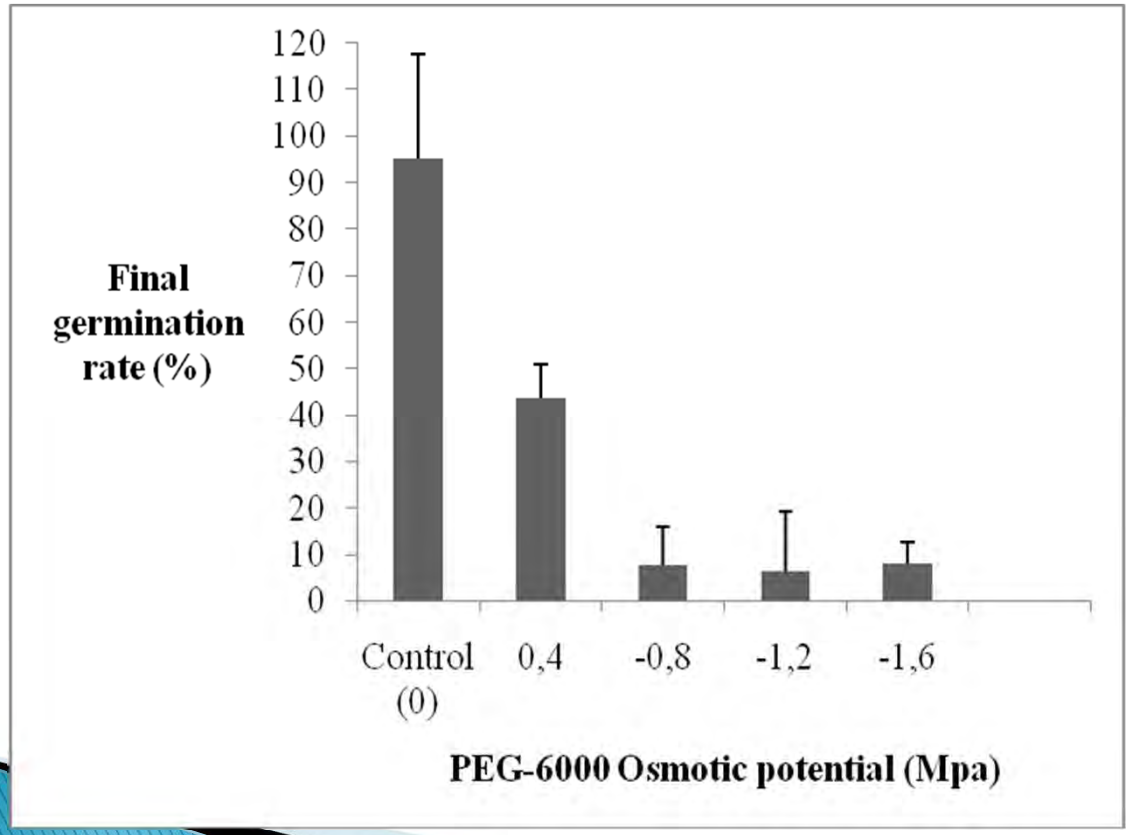
Results

Significant effect on final germination rate and time to 50% of seeds germinated of the different baobab provenances tested.

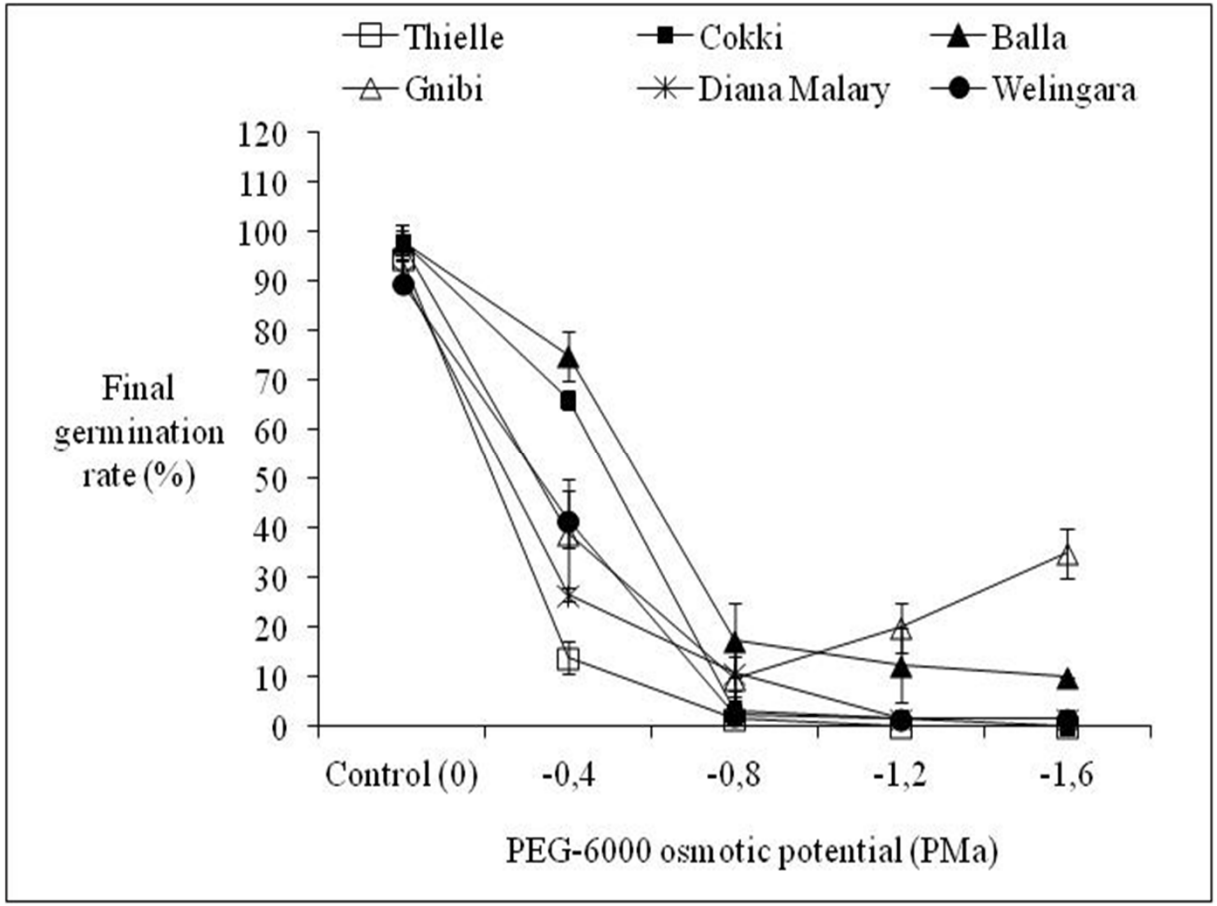
- The highest percentage germination (91.23%) was obtained under control condition and the rate and final seed percentage germination decreased with an increase in osmotic stress.



PEG acting as an osmotic agent dehydrating seeds, inhibits hydrolysis of food reserves from the seed and thus germination capacity

Results

- Control treatment was not significantly different for all six baobab provenances. However, significant differences for final percentage germination of baobab provenances at osmotic potentials ranging between -0.4 and -1.6 MPa.
- Balla and Gnibi both had the highest final germination rates under -1.2 to -1.6 MPa conditions, indicating their higher germination tolerance to water deficit stress.



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Results

Average final germination rate of baobab provenances was 95.11% for control and 6.28% for – 1.6 MPa, while average time needed to attain 50% of seed germinated for control was 3.11 days and 9.11 days for - 0.4 MPa of PEG.

Final germination rate for all baobab provenances never reached 50% in PEG down to -1.6 MPa during the experiments.

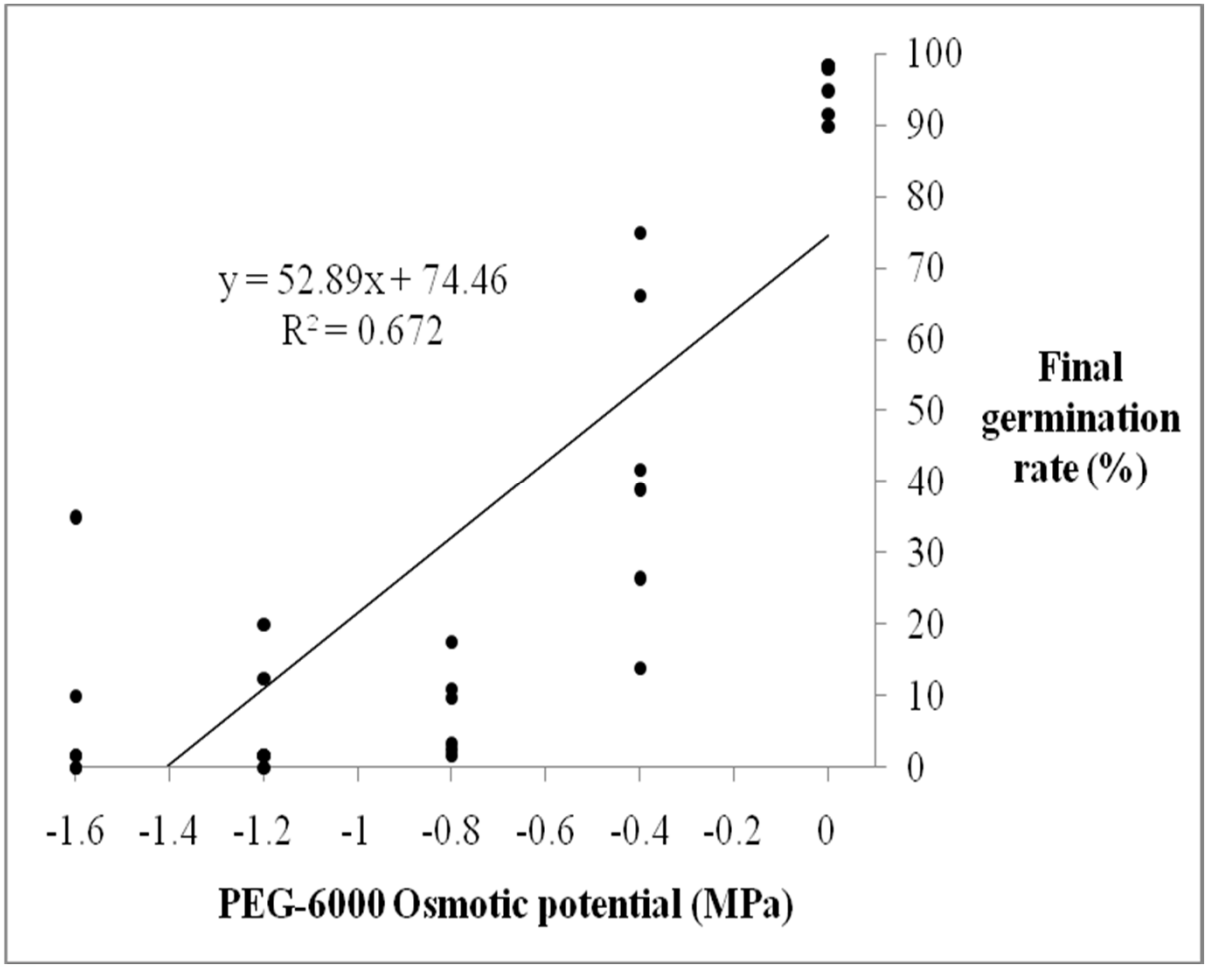
Balla and Gnibi obtained 50% of germinated seeds earlier at 7.53 and 8.87 days, respectively, compared to Thielle which reached 50% of germinated seeds at 10.73 days.

Results

Using Pearson correlation analysis, the final germination rate closely and positively related to the PEG-6000 osmotic potential (r = 0.82***)

Good index for screening provenances for differences in germination under water deficit stress:

it seem to be more affected than the other germination parameters under drought stress conditions



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Conclusion

In our experimental conditions, the responses of baobab provenance seed germination to different PEG-6000 treatments revealed that their germination capacity decreased with a decrease in PEG-6000 induced osmotic potential.

It appears that seed germination of all baobab provenances was severely affected by drought stress simulated by PEG-6000 at osmotic potential ranging from -0.8 MPa to -1.6 MPa.

Baobab seeds from the Sahel zone (Cokki and Thielle) lost their germination capacity at -1.6 MPa whereas seeds of Gnibi and Balla from the Sudano-sahel zone appear to better tolerate drought stress with relatively higher germination rates under severe water deficit stress.

domestication and sustainable growth and leaves production in the semi-arid zones.

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Policy recommendations

Such studies contribute to domestication of the baobab tree and selection of so-called plus trees in order to improve productivity of the species as well as enhance food supply and income generation for rural population

- **Sharing knowledges and disseminating results with the local community with appropriate methods in their own languages**
- **Integration of gender responsiveness on domestication and researches: empowering womens**
- **Think about new technologies for facing to climate change effects**

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Thank you for your attention

Thanks to CTA
for supporting
my participation