Effect of drought and heat, on the performance of bambara groundnut (*Vigna subterranea*) landraces.

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INTRODUCTION

Bambara groundnut is an indigenous African legume. It is an indeterminate crop and carries a trifoliate leaf on a prominent petiole. The crop is similar to peanut and forms pods and seeds on or just the ground. The flower stalk penetrates the soil and develops into a pod containing the seeds.

MATHIEU, A FRENCH EXCHANGE STUDENT AT CSIR-CROPS RESEARCH INSTITUTE

- The crop has been reported as a drought tolerant crop which is capable of producing some yields where other crops such as groundnut fail to survive (Linnemann and Azam-Ali, 1993).

- The crop is useful in the cropping system and found intercropped with cereals and root and tuber crops. In Botswana and Burkina Faso bambara groundnut is intercropped with maize, millet and sorghum (Chaba, 1984; Drabo *et al.,* 1997).

- The crop has a high potential for the attainment of food security and poverty alleviation in most countries of the African continent especially for women who form the bulk (63%) of producers (Berchie *et al.,* 2010, Sesay *et al.*, 2008).

- With the rapidly changing climatic conditions such as erratic rainfall, global warming and its attendance effect on agriculture, every research effort to improve on the yield and acceptability of bambara groundnut will be a major boost towards solving the problem of hunger and malnutrition in most parts of Africa and beyond.

Introduction

- Factors limiting increasing utilization of the crop include lack of awareness, lack of improved varieties, poor agronomic practices, limited potential as a cash crop, hardness to cook, unavailability of seeds and variation in yields from season to season.

Bambara groundnut seeds

Fig. 1: Bambara groundnut seeds

USES

Bambara groundnut is essentially grown for human consumption

- Immature seeds are boiled and eaten as snack
- Mature dry seeds are boiled and eaten as pulse
- Mature seeds can also be ground into flour after roasting to prepare porridge (Brink and Belay, 2006)
- Doku and Karikari (1971) reported that bambara groundnut could be canned and in Ghana, 40,000 cans of various sizes were produced annually which tasted as baked beans.
- In Ghana mature dry seeds are boiled to which pepper and salt are added "aboboi" to complement fried ripe plantain or "gari" (Doku, 1997).
- In Nigeria, paste made from dried seeds is used in the preparation of fried or steamed products (Obizoba, 1983)

Bambara has a balanced protein and high carbohydrate content compared to Soybeans and Peanuts

Legume	Protein	Carbohydrate	Lipids
	%	%	%
Soybean	34	32	19
Peanut	23	25	46
Cowpea	22	63	1
Bambara	12-25	43-69	5-7

Source: Biochemistry Division, CSIR-Crops Res. Institute. June, 2008.

The oil content of Bambara is low……

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THE LOW OIL CONTENT OF BAMBARA MAY EXPLAIN WHY IT IS AN UNDER-UTILISED AND UNDER-RESEARCHED CROP

- Smart and Simmonds (1995) observed that peanuts which were introduced into West Africa from Brazil may have replaced bambara groundnut because peanuts contain significant amount of oil and can be grown as an oil seed crop.
- A cash crop with export potential for the colonial powers replaced a food crop for the subsistence of the local population

The Paradox

"The story of *Vigna subterranea*, until fairly recently, has been one of neglect, decline and relegation. It is a paradox that an indigenous African crop which produces an almost complete food, is one of the most drought tolerant, easy to cultivate crops which makes very little demand, if at all, on the soil, should be so relegated in its own countries without being accorded any research attention and, worse still earn the "accolade" of a poor man's crop." (Doku E. V. 1996).

STUDY OBJECTIVES

- Identify the responses of the selected bambara groundnut genotypes to heat and drought stress on the field

- Identify genotypic responses of 13 bambara groundnut genotypes to drought stress under controlled environment.

Experimental design and plot size

- Experimental design was an RCBD factorial with three replicates
- Plot size was 6m x 6m (13 rows and 31 hills).
- Seeds were sown at 2 seeds/hill at inter row spacing of 50 cm and intra spacing of 20 cm.
- Seedlings were thinned to one plant/hill 20 DAS (Plant population of 10 plants/m^2)

Drought and Heat Trial at Tono

- Five landraces were used in the heat and drought trial at Tono in the Upper East Region of Ghana. Drought trial, Tono:
- The drought trial was irrigated once weekly till 30 DAS after which irrigation ceased.
- The control was irrigated to field capacity once weekly till maturity using a furrow irrigation.

Drought study at the Dept. of Plant Agriculture University of Guelph, Canada (Plant materials)

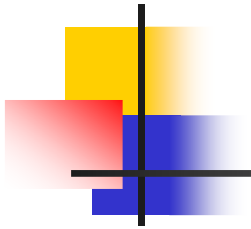
13 bambara groundnut landraces were used for the study. Five of these were used in the 2-yr field study in Ghana.

The remaining seven are:

Red eye
Zebra-coloured
Black seed
Mottled cream
Brown with white eye
Tan 1 from Tanzania
Tan 2 from Tanzania

- 10 from Ghana
- 2 from Tanzania
- 1 from Burkina Faso

Plant material



- 156 4-litre pots were filled with top soil. 20:20:20 N:P:K was applied at 4g/pot and watered. Seeds were surface sterilised and treated with Apron Combi before sowing against soil and seed-born fungus.
- Seeds were sown at two seeds per pot and thinned to one seedling per pot on emergence. Plants were arranged in a Completely Randomised Design (CRD) with 6 replicates per landrace per growth chamber
- Drought: Irrigation ceased at 30 DAS and resumed at 60 DAS. The control was irrigated every three days till the termination of the experiment.
- Photoperiod treatments were 12 hrs:12 hrs, light:darkness.
- Growth chamber temperatures were maintained at 30^{o}C in the day and 25^{o}C in the night at a relative humidity of 60%

- Light : Light was maintained at PAR of 200-250 umol m^{-2} s^{-1}. Pot positions were randomised every 4 days to prevent possible biasness due to light and growth chamber effect.

- Chlorophyll content was obtained using a Minolta SPAD 502 chlorophyll meter.

- Stomatal conductance was measured using a Li-6400 chlorophyll fluorometer on both the drought and irrigated treatments.
- Morphological changes with respect to drought were observed.

Drought Treatment

- Data was analysed for Analysis of variance (ANOVA) using the Statistical Analysis System (SAS), USA Version 9.1.

- Days to flowering, emergence, pod dry weights and root dry weights (photoperiod trial) were log transformed before analysis.

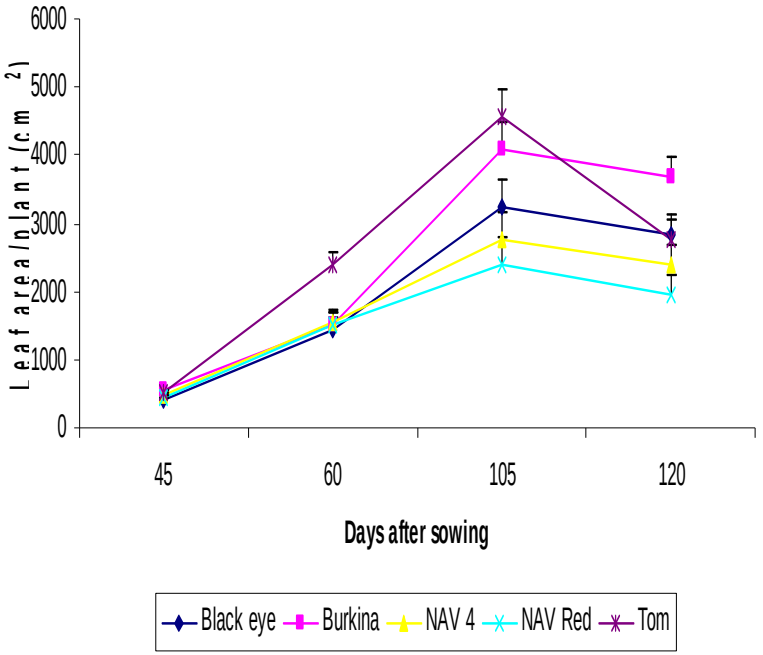
- RESULTS

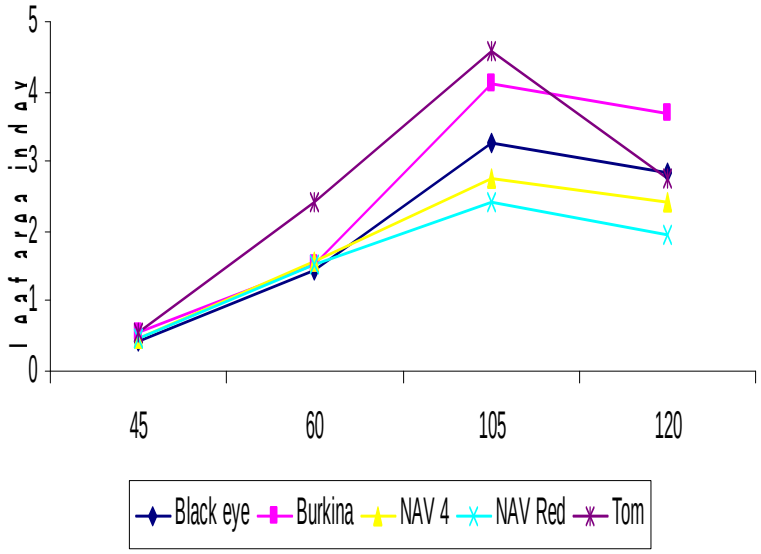
Table 1: Plant height, plant width and pod dry weight for bambara groundnut landraces Tono (Heat trial) (2007)

	Plant height (cm)	Plant width (cm)	Pod dry wt. (g/m^2)
Landrace			
Black eye	20.5	38.2	48.7
Burkina	20.5	30.9	118.5
NAV 4	21.3	39.9	54.0
NAV Red	22.5	36.5	52.5
Tom	25.3	40.2	0.0
Mean	22.0	37.1	54.7
CV (%)	7.2	10.7	20.5
LSD (0.05)	2.5	6.1	17.3
P value	0.005	0.037	<0.001

Table 2: Root dry weight and leaf dry weight (Tono) drought trial.

	Root dry weight (g/m^2) 120 DAS	Leaf dry weight (g/m^2) 105 DAS	Leaf dry weight (g/m^2) 120 DAS
Landrace			
Black eye	2.10	142.0	103.8
Burkina	3.66	159.3	196.3
NAV 4	2.30	146.7	106.4
NAV Red	1.84	154.7	132.7
Tom	2.17	162.0	93.9
Mean	2.41	152.9	126.6
CV %	21.3	22.1	22.4
LSD (0.05)	0.96	NS	53.5
P value	0.017		0.013





Figs. 2 a & b: Leaf area and leaf area index against days after sowing Tono, drought experiment

Guelph Study

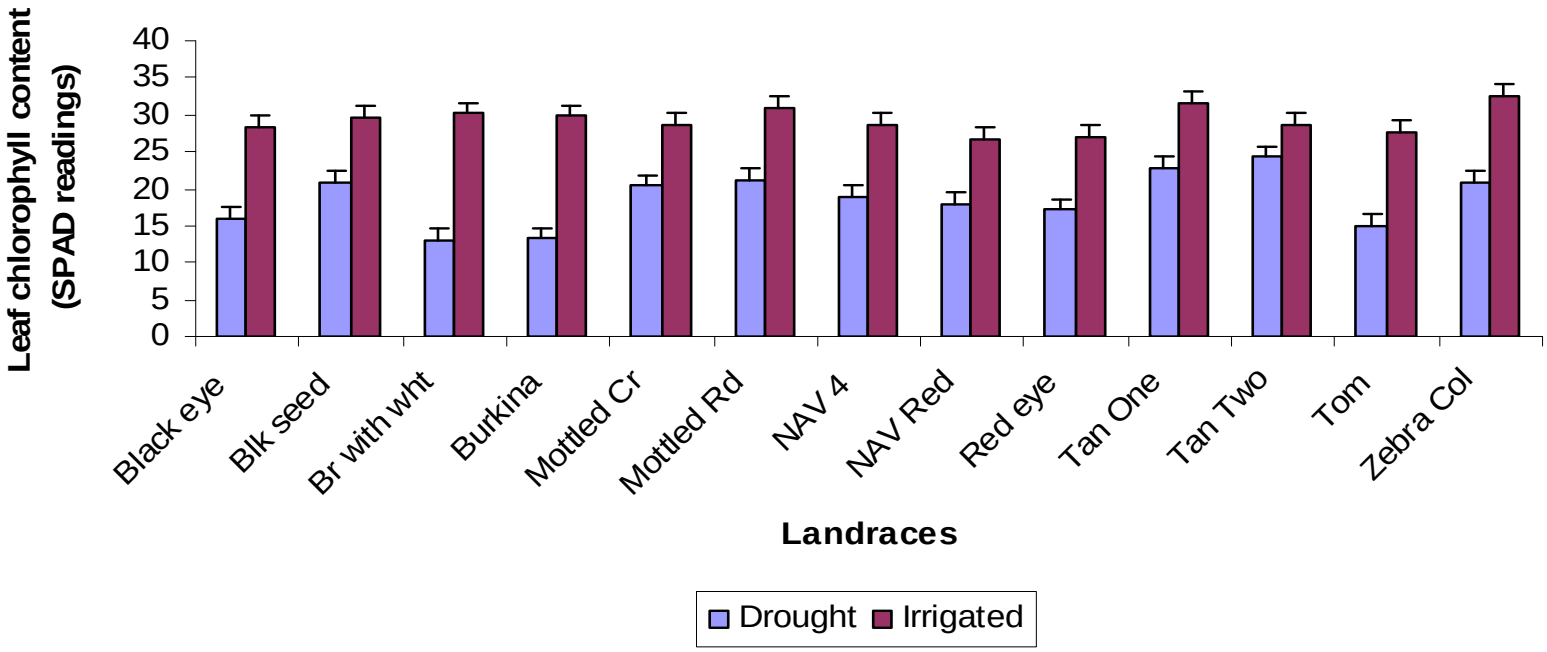


Fig 3 :Leaf chlorophyll content as affected by landrace and irrigation treatment

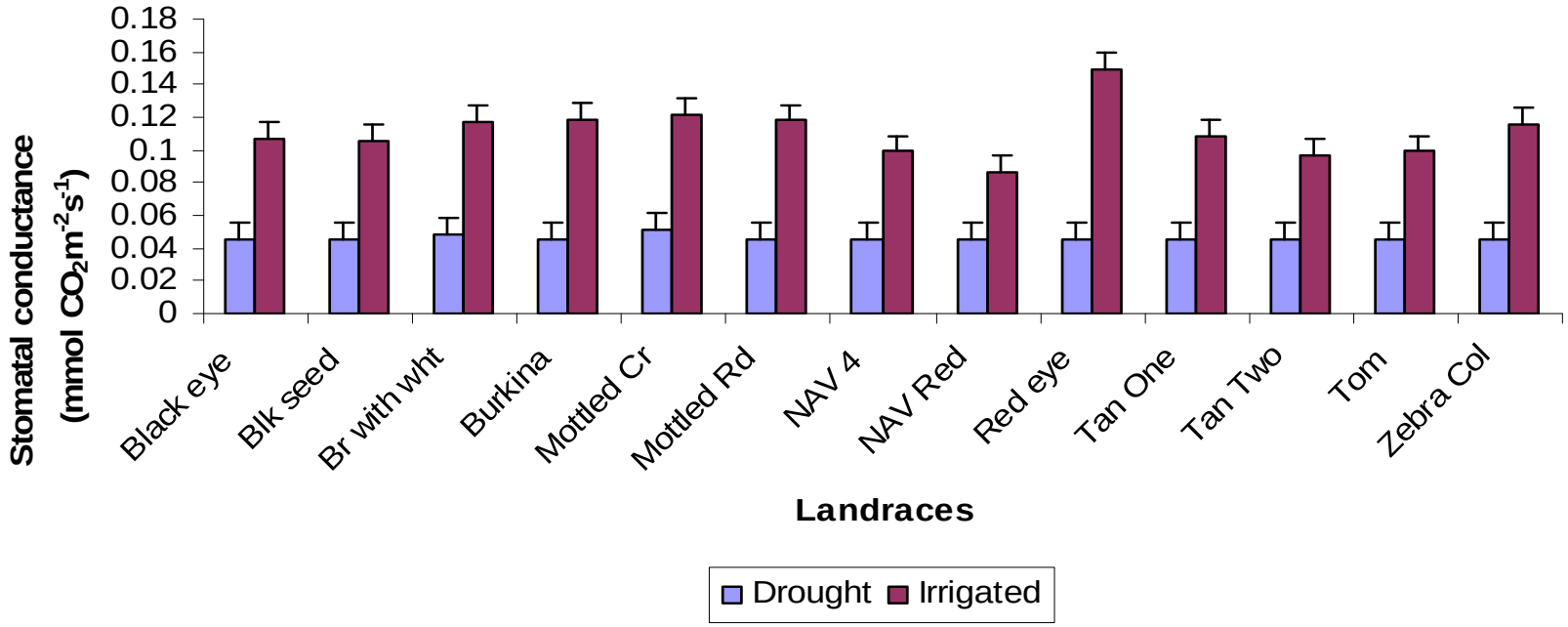


Fig 4: Stomatal conductance as affected by irrigation treatment and landraces

- Trend of drought effect on the 13 bambara groundnut landraces.

Fig. 5: Beginning of treatment 30 DAS, Drought (L) , Irrigated. (R)

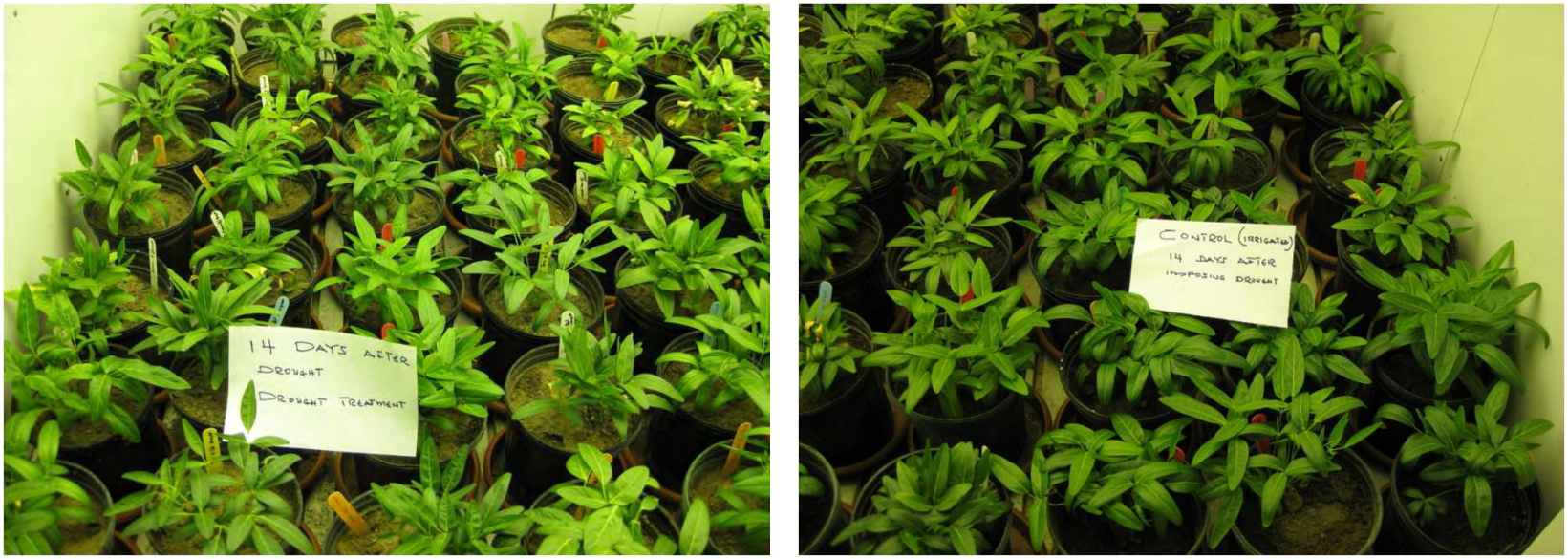


Fig 6: Drought (L) Irrigated (R), 14 days without irrigation, 44 DAS

Fig 7: Drought (L), Irrigated (R), 20 days without irrigation 50 DAS

Fig 8: Drought (L), Irrigated (R), 25 days without irrigation, 60 DAS

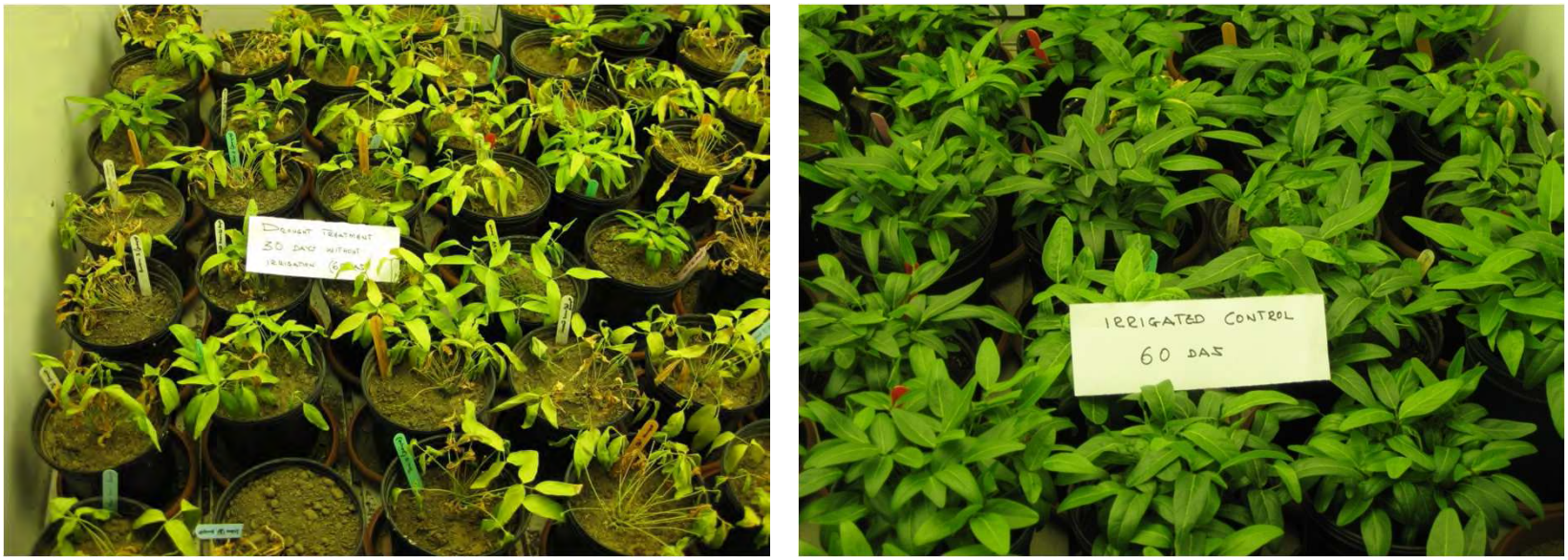


Fig 9: Drought (L), Irrigated (R), 30 days without irrigation, 60 DAS

Fig 10: Tan 1 droughted with spindle-shaped leaves, Mottled cream droughted with reduced canopy size relative to the control

Fig 11: Post drought recovery, Tan One, (L), Black eye (R)
7 days after re-irrigation 67 DAS

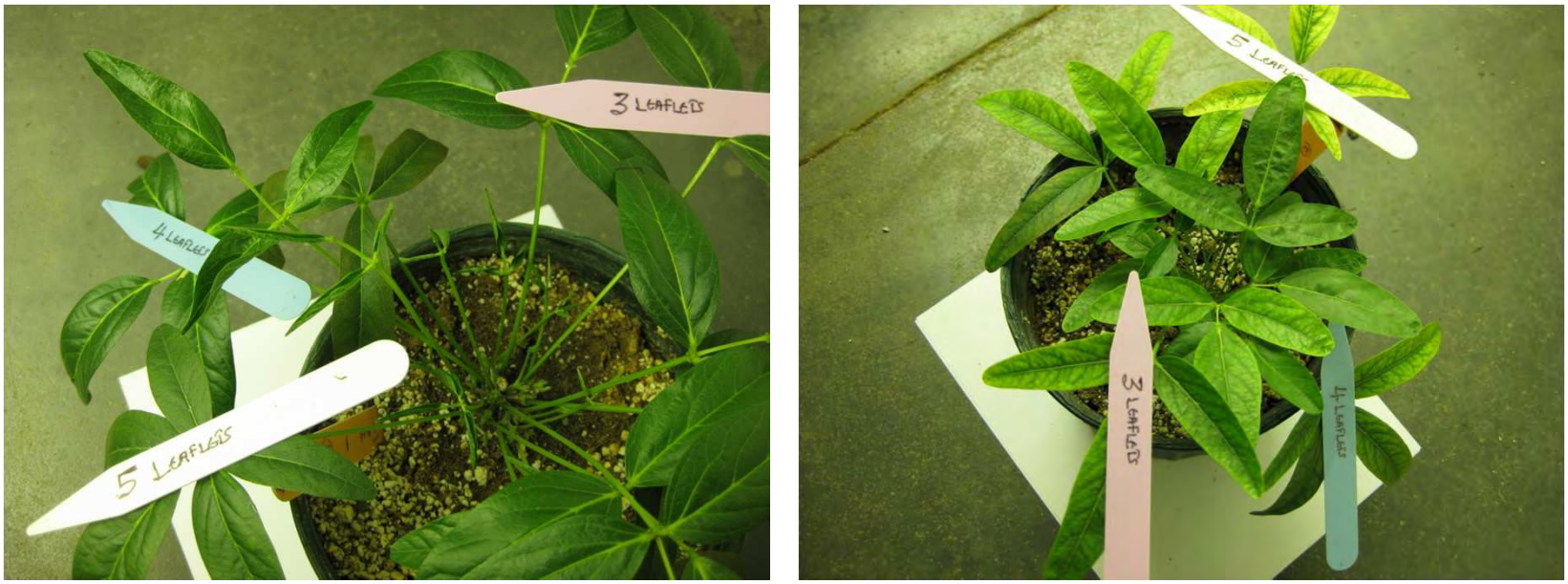


Fig 12: Multiple leaflets on different petioles of same plant

TABLE 3: Effect of seed priming on mean number of days to 50% emergence

Seed priming Treatment	Days to 50% emergence
Soaking seed in water for 24 h	6.9b
Soaking seeds in water for 48 h	6.9b
Control (No soaking in water)	9.3a

- Figures in a column bearing the same letters are not significantly different (p=0.05) by Duncan's Multiple Range Test

TABLE 4: EFFECT OF SEED PRIMING ON MEAN FINAL PERCENTAGE ESTABLISHMENT

Seed priming treatment	Mean final percentage establishment
Soaking seed in water for 24 h	85.6a
Soaking seeds in water for 48 h	79.6a
Control (No soaking in water)	53.4b

- Figures in a column bearing the same letters are not significantly different (p=0.05) by Duncan's Multiple Range Test

CONCLUSION

- The study observed differences within and between bambara groundnut genotypes with respect to their tolerance to drought.
- 24 h soaking of bambara groundnut seeds in water before sowing enhances seedling emergence and final seedling establishment.

Acknowledgement

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THANK YOU