The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

CROPS FOR THE FUTURE RESEARCH CENTRE

BamYield Workshop,

2nd bambara groundnut workshop, 11th-12th December 2012

Plant physiology; fertility, photoperiod and drought tolerance

Bambara groundnut (*Vigna subterranea* (L.) Verdc.)

Bambara plant

Semi-Arid Nigeria (Sudan savanna), 500-800 mm rainfall, 32 ^{0}C, Sandy soil >80% sand

Bambara growing on a marginal soil

Pod

Bambara unearthed at harvest

Seed

Introduction

- Origin: dry savannas of Nigeria & in Cameroon
- Widely cultivated in South America, Asia & Oceania
- Belongs to section *Vigna*, the subgenus *Vigna*, the genus *Vigna,* the subtribe Phaseolinae, the tribe *Phaseoleae* and the family *Papilionaceae*
- Chromosome number is 2n=22
- Annual herbaceous plant
- Germination is hypogeal with fruiting as with *Arachis hypogea* (groundnut) is subterranean (underground)
- Nitrogen fixing legume can fix as high as 100kg N/ha
- Seeds contain 6.5% oil, 18% protein (high lysine content), rich in carbohydrate (60%)

Introduction

- Hardy plant well suited to savanna region
- Grown from sea level to altitude of 2000 m
- 30-35 ^{0}C is optimum
- In many genotypes, flowering is photoperiodinsensitive,
- **While the onset of podding is retarded by long photoperiods.**
- **In some genotypes both flowering and the onset of podding are delayed by long photoperiods**
- **Podding may also be delayed by drought**
- Rainfall 600-1,500 mm
- Less susceptible to water stress and mineral deficiency than groundnut
- Prefers sandy, well drained soil
- pH 5.0-6.5 suitable
- Average yield of dry seeds: 300-800 kg/ha
- Bambara groundnut is grown primarily for its seeds, which are used in many types of foods and medicine

CFFRC Supported Projects in Plant Physiology

Fertility

Acid soil, phosphorus (rock phosphate) , Nitrogen fixation, bambara groundnut genotypes

Assessing the N_2 Fixation of Bambara Groundnut Genotypes at various P Levels and Liming Treatments on Tropical Acidic Soils

Supervisors

- Ajit Singh, UNMC,
- Festo Massawe, UNMC
- Debbie Sparkes, UK
- Ibraheem M. Abdulsalam Alshareef, CFFRC
- Yasmeen Siddiqui, UPM
- Sean Mays, UK/CFFRC
- Felix Dapare Dakora, Tshwane Uni. of Tech. Pretoria, SA

Level: Ph.D.

(This PhD links with a series of studentships on Bambara groundnut which range from bioinformatics to product development and cropping systems)

Problem Statement

- Malaysian soils are predominantly acidic, weathered and leached and are thus deficient in range of nutrients
- Bambara presents a great potential for increased food production on tropical marginal soils
- Studies on the abiotic stress physiology and N_2 fixation are very limited
- Exploitation of biological N_2 fixation is constrained by environmental and nutritional factors like soil acidity and P

Way forward

- Exploit the genotypic variation to trap P & tolerate acidic soil
- Liming to reduce the aluminum saturation of the soil and to correct calcium deficiency is often sufficient to improve the growth and nodulation of the plants
- Direct addition of fertilizer to the soil may not work well as the fertilizer itself will become unavailable Phosphate Rock dissolves slowly can provide a cheap source of P fertilizer
- Rock phosphate may dissolve more readily in acid tropical soils

Objectives

- To evaluate the nitrogen fixation efficiency of various bambara nut genotypes under P and soil pH stress conditions
- To assess the influence of phosphorus levels using rock phosphate on nitrogen fixation
- To investigate the effect of liming (pH) on nitrogen fixation
- To study the morphological and genetic characterization of bambara groundnut

Procedure & outcome

- Two-year greenhouse and field experiment at UPM
- Physiological parameters using photosynthesis system, C02 flux system and chlorophyll meter.
- Laboratory work for soil and plant analysis
- Nitrogen fixation: N-difference method and N15-abundance technique.

Outcome

- Identifying genotypes for various stress conditions (pH & P-nutrition) will lead to efforts being undertaken for increased bambara groundnut production and
- Incorporation into various cereal-based cropping system in Malaysia and elsewhere

Drought Tolerance

Drought, Metabolic and physiological traits

Metabolic and physiological traits associated with bambara groundnut adaptation in contrasting environmental conditions

Supervisors

- Festo Massawe, UNMC
- Sean Mayes, UoN
- Sayed Azam-Ali, CFFRC
- David L Ndzi, University Malaysia Perlis

Level: PhD (includes University Fees, stipend and consumables)
The study will link with a series of studentships on Bambara groundnut, ranging from bioinformatics to product development.

Problem statement

- Drought –a major limiting factor for crop production

- Limited evidence as to resistance of bambara ground nut to drought

Way forward

- The crop is known to adjust its phenology depending on the prevailing environmental conditions
- This plasticity has enabled the crop to perform well under water stressed & watered conditions
- Understanding of the mechanisms of its response to drought needs to be developed

Objectives and outcome

- To investigate metabolic and physiological traits associated with bambara groundnut adaptation in contrasting environmental conditions

Outcome:

- Select superior genotypes for inclusion as parents in breeding programme and
- Understand the physiological mechanisms underlying adaptation to differing environments

Photoperiod

Geographical location , photoperiod sensitive genotypes

How does geography affect or reflect genetic variation in bambara groundnut?

Supervisors

- Festo Massawe, UNMC
- Jeremy Morley , UK
- Sean Mayes, UK

Level: Mres/PhD

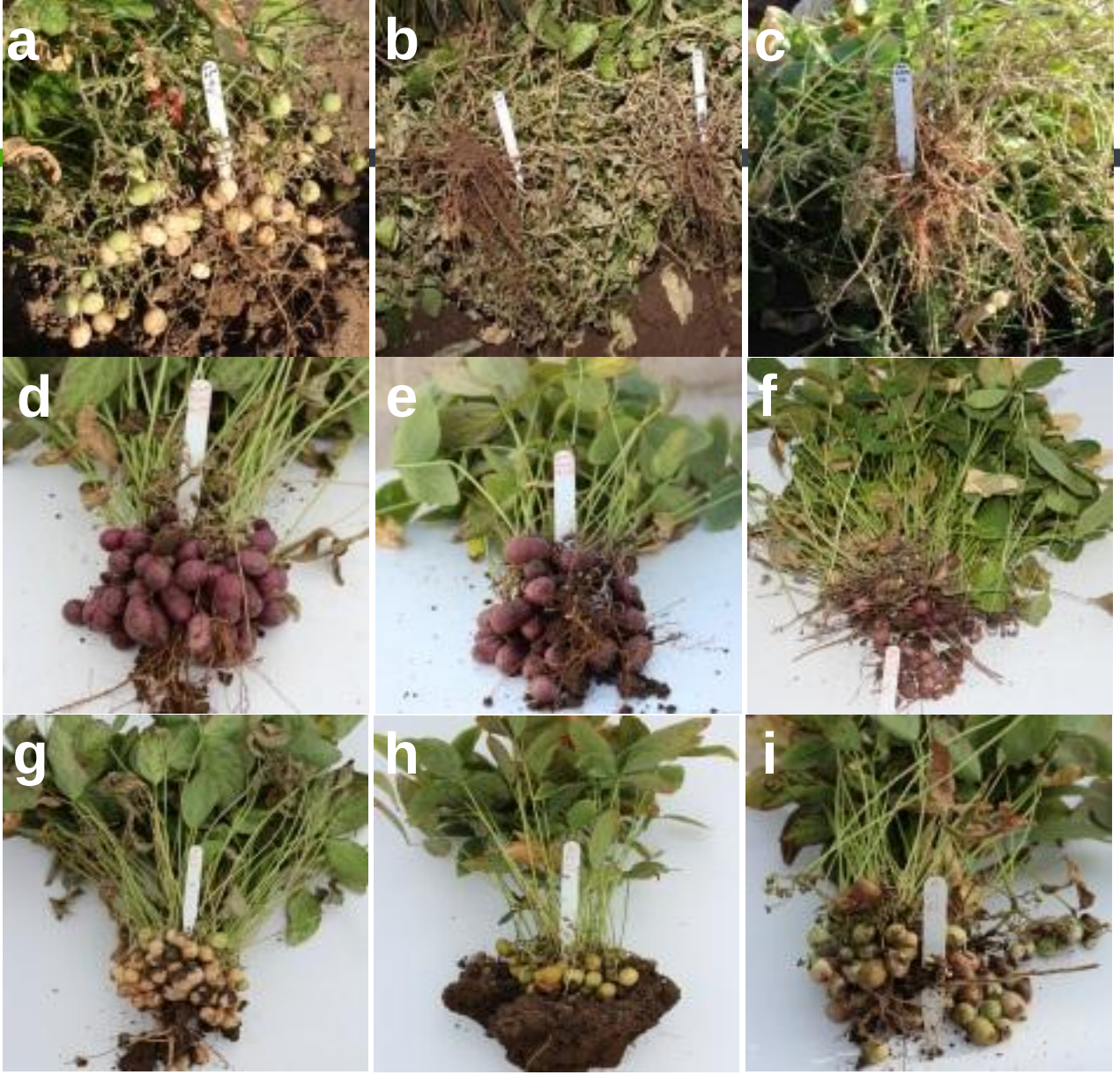
Background

- Variation in the yield of Bambara groundnut exists within and between geographical locations
- This variation in yields was attributed by several workers to variations in photoperiod
- There is a strong photoperiodic effect on pod-filling in bambara groundnut, and considerable differences exist between landraces under long-days

Objective

- To determine variation in performance of bambara groundnut landraces to photoperiod stresses

Response to photoperiod



Fruit set, fuit filling and maturity in bambara groundnut as a function of photoperiod: (A, B, & C) = Ankpa 4 in 12, 14, and 16 hours; (D, E, & F) = Uniswa Red in 12, 14, and 16 hours; (G, H, & I) = Dip C in 12, 14 and 16 hours respectively

Outcome

- Identification of landraces insensitive to photoperiod will provide materials which can be cultivated in areas where bambara groundnut production is negatively affected by long photoperiod

- Exchange of materials with other research institutes for crop improvement purposes

- An understanding of the genetic control of photoperiod response of podding may become an important tool for genetic improvement