Indian Journal of Agricultural Sciences **83** (5): 579–81, May 2013/Short Communication

Evaluation of Bambara groundnut (*Vigna subterranea*) landraces for their agronomic and physiological traits

S L MEENA[1] and F J MASSAWE[2]

School of Biosciences, The University of Nottingham, Malaysia Campus, Semenyih 43500 Malaysia

Received: 21 February 2012; Revised accepted: 12 March 2013

Bambara groundnut (*Vigna subterranea* (L.) Verdc.) is a grain legume widely cultivated as source of protein (19-22%) and carbohydrate (42-69%) making it a good complement for cereal-based diets (Minka and Bruneteau 2000) and plays important socio-economic role in dry areas of Africa. Immature seeds are eaten as snack and mature as pulse. The seeds are used also as feed for pigs and poultry and haulm as fodder. Linnemann and Azam-Ali (1993) reported greater gross energy value of the seeds than that of pigeon pea, cowpea and lentil (*Lens culinaris* Medik). Reasons why the crop has remained underutilized may be associated with the perception that it has limited economic potential outside its areas of cultivation (Azam-Ali *et al*. 2001). It's now widely distributed and grown in Asia, parts of Northern Australia, and South and Central America. Information on genotypic differences within a species and their underlying physiological bases are important to improve crop productivity. Underutilized tropical crops like Bambara groundnut have a large number of landraces grown from locally adapted genotypes rather than true varieties. It is essential to quantify any genotypic variation amongst landraces in growth and development before initiating any crop improvement programme aimed increasing productivity (Massawe *et al*. 2005). The present study therefore was undertaken to evaluate the genotypic variability with respect to agronomic and physiological traits of the landraces collected from three contrasting environments.

Bambara groundnut landraces namely Bogor, Rano Black and Gaborone Cream from Indonesia, Nigeria and Botswana, respectively were evaluated during 2010–11 at the university of Nottingham, Malaysia Campus stretching from 2°9'N to 101°85'E. The temperatures are generally ranged between 29–33°C with high humidity (71–82%) year-round. The experiment was arranged in a randomised complete block design with nine replications under transparent shade house. Seeds of the landraces were sown in pots filled with soil (organic top soil) and seedlings were thinned to one seedling per pot at 20 days after sowing (DAS). Relative chlorophyll content was measured using portable chlorophyll meter (SPAD 502). Stomatal conductance (mmol/m^2/s) was measured by leaf porometer using the steady state technique (measures the vapour flux from the leaf surface to the atmosphere). PAR ceptometer LP-80 was used to measure interception of photosynthetically active radiation (µmol/m²/s). The measurements were made in clear and sunny weather on four occasions (42, 68, 92 and 114 DAS). Intercepted PAR (photosynthetically active radiation) was used to estimate radiation use efficiency (RUE) on above ground biomass production. Plant samples were dried for 48 hours in an oven maintained at 80°C and weighed for dry matter production. Analysis of variance (ANOVA) was performed on data using Gen-Stat statistical software program. Differences between treatment means were detected by least significant difference (LSD) at 5% probability.

The seeds of Bogor were emerged first after 7 days of sowing and differed significantly from emergence of Gaborone Cream. The landrace Rano Black took significantly less number of days to attain flowering (40 DAS), pod formation (68 DAS) and maturity (116 DAS) over Gaborone Cream and Bogor (Fig 1). The landrace Gaborone Cream took fewer days (30) to flower after emergence while Bogor

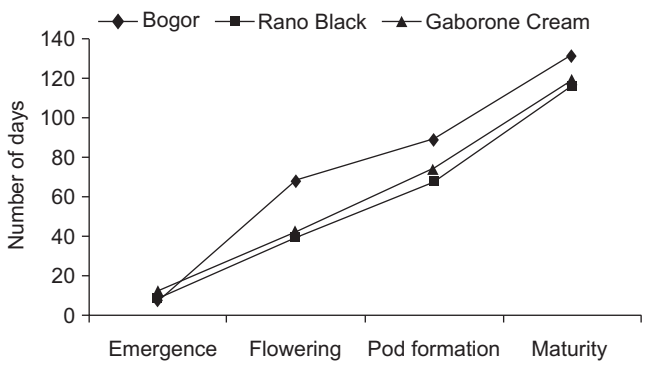

Fig 1 Plant development of bambara groundnut landraces

[1]Senior Scientist (e mail: dr_slmeena@yahoo.co.in), Indian Grassland and Fodder Research Institute, Western Regional Research Station, Avikanagar (Malpura), Tonk, Rajasthan 304 501; [2]Associate Professor (e mail: festo.massawe@nottingham.edu.my)

took double the time (61). On the other side Bogor took least number of days (21) to attain pod formation over flowering followed by Rano Black (28) and Gaborone Cream (32). The landrace Rano Black was earliest to mature may be rated as an early maturing landrace. These landraces therefore could widely adapt to a range of environments providing opportunity for a wide cultivation of the crop beyond its current centres of cultivation (Berchie *et al.* 2010). The time spent by the landraces between different developmental stages could be useful for breeders to enhance productivity of the crop.

Significant differences were observed among the landraces with respect to their SPAD value, stomatal conductance and PAR interception of leaves. The average SPAD value was higher in Rano Black (46.05) followed by Bogor (37.43) and Gaborone Cream (31.18). The trend of SPAD value over time was very similar in all three landraces with greater in Rano Black throughout the plant growth and development (Fig 2). The SPAD value was decreased with plant age in all landraces, with more marked in oldest leaf than in fully expanded leaf. Several authors had found decrease in SPAD readings with plant age (Rodrigues 2004, Mauromicale *et al.* 2006). The SPAD values recorded with portable chlorophyll meter provide an indication of the relative amount of total chlorophyll content of the leaves. Xu *et al*. (2000) found highly significant correlations between SPAD values and total chlorophyll content as well as between SPAD values and visual stay-green ratings in seed sorghum. Stomatal conductance was higher in all three landraces at early stages of plant growth and decreased steadily with age of the plants (Fig 3). In the early stage of plant growth the stomatal conductance was higher in Rano Black and at later stage it was in Gaborone Cream. Average stomatal conductance was higher in Rano Black (226 mmol/m²/s) followed by Gaborone Cream (216 mmol/m²/s) and Bogor (147 mmol/m²/s). Intercepted PAR was greater in Rano Black throughout the period of plant growth (Fig 4). Average intercepted PAR was also higher in Rano Black (150 µmol/m²/s) followed by Bogor (120 µmol/m²/s) and Gaborone Cream (103 µmol/m²/s). Increasing trend of intercepted PAR was observed with age of the plants in all three landraces.

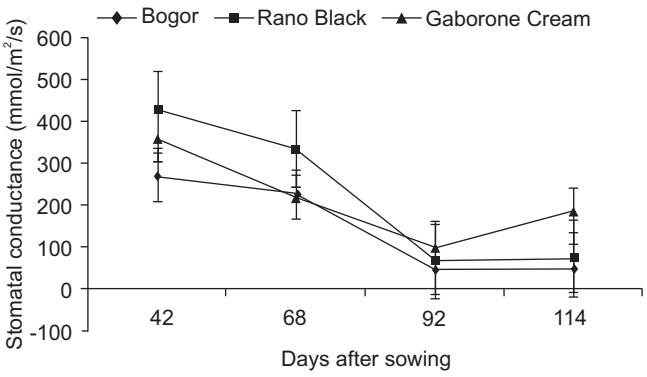

Fig 3 Stomatal conductance over time in bambara groundnut landraces

Vegetative growth is proportional to intercepted photosynthetically active radiation (Monteith 1977). Quantifying light interception by plant canopies provides important information about canopy physiological processes.

Pod bearing percent, dry matter production and seed yield were differed significantly among the landraces. Pod bearing percent was recorded higher in Gaborone Cream (66%). The landrace Rano Black produced maximum number of flowers per plant but the landrace exhibited heavy flower droppings, hence pod bearing/setting was least (20%). This could be a great challenge to the physiologists and breeders for further improvement in the landrace. The landrace Rano Black produced 22, 114% more dry biomass and 20, 50% more seeds over Bogor and Gaborone Cream, respectively. Radiation use efficiency of Rano Black (0.324 g/MJ) was significantly higher over Bogor (0.305 g/MJ) and Gaborone Cream (0.195 g/MJ). Lower values of RUE in the study may be due to environmental factors such as light saturation, plant canopy structure, nutrient and moisture stress, etc. Variation in RUE may arise from differences in partitioning between root and shoot or from differences in PAR interception among the landraces (O' Connell *et al*. 2004). Radiation use efficiency is the key factor determining the crop yield and related to crop biomass and leaf area index. To

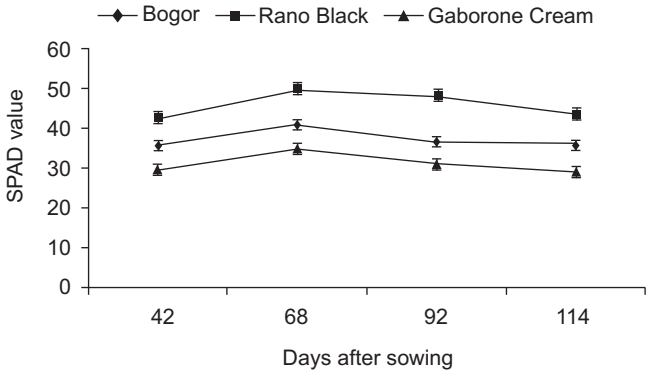

Fig 2 SPAD value over time of bambara groundnut landraces

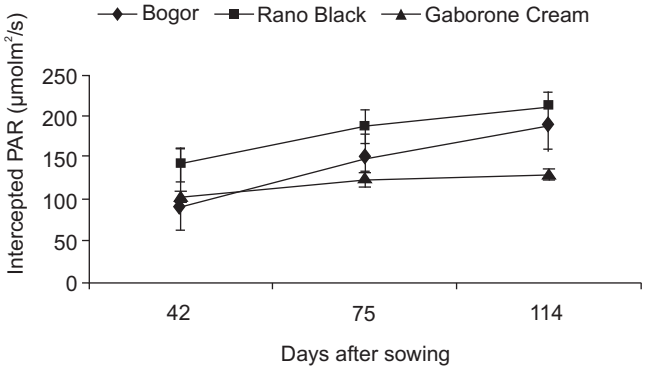

Fig 4 PAR interceptions over time in bambara groundnut landraces

obtain higher yield from a given landrace under normal conditions, it is necessary to achieve optimum RUE. The landrace Rano Black recorded higher harvest index (0.34) followed by Gaborone Cream (0.31) and Bogor (0.26). The seed yield of crops can be expressed as a function of light interception, radiation use efficiency and harvest index.

SUMMARY

Three Bambara groundnut landraces namely Bogor, Rano Black and Gaborone Cream were evaluated for their agronomic and physiological traits at the University of Nottingham Malaysia campus. The seeds of all three landraces were sown in pots filled with organic top soil. Stomatal conductance, light interception and relative chlorophyll content of leaf were measured by leaf porometer, ceptometer LP-80 and chlorophyll meter (SPAD-502), respectively. The measurements were made in clear and sunny weather on four occasions (42, 68, 92 and 114 DAS). Appreciable differences were found among the landraces with respect to their agronomic and physiological traits. The landrace Rano Black was earliest to mature with greater SPAD value, stomatal conductance, PAR interception, RUE, dry matter production, seed yield and harvest index. The landrace depicted an early maturing trait with potential to capture environmental resources efficiently. Findings of the present study are discussed and its implications for its value in Bambara groundnut improvement programmes explored.

ACKNOWLEDGEMENTS

The authors greatly acknowledge the ministry of tribal affairs, Government of India for proving fund to undertake the study. Thanks are due to Dr Debbie Sparkes, Associate Professor, the University of Nottingham, England, UK for her kind guidance and support during the Post-doctoral research programme.

REFERENCES

Azam-Ali S N, Sesay A, Karikari S K, Massawe F J, Aguilar-Manjrrez J, Bannayan M and Hampson K J. 2001. Assessing the potential of an underutilized crop – A case study using Bambara groundnut. *Experimental Agriculture* **37**: 433–72.

Berchie J N, Sarkodie-Addo J, Adu-Dapaah H, Agyemang A, Addy S, Asare E and Donkor J. 2010. Yield evaluation of three early maturing Bambara groundnut (*Vigna subterranea* (L) Verdc.) landraces at the CSIR-Crops Research Institute, Fumesua-Kumasi, Ghana. *Journal of Agronomy* **9**: 175–79.

Linnemann A R and Azam-Ali S N. 1993. Bambara groundnut (*Vigna subterranea* (L.) Verdc). (*In*) *Underutilized Crops*: *Pulses and Vegetables,* pp 13–57. Williams J T. Chapman & Hall, London.

Massawe F J, Mwale S S and Roberts J A. 2005. Breeding in Bambara groundnut (*Vigna subterranea* (L.) Verdc.): stragic considerations. *African Journal of Biotechnology* **4**: 463–71.

Mauromicale G, Ierna A and Marchese M. 2006. Chlorophyll fluorescence and chlorophyll content in field-grown potato as affected by nitrogen supply, genotype, and plant age. *Photosynthetica* **44**: 76–82.

Minka S R and Bruneteau M. 2000. Partial chemical composition of Bambara pea. *Food chemistry* **68**: 273–6.

Monteith J L. 1977. Climate and the efficiency of crop production in Britain. *Philosophical Transaction of the Royal Society of London*. **B281**: 277–97.

O' Connell M G, O' Leary G J, Whitfield D M and Connor D J. 2004. Interception of photosynthetically active radiation and radiation-use efficiency of wheat, field pea and mustard in a semi-arid environment. *Field Crops Research* **85:** 111–24.

Rodrigues M A. 2004. Establishment of continuous critical levels for indices of plant and preside dress soil nitrogen status in the potato crop. *Communications in Soil Science and Plant Analysis* **35**: 2067–85.

Xu W, Rosenow D T and Nyugen H T. 2000. Stay green trait in seed sorghum: relationship between visual rating and chlorophyll concentration. *Plant Breeding* **119**: 365–7.