

Research Application Summary

Development, promotion and dissemination of improved *Fusarium* wilt resistant pigeon pea lines in drought prone areas of Uganda

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Abstract

Pigeon Pea (*Cajanus cajan*) remains a relatively untapped food legume crop in Uganda and in many parts of Africa mainly due to lack of promotion and availability of varieties that meet producer and consumers needs. The crop is a rich source of protein, fixes nitrogen in the soil and is tolerant to drought conditions. This makes it an ideal crop for the semi-arid areas of Africa. This project is using a participatory breeding approach to develop and promote consumer/market preferred pigeon pea varieties resistant to *Fusarium* wilt disease (*Fusarium udum*) and drought among farmers in northern Uganda. To do this, a collection of landraces and elite materials from Uganda, Malawi and ICRISAT is being screened for farmer desired qualities. Promising lines will be analyzed for performance under *Fusarium* wilt infection and drought, and thereafter selected lines will be entered into a breeding program. All research activities have been designed as part of two students' M.Sc. thesis research, involving a Ugandan and a Malawian student.

Key words: Breeding, *Cajanus cajan*, *Fusarium udum*

Résumé

Le petit pois (*Cajanus cajan*) reste une culture vivrière, une légumineuse relativement inexploité en Ouganda et dans de nombreuses régions d'Afrique en raison principalement du manque de promotion et de la disponibilité des variétés qui répondent aux besoins des producteurs et des consommateurs. La culture est une riche source de protéines, fixe l'azote dans le sol et est tolérant à la sécheresse. Cela en fait une culture idéale pour les zones semi-arides d'Afrique. Ce projet utilise une approche de sélection participative pour développer et promouvoir la consommation / marché de prédilection des variétés de petit pois résistant à la fusariose (*Fusarium udum*) et à la sécheresse chez les agriculteurs dans le nord de l'Ouganda. Pour ce faire, une collection de variétés locales et

les matériaux d'élite de l'Ouganda, du Malawi et de l'ICRISAT est projeté pour les agriculteurs. Des lignées prometteuses seront analysées pour déterminer le rendement en vertu de l'infection par la fusariose et la sécheresse, et par la suite les lignes sélectionnées seront inscrits dans un programme d'élevage. Toutes les activités de recherche ont été conçues dans le cadre de deux étudiants de maîtrise, thèse de recherche, impliquant un Ougandais et un étudiant du Malawi.

Mots clés: Élevage, *Cajanus cajan*, *Fusarium udum*

Background

Pigeon pea, *Cajanus cajan* (L) Millsp. is one of the major grain legume crops in Eastern and Southern Africa, Asia and Central America (Hillocks *et al.*, 2000; Silim, 2000; Souframanien *et al.*, 2003). It is an ideal crop for the semi-arid areas of Africa, due to its drought tolerance (Odeny, 2000; Owere *et al.*, 2000) and there is great potential for it to be more widely grown. The crop is largely grown by subsistence farmers in the warm semi-arid and sub-humid tropics and often on poor soils with few or no inputs due to its ability to fix atmospheric nitrogen (Adu-Gyamfi *et al.*, 2007) and ability to solubilize fixed phosphorus (Ae *et al.*, 1990). Compared to other grain legumes, pigeon pea has received relatively little research attention. Yet there is a great potential to grow pigeon pea more widely in Africa if varieties that are more acceptable to farmers and adaptable especially to drought prone areas are made available.

Considerable effort has been devoted by ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) to develop wilt-resistant pigeon peas, adapted to a wide range of environments. Some of the promising germplasm is available to be tested in different agro-ecologies. This project seeks to identify and promote improved pigeon pea varieties among already developed Fusarium wilt resistant lines developed by ICRISAT and also test other germplasm in drought prone areas of Uganda and Malawi. It also seeks to initiate a pigeon pea breeding program at Makerere University whose goal will be to develop new pigeon pea varieties with characteristics that fit farmer's preferences in the long run.

Literature Summary

Achieving food security and poverty alleviation in Sub-Saharan Africa will require a large cadre of well-trained agriculturists, and development partnerships that derive their agenda from the needs and voices of the continent's populace (Bharati *et al.*, 2004). Because of the diverse needs of Africa's farming

community and persistent poverty and food insecurity, investing in plant breeding is a matter of necessity. This project therefore proposes to train two plant breeders to improve on the very limited capacity of high level trained plant breeders essential for crop variety releases and spearheading strong innovations systems. This is critical for enhancing agricultural productivity to address food insecurity and livelihood issues especially in sub-Saharan Africa (FAO, 2005).

Over the years ICRISAT has developed some improved pigeon pea germplasm. For example, varieties suited to specific production systems have been identified: wilt-resistant long-duration varieties for Kenya, Malawi and Tanzania, and high-yielding medium-duration types for Kenya, Malawi, Mozambique, Tanzania and Uganda. The adoption of these varieties can be greatly enhanced if farmer desired qualities such as cooking qualities and dual purpose (grain and green vegetable) are included in good agronomic backgrounds (pest tolerance and disease resistance). Such varieties can be made available to farmers through sustainable small-scale seed production schemes. This approach has enabled the crop begin to regain importance in Eastern and Southern Africa (ICRISAT, 2009).

Recently, the crop regained importance with the development and adoption of new varieties. In Eastern and Southern Africa, pigeon pea recorded a 133% increase in area and a 178% increase in production between 1976 and 2006. In Eastern Kenya, about 20% of the farmers have adopted new varieties. Farmers have also started adopting medium duration pigeon pea varieties (ICEAP 00554 and 00557) both for grain purposes as well as a green vegetable. In Tanzania, about 50% of the farmers in Babati district adopted new varieties and production area expanded beyond the traditional Babati district to reach the neighbouring districts of Karatu and Mbulu. The use of long duration Fusarium wilt resistant and consumer/market preferred variety (ICEAP 00040) in northern and central Tanzania, Kenya and Malawi resulted in increased grain yields and lowered production costs in comparison to local genotypes (ICRISAT, 2009).

Study Description

The present research has three study components as described below.

Identification of sources of genes for important traits for pigeon pea improvement: Studies done by Wasike *et al.*

(2005) showed that African pigeon peas are closely related to the Indian cultivars, however, the African cultivars appear to be less genetically diverse than the Indian cultivars, which could act as source of novel traits for further improvement of African germplasm. This study is examining preferred traits (resistance to Fusarium wilt, drought tolerance and yield potential) among collected germplasm of various origins to improve local varieties. In addition to elite materials from ICRISAT, collections have been made in Uganda and Malawi. Controlled experiments have been set up at the National Semi-Arid Crop Resources Research Institute (NaSARRI) Serere, Soroti in eastern Uganda, and Makerere University Agricultural Research Institute, Kabanyolo (MUARIK) in central Uganda. The study is evaluating the performance of the collections for resistance to Fusarium wilt, pest resistance (Night and Ogenga-Latigo, 1994), drought tolerance, yield potential and other consumer preferred traits.

Genetic studies of important traits for pigeon pea. This component seeks to understand the genetics of inheritance of three key traits (resistance to Fusarium wilt, drought tolerance and yield). It will also identify superior parental lines for specific traits and pinpoint cross combinations likely to yield desirable segregates using parental materials from ICRISAT and locally grown varieties in Uganda and Malawi. To do this, F_1 and F_2 population will be developed and thereafter advanced to F_3 and F_4 populations using Single Seed Decent (SSD) selection. Estimation of variance components and heritability will be undertaken.

Participatory evaluation of elite pigeon pea germplasm. Participatory plant breeding (PPB) is a proven approach that often results into faster adoption, utilization and release of crop varieties (Weiltzen *et al.*, 2006). This study will set up participatory variety selection (PVS) sites in three of the major pigeon pea producing districts in Uganda, i.e., Lira, Arua and Gulu. Improved germplasm developed by ICRISAT and those identified during the on-station trials will be tested in targeted areas of Uganda, and also in Malawi. At every stage of PPB, active participation of farmers will be sought. Participating farmers, NGO's and CBO's will be selected based on their previous or current involvement in pigeon pea production and promotion programs. At each site, participants will make their own observations of the performance of the lines on display and rank them according to their criteria (yield, growth habit, pod colour, seed colour, cookability, taste, etc). Where promising

lines have been identified individuals or groups will be encouraged to grow them in their fields. Identified superior and promising varieties will be fronted for promotion and release as varieties in Uganda and Malawi.

Research Application

Using field plots set up in northern (Ngetta) and central (Kabanyolo) Uganda, key agronomic traits are being evaluated. Standard descriptors previously described by ICRISAT are being used to characterize the germplasm collection. A confined screen house trial will be conducted to test reaction of the germplasm to Fusarium wilt disease. Promising parental material identified from the field screening and screen house trials will be entered into a breeding program. This will include genetic analysis for number of resistance genes and gene action to Fusarium wilt. Additionally, the initial impression from the field visits so far in Uganda indicated more widespread incidence of the Fusarium wilt disease than previously thought. More detailed disease mapping beyond the scope of this project will be needed. However, for an initial understanding of diversity of this pathogen, a few isolates are being characterized.

The projects will thus initiate a pigeon pea breeding program at Makerere University in Uganda and create strong linkages between ICRISAT and Makerere University. The breeding program will lead to the promotion and dissemination of improved pigeon pea varieties in drought prone areas and in so doing improve food security for the rural poor in Uganda and Malawi. The training of plant breeders will improve on the capacity for plant breeding in Africa and hence enhance the capacity for Africa to tackle its food security problems through innovative scientists.

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