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Research Application Summary

Developing a broad soybean germplasm base and durable resistance to soybean rust disease in Uganda

Tukamuhabwa, P.[1*]., Tusiime, G.[1] & Kawuki, R.[2]
[1]Makerere University, Department of Crop Science, Box 7062, Kampala, Uganda
[2]National Crops Resources Research Institute, P.O. Box 7084, Kampala, Uganda
Corresponding author: p.tuka@agric.mak.ac.ug

Abstract

Soybean rust, *Phakopsora pachyrhizi* is a major threat to soybean production world-wide. In Uganda breeding for soybean rust resistance has taken priority over other objectives since the first disease rust outbreak in 1996. Three resistant varieties Maksoy 1N, Maksoy 2N and Namsoy 4M released by the soybean breeding programme are showing signs of resistance breakdown. This calls for broadening of the genetic base of local breeding material to be able to cope with soybean rust which is expected to be more severe in countries where it is endemic. Several other strategies can be implemented to control soybean rust. These include germplasm enhancement and breeding for durable resistance. This research seeks to use durable partial resistance to select candidate genotypes to incorporate into the breeding programme. Key outputs of the research will include resistant genotypes, inventories of genetic variability present in the available soybean germplasm and a description of rust races in Uganda.

Key words: Acquired Systemic Resistance, genetic variability, partial resistance, *Phakopsora pachyrhizi*, SSR

Résumé

La rouille de soja, *Phakopsora pachyrhizi* est une menace importante à la production de soja dans le monde entier. En Ouganda, la multiplication pour la résistance à la rouille de soja a pris la priorité au-dessus d'autres objectifs depuis la première manifestation de cette maladie en 1996. Trois variétés résistantes Maksoy 1N, Maksoy 2N et Namsoy 4M enregistrées par le programme de production du soja montrent des signes de défaillance de la résistance. Ceci demande l'élargissement de la base génétique du matériel de multiplication local pour pouvoir faire face à la rouille de soja qui pourrait être plus grave dans les pays où elle est endémique. Plusieurs autres stratégies peuvent être mises en application pour contrôler la rouille de soja. Ceux-ci incluent le perfectionnement du matériel génétique et la multiplication pour la résistance durable. Cette recherche cherche à employer la résistance partielle durable pour choisir

les génotypes candidats à incorporer au programme de reproduction. Les produits essentiels de la recherche incluront des génotypes résistants, des inventaires de la variabilité génétique actuelle dans le matériel génétique disponible de soja et une description des lignées de rouille en Ouganda.

Mots clés : Résistance systémique acquise, variabilité génétique, résistance partielle, *Phakopsora pachyrhizi*, SSR

Background

Soybean, *Glycine max* occupies an important role in agriculture as one of the most versatile crops. Despite its importance yield losses of up to 80% are incurred due to the virulent and highly variable soybean rust, *Phakopsora pachyrhizi* impacting negatively on the farmers' livelihood and soybean dependent industries. Several approaches have been undertaken to manage rust but genetic resistance is the most economical and strategically important option (Arias *et al.*, 2008). In Uganda, the success commercial varieties Maksoy 1N, Maksoy 2N and Namsoy 4M had in controlling the heavy losses to soybean rust is now disappearing (Tukamuhabwa *et al*., 2009). This necessitates utilisation of newer gene sources, broadening of the available genetic resistance base and understanding the soybean rust pathogen diversity. In addition other durable forms genetic resistance such as partial resistance need to be investigated in the available germplasm for possible use in the soybean breeding programme.

Literature Summary

Research on durable rust resistance has gathered momentum in crops such as peas, wheat and barley because of its effectiveness against a range of pathogen races. Durable resistance to ASR manifests through a spectrum of red brown reaction phenotypes (Bonde *et al*., 2006). However, no soybean variety possessing durable partial resistance has been released due to the challenge of incorporating rust evaluation techniques for durable resistance in breeding programmes (Hartman *et al*., 2005). The feasibility of employing various parameters for measuring partial resistance can be a step towards integrating this form of resistance in the local breeding programme. Breeding for resistance to ASR is a continuous process focusing on identifying resistant gene sources and variability of the pathogen. Soybean rust populations are highly dynamic and it is necessary for breeding efforts to keep pace with the prevalent pathogen races (Yorinori, 2008). The availability of new effective race differentials and molecular tools necessitates renewed

efforts in pathogen characterisation which will provide direction to the current resistance breeding efforts.

Study Description

This research will be undertaken by two MSc Crop Science students at Makerere University. In order to identify suitable parental lines for inclusion in the local breeding programme there is need to determine the level of genetic diversity in the local and exotic soybean germplasm being maintained at Kabanyolo. This study will involve phenotypic and molecular characterisation of 90 exotic accessions for various traits. In order to effectively deploy single gene resistance, there is need to understand the pathogen variability and distribution in the major soybean growing areas of Uganda. Thus, the second part of the study will involve determining prevalent soybean rust races through the use of race differentials with single spore isolates and standard sets of Simple Sequences Repeat (SSR) markers used for genotyping the pathogen. Subsequently, the various races identified from the study will be used to identify soybean lines with broad resistance. Several other elite breeding materials with be tested for adaptation and stability on farmers' fields in Mayuge, Kamwenge, Apac, Lira and Budaka districts using Additive Main effects Multiplicative Interactive (AMMI) model.

Research Application

The value of broad genetic resistance to prevent genetic vulnerability of cultivars to disease pressure cannot be overemphasised. In addition, an understanding of the level of genetic diversity in both the local and exotic lines will ensure maximisation of the genetic improvement of soybeans for sustainable resistance ASR. Knowledge of pathogen distribution will allow for targeted breeding of resistant soybean varieties. Ultimately, better soybean varieties will be developed and released to sustain farmers' nutritional well-being and their general livelihoods.

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