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# Introgression of common bean rust resistance into selected Malawian market class varieties

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# Presentation Outline

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- Problem statement
- Objectives
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**Figure 1: Bean rust spots on common bean leaf**

# Introduction



- There are 30 released common bean (CB) market class varieties in Malawi.
- The mean productivity of CB varieties is 650 kg/ha, far below the global north mean productivity of 2000 kg/ha due to abiotic and biotic stresses
- Bean rust disease caused by *Uromyces appendiculatus* (Ua) is among the common abiotic stresses that reduce bean yield.
- CB subsistence farmers in Malawi mostly rely on unsustainable and expensive methods such as fungicides application and cultural methods to control bean rust (IPM plan, 2015).

# Introduction cont'd...



- Breeding for host resistance therefore remains the most economic and environmentally sustainable method for controlling bean rust (Wafula et al., 2023).

# Problem Statement



- Ua considered the most variable virulent pathogen with many races that cause yield losses of 65-100% (Souza et al., 2014).
- Previously breeding programs in Malawi focused on rust resistance as a breeding objective and incorporated bean rust resistance genes in released varieties (Bokosi et al. 1994).
- Bokosi (1994) identified four bean rust races, namely, A953, A956, A957, and A9511, based on their reactions to a set of 19 differential cultivars.
- These races caused massive yield losses in both the released varieties and breeding lines.
- Most released (commercial and market-class) CB varieties such as NUA 45, NUA 35, NUA 59, SUG131, DRK47, and SER 83, which were planted at Kasinthula research station in Chikwawa, Malawi, during the 2021–2022 dry season, succumbed to Ua (CIAT-Malawi, 2022, 2023).

# Problem Statement



- Farmers have also reported susceptibility of the released varieties to Ua in their fields
- However, the question as to whether we are dealing with the same races of Ua identified by Bokosi or different ones is inconclusive in the Literature.
- This calls for a more coordinated resistance breeding program aimed at deploying durable bean rust resistance genes and characterizing the bean rust races through periodic race surveys.
- Introgression of bean rust resistance from CB sources into selected CB market class varieties through marker-assisted backcrossing is therefore required for resistance profiling and for improved livelihoods.

# Objectives

## Main Objective

- To introgress bean rust resistance into selected market class varieties using marker-assisted backcrossing.

## Specific Objectives

- i. To characterize bean rust races common in bean growing areas in Malawi.
- ii. To validate SCAR markers SK14, SA1079/ 800, SI19 and SAE19 linked to the Ur-3, Ur-4, Ur-5 and Ur-11 genes for rust resistance in selected common bean germplasm collection.
- iii. To introgress Ur-3, Ur-4, Ur-5 and Ur-11 bean rust resistance genes into market class varieties using marker-assisted backcrossing.

# Materials and Methods



## Area of Study

- The study will be carried out in common bean growing areas within northern region of Malawi (Chitipa, Rumphu, Mzimba).

## OBJ 1: Field survey & bean rust race characterization

- Bulk leaf samples with visible rust pustules will be collected primarily from 30 farmers' fields (20 samples/field) per district.
- Field size will be determined & bean plants at flowering & mid-pod formation stages will be randomly sampled following an inverted V outline.
- Bean rust incidence will be recorded from 20 sampled plants of the same cultivar within the sample field. Rust disease severity will be rated using a modified CIAT 1–9 scale.
- The variety name from which the diseased leaf samples will be collected will be meticulously recorded.
- The bulk leaf samples will be placed into labeled envelopes (Steadman, 2015a), dried at room temperature with silica gel.



## OBJ 1 : Continued

- Viable bean rust isolates obtained from the field survey will be purified through single-spore isolation in the microbiology laboratory at Mzuzu University.
- For every isolate, a single, unopened pustule with 25 mm<sup>2</sup> surrounding leaf tissue will be ripped apart, and the spores will be collected and multiplied on a susceptible cultivar for three consecutive cycles.
- These isolates will then be characterized into physiological races using six plants (2 plants/replicate) of each differential cultivars following a 1-6 rust severity rating standard scale by Steadman et al. (2002).
- A mixture of the identified bean rust races based on their reaction with differential cultivars will be used to prepare the inoculum for rust resistance phenotyping in a collected germplasm consisting of donor parents and market class varieties.
- The donor parents and market class varieties will be screened in a controlled experiment arranged in alpha lattice to ascertain their level of resistance to bean rust using a mixture of local bean rust races.
- The donor parent exhibiting a viable level of resistance across various local Ur races will be selected for inclusion in the backcrossing program, preferably one harbouring multiple Ur genes.

# Obj 2: Validation of SCAR markers linked to the Ur genes for rust resistance in selected common bean germplasm collection



Gene	SCAR MARKER	PRIMER SEQUENCE	Amplicon Length
Ur-3	SK14	Forward- CCC GCT ACA CAC CAA TAC CTG Reverse- CCC GCT ACA CTT GAT AAA ATG TTA G	620bp
Ur-4	Ur-4 SA1079/800	Forward- CTA TCT GCC ATT ATC AAC TCA AAC Reverse- GTG CTG GGA AAC ATT ACC TAT T	1079 and 800 bp
Ur-5	SI19	Forward-AAT GCG GGA GAT ATT AAA AGG AAA G Reverse-AAT GCG GGA GTT CAA TAG AAA AAC C	460 bp
Ur-11	SAE19	Forward- CAG TCC CTG ACA ACA TAA CAC C Reverse- CAG TCC CTA AAG TAG TT GTC CCT A	890 bp
Ur-11	UR11-GT-2	Forward-CGCACTTAGGAGCACAAA Reverse-TGGTGGGTCCCATATTTTG	450 bp

## Obj3: Introgress bean rust resistance genes into market class varieties using marker-assisted backcrossing



- Three susceptible market class varieties will be subjected to a cross with a bean rust-resistant variety harbouring specific Ur gene(s), with confirmed resistance to a range of local bean rust races in order to produce  $F_1$  seeds.
- True  $F_{1s}$  will undergo backcrossing to a market class recurrent variety.
- The selection of  $BC_1F_1$ ,  $BC_2F_1$ ,  $BC_2F_2$ ,  $BC_2F_3$  individuals will be facilitated through the utilization of a polymorphic SCAR marker linked to the target Ur gene.



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