Evaluation of local and introduced soybean varieties for response to soybean rust pathogen across soybean production ecologies of east and southern Africa

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Soybean rust, caused by *Phakopsora pachyrhizi* has emerged as a major threat to soybean production in Africa due to its rapid spread across the continent, as spores can easily be dispersed by winds. Control has mainly been through fungicide application that significantly increases production cost and environmental risks, and is uneconomical and not accessible to many smallholder farmers. Deployment of resistant soybean cultivars is the preferred management method because it is more economical and environmentally friendly. Host resistance to soybean rust exists, and so far, six resistant genes (Rpp1 to Rpp6) have been identified and are being used as source of resistance in breeding programs. However the short-term durability of these genes reflects virulence variability among *P. pachyrhizi* populations and the development of new physiological races in field populations. There is an urgent need to identify resistant soybean genotypes that can be deployed in breeding programs or can be fast-tracked for release in the country. Efforts to control the disease through identifying and introducing resistance cultivars will enhance sustainable production of soybean. This will lead to improved soil fertility, improved nutrition among households, increase in incomes, and better livelihoods. The aim of this study was to validate the utility of identified resistant genes in the east Africa, identify effective resistance accessions and recommend their use in national breeding programs to develop resistant cultivars.

Methodology

Soybean germplasm consisting of 47 IITA soybean lines, 19 AVRDC lines, six USDA lines (with known resistant genes), four Seedco (Zimbabwe) lines and local checks were established in the rust hotspot sites in Malawi, Tanzania and Uganda (Table 1). Randomized complete block design (RCBD) method with two replications was used.

Each plot consisted of three-1m long rows for each accession with spacing of 50cm between rows and 5cm within rows under natural soybean rust inoculum in the first season. In the second season, four rows 5m long each were used. An infector row of highly susceptible variety was planted around the blocks to increase the rust inoculum. Disease severity (percentage of leaf area affected) was evaluated on five randomly selected plants based on a Bayer scale (1-9) at growth stages R1 (beginning flowering) and R6 (pod filling). Three individual leaflets at the bottom, middle and top canopy of five randomly selected plants in each plot were rated individually. Disease severity of the entire plant was based on the mean severity of the three canopy levels. Reaction types on the soybean leaves were recorded as Reddish brown (RB), Immune (IM) or TAN. Sporulation levels were also recorded based on 0-3 scale; where 0 equals to no sporulation, 1- little, 2- moderate and 3-abudant sporulation. (Fig 1)

Table 1: Different locations and institutions that will conduct the screening of soybean germplasm for resistance to soybean rust.

Country	**Region**	**District**	**Site**	**Host Institution**
Tanzania	Ruvuma	Namtumbo	Suluti	ARI-Uyole
	Songwe	Mbozi	Mbimba	ARI-Uyole
	Iringa	Mufindi	Ilete	CDI
	Morogoro	Kilosa	Msimba	ARI-Ilonga
		Kilosa	Ilonga	ARI-Ilonga
Malawi	Central	Lilongwe	Chitdze	IITA-Malawi
	Southern	Thyolo	Bvumbwe	IITA-Malawi
Uganda	Central	Wakiso	Namulonge	MAK
	Northern	Lira	Ngetta	MAK
	Western	Kasese	Mubuku	MAK
Zambia	Eastern	Chipata	Chipata	ZARI-Msekera
		Mambwe	Mambwe	ZARI-Msekera
	Central	Kabwe		GART

ARI- Agricultural Research Institute, CDI-Clinton Development Initiative, IITA-International Institute of Tropical Agriculture, MAK-Makerere University; ZARI-Zambia Agricultural Research Institute. GART-Golden Valley Agricultural Research Trust.

	Severity %	**Mid point**
1	0	0
2	<2.5	1.25
3	2.5 to 5	3.75
4	5 to 10	7.5
5	10 to 15	12.5
6	15 to 25	20
7	25 to 35	30
8	35 to 67.5	51.25
9	67.5 to 100	83.75

Table 2: Scale for assessment of soybean rust severity (Walker et al., 2011)

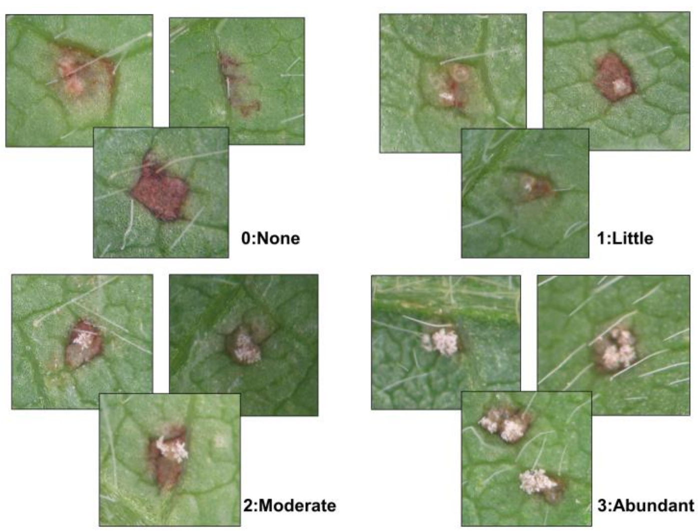

Fig 1. Scale used for assessment of soybean rust of levels of sporulation (Akamatsu et al.,2010)

Results and Discussion

Establishment of the genotypes was affected by drought that led to poor germination or even complete loss of the soybean seeds. Drought may also have affected disease establishment as evidenced by the low disease severities recorded across all locations.

For instance in Malawi data was only collected at Bvumbwe. In Tanzania, data was recorded for only Suluti, Mbimba and Msimba while in Uganda, data was collected in Mubuku and some few genotypes at Ngetta. Two of the sites in eastern Zambia failed whereas no rust infection was observed at Kabwe site. Here we present the result from Msimba and Mubuku sites.

A total of 38 and 45 soybean accessions were evaluated in Msimba and Mubuku respectively. Soybean rust severities ranged from a score of one to nine with the majority of accessions having severity score of three and seven at Msimba and Mubuku respectively (Fig. 1). Generally higher disease severities were recorded in Mubuku compared to Msimba with two of the accessions (TGx 1993-4FN and TGx-1995-5FN) registering severity of one. A total of 33 accessions (87%) recorded a RB infection type at Msimba while only nine (20%) were recorded at Mubuku. More TAN infection types (>70%) were recorded at Mubuku (Fig 2.). About 80% of the accessions at Msimba had sporulation level of one. This could be associated to the low soybean rust pressure due to the drought conditions experienced during the season. The Two accessions also recorded 0 sporulation level at (Mubuku Fig. 3), the accession had no observable lesions on the leaves.

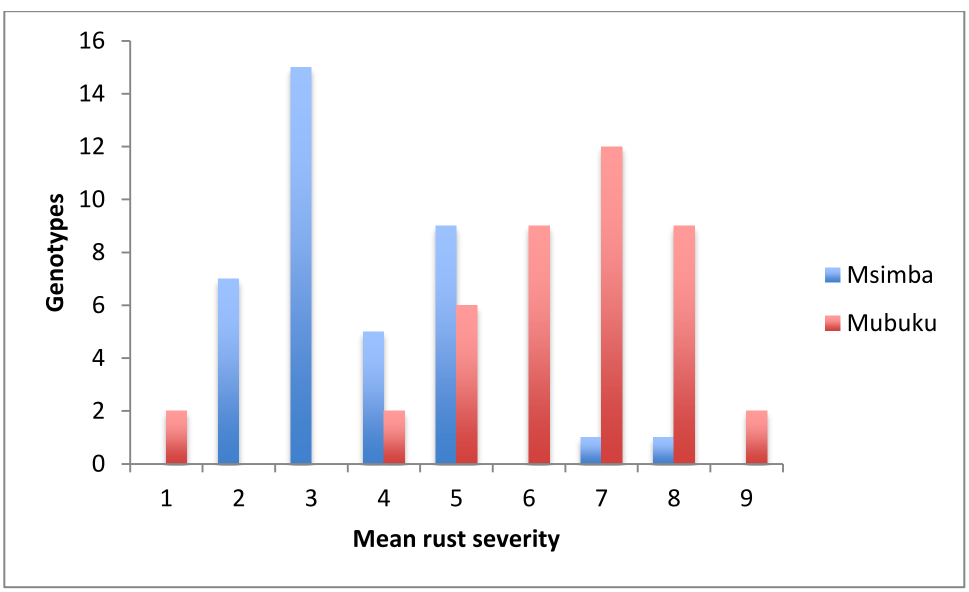

Fig. 2. Frequency distributions for the soybean accessions with mean severities of 1 to 9.

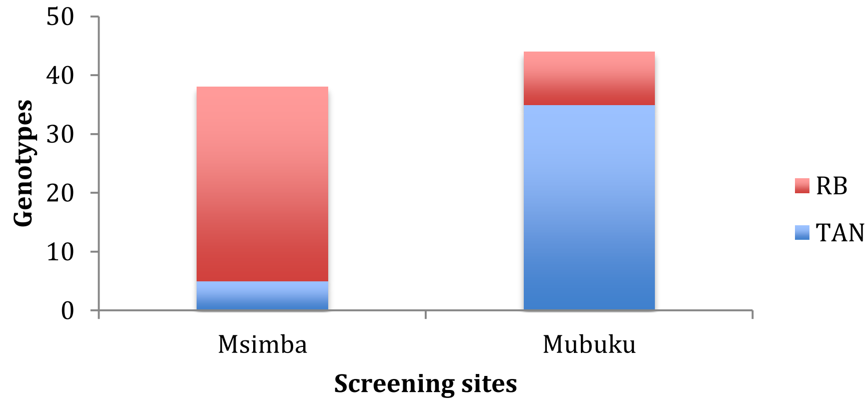

Fig 3. Frequency distribution of soybean accessions with TAN and RB infections. The number of accession in Msimba was less due to poor seed viability.

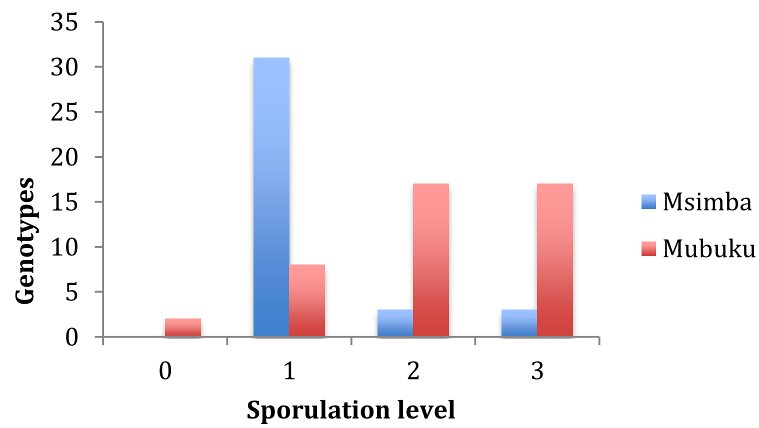

Fig 4. Frequency distributions for the soybean accessions with sporulation levels of 0 to 3.

Higher severities observed in Uganda may imply that the rust population maybe more virulent compared to the Tanzanian population. Accessions with severities score of less than six (<20%) or had RB infection types and sporulation of less than 2 were selected for re-evaluation in season two. The resistant accessions that will be identified from this study will be recommended for use in national breeding programs.