Pyramiding earliness, aphid and *Macrophomina* resistance into farmer preferred *Striga* resistant cowpea lines

Patrick Attamah

African Cowpea Consortium (ACC) Annual Meeting and Training Session. 2023

KT Project Team at CSIR-SARI

Name	Role
Patrick Attamah	PI
Dr. Francis Kusi	Mentor
Salim Lamini	Plant Pathologist
Frederick Justice Awuku	Lab Manager
Gloria Mensah	Assist. Lab Manager
Owusu Yaw Emmanuel	Cowpea breeder
Anthony Nyaaba	Field Technician
Frederick Agemga	Driver

Presentation Outline

- Background
- Objective
- Summary from previous activities
- Main activities
- Results
- Way forward
- Acknowledgement

Background

- KT funded projects led to the development of lines that are extra early maturing, and resistant to aphids and *macrophomina* disease.

- The focus has been to improve the striga resistant lines Wang Kae and KT Benga.

- None of the lines developed has all the three traits namely, extra earliness, aphid and *macrophomina* resistance.

OBJECTIVE

Develop a climate smart and eco-friendly variety that is resistant to aphids and *macrophomina* and matures in 60 days or less after planting

Summary of previous activities

- **Multiplication of seeds for AVISA Regional cowpea Trial (RCT) project**
- **Multiplication of Parental lines**
- **Development of F_1s (breeding populations)**

Main activities

- Development of F_2 and BC_1F_1 populations
- Phenotyping F_2 populations for earliness, *Striga* and *M. phaseolina* resistance under greenhouse condition
- Screening $F_{2:3}$ populations for extra earliness under rainfed condition in the open field
- Screening of extra early lines for aphid resistance

Development of F_2 and BC_1F_1 populations

- F_1s were planted along side their parents in the greenhouse
- Leaf samples were collected for DNA extraction and test for hybridity
- True hybrids were Advanced to the next generation

Results

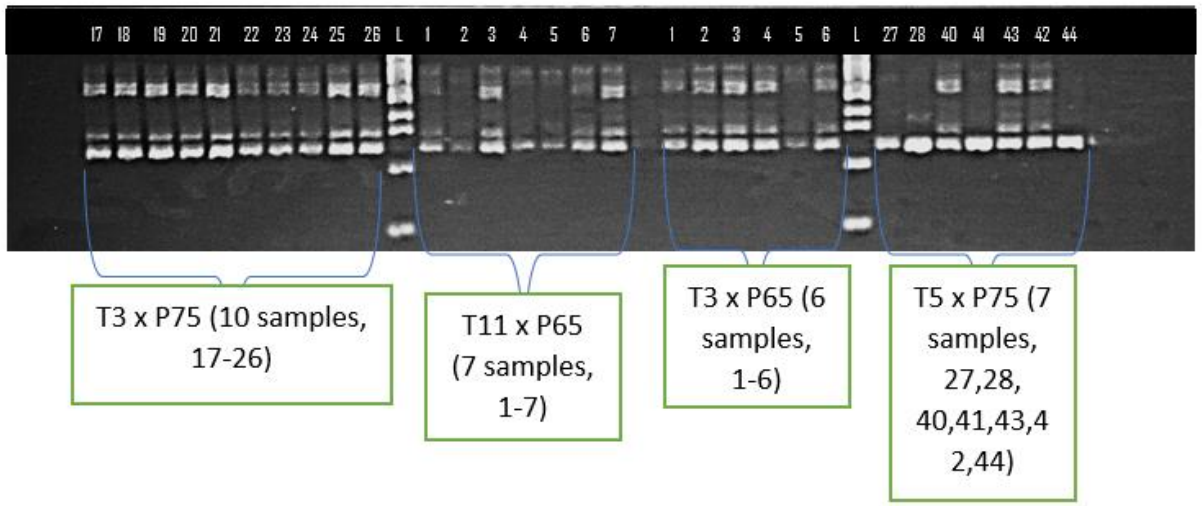


Fig. 1: Gel image showing F_1 populations genotyped with EX 40 marker.
NB: T3, T11 and T5 band size is 290; P75 and P65 band size is 250

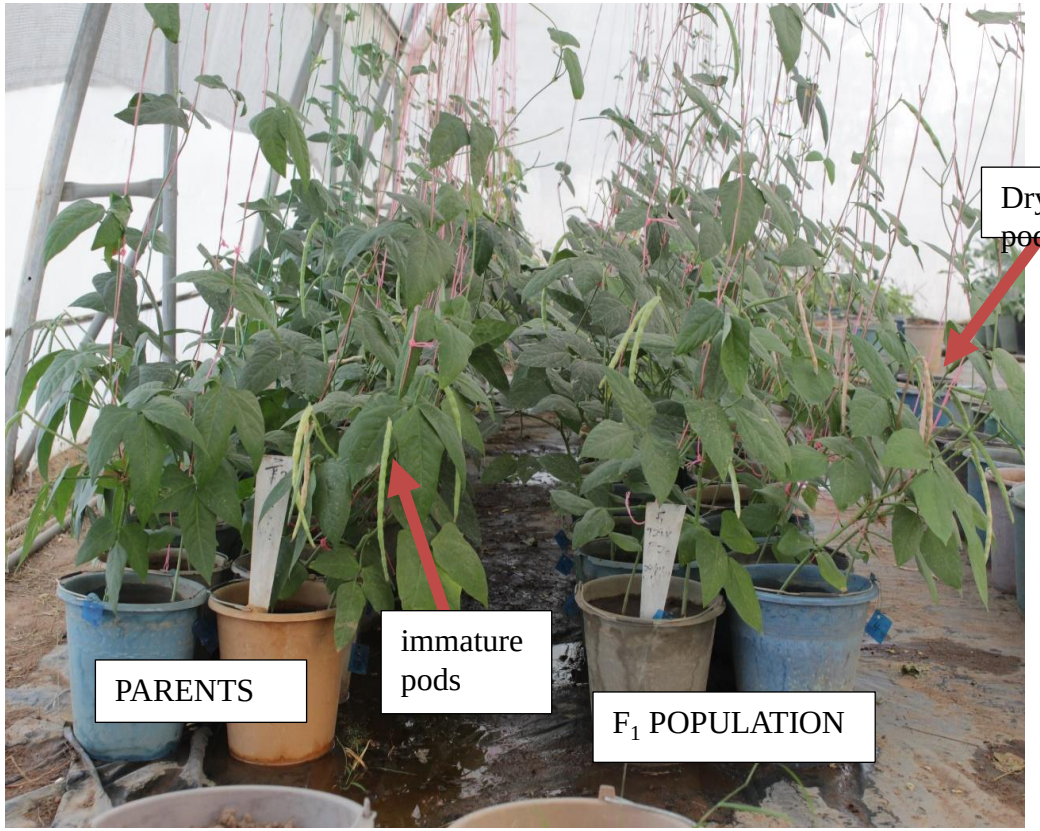


Fig 2: F_1 populations and their parents at full podding stage showing different pod maturity.

Phenotyping F_2 populations for earliness, *Striga* and *M. phaseolina* resistance under greenhouse condition

- Filled pots with topsoil
- Inoculated with striga seeds (10 g per pot)
- Water pots and leave overnight
- Dibble hole (~2 cm deep) for cowpea seed
- 3 colonized rice grain (inoculum) was put in each hole in addition to the cowpea seed

Table 1: F_2 population screened for earliness and resistance to striga and Macrophomina

Population	Pedigree	Number of seeds
1	P75/T5	100
2	P75/T3	100
3	P75/T29	100
4	P65/T3	100
5	P65/T5	100
6	P65/29	100
7	P70/T5	100
8	P70/29	100

Data collection

Table 2: Disease severity score for *Macrophomina* root rot disease of cowpea

Disease scale	Interpretation
1	No visible symptoms on plants.
3	Lesions are limited to cotyledonary tissue or hypocotyl.
5	Lesions have progressed from cotyledons to about 2 cm of stem tissues.
7	Lesions are extensive on stem and branches.
9	Most of the stem and growing points are affected by the formation of sclerotia on stem.

- The days to flowering and maturity of the individual plants
- Striga emergence

Results

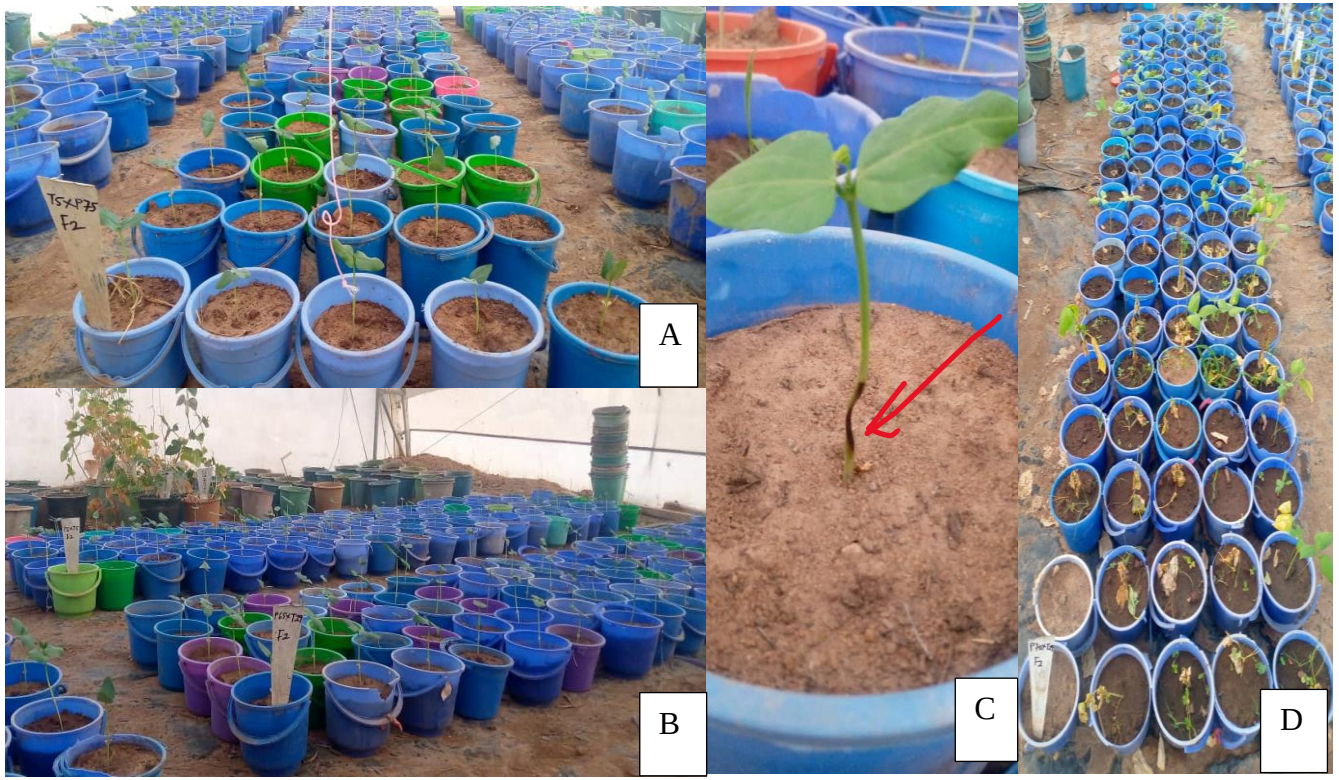


Fig 3: Sceening of F_2 populations for earliness, Striga and *Marcrophomina* resistance.

A&B = seedling establishment; C &D = *Macrophomina* damage to seedlings

Table 2: Summary results of phenotypic screening of F_2 populations

Population	Disease reaction			number of plants flowering less than 35 days
	Resistant	Susceptible	total	
P75/T3	85	15	100	17
P75/T5	87	13	100	24
P75/T29	87	10	97	10
P65/T3	53	37	90	7
P65/T5	84	7	91	5
P65/T29	47	31	78	5
P70/T5	43	7	50	3
P70/T29	21	46	67	3
Total	**507**	**166**	**673**	**74**

Screening $F_{2:3}$ populations for extra earliness under rainfed condition in the open field

- Plot: Single row 1 m plot
- Pod per row planting
- One seed per hill
- 20 cm between hills
- Five plants per plot
- Checks: Parental lines, Wang Kae, KT benga

Results

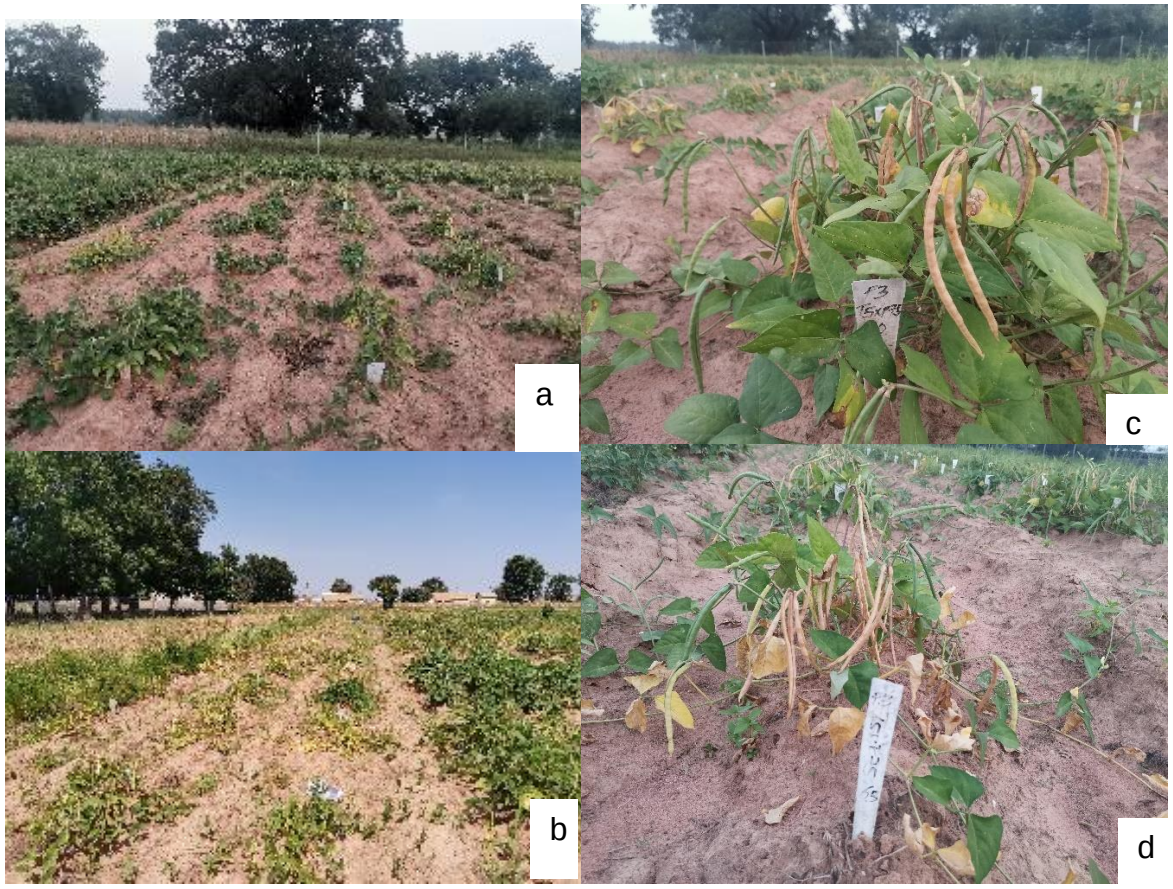


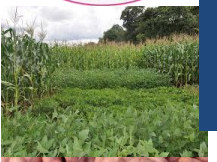
Fig 4: Field evaluation of selected F_3 lines for earliness and striga resistance. A= field showing different lines with varying maturity before harvest; B = Lines ready for harvest, some lines still not matured; C&D = single plot in which some plant mature before others

Figure 5: Pod characteristics and seeds packaging of selected lines after harvest. a=long pods; b = 4 pods per peduncle; c&d=seeds of selected plants.

Table 3: Summary statistics of the populations evaluated under field condition

	T29 x P75		T3 x P75		T5 x P75		T5 x P65		T29 x P65		T29 x P70	
parameter	Flower	maturity	flower	maturity	flower	maturity	flower	Maturity	flower	maturity	flower	Maturity
Number of plants	74	74	45	45	55	55	15	15	10	10	7	7
Mean	36.6	57.8	36.6	58.7	36.6	58.2	38.1	58.8	36.7	57.5	36.7	58.9
Minimum	31.0	49.0	32.0	52.0	32.0	52.0	33.0	52.0	32.0	52.0	32.0	53.0
Median	36.0	58.0	36.0	58.0	36.0	58.0	38.0	60.0	36.0	57.5	36.0	59.0
Maximum	44.0	66.0	42.0	68.0	43.0	64.0	43.0	63.0	43.0	63.0	42.0	64.0
S. D	2.6	3.4	3.1	4.3	2.5	3.0	3.0	3.9	3.8	3.6	3.6	4.1
Variance	6.8	11.6	9.8	18.1	6.3	9.1	9.1	15.6	14.5	13.2	13.2	16.8
SE mean	0.3	0.4	0.5	0.6	0.3	0.4	0.8	1.0	1.2	1.1	1.4	1.5
C.V.	7.1	5.9	8.5	7.2	6.9	5.2	7.9	6.7	10.4	6.3	9.9	7.0

Screening of extra early lines for aphid resistance







- Extra early lines (matures > 60 days) of T3 x P75 from the field evaluation were screened
- Susceptible check: Apagbaala
- Resistant checks: SARC 1-57-2, IT97K-556-6 and Zaa/556/SARC_P38
- Each seedling was infested with 5 forth instar aphids at 7 days after planting

- Aphids fed and multiplied on seedlings for 3 weeks
- Seedlings were score resistant or susceptible relative to the checks
- Insecticides were sprayed to terminate the experiment
- Resistant plants were allowed to flower and produce seeds

Results

Figure 6: Screening of extra early lines under artificial aphid infestation

Way forward

- Phenotype extra early lines for
  - –Aphid resistance
  - –Macrophomina resistance
  - –Striga resistance
- Preliminary yield trial of pyramided lines
- On-station replicated trials

Acknowledgement

- KT support
- KT consultants
- Dr. Francis Kusi
- Management and staff of CSIR-SARI