

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



Council For Scientific and Industrial  
Research Savanna Agricultural Research  
Institute (CSIR-SARI), Tamale, Ghana

Project team members

Mr Patrick Attamah, CSIR-SARI, Ghana

Publications

Project locations



Farmers' field day organised by the CSIR-SARI KT cowpea breeding programme in Dimabi, Ghana, 2018.

## PROJECT OVERVIEW

### Background

The aphid species *Aphis craccivora* (Koch) is a major pest of cowpea across West Africa. The CSIR-SARI Kirkhouse Trust (KT)-funded cowpea breeding project kicked off in 2011 under the leadership of Dr Francis Kusi with the identification of SARC 1-57-2 as being resistant to aphid infestation, and with the recognition that the microsatellite locus CP171/172 is linked to the gene responsible for this resistance. The programme introduced this resistance gene by marker assisted selection into five popular Ghanaian cowpea varieties, namely IT99K-573-1-1, IT99K-573-3-2, Nhyira, Asetanapa and Zaayura.



The five improved cowpea varieties released by the CSIR-SARI programme funded by KT: Kirkhouse Benga (improved IT99K-573-2-1); Wang Kae (improved IT99K-573-1-1); Zaayura Pali (improved Zaayura); Soo-Sima (improved Nyira); and Difeele (improved Asetanapa).

This work resulted in the release in 2016 of **Kirkhouse Benga** (improved IT99K-573-2-1); **Wang Kae** (improved IT99K-573-1-1); **Zaayura Pali** (improved Zaayura); **Soo-Sima** ("Sweet Cowpea", improved Nyira); and **Difeele** ("Good Soup", improved Asetanapa). For this work, Dr Kusi was awarded a PhD from the University of Ghana (thesis title: "Deployment of the cowpea aphid resistance gene for cowpea improvement in Ghana") in 2015, and in the following year, he won the national Best Agricultural Research Scientist Award.

The subsequent phase of the project aimed to add a second source of aphid resistance (present in the breeding line IT97K-556-6) to the improved varieties, with the intention of protecting them against resistance breakdown: this was the lead topic of **Mr Patrick Attamah's** PhD research (who is expected to graduate late 2021).

Research conducted by **Mr Salim Lamini** focused on identifying sources of resistance and molecular markers for charcoal rot disease (caused by the fungus *Macrophomina phaseolina*), resulting in the identification of IT97K-573-1-1 as a source of resistance.

**Mr Emmanuel Owusu's** PhD research has centred on the genetics of and breeding for early maturity, leading to the choice of the varieties Sanzi and CB27 as suitable donors to shorten the life cycle of local germplasm.

**The current phase of the project (2021-2023)**, under the leadership of **Mr Patrick Attamah**, will develop improved **Kirkhouse Benga** and **Wang Kae** varieties that combine **resistance to Striga**, two genetic sources of **resistance to aphids**, **resistance to Macrophomina**, **large seed size**, and **early maturity** for terminal drought avoidance.



An aphid infested cowpea seedling (i); artificial infestation with aphids in the screen house to test for susceptibility/resistance (ii); CSIR : SARI mobile screen house used for sampling aphids in several locations in Ghana to study the genetic diversity of populations (iii); the improved individual sleeve cage for testing individual plants for aphid resistance (iv).

## PROJECT TEAM MEMBERS

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### Mr Patrick Attamah

Principal Investigator, Council For Scientific and Industrial Research-Savanna Agriculture Research Institute (CSIR-SARI)

Mr Attamah has recently become the PI of the KT cowpea improvement project. He completed his PhD in 2021 at the Kwame Nkrumah University of Science and Technology (KNUST), Ghana.



### Dr Francis Kusi

Project mentor; Acting Director of CSIR-SARI; Head of the Upper East Farming System Research Group

Dr Kusi led the KT cowpea breeding programme from its inception in 2011 to 2021. A former KT PhD Scholar (Crop Sciences, Entomology, University of Ghana, 2015). The title of his thesis project is: *Deployment of the cowpea aphid resistance gene for cowpea improvement in Ghana.*



### Mr Emmanuel Owusu

KT PhD Scholar, Kwame Nkrumah University of Science and Technology (KNUST), Ghana PhD Complete



### Mr Salim Lamini

Research Scientist, KT PhD scholar, University of Ghana PhD Complete



### Mr Frederick Awuku

Lab Manager, former KT MSc scholar MSc Complete



### Ms Gloria Mensah

Lab Technician, former KT MSc scholar MSc Complete



### Mr Mukhtaru Zakaria

Field Technician



### Mr Anthony Nyaaba

Field Technician



### Mr Frederick Agemge

Driver

## STUDENT PROJECTS

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### Pyramiding of two different sources of aphid resistance genes into farmer preferred cowpea varieties in Ghana

#### Mr Patrick Attamah

PhD student, Kwame Nkrumah University of Science and Technology (KNUST). Supervisors: Professor Richard Akromah, KNUST, Dr Francis Kusi, CSIR-SARI, and Dr Alexander Wireko Kena, KNUST.

#### Background

Two aphid resistant cowpea varieties, SARC 1-57-2 and IT97K-556-6, were previously identified in CSIR-SARI. Resistance in these varieties was shown to be controlled by a single dominant gene, but the genes controlling resistance in SARC 1-57-2 and IT99K-556-6 are different, non-allelic and unlinked (located in two separate chromosomes).

#### Objective

The protection to aphids provided by two independent resistance genes is expected to be more durable than the protection conferred by a single gene.



Mr Patrick Attamah making crosses in the screen house.

The aim of the project was to combine the aphid resistant genes from the two parents into the five varieties previously improved by the CSIR-SARI cowpea improvement programme: Kirkhouse Benga (improved IT99K-573-2-1); Wang Kae (improved IT99K-573-1-1); Zaayura Pali (improved Zaayura); Soo-Sima (improved Nyira); and Diffele (improved Asetanapa). Two molecular markers, SNP1\_0912 and CP171/172, were used to select the IT97K-556-6 and SARC 1-57-2 aphid resistance genes in backcross progenies. The backcross populations were also tested for their susceptibility to aphids by artificial infestation.

### Achievements

Backcross populations (BC4) from each of the recurrent parents and each of the aphid resistance donor parents were developed, and the pairs derived from the same recurrent parent were intercrossed to combine the resistance genes. Breeding lines homozygous for both aphid resistance genes have been selected. The improved Kirkhouse Benga and Wang Kae are also resistant to Striga.

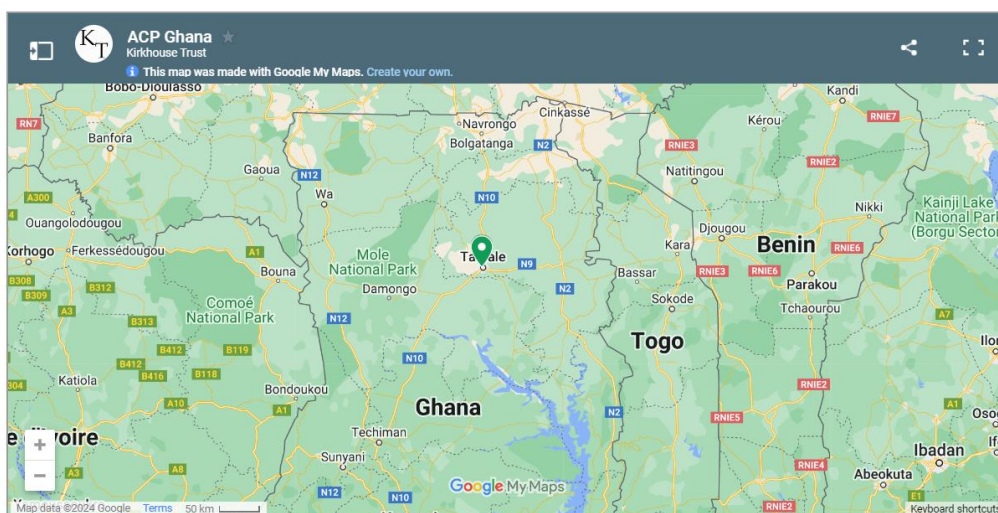


Phenotype of parent varieties and BC4F2 under artificial aphid infestation: IT97K-556-6, one of the donor varieties for aphid resistance (i); IT99K-573-2-1, the recurrent parent for Kirkhouse Benga, destroyed by aphids (ii); vigorous plant from a BC4 population derived from a cross between IT97K-556-6 and IT99K-573-2-1 (iii); the F1 population derived from a cross between the two parallel BC4 being advanced to the F2 generation where plants containing two copies of both aphid resistance genes (double homozygous- 1 in every 16 plants) can be selected for using molecular markers (iv).


### PUBLICATIONS

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- Kusi, F., Nboyine, J.A., Attamah, P., Awuku, J.F., Sugri, I., Zakaria, M., Lamini, S., Mensah, G., Larweh, V., Owusu, R.K. and Agyare, R.Y., 2020. Stability of sources of resistance to cowpea aphid (*Aphis craccivora* Koch, Hemiptera: Aphididae) across major cowpea production zones in Ghana. *International Journal of Agronomy* 2020.
- Lamini, S., Cornelius, E.W., Kusi, F., Danquah, A., Attamah, P., Mukhtaru, Z., Awuku, J.F. and Mensah, G., 2020. Prevalence, incidence and severity of a new root rot disease of cowpea caused by *Macrophomina phaseolina* (Tassi) Goid in Northern Ghana. *West African Journal of Applied Ecology* 28: 140-154.
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- Kusi, F., 2014. Deployment of the cowpea aphid resistance gene for cowpea improvement in Ghana (Doctoral dissertation, University of Ghana).

### PROJECT LOCATIONS



Location of Research Station in Tamale, SARI Ghana

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