Kirkhouse Times

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Welcome to the 10th Issue of the Kirkhouse Times which focuses on the West Africa Cowpea Consortium (WACC) activities supported by The Kirkhouse Trust SCIO (KT).

The WACC projects commenced in 2006 and initially focused on resistance to *Striga gesneroides* in Cowpea (*Vigna unguiculata*). Following the success of the programme the projects worked towards introducing resistance to additional constraints; one of the first was aphid resistance.

This issue of the Kirkhouse Times newsletter includes articles from two KT funded projects looking at aphid resistance and *Striga* resistance. There is also an article on maintenance of a dust hood designed by KT for use by the WACC and other projects supported by KT.

COVID-19: The past year has been quite a challenge. KT has mostly been required to work from home and was unable to travel to Africa for the usual annual meetings and project visits. However, the work of KT has continued and the associated projects have coped very well in the circumstances. Credit goes to them for managing to continue with minimal disruption to their work plans. Thanks to the cooperation of all those taking part, meetings held online, in place of the usual annual meetings, were a success.

The Kirkhouse Trust hopes 2021 will bring normality and that everyone remains in good health.

Highlights

Cowpea trials in Benin — *Dr Symphorien Agbahoungba*

Dr. Ir. Symphorien Agbahoungba, Head of cowpea breeding program in the Laboratory of Applied Ecology, University of Abomey-Calavi, Benin.

Dr Symphorien Agbahoungba

Dr. Symphorien Agbahoungba along with his team (M. Boris M.E. Alladassi, M. Ariel Frejus K. Sodedji and M. Mathieu A.T. Ayenan) started implementing their Kirkhouse Trust project in 2017. Two activities are ongoing: screening for sources of resistance to aphids (Aphis craccivora) and striga (Striga gesnerioides), and exploring the adaptability and yield stability of exotic varieties in Benin.

Screening for sources of resistance to resistance to aphids and striga

Fig. 1: Scoring seedlings for aphid damage.

The team are evaluating a set of varieties developed by WACC colleagues from Ghana, Burkina Faso and Nigeria along with a selection of local varieties. The aphid screen was conducted over 2018 and 2019, and is based on the protocol developed at SARI by Francis Kusi. Each plant was infested at the two leaf stage (3-4 days after emergence) by five adult aphids, and the plants were monitored over the next 24 h to ensure that five aphids had settled. The multiplication of aphids on each caged plant was monitored for up to 21 days, after which the seedlings were classified as either resistant or susceptible (Figs 1 and 2).

A pot trial method was used to screen for striga resistance; the experiment was run under screen-

Fig. 2: Counting aphid numbers.

house conditions over two growing seasons. A measured quantity of striga seed was mixed with sterilized soil and kept moist for three weeks, at which point cowpea seeds were introduced; at the end of the growing period, the number of emerged striga plants was counted and the vigour of both the host and the parasite plants was monitored. In addition, the number of attachment sites of the parasite on the host roots was determined by inspection of washed roots. The varieties which were determined as being resistant to both aphids and striga (zero attachment sites) were Apagbaala, Fuampea 1, Fuampea 2, IT97K-556-6, Komcallé, IT00K-1263, TZ Gourgou, Tvu15445 and Agbloto.

Adaptability and yield stability

The set of varieties was tested during 2019 in four cowpea growing regions of the country, namely Agbangnizoun, Klouekanmey, Saclo/Cana and Zakpota, over the two growing seasons. The experiment was set out as a randomized complete block with three replications. Each variety was represented by a four row 5 x 3 m plot with a between row spacing of 75 cm and a within row between plant spacing of 30 cm. Three seeds were planted in each hole, thinned ten days after emergence to leave two plants per hole. In order to ensure a consistent level of aphid pressure, the highly susceptible variety Tawa was grown both between and at each end of every plot. The plants were monitored over the course of the experiment by two extension officers and at least six local cowpea farmers (Fig. 3); the traits followed were aphid infestation, striga occurrence and yield (Fig. 3). The varieties favoured most strongly by the farmers were IT00K-1263, Fuampea 1, Fuampea 2, IT-15445, IT97K-556 and IT97K-449-35.

Fig. 3: Farmers and extension officer evaluating the cowpea varieties

The KT project highlighted the cowpea breeding activity conducted by the University of Abomey-Calavi's Laboratory of Applied Ecology, and has helped Symphorien obtain additional support both for the characterization of local cowpea germplasm and for the development of new varieties adapted to conditions in Benin. In addition, Symphorien's team successfully organized the 2019 WACC annual meeting in Cotonou from 15-19th October and is currently is establishing, with the support of KT, a seed dissemination project based on some of the varieties which have been tested.

Page 3: Pyramiding two sources of aphid resistance genes into farmer preferred cowpea varieties

Pyramiding two sources of aphid resistance genes into farmer preferred cowpea varieties

Patrick Attamah & Frederick Awuku

Patrick Attamah and Frederick Awuku are based at the Savannah Agriculltural Research Institute (SARI) in Ghana and are part of the WACC project team. The work described forms part of Patrick's PhD project. Frederick is the Lab Manager at SARI and is working with Patrick on the molecular activities described.

Patrick Attamah

Frederick Awuku

The cowpea aphid (*Aphis cracivora*) is a notorious pest of cowpea wherever the crop is grown, causing economic damage all the way from the seedling to the podding stage. In addition to aphids, the crop's reproductive development can also be compromised by the activity of flower thrips and a complex of pod-sucking bugs. While chemical interventions to control pest infestation at the reproductive stage should be effective against aphids, across West Africa, aphids are the only major insect pest which farmers regularly confront during the plants' vegetative stage. Thus, deploying aphid resistant crop varieties can reduce farmer expenditure on insecticide.

Natural variation for aphid resistance is well documented in cowpea; typically, its genetic basis is simple, making it relativey straight-forward to breed for resistance. Some years ago, the Ghana CSIR-SARI research group, led by Dr. Francis Kusi, identified SARC 1-57-2 as a donor of resistance which is expressed at the seedling stage, and have been able to deduce linkage between the resistance gene and the SSR locus CP 171/172. This finding has allowed for the SARC 1-57-2 resistance to be introgressed into susceptible cowpea by deploying marker-assisted selection. Supported by funding provided by Kirkhouse Trust SCIO, the SARI programme has released five new aphid resistant cowpea varieties in 2016. Single genes for resistance are, however, vulnerable to break down since their widespread deployment can spur the development of novel pest biotypes. The stacking of multiple resistance genes is seen as a prudent insurance policy to reduce the risk of sudden breakdown. With this in mind, the SARI group has been exploring additional sources of aphid resistance. One of these is carried by the IITA breeding line IT97K-556-6. Inheritance and allelism studies have demonstrated that this resistance is controlled by a single dominant gene, which is non-allelic to the one harboured by SARC 1-57-2. The team is now engaged in stacking these two genes into farmer-preferred varieties, using a marker-assisted backcrossing strategy.

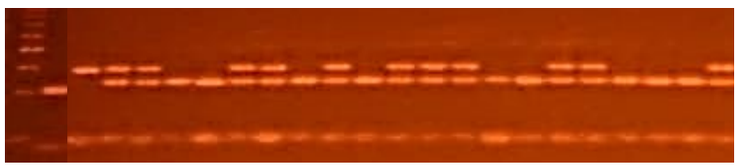

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Fig 1: Segregation for the CP 171/172 amplicon among BC_2F_1 progeny bred from the cross [IT99K-573-1-1 x SARC 1-57] x IT99K-573-1-1*2.
L=50 bp ladder; lane 1: IT99K-573-1-1; 2: SARC 1-57-2; lanes 3-22: BC_2F_1 individuals. Lanes 3,4,7,8,10,12-14,17,18 and 22 each carry the SARC 1-57-2 allele and were checked for aphid resistance before being used for the next round of backcrossing.

Two groups of recipient variety have been targeted: the first consists of the five varieties in which the SARC 1-57-2 gene has already been introduced and a second group made up of three susceptible varieties. Two introgression strategies are being implemented. The first uses the parallel backcross method, in which one stream uses CP 171/172 to track the presence SARC 1-57-2 gene and the other that of the converted SNP marker 1_0912 which is linked to the IT97K-556-6 resistance (Fig. 1).

The second strategy is the gamete selection method in which the recipient is crossed to the F1 hybrid between the two donors, followed by a backcross series involving repeated crosses (up to BC4F1) to the recipient parent; selection at each BC generation is based on the simultaneous presence of both CP 171/172 and 1_0912 (Fig. 2). In both strategies, the two markers will also be used to select for segregants fixed for both aphid resistance genes. Because the target genotype harbours two, rather than just one aphid resistance gene, the hope is that its resistance will prove to be more durable than that of varieties which harbour only a single resistance gene.

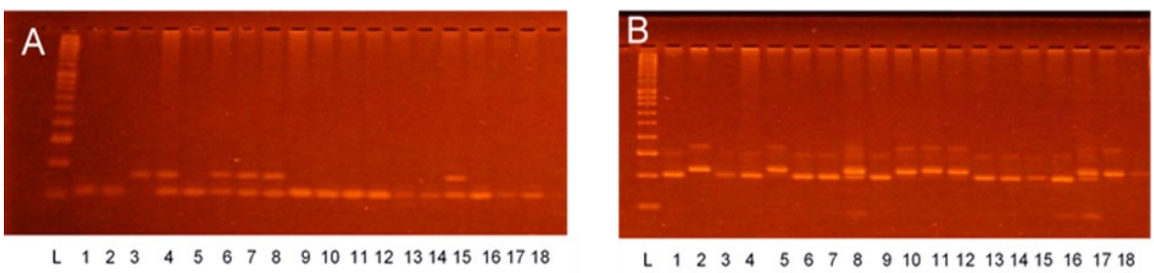

Fig 2: Segregation for (A) the CP 171/172, (B) the 1_0912 amplicon among BC2F1 progeny bred from the cross [Asetenapa x (IT97K-556-6 x SARC 1-57-2] x Asetenapa*2.
L=50 bp ladder; lane 1: Asetenapa; 2: IT97K-556-6; 3: SARC 1-57-2; 4-18: BC2F1 individuals. Lane 8 is heterozygous for both markers and was thus selected for the subsequent backcross.

Special Mentions : Graduations and Awards

Congratulations to Alice Kabeja who graduated with a PhD at University of California, Davis in November 2020 with a thesis titled: "Gene ecology of the climbing common bean (Phaseolus vulgaris) - Bean Common Mosaic Virus/ Bean Common Mosaic Necrosis Virus (BCMV/BCMNV) relationship in Rwanda: a key for the development of virus-resistant beans ." Alice also received funding from BHEARD (Borlaug Higher Education for Agricultural Research and Development).

Congratulations to Prof. Michael Timko, Coordinator of the Trust funded West African Cowpea Consortium (WACC), University of Virginia who has been awarded the *Chavalier de l'Ordre de l'Etalon* by the Government of Burkina Faso for his contribution to research on cowpea in Burkina Faso.

Congratulations to Yona Masheti who graduated with an MSc at University of Nairobi in September with a thesis titled "Performance of Bean Genotypes Under Disease Pressure In Different Environments And Planting Dates In Western Kenya"

Congratulations to Prof. Sir Edwin Southern, Chair of The Kirkhouse Trust who has been awarded the *Chavalier de l'Ordre de l'Etalon* by the Government of Burkina Faso for his contribution to research on cowpea in Burkina Faso.

Congratulations to Gloria Mensah who graduated with an MPhil at Kwame Nkrumah University of Science & Technology in August 2020 with a thesis titled "Mode of Inheritance and Genetic Relatedness of New Sources of Cowpea Aphid Resistance Found in Ghana"

Special Mentions : With thanks

Our thanks goes to Dr Eugene Terry, who has worked with The Kirkhouse Trust as a consultant on seed systems since 2013. His advice has been invaluable for progressing the seed dissemination activities funded by KT, and other project activities.
Best wishes go to Dr Terry for his future endeavours.

KT Times, Issue No. 11

The next issues of the KT Times will be published in 2021. As with this issue, it will only be published on line.

We hope to include an article on the successful release of another new variety developed by one of the West African Cowpea Consortium (WACC) projects.

Please get in touch with The Kirkhouse Trust if you have suggestions for articles you would like to see in the KT Times or if you would like to submit an article for publication in a future newsletter. Contact details are available on the KT website (www.kirkhousetrust.org).