Research on tropical forage grasses to mitigate greenhouse gas emissions and combat climate change

Dr. Jacobo ARANGO MEJIA
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Reason for the Award

The award recipient conducted a pioneering cultivation study to demonstrate the usefulness of pasture grass with high Biological Nitrification Inhibition (BNI) capacity for inhibiting the formation of nitrous oxide in soils. This is based on a concept conceived by the Japan International Research Center for Agricultural Sciences (JIRCAS). Moreover, the recipient has improved greenhouse gas measurement technologies and has developed an advanced assay technique that is the world's only method of enabling simultaneous screening of germlines obtained from several hundreds of individuals. His research is valued highly as the first to demonstrate a potential technology for inhibiting nitrous oxide formation in soils. It is expected to contribute greatly to the battle against global warming.

Outline of Research Achievements

The mitigation of climate change (CC) is a major and crucial challenge for humanity. This phenomenon has profound effects on agricultural production and food security, and CC effects are projected to become worse. As a young Colombian scientist, Dr. Arango is highly focused on developing tools and technologies to mitigate CC through reduced greenhouse gas emissions. He has conducted strategic research to demonstrate how tropical forages can reduce the environmental footprint of livestock production. One concrete example is the exploitation of the Biological Nitrification Inhibition (BNI) capacity of *Brachiaria* and *Panicum* tropical forage grasses. The BNI concept was conceived by JIRCAS in collaboration with CIAT more than a decade ago. Long-term collaborative research between JIRCAS and CIAT has provided direct evidence for inhibition of soil nitrification by plants via root exudation. The high BNI potential found in these forage grasses increases nitrogen use efficiency and reduces nitrous oxide emissions. A major outcome from his research is the development and application of accurate phenotyping tools for this key BNI trait. Another significant outcome is the development of a feeding strategy/technology through identification of superior diets for cattle, based on a combination of tropical forage grasses and tree legumes. Since these nutritious forages are more efficiently utilized by target animals, methane emissions from enteric fermentation are effectively reduced.

Main Publications:

(1) Teutscherova N., Vazquez, E., Arevalo, A., Pulleman, M., Rao, I., and **Arango J.** Differences in arbuscular mycorrhizal colonization and P acquisition between genotypes of the tropical *Brachiaria* grasses: Is there a relation with BNI activity? *Biology and Fertility of Soils* 55:325–337 (2019).

(2) Molina I, Montoya, D., Zavala, L., Barahona, R., **Arango J.**, and Ku-Vera J.C. Effects of tannins and saponins contained in foliage of *Gliricidia sepium* and pods of *Enterolobium cyclocarpum* on fermentation, methane emissions and rumen microbial population in crossbred heifers. *Animal Feed Science and Technology* 251:1–11 (2019).

(3) Nuñez J., Arevalo, A., Karwat, H., Egenolf, K., Miles, J., Chirinda, N., Cadisch, G., Rasche, F., Rao, I., Subbarao, G., and **Arango J.** Biological nitrification inhibition activity in a soil-grown biparental population of the forage grass, *Brachiaria humidicola*. *Plant and Soil* 426. 401–411 (2018).

Development of a simple, accurate, and economical diagnostic test and pooled testing system for detection of porcine epidemic diarrhoea virus

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Reason for the Award

The award recipient has developed a simple and highly accurate assay kit for virus detection in the field of research into porcine epidemic diarrhoea (PED), for which detection methods are scarce. Her assay kit, which has been put to practical application in Vietnam, requires no sophisticated devices and is thus available for use in other developing countries. The recipient's research is valued highly, because her low-cost detection kit has already been widely used in Vietnam and her assay system is highly versatile and applicable to animal infectious diseases of great public concern, such as hog cholera, in addition to PED.

Outline of Research Achievements

There is an adage that says "prevention is better than cure" but the truth is that we do not invest sufficiently in prevention. Prevention is a difficult but important message for the control of transboundary animal diseases (TADs), including porcine epidemic diarrhoea (PED). PED is an emerging and re-emerging epizootic swine disease that causes massive economic losses with high morbidity and mortality in piglets worldwide. In Vietnam, PED was first observed in 2009 and has developed to an endemic stage. PED prevention and control are expected to have a positive impact on food security; thus, early detection of PED virus-infected herd through active surveillance is necessary. However, surveillance is applied only to individuals using the 'gold standard' polymerase chain reaction (PCR) method, which is difficult to use for developing countries like Vietnam due to cost and most laboratories in the country being under-equipped and unable to meet the sophisticated requirements for PCR.

To solve this problem, we successfully developed an innovative test for diagnosing PEDV infections. This test, which uses the loop-mediated isothermal amplification (LAMP) method, has high sensitivity and specificity, and is cheap, rapid, and simple. Furthermore, our new system can be used not only on individual animals but also on several animals at once. The system is practical and has high applicability in unequipped laboratories and developing countries. It also supports the design and implementation of large-scale epidemiological surveys and enables active surveillance for the effective control of PED and other diseases.

Main Publications:

(1) **Mai T.N.**, Nguyen V.D., Yamazaki W., Okabayashi T., Mitoma S., Notsu K., Sakai Y., Yamaguchi R., Norimine J. and Sekiguchi S. Development of pooled testing system for porcine epidemic diarrhoea using real-time fluorescent reverse-transcription loop-mediated isothermal amplification assay. *BMC Vet Res* 14(1): 172 (2018).

(2) Koike, N., **T.N. Mai**, M. Shirai, M. Kubo, K. Hata, N. Marumoto, S. Watanabe, Y. Sasaki, S. Mitoma, K. Notsu, T. Okabayashi, A. Wiratsudakul, E. Kabali, J. Norimine and S. Sekiguchi. Detection of neutralizing antibody against porcine epidemic diarrhea virus in subclinically infected finishing pigs. *J Vet Med Sci* 80 (11): 1782–1786 (2018).

(3) Huynh, T.M.L, B.H. Nguyen, V.G. Nguyen, H.A. Dang, **T.N. Mai**, T.H.G. Tran, M.H. Ngo, V.T. Le, T.N. Vu, T.K.C. Ta, V.H. Vo, H.K. Kim and B.K. Park (2014). Phylogenetic and phylogeographic analyses of porcine circovirus type 2 among pig farms in Vietnam. *Transbound Emerg Dis* 61(6): e25–34 (2014).

Molecular approaches in identification, diversity and management of important insect pests in India

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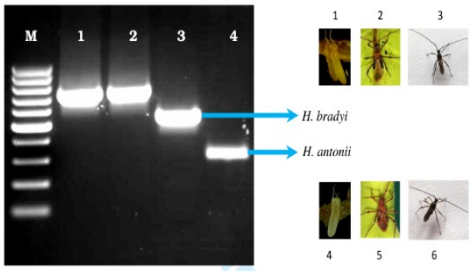
Reason for the Award

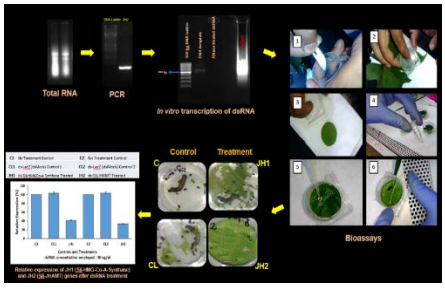
The award recipient has developed DNA barcodes and species-specific markers that enable non-experts to accurately identify pest insect species independently of their life stages, sex, and color morphs, and that are now playing important roles in field pest control and agrochemical development. The recipient's research is highly valued on account of its excellent outcomes, from a basic study via applied research that eventually yielded practical applications. These practical applications are particularly promising for the development of species-specific agrochemicals with minimal environmental impact.

Outline of Research Achievements

The accurate identification and management of insect pests has been a herculean task for several decades. Dr. Rebijith has successfully developed several DNA barcodes and species-specific markers that can identify various insect pests of agricultural crops independent of life stages, color morphs and sex. His exceptional work on molecular diversity has revealed the existence of cryptic species and genetic groups in various insects such as aphids, thrips and whiteflies, and his collaborative research on insecticide resistance status in *Bemisia tabaci* genetic groups has been widely appreciated. Furthermore, Dr. Rebijith demonstrated the utility of RNA interference in the management of *Aphis gossypii*, *B. tabaci*, *Helopeltis antonii*, *Plutella xylostella*, etc. for the first time in India. His work on small RNAs and RNAi has revealed the differentially expressed microRNAs in the juvenile hormone biosynthetic pathway in *Spodoptera*. Lastly, his work on artificial miRNA-mediated gene silencing is the basis behind novel pest management strategies that are being developed.



Species-specific markers for *H. bradyi* & *H. antonii*



dsRNA synthesis and bioassay

Main Publications:

(1) **K.B. Rebijith**, R. Asokan, H. Ranjitha Hande, and N. K. Krishna Kumar. The first report of miRNAs from a thysanopteran insect, *Thrips palmi* Karny using high-throughput sequencing. *Plos One* 11(9): e0163635 (2016).

(2) **K.B. Rebijith**, R. Asokan, H.H. Ranjitha, N.K. Krishna Kumar, V. Krishna, J. Vinutha, and N. Bakthavatsalam. RNA interference of odorant binding protein 2 (OBP2) of the cotton aphid, *Aphis gossypii* (Glover), resulted in altered electrophysiological responses. *Applied Biochemistry and Biotechnology* 178(2): 251–266 (2016).

(3) **K.B. Rebijith**, R. Asokan, N.K. Krishna Kumar, V. Krishna, B.N. Chaitanya, and V.V. Ramamurthy. DNA barcoding and elucidation of cryptic aphid species (Aphididae) in India. *Bulletin of Entomological Research* 103: 601–610 (2013).