Quality Rice. Quality Life.

2017 National Rice R&D Highlights

CROP PROTECTION DIVISION

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TABLE OF CONTENTS

		Page
Executive Summary		1
I.	Screening of Rice Materials for Insect Pest and Diseases Resistance	1
II.	Biology and Ecology of Pests	5
Abbreviations and acronymns		14

Crop Protection Division

Division Head: Genaro S. Rillon

Executive Summary

The Crop Protection Division aimed to generate, develop, and promote sustainable pest management strategies that will help farmers improve their pest management decision-making. The Division aimed to generate pest management strategies that promote ecological diversity and are environment-friendly, safe, economical, sustainable, and compatible with other management options.

Four projects were implemented: 1) Evaluation of rice materials for insect pest and disease resistance; 2) Evaluation of the biology and ecology of pest; 3) Evaluation and optimization of fossil fuel-free rice pest management strategies and techniques; and 4) Functional role of biocontrol agents in reducing pest damage to plants.

The interrelated projects contribute to the development of better pest management strategies including the identification of resistant varieties that serves as first line of defense against pests. Moreover, results from these researches will be the basis to improve farmers' decision-making in managing their pests; ensuring that pest infestation and outbreaks are mitigated at the safest and most sustainable and economical way.

I. Screening of Rice Materials for Insect Pest and Diseases Resistance

Juliet P. Rillon

The project aimed to determine the reaction of the promising lines and resistance stability of high yielding varieties to major rice insect pest and diseases and to determine the spectrum of diseases of selected accessions against differential blast and bacterial blast isolates. It is composed of four interrelated studies.

New sources of disease resistance genes against blast isolates and bacterial leaf blight races were characterized. The identified resistant accessions are potential source of resistance genes for breeding. Moreover, identified resistant lines to major rice diseases and insect pests were forwarded to breeders. Approved rice varieties were likewise re-evaluated for stability of resistance to major pests.

The first study focused on the disease resistance, in which rice lines were evaluated for the reactions of the new and superior rice lines to major rice diseases. Results indicated that 143 rice lines showed resistance to blast and 2 entries to tungro.

The second study characterized and compared the reactions of different rice lines to major insect pests. Results showed that majority of the entries in all ecosystems have intermediate reaction to brown planthopper (BPH) and green leafhopper (GLH).

The third study focused on the resistance stability of high yielding varieties to major insect pest and diseases. The 43 popular and recommended PSB and NSIC varieties that were evaluated have resistance to intermediate reactions to major insect pest and diseases.

The last study characterized new sources of disease resistance genes in PhilRice Genebank accessions. Seven lines have resistance spectrum against the 20 differential blast isolates and these are potential sources of novel broad spectrum resistance genes.

Screening of Rice Materials for Insect Pest and Disease Resistance
Juliet P. Rillon, MSV Duca, ND Santiago, MLB Palma, KMB Guarin

Rice (Oryza sativa) is one of the most important cereals being consumed all over the world. Because of the increasing demand for rice, approaches to increase its production has been explored, leading to the development of fungal, bacterial, and viral diseases such as blast, bacterial leaf blight, sheath blight, and tungro. To identify rice lines for breeding, 376 rice varieties from 7 groups (preliminary yield trial-regular, preliminary yield trial-special purpose, KOPIA, saline submergence, WV variability, PVP, and traditional rice varieties) were evaluated for reactions to blast, bacterial leaf blight, sheath blight, and tungro during WS 2017. Blast incidence was evaluated 30-35 days after sowing while bacterial leaf blight and sheath blight was examined 14 days after inoculation of the disease to the test plant. Under induced method, tungro infestation was evaluated 3-4 weeks after inoculation and after 45 and 60 days of transplanting under modified method. One hundred forty-three lines were found resistant, 61 intermediate, and 143 susceptible to blast. For bacterial leaf blight reactions, 6 were identified resistant, 230 intermediate, and 35 susceptible to the disease. For sheath blight reaction, 16 varieties showed an intermediate reaction and 229 were susceptible. Three tested entries were found resistant against tungro, 3 intermediate, and 347.

Centralized Screening for Resistance to Major Insect Pests of Rice
Gilely dC. Santiago

Insect resistance comprises the heritable qualities of a plant enabling it to reduce the degree of insect damage it suffers (Painter, 1951). Insect resistant varieties are major elements in the integrated control of rice insect pests and their use is compatible with other control tactics.

This study characterized and compared the reactions of different entries/selections to major insect pests to avoid recommending highly susceptible commercial varieties.

Evaluation of different rice lines for resistance against major insect pests of rice was implemented in both field and screenhouse conditions. Under the natural field condition, rice lines from different ecosystems were planted late to meet the required pest pressure for evaluation against stem borer (SB). In the screenhouse condition, compartment seed-boxes were used to evaluate the different entries against brown planthopper (BPH) and green leafhopper (GLH). NCT manual and Standard Evaluation System (SES) of IRRI was followed in the evaluation.

Four hundred eighty-eight entries from different ecosystems were evaluated under field condition against SB during DS 2017. Evaluation at vegetative stage showed a valid data based on susceptible check TN1 with 39.81% damage. Similarly, data at reproductive stage (whiteheads) were also valid with 26.44% damage on TN1. Under the screenhouse condition, majority of the entries were intermediate to BPH and GLH.

Two hundred eighty-two entries were evaluated during WS 2017 under natural field and screenhouse condition. The damage of SB at vegetative stage did not reach the minimum required insect pressure but were infected by Rice Tungro Virus (RTV); hence, the data on reproductive stage in this season was not valid. All rice entries had intermediate reaction to BPH and GLH under the screenhouse condition.

Resistance Stability of High-Yielding Varieties (HYVs) to Major Insect Pests and Diseases of Rice
Gilely dC. Santiago, MSV Duca, EM Valdez

Rice is easily attacked by insects and diseases, and crops are presently more vulnerable owing to reduced genetic variability. Several epidemic outbreaks of diseases and insects have occurred in different parts of the rice-growing world during the last 20 years. To combat disease and insect problems, breeding programs prioritize the development of varieties with multiple resistance. A field study was established in 2017 to determine the resistance stability of high yielding/ popular varieties to the major insect pests and diseases of rice.

The recommended popular PSB and NSIC rice varieties 5-10 years ago were chosen and planted. Their reactions to biotic stresses were benchmarked from the time of their release. These varieties were laid out following the RCBD design and re-evaluated against the major insect pest and diseases under field and screenhouse condition following the NCT protocol.

During DS 2017, a valid data was obtained at vegetative stage of the varieties with 33.23% damage on susceptible check TN1. Result showed that of the 43 varieties, 4 were resistant and 38 were intermediate. At reproductive stage, majority of the varieties were susceptible to whiteheads (WH).

During WS 2017, evaluation at vegetative and reproductive stage showed a very low stemborer population in the field resulting in an invalid data. In the screenhouse condition, majority showed intermediate reactions to BPH and GLH. Disease evaluation under the natural field condition showed that majority of the HYVs had resistant reactions to different diseases. Under the induced method (greenhouse), majority had susceptible reactions to blast, BLB, ShB, and tungro.

Characterizing New Sources of Disease Resistance Genes in the PhilRice Genebank Accessions
Jennifer T. Niones and MC Garcillano

Rice blast disease was used to be prevalent only in the Philippine tropical upland cropping systems. Gradually, its occurrences spread in intensively cultivated irrigated lowland and rainfed ecosystems causing significant yield losses. PhilRice breeding program for rice blast disease resistance recognizes the importance of diversity in resistance genes within the available germplasm. Thus, in the following study, the presence of resistance genes in selected Philippine traditional rice varieties (TRVs) collected and stored at the PhilRice Genebank was estimated based on a differential system for rice blast disease. The disease consists of differential blast isolates (Pyricularia oryzae Cavara) from the Philippines and international differential rice varieties (Oryza sativa L.) with known resistance genes developed at IRRI. By artificially inoculating rice germplasm with 20 standard blast isolates and comparing their reaction patterns with the blast monogenic lines, about 14 kinds of resistance genes: Piz-5, Pita-2, Pi5(t), Pik-m, Pik alleles, Pii/ Pi3, Pita, Pi12(t), Pi11(t), Pib, Piz-t, Pi20(t), Pia, Pik-s and unknown R genes, were estimated in 53 accessions . Seven of the evaluated TRVs were resistant to 20 differential blast isolates while 31

varieties exhibited 0.8- 0.9 broad resistance spectrum index. Rice accessions having different resistance spectrum against the differential blast isolates may imply the presence of a novel blast resistance genes within these genotypes and may prove to be valuable in PhilRice varietal improvement program for blast resistance.

II. Biology and Ecology of Pests
Gerardo F. Estoy, Jr.

Generally, the study was conducted to know the biology, ecology, and management of the rice grain bug (RGB), Paraeucosmetus pallicornis. Specifically, it aimed to determine the biology of RGB, population fluctuation trend of RGB using light traps, and rice yield loss due to RGB. It also evaluated insecticides for chemical control (last option) of the rice grain bug. There were four studies under this project.

The first study focused on the biology, ecology, and management of the rice grain bug. Three insecticides were evaluated for the control of RGB (last option) namely: cypermethrin, chlorpyrifos, and diazinon (a.i). Among the tested insecticides, cypermethhrin was the most effective in controlling RGB having 100% mortality rate after an hour of application. Yield loss assessment due to RGB has no significant difference among the treatments applied.

The second study explored the genetic diversity and cultural characteristics of Magnaporthe grisea in the Philippines. Magnaportherisea was morphologically characterized using 27 M. grisea isolates in 4 solid media (Host extract agar + 2% Sucrose, Oatmeal agar, Potato dextrose agar (PDA) + Biotin + Thiamine, and Richard's agar) based on type of margin, colony color, form, and elevation. Based on the evaluation, there were 4 growth patterns in PDA + Biotin + Thiamine, 4 in Richard's agar, 4 in Host extract agar + 2% Sucrose, and 6 in Oatmeal agar.

The third study examined the seasonal fluctuation of stemborer and other arthropods at PhilRice CES. Thirteen and 14 species of insect pests, mostly hoppers, were recorded from the JICA and KOPIA light trap catches, respectively. Light trap collections from January-June 2016 showed that the peak population of adult yellow stem borer (YSB) was observed on April 27, 2017 with 944 and 981 moth in JICA-type and KOPIA-type light trap, respectively. The most number of brown planthopper (BPH) population catches (4, 317) was recorded on March 16, 2017 in the JICA-type light trap while it was relatively low in the KOPIA-type. The same trend was observed for other hoppers: zigzag leafhopper (ZLH), green leafhopper (GLH), and whitebacked planthopper (WBPH). Other insect pests of major importance were the leaf folder (LF), rice black bug (RBB) and rice bug (RB), but populations were low.

For the natural enemies, 10 predators and 3 parasitoids were recorded from JICA-type while 8 predators and 1 parasitoid in the KOPIA-type. In addition, s6 and 4 families of detritivores/tourists were also recorded from JICA and KOPIA-type of light trap, respectively. Percent catches from the JICA-type light trap were: 45.02% pests, 26.8% predators, 0.288% parasitoids, and 27.89% other arthropods; while 29.05% pests, 35.59% predators, 0.03% parasitoids and 35.33% other arthropods were recorded from the KOPIA-type light trap.

The last study surveyed and characterized the weedy rice biotypes in Northern and Southern Mindanao. Four provinces, 13 municipalities, and 35 barangays were surveyed during DS 2017 for weedy rice occurrence in Northern and Southern Mindanao. Seeds were collected from the surveyed sites and were characterized in the laboratory. Each weedy rice biotypes were coded based on grain characteristics and designated as WR-Cot 1, WR-Cot 2, WR-Cot 3 (weedy rice biotypes mostly found in Cotabato); WR-SuK 1, WR-SuK 2, WR-SuK 3, WR-SuK 4, and WR-SuK 5 (weedy rice commonly found in Sultan Kudarat). Among weedy rice biotypes, WR-SuK 2 and WR-Cot 2 were the most prevalent in the sampling sites.

Genetic Diversity and Cultural Characteristics of Magnaporthe grisea in the Philippines
Fe A. Dela Peńa, AA dela Cruz, MJC Duque, IV Sabassaje, RG Capacao, ES Avellanoza

This study aimed to assess the genetic, cultural and morphological diversity of the isolates of the rice blast pathogen from different rice growing areas in the Philippines (rainfed, lowland, cool-elevated, and irrigated lowland).

Genetic variations were determined by running the samples through Polymerase Chain Reaction (PCR) using 9 different primers. Only E10 primer showed polymorphism. Results showed observable variation of fingerprint profiles of M. grisea isolates.

The cultural variability and sporulation of M. grisea isolates were studied on 4 solid media: Potato Dextrose Agar + Biotin + Thiamine (PBT), Host Leaf Extract + 2% Sucrose Agar (HEA), Oatmeal Agar (OA), and Richards's Agar (RA). The isolates were characterized after 7 days of incubation under room temperature. They were subsequently characterized based on colony color, form, elevation, and margin. Result showed that there were 4 growth patterns identified in PBT; 4 in HEA; 4 in RA; and 6 in OA. Moreover, of the 4 media tested, M. grisea isolates showed better sporulation in OAr > HEA > PBT > RAr, respectively.

Seasonal Fluctuation of Stemborer and other Arthropods at PhilRice CES
Gilely dC. Santiago, EM Valdez

Management of insect pests employs several tactics that should be compatible with each other to become effective. Managing insect pests is difficult as they are generally widely distributed and their populations are oftentimes overlapping. Executing management strategies is also challenging as control is specific to certain pests and during its growth stage. As such, knowing the right time to apply intervention is necessary to better manage a particular pest.

Light trapping is a tool used in determining the population fluctuation of arthropods as it provides a significant clue to the diversity of insects active at night. It can also aid in predicting how populations fluctuate during a particular period in relation to the current weather conditions. Although the market is flooded with different models of light traps, scientific data on the trap collection, diversity, number, and its efficacy is yet to be available. This information can help field researchers in selecting light-traps that will attract specific order insects. As such, two different light sources were compared and analyzed.

Two types of light trap, the JICA-type and KOPIA-type, were installed at PhilRice CES to understand population dynamics of the major insect pests. The weekly light trap collections from the two types of light trap from January to June 2017 were sorted, identified, and counted in the laboratory. Initial result showed that the arthropod catches vary with the different types of light trap. However, population peak of the major pests were comparable.

Survey and Characterization of Weedy Rice Biotypes in Northern and Southern Mindanao
Edwin C. Martin, DKM Donayre, FR Sandoval, JS Bruno

Weedy rice diminishes the quality and yield of cultivated rice. However, local reports documenting its phenotypic characteristics particularly in South/North Cotabato, Sultan Kudarat, and Maguindanao (Central Mindanao) are limited. This study investigated the incidence, biology, and phenotypic characteristics of weedy rice, which was surveyed and collected from Central Mindanao rice fields in WS 2016 and in 2017. Twenty four weedy rice biotypes were designated as WR-Suk3, WR-Min1, WR-Min2, WR-Min3, WR-Cot2, WR-Min4, WR-Min5, WR-Min6, WR-Min7, WR-SuK4, WR-Min8, WR-Min9, WR-Cot3, WR-Min10, WR-Min11, WR-Min12, WR-Min13, WR-SuK5, WR-Min14, WR-Min15, WR-Min16, WR-Min17, WR-Min18, and WR-Min19 (2016 WS); 27 weedy rice biotypes in 2017 WS (WR-SuK3, SuK4, SuK5, WR-Cot2, Cot3, WR-Min1, Min4, Min5, Min6, Min7, Min9, Min13, Min15, Min16, Min20, Min21, Min22, Min23, Min24, Min25, Min26, Min27, Min28, Min29, Min30, Min31, Min32, and Min33; and 25 weedy rice biotypes namely WR-Min1, Min4, Min5, Min6, Min7, Min9, Min10, Min13, Min25, Min27, Min31, Min32, Min37, Min38, Min39, Min40, Min41, Min42, Min44, Min45, WR-Suk3, SuK4, Suk5, WR-Cot2, and Cot3 (2017 WS). The most prevalent biotypes were WR-SuK3 (WS 2016), WR-Min15 (DS 2017), and WR-Suk3 (DS 2017).

Laboratory and screenhouse experiments were conducted at PhilRice CES. Under screenhouse conditions, all biotypes matured earlier and had better agronomic characteristics than cultivated rice NSIC Rc 222, implying that weedy rice significantly threatens rice production.

III. Evaluation and Optimization of Fossil Fuel-free–rice Pest Management Strategies and Techniques

Dindo King M. Donayre

In the Philippines, pesticides remain the farmers' top option to combat different kinds of rice pests. Because of this, major pests outbreak and resurgence occur as a result of continuous use of the same quality and quantity of pesticides in the field.

There are other available pest management strategies and techniques that are also effective and do not require or minimally entail fossil fuel energy such as use of resistant varieties and of cultural and biological control methods. As none of these will work alone, a holistic approach is still needed to achieve better pest management and avoid undesirable effects to humans, animals, and the environment while lessening fossil fuel use.

This project has 10 interrelated component studies that aimed to develop, evaluate, and optimize fossil fuel-free-rice pest management strategies and techniques against selected major pathogens, insect pests, weeds as well as the invertibrate and vertibrate pests of rice. Of the ten components, three of these were still on-going in 2017.

In evaluating endophytic and epiphytic fungal isolates from rice against blast pathogen, results showed that isolates had varying degrees of endoglucanase activities and mycelial growth inhibitions against the fungal pathogen.

Separate study also showed that T. harzianum isolates, which were applied as seed treatments or foliar sprays effectively reduced incidence of rice blast and brown spot and sheath rot diseases.

Exploring Endophytic Fungi from Rice: their Role in Plant Protection and Practical Use in Biological Control

Jennifer T. Niones, DKM Donayre, JA Poblete

Fungal endophytes are microorganisms that spend the whole or part of its life cycle colonizing the inter- and/or intracellular spaces of a healthy host plant without causing infections and apparent symptoms of disease. Evidence on the role of fungal endophytes in the direct biocontrol of pathogens and indirect biocontrol through induction of systemic resistance in plants are increasing. Thus, fungal endophytes indicate potential for managing crop disease. With its long history of cultivation, traditional rice varieties are likely to harbor unique populations of fungal endophytes than the extensively-bred modern rice varieties treated with agrochemicals. This study assessed a collection of fungal endophytes isolated from traditional rice varieties for in-vitro antifungal activity against rice blast (Pyricularia oryzae) and sheath blight (Rhizoctonia solani) pathogens. In-vitro inhibitory assay results identified 45 isolates that can inhibit the mycelial growth of either R. solani or P. oryzae. Moreover, nine endophytic fungal isolates inhibited the mycelial growths of both fungal pathogens. Evaluation of the extracellular proteolytic and endoglucanase activity of these inhibitory fungal endophytes showed that none of them exhibited proteolytic activity. They also showed varying degree of endoglucanase activity as shown by the zone of hydrolysis around the fungal colony. This may imply that the antimicrobial activity of the fungal endophytes isolated from traditional rice varieties is not necessarily associated with its ability to produce extracellular proteases.

Epiphytic Microbial Antagonists and their Effects on the Rice Blast Pathogen

FA Dela Peńa, JA Cruz, R Capacao, DKM Donayre

The above ground parts of plants are normally colonized by bacteria, yeast, and fungi known as epiphytes, which may contribute a large impact to our ecosystem. Studies on these microorganisms may lead to new innovations and possible cures for existing or future diseases. Thus, this study isolated, screened, selected, identified, and evaluated the action of epiphytic fungi from rice leaves against Magnaporthe grisea isolate. Sixty-six epiphytic fungi were isolated and purified from the collected leaf samples from Cabanatuan, Palayan, General Tinio, Penaranda, Talugtug, Cuyapo, Guimba, and Lupao in Nueva Ecija. There were 16 coded species of Curvularia, 13 sterile mycelia, 11 Fusarium, 9 Penicillium, 6 Bipolaris, 4 Aspergillus, 3

Mucor, and 1 each for Alternaria, Nigrospora, Pestalotia, and Paecilomyces isolated from the samples collected. Out of 96 purified epiphytic fungi (additional 30 isolates from 2016 collection) subjected to preliminary in-vitro bio-efficacy screening, 48 isolates demonstrated an antagonistic effect against M. grisea when subjected to dual culture test. Among the 48 selected potential epiphytes, 20 isolates caused >25% growth inhibition. Coded species of Tat2 and Tat28 (still unidentified) caused the highest inhibitory effects on M. grisea with 88.03 and 83.25% growth inhibition followed by coded species of Mucor sp. LB2 and CaT4 with 63.07 and 60% growth inhibition, respectively. Moreover, two modes of antagonistic effects were observed: 1) rapid mycelial growth of the antagonists towards the M. grisea isolates which suppressed its growth and (2 inhibition of the mycelial growth of M. grisea without direct contact to the antagonist.

Evaluation of Trichoderma harzianum Isolates for the Management of Blast, Sheath Rot, and Brown Spot Diseases of Rice
Ma. Salome V. Duca, DKM Donayre, FR Sandoval

Trichoderma harzianum is known for its antagonistic and mycoparasitic actions against wide range of fungal pathogens. Its efficacy against fungal pathogens of rice, however, are very limited. This study determined and evaluated the efficacies of two Trichoderma harzianum isolates as biological control agents against blast, sheath rot, and brown spot disease-causing fungal pathogens of rice. Results showed that both T. harzianum isolates (T5Oi and TMDRi) applied as seed treatments and foliar sprays were effective against the three fungal pathogens. Seeds soaked in spore suspensions of both T. harzianum isolates resulted in the reduction of brown spot incidence by 72-89%, sheath rot by 42-84%, and blast disease by 26-78%. When applied as foliar sprays, brown spot incidence was reduced by 47-53% while sheath rot and blast diseases were down by 34-60 and 15-25%, respectively.

IV. Functional Role of Biocontrol Agents in Reducing Pest Damage to Plants
Jennifer T. Niones

Insect pests, diseases, and weeds remain to be one of the significant limiting factors of crop productivity. Farmers spray their crop with vast amount of synthetic chemical pesticides as control method. However, the increasing awareness on the unfavorable human and environmental effects of pesticide use had led to the search for alternative strategies to combat the destructive effects of pests on crops. The use of microbial agents as alternatives in managing pest and diseases is seen as major component in sustainable farming. Understanding the mechanisms on how microbial agents

protect the plant from pest infestation is paramount to the development and usefulness of these microorganisms in reducing the use of pesticides, in both subsistence and intensive agricultural systems. Moreover, microbial conservation and management efforts must be in place at the early stage of biocontrol agent development.

Maintaining and preserving microbial cultures ensures the quality of microbial agents not only for research but most especially for commercialization and public use. The project generally aimed to gain in-depth understanding of the functional role of microbial agents in reducing pest damage to rice plants and to ensure proper conservation and management of beneficial microbes. The project has three studies with the following specific objectives: 1) optimize a bait-base delivery method for S. singaporensis, a protozoan parasite to control rodent pest; 2) determine the disease resistance enhancing ability of selected strains of plant growth promoting rhizobacteria against rice blast disease (Magnaporthe oryzae) and rice sheath blight (Rhizoctonia solani); and 3) develop conservation and preservation strategies for beneficial microbes from the rice environment to ensure their physiological and genomic integrity and quality for research and development.

The study, Development of Rice-based Bait for Sarcocystis singaporensis (CPD 009-001), evaluated different substrates as effective bait base against rodents. It showed that regular milled rice can be used as the main ingredient of the bait base. To be used as substrate, milled rice can be mixed with other food ingredients and molded to hold and maintain the virulence of S. singaporensis

The study, Disease Resistance Inducing Ability of Selected Isolates of Plant Growth Promoting Bacteria (CPD 009-002), examined host defense response enzyme activity such as the superoxide dismutase (SOD) to better understand the role of Streptomyces mutabilis, a plant growth promoting rhizobacterium, in mediating host resistance in response to rice blast pathogen (P. oryzae). Evaluation of the activity of the host defense response enzyme, superoxide dismutase (SOD), showed a significantly higher level of enzyme activity in plants with S.mutabilis than in plants without S. mutabilis.

The study, Conservation and Management of Microbial Agents (CPD 009-003), stored microbial isolates in different in-vitro preservation methods. Microbial collection included reference pure cultures of 3 species of plant growth promoting bacteria, 2 species of fungal biocontrol agents, 3 strains of drought -tolerant bacteria, 6 strains of lignin- degrading bacteria, a set of Xanthomonas oryzae pv. oryzae (14), and Pyricularia oryzae (20) differential isolates and additional 2 species of rice pathogens.

A Material Transfer Agreement for Non seed Biological Materials (MTA-NSBM) has been finalized. This document sets the terms and conditions on the use and exchange of some of these microbial cultures.

Development of Rice-based Bait for Sarcocystis singaporensis
Ulysses G. Duque, MJC Ablaza

Sarcocystis singaporensis is a protozoan parasite used as biological rodent control agent. The study aimed to develop bait base that can deliver S. singaporensis to its target pest .

Test was conducted to determine the most preferred food component by the rodents as main ingredient of the bait base. Regular milled rice was compared to other food components such as milled corn, roasted coconut meat, and aromatic rice. Following the method used by Velimerov et al., (2011), 10 individually caged rats were subjected to no choice feeding test. R. tanezumi (5 males and 5 females) were fed with each treatment for four consecutive days. Daily consumption of test rats were recorded and analyzed. The set-up was repeated five times. Results of the preference test showed that regular milled rice can be used as the main ingredient of the bait base. It needs to be mixed with other food ingredients and molded to hold and maintain the virulence of the organism. Field testing and evaluation of the developed bait need to be evaluated.

Disease Resistance Inducing Ability ofSselected Isolates of Plant Growth Promoting Bacteria
Jennifer T. Niones, JA Poblete

The study aimed to determine the disease resistance enhancing ability of Streptomyces mutabilis and Bacillus sp. against rice blast disease (Magnaporthe oryzae) and rice sheath blight (Rhizoctonia solani). Moreover, the mechanism of host protection elicited by these plant growth promoting bacteria, particularly the induction of cellular plant defense responses, was characterized.

The activity of superoxide dismutase (SOD) in leaf extract from different treatments was assayed by measuring the rate of the reduction with a superoxide anion. SOD activity in the experimental sample is measured as the percent inhibition of the rate of formazan dye formation, which was monitored using a spectrophotometer that measures the amount of the colored NBT-diformazan dye product. Assay results showed that SOD enzyme activity was significantly greater ($P<0.05$) in plants with S.mutabilis than in plants without S. mutabilis. However, when inoculated with conidial suspension of P. oryzae, the SOD enzyme activity of S. mutabilis+ and S. mutabilis – was not significantly different. On the other hand, sheath blight disease index is higher in plants without Bacillus sp. than those with Bacillus sp. The SOD activity in Bacillus sp. inoculated plants under disease pressure is yet to be examined.

Conservation and Management of Microbial Agents
Jennifer T. Niones, JA Poblete, M Garcillano

The study primarily aimed to preserve and maintain reference strains of PhilRice collection of biologically important microbial isolates such as plant growth promoting microorganisms, biological control agents, and virulent isolates of major rice pathogens. Current collection comprise of reference cultures of 3 species of plant growth promoting bacteria, , 2 species of fungal biocontrol agents , 3 strains of drought -tolerant bacteria, 6 strains of lignin- degrading bacteria , a set of Xanthomonas oryzae pv. oryzae (14), and Pyricularia oryzae (20) differential isolates and additional 2 species of rice pathogens . They are stored in different in vitro preservation methods. Each preservation techniques were regularly evaluated for their effects on the morphological and physiological integrity of the microbial cultures over time. Access, use, and exchange of some of these microbial cultures are governed by the terms and conditions set in the Material Transfer Agreement for Non seed Biological Materials (MTA-NSBM).

Abbreviations and acronymns

ABA – Abscicic acid
Ac – anther culture
AC – amylose content
AESA – Agro-ecosystems Analysis
AEW – agricultural extension workers
AG – anaerobic germination
AIS – Agricultural Information System
ANOVA – analysis of variance
AON – advance observation nursery
AT – agricultural technologist
AYT – advanced yield trial
BCA – biological control agent
BLB – bacterial leaf blight
BLS – bacterial leaf streak
BPH – brown planthopper
Bo - boron
BR – brown rice
BSWM – Bureau of Soils and Water Management
Ca - Calcium
CARP – Comprehensive Agrarian Reform Program
cav – cavan, usually 50 kg
CBFM – community-based forestry management
CLSU – Central Luzon State University
cm – centimeter
CMS – cystoplasmic male sterile
CP – protein content
CRH – carbonized rice hull
CTRHC – continuous-type rice hull carbonizer
CT – conventional tillage
Cu – copper
DA – Department of Agriculture
DA-RFU – Department of Agriculture-Regional Field Units
DAE – days after emergence
DAS – days after seeding
DAT – days after transplanting
DBMS – database management system
DDTK – disease diagnostic tool kit
DENR – Department of Environment and Natural Resources
DH L– double haploid lines
DRR – drought recovery rate
DS – dry season
DSA - diversity and stress adaptation
DSR – direct seeded rice
DUST – distinctness, uniformity and stability trial
DWSR – direct wet-seeded rice
EGS – early generation screening
EH – early heading
EMBI – effective microorganism-based inoculant
EPI – early panicle initiation
ET – early tillering
FAO – Food and Agriculture Organization
Fe – Iron
FFA – free fatty acid
FFP – farmer's fertilizer practice
FFS – farmers' field school
FGD – focus group discussion
FI – farmer innovator
FSSP – Food Staples Self-sufficiency Plan
g – gram
GAS – golden apple snail
GC – gel consistency
GIS – geographic information system
GHG – greenhouse gas
GLH – green leafhopper
GPS – global positioning system
GQ – grain quality
GUI – graphical user interface
GWS – genomwide selection
GYT – general yield trial
h – hour
ha – hectare
HIP - high inorganic phosphate
HPL – hybrid parental line
I - intermediate
ICIS – International Crop Information System
ICT – information and communication technology
IMO – indigenous microorganism
IF – inorganic fertilizer
INGER - International Network for Genetic Evaluation of Rice
IP – insect pest
IPDTK – insect pest diagnostic tool kit
IPM – Integrated Pest Management
IRRI – International Rice Research Institute
IVC – in vitro culture
IVM – in vitro mutagenesis
IWM – integrated weed management
JICA – Japan International Cooperation Agency
K – potassium
kg – kilogram
KP – knowledge product
KSL – knowledge sharing and learning
LCC – leaf color chart
LDIS – low-cost drip irrigation system
LeD – leaf drying
LeR – leaf rolling
lpa – low phytic acid
LGU – local government unit
LSTD – location specific technology development
m – meter
MAS – marker-assisted selection
MAT – Multi-Adaption Trial
MC – moisture content
MDDST – modified dry direct seeding technique
MET – multi-environment trial
MFE – male fertile environment
MLM – mixed-effects linear model
Mg – magnesium
Mn – Manganese
MDDST – Modified Dry Direct Seeding Technique
MOET – minus one element technique
MR – moderately resistant
MRT – Mobile Rice TeknoKlinik
MSE – male-sterile environment
MT – minimum tillage
$mtha^{-1}$ - metric ton per hectare
MYT – multi-location yield trials
N – nitrogen
NAFC – National Agricultural and Fishery Council
NBS – narrow brown spot
NCT – National Cooperative Testing
NFA – National Food Authority
NGO – non-government organization
NE – natural enemies
NIL – near isogenic line
NM – Nutrient Manager
NOPT – Nutrient Omission Plot Technique
NR – new reagent
NSIC – National Seed Industry Council
NSQCS – National Seed Quality Control Services
OF – organic fertilizer
OFT – on-farm trial
OM – organic matter
ON – observational nursery
OPAg – Office of Provincial Agriculturist
OpAPA – Open Academy for Philippine Agriculture
P – phosphorus
PA – phytic acid
PCR – Polymerase chain reaction
PDW – plant dry weight
PF – participating farmer
PFS – PalayCheck field school
PhilRice – Philippine Rice Research Institute
PhilSCAT – Philippine-Sino Center for Agricultural Technology
PHilMech – Philippine Center for Postharvest Development and Mechanization
PCA – principal component analysis
PI – panicle initiation
PN – pedigree nursery
PRKB – Pinoy Rice Knowledge Bank
PTD – participatory technology development
PYT – preliminary yield trial
QTL – quantitative trait loci
R - resistant
RBB – rice black bug
RCBD – randomized complete block design
RDI – regulated deficit irrigation
RF – rainfed
RP – resource person
RPM – revolution per minute
RQCS – Rice Quality Classification Software
RS4D – Rice Science for Development
RSO – rice sufficiency officer
RFL – Rainfed lowland
RTV – rice tungro virus
RTWG – Rice Technical Working Group
S – sulfur
SACLOB – Sealed Storage Enclosure for Rice Seeds
SALT – Sloping Agricultural Land Technology
SB – sheath blight
SFR – small farm reservoir
SME – small-medium enterprise
SMS – short message service
SN – source nursery
SSNM – site-specific nutrient management
SSR – simple sequence repeat
STK – soil test kit
STR – sequence tandem repeat
SV – seedling vigor
t – ton
TCN – testcross nursery
TCP – technical cooperation project
TGMS – thermo-sensitive genetic male sterile
TN – testcross nursery
TOT – training of trainers
TPR – transplanted rice
TRV – traditional variety
TSS – total soluble solid
UEM – ultra-early maturing
UPLB – University of the Philippines Los Baños
VSU – Visayas State University
WBPH – white-backed planthopper
WEPP – water erosion prediction project
WHC – water holding capacity
WHO – World Health Organization
WS – wet season
WT – weed tolerance
YA – yield advantage
Zn – zinc
ZT – zero tillage

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We are a government corporate entity (Classification E) under the Department of Agriculture. We were created through Executive Order 1061 on 5 November 1985 (as amended) to help develop high-yielding and cost-reducing technologies so farmers can produce enough rice for all Filipinos.

With a "Rice-Secure Philippines" vision, we want the Filipino rice farmers and the Philippine rice industry to be competitive through research for development in our central and seven branch stations, coordinating with a network that comprises 59 agencies strategically located nationwide.

We have the following certifications: ISO 9001:2008 (Quality Management), ISO 14001:2004 (Environmental Management), and OHSAS 18001:2007 (Occupational Health and Safety Assessment Series).

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