2018

NATIONAL RICE R&D HIGHLIGHTS

CROP PROTECTION

DIVISION

PHILRICE

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CROP PROTECTION

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. Pest management strategies should be ecosystem-based that promote ecological diversity, environment-friendly, safe, economical, sustainable, and compatible with other management options. Hence, the division contributes to the achievement of the PhilRice strategic outcomes: increased productivity, cost effectiveness, and profitability of rice farming in a sustainable manner; enhanced value, availability, and utilization of rice, diversified rice-based farming products for better quality, safety, health, nutrition, and income; and advanced rice science and technology as continuing sources of growth.

The division implemented three projects that could contribute to the development of sound pest management strategies and pest-resistant varieties: evaluation of rice materials for insect pest and disease resistance, characterization of resistant PhilRice breeding lines and germplasm; and identification of the ecology of yellow stemborer, plant hoppers, and other arthropods.

Experimental field setup on the evaluation of resistance to bacterial leaf blight.

PROJECT 1:

EVALUATION OF RICE LINES FOR DISEASE AND INSECT PESTS' RESISTANCE

JP Rillon

The role of screening is very important in identifying rice lines that will show resistance to major diseases and insect pests and this compliment rice varietal development to produce better varieties. Promising rice lines and varieties were evaluated for resistance to blast, bacterial leaf blight (BLB), sheath blight (ShB), tungro, green leafhopper (GLH), brown planthopper (BPH), and yellow stemborer. A field study was also established to determine the resistance stability of high yielding/popular varieties to the major insect pests and diseases of rice under field and screenhouse conditions.

Evaluation of rice lines for resistance to major rice diseases

JP Rillon, KM Guarin, SE Santiago, N Santiago, and MS Duca

This study aimed to identify rice lines resistant to major diseases that could be used for breeding. Results showed that among the entries tested, 444 rice lines were resistant to blast while intermediate reaction to disease was observed in 159 entries. Seventeen entries were found to be resistant to BLB while 239 entries had intermediate reaction to the disease. Intermediate reaction to ShB was observed in 121 entries while PYT-R 42 had an intermediate reaction to tungro under induced method. Evaluating resistance on major rice diseases was regularly conducted to identify potential source of diseases resistance.

Centralized screening for resistance to major insect pests of rice

G Santiago

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

Evaluation of different rice lines for resistance against major insect pests of rice was carried out 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 BPH and GLH. NCT manual and Standard Evaluation System (SES) of IRRI was followed in the evaluation.

During DS 2018, 248 entries from different ecosystems were evaluated under field condition against SB and BPH; and GLH under screenhouse condition. Low stemborer pressure was observed during the vegetative and reproductive stage of the entries; hence, the data was not valid. Majority of the entries were intermediate to BPH and GLH under screenhouse condition.

A total of 560 entries were planted late in August 2018, which were evaluated against SB, BPH, and GLH. Evaluation at vegetative stage showed a very low insect pressure. Evaluation under screenhouse condition showed that majority of the entries were intermediate to BPH and GLH.

Resistance stability of high yielding varieties to major insect pests and diseases of rice

G Santiago, MS Duca, and EM Valdez

A field study was established in 2018 dry and wet seasons to determine the resistance stability of high yielding/ popular varieties to the major insect pests and diseases of rice.

PSB and NSIC rice varieties that were recommended to farmers 5 to 10 years ago were chosen and planted. Their reactions to biotic stresses at the time of release served as benchmark data. 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 2018, majority of the 43 varieties had intermediate reaction to BLB but resistant to blast and rice tungro disease under the natural field condition. Under induced method, 25 varieties had intermediate reaction to BLB while 19 were susceptible. Seven varieties had resistance while 26 had intermediate reactions. Majority of the varieties had intermediate reactions to BPH and GLH under the screenhouse condition.

Optimization of a Rapid Screening Method for Sheath Blight under Screenhouse Conditions

ES Avellanoza, JP Rillon, and RT Miranda

This study aimed to test different screening protocol for sheath blight under screenhouse condition for a rapid screening protocol to identify rice varieties that will exhibit resistance to *Rhizoctonia solani kuhn*. Nine rice varieties with known disease reactions to ShB were acquired and assembled from the Genetic Resources Division and the Plant Breeding Division. A preliminary setup was conducted in the screenhouse to validate and optimize the efficiency of micro-chamber method optimized by Somera and Alfonso (2012). Inoculum carriers' preliminary observation showed that PDA mycelial disks and rice hull plus rice bran have the most stable and effective substrate among the three inoculum carriers evaluated. The combinations of rice hull plus rice bran (3:1) ratio and nutrients in the PDA agar supplemented more nutrients for pathogen to utilize that makes the substrates or inoculum carriers last longer after the inoculation. Seedling age test materials inoculated at 14-day old seedlings with chamber were more susceptible to the pathogen as compared with 21-day old seedlings.

Inoculation of weedy rice accessions with differential bacterial blight (Xanthomonas oryzae pv. oryzae) isolates

PROJECT 2:

CHARACTERIZATION OF PHILRICE ELITE GERMPLASM FOR FUNCTIONAL DISEASE RESISTANCE GENES

JT Niones

In an intensive rice production system worldwide, rice diseases are one of the significant factors limiting productivity and food security. In the Philippines, rice blast, BLB and ShB and tungro viruses have caused significant yield losses in major rice growing areas in the country. With the increasing awareness of the undesirable human and environmental effects of pesticide application, development and deployment of resistant cultivars have been a forefront in disease management.

Host resistance is considered the most effective, economical and environmentally friendly way of rice disease management. PhilRice had long acknowledged this by making disease resistance as one of the traits mainly considered in its varietal improvement program. However, host resistance is constantly challenged by the diversity of infecting pathogen population. The instability of pathogen population necessitates a broad genetic and cytoplasmic background of new varieties being developed for a more effective and durable disease resistant varieties. Diversity in resistance genes within the available germplasm is therefore extremely valuable in the breeding program for rice disease resistance.

This project implemented two studies that aimed to better characterize the resistance of PhilRice breeding lines under development and other rice germplasm as potential source of resistance genes against rice blast and bacterial leaf blight. In 2018, the project systematically analyzed the range/spectrum of rice blast and bacterial blight resistance and determined the

resistance genes possibly harboring in selected weedy rices. Selected weedy rices were also genotyped for the presence of resistance genes using DNA markers of known bacterial blight and rice blast major resistance genes.

Identification of major blast resistance genes in PhilRice elite rice germplasm and other materials as potential source of blast resistance genes

JT Niones, MC Garcillano, and JM Manangkil

Rice blast disease caused by the fungal pathogen *Magnaporthe oryzae* imposes a constant constraint to the stable rice production worldwide. In the Philippines, rice blast disease has been frequently reported in upland rice growing areas and rainfed lowland environments that are prone to drought, which caused yield losses ranging from 50-85% in some epidemic years. In this study, 46 weedy rice biotypes were evaluated using differential system for rice blast disease consisting of 12 differential blast isolates (*Pyricularia oryzae Cavara*) from the Philippines and international differential rice varieties (*Oryza sativa* L.) with known resistance genes developed at the International Rice Research Institute (IRRI) to detect the presence of blast resistance genes. By artificially inoculating weedy rice biotypes with 12 standard blast isolates, seven groups were generated wherein the seventh group were classified as unique group. Fifteen weedy rice biotypes consisting of B8, B12, Suk 1, Suk 2, Iloilo 1, Iloilo 2, and WR-Min 2 were identified as resistant in all 12 differential isolates. It was also observed that most of subgroup of biotypes that have same reaction pattern belong to Iloilo 2 and WR-Min 2. Gene estimation showed that the most estimated R genes were *Piz-5, Pia* and *Pi20(t)* while the least estimated R genes were *Pi5(t), Pib, Pi12(t), Piz-t, Pii, Pi3, Pita, Pita-2, Pi11(t)* and *Pik* Alleles. Moreover, out of 46 biotypes, 24 were estimated to harbor unknown R genes. Using molecular markers, *Pi2/9/zt, Pii, Pia* and *Pik* alleles were detected on 12 weedy rice biotypes. Different resistance spectrum of weedy rice biotypes against differential blast isolates may imply the presence of a novel blast resistance genes and can be a potential source of blast resistance genes for varietal improvement program for blast resistance.

Identification of Bacterial Blight Resistance Genes in PhilRice germplasm and Potential Source of Bacterial Blight Resistance Genes

ES Avellanoza, LC Jain, and JT Niones

Weedy rice *(Oryza sativa f. spontanea*) is a weedy form of rice with genetical, morphological, and physiological similarities with the cultivated rice. Previous studies showed that weedy rice can be a potential source of novel disease resistance genes against major rice diseases that can be exploited for host resistance studies. This study aimed to determine the spectrum resistance profile and resistance genes in bacterial leaf blight resistant weedy rice biotypes under controlled conditions. Forty-nine weedy rice biotypes were subjected to phenotyping, identifying resistance spectrum, and estimating *Xa-gene* based on the differential system for rice bacterial blight disease consisting of 14 *Xanthomonas oryzae pv. oryzae* (*Xoo*) differential isolates in the Philippines international bacterial blight differential rice varieties (*Oryza sativa* L.) with single known resistance genes. The 49 weedy rice biotypes showed a narrow spectrum of resistance and is specific to only 1-4 *Xoo* races. Based on their resistance spectrum against diagnostic *Xoo* differential isolates, the bacterial blight resistance genes possibly present in these weedy rices accessions cannot be estimated. It is possible that an unknown/novel resistance gene is controlling the bacterial blight resistance in these weedy rices; providing a diverse source of bacterial blight resistance genes for gene stacking or pyramiding.

DKM Donayre observes the Cyperus rotundus, a common weed in lowland ecotype, under the growth and development of NSIC Rc 222

PROJECT 3:

ECOLOGY AND MANAGEMENT OF KEY PESTS OF RICE AND CONSERVATION OF BENEFICIAL ORGANISMS

DKM Donayre

Pests are one of the limiting biotic agents in any rice production as they significantly reduce yield and quality of harvests, and income if not properly managed. Management techniques are easily available to combat pests. However, studying the biology and ecology of target pests must be determined first to obtain a successful, effective, and economical pest management. In the Philippines, the use of pesticides to combat rice pests remains the foremost option for many farmers. Alternative control techniques such as the use biological control agents and other potential organisms have been suggested to minimize injudicious use of pesticides. Potential organisms were also previously identified to be effective against major pest of rice. Unfortunately, many of these did not reach to the end-user because of limited scope of exploration and lack of evaluation. Thus, this project implemented eight interrelated studies to determine a) ecology of yellow stemborer, planthoppers, and other arthropods on selected ricefields in the country; b) determine the competitive ability of *Cyperus rotundus* against irrigated rice; c) the efficacy of fungal endophytes, fungal epiphytes, and selected weed species against rice blast and sheath blight pathogens; d) the efficacy of golden apple snail and *Lantana camara* as attractants to rice bug; and e) the preservation methods that can maintain the viability and genetic integrities of beneficial microorganisms.

Seasonal Fluctuation of Stemborer and Other Arthropods at PhilRice CES

G Santiago and EM Valdez

An experiment was conducted to determine the population dynamics of yellow stemborer and other arthropods at PhilRice CES. Light traps were installed in strategic locations and sampling was done once a week at three hours per night. Trapped arthropods were collected, sorted, identified, and counted. Data on trap catches showed that population of adult yellow stemborer was highest in March (1176 adult moths) and in September (48 adult moths). High population of brown planthopper was also observed in March (2,328 adults) and in August (4,552 adults). Similar trends were also observed on zigzag leafhopper (ZLH), GLH, and white-backed planthopper (WBPH). Among the insect pests collected, ZLH had the highest total number of trap catches (12,692 adults). Other insect pests such as rice black bug, leaf folder, and rice bug had less populations. Mirid bug was the most dominant among natural enemies with total trap catches of 1,016 in March and 10,215 adults in September (10,215).

Development of management options for rice planthoppers

GS Rillon and CC Encarnacion

The rice planthoppers (RPH) such as BPH and WBPH were recently reported as potential constraints in Philippines rice production. Hence, this study aimed to reduce the vulnerability of rice crops to prevent losses caused by RPH pest outbreaks in the Philippines. Major activities during the year include the monitoring of RPH and associated viruses at PhilRice CES Science City of Muñoz and in Mabini, Sto. Domingo, Nueva Ecija. Data showed that rice planthopper population peaks in February-March and September. Low RPH population were also recorded in DS 2018. However, more planthoppers were recorded in WS than in DS. Consistently, more BPH were recorded than WBPH. Low hopper burn injury was recorded. Rice plant showing virus diseases transmitted by RPH was not observed at PhilRice CES and nearby farmers' fields.

Competitive Ability of Lowland Ecotype Cyperus Rotundus Against Irrigated-Lowland Rice

DKMDonayre, JS Bruno, EC Martin, and AML Latonio

Flooding is considered as one of the most effective weed control techniques against many weed species of rice. This technique, however, has yet to be evaluated in a lowland ecotype of *C. rotundus*. Two trials were conducted at PhilRice CES from February to October 2018 to determine the responses of pre-sprouted and non-sprouted tubers of lowland ecotype *C. rotundus* to different flooding and burial depths under greenhouse conditions. Treatments involved were flooding tubers at three water depths (0, 3, and 5cm) in combination with three burial depths (0, 5, and 10cm) arranged in two-way factorial design in RCBD with five replications. All plants were allowed to grow and mature until 100 days. Height, number of shoots, dry weight of shoots and roots, and number of tubers per plant were recorded and analyzed. Results showed that flooding and burial depths influenced growth and development of tubers of lowland ecotype *C. rotundus.* Regardless of burial depths, pre-sprouted and non-sprouted tubers completely developed (100%) into new plants when flooding was absent (0cm flooding). Some tubers still grew and developed into new plants even when subjected to 3cm and 5cm flooding at 0cm burial depth (on top of the soil surface). No continuous growths were observed on tubers subjected to flooding depths of 3cm and 5cm buried at 5cm and 10cm. Pre-sprouted tubers at 0cm flooding generally had high number of off-shoots, dry weight of shoots

and roots, and number of tubers per plant than the non-sprouted tubers. Results suggest that flooding up to 5cm depth helps inhibit the sprouting and growth of buried tubers of lowland ecotype *C. rotundus*. It is less effective, however, for those tubers that are on top of the soil.

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

JT Niones, DKM Donayre, SE Santiago, and JS Bruno

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. The role of fungal endophytes in the direct biocontrol of pathogens and indirect biocontrol through induction of systemic resistance in plants is increasing. Thus, they hold a great potential for crop disease management. This study assessed the endophytic fungi isolated from traditional rice varieties for in vitro phosphate-solubilizing activities using selective culture media. Cultural and morphological characterizations of the candidate endophytic fungi were also conducted. Three coded EF isolates, namely 22CLt, 25CLm, 21Cut, were inhibitory to both *R. solani* and *P. oryzae* and exhibited endoglucanase productions and phosphate solubilizing activities. The EF isolates were considered as candidate isolates for biocontrol agent against rice pathogens.

Evaluation of Antifungal Potential of Epiphytes Against the Rice Blast Pathogen

FA Peña and LB Paraiso

Fungal epiphytes are microbes residing on the surface of the plant surface. However, their use has not been explored in contrast to fungal endophytes were a number of studies have been conducted in relation to plant protection. This study is one of the few works describing the potential of epiphytic fungi that can antagonize the rice blast fungus, *Magnaporthe grisea*. There were 10 potential epiphytic fungi isolated from rice leaves and used to challenge the rice blast fungus in vitro. Dual culture test of the fungi showed three modes of antagonism: (1) pathogen mycelia overgrown by fungal epiphytes mycelia [*Penicillium sp.* GM15 and *Fusarium sp.* LM1], (2) suppression by colonizing half of the plate [*Curvularia sp.* GM11, *Penicillium sp.* DT11, GM20, GM7, GT19, and GT27], and (3) through antibiosis as shown by zone of inhibition [*Aspergillus sp.* GT29 and *Penicillium sp.* GM6]. Bacterial epiphytes showed a large zone inhibition against the rice blast fungus. Bacterial isolate CLSUM4 (33.84%) and CLSUT13 (33.71%) showed the highest percent inhibition against the rice blast fungus. Production of IAA was exhibited by fungal isolates GM11 and LM1 and bacterial isolates CLSUM4 and CLSUM6. Total number of carbon utilized by the fungal epiphytes was also determined. Interestingly, isolate GM20 had metabolized the highest at 66 carbon sources while the isolate that catabolize the least are GT27, GM15, and GT19. The amount of utilized carbon determined its antagonistic potential. Pathogenicity test showed that none of the fungal isolates are pathogenic to the rice plant. Thus, this study proved the potentials of fungal and bacterial epiphytes from rice leaves as biocontrol agents against *M. grisea* causing rice blast.

Antifungal Effects of Chromolaena Odorata and Ageratum Conyzoides Against the Philippine Isolate of Magnaporthe Grisea Causing Rice Blast Disease

FA Dela Peña and LB Paraiso

Efficacy of *Chromolaena odorata* and *Ageratum conyzoides* extracts for the control of *M. grisea* was conducted using ethanolic, acetone, and methanolic extracts. Results showed that *Ageratum conyzoides* at 100% concentration leads to total inhibition of mycelia *M. grisea.* On the other hand, *Chromolaena odorata* extracts leads to 68% mycelial growth reduction of rice blast fungus. The two extracts also inhibited conidial growth of *M. grisea* on slide germination test. However, when the extracts were applied on the leaves of rice, phytotoxicity seen as burning or withering of the rice leaves was observed. Thus, the extract should not be recommended for use as biofungicide against the rice blast fungus regardless of its effect on the mycelia in vitro as it negatively affects the host plant.

Evaluation of Golden Apple Snail and Lantana Camara As Attractants For Rice Bug

EM Valdez, DKM Donayre, AML Latonio, and JS Bruno

A field study was conducted in Maria Aurora and Baler, Aurora; and Burgos, Pangasinan (wet season) to determine the efficacy of golden apple snail (GAS) and *Lantana camara* as attractants to rice bug. Crushed and uncrushed GAS at 1kg each and *L. camara* at 100, 300, and 500g were randomly arranged in the field through RCBD. Number of rice bug individuals attracted were counted the next day. Results showed that rice bugs were attracted to GAS irrespective whether it is crushed or not. However, higher number of rice bugs were attracted to the crushed GAS the next day after installing. No rice bugs were attracted to *L. camara.*

Conservation of Organisms with Beneficial Uses to Pest Management

DKM Donayre, JT Niones, and JS Bruno

This study aimed to determine the best preservation methods that can maintain the viability and genetic integrities of collected microorganisms. Twelve epiphytic and twelve endophytic fungal isolates effective against rice blast fungus, two disease-causing fungal pathogens of rice (ShB), and two fungi as potential biological control agents against weeds (*Paspalum distichum* and *Sphenoclea zeylanica*) were preserved in four storage materials subjected to different time and temperature conditions. Regrowth and re-sporulation of these potential organisms have yet to be determined in 2019 based on the times of their storage.

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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