

AGRICULTURAL SCIENCES

54. POLYMERASE CHAIN REACTION (PCR) AMPLIFICATION OF DNA GENOME SEGMENTS OF BANANA BUNCHY TOP VIRUS (BBTV)

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Banana bunchy top disease (BBTD) is one of the most devastating diseases of bananas caused by banana bunchy top virus (BBTV). The BBTV has a multi-component genome consisting of at least six single-stranded circular DNA components. In this study, the presence of DNA encoding the coat protein (CP) during systemic infection of BBTV in artificially inoculated banana was determined by the polymerase bp product in pseudostem 26 days after inoculation (DAI), in root and corm 31 DAI, and in rolled young leaf, older leaf and in corm 52 DAI. In naturally infected banana plants, BBTV stem loop (SL) region and BBTV DNA component encoding the movement protein (MP) were detected in young leaves. PCR amplification of SL region and MP DNA segment generated a 1000 bp and a 380 bp product, respectively. Consistent amplification of MP DNA segment indicated that MP DNA was present in high concentration. PCR amplification using specific primers provides a useful tool in determining the presence of BBTV DNA components.

Key words: banana, polymerase chain reaction (PCR), banana bunchy top virus (BBTV)

55. CLONING, CHARACTERIZATION, AND SEQUENCING OF MATURATION-RELATED cDNAs FROM SUGARCANE (*Saccharum Officinarum* L.)

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The aims of this study are to generate and clone cDNAs encoding the ACC synthase through Reverse Transcription-Polymerase Chain Reaction, to monitor the level of expression of the gene through northern blot analysis, and to determine the relative number of copies in the genome by southern analysis.

Oligonucleotides (EZ 2 and EZ 4) based on the conserved regions of ACC synthase were synthesized and used in the RT-PCR using cDNA pool from the 13-month-old apical tissue. A 1.2k b fragment was amplified which was cloned in the pGEM-T-Easy vector and later used in the transformation of *E. coli* DH5 α .

Two putative clones coding for maturation genes were identified and partial nucleotide sequences of SACS1 (612 bp) and SACS 2 (712 bp) were determined. Computer search showed no homology of SACS 1 with known ACC synthase but has sequence similarity with a DNA binding protein. SACS 2 does not have sequence similarity with known structural genes in the Genebank due to unreliable DNA sequence containing 15% unknown nucleotide base N.

A low level expression of SACS 1 was detected on the 6th month when stalk elongation starts to slow down and increase until the 13th month when the sucrose accumulated is uniform throughout the stalk. Southern blot analysis suggests the presence of only one copy of SACS 1 in the sugarcane genome.

Key words: cloning, cDNA, *Saccharum*, sugarcane, RT-PCR, ethylene, maturation

56. MOLECULAR CLONING OF DNA SEGMENTS OF ABACA BUNCHY TOP VIRUS (ABTV)

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Abaca bunchy top virus (ABTV) is assumed to be synonymous to banana bunchy top virus (BBTV) but transmission experiments show dissimilarity between the two. For studies aimed to distinguishing differences between the said viruses at the molecular level, cloning of ABTV genome segments is necessary.

Polymerase chain reaction (PCR) and standard cloning procedure were used to produce gene constructs containing ABTV DNA segments. Total nucleic acid extracts were obtained from bunchy top infected abaca plants. The extract DNA was amplified using the stem loop primers SLR and SLL. These primers were designed based on the nucleotide sequence of the conserved stem loop region of BBTV DNA genome. The PCR products were inserted into a plasmid vector and transformed into *Escherichia coli* DH5 α cells. These constructs will be used in differentiating BBTV from ABTV and in the development of transgenic abaca resistant to ABTV.

Key words: abaca, polymerase chain reaction (PCR), cloning, abaca bunchy top virus (ABTV), transformation

57. GENE INTROGRESSION IN THE NON-TUBER FORMING *Solanum*

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Nineteen species of the no-tuber forming *Solanum*, including *Solanum melongena*, eggplant, obtained from the National Plant Genetic Resources Laboratory were used in the hybridization program with the aim of determining the genetic affinity among the species and ultimately transferring desirable genes (resistance to pests and diseases, prolificacy, tolerance to abiotic stresses) from the wild relatives to the cultivated eggplant. A total of 135 cross combinations were made from which only 43 cross combinations developed fruits with very few seeds recovered. The degree of genetic relationship was measured in terms of percentage seed developed and chromosomal behavior of the hybrids during meiosis. Percent seed recovery ranged from 0.0% to 80.0%. Meiotic analysis of the different species and the hybrids gave a chromosome number $2n=24$. The chromosome behavior of the parentals was generally normal. The hybrids on the other hand exhibited partial to complete homology among the chromosomes of the parental species. Laggards and bridges were observed in both parents and hybrids. Pollen fertility of the different species ranged from 77.37% to 98% whereas they hybrids had a range of 9.74% to 30.5%. Backcrossing to the *melongena* parent was done for four generations in cross *aethiopicum* \times *melongena*. Partial morphological characterization of the hybrids showed gene introgression from *S. aethiopicum* to *S. melongena*.

Key words: introgression, *Solanum melongena*, *Solanum aethiopicum*, eggplant

58. SEGREGATION ANALYSIS IN COCONUT USING MOLECULAR MARKERS

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Selected germplasm of coconut was tested for polymorphism using microsatellite, also called simple sequence repeats (SSR), and amplified fragment length polymorphism (AFLP) marker technologies. Results showed that all the dwarf populations analyzed exhibited a high degree of homogeneity while the tall populations revealed a high degree of allelic diversity. Based on the results of the polymorphism survey, SSR, and AFLP primers were selected to test for the segregation pattern of the F₁ population from the cross between Tacunan Green Dwarf and Bago Oshiro Tall. Segregation analysis of F₁ progenies showed a 1:1 Mendelian ratio typical of a backcross population. The implication of the results of the present study in the coconut improvement program will be discussed.

Key words: coconut, *Cocos nucifera*, microsatellite, simple sequence repeats, amplified fragment length polymorphism

59. MOLECULAR TAGGING OF BRUCHID AND *Cercospora* LEAF SPOT RESISTANCE GENES IN MUNGBEAN USING AFLP AND RGA MARKERS

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Two major constraints in mungbean production are grain loss caused by bruchid (*Callosobruchus*) damage during storage and *Cercospora* leaf spot disease. Amplified fragment length polymorphism (AFLP) and resistance gene analog (RGA) primers were used to develop and identify markers associated with resistance genes to bruchid and *Cercospora*. Sixty four selective Eco RI/Mse I primer

pairs obtained from Gibco BRL/Life Tech Analysis II were used to screen for polymorphism using two mapping populations, P7 x TC and NCM 53 x Acc. 25. Thirty (30) of the 64 AFLP primer pairs with good amplification products generated a total 1,520 bands of which 336 bands (21.1%) were polymorphic between P7 and TC and 261 bands (17.2%) between NCM 53 and Acc. 25. Using a P7 near-isogenic line (RP70, putative AFLP markers associated with the introgressed resistance segmen from TC were identified using 17 AFLP primers. For RGA, 19 primer pairs were evaluated of which 10 primers gave polymorphic bands between P7 and TC. The 10 primer pairs generated a total of 268 bands of which 117 bands (43.6%) showed polymorphism between P7 and TC. The 10 RGA primers will be used to determine markers associated with bruchid resistance genes using a near isogenic line of P7.

Key words: mungbean, *Cercospora*, bruchid, *Callosobruchus*, AFLP, resistance gene analog

60. REGENERATION OF TRANSGENIC NEW PLANT TYPE LINES FROM *A. Tumefaciens*-INFECTED IMMATURE INFLORESCENCE

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The increasing population rate and shrinking area devoted to rice production in the Philippines pose a big challenge to plant breeders. Genetic engineering of PhilRice is being conducted to support the existing strategies to increase the yield potential of rice such as the improvement of pest resistance in the high yielding varieties, in the new plant type (NPT) elite lines, and in the cytoplasmic male sterile (CMS) lines used in hybrid rice breeding. The use of the natural vector *Agrobacterium tumefaciens* for gene delivery to Philippine-bred rice varieties necessitates the investigation of the suitable explant for susceptibility to infection. Early studies focused on the ability of different explants to produce embryogenic calli suitable for transformation experiments from 6 inbred lines, 9 NPT lines, AND 6 CMS lines. The young inflorescence and mature embryos equally produced embryogenic calli, but not as good as the immature embryos scans contamination. *A. tumefaciens* strain EHA1 O5 (pTOK233) harboring the reporter β -glucuronidase gene and the hygromycin resistance genes were tested on their infectivity to the different explants and genotypes. A few inbreds and CMS lines, and most of the NPT elite lines showed GUS activity as manifested by the blue

precipitate present in the transformed cells after X-gluc staining. Regenerated plants from these transformed calli showed the presence of the GUS gene in PCR analysis. The efficiency in obtaining transgenic plants is relatively higher compared to the regeneration using calli derived from mature seeds.

Key words: genetic engineering, rice, *Oryza sativa*, young inflorescence, *Agrobacterium tumefaciens*, plant regeneration, calli

61. MOLECULAR ANALYSIS OF ON-FARM BIODIVERSITY OF RICE IN THE PHILIPPINES

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On-farm biodiversity of rice in the Philippines was analyzed using 1992 and 1997 survey data and 41 microsatellite markers to determine the popular varieties planted by farmers and their molecular diversity, respectively. Survey data showed that the use of modern varieties was widespread and more diverse in all regions. A total of 30 different varieties were planted in 1992 and 156 varieties in 1997. Among these varieties, ten most popular varieties were identified. These were released mostly between 1975 and 1999, and preferred by about 77% of the farmers. IR 64, a high-yielding variety with good eating quality, was the most widely used, suggesting the responsiveness of rice farmers to consumer preferences. Over time, the adoption pattern and relatedness of varieties changed. When the pattern of adoption was combined with molecular data in determining the genetic diversity (weighted), the diversity index decreased. The increased relatedness of the popular varieties planted in 1997 decreased the on-farm diversity. Among the regions in the Philippines, Mindanao region has the highest on-farm diversity. The pattern of adoption changed on-farm diversity substantially specially in areas where IR 64 was widely adopted like in the Visayas region where most farmers used it in 1992. Overall, the weighted on-farm diversity is lower than the genetic diversity based on molecular data alone (unweighted). Results show the impact of widespread use of a particular variety in the maintenance of biodiversity.

Key words: biodiversity, DNA marker, microsatellite, rice

62. IDENTIFICATION AND CHARACTERIZATION OF ACC SYNTHASE cDNAs EXPRESSED DURING SINTA PAPAYA (*Carica papaya*, L.) FRUIT RIPENING

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The cloning and characterization of cDNAs encoding ACC synthase from papaya hybrid Sinta is described. Total RNA from 80% ripe fruit was subjected to R T-PCR using primers specific for the ACC synthase gene. Five genes with different ECO RI restriction digest patterns and MW range of 1.1 to 1.4 kb were cloned. A cDNA of length 1,206 bp and coding for a 402-amino-acid polypeptide contained the highly conserved region shared by both ACC synthases and aminotransferases. Partial sequencing information indicate that all five genes are highly homologous to one another as well as to three their ripening-related ACC synthase cDNAs isolated from other papaya cultivars. Hybridization studies on northern and southern blots are currently being done to further characterize the five genes. Such information will help elucidate the ripening process undergone by hybrid papaya fruits.

Key words: cloning, cDNA, ACC synthase, *Carica papaya*, fruit ripening, RT-PCR, ethylene, southern blot, northern blot

63. MOLECULAR CLONING OF THE COAT PROTEIN GENE OF PAPAYA RINGSPOT VIRUS (PHILIPPINE ISOLATE)

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Development of constructs containing certain genomic sequences of viruses has been the basic technique used in the study of the organism's genetic organization. One of the strategies in developing disease resistant crops is pathogen-derived resistance against virus infections. An example of which is the production of a transgenic crop expressing the viral coat protein. Crude RNA from leaves infected with a local PRSV isolate was extracted. Complementary DNA (cDNA) was synthesized using reverse transcriptase and the coat protein (CP) gene sequence was amplified by PCR using specific primers. The fragment encoding the CP gene

was inserted into a plasmid vector and transformed into *Escherichia coli* DH5 α . A gene construct containing a part of the CP gene of one isolate is already available for sequencing and cloning on other isolates is still ongoing. The clones will be utilized in PRSV genetic variability studies and in the development of transgenic papaya resistant to ringspot disease.

Key words: papaya, papaya ringspot virus (PRSV), polymerase chain reaction (PCR), pathogen-derived resistance, complementary DNA (cDNA), reverse transcriptase, coat protein, cloning

64. CONTROL OF RIPENING IN PAPAYA BY GENETIC ENGINEERING

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Papaya is an important fruit commodity in the Philippines and in other ASEAN countries. Its greater production and export potential are limited by the papaya ring spot virus (PRSV) problem and relatively short shelf life. This research addresses the latter problem with the objective of developing papaya varieties with delayed ripening trait, thus, longer shelf life.

In climacteric fruits such as papaya, ethylene controls the rate of ripening. One strategy to delay fruit ripening which has been employed in other fruits with success is the genetic manipulation of the plant genes involved in ethylene production during the ripening process.

In this project, we have cloned the ripening-related ACC synthase genes from the Davao Solo (yellow flesh) papaya variety and constructed an anti-sense transformation vector. We have transformed somatic embryos with this gene construct via the biolistic process. Putative transgenic tissues were selected and regenerated into plantlets. These plantlets will be grown in a BL2 greenhouse and their fruit will further be selected for the delayed ripening trait. The development of delayed ripening phenotypes via antisense technology will produce papaya varieties with better postharvest and transport characteristics that will be reflected in fruits of consistent superior quality and therefore better market prices.

Key words: papaya, ripening, transformation, ACC synthase, ethylene

65. DEVELOPMENT OF VEGETABLE IPM PROGRAM IN RICE-BASED CROPPING SYSTEM

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A study was conducted to identify the different insect pests and beneficials at different growth stages of eggplant and stringbeans and identify as well the critical growth stage(s) of the crops against insect infestation.

The occurrence of insect pests and beneficials relative to crop age was determined in both protected and unprotected plots. After mapping the insect pests and beneficials based on three cropping seasons, a strategic insecticide application was formulated and compared with farmers practice and untreated control.

A characteristic pattern of pest population of natural enemy attraction was recorded. In stringbeans, three peaks of infestation or critical periods (window) for crop growth seems attractive to early sucking pests such as leafhopper and aphid. The critical periods were 19-20, 53-54, and 65-75 days after emergence (DAE). In addition, 51-53 and 65-70 days, were critical periods to podborer damage. In eggplant, leafhopper and thrips predominated throughout the crop growth stage and their respective densities were highest at 20-25, 40-45, and 85-90 days after transplanting (DAT). Another significant observation is the apparent relationship of shootborer damage (highest at 67 DAT) and beneficials like spider and coccinellid. The shootborer damage declined at 47 DAT and 81 DAT, the stage which coincided with the peak of spider and coccinellid populations indicating, among others, the probable role of beneficials in shootborer control.

The arthropod population dynamic data obtained were used to formulate a strategic insecticide application to optimize the effect of insecticides on insect pests while minimizing its impact on beneficials.

Efforts to demonstrate the judicious use of appropriate insecticide application based on insect occurrence and monitoring the critical windows showed that strategic applications in stringbeans and eggplant resulted in reduced spray application frequency. This strategy saved three applications in stringbean and six applications in eggplant compared to the farmers' practice.

While at times there were no significant quantitative yield differences between strategic insecticide application and farmers' practice plots, the savings in

pesticide inputs and environmental safety cannot be ignored. It is apparent that the unprotected (unsprayed) plots in most cases yield is much lower than any of the other two treatments.

Further refinements in the strategies used including insecticide x parasitoid complementation are currently being studied. Initial data showed very promising results.

Key words: vegetable IPM, eggplant, stringbeans, rice- based cropping system

66. TRANSPLANTED IRRIGATED LOWLAND RICE PROGRAM AT PHILRICE

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Transplanting is still the predominant method of planting rice. Majority of the farmers in Luzon and Mindanao are transplanting rice in irrigated lowland fields, the most dependable source of rice in the country. Compared to direct seedling, transplanted rice has higher productivity but it is labor intensive. The average yield in irrigated lowland is 3.5 t/ha; but under the Gintong Ani Program, farmers yield average to 4.4 t/ha. With decreasing area devoted to rice and the global liberalization, research and development activities in transplanted regime have to be continued. The program aims to develop farming technologies that will improve and sustain yields in the transplanted irrigated lowland rice and to attain an average yield of 7.5 t/ha and 10 t/ha in multi-location trails by 2002 and 2005, respectively. Specifically, the research agenda will develop and promote location-specific nutrient and pest management technologies, improve and sustain yields of transplanted irrigated lowland rice; and implement technologies; that are efficient, practical, and environment-friendly. Major accomplishments and current activities will be presented.

Key words: rice, transplanted rice, irrigated lowland, technology development

67. IMPROVEMENT OF IR64, C4-63G, PSB Rc 4, AND BPI-RI-10 FOR TRANSPLANTED IRRIGATED LOWLANDS

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Four rice varieties, IR64, BPI Ri-10, PSB Rc 14, and C44-63G, are very popular in the Philippines. However, these are not resistant to bacterial leaf blight (BLB), one of the most serious diseases of rice in farmers' fields. With the identification of new genes like *Xa-21* that was not available during their development, these varieties can be improved through incorporation of new important traits like disease resistance. This study aims to improve BPI-Ri-10, IR64, C4-63G, IR546883, and PSB Rc4 through incorporation of *Xa-21* and *xa-5* for BLB resistance.

For four seasons, 146 advanced lines from the crosses involving these popular varieties were evaluated in replicated trials together with the five high yielding parentals. The plants grown in 6 rows plots with 11 hills were clip-inoculated with Maligaya strain of *Xanthomonas oryza* pv. *Oryza* (*Xoo*) at maximum tillering and was scored 19 days after inoculation. All lines were found resistant indicating that they had the introduced *Xa-21* of *xa-5* gene. Across seasons, the highest yield of 7.02 t/ha was obtained from C4- 63G/IRBB21 cross. This line has *Xa-21* gene good for almost all races of BLB in the Philippines. The IR64 progeny with *Xa-21* closely followed with 6.92t/ha, and PSB Rc4 with *xa-5* at 6.84 t/ha. Although BPI-Ri-10 progenies were not among the best ten lines, several lines from this cross have an average of 6 t/ha across four seasons. These elite lines are now in the replicated yield trails and will be advance to multi-location trials.

Key words: rice, bacterial leaf blight, disease resistance, *Xa-12* gene, high yield

68. ANALYSIS OF TECHNICAL EFFICIENCY OF RICE PRODUCTION IN CAMARINES NORTE AND NUEVA ECIJA IN THE PRESENCE OF THE EL NIÑO PHENOMENON

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This study deals mainly on the analysis of technical efficiency of rice farmers in Nueva Ecija and Camarines Norte as affected by weather abnormality such as the El Niño phenomenon. The technical efficiency of rice farmers was determined through a Maximum Likelihood Estimation of non-deterministic frontier production function. The resulting technical efficiency was then regressed with a dummy variable in order to measure the effect of the El Niño phenomenon. Furthermore, it was regressed against some socioeconomic characteristics of farmers to determine the factors affecting efficiency under such circumstances. The production in each province was also regressed against the El Niño dummy variable to seek its effect on yield level. Results of the study showed that the El Niño phenomenon has no significant effect over the technical efficiency of rice farmers in the two provinces. This implies that farmers do not change their cultural and farm management practices even under the presence of the El Niño phenomenon. The results also revealed that socioeconomic characteristics such as age, education, training attended, and tenure status have no significant effect over technical efficiency. This is not due to inherent lack of relationship between the said variables but merely attributed to the relative homogeneity of the respondents. It was also found out that the El Niño phenomenon significantly increased the yield in Camarines Norte during the dry season while significantly reduced the production in both provinces during the wet season. The production enhancing effect was primarily accounted to the increased solar radiation during the dry season while yield-reducing effect was accredited the absence of normal rainfall that the two provinces usually received during such season. The study also determined the inputs significantly increasing production under such weather stress. These significant factors are water, fertilizer, and pesticide during dry season; and labor, fertilizer, and insecticide during the wet season. This implies that with the efficient use of such inputs, the farmers might minimize the yield reduction or maximize the production enhancing effect of the El Niño phenomenon. Finally, it was recommended that results of the study be verified using a more reliable proxy variable for El Niño such as rainfall data.

Key words: El Niño, dry season, wet season, Camarines Norte, Nueva Ecija, rainfall

69. RAPID DEVELOPMENT OF IMPROVED INDICA RICE VARIETY THROUGH ANTHR CULTURE TECHNOLOGY

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The major application of anther culture (AC) technology in rice breeding is to accelerate production of stable, homozygous breeding lines from genetically diverse, heterozygous genotypes. This results in the shortening of the time required for development of new varieties. The technology also offers the possibilities of introducing into plants variability that could be utilized for crop improvement. Anthers from IR64, a commercially released indica rice variety with premium grain and eating quality, were cultured in vitro. From a total of 57,549 anthers plated, we regenerated 45 green plants, of which, 19 are doubled haploids. These doubled haploid regenerants yielded a total of 147 doubled haploid breeding lines (DHL). A DHL is defined here as a tiller developed from an AC-derived doubled haploid regenerant. From these DHL, five were selected based on phenotypic acceptability, excellent kernel quality, moderate shatterability, and field resistance to diseases. The yield performance of three of the five lines was evaluated for two seasons, in 1999 dry and wet season, comparing them with the seed-derived (SD) IR64. At this point, the DHLs were at R_2 and R_3 generation, respectively. For two seasons, the AC-derived IR64 DHL matured earlier, and yielded better than the SD IR64. They produced more and comparable productive tillers in dry and wet season, respectively. The AC-derived IR64 plants were taller than the SD IR64 during the dry season, but shorter during the wet season. The data indicated that the SD IR64 during the dry season, but shorter during the wet season. The data indicated that the SD IR64 elongated more during the wet season trial. It can be inferred that SD IR64 is more sensitive to solar radiation than the AC-derived IR64. This needs further study. Based on yield performance, one AC-derived IR64 was selected and elevated to the general yield trial (GYT). Conventionally, it will take at least six years for a breeding line to reach this stage. However, with the AC-derived IR64 selection, it took only three years. Thus, with anther culture technology, varietal improvement is expedited.

Key words: anther culture, doubled haploid line, yield performance, rice breeding

70. COMPARATIVE ANTHER CULTURE RESPONSE OF GENETICALLY DIVERSE AND HIGHLY HETEROZYGOUS INDICA RICE TO 2,4-D AND PAA-ENRICHED MEDIUM

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Anthers from 18 genetically diverse and highly heterozygous F_1 crosses and two inbreds of rice were cultured in callus induction medium, supplemented with either 2,4-dichlorophenoxyacetic acid (2,4-D) or phenylacetic acid (PAA). Anthers from ten crosses formed more calli in 2,4-D-enriched medium, eight in PAA-enriched medium, while two had comparable callus formation in both media. Percent callus formation ranged from 3.19 to 29.56 in 2,4-D-enriched medium, with a mean of 12.28 ± 7.91 . In medium supplemented with PAA, callus formation ranged from 2.95 to 32.85%, with a mean of $12.94 \pm 8.41\%$. Significant differences in callus formation were obtained for genotype, but not for callus induction medium, nor for the interaction between genotype and culture medium. The callused anthers were transferred to various regeneration media to induce shoot and root formation. The green plant regeneration obtained for majority of the genotypes, was less than 1.0%, based on the total anthers plated. From our previous study with inbreds, we showed that PAA can induce direct regeneration in the same callus induction medium, without transfer of callused anthers into regeneration medium. This is one possible advantage of using PAA, as auxin for callus induction, over 2,4-D. We would like to exploit this advantage with our highly heterozygous breeding materials. This one-step anther culture protocol using PAA saves labor, time, laboratory supplies, and chemicals, as far as generating anther culture-derived breeding lines is concerned. Further study with other genotypes will be conducted to establish this point.

Key words: anther culture, indica rice, 2,4-D, PAA callus induction, direct plant regeneration

71. IN VITRO RESPONSE OF ANTHER CULTURE-DERIVED IR64 BREEDING LINES

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Genotype is one of the major factors that determines the in vitro response of rice, and hence, the extent of utilization of in vitro culture in rice improvement. IR64 is one of the indica rice varieties recalcitrant to in vitro culture. In our anther culture (AC) work, we regenerated green plants from 0.08% of the total anthers (57,549 anthers) we cultured from the rice variety IR64. We advanced and evaluated these regenerants, and we selected some promising AC-derived IR64 breeding lines. This study was conducted to determine if the in vitro response was enhanced in the anther AC-derived IR64 breeding lines compared with seed-derived (SD) IR64. We used three explants, viz., young inflorescence, mature seed, and anther to establish the cultures. Our preliminary results indicated comparable callus formation from mature seeds of the AC-derived and SD IR64. Relatively more embryogenic calli were obtained from AC-derived lines. One of the three AC-derived lines regenerated more green plants than the SD IR64. With inflorescence culture, we used callus induction medium supplemented with either 2,4-D or PAA. In culture medium supplemented with PAA, more young spikelets regenerated shoots directly from AC-derived compared with the SD IR64. With 2,4-D, callus formation for AC-derived lines was not enhanced. However, one of the three AC-derived lines evaluated had enhanced green plant regeneration. With anther culture, better response was obtained from AC-derived lines, in terms of callus formation and green plant regeneration. Further studies will be conducted to establish the repeatability and stability of the in vitro responses observed.

Key words: anther culture, seed culture, inflorescence culture, variant

72. RICE VARIETIES AND GRAIN QUALITY ATTRIBUTES PREFERRED IN ADVERSE ENVIRONMENT

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A survey was conducted in adverse rice growing areas to determine farmer choice for varieties and consumer preference for grain quality. The provinces

visited were Cagayan and Camarines Sur for saline-affected areas; Agusan del Norte and Nueva Vizcaya for zinc-deficient areas; and the province of Ifugao for cool-elevated areas. Five municipalities for each province were chosen and three barangays for each municipality were visited. The most popular variety was IR 66 in Cagayan, PSB Rc 10 in Camarines Sur, PSB Rc 18 in Agusan del Norte, BPI R 10 in Nueva Vizcaya, and a native or traditional variety in Ifugao. All of the provinces surveyed showed that the major reasons for choosing the varieties was high yield, except in Ifugao where the highest premium was placed on grain quality. Asked about the grain quality attributes, the consumers indicated that taste was the most important. The other characteristics preferred were aroma, tenderness, and smoothness for cooked rice and maximum height increase and whiteness for raw rice. This information will provide the breeders and biotechnologists a guide in developing rice varieties with good grain quality for the adverse areas.

Key words: rice varieties, grain quality, adverse environment, saline, zinc deficiency, cool-elevated, raw rice, cooked rice, consumer preference, farmer choice

73. MASS SCREENING FOR RICE SEEDLING SALT TOLERANCE AT PHILRICE

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A rapid screening method for rice seedling salt tolerance was established at the Philippine Rice Research Institute in June 1996 to identify and assess the degree of salt tolerance of different lines and varieties. The procedure is an integral component of the project on development of salt tolerant varieties where by only lines rated tolerant and moderately tolerant in the observational nurseries are advanced to succeeding performance evaluation. The technique was a modification of the procedure being used at the International Rice Research Institute (IRRI) using Yoshida nutrient solution. Salt tolerance at electrical conductivity (EC) 12 mS/cm can be recognized after 21 d after sowing or 16 d after salinization.

Sources of materials for testing included the traditional rice variety collection, uniform lines from the breeding program of PhilRice, and introductions from collaborative breeding institutions. As of January 2000, a total of 5331 lines/varieties had been screened in the different nurseries and trials. Out of those screened, 601 (10.9%) and 1536 (27.8%) were rated tolerant and moderately tolerant, respectively.

The procedure is presently being modified using seawater instead of adding NaCl to increase the EC. Seawater samples from four locations showed an average of 42.7 mS/cm EC and 1.85 ppm sodium content. The use of artificial seawater solution will simulate water conditions during salt intrusion where other salts are present.

Key words: electrical conductivity, mass screening, rice, salt tolerance, seawater

74. HUNTING THE RICE TUNGRO RESISTANCE GENE USING BACTERIAL ARTIFICIAL CHROMOSOMES AND RESISTANCE GENE ANALOGUES

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As a step toward engineering resistance to tungro, the most destructive viral disease of rice in Southeast Asia, a map-based cloning approach was initiated to isolate a resistance gene against tungro spherical virus, the primary causal organism. Fine genetic mapping is underway to identify AFLP markers <1.0 cM from the R locus. In parallel, physical mapping was carried out starting with RFLP and RAPD markers at ~ 1.0 cM. Four BAC clones were selected from libraries obtained from the International Rice Research Institute and the University of California, Davis using three anchor markers (C708, CDO456, and CDO783) at the resistance region. During chromosome walking from the anchor BAC clones, seventeen BAC ends were isolated by TAIL-PCR (thermal asymmetric interlaced polymerase chain reaction) that were used to identify 28 new candidate BAC clones in subsequent hybridization. A contig of 14 clones at the C708 locus, a contig of 12 clones at the CDO456 locus, and another contig of 5 clones at the CDO783 locus were localized. Together with IRRI's screening, 36 BAC clones flanking the genes were identified at the target region. The size and arrangement of the tentative contig at the C708 locus were determined through pulse-field gel electrophoresis and cross hybridization. Gene hunting using PCR with RGA (resistance gene analogue) primers was also initiated on the 14 BAC clones. Clone 8P 16 gave major PCR bands with primer pair 1) ptokin 1 and ptokin 2, and 2) XLRR inverse 1 and inverse 2. Clone 16D8 also produced distinct PCR bands with the ptokin 1-ptokin 2 primer pair.

Key words: BAC, RGA, TAIL-PCR, RTVS, AFLP, RFLP, RAPD, physical mapping, chromosome walking, contig

75. PCR-BASED DNA FINGERPRINTING OF ANTHR-CULTURE DERIVED INDICA RICE BREEDING LINES

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Stable breeding lines were obtained from anther culture-derived variants from indica rice variety Wagwag and IR64. For some variants, differences in some agronomic traits were established. Other variants, however, are morphologically and agronomically similar. To genetically differentiate these variants, we subjected them to RAPD (randomly amplified polymorphic DNA) and SSR (simple sequence repeats) analysis. For RAPD analysis, we screened 37 primers. With Wagwag variants, 24 primers are polymorphic and four are monomorphic. The rest of the primers did not amplify. Only nine, those polymorphic primers that amplify in all samples, were scored. With IR64, 11 primers are polymorphic, 4 are monomorphic. Only 10 polymorphic primers were scored. For SSR analysis, we screened 26 and 40 primers for Wagwag and IR64 variants, respectively. Twenty and 16 primers were scored for Wagwag and IR64, respectively. The results of the amplification reactions with the rest of the primers are not scorable. With the polymorphic molecular markers we were able to genetically differentiate the AC-derived variants from one another, and from the seed-derived parental genotype.

Key words: anther culture, RAPD, SSR, indica rice

76. GENETIC TRANSFORMATION OF RICE (*Oryza sativa* L) USING PIN2 AND GNA GENES FOR INSECT RESISTANCE

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Currently, insect pests are controlled mostly by chemical insecticides which also eliminate the beneficial insects and arthropods in the rice causing pest resurgence and more extensive damage. Introduction of Pin2 and GNA genes in rice is expected to confer tolerance/resistance to lepidopterans (stem borers, leaf folders, cutworms) and homopterans (brown planthopper, green leafhopper) pests, respectively.

Calli induced from sutella of mature seeds and immature embryos of IR72, PSBRc 14, PSBRc28, LX15, Taipei 309, and IR43 served as materials for transformation. Friable and embryogenic types of callus were shown to be excellent material for transformation as reported for japonica rice by Hiei et al. (1994). All the varieties being used produced the same kind of callus. On the other hand, among the varieties, Taipei 309, and LX15 had the highest callus induction rate while PSBRc14 had the lowest.

Embryogenic calli bombarded with pTWA and pubiGNA containing Pin2 and GNA genes, respectively, using the particle inflow gun apparatus were kept in the selection medium for at least one month or until the calli from the control treatment (not bombarded with Pin2 and GNA genes) died. Calli were then transferred into plant regeneration medium.

Plants were regenerated from BASTA^R and hygromycin resistant calli induced from both mature seeds and immature embryos. Molecular analyses and physiological evaluation of the putatively transgenic are presently being undertaken. Preliminary PCR analysis showed positive results.

Key words: rice, transformation, particle bombardment, Pin2, GNA, insect resistance, embryogenic calli, BASTA, hygromycin

77. EFFECT OF MIST-POLISHING ON THE PHYSICOCHEMICAL AND SENSORY PROPERTIES OF RICE

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The general impression on NFA rice is that it is of poor quality. One of the possible methods to eliminate this impression is through mist-polishing. Mist-polishing is a process wherein water, in the form of mist, is sprayed unto the grains during the polishing stage to remove excess dust, bran, and the aleurone layer remaining in the longitudinal groove. Physicochemical analysis and sensory evaluation were conducted using stocked NFA rice, remilled rice, and remilled-mist-polished rice to determine the effect of mist-polishing on rice grain quality. The most distinct difference among the three samples was seen in the physical properties of raw milled rice. The mist-polished sample was significantly superior over the remilled sample in color, gloss, translucency, and general acceptability. The remilled sample was, in turn, significantly superior over the original stock sample. However, in the cooked samples, remilled and mist-polished samples did not differ significantly in sensory and physicochemical properties and aerobic plate count. For these parameters, remilling was enough to improve the quality of the stock sample.

Key words: NFA rice, mist-polishing, remilling, grain quality, physicochemical properties, aerobic plate count, sensory evaluation, gloss translucency, color

78. PHYSICOCHEMICAL PROPERTIES OF IRON FORTIFIED RICE FLOUR

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Rice flour prepared from PSBRc 10 rice variety intended for use in the production of traditional rice-based food products and noodles was fortified with iron by manual mixing for 30 min to 1h. The non-fortified rice flour contained $8.00-9.35 \pm 0.679$ mg Fe/100g rice flour while the treated sample had iron content ranging from 17.71 to 37.50 mg/100g. Analysis of variance (ANOVA) at 5% level of significance revealed that non-fortified rice flour was significantly whiter (75.27 whiteness values) compared to those containing ferrous fumarate (FF) (74.20 whiteness values) and ferrous succinate (FS) (73.43 whiteness values) at concentrations of 30 mg/100g. Bulk density of iron fortified rice flour was significantly higher compared to the control. Setback and breakdown viscosities slightly change with the addition of FF. Ferrous succinate treated rice flour on the other hand showed slight decreases in their peak and final viscosities. Other important properties were not affected which indicates that iron fortified rice flour could find several applications in the rice-based food industry.

Key words: rice flour, noodles, ferrous fumarate, ferrous succinate, whiteness, bulk density, setback, breakdown, peak viscosity, final viscosity

79. RICE NOODLE CHARACTERISTICS AS AFFECTED BY IRON

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Noodles were prepared using rice flour fortified with 10, 20 and 30 mgL⁻¹ 100 ferrous fumarate and ferrous succinate. The process involved soaking, steaming, kneading, extrusion, boiling, and drying. The rice flour (RFN) was characterized in terms of cooking and sensory qualities. The retention of iron at different stages

of noodle production was also assessed. Cooking losses of non-fortified and fortified overall flavor, smoothness, and chewiness of RFN were not affected with the addition of ferrous fumarate. No significant changes were also observed in the overall appearance, overall flavor, and overall texture of RFN enriched with ferrous succinate. A slight difference in the overall appearance of ferrous succinate-treated RFN were noted which was attributed to a slight change in color. Sensory qualities were most acceptable at fortification levels of 20 mg/100g.

Key words: noodles, rice flour, ferrous fumarate, ferrous succinate, cooking quality, sensory quality, cooking losses, overall flavor, overall appearance, overall texture

80. VARIABILITY IN RICE STEM BORER POPULATIONS AND ITS IMPLICATIONS IN THE DEVELOPMENT AND POSSIBLE RELEASE OF BT ENGINEERED RICE

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The Bt gene had been successfully engineered in several crops and it will not be long that its transfer and stable expression in rice will be realized. Engineering one very effective gene in rice does not mean a successful, stable agriculture. There are so many unresolved issues and straightforward answers unanswered. Understanding the complexities in the interactions would mean a better chance in the deployment of the technology in a sustainable manner. To achieve this requires good evaluation for useful *Bt genes*; assessment of the potential for resistance in rice pests, and in this case the stem borer; transformation technology and gene expression; field tests of strategies to delay resistance; germplasm development and distribution. Thus there is a need to understand ecological and genetic interactions between *Bt toxins*, rice and rice pests and natural enemies. The results of this study provide some answers to these needs.

As to the search for the useful *Bt gene*, the result, of the study show that there are some *Bt genes* which could serve as candidates for introduction into the rice genome based on several criteria: lack of genetic homology with toxins of standard strains, high efficacy at killing specific stem borer pests, and unique mode of action. These are *CryIAc* for the striped stem borer and *CryIAc*, *CryIIA*, and *CryIC* for the yellow stem borer. The striped stem borer is very susceptible to *CryIAc* but not with the other two endotoxins, *CryIIA* and *CryIC* which were found to be as equally effective as *CryIA[c]* against yellow stem borer. Another impor-

tant finding derived from this study is that those *Bt* endotoxins which has no "knockdown effects" are we effective not by killing but also by avoidance of the insects and inhibition of the growth of the larvae. This information is important to develop strategies in the proper development of the engineered rice.

An understanding of the pest movement based on genetic structure is essential for the logical development of resistance management strategies. The results of this study show geographical variation in response of different rice types and Bt-transgenic rice. This only indicates that any *Bt*-transgenic rice will not have the assurance of complete success when deployed in all the local fields where it will be planted. It was shown in this study that resistance to the very toxic *CryIAc* varied from population to population, thus there is a possibility that populations of these insects have the potential to overcome the effect of the *Bt* toxins expressed in rice. The problem will be compounded with large movements of these resistant insects to adjacent rice fields causing yield losses.

The practices of farmers of heavy pesticide use may contribute to the failure of the Bt-transgenic rice. It was found in a local survey of farmers management of rice pests that spraying with insecticides is done whether the rice variety is resistant or not. It is most likely that when *Bt*-rice will be deployed, this will be treated just like other varieties. Considerable effort should be exerted to help farmers realize the proper way of managing rice through education and participatory training in pest management

Key words: *Bacillus thuringiensis*, pest management, variability

**81. RESISTANCE SCREENING OF FARMERS' AND
COMMERCIAL VARIETIES OF EGGPLANT AGAINST
THE LEAFHOPPER, *Amrasca biguttula* (ISHIDA) AND THE
EGGPLANT BORER, *Leucinodes orbonalis* BUENEE**

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Eleven eggplant varieties were screened for resistance to the leafhopper *Amrasca biguttula* (Ishida) at the Central Experiment Station, PhilRice, Muñoz, Nueva Ecija in separate trials. Results in the first trial showed that the farmers' variety, Abar, was tolerant having higher yield than Dumaguete Long Purple (DLP), despite comparably the same number of leafhoppers as the susceptible variety. The relatively thicker leaves and more dense trichomes possibly conferred tolerance to Abar against the leafhopper.

In the second trial, antixenosis or non-preference (oviposition and feeding) was demonstrated by SRO2, a farmers' variety from Ilocos, at the early vegetative and reproductive stages of plant growth. The number of nymph and adult leafhopper was consistently low in all three leaf positions. Leafhoppers preferred to feed on DLP and Lon Violet throughout the sampling period. Damage ratings showed least leaf yellowing and, cupping for SRO2 but advanced damage for Long Violet and DLP. The mechanism of resistance of SRO2 should be further investigated in view of its possible use in eggplant varietal improvement. IPB GSI, an improved IPM leafhopper tolerant line, significantly yielded the highest healthiest, and largest fruits in all four harvesting periods despite the number of leafhoppers present. IPB GSI is a good candidate for leafhopper tolerance. However, more breeding works should be conducted to further raise the level of tolerance.

Key words: eggplant borer, eggplant leafhopper, *Amrasca biguttula*, *Leucinodes orbonalis*, host plant resistance in eggplants

82. EFFECTS OF TEMPERATURE, pH, AND NITROGEN SOURCES ON THE GROWTH AND SPORULATION OF *FUSARIUM* CAUSING WILT AND ROOT ROT OF GARDEN PEA (*Pisum sativum* L.)

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The ability of *Fusarium oxysporum* f.sp. *Pisi*, Schlecht. Snyder and Hansen and *F. solani* f. sp. *Pisi*, Apell and Wollenweber to cause wilt and root rot on Garden Pea are influenced by temperature, pH, and nitrogen sources.

Both species of *Fusarium* grew under a temperature range of 10°C to 30°C in potato dextrose agar (PDA). Scanty mycelia was noted at 10°C. *F. oxysporum* reached the widest colony diameter of 80 mm and a spore count of 99/mL at 30°C, while 88 mm colony diameter and 86 spore count /ml was obtained at the same temperature after 1 week.

In terms of pH, both species of fungi grew at pH range of 3.0 to 8.0. However, the widest colony of 70 mm with the highest spore count of 250/mL of *F. oxysporum* was obtained at pH 5. The same trend was noted on the growth and sporulation of *F. solani*. The widest colony of 69 mm and a spore count of 395/mL were recorded at the same pH (5) after 1 week using potato dextrose agar (PDA). Growth and sporulation of the fungus declined as the pH was raised to neutral (7.0).

In relation to nitrogen sources, both species of *Fusarium* utilized different nitrogen sources: ammonium nitrate, ammonium sulfate, calcium nitrate, potassium nitrate, sodium nitrate, and urea. The heaviest mycelia weight of .17 g of *F. oxysporum* was obtained in potassium and is comparable with oven dry weight of mycelia from the standard media potato dextrose agar (PDA), while the heaviest mycelia dry weight of 18 g of *F. solani* was obtained from ammonium nitrate. On the contrary, the highest spore count of 806/mL was produced in calcium nitrate for *F. oxysporum* while 697 spores/mL was found in potassium nitrate for *F. solani*. Spore counts obtained from calcium nitrate and potassium nitrate were comparable with spores produced in potato dextrose agar after 1 week. Limited growth and sporulation was recorded in ammonium sulfate.

The results obtained from the laboratory experiments clearly demonstrated the effects of temperature, pH, and nitrogen sources on the growth and development of *Fusarium* wilt and root rot. These factors must be considered in any management scheme for the disease under natural conditions.

Key words: Fusarium wilt, root rot, arden pea, temperature, pH, nitrogen, management

83. MANAGEMENT STRATEGIES FOR COTTON FLOWER WEEVIL, *Amorphaidea lata* MOTSCHULSKY

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Flower weevil, *Amorphaidea lata* Motsch., is one of the major insect pests of cotton that provides difficulty among pest managers. Its behavioral characteristics render it unmanageable. The adult feeds and lays its eggs mainly on newly opened flowers. This causes a premature shedding of the young boll. It then spends all its larval stages inside until pupation. If left unchecked, cotton farmers experience yield loss of about 28-30 percent.

The management strategies for flower weevil, *Amorphaidea lata* Motsch., is an orchestration of the different researches done for a decade at the Cotton Development Administration Research and Operation Centers. The components of the management strategies are as follows: (1) dusting flower with ash supplemented by collection and burning of shed young bolls, (2) early planting during the months of August and September, (3) wider row spacing of planting, (4) dense planting, i.e., 100,000 plants/ha, (5) close season planting, (6) planting of trap crop like okra, (7) irrigation management at critical stages of the pests, (8) releases of *Euborellia annulata*, and (9) use of granular systemic insecticides.

Various combinations of these components applied at the right time reduced flower weevil population and subsequently change resulting in increased farmers' yield with income with the added benefits of reducing pollution to the environment.

Key words: *Amorphaidea lata*, young bolls, dense planting, close season, trap crops, *Euborellia annulata*, cotton

84. RICE HULL BURNING: A FARMER'S TECHNOLOGY FOR MANAGEMENT OF RICE ROOT-KNOT NEMATODE IN A RICE-ONION CROPPING SYSTEM

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Rice hull burning (RHB) is a traditional cultural practice of many onion growers in San Jose City, Nueva Ecija, Philippines mainly for weed control and yield increase. The resulting carbonized rice hull is incorporated into the soil during land preparation before transplanting of onion. Studies to evaluate the effect of RHB on rice root-knot nematode, *Meloidogyne graminicola*, and onion yield were conducted in a farmer's field naturally infested by the pathogen. Fifteen cm-thick rice hull was sufficient to reduce the nematode population in the soil. The effect of heat from burning rice hull on the nematodes reached up to 30 cm deep. The effect of deep plowing on nematode population was insignificant in comparison with standard plowing. Increasing thickness of RHB gave a significant contribution to increase of onion yield and production of bulbs of export-quality. Plots that received 30 cm-thick rice hull gave 27% more large bulbs than 15 cm-thick hull and 40% more than no RHB. Thirty 3 cm-thick rice hull gave a yield advantage of 31% over no RHB while 15 cm-thick hull gave a yield advantage of 11%.

Key words: root-knot, *Meloidogyne graminicola*, rice hull burning, management, rice-onion system

85. ARTHROPOD PESTS OF BAMBOOS: TAXONOMY, BIOLOGY, NATURAL ENEMIES, AND HOST PLANT RESISTANCE

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Sixty (60) species bamboo arthropod pests (57 insects, 3 mites) were collected from several species of bamboos in nurseries, and natural stands around the

Philippines. These were identified to genus and/or species levels. These include the following: Bamboo node mealybug-*Antonina* sp. aff. *thaiensis* Takahashi; Bamboo shoot mealybug-*Palmicallus* sp. aff. *Bambusum* Tang; Bamboo leaf mealybug *Paracoccus interceptus* Lit; Bamboo culm mealybug - *Chaetococcus bambusae* (Maskell); Bamboo planthopper - *Purohita* sp.; Bamboo green mites - *Schizotetranychus* sp.; Bamboo culm borer - *Chlorophorus* sp. and Bamboo leaf folder - *Pyrausta* sp. A rodent (*Rattus tanezumi*) and one snail were also observed but not collected. New species, whose description are being prepared include: *Neoclavicoccus* sp. nov. (Pseudococcidae), from Makiling and Palawan, *Bambusaspis* sp. nov. (Asterolecaniidae) from Palawan, *Coccus* sp. nov. (Coccidae) from Palawan and Subic Bay Forest Reserve, *Greenaspis* sp. nov. (Diaspididae) from Mount Makiling, *Odonaspis* sp. nov. (Diaspididae) from Davao and *Kuwanaspis* sp. nov. (Diaspididae) from Laguna.

New records include: *Caloris cahira* (Moore) and *Thoesa* sp., as well as *Dolechallia bisaltide philippinensis*, *Melicodes tenebrosa tenebrosa*, *Protaetia* sp., *Melamitis leda* new host records.

The list of bamboo pests from Gabriel's latest compendium was further updated by incorporating new findings in this project and results from further review of literature. The revised checklist records 110 species, which is 93% higher than Gabriel's 57. However, the inclusion of *Planococcus lilacinus* (Cockerell) in Gabriel's checklist is here regarded as doubtful and most probably constitutes a misidentification. It has never been recovered from any of the bamboo mealybugs collected from all over the country. The species being referred to is most probably *Paracoccus interceptus* Lit.

Key words: bamboo pests, bamboo insects, arthropods

86. CRITICAL PEST LEVEL FOR BOLLWORM, *Helicoverpa armigera* (HUBN.)

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Cotton bollworm is one of the major pests of cotton and different control methods are used to control this pest. The use of insecticides is the most effective strategy but it should only be implemented when necessary, that is when the pest has reached the damaging level. In cotton, the critical pest level (CPL) is used as basis on whether to spray or not. Farmers claim that some of the recommended insecticides against bollworm are no longer effective. It is suspected that one of the possible reasons is the CPL currently used as basis in spraying. Hence, this

study was conducted to determine the CPL for bollworm at vegetative, squaring, flowering, and bolling stages of cotton. It was done at the Research and Development Center, CODA, Batac, Ilocos Norte.

The cage technique was used in the experiment. Nylon mesh cloth cages were used to confine 20 hills of cotton with two plants per hill. Determination of the CPL was done at vegetative (22-42 DAP), squaring (43-63 DAP), flowering (64-84 DAP), and bolling (85-105 DAP) stages. Varying number of larvae were released inside each cage. These were: (a) 0; (b) 1; (c) 2; (d) 3; and (3) 4. Shed squares, flowers and young bolls were collected and classified according to cause of shedding. The number of shed structures due to bollworm damage was recorded. Yield loss due to bollworm was computed based on the shed structures. Cost of control and yield loss were used as basis in determining the CPL for bollworm at different growth stages.

An increase in bollworm density meant an increase in the number of shed reproductive structures, resulting in corresponding decrease in the number of harvested bolls and consequently seedcotton yield. At vegetative (22-42 DAP) and squaring (43-63 DAP) stages, results showed that there is need to spray when the CPL of two bollworms/20 plants was reached. However, at flowering (64-84 DAP) and bolling (85-105 DAP) stages, spraying should be done at the CPL of three and two bollworms/20 plants, respectively.

Results imply that proper timing and judicious use of insecticides are important. It should only be done when the need arises or when the CPL is reached to avoid unnecessary expense.

Key words: critical pest level, bollworm, growth stage, yield loss, control cost

87. INSECTICIDE AND FUNGICIDE EFFECTS OF BETEL, *Piper betle* L. VOLATILE OIL ON SELECTED COTTON PESTS

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The variety and versatility in the biological activity of indigenous plants in the Philippines warrant investigation as potential sources of pesticide materials. With an abundant source and ease in cultivation, these materials can possibly be tapped as substitutes or complements to chemical pesticides, the latter being a necessary evil in agricultural production. A common ingredient in the chewing of tobacco by old people the betel, *Piper betle*, is one such plant worthy of investigation.

The volatile oil from betel, *Piper betle* L. leaves obtained by steam distillation, was yellowish brown with a strong peculiar aromatic odor. Through liquid-solid chromatography and successive elution with organic solvents, namely petroleum ether, and dichloromethane and methanol, the oil yielded three fractions.

Bioassay on selected cotton pests showed that the volatile oil and fractions isolated either by petroleum ether or dichloromethane effectively controlled sucking pests of cotton, notably, *Aphis gossypii* and *Amrasca biguttula*, and acted as ovicide against *Helicoverpa armigera* and *Pectinophora gossypiella*. The oil, however, stimulated *H. armigera* adults to deposit eggs and its larvae to feed on treated substrate, but deterred *P. gossypiella* and *Amorpha laticarpa*. Interestingly, its fractions inhibited egg deposition of *H. armigera*, *P. gossypiella*, and *A. laticarpa*, indicating a marked selectivity as well as synergism in insecticide action.

Similar trend in effectiveness a fungicide was observed for the oil and its two fractions against damping-off organisms, *Sclerotium rolfsii*, *Fusarium oxysporum*, and *Rhizoctonia solani*, in that order.

Using GC-MS, the fractions had six and three major components obtained by petroleum ether and dichloromethane, respectively. The components were generally terpenes and sesquiterpenes, notably allylphenol, caryophyllene, eugenol, betelphenol, cineol, cadinene, and menthone.

The pesticide action of *P. betle* volatile oil indicates potential as control agent for cotton pests, although, field evaluation is still necessary, in addition to determining its effect on the natural enemies. Also, with the oil being equally or more effective than its fractions, its prospect for formulation and application in agriculture seems viable; however, with its mammalian toxicity to be established yet.

Key words: insecticide, fungicide, *Piper betle*, volatile oil, *Aphis gossypii*, *Amrasca biguttula*, *Helicoverpa armigera*, *Pectinophora gossypiella*, damping-off organisms

88. *Argemone mexicana* L. (PAPAVERACEAE) PRICKLY POPPY: A NEW NON-QUARANTINE PEST RECORD IN THE PHILIPPINES

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Argemone mexicana L., commonly known as prickly poppy, is an exotic weed that was recently detected in onion growing areas of Bongabon, Nueva

Ecija. Aside from competing with soil nutrients and sunlight with onions, the prickly poppy is also hazardous to farmer due to spines that can prick the legs and arms. This weed is not present during the rainy season; it emerges after rice harvest. Thus it can be surmised that it is dormant during the wet season. In fact this weed is common in drylands.

The description of this exotic weed and its field density are discussed.

Key words: onion, *Argemone mexicana* prickly poppy, Bongabon, drylands, exotic weed, Nueva Ecija

89. DAMAGE ASSESSMENT OF LEPIDOPTEROUS PESTS OF ONION IN NUEVA ECIIJA

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The lepidopterous pests, of onion which are leaf chewers were studied during the 1999 growing season. The pest group in Nueva Ecija includes cutworms, earworms, semi-loopers, and a new lepidopterous pest of onion. The cutworms are the dominant species.

Approximately 20% of red pinoy yield is reduced due to the damage caused by these lepidopterous pests. The sampling protocols and details of the result are discussed.

Key words: lepidopterous pests, cutworms, damage assessment, onion, red pinoy, leaf chewers

90. INSECT PESTS AND NATURAL ENEMIES FROM STORED PRODUCTS IN JAPAN

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Severe infestation by insect pests on stored products shortens shelf life and leads to product deterioration. It is important therefore to identify these insect pests as well as their natural enemies as a step toward the development of control measures against them. Stored product samples such as cereal grains and animal feeds were collected from 15 sites in Kumamoto, Ibaraki, Okinawa, and Hokkaido prefectures in Japan. After isolating the insect pests, predators, and parasites from the samples, their identity was determined based on morphological characteristics. A total of 14 species of insect pests were identified from the samples and majority of them were beetles. *Tribolium castaneum* (red flour beetle) and *Stegobium paniceum* (drugstore beetle) were the most frequently occurring species in the samples. Among the various sources of the samples, Kumamoto Kikuchi Shokuryo and Kashima Forage Company had the most number of insect pest species. The predators found in the samples were *Gnathoncus nannetensis*, *Ar:isolabis maritime*, *Alleocranum biannulipes*, *Carcinops pumila*, pseudoscorpion, spider, beetle, and an unknown, while the parasites included two unknown species and *Ventulia canescens*.

Key words: stored products, insect pests, predators, parasites, natural enemies, *Tribolium castaneum*, *Stegobium paniceum*, post-harvest, cereal grains, animal feeds

91. A SURVEY OF BUTTERFLIES AND SKIPPERS (LEPIDOPTERA: RHOPALOCERA) FROM MOUNT BANAHAO DE LUCBAN, QUEZON PROVINCE, PHILIPPINES

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A survey of the Rhopalocera of Mount Banahao de Lucban was conducted from July 1997 to December 1999. Four main sampling and observation sites were designated, namely, the Samil River area (700-100 m asl), Manglit-Palola (750-900 m asl), Barod-Palola (700-1100 m asl), and Balicatan (900-1200 m asl). A total of 76 species were identified. These are distributed in nine families namely: Hesperiidae, Papilionidae, Satyridae, Amathusiidae, Nymphalidae, Danaidae, Peiridae and Lycaenidae. The best represented family is Pieridae with 14 species. *Troides rhadamantus* Lucas which is included in Appendix II of CITES list can still be found in the mountain particularly around the Samil area, but was sighted only twice throughout the entire study period.

Key words: butterflies, Rhopalocera, *Troides rhadamantus*, Mount Banahao de Lucban

92. GROWTH AND DEVELOPMENT OF RICE STEMBORER IN AN ARTIFICIAL DIET

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In searching for an alternative host for the yellow stemborer eggs for parasitoid studies, a corn borer diet was tested for growth and development of rice stemborer for pupa production and found suitable for rearing. Neonates of stripped stemborer, *Chilo suppressalis* (Walker) were infested on the diet. Parameters such as larval/pupal weights, larval/pupal periods, adult survival, and fecundity were observed. Forty eight percent of the larvae survived, grew, and developed into adults on the corn borer diet. Development period ranged from 34 to 57 days with a mean of 44.34 ± 7.52 days. Mean larval period was 37.41 ± 7.05 days, mean pupal period 7.05 ± 1.54 days, and mean development period peaked at 36 to 45

days. Each female was able to lay an average of three eggmasses with a mean egg count of 92.21 ± 55.17 eggs.

Key words: stemborer, *Chilo suppressalis*, larvae, corn diet, eggmasses

93. BUTTERFLY MANURE: A NOVEL SOURCE OF BIO-ORGANIC FERTILIZER

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Butterfly manure from the larvae of *Danaus chrysippus* L., plain tiger was collected from the Tarlac butterfly breeding site. The main host plant where these larvae feed is *Calotropis gigantea*. The larvae manure was air dried and analyzed at the Analytical Services and Soil/Plant Test Kit Project of the Department of Soil Science, U.P. Los Baños.

The nitrogen (N) content of butterfly manure at 1.19% approximates that of carabao (1.09%-1.22% a.i.). Its potassium content of 2.14% is higher than that of cattle and almost equal to poultry. The other chemical components of butterfly manure are discussed and compared with other sources of bio-organic fertilizers.

Key words: *Danaus chrysippus*, butterfly manure, bio-organic fertilizer, larvae, poultry, cattle, plain tiger, nitrogen, potassium

94. GRAFTED TOMATO FOR OFF-SEASON PRODUCTION

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An experiment was conducted to determine the efficacy of grafting Apollo and FMTT-22 tomato plants onto eggplant rootstock using rain shelter and raised bed condition.

Growing tomatoes in the Philippines is usually done in lowland areas during the dry season. During the rainy season, (hot-wet months) particularly in Nueva Ecija, production of tomatoes is concentrated on very small hilly areas making the price almost unaffordable to consumers. This situation offers very high opportunity to off season production through grafting and planting tomatoes in the lowlands.

Grafting tomatoes onto eggplant rootstock may offer resistance to flooding during the rainy season. Upgrade tomatoes when flooded results in wilting and ultimately death of the plants.

One-month seedlings of Apollo and FM TT-22 tomatoes were grafted to the same age of EG-203 eggplant rootstock. The rootstock and the scion were cut just above the first leaf to form a wedge and inserted into opposite ends of a rubber tube. Grafted seedlings were transferred to a chamber with approximately 80-90% relative humidity for one week and later on brought out from the chamber for hardening prior to transplanting.

Results of the experiment indicated that plant survival significantly increased in Apollo but not for FM TT-22. The percent survival from grafted Apollo was 74 percent higher than the non-grafted ones. In terms of the number of fruits, grafted Apollo had ten percent more fruits than the non-grafted plants.

Grafting likewise influenced significantly the weight of fruits per plant and computed yield per hectare. Grafted Apollo significantly produced higher fruit weight than the non-grafted plants. Furthermore, significantly higher yield was obtained from grafted Apollo plants, with mean yields of 15.48 tons per hectare from the grafted plants and 7.45 tons per hectare from the non-grafted. Grafting increased yield by 107 percent. For FM TT-22, yield for both grafted and non-grafted plants were the same.

Key words: grafted tomato, root stock, scion, rainshelter

95. BAMBOO SHOOTS AS SUBSTITUTE VEGETABLE DURING LA NIÑA

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Twenty-one (21) provinces were visited to survey several species of bamboo in natural stands and bamboo plantations. Bayog (*Dendrocalamus merrillianus*) is the predominant bamboo shoot species in Northern and Central Luzon, mostly

kawawang tinik (*Bambusa blumeana*) and bolo or kawawang tsina (*Gigantochloa levis*) in Southern Luzon. Kiling (*Bambusa vulgaris* var. *vulgaris*) is predominant in the Bicol regions, giant bamboo (*Dendrocalamus asper*) in Central Mindanao and laak (*Bambusa philippinensis*) in Southern Mindanao.

The predominant bamboo species in an area is usually the one used as food and all bamboo shoots in the market are sold fresh. Each region has its own manner of processing bamboo shoots and Unique shoot delicacies. The presence or absence of bamboo shoots in an area's market place is a good indicator of the presence or absence of natural or cultivated bamboo strands.

Key words: bamboo shoots, La Niña phenomenon

96. FREEZE-DRYING CHARACTERISTICS OF MANGO (*Mangifera indica* L.) PUREE AT THREE LEVELS OF PRE-FREEZING TEMPERATURES

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The problem that besets the Philippine mango industry is the seasonality in production vis-à-vis unstable market situations characterized by a period of supply glut (February-June) resulting in low prices, followed by a longer period of severe undersupply (July-January) with prices in the market rising to exorbitant levels. Although there are processed mangoes available in the market, development of new products such as freeze-dried mango powder, is still necessary in the food industry. Hence, it is important to establish technical information in the freeze drying of mango puree in order to produce high quality mango powder.

The study was conducted to establish the freezing and freeze-drying characteristics of mango puree at pre-freezing temperatures of -40°C and -65°C (using an ultra-low temperature freezer) and -196°C (direct immersion in liquid nitrogen). Aseptically processed mango puree used in the study was pre-frozen at -40°C, -65°C, and -196°C. These samples were freeze-dried at 2 to 3% moisture content (MC) wet basis at a vacuum pressure of 0.005 to 0.001 torr. Parameters studied included freezing behavior, freezing point, critical zone, rate of heat removal, freeze-drying duration, freeze drying rates, and percent power recovery.

Results of the study showed that removal of sensible heat at -40°C, -65°C, and -196°C from the initial product temperature to below its freezing point required at time duration of 42, 35, and 2.87 minutes, respectively. Meanwhile, the time required to remove the latent heat from the sample product were 125, 9, and 6.58 minutes for the different temperatures applied. Using graphical analysis, the critical zone at -40°C, -65°C, -196°C ranges from -0.05°C to -11.48°C.

The study showed that the freezing point for mango puree was -2.42°C . The heat removal rate below and above freezing at -40°C , -65°C , and -196°C were 60.7, 46.6, and 37.5 kJ/h, respectively. This effect was attributed to an increase in surface area of sublimation caused by cracks that developed during freezing as a consequence of thermal shock. Freeze drying of mango puree at pre-freezing temperatures of -40°C , -65°C which required -196°C did not have any marked effect on powder yield. The technical information obtained in the freeze drying of mango puree added to the body of knowledge in the field of food processing. Such information can be applied in the commercial production of freeze-dried mango powder in a pilot scale to determine its economic viability.

Key words: freeze drying, mango puree, ultra low temperature freezing, liquid nitrogen, aseptic processing, freezing point of mango puree, vacuum pressure, freeze-drying rate, freeze-dried mango powder, percent powder recovery

97. ANALYSES OF THE SHELF LIFE OF COMMERCIAL TEMPURA AND SAUCE IN CEBU CITY

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This is a study on the shelf life of commercial tempura and sauce sold by street vendors in Cebu City based on its physicochemical, microbial, and sensory analyses observed under ambient and refrigerated conditions, packed and unpacked.

The newly processed tempura contained physicochemical parameters of 39.02% moisture; 8% fat; 11.05% protein; 3.31% ash; 38.62% carbohydrates; and water activity level (Aw) of 0.98. The bacterial count had reached 1.34×10^8 cfu/g higher than the standard count of 10^2 cfu/g by the Bureau of Food and Drugs (1990). Mold growth and *Staphylococcus aureus* were detected in the product. Based on sensory assessments, the shelf life of unpacked and packed tempura stored at ambient temperature lasted for only four days while samples stored at refrigerated temperatures were still acceptable after eight days of storage.

Tempura sauce had physicochemical parameters of 84.39% moisture; 0.2% fat; 0.81% protein; 2.6% ash; 12% carbohydrates; and 0.99 water activity (A_w) level. Mold growth was evident in the product and bacterial count had reached to 4.20×10^3 cfu/g. Based on sensory assessments, the tempura sauce stored at ambient condition, unpacked and packed, lasted for only four days while those samples stored at refrigerated conditions were still acceptable by the panelists after eight days of storage.

There was a significant mean difference between the different treatments at a 0.05 level of significance using the analysis of variance (ANOVA) and least significant different Tests.

Key words: shelf life, tempura, tempura sauce, physicochemical analysis, microbial analysis, sensory analysis, refrigerated condition, ambient condition

98. CHANGES IN SOIL PROPERTIES ASSOCIATED WITH APPLICATION AND BURNING OF RICE HULLS IN PERI-URBAN VEGETABLE PRODUCTION AREAS IN CENTRAL LUZON

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Peri-urban vegetable production is characterized as a highly intensive agriculture system. Large cities like Metropolitan Manila depends on such system for a year-round supply vegetables. However, year-round vegetable production is beset with a wide range of constraints such as rains or floods, insects, diseases, weeds, and soil-related problems.

One of the major peri-urban areas in Central Luzon is found in San Leonardo, Nueva Ecija. In this site, the cost of weed control ranked next to the cost of insect control due to the prevalence of various weed species in succession. This condition prompted farmers to resort to the application and burning of rice hulls in their fields. Considering the negative effect of burning on the environment, a research study was conducted to identify the impacts of burning rice hulls both on soil and on pak-choi. Pak-choi, also known as pechay, is one of the most common peri-urban vegetables.

Rice hulls were applied at a thickness of one foot and one-half foot each in 16 one by four meter-plots. Four plots of the same dimensions were not applied with rice hulls for comparison. These thickness were equivalent to a weight of 74 and 147 tons/ha of rice hulls, respectively. The rice hulls were burned until a

carbonized rice hull (CRH) was left. After five days, when the CRH had cooled, it was incorporated into the soil through the use of a hand tractor.

Pak-choi seedlings were transplanted into the 20 plots. Plots without CRH were fertilized with 90-30-30 kg NPK/ha while four plots each from the 74 and 147 t/ha rice hulls, applied plots was fertilized with 90-30-30 kg NPK/ha and 45 – 30-30 kg NPK/ha. The field layout for the experiment was randomized complete block design.

Two consecutive cropping of pak-choi were done. During the second cropping, there was no application of rice hulls to evaluate any residual effect that could be detected in terms of weed control and yield. Soil samples were taken before planting and after harvest of the first and second crops for physical and chemical analysis of soil properties that were affected by CRH incorporation. Marketable yield of pak-choi and weed density was measured during the study.

A marked increase in soil organic, exchangeable potassium, and soil porosity was observed due to rice hull burning. The increase in porosity was attributed to the significant reduction in soil bulk density.

Burning of rice hull exerted a very positive effect on weed control during the first crop ranging from 180 percent in one-half foot thickness of application to 600 percent in one foot thickness of application. In the second crop weed control ranged from 100 to 1000 percent. Furthermore, a reduction in the amount of fertilizer to achieve the same yield was observed due to incorporation of CRH. This is applicable during the first and second cropping.

99. REGIONAL ASSESSMENT AND COLLECTION OF AVAILABLE DYE-YIELDING PLANTS IN THE PHILIPPINES

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A total of 65 dye-yielding plant species in seven geographical regions of the Philippines were identified, collected, and documented. This discussion focuses on the collection, plant parts extracted, methods of dye extraction, dye-yield color, and uses and/or applications based on structured and unstructured interviews among local people.

The information gathered will serve as reference among people engaged in dye extraction and proprietors of small-scale industries, handicrafts, handloom weaving industries, fan and mat weaving, abaca weavers, fashion accessories, and costume jewelry available in the country. The information is suitable for local

radio and TV interviews, and is an interesting subject matter among high school students especially those conducting investigatory work.

Key words: dye-yielding, extractive, natural forest, indigenous, resource survey, assessment.

100. *Limnocharis flava* L. BUCH., and *Salvinia molesta* MITCHELL: POTENTIAL THREATS TO AQUATIC ECOSYSTEM IN LUZON

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Limnocharis flava L. Buch., locally known as "sandok-sandokan", belongs to family Butomaceae. Introduced from Tropical America, it was first collected in Java in 1870 and is now a native of Tropical Asia. *Salvinia molesta* Mitchell is a floating aquatic fern of South American origin. It has become a serious pest in parts of Asia, Africa, and Australia. Its presence in Iloilo was earlier reported and has spread to Luzon. Local folks call it "giant Azolla". Both weeds have infested lowlands rice paddies, while the latter has started invading swampy areas, irrigation canals, and waterways in Lucban, Quezon threatening nearby towns.

Limnocharis flava has a long triangular petiole crowding at the base of the stout rootstock. Leaves are large, the blade somewhat rounded with a peltate base. Flowers are in umbels with stout peduncles 3 sepals 3 yellow petals. Fruits are round capsules with 14-34 carpels, maturing in 21-24 days after flower opening. Each carpel has 22-123 small, brown to black seeds.

Salvinia molesta as fragile horizontal floating stems with difficult-to-wet hairy leaves. It produces numerous sporocarps, which contain the megasporangia and microsporangia. Growth is rapid and a means of dispersal is through fragmentation of the stem occurring rather easily.

The capacity of *Limnocharis* to produce tremendous numbers of small seeds and to reproduce vegetatively through offshoot production at the tip of the flower stalk make this plant potentially damaging.

Key words: *Limnocharis*, *Salvinia*, *Salvinia molesta*, *Limnocharis flava*

101. MANGROVE COMMUNITY STRUCTURE IN CARMEN, CEBU

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Coastal ecosystems are particularly important to the people as they provide both subsistence and cash-crop fisheries and other benefits, such as wood from mangrove forests. These ecosystems also contain a high biodiversity of animals and plants which can be a source of novel biochemical products and form a basis for valuable eco-tourism industry activities and discovery of new biochemical products. In Carmen, Cebu, mangrove communities are being utilized by the local coastal community into aquaculture farms or reclaimed for human settlements. Like any other coastal areas in the Philippines, these resources are being exploited without logical understanding of their ecology. This may eventually lead to depletion. Thus, the need for the residents of the community who are direct users of the resources to understand and rationalize their use. One objective of the CSCST-CFT, Carmen, Cebu Campus program is to assess the remaining valuable marine resources by conducting a study on the community structure and distribution of mangroves of the coastal areas of Carmen, Cebu. The result of the study will provide the community baseline information about the status of mangrove resources and guide them on how to utilize and maintain the remaining resources wisely.

Carmen, Cebu is located 41 km northeast of Cebu City. Five stations were established for the study namely: Dawis, Luyang, Puente, Cogon, and Poblacion. The mangrove vegetation structures of the five stations were analyzed from June to September 1999 by taking the following measurements: number of individuals per unit area, basal areas, and tree height. The number of individuals per species were counted from a 10 x 10 sq meter-area; 20 to 50% of the trees of each species were measured for their circumference above the primary root using a calibrated tape. Tree height which is the vertical distance between the ground up to the tip of the crown was measured using a calibrated pole. Field testing and identification of other mangrove species outside of the quadrant were also done.

After four months of sampling, the most common mangrove species like *Sonneratia alba* (pagatpat), *Rhizophora stylosa* (bakauan-bankau), and *Avicennia marina* (bungalon) were found in the five stations of Carmen, Cebu. However, the diversity of mangrove species like *Sonneratia alba*, *S. caseolaris*, *Avicennia alba*, *A. lanata*, *marina*, *A. officianalis*, *Rhizophora stylosa*, and *Ceriops tagal* were found mostly in secondary growth in Luyang, Carmen, Cebu. The numerical dominance of *Rhizophora* species is due to its success in colonizing new areas.

One of the reasons for this is attributed to the reproduction strategy of *Rhizophora* species. *Rhizophora* is oviparous, meaning, the propagules germinate and mature in the mother plant before they are released and dispersed. That is one of the reasons why *Rhizophora* species are widely used for mangrove reforestation. Propagules, when laid down in the mud, grow and take root quickly.

102. THE INFLUENCE OF BODY WEIGHT AND DIET ON THE AMMONIA EXCRETION OF THE AFRICAN CATFISH, *Clarias garlepinus*

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Three size groups of African catfish, *Clarias garlepinus*, with mean weights were 124.5 g (adult size group), 5.4 g (juvenile size group), and 1.1 g (fingerling size) were given two types of diets (trash fish and floating pellets) to determine the influence of body weight and diet on ammonia excretion. Highest weight-specific excretion rate ($5.23 \text{ mg NH}_3\text{-N kg}^{-1} \text{ h}^{-1}$) was obtained from juveniles and fingerlings fed with trash fish and lowest ($0.24 \text{ mg NH}_3\text{-N kg}^{-1} \text{ h}^{-1}$) among adults fed with commercial pellets. Regardless of diet given, post-prandial excretion rates at 28°C were generally higher among fingerlings and lowest in adults. Within same size groups, excretion rate was 50-84% higher among test animals fed with trash fish. Significant differences in ammonia excretion in relation to diet stresses the dissimilarities of the protein and amino acid requirements of the test group. The hourly ammonia excretion rate obtained in this study can be used to determine the build-up of ammonia in ponds which could be exported to rivers and inland waters.

Key words: body weight, diet, ammonia excretion, *Clarias garlepinus*, trash fish, commercial pellets, weight specific excretion rates, pollution, water quality, post-prandial excretion rates

103. SEED QUALITY-RESPONSE TO FUNGICIDE TREATMENT OF A LINE AND F₁ HYBRID SEEDS

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IR 58025 A (A line) and F₁ hybrid seeds harvested during the wet season 1999 at the PhilRice-Central Experiment Station were dipped in various concentrations of benomyl to control fungal growth during a germination test. Hybrid seeds were germinated in petri dishes lined with moistened filter paper then stored in a germination room with Temperature range of 28-32°C.

Washing and ten-minute dipping in 5 and 3% benomyl solution resulted in high germination percentage in A line and PSB Rc 27H (F₁) mestizo hybrid, respectively. Germination of hybrid seeds at these fungicide concentrations was characterized by minimal fungal infection.

Fungal growth in A line and PSB Rc 72H (F₁) hybrid seeds washed with tap water was not controlled. A line seeds washed then dipped into 3% benomyl solution exhibited minimal occurrence of fungal growth. Prolonged dipping seeds for 10 minutes in 3% solution significantly controlled fungal growth. On the other hand, five-minute dipping in 3% solution proved very effective in controlling fungal growth in PSB RC 72H (F₁) seed.

Key words: hybrid, mestizo, A line, benomyl, germination, fungal growth, concentration, IR 58025A, PSB Rc 72H, F₁

104. PEDOLOGICAL CHARACTERIZATION AND AGRONOMIC POTENTIALS OF SOILS ASSOCIATED WITH KENNON LIMESTONE

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The importance of understanding the characteristics of soils associated with limestone lies in their extensiveness. Extensive research has not been conducted

on soil-landscape relationships involving limestone in Benguet and in other parts of the country. Thus a study of Kennon limestone is necessary to set the limits of its properties in relation to soil formation and possibly to serve as a tool in predicting properties of soils associated with other limestone formations that exhibit the same characteristics. Several reconnaissance trips were taken across areas where Kennon limestone formation was mapped. After the survey, sites for detailed soil description and sampling were selected. Thus, four landsurface units (interfluvial, fall face, transportationals slope and colluvial footslope) were described and sampled in La Trinidad, Benguet and Green Valley, Baguio City. At each land surface unit, a pit of approximately 1 square meter was excavated up to more or less 2 meters depth for description and sampling. Soil samples taken were prepared for laboratory analysis.

The morphological, physical, chemical and mineralogical properties of soils in four land surface units along the Kennon limestone formation indicated strong correspondence between landscape positions and soil properties. The land surface units studied in La Trinidad, Benguet are the interfluvial, fall face, transportationals slope and colluvial footslope. The same land surface units were replicated in Mt. Sto. Tomas, Green Valley, Baguio City. The soils were classified using the framework of Soil Taxonomy.

The stable nature of the interfluvial in both locations allowed the formations of deep and well-developed profiles. Classified as Typic Haplohumults, the soils show distinct development of umbric epipedons and thick argillic horizons. The soils formed in the fall face of La Trinidad and Green Valley have two different genetic pathways. In La Trinidad, the soil shows distinct umbric epipedon with cambic subsurface diagnostic horizons; hence it is classified as Typic Dystrypepts. In Green Valley the presence of limestone outcrops, which somehow stabilizes the landscape unit, favors the development of mollic epipedon and argillic subsurface layer. The soils are therefore grouped as Typic Argiudolls.

The soil properties of the transportationals slope in La Trinidad are almost identical with those of Green Valley. In both sites, the soil profiles are deep and well developed. Both soils, identified as Typic Hapludalfs, have umbric epipedons and subsurface argillic horizons.

The soil in the colluvial footslope of La Trinidad is more developed than the soil in Green Valley. The soil in the former has a deep and well-developed profile. The surface soil is mollic epipedon and the subsurface horizon is argillic. The soil is Typic Argiudolls. The soil in the latter, on the other hand, has ochric epipedon and cambic horizon in the surface and subsurface layers, respectively. Thus, the soil is classified as Fluventic Dystrypepts.

All soils observed in the different land surface units of La Trinidad and Green Valley, except those that are located in the fall face, are suitable for agricultural uses. The utilization of soils in the fall face is constrained by its steep location. Thus, the soils can be best utilized for forest trees and or fruit-bearing trees.

Key words: Kennon limestone, landsurface units, diagnostic horizons, epipedon, soil classification, soil taxonomy, agro-technology transfer, Haplohumults, Dystropepts, Argiudolls

105. GENETIC DIVERSITY ANALYSIS OF PHILIPPINE MAIZE INBRED LINES USING MICROSATELLITE MARKERS

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The success of a maize hybrid breeding program relies on the systematic evaluation and selection of inbred lines as parents based on their heterotic patterns. Heterotic patterns (HP) can be established using diallele analysis but the process is tedious, time-consuming, and costly, particularly if many lines or populations are involved. Fingerprinting and diversity analysis of inbred lines using molecular markers could reduce the number of lines required for testing and time needed to establish heterotic patterns. Inbred lines developed at IPB-CA-UPLB were analyzed using SSR or microsatellite markers. Sixty maize SSR primers were used to analyze the diversity of the 33 yellow and 47 white inbred lines. NTSYS analysis based on Nei's dissimilarity coefficient revealed clustering of very closely related inbred lines. The results of the study could provide maize breeders relevant information as a guide in selecting potential inbred lines as parents in a hybrid-breeding program.

Key words: maize, inbred line, hybrid, SSR, microsatellite, fingerprinting, heterotic

106. MINERAL CONCENTRATION IN THE BLOOD OF GRAZING GOATS AND SOME FORAGES IN HALAR-LADEN AREAS OF TARLAC, CENTRAL LUZON

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In 1998, about 5% of the country's goat population was raised in Tarlac, one of the provinces hard hit by the eruption of Mt. Pinatubo in 1991. Goats subsist mainly on forage species that grow predominantly or sporadically in lahar-laden areas characterized as sandy, dry, acidic with sulfur content 10 times more than the normal organic or mineral soils, and infertile because of organic carbon and nitrogen. In the absence of concentrate feeding, there is a high possibility that the mineral levels, particularly copper, selenium, and zinc, of the animals are below critical levels, as a result of insufficient minerals from the feedstuffs.

The study was conducted to determine the mineral status of 60 native goats and eight forage species, namely: *Cynodon plectostachyus*, *Pennisetum purpureum*, *Eleusine indica*, *Cynodon dactylon*, *Calopogonium muconoides*, *Centrosema pubescens*, *Leucaena leucocephala*, and *Mimosa pudica* in lahar-affected areas of Concepcion, Tarlac. Forage and blood samples were collected six times from December 1996 to September 1997, and analyzed for calcium, phosphorus, magnesium, sulfur, copper, iron, molybdenum, and zinc using an inductively coupled plasma emission spectrometer, and selenium using fluorometric detection of the 2,3-diaminoapthalene.

Forage calcium and sulfur were non-limiting. Most forage species had low phosphorous, copper, and selenium, while some species had magnesium and zinc levels lower than the critical limit because of low mineral content and high percolation rate of lahar deposits. Iron and molybdenum were in excess.

The effect of the seasonal variation as well as the direct effect of the feedstuffs from the lahar-laden areas on the mineral status of the grazing goats was observed. More than 20% of the animals had low levels of calcium, copper, zinc, and selenium especially during the dry season possibly due to insufficient amount of these elements and excessive molybdenum and iron in most forages. While the percentage of the animals with low levels of Cu, Zn, and Se decreased during wet season, the percentage of the animals with low levels of Ca increased. The better growth of forage and higher concentration of Cu, Zn, and Se during the wet season could have contributed to this effect. Conversely, calcium in forage was

high, but 47% of the animals had low plasma calcium concentration during the wet season possibly due to low availability of Ca in the forage.

Although no clinical signs of mineral deficiencies were observed, supplemental feeding would be important since the condition of the pasture in lahar-laden areas was not expected to improve in the next years. Intensified use of *L. leucocephala* with better mineral profile would be ideal in order to improve the mineral status of the grazing goats.

Key words: lahar-laden, minerals, goats, forage

107. SELENIUM SUPPLEMENTATION IN GRAZING GOATS: EFFECTS ON BLOOD AND MILK SELENIUM AND GROWTH PERFORMANCE OF KIDS BORN TO DOES RECEIVING SELENIUM-SOLUBLE GLASS-BOLUS

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Philippine goats are traditionally raised under backyard level with negligible concentrate supplementation and feeding is primarily based on available fibrous crop residues or vegetation available in communal pastures. The mineral content of feed resources is generally low; thus, a high possibility that grazing animals suffer from known mineral deficiencies particularly in selenium.

The effectiveness of soluble glass boluses (SGB) to increase Se level has been known in sheep, but only limited literature is available on goats.

This study was conducted to determine the effects of SGB containing selenium on blood and milk Se levels, and growth performance of kids born to does receiving intraruminal SGB. A total of 50 grazing upgraded Philippine goats with mean body weight of 20 kg were evenly divided into two treatment groups; without SGB (Control) and with SGB (Treated). The animal grazed in a Se-deficient pasture in the experimental farm of the Central Luzon State University, without any concentrate supplementation, during the 12-month study. Two boluses in six months intervals were administered. Samples of goats' and kids' blood were collected monthly and analyzed for Se content using fluorometric detection of the 2-3 diaminonaphthalene following the procedure of Watkinson.

After three months of SGB administration, the treated group had higher blood and milk Se contents than the control. Blood Se levels among kids born to SGB-treated does reflected maternal treatments, i.e., a two-fold increase in Se level over the untreated group. Significant correlation was noted between blood and milk Se levels in does, and blood Se in kids. No positive response was observed in the birth weight and growth performance of kids suckling milk with relatively higher Se concentration. Results suggest that although SGB administration significantly increased blood as well as milk Se levels of does grazing in Se-deficient pastures, this did not improve birth weight and growth performance of their offspring.

Key words: selenium, Philippines, goats, SGB, blood, milk, growth performance