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AGRICULTURAL SCIENCES

DATA MANAGEMENT SYSTEM FOR GERMPLASM

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A new database management system has been developed for the PhilRice Genebank called GEMS-PhilRice Germplasm Data Management System. GEMS is a simple, user-friendly database that allows easy access to the wealth of information about the rice germplasm collection at PhilRice. GEMS holds information on the passport, characterization, evaluation, viability, and inventory of the existing materials. Access to these information simply involve dragging the mouse, clicking buttons and typing search words. Search options are unlimited with regard to combination of target items. Search reports may be generated in various formats such as individual accession profiles or as a group list with selected data sets. Custom searches have been designed for many frequently-requested search items, and for vital data concerning with bright color combinations enlivening every turn. the system can allow worldwide access through the Internet pending the installation of the necessary hardware at PhilRice. Data exchange is straightforward with most of the widely used data formats. Expansion will include storage of plant photographs and enhanced integration with the preparation of planting plans.

Keywords: *germplasm, documentation, database*

CHARACTERIZATION OF HETEROSIS IN PHILIPPINE HYBRID RICE GERMPLASM

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The exploitation of heterosis or hybrid vigor is the goal of hybrid rice breeding. Since genetics is acknowledged to be the basis of heterosis, PhilRice has diversified its hybrid rice germplasm through collaborations with Chinese R & D institutions. These have led to the introduction of new cytoplasmic male-sterili (CMS) and restorer lines into PhilRice's breeding program. Genetic diversity analysis of CMS lines, for example, has revealed nine groups within the PhilRice's CMS materials and a wide array of testers would provide baseline information that would be useful in charting the future of Philippine hybrid rice breeding. Using 850 F_1 derived from eight CMS lines, we examined the maintaining and restoring ability of 450 testers/inbreds. In the average, 19% of the testers were effective restorers while 28% were partial of effective maintainers of eight CMS lines. Crosses made with CMS Lian A were mostly heterotic (34%), and crosses to CMS 28A were mostly sterile (65%). Of the 8 CMS lines, Lian A was the most easily restored while 28A was the most easily maintained. Heterosis levels for ten vegetative and reproductive traits were also analyzed. Trait-wise, more than 20% of the F1 hybrids showed at least 20% superiority over the male parent (MP) for number of productive tillers, spikelet number, grain weight, and grain yield. Distribution of MP heterosis was normal for maturity, plant height, panicle length, grain length, and grain width, and was bimodal or skewed for number of productive tillers, spikelet number, spikelet fertility, grain weight, and grain yield. These results suggest the greater likelihood for selecting heterotic combinations for the latter group of characters. For grain yield, 21% of the hybrids showed at least 20% heterosis indicating that breeding progress is attainable using the gene pool studied.

Keywords: heterosis, genetic diversity, germplasm, CMSD, hybrid rice

MOLECULAR GENETIC DIVERSITY AND HETEROSIS IN RICE

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Molecular markers are powerful tools for assessing genetic diversity at the level of DNA. In hybrid rice, genetic diversity has been acknowledged to be the basis of heterosis or hybrid vigor. Simple sequence repeats (SSRs) or microsatellites, due to their codominant inheritance, are among the DNA marker types most suited for assessing genomic heterozygosity. We examined the relationship of SSR heterozygosity and heterotic potential for eight vegetative and reproductive traits in 48 rice hybrids developed from five cytoplasmic-genetic male sterile (CMS) and ten male parents. These parental lines represented the breadth of genetic diversity in current Philippine hybrid rice germplasm. F_1 heterozygosity was deduced from parental genotypes at 44 microsatellite loci spanning the 12 rice chromosomes. Based on at least 75% genetic similarity, the CMS and male parents clustered into two and eight groups, respectively. SSR heterozygosity and heterotic performance (superiority over the male parent) in the 48 hybrids were significantly correlated for the number of productive tillers per plant (r=0.37*) and leaf area index (r=0.34*). When only hybrids with positive heterosis were analyzed to remove maintainer effects, marker heterozygosity and heterosis were significantly correlated for maturity (r=0.60*), leaf area index (r=0.45*), and number of productive tillers per plant (r=0.43*). However, insignificant correlations were observed for plant height, root length, root weight, harvest index, and grain yield. Correlations were also insignificant when heterosis was based on the check varieties, PSBRc28 and PSBRc72H *(Mestizo)*. These results suggest that while SSRs are useful for genetic diversity assessment, markers unlinked to specific traits may not be very effective in predicting heterotic performance for these traits in the diverse hybrid rice germplasm pool studied.

Keywords: Hybrid rice, heterosis, simple sequence repeat (SSR), genetic diversity, molecular marker

IDENTIFICATION OF GENETIC DONORS FOR RICE SEEDLING VIGOR

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The development of cultivars that perform well under direct-seeded culture requires specific traits such as seedling vigor (SV). SV is essential for optimum stand establishment and competitiveness against weeds. We analyzed the genetic variation for SV in 49 promising parentals under controlled laboratory (slantboard test) and greenhouse (wet and anaerobic) conditions. Highly significant (P<01) differences were observed for shoot, root, mesocotyl, coleoptile lengths using the slantboard test procedure. Under wet and anaerobic conditions, significant differences were observed for shoot length, phenotypic vigor, and emergence vindex. Some varieties, namely, Black Gora, UG-20, and IR64683, performed well under both laboratory and greenhouse environments. Rank correlation analysis showed shoot length under weseeded condition was highly associated with mesocotyl (r=0.54**) and cleoptile lengths (r=0.63**) in the slantboard test. Likewise, shoot length was highly correlated with mesocotyl (r=0.68**) and coleoptile (r=0.82**) lengths in the slantbord test. Highly significant correlations of shoot length with root length (r=0.98**) and emergence index (r=075**) under anaerobic conditions were likewise observed. Indica cultivars were more vigorous under both laboratory and greenhouse environments, compared with japonica types. Nine high-SV genotypes were identified in addition to known SV genetic donors. These include CG-14, CG-17, CG-20, UG-20, Brown Gora, Dular WB, Vandana IR, 64683, and AUS 257.

Keywords: seedling vigor, genetic, emergence, direct-seeding, rice

BREEDING SALT-TOLERANT RICE VARIETIES IN THE PHILIPPINES

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There are two major regions in the country where salinity problem has been reported. One is the Bicol River Basin area in the province of Camarines Sur (37,184 ha) and the other is in the delta plains of Cagayan Valley River Basin (35,000 to

45,000 ha). These two regions and some areas found in Iloilo, Samar, Bulacan, and Pampanga cover more than 100,000 ha of salt-affected areas in the Philippines.

Rice production in the salt-affected areas ranges from 1 to 2 tons/ha only, while yields in favorable areas can reach 5 tons/ha or more. In extreme cases, a total crop failure results. Rice cultivation is one of the alternatives to utilize the idle lands affected by salinity because saline soils are hydrologically, physiologically, and climatically suited to rice.

The location-specific strategy of shuttling breeding materials to the problem areas is a fast and effective approach in identifying lines adapted to coastal areas. Through this strategy, seven promising lines adapted to specific saline areas have been identified and entered in the National Cooperative Test (NCT). One of the lines, PR25989-2-4B, can yield 3.3 tons/ha under salt stress and was recently recommended by the Rice Technical Working Group (RTWG) for pre-release. If acceptable to farmers, PR25989-2-4B will be the first PhilRice-developed line to be nominated to the NSIC as a variety for saline ecosystems.

The prospect for better productivity of salt-affected soils can be attained with the availability of rice varieties tolerant to moderate salinity. However, there is still a need to develop rice varieties that can grow in soils with an electrical conductivity (EC) of more than 6.0 dSm^{-1} during the seedling stage. Apparently, advances in biotechnology could hasten breeding for salt-tolerant varieties

Keywords: breeding, rice, salt tolerant, salinity

SCREENHOUSE EVALUATION OF TRANSGENIC IR72 CONTAINING XA21 GENE FOR BACTERIAL BLIGHT RESISTANCE

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T4 generation of transgenic IR72 lines containing Xa21 genes for bacterial blight resistance were evaluated in the screenhouse for their response to nine races of *Xanthomonas oryzae* and one local Maligaya isolate as compared to untransformed IR72; IRBB21, a conventionally-bred line with *Xa*21 gene; and IR24, a susceptible control in dry and wet season evaluations. Inoculation was done at maximum tillering stage following the clipping method and the % diseased leaf area (% DLA) was measured 14 and 21 days after inoculation. Experiments during the dry and wet season trials revealed that IR24, obtained the highest mean %DLA of 64.50%. The untransformed IR72, which contained some genes for resistance to Xoo showed an intermediate response with an average %DLA of 39.72%. On the other hand, IRBB21,

showed a moderately resistant response, 14.80% DLA. Most of the transgenic lines were resistant to moderately resistant, with an average ranging form 4.68 to 7.12% across the lines and 1.06 to 15.5% across races. The differences among transgenic lines, however, were not significant, which may imply that transgene integration events might have been the same. Race 6 is the most virulent with mean while the Maligaya isolate is the weakest. Molecular analysis is being conducted to determine the genetic constitution of the transgene.

Keywords: transgenic lines, *Xanthomonas oryzae,* Xa21 gene, virulence, susceptible, resistance, diseased leaf area

GENETIC ENGINEERING APPROACH TO DEVELOP PEST RESISTANCE IN RICE

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Genetic engineering is being conducted at PhilRice to improve the pest resistance of high-yielding inbreds, new plant type lines and cytoplasmic male sterile (CMS) B Lines. From collaborators outside the country, we have obtained different pest resistance genes; pZ100 (chitinase and glucanase genes for sheath blight resistance), pTW-a (*pin*II gene for insect resistance), and pB822 (Xa21 gene for resistance to *Xanthomonas oryzae);* and plasmids containing the two reporter genes – green fluorescent protein (gfp) and the β-glucuronidase genes. Initial steps in developing *Agrobacterium tumefaciens* strain EHA 105 to contain the reporter genes and some pest resistance genes have been successfully conducted using the freeze-thaw and electroporation methods. Preliminary results on the use of new strategies in *A. tumefaciens*-mediated transformation of rice cells; the co-transformation system, and the presence of two binary vectors in one strain will be presented.

Keywords: genetic engineering, *Agrobacterium tumefaciens,* transformation, rice.

MANAGEMENT OF SOIL-BORNE DISEASES IN RICE-VEGETABLE SYSTEMS

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During the four years of continuous monitoring of soil-borne pathogens infesting rice-vegetable systems in San Jose, Nueva Ecija, five were found to seriously affect rice and vegetable crops, namely, seedling damping-off of onions (*Fusarium* sp.), bulb rot of onions (*Fusarium sp.* and *Rhizoctonia solani*), pink root of onions (*Phoma terresttris*), bacterial wilt of eggplant, tomato and pepper (*Pseudomonas solanacearum*), and sheath blight of rice (*Rhizoctonia solani*). In Bongabon, Nueva Ecija soil-borne diseases affecting onions were pink root (*Phoma terrestris*) and bulb rot of onions (*Fusarium* spp. and *Rhizoctonia solani*). Twenty out of 47 sampling sites surveyed in Nueva Ecija were positive to pink root, while 4 out of 10 sites in Pangasinan and 2 out of 8 sites in Nueva Vizcaya had pink root. The incidence of bacterial wilt in San Jose City was high in eggplant-growing areas.

In the straw mulch experiment, *R. solani, Fusarium* spp. and *Trichoderma* spp. were detected to be present in the rice straw used as mulch prior to transplanting and carried over to onion. *R. solani* was no longer detected in straw mulch just before harvest.

In vitro evaluation of the five species of *Trichoderma* as potential biocontrol agents showed antagonistic effects to all of the seven soil-borne pathogens. On the potential of *Bacillus* isolates as biocon agents, *Bacillus* sp. 1 showed inhibitory effects to Fusarium 1,3, *P. terrestris* and *Sclerotium rolfsii*, while, *Bacillus sp.* 2 and *Bacillus pumilus* were both effective against *Fusarium 1,3,P.*

The experiment on rice hull burning in San Jose showed non-occurrence of soil-borne diseases in both burned and unburned plots. Moreover, there was a reduction in population of colony-forming units of soil-borne fungi in the burned plots as compared to unburned plots. Compost application did not have any significant effects on the incidence of pink root. Preliminary results in the crop rotation experiment showed that the use of pepper, peanut, mungbean, and cucumber as rotation crops reduced the incidence of pink root in onion.

Keywords: biocontrol agents, bacterial wilt, sheath blight, pink root, mulch, seedling damping off, bulb rot, rotation crops, soil-borne diseases, management.

EARTHWORM COMPLEX IN THE IFUGAO RICE TERRACES

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Over the last 10 years, the earthworm complex has threatened rice production in the Ifugao rice terraces (IRT). They are arrayed with other factors that have been contributing to the gradual disintegration of the vaunted "eighth wonder of the ancient world."

We observed that the damage is not directly on the rice plant in most cases, but more on the soil. Their intense activities in the soil, such as burrowing and making tunnels have caused water seepage and soil erosion. Severe infestation enhances weed growth and collapse of terrace walls. Intense burrowing also damages the roots of rice seedlings and such activities cover up seeds, causing abnormal growth of rice seedlings.

In collaboration with the department of Life Science, Maharishi University of Management. USA, we have discovered several new species of earthworms in the IRT. A brief description and the difficulty to identify them with all known taxonomic keys are discussed. We are currently pursuing two approaches: genetic analysis (DNA sequence), and the extensive search for sexually-reproducing populations in natural habitats, to facilitate the naming of the earthworm species.

Keywords: earthworm, rice, earthworm complex, Ifugao Rice Terraces, genetic analysis, DNA sequence

Meloidogyne graminicola: A NEMATODE PEST FROM RICE TO ONION

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Meloidogyne graminicola, a parasitic nematode of rice, was found to have attacked onions in many areas in Nueva Ecija grown after rice. This is the first report

of *M. graminicola* attacking onions. The nematode is soil-borne and resistance to the nematode has not been observed in several rice and onion cultivars, making this pest a potential threat to rice-onion production systems. If not arrested, it might affect the livelihood of many farmers in Central Luzon where 60% of the fields are planted to onions for export to Japan, Hongkong, and other countries.

Several rice and onion fields were surveyed for incidence of *M. graminicola.* Different vegetable crops were evaluated for resistance to *M. graminicola.* Some management strategies to control this pest to a tolerable level were conducted in farmer's field naturally infested by the nematode.

Mungbean, cucumber, peanut, and hot pepper are potential rotation crops after rice. Nematode population can be controlled by rice hull burning, a technology practiced by many farmers in San Jose City. Mycorrhizae can improve onion seedling height and emergence from the soil.

Keywords: Root-knot, *Meloidogyne graminicola,* onion, incidence, control

Monolepta sp. (Chrysomeliidae: Coleoptera), A NEW PEST OF CORN SEEDLINGS

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A Chrysomelid beetle, identified as *Monolepta sp.*, a new pest of corn seedlings is hereby reported for the first time in the Philippines. This pest was observed in corn experimental plots of the Plant Quarantine Support Laboratory at the Central Experimentation Station, UP Los Baños. This beetle closely resembles the morphological features of corn silk beetle, *Monolepta bifasciata* Homstedt except the black mark which is found on the elytra of the species *fibasciata.* This new pest species has an ochre-brown color. It measures 4.0-4.5 mm. The beetle mimics the damage caused by corn semi-looper. The beetle can cause seedling death with severe infestation. This new pest was also observed feeding on graminacious weeds particularly kabit-kabit (Tagalog), sabung-sabong (Ilocano), *Eleusine indica* (L) Gaerntn, and agingay (Tagalog), marapagay (Ilocano) *Rotboellia exaltata* L.f.

Keywords: Chrysomelid beetle, corn seedlings, new pest, corn, Monolepta sp.

Macrosiphum (Sitobion) miscanthi Takashi: A NEW APHID ATTACKING SUGARCANE (HOMOPTERA: APHIDIDAE)

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Of the 345 varieties of sugarcane, seven harbored the aphid, *Macrosiphum (Sitobion) miscanthi* Takahashi, namely: B50112, BM 357, CP 65357, H 60-11902, Phil 58260, Q 44 and Q 114. As a virus vector, the aphid was found to infest the sugarcane arrows only, unlike the wooly aphid, *Ceratovacuna lanigeraa,* which infested both the leaves and the stalks. The pollen from arrows was collected early in the morning by tapping the inflorescence on a funnel-like cardboard. Specimens were collected and mounted for identification. The aphid was aliencolae and completed its life cycle within the arrows. Descriptions and other ecological notes are provided.

Keywords: Aphidedae. *Macrosiphum (Sitobion) miscanthi* Takahashi, sugarcane

COMPETING ABILITY AND CONTROL OF *Echinochloa colona* (L.) LINK IN COTTON

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Echinochloa colona (L.) Link is one of the most prevalent weeds in cotton. This weed causes profound reduction in yield because of its severe infestation, rapid growth, fast and numerous tiller production, and great competitive ability. It is more competitive than *Cyperus rotundus* L. and *Trianthema portulacastrum* L. causing a reduction in seedcotton of 74%.

Information on the competing ability and growth stage of *E. colona* which is most susceptible to herbicide will aid in the determination of a precise timing of application in order to obtain maximum control of the weed. Hence, two pot experiments were conducted in Batac, Ilocos Norte to determine the competing ability of this weed in cotton supplied with varying nitrogen levels and identify the stage of growth that can be effectively controlled by fluazifo-butyl.

Increase in height, lead production, nitrogen content, and seed output of *E. colona* was observed as nitrogen level was increase from 35 to 105 kg/ha. *E. colona* plants that grew with cotton were shorter; produced shorter panicles, fewer tillers, panicles, spikes, and seeds, and exhibited earlier tillering, flowering and panicle production than in monoculture.

Height of cotton, number and weight of bolls also increased at high nitrogen, Boll production was reduced by 54.5% where *E. colona* competed with the crop for the whole season. Crop yield reduction was due to decreased nitrogen content, shorter cotton plants with fewer and smaller bolls.

Effective control of *E. colona,* plants before they completed with cotton was attained when application was done at the 4th and 8th leaf stages. As a result, taller plants, increased number and weight of bolls were obtained.

The overall implication of the study is that for maximum utilization of nitrogen fertilizer applied, weed control is a necessity.

Keywords: *Echinochloa colona* (L.) Link, fluazifop-butyl, bolls, seedcotton

Hispodonta sp. (Alticinidae: Chrysomeliidae) A NEW PEST OF BANANA

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The presence of *Hispodonto sp.* an obscure pest of banana in the Philippines, has caused alarm for the first time. The flat, ovoid larva of this beetle scarifies midrib and sterm tissues. It also feeds on unrolled leaves creating parallel perforations when opened. It is usually found in the moist portion of the bracts. The adult beetle is moderately sized with the elytra slightly broadened posteriorly. It makes a horizontal straight line feeding marks on the opened leaves. It has been observed also on unrolled central leaf. This pest is now rampant in Benguet Province and Baguio City. It has also reached the provinces of Kalinga and Apayao. The bioecology of this pest and extent of damage in the Cordillera are being studied further.

Keywords: Cordillera, Hispodonta sp., banana, Benguet, bio-ecology, new pest, Chrysomellid beetle, Hispinae, Philippines

THE ENDANGERED GIANT WILD HONEYBEES *(Apis dorsata Fab.)* HABITAT AND BEHAVIOR

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The habitat and behavior of giant wild honeybees *(Apis dorsata* Fab.) or "pukyutan" were studied in six types of ecosystems namely: dipterocarp, mangrove, mossy, pine, and agroforest in Northern Philippines from 1995 to 1998. Field observations together with wild honey harvesters were made in order to gather benchmark information needed in developing appropriate conservation strategies for this endangered species and how they can be managed to pollinate other crops.

"Pukyutan" thrives in all the three regions in Northern Philippines but prefer to build nests in the Cordillera, particularly Benguet Province, where it is cooler and with distinct wet and dry seasons. The order or preference for building nests is dipterocarp forest followed by dipterocarp-pine forest, agroforest or fruit trees nearby houses, and mangroves, where there are food sources and suitable nests sites. They do not build nests in pine, mossy and molave forests, and on open agricultural areas, ranches or grasslands but may forage in these areas when there are flowers in bloom.

"Pukyutan" builds one nest with one comb on partially shaded and either alive or dead trees. They prefer tree trunks with smooth, fine-textured and clean barks; 15 to 30 cm in diameter and inclined between 10 to 50°; at least 2 m long; and 1 to 12 m high above the ground surface.

The mature adult bees transfer to other places when environmental conditions become unfavorable and when food is scarce. They are less gentle but they sting people only when they are disturbed. A colony consists of thousands of bees (eggs to adult stages) and all of them are killed during honey harvest due to improper harvesting technique, forest fires, and environmental pollution.

Keywords: giant wild honeybee, *Apis dorsata*, "pukyutan", honey, honeybees

PHILIPPINE SPECIES OF *Illeis* Mulsant (COLEOPTERA: COCCCINELLIDAE: COCCINELLINAE: PSYLLOBORINI)

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The Psylloborini group plays an importance role as a biological control agent feeding on aphids, white flies, mites, and fungi. Among the ladybird beetles, this group has been considered mycetophagous. There are about two genera, namely: *Psyllobora* Timberlake and *Illeis*. Timberlake existing in the Philippines. Fortunately, the genus Illeis is presented locally by two species. This includes the endemic *I. luzonica* Timberlake and the introduced *I. koebelei* Timberlake. On the other hand, *I. koebelei* is represented by two subspecies, namely, *I. k. koebelei* Timberlake and *I. k. amamiana Miyatake*. Descriptions and key to the species and subspecies are provided.

Keywords: coccinellidaee, Psylloborini, Illeis spp., I. luzonica timberlake, I. koebelei koebelei timberlake, I. koebelei amamiana Miyatake, mycetophagous

EL NIÑO AND ITS EFFECT ON FIELD POPULATION INCREASE OF MIGRATORY LOCUST

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Noticeable increases in the field population of migratory locust, *Locusta migratoria manilensis* Meyen were observed during the El Niño in 1998 in the Visayas, Mindanao, Luzon, and Palawan. there was also parallel population biodiversity build-up on other species of grasshoppers such as *Valanga nigricornis* and *Gastrimargus marmoratus*.

The drying up of surroundings during El Niño caused the congregation of migratory locusts in remaining green patches. Subsequent population build-up followed. This phenomenon of migratory locust population build-up was observed in Bulacan, Tarlac, Pampanga, Nueva Ecija, Zambales and Pangasinan in Luzon. Aggregation of migratory locust in the Visayas, particularly Negros Oriental and Occidental, was observed to have originated in sugar cane fields adjacent to creeks or river tributaries where green grasses abound. In Mindanao, population groupings were observed in green patches just after corn harvest at General Santos City. Population increases in Narra, Palawan was also observed in remaining green covers and migratory forms attacked corn and rice.

Population build-up in Luzon was not successful due to continuous rain. Thus, mating, feeding and related activities were interrupted by strong rains. Population build-up in Mindanao and Visayas were successful due to short duration rains from May onwards. These rains favored the growth and reproduction of migratory locust in the green grasses in the case of Mindanao and the sugar cane fields in the Visayas. Hence, the migratory locust population reached migratory forms which are still attacking crops in Negros Oriental in the Visayas and in General Santos City in Mindanao.

Other grasshopper species also showed elevated population level but not as high as those of the Locust species.

Keywords: migratory locust, Visayas, Mindanao, Luzon, Palawan, bio-physical, El Niño, population, *Locusta migratoria manilensis*

INSECTICIDAL PROPERTIES OF SEVEN INDIGENOUS PLANTS AGAINST THE ORIENTAL MIGRATORY LOCUST ON SUGARCANE

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The oriental migratory locust, *Locusta migratoria* manilensis Meyen, poses a threat to the sugar industry with the recent severe infestation of vast areas of sugarcane in the country. It defoliates sugarcane completely, leaving it with only the midribs. To suppress locust population, the use of chemicals is still recommended. Recent findings, however, report the potential of insecticidal compounds occurring naturally in plants and their great promise as alternative to synthetic chemicals. Hence, crude extracts from leaves of seven indigenous plants were tested on the locust.

At 10% concentration, neem (*Azadirachta indica* A. Juss.), kakawate (*Gliricidia sepium* Jacq.), oregano (*Coleus amboinicus* Lour.), and serpentina (*Andrographis*

paniculata (Burm. F.) Rees) extracts sprayed on sugarcane showed growth inhibitory, repellent, antifeedant, eradicative, and protective properties against the locust. None of the hoppers on *A. indica* developed into adults and had 100% mortality seven days after treatment. Locusts on *A. paniculata, C. amboinicus,* and *G. sepium* treatment were shorter and lighter with prolonged nymphal development and has lower growth index than those on marigold *(Tagetes erecta),* sambong *(Blumea balsamifera* (L.) D.C. Prodr.), and chichirica *(Cantharanthus roseus* (L.) G. Don extracts. In free and no choice tests, these four plants had repellent and antifeedant actions on the hoppers and flyers. *A. indica* consistently protected sugarcane from the locust, but the efficacy of the other plants decreased with the length of time. The insecticidal properties of these indigenous plants can be considered in the formulation and implementation of integrated locust management strategies in future infestation.

Keywords: locust, *Locusta migratoria* manilensis, sugarcane, *Azadirachta indica, Gliricidia sepium, Coleus amboinicus, Andrographis paniculata,* growth, inhibitory, repellent, antifeedant

DIVERSITY AND FORAGING BEHAVIOR OF INSECT POLLINATORS OF COMMON FRUIT TREES IN CENTRAL LUZON STATE UNIVERSITY

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Assessment of the diversity of insect pollinators of common fruit trees in Central Luzon State University was conducted to identify the pollinators of the common fruit trees and to observe the foraging behaviors of these pollinators.

Results show that there were 16 insect pollinators identified and observed visiting the flowers of the common fruit trees in CLSU. They were classified under 3 orders, 13 families, and 16 genera.

Among these pollinators *Phormia regina* (blow fly) got the highest value in density, dominance, frequency, and importance value followed by *Eristalis sp.* (syrphid fly).

The foraging activities in the insect pollinators on the flowers of common fruit trees were also studied. Results revealed that mostly pollinators randomly visited the flowers and some stayed on the flower for a few seconds while others stayed for only a few minutes. Some visited and stayed for a long time on flowers which were not yet pollinated or contained rewards such as nectar and pollen which are sources of food for pollinators.

Over all, the species diversity value of these pollinators was 78, which indicates that they are diverse due to the multiple number of flowers of fruit trees which they can pollinate and secure as their food.

Keywords: diversity, foraging, behavior, insect, pollinator, reward, nectar, pollen, density, dominance, frequency

DEVELOPMENT OF SILKWORM, F1 HYBRIDS FOR SEMI-ARID CONDITION

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This research aimed to develop silkworm F_1 hybrids that could be used for year-round cocoon production and perform better than locally-available varieties in terms of coccon yield and quality. Six bivoltime and three multivoltine purelines were developed and evaluated for their combining ability using Dialle! Analysis of Griffing's Method 1 (Parents, F_1s, and Reciprocals) at the Sericulture Research and Development Institute, Bacnotan, La Union from 1990-1997. The performance of the promising silkworm hybrids were also evaluated in farmer's fields.

The results of the combining ability tests revealed that the promising hybrids are: for single cocoon weight, DMSU 101 X DMSU 115, DMSU 100 X DMSU 103, and DMSU 102 x DMSU 103, for cocoon shell percentage, DMSU 100 x DMSU 101 and DMSU 103 x DMSU 115, for cocoon yield per box, DMSU 102 x DMSU 103, DMSU 100 x DMSU 107, DMSU 101 x DMSU 103, DMSU 101 x DMSU 107, and DMSU 101 x DMSU 115, for cocoon filament length, DMSU 101 x DMSU 102, DMSU 100 x DMSU 115, and DMSU 103 x DMSU 107.

The cocoon yield performance of the developed F_1 hybrid DMSU 101 x DMSU 115 and its reciprocal was better than the highland silkworm hybrid when reared at the Sericulture Extension Site in Sta. Maria, Ilocos Sur. The same hybrid combination and its reciprocal, as well as the F_1 hybrid of DMSU 115 and DMSU 103, proved promising when reared in the other extension site in Ilocos Norte.

Keywords: Silkworm F_1, hybrids, Grifting's Diallel Analysis, promising hybrids; single cocoon weight; cocoon shell percentage; cocoon yield box

EXTRACTION AND CHARACTERIZATION OF TOBACCO SEED OIL

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Oil from seeds of three tobacco types (Flue-cured: reams 266, Burley: 21 and Native: Sammaha) were extracted and analyzed for physical and chemical properties. Oil content yield by solvent extraction method using petroleum ether and hexane as solvents ranged from 29 to 44%. Extraction using haxane yielded more oil than when petroleum was used as solvent for all samples.

Physical and chemical characteristics namely: refractive index, color, specific gravity, saponification value, unsaponifiable matter, iodine value, peroxide value, lenoleic acid, calorific value, and hydroxyl value were determined.

Fatty acid analysis and acid value were likewise determined.

Keywords: Tobacco seed oil, physical characteristics, chemical characteristics, solvent extraction, calorific value

USE OF ORGANIC SUBSTANCES TO PROMOTE ANTHER CULTURE RESPONSE IN RICE

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Coconut water, cocogro (coconut water growth hormone extract, BIOTECH, UPLB) and banana powder (Sigma Chemical Company, St. Louis, MO, USA) are some organic substances that can be utilized to promote anther culture response in rice. In this study, we evaluated the effect of coconut water (150 mL/L) and varying levels of cocogro (5, 10 20 mL/L) and banana powder (1, 5 10 g/L) on the anther culture response on rice. Desiccated and undesiccated anther culture-derived calli were used as experimental materials.

Incorporation of coconut water as an additional source of plant growth hormone in regeneration medium, enhanced green plant regeneration in responsive japonica rice variety, Taipei 309, especially when coupled with tissue desiccation. Similarly, enhanced green plant regeneration was obtained from 3 of the 5 F_1 crosses

evaluated in the medium supplemented with cocogro as sole source of plant growth hormones, replacing NAA and kinetin. Across genotype, cocogro, at 5 mL/L level, yielded the most number of calli which regenerated green plants. Reduced number of albino plants were obtained from desiccated calli cultured in media with 5 and 20 mL/L cocogro. Moreover, combining cocogro with tissue desiccation reduced the incidence of tissue browning (necrosis). Banana powder treatment did not enhance greenplant regeneration for the two F_1 crosses evaluated. However, callus necrosis was markedly reduced (47-100%) with increasing level of banana powder in the medium.

Keywords: anther culture, rice, coconut water, cocogro, banana powder, tissue desiccation, callus, green plant regeneration, albino plants necrosis

THE ACCEPTABILITY OF TILAPIA *Oreochromis mossambicus* SPREAD

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In the present situation where the catch is nearing the maximum sustainable yield and aquaculture is constrained both in space and environmental concerns, the most direct and immediate contribution to increase food supplies is by reducing post-harvest losses (Santos, 1995). Tilapia *Oreochromis mossambicus*, being prolific, thus rampant in every region is considered unutilized due to its off flavor taste. This study sought to formulate tilapia spread with different flavors, e.g. lemon, coconut wine (tuba), and ethanol.

Tilapia *Oreochromis mossambicus* were purchased fresh from the CFT fishpond and transported to the research laboratory. They were washed with potable water, dressed and precooked at 95°C for 30 minutes. It was cooled, flaked, and treated with different flavors, e.g. lemon, coconut wine (tuba) and ethanol. They, including the control sample, were then individually heated for one hour until dry. The flavored samples were mixed with mayonnaise, pickle relish, pimiento, sugar, and salt. The mixtures were packed and processed for 45 minutes at 10 lbs pressure. The finished products were subjected to descriptive and consumer testing and analyzed using ANOVA at %% level of significance, proximate composition, and cost analyses. About 50 consumers and 10 trained people compressed the test panel.

Results of the preference test showed no significant differences between the newly processed tilapia spread with different flavors and the control sample. After three months of storage, tilapia spread treated with coconut wine (tuba), lemon and

the control sample were not significantly different from one other but significantly different from samples treated with ethanol, that ranked last based on its mean. After 10 months of storage, tilapia spread enriched with lemon ranked first based on its mean but was significantly different from the other samples due to its rancid flavor. Thus, the accepted product was tilapia spread with lemon flavor, which contained 10.44% protein, 20.20% moisture, 27.80% fat, 1.62% ash and 39.95% carbohydrates. The production cost per bottle with a net weight of 225 grams was only P16.45, whereas samples treated with coconut wine (tuba), ethanol, and the control cost P16.35, P16.90, and P16.30, respectively.

Keywords: tilapia, *Oreochromis mossambicus*, processing

Bacillus cereus var. IMPROVED SENSORY AND PROTEIN QUALITIES OF FERMENTED "TINABAL MOLMO *"(Scarus spp.)"*

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Bacterial starter culture has been added in some fermented products to hasten fermentation. *Bacillus cereus var.* and *Pediococcus pentosaceus* isolated from "tinabal molmol" were used in the fermentation of this product. The fish samples, parrot fish or locally called fish were inoculated with the young culture of *B. cereus* and *P. pentosaceus* after 24 hours of salting. The inoculum rate was about 10% by volume of the starter culture based on the weight of the fish. The inoculated slated fish were allowed to ferment for 15 days at room temperature (28 $\pm$ 2°C). The fermented fish were subjected to sensory evaluation and amino acid analyses through High Pressure Liquid Chromatography. Inoculation of pure culture of *Bacillus cereus var.* improved the flavor and essential amino acid content of the fermented fish.

Keywords: tinabal molmol, starter culture, inoculum, fermentation, sensory evaluation, laboratory panelist, Bacillus cereus var., Pediococcus pentosaceus

LEVELS AND SOURCES OF SIGNIFICANT WASTEWATER PARAMETERS IN SELECTED SUGAR MILLS IN THE PHILIPPINES

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Wastewater samples in two sugar mills were analyzed for physico-chemical analysis in 1996 to February 1998. The significant wastewater parameters (BOD, COD, pH, TSS, oil, and grease) were analyzed using standard and alternative analytical procedures.

The study focuses on the levels and sources of significant wastewater parameters for possible baseline information on the physico-chemical characteristics for sugar mill waste. Correlation study between BODs and COD was also conducted and statistical results revealed that there is no direct relationship between the two parameters established using sugarcane wastewater.

The examination of trends in these parameters, major sources as well as their point of entry into, and possible pathways through, the waste treatment plant and hydrological cycle is discussed. It also reports the first attempt to determine the efficiency of the individual wastewater treatments plants, (WTP) of selected sugar mills visited, processes involved, and some management practices in mitigating the impacts of water pollution.

Keywords: BOD, COD, sugarcane wastewater, WTP, pH, TSS, baseline information

CUMULATIVE EFFECTS OF THE EXISTING LAND USES ON THE WATER RESOURCE OF THE SAND DUNES OF ILOCOS NORTE

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Cumulative effects of the existing land uses (LUs) on the quantity and quality of the water resources in the different portions of the sand dunes in Ilocos Norte was assessed from December 1997 to Febuary 1998. The LUs that depend on groundwater resources are residential, tourism-based, and agricultural.

The static water table observed in the study area was confined to shallow well areas (SWA). Estimated water supply based on pumping test and estimated renewable safe groundwater yield based on recharge rate, were comparably substantial. Current LUs used only 4% of estimated supply of 67.15 million liters per day (M lpd) or estimated renewable safe yield of 74.80 m lpd (based on recharge rate). Future expansions of different LUs based on different scenarios indicate a big increase in water demand. However, estimated safe groundwater yield far exceeds this demand. In fact, a full-range development of the sand dunes (based on current uses) shows a water demand of 50.93 M lpd, which is 68% of the available safe yield.

Analysis of the sand dunes' current groundwater also showed a level of quality demanding slight restrictions for domestic use. Nitrate concentration, for instance, exceeded the permissible level in most parts of the residential area. Evidence of contamination with coliform *(E. coli)* was also found in most of the areas but still passed the permissible limits for most uses.

The study predicts that the continuous expansion of various uses in the area will affect the available supply not only due to massive extraction but also due to contamination. This dilemma should serve as a challenge for the sand dune's users to manage every activity in a manner that would not adversely affect the water supply and quality, so that the full range of benefits that this resource can offer is maintained and sustained.

GROWTH, FEED CONVERSION RATIO, AND SURVIVAL OF THE PHILIPPINE ABALONE *Haliotis asinina* CULTURED IN NET CAGES AT DIFFERENT STOCKING DENSITIES

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The effects of different stocking densities on the growth, feed conversion ration, and survival of two size goups of the Philippine abalone *Haliotis asinina* were determined. Three culture trials were conducted in net cages installed in a sheltered cove in Guimaras Province. Trials 1 and 2 were conducted using 15-20 mm abalone juveniles for 150 days, whereas trial 3 was conducted using 35-50 mm abalone for 180 days. The animals were fed sufficient amounts of the red alga, *Gracilariopsis bailinae* (=*G. heterochada*) throughout the experiment.

The results showed an inverse relationship between growth (length and weight) and stocking density. At high densities, stacking restricted movement and feeding of animals. Hence, food limitation was one of the factors that affected growth of abalone at high densities. Another factor that contributed to slower growth of aba-

lone at high densities was rate of water flow. Water movement stimulates feeding and, therefore, growth of abalone. Feed conversion ratio was not influenced by density but was observed to be higher for larger animals. Survival was not significantly affected by density.

Net cages are appropriate for culture of *H. asinina*. This study showed *H. asinina* can reach commercial size of about 60 mm in one yar. The results also showed that growth of *H. asinina* can be sustained using a single-species diet as food source. An economic analysis is important in choosing the best stocking density for commercial production.

Keywords: Philippine abalone, *Haliotis asinina;* stocking density, feed conversion ratio; survival; cage culture

CULTURE OF "LATO" *Caulerpa lentillifera* IN PONDS USING AN ARTIFICIAL SUBSTRATE

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Caulerpa lentillifera, locally known as "lato" is one of the few seaweed species of high demand in local and foreign markets. In recent years, the demand for fresh and salted Caulerpa and other seaweeds has increased considerably. In some areas of the country, the supply of Caulerpa is harvested from the wild in the coastal or marine waters. Extensive cultivation of Caulerpa in enclosed ponds has already been carried out commercially in Cebu, particularly in Kalawisan, Mactan Island and a few other places in the country. However, the development and or improvement of culture techniques to further increase Caulerpa is needed as the prospects of mass production of this seaweed is promising. The study aims to culture Caulerpa in ponds using an artificial substrate, and to determine the efficiency of the artificial substrate.

The study was conducted at the CSCST College of Fisheries Technology fishpond project in Carmen, Cebu. Knotless nylon nettings or V-net (0.5 x 20 m) was used as artificial substance. Ten (10) strips were prepared and installed in rows about 1 m perpendicular to the pond bottom. Caulerpa seedldings were planted by sticking 500 grams each in between the substrate into the mud at about 50 cm intervals. Water parameters such as salinity, temperature, depth, and pH of the water was monitored every week. After 62 days, the length of shoots was measured, weighed, and analyzed using T-test at 0.5 levels of significance.

After 62 days of culture, the mean measurement of shoots using substrate was significantly different from the control. However, the net weight production was not

significantly different from each other at 0.05 level of significance. The results revealed that an artificial subtrate improved the quality of the Caulerpa in terms of the physical appearance and the number of shoots developed at the stem of the plant. The shoots developed were dark green in color and were longer compared the control.

Keywords: *Caulerpa lentillifera*, lato, seaweeds, fishpond, substrate