

AGRICULTURAL SCIENCES

CHEMICAL COMPOSITION AND FEEDING VALUE OF HEDGE LUCERNE [*DESMANTHUS VIRGATUS* (L) WILL.] IN FORMULATED BROILER RATION

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This study was conducted to: 1) evaluate the chemical composition of *Desmanthus* leaf meal (DLM); 2) determine the effects of varying levels of DLM in formulated ration (FR) on the feed consumption, feed efficiency, gain in weight, dressing percentage and carcass yield of birds; and 3) determine the cost of production, net income and return on investment of broiler production. Using a randomized complete block design with 3 replications (10 birds/replicate), 150 straight-run day-old Hubbard broiler chicks were given the following dietary treatments: 100% commercial mash-CM, 100% formulated ration-FR, 97% FR with 3% DLM, 94% FR with 6% DLM and 91% FR with 9% DLM.

While the treatment diets significantly affected feed efficiency, final weight, daily gain in weight and total gain weight of birds, these did not influence the eviscerated carcass yield with or without giblets (dressing percentage) and the percent breast, thighs, drumsticks, wings and backs of slaughtered birds. Increasing levels of DLM in FR correspondingly increased the fiber contents of the diets. Feeding commercial mash entailed the highest expense among the diets while the addition of 6% DLM in FR realized the highest net income per bird. *Desmanthus* leaf meal inclusion in FR was found to be best at 6% level although the growth rate was comparable with DLM inclusion at 3% and 9% levels. The addition of 6% DLM to formulated broiler ration is recommended because it elicited better performance in birds while obtaining the highest profit.

IMPORTANT INSECT PESTS OF MANGIUM (*ACACIA MANGIUM* WILLD.)

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This paper presents the first comprehensive account about the important insect pests, i.e., insects causing serious damage such as mortality, stunted growth and severe defoliation of mangium, *Acacia mangium* Willd., in the Philippines. The results of a series of monthly surveys conducted from 1990 to 1992 at the forest nursery and plantations of the Paper Industries Corporation of the Philippines (PICOP) in Surigao del Sur provide first-hand information on the identification, morphological features and nature of damage caused by the seven important insect

pests – four defoliators, two stemborers and a root feeder – to trees and seedlings of mangium, Mangium is one of the exotic tree species in the government's National Forestation Program (NFP). This information will guide NFP workers involved in the development of mangium plantations in the country in the prompt detection and correct identification of the insects – the key to effective management of the pests.

INTEGRATED PEST MANAGEMENT OF ASIAN CORN BORER [*OSTRINIA FURNACALIS* (GUENEE)] ON CORN, (*ZEA MAYS* LINN.) INCLUDING THE USE OF MONITORING AND FORECASTING MODEL IN THREE COMPREHENSIVE AGRARIAN REFORM PROGRAM (CARP) AREAS

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Three Integrated Pest Management (IPM) techniques, farmers' practice and control on the Asian corn borer, *Ostrinia furnacalis* (Guenee), were studied in three Comprehensive Agrarian Reform Program (CARP) areas in the country from Oct. 15, 1991 to March 4, 1992.

The study aimed to verify the National Crop Protection Center's developed technologies, together with the government's recommended Maisagana corn borer control, and compare these with the farmers' practice and control.

A randomized complete block design (RCBD) using 375-sq. m. per plot replicated four times for each treatment was done.

The results revealed that in terms of yield, the National Crop Protection Center's (NCPC) Technology #1. Spot treatment + detasselling and NCPC Technology #2. Monitoring and simulation + release of *Trichogramma* were statistically comparable with the government's Maisagana program and better than the farmers' practice and control in reducing the Asian corn borer field population and subsequent damages.

Population and damage data showed that the densities of the Asian corn borer were generally low and damages were below the economic threshold in all the three areas.

DEVELOPMENT OF NATURAL PART SKIM MOZZARELLA-TYPE CHEESE FOR THE PIZZA INDUSTRY

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A natural Mozzarella-type (MZA) cheese was developed from different blends of reconstituted skim milk and fresh whole cow's milk (RSM/WCM) and ana-

lyzed for gross composition, meltability and stretchability in comparison with that simultaneously made from fresh whole cow's milk (WCM). This move was inspired by the ready market for Mozzarella cheese in the expanding local pizza industry.

Physico-chemical analysis showed that the replacement of part of the WCM with 10% reconstituted skim milk (RSM) had a highly significant effect on total solids, fat and specific gravity of the cheesemilk, with the higher substitution giving lower total solids and fat but higher specific gravity. Fat content of blends varied from 2.30% to 1.27%. The blend had no significant effect on pH and total protein. However, the substitution tended to increase the titratable acidity.

Cheese analysis revealed that all blends had no significant effect on cheese pH and salt and for moisture at the lower substitution. Higher substitution levels gave a significantly higher moisture but more rigid curd. The blend, however, had a highly significant effect on fat and fat-in-dry-matter (FDM) content of cheese which decreased with increasing levels of RSM. Fat-in-dry-matter varied from 39.28% to 24.81% compared to 52.82-58.41% of the control cheese.

All the blended (RSM/WCM) part skim MZA cheeses exhibited no oiling off and gave lower meltability but better shreds and stretchability with longer strings than the full-fat WCM cheese when baked. Part-skim cheeses of specific blends that had the best shredding, melting and stretching characteristics without oiling off were identified and therefore would be highly acceptable for a pizza topping required by the local pizza industry.

SENSITIVITY OF *COTESIA PLUTELLAE* AND *DIADEGMA SEMICLAUSUM* PARASITOIDS OF DIAMONDBACK MOTH (*PLUTELLA XYLOSTELLA* L.) TO SEVERAL INSECTICIDES

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The toxicity of several insecticides (deltamethrin, fenvalerate, teflubenzuron, malathion, methamidophos, carbaryl, cartap and *Bacillus thuringiensis* var *kurstaki*) to adult *Cotesia plutellae* and *Diadegma semiclausum* was determined by residual film method. Based on LC₅₀ and LC₉₅, methamidophos, malathion, cartap and deltamethrin were toxic to *Cotesia* while fenvalerate, carbaryl, teflubenzuron and *B. t. kurstaki* were relatively non-toxic to the parasitoid. *Diadegma* was most susceptible to methamidophos, cartap, fenvalerate and deltamethrin. In contrast carbaryl was non-toxic to this parasitoid.

The effect of teflubenzuron, *B. t. kurstaki* and cartap on the parasitization and development of *Cotesia* and *Diadegma* was determined by spraying the cabbage plant using the LC₅₀ of DBM to the insecticides with two methods of exposure: 1) one-day-old parasitized second instar larvae of DBM were sprayed with insecticide; and (2) the larvae were sprayed first before they were exposed for

parasitization. The first method showed that cartap has the least effect with 67.7% parasitism compared to 75% in the control while teflubenzuron and *B.t. kurstaki* reduced survival to 49 and 45.6%, respectively. The second method showed a reduction in parasitization ranging from 59 to 88% especially with *B.t.* and cartap.

PREPARATION AND EVALUATION OF CONTROLLED RELEASE FORMULATIONS OF HERBICIDES USING RADIOCHEMICAL TECHNIQUES

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Two alginate- and two corn-cob-based controlled release formulations of thiobencarb were studied for the release rates of the active ingredient in distilled and paddy water. The release of the active ingredient from the corn cob formulation coincided with the critical period for weed competition.

Likewise, three alginate formulations of thiobencarb and one of propanil were prepared in the laboratory with varying kaolin content. Four alginate-based formulations of butachlor were likewise prepared with the incorporation of rice straw as a substitute carrier. The release rates of the active ingredients of these formulations in water were studied with the use of radiotracer techniques and analysis by gas chromatography.

CYTOLOGY, MORPHOLOGY AND POLLEN FERTILITY OF INTERSPECIFIC HYBRIDS BETWEEN *ORYZA SATIVA* and *O. OFFICINALIS*

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UPL Ri₃ was crossed with *Oryza officinalis*, a source of resistance against BPH, CLH and WBPH. Embryos were cultured *in vitro* resulting in several identical hybrid plants. F₂ seeds were obtained from natural seed setting in F₁ plants. These were germinated *in vitro* and grown in the greenhouse for evaluation. The present study aims to analyze the morphology, pollen fertility and cytology of the F₁ and F₂ plants.

The F₁ hybrids had semi-erect, grassy and vigorous growth. Like the wild parent, they had perennial life cycle, rigid awns, well exerted panicles and purple stigma, auricles and basal leaf sheath. F₂ plants resembled the F₁s but these had soft-textured awns, moderately well-exerted panicles and longer anther, flagleaf, panicles, grain and culm. Variation in tillering ability, panicle type, grain size and color of the leaves, basal leaf sheath, awn, apiculus and internode were noted among the F₂ plants.

Pollen fertility obtained from the F_2 s ranged from 0 to 0.45%, similar to 0.49% pollen fertility obtained from the F_1 s. A wide array of chromosomal aberrations were noted in the F_1 s and F_2 s. Among these are the occurrence of univalents, trivalents, laggards, bridges, early disjunction, non-congression, chromosome elimination and extra chromosomes.

POLLINATION STUDIES IN PASSION FRUIT

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Pollination studies were conducted on *Passiflora edulis* var. *flavicarpa* (yellow variety) to determine the extent of self-incompatibility in a selected line. Self incompatibility was assessed by selfing and outcrossing the selected line and determining the percentage of fruit set 7-10 days after pollination. Stigmatic receptivity and pollen fertility were also evaluated.

MOLECULAR TAGGING OF THE GENE FOR BROWN PLATHOPPER RESISTANCE TRANSFERRED FROM WILD SPECIES *ORYZA AUSTRALIENSIS* INTO RICE *O. SATIVA*

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Brown planthopper (BPH) is the major insect pest of rice. Incorporation of genes from diverse sources for pest resistance is an important strategy to develop varieties with durable resistance. Following embryo rescue, hybrid and backcross progenies were produced from the cross of cultivated rice (*O. sativa* $2n = 24$ AA) and *O. australiensis* ($2n = 24$ EE). Of the 600 BC2F4 progenies derived, 4 were resistant to BPH. One of the introgression lines (IR65482-4-136-2-2) resistant to biotype 1, 2, 3 of BPH was used for RFLP analysis. Monosomic alien addition line analysis showed that the gene for BPH resistance is located on chromosome 12 and is monogenically inherited. Of the 14 probes mapped to chromosome 12, only one marker (RG457) detected introgression. Cosegregation between RG457 and BPH resistance was studied in F2 derived from the cross of introgression line and the susceptible recurrent parent. Molecular analysis showed that the gene for BPH resistance is linked with RG457 at a distance of 3.68 ± 1.29 cm. Such close linkage will be useful in marker-based selection while transferring BPH resistance from introgression line into other elite breeding lines. Introgression at molecular level indicates that the mechanism of alien gene transfer is probably genetic recombination through crossing over rather than substitution of whole or large segment of chromosome of wild species.

ESTABLISHING A COUNTRY CORE COLLECTION IN MUNGBEAN

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The Asian Vegetable Research and Development Center is responsible for the global base collection of mungbean. The total number of accessions registered in its collection is 5511. A core collection or a condensed yet representative assembly of accessions from this germplasm collection is being developed.

The objective is to establish groups of relatively homogenous accessions, based on morpho-agronomic descriptions, upon which nomination for inclusion in the core collection could be based. The strategy used is to form country core collections from which a global core could be established.

SOMATIC KARYOTYPE OF SEVEN SPECIES OF *CAPSICUM*

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Capsicum annuum, *C. frutescens*, *C. baccatum*, *C. chinensis*, *C. eximium*, *C. pubescens* and *C. chacoense* had distinct karyotypes based on chromosome arm ratios and length. *C. baccatum* and *C. eximium* had very similar karyotype. A secondary constriction producing a satellite was observed in a metacentric chromosome of *C. annuum* and *C. chinense*. This was observed in two metacentric chromosomes of *C. pubescens* and *C. chacoense*. *C. frutescens*, *C. baccatum* and *C. eximium* did not show any satellite. *C. frutescens* has a very similar karyotype to *C. annuum* except for presence of a SAT-chromosome in the latter.

The banding pattern due to cold treatment was found useful in chromosome identification in pepper. The metacentric chromosomes in all species showed centromeric and telomeric bands except in *C. pubescens* and *C. chacoense* which in addition showed intercalary bands. Some chromosomes of *C. baccatum* showed darkly stained whole arms. This distinguishes it from *C. eximium* with which it has a very similar karyotype in terms of length and arm ratios. Bands were useful in distinguishing pairs of homologous chromosomes which were difficult to identify based on length and arm ratios alone.

Based on the karyotype analysis, *C. baccatum* is closely related to *C. eximium*. They were the only two species that had very similar karyotype. Even so, banding pattern in the two differed. Variation in the karyotype of the different species suggests structural differences in their chromosomes. The nucleolus organizing region is involved in some cases as shown by differences in the number of SAT-chromosomes.

IMPROVING YIELD POTENTIAL OF WET-SEASON RICE CROP: THE IMPORTANCE OF PANICLE SIZE

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In the wet season, the contribution of panicle number to rice (*Oryza sativa* L.) grain yield is limited by solar radiation. Therefore, panicle size may play an important role in improving yield potential. A study was conducted in 1992 wet season to determine the importance of panicle size on grain yield. Comparison was made between IR72 and IR60819-34-2-1 under four fertilizer regimes and several split applications. Maximum yield was 5.94 t/ha for IR72 and 6.5 t/ha for IR60819-34-2-1. IR60819-34-2-1 outyielded IR72 across N treatments. Twenty-eight percent more spikelet per panicle for IR60819-34-2-1 than IR72 resulted in 15% difference in spikelets/m² between the two cultivars. No significant differences were observed in panicles/m², filled spikelet percentage and 1000-grain weight between the two cultivars. Although yield of the two cultivars differed significantly, their total biomass was similar so that IR60819-34-2-1 had higher harvest index than IR72. To achieve high yield in the wet season, emphasis should be given to panicle size rather than panicle number.

LATE SEASON N APPLICATION TO IMPROVE HEAD RICE YIELD AND GRAIN QUALITY

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In high-yield irrigated rice (*Oryza sativa* L.) environments, fertilizer recommendations involved split application of N basally and 5-7 days before panicle initiation (PI) which leaves the crop solely dependent on soil N from flowering to maturity. This research was conducted to test whether or not an additional N application at flowering would improve yield and grain quality. Two field experiments were conducted at IRRI during 1992 dry season (DS) using varying rates and timing of N application on three rice cultivars. In one experiment, a new hybrid line (IR64616H) responded to an additional 45 kg ha⁻¹ applied at flowering with a yield increase of nearly 1 t ha⁻¹, while the yield increase for IR72 and IR58109-113-3-3-2 was only 0.3 t ha⁻¹. For all cultivars, however, N applied at flowering resulted in 33% increase in the head rice yield, 27% for milled rice protein and 15% for translucency. In a second experiment, N application at flowering did not increase grain yield but resulted in significant increase in head rice yield (+14%), milled rice protein (+16%) and translucency (+13%). Application of 40 kg N ha⁻¹ at flowering had a greater effect on grain quality than a comparable increase in the basal of PI N rate. These results emphasize the importance of late season N supply for improving the nutritional status of rice grain and the head rice yield.

INDUCTION AND LONG-TERM MAINTENANCE OF CALLUS FROM ENDOSPERM TISSUE OF CALAMANSI (*X CITRO FORTUNELLA MITIS*) **J. Ingram and H. Moore)**

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Endosperm tissues were successfully excised from 60-64 day old seeds of calamansi. Primary calli were preferentially induced (33-35%) from the mid portion of the endosperm tissue using Murashige and Tucker (MT) medium (1966) supplemented with 1.0 mg/L 2,4-dichlorophenoxyacetic acid (2, 4-D) and 0.1 mg/L 6-benzylaminopurine (BAP).

The primary calli proliferated when subcultured onto MT medium with 2.0 mg/L 2,4-D, 5.0 mg/L BAP and 5% sucrose. Callus growth was better under diffused light (75%) than in complete darkness (0) or under lighted condition (25%). Subsequent monthly subcultures of calli led to the establishment of long-term callus cultures which to this time are one year and seven months old. These long-term callus cultures proliferated and formed green compact meristemoids when subcultured onto Murashige and Skoog (MS) medium with 0.5 mg/L BAP and 11% galactose. The aged calli [(a condition required for shoot regeneration in the case of calamansi (Avenida, et al, 1991)] are currently subjected to conditions for plantlet regeneration with the ultimate aim of producing plants with seedless fruits.

EMBRYOGENIC AND ORGANOGENIC CALLUS INDUCTION, MAINTENANCE AND PLANTLET REGENERATION IN MAIZE (*ZEA MAYS* L.) CV IPB VAR 4 AND INBRED LINE P123

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Media additives, asparagine, L-proline and casein hydrolysate (CH) were tested for embryogenic (E) and organogenic callus induction and maintenance in maize (*Zea mays* L.) using immature embryos of cultivar IPB var 4 and inbred line Pi23. Best results on callus induction were observed on cultures grown on MN_6 medium which consisted of N_6 salts and supplemented with 0.5 mg/L 2,4-dichlorophenoxyacetic acid (2, 4-D), 2.25 mg/L glycine, 1.5 mg/L thiamine HCl, 9.2 mg/L nicotinic acid, 1.5 mg/L pyridoxine HCl, 2% sucrose and the media additives, L-proline (2.3 g/L) and casein hydrolysate (200 mg/L). The primary calli obtained were friable and compact.

Maintenance of E calli was achieved by consistent selection of such calli and transfer every 14 days onto fresh medium with increased concentration of 2, 4-D (1.0 mg/L). Brief exposure (3-6 days) of E. Calli to differentiation medium supple-

mented with 3-4 mg/L 6-benzylaminopurine (BAP) increased the recovery of germinating embryos. Transfer of plantlets to hormone-free medium allowed their continued development.

Initial evaluation of regenerated plants under greenhouse condition showed abnormalities such as dwarfing, tillering and absence of tassel. General 1 (G1) progeny of IPB Var 4 was recovered by pollination of the ear with pollen of cv Yellow Sweet Glutinous from field-growth plants.

"BASIC SEED" PRODUCTION IN POTATO (*SOLANUM TUBEROSUM* L.) CV BANAHAW AND ASN 69.1

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"Basic seeds" or minitubers of potato cv Banahaw and ASN 69.1 were derived from microtubers of "pre-basic seeds" produced *in vitro*. The microtubers ranged in size from ≥ 5 mm to ≥ 10 mm. Multiplication rate from microtuber to first generation (G1) minituber was 1:4 for both varieties. G1 minitubers ranged in size from ≤ 10 mm to 40 mm. Generation 2 (G2) minitubers were produced from G1 minitubers at the rate of 1:4 for Banahaw and 1:5 for ASN 69.1. G2 minitubers ranged in size from ≤ 10 mm to ≥ 45 mm. All microtuber production was conducted at the CMPB laboratory, IPB while all minituber production was conducted at the Bureau of Plant Industry, Baguio City.

This basic seed production is a vital component of the microtuber production technology for the commercial production of certified seed tubers of potato introduced in 1992 by Rasco, Pateña and Barba.

PLANT REGENERATION FROM *INDICA* AND *JAPONICA* RICE PROTOPLASTS AND CYTOLOGICAL AND FIELD STUDIES OF REGENERATED PLANTS

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One of the most significant developments in plant tissue culture has been the isolation and culture of protoplasts. Protoplasts are ideal for gene transfer and generation of variation.

Protocols for protoplast isolation from suspension cultures and direct isolation from primary calli, culture and plant regeneration have been established. More than 5000 plants have been regenerated from different varieties of *indica*, *japonica* and wild rice.

The chromosome behavior and number of 92 IR43 and 35 IR57311-95-2-3 protoplast-derived R_0 plants were determined. There were 62% of the IR 43 and 97% of the IR 57311-95-2-3 regenerants which were normal diploids. Tetraploidy and abnormal chromosome behavior were observed in both cultivars.

Taipei 177 protoclones and the seed-derived control were evaluated and compared on 13 agronomic traits, grain quality characteristics and yield components under field conditions for two seasons. Significant variations both positive (+) and negative (-) relative to control were observed for number of days to flower (-), culm length (-), panicle length (+), flagleaf length (+), flagleaf L-W ratio (+) and primary branch per panicle (+) in the protoplast-derived lines. No significant difference in yield was observed.

MICROENVIRONMENT, DISEASE DEVELOPMENT AND YIELD INTERACTION IN RICE-CORN MONOCROPPING AND INTERCROPPING SYSTEMS

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This study was conducted at Central Mindanao University, Musuan, Bukidnon from May to October, 1991 to characterize the microenvironment of a rice-corn intercropping system, and to determine the relation of some microenvironmental parameters with disease development and disease severity.

Daily field temperatures (soil and air) were reduced by rice + corn intercropping. A lower air temperature profile with higher relative humidity resulted from intercropping, and it is more conservative of soil moisture than the monoculture. Incidence of major diseases like rice blast was lower in magnitude and less severe in the intercrop compared to monoculture on the later stages of crop growth. Downy mildew in corn increased with time with higher incidence in monoculture compared to the intercrop. Planting late in the wet season, with the early onset of disease produced higher disease incidence levels. Incidence and severity of rice blast were found higher with lower day time Rh, air temperature and soil temperature while downy mildew increased with lower air temperature.

There was little variation in yield and yield components in intercropping and monocropping. Increase in rice blast incidence reduced the yield by as much as 17.76% with a delay in planting (June 15). With downy mildew infection, greater plant density in monoculture had yield advantage over intercropping. Intercropping rice with corn in the uplands creates a better system of utilizing space, moisture, light and suitable soil and air temperature.

EVALUATION OF TRADITIONAL PROCESSING METHODS OF NAMI (*DIOSCOREA HISPIDA*) IN TERMS OF CHIP QUALITY, NUTRIENT AND DIOSCORINE CONTENTS

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A comprehensive survey was done in eight provinces in Northern Philippines to evaluate the indigenous processing methods for nami in terms of chip quality, nutrients and nutrient contents. Nutrient and dioscorine were analyzed following the processing stages of common brine soaking method in chips produced from other detoxifying methods.

Weight, quality, nutrient and dioscorine contents of chips varied depending on the preserving, soaking and washing treatments used. Lowest percentage and whitish chip color were obtained from chips treated with 5% w/v of 80% proof gin while the rest were comparable. Poor quality with high dioscorine content was obtained in roasted tuber.

SOMATIC EMBRYOGENESIS OF CALLOIDS FROM IMMATURE COCONUT EMBRYOS

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Seven- to eight-month old embryos from either Catigan or Cat x Bay population produced calloids as early as three weeks from initial culture in initiation medium with high 2, 4-D level. Embryogenesis and plantlet regeneration were attained when the auxin concentration was gradually lowered while the cytokinin level was increased. An attempt was made to establish one of the regenerated complete plantlets to *ex vitro* condition. The plantlet was planted in sterilized fine sand in a humidity chamber but it failed to get established. It died after about four weeks.

DAILY GROWTH RATE MEASUREMENTS DEMONSTRATE OSMOTIC AND IONIC EFFECTS OF HIGH SALINITY TREATMENTS ON RICE

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A nondestructive method of screening for salt tolerance in rice involving measurement of leaf elongation rate (LER) was tested on Nona Bokra (salt-tolerant) and IR28 (salt-susceptible) cultivars. Two-week-old seedlings were grown

at 1, 50 and 100 mol m⁻³ NaCl for 21 days and LER measured daily. The LER of Nona Bokra immediately decreased at 50 and 100 mol m⁻³ NaCl, indicating an osmotic effect of NaCl; that of IR28 slowly but continuously decreased implying an ionic effect. Nona Bokra adapted to the stress by maintaining a constant but reduced growth at high NaCl concentrations while IR28 did not. To estimate the entry of salt into the leaf, this screening method was further improved by clipping 1/3 of n-1 leaf for chemical analysis; this did not affect LER. Based on LER, Nona Bokra recovered two days after salinity was removed whereas IR28 did not. The quick recovery of Nona Bokra is another proof of an osmotic effect of NaCl while the failure of IR28 to recover was related to the large concentration of Na in the shoot and the inability to reduce this after salinity was removed. The results demonstrate that measurement of LER provides a convenient and non-destructive measure of salt tolerance. LER indicates the ability of rice to adapt to salinity and provides information about optimum time for sampling. This method may also be useful for evaluating other environmental stresses involving ion excess or deficiency.

MEASUREMENTS OF ULTRAVIOLET-B-IRRADIANCE UNDER FIELD CONDITIONS

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A major consequence of ozone depletion is an increase in UV-B radiation (280-320 nm) which has profound effects both in plants and in human beings. UV-B irradiance measurement, which could be affected by different factors, is critical in the study of UV-B effects on crops. An experiment was conducted to determine UV-B irradiance at different voltages (160-220V), solar irradiance and film photooxidation. Supplemental UV-B was provided by preaged UV-emitting fluorescent lamps that were enclosed by either cellulose acetate (UV-B treatment or mylar polyster (control treatment) films. UV-B irradiance was measured using an Optronic 752 Spectroradiometer. UV-B output was negatively associated with electrical voltage. There was a 5-35% reduction in UV-B irradiance from 205 to 160 volts. To obtain better UV-B output from the lamps, the voltage must not be lower than 205 volts. At IIRRI, Los Baños, Philippines, the ambient UV-B level in dry season is about 6.0kJ/m²/day on a clear day. Ambient UV-B irradiance is linearly related to total solar radiation ($r^2=0.97^{**}$). The photooxidation of cellulose acetate can reduce the UV-B output by about 25% after one week of exposure. This suggests that cellulose acetate films must be replaced within seven days to ensure appropriate UV-B output. Uniform distribution of UV-B irradiance under the lamps could be successfully evaluated using a portable UVX radiometer.

RICE DEVELOPMENT AND GROWTH AS AFFECTED BY CARBON DIOXIDE

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The fact that atmospheric carbon dioxide (CO_2) is increasing had been established but how it will affect the world's food supply is not known. Few studies have been done on the effects of CO_2 on different rice (*Oryza sativa* L.) cultivars for the duration of crop growth. A controlled environment experiment was conducted to assess the response of five lowland rice cultivars (IR20, IR30, IR46, IR64 and IR72) to ambient ($350 \mu\text{L L}^{-1}$) and high ($425, 500, 600$ and $750 \mu\text{L L}^{-1}$) CO_2 . Plants were grown from seeding to flowering in naturally-lit, CO_2 -, temperature-, and humidity-controlled growth chambers. Temperature inside the chambers was maintained at $33/25^\circ\text{C}$ day/night and vapor pressure deficit was set at 12 mPa. Plant height for all cultivars was increased by CO_2 enrichment with the greatest increase occurring at $500 \mu\text{L L}^{-1}$. Tiller number was also increased by high CO_2 . Flowering was delayed at $425\text{-}500 \mu\text{L L}^{-1}$ CO_2 . Greatest biomass and leaf area were also observed at $425 \mu\text{L L}^{-1}$ CO_2 for all cultivars except IR30. For IR30, all the high CO_2 treatments increased biomass but were not significantly different from each other. Significant changes in development and growth of rice can be expected in the future with increased carbon dioxide level.

YIELD POTENTIAL LIMITATIONS: FACTORS AFFECTING YIELD OF DEEPWATER RICE IN RELATION TO NEW PLANT TYPE

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Traditional deepwater rices (DWR) are low yielding (<2 tons/ha). Improvement of plant type is important to increase and stabilize yields. Field studies were conducted in 1992 wet season at IRRI to quantify yield differences as affected by number of main stems, primary and nodal tillers. The effects of genotype versus environment were evaluated by comparing growth of DWR cultivar (HTA 60) with high yielding irrigated cultivar (IR72). HTA 60 and IR72 were grown at 20, 40, 80, 160 and 320 plants/ m^2 to vary number of different tiller types.

Increasing density in HTA 60 increased yield from 2 to 5 t/ha, as a result of two to threefold increase in leaf area index (LAI) and number of main stems. The LAI and stems/ m^2 were also highly correlated with yield in IR72. In HTA 60, only 20 and 40 plants/ m^2 produced nodal tillers which contributed <20% of the yield. Plants at high density (HD) had mainly main and primary tillers which yielded more than twice those at low density (LD). However, HD plants had threefold lower yield/panicle for main and primary tillers. Main tiller contributed >35% of

total yield in HD plants. LD plants had more spikelets/panicle than HD plants. There was no significant difference in panicle/straw ratio, filled grain percentage and plant height in either HTA 60 or IR72 although HD DWR plants elongated faster at the start of flooding. New plant type for DWR may be achieved by increasing the proportion of main stem tillers relative to the proportion of nodal and primary tillers. It would be useful to evaluate this with DWR cultivars with low tillering ability planted at high density.

RICE ROOT SAMPLING AND MEASUREMENT TECHNIQUES WITH EMPHASIS ON DROUGHT

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Root system evaluation is essential to understand crop responses to water deficit. Because roots grow underground, however, they are very difficult to study. Moreover, there is generally a large environment impact on root growth and morphology so root observations tend to have large variations. We described several major root sampling and measurement techniques, including trench profile, auger, monolith, pinboard, core and minirhizotron.

The trench profile method needed the most labor, but required no sophisticated equipment unlike the monolith, auger and core sampling methods which required a Comair root length scanner. All techniques used destructive sampling, except the minirhizotron which measured roots *in situ*. Effects of soil texture, cracking, strength and flooding on the choice of sampling method are also discussed.

EFFECT OF SEED AGING ON CROP ESTABLISHMENT OF RICE CULTIVARS IN ANAEROBIC SEEDING

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High seed vigor is important to obtain good crop establishment in direct seeded rice where anaerobic condition is a constraint. The effect of accelerated aging treatment on the cultivar difference in crop establishment was studied under various anaerobic conditions. Seeds of anaerobic tolerant (ASD1, JC178, Thaotabi, Kuchi) and susceptible (IR36, IR50) cultivars were subjected to aging treatment (43°C and 100% RH) for 3, 6 and 9 days. Then their seedling growth was characterized in 100% N₂ gas in the laboratory, in flooded soil (2.5 cm seeding depth, 2.5 cm water depth) in containers in the screenhouse, and in lowland direct seeded field (1.0 cm seeding depth, water saturated soil).

The aging effect persisted even though the environment for seedling growth was changed from laboratory to the field. The additive effect of aging and anaero-

bic soil condition severely depressed percent emergence, vigor index, seedling height, leaf development, length of coleoptile, mesocotyl and roots, and shoot dry weight. Cultivar ASD1 was found to withstand significantly the cumulative stresses of aging and anaerobic soil conditions. Vigor index in the container and coleoptile elongation in N_2 gas closely correlated with the percent emergence in the field with the coefficient of 0.828** and 0.843**, respectively. The results suggest that ASD1 might be a good material for breeding rice cultivar suitable for direct seeding and that vigor index and coleoptile elongation could be used as selection criteria.

DEFOLIATION AS A METHOD OF SCREENING RICE FOR DROUGHT TOLERANCE AT FLOWERING

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Screening rice (*Oryza sativa* L.) for drought tolerance at flowering is difficult because different rices flower at different times. Previous research showed that yields of plants subjected to flowering are related to accumulation and remobilization of non-structural carbohydrates. We hypothesized that defoliation during flowering would induce the plant to remobilize carbohydrates from the culms to the panicles similar to water stress effects. Defoliation was tested on 34 upland (Cavinti, Laguna) and 31 rainfed lowland (Victoria, Tarlac) lines and cultivars during the 1991 and 1992 wet seasons. All leaves or two leaves (flag leaf and penultimate leaf) were removed when first panicles emerged and a non-defoliated treatment was used as control. IR55549-01-2 and IR60077-24-B were high yielders in both control and defoliated treatments while IR60088-22 and IR47686-18-7-B were low yielders under upland condition. IR55736-31-2-1-2-1, IR33380-7-2-1-3 and IR58823-55-8-3-3-3 were high yielders in defoliated and non-defoliated treatments while IR63497-1-3, IR55008-74-3-1-1, IR55008-74-3-1-1 and IR58926-2-3-1-2-2 gave low yields under rainfed lowland condition. Thus, the defoliation method can be used to screen rice for drought resistance at flowering.

CHEMICAL CHANGES IN ABACA FIBER DERIVED FROM STALKS STORED AT VARIOUS DURATIONS

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Stalks of Makiling Puti abaca cultivar at pre-flagleaf stage of development were stored at various periods of time, namely, 0 (control), 10, 20, 30, 40, 50 and 60 days to determine the changes in chemical characteristics of the fiber during

storage. Fiber tensile strength and alphacellulose content were significantly increased when stalks were stored up to 30 days. Regardless of storage duration, on the other hand, fibers extracted from the inner leafsheath had significantly the lowest values for these parameters. Significant interaction effects between storage duration and leafsheath position were observed for the mean percentage fiber recovery, holocellulose and crude fat contents of abaca fiber. Prolonged storage of stalks (60 days) significantly impaired fiber quality of the outer leafsheaths particularly their holocellulose content.

EFFECT OF SULFATE ON METHANE PRODUCTION IN RICE PADDIES

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Rice paddies are considered to be among the most important sources of atmospheric methane (CH_4). Methane production in rice paddies is controlled by many factors including fertilizer application. Sulfate, a common fertilizer component, has been found to inhibit methanogenesis in aquatic sediments. A greenhouse experiment was conducted to determine the effect of sulfate on methane production in a flooded rice soil. Gypsum at 0, 350, 1000 and 2000 ppm sulfate was added to Maahas clay soil with and without IR72. Soil-entrapped CH_4 , Eh and pH were monitored weekly for 13 weeks.

The decrease of entrapped methane with increasing levels of gypsum in the unplanted soil confirmed the inhibitory effect of sulfate on methane production. Soil Eh and pH were not significantly affected by the addition of sulfate. Apparently, the inhibitory effect of sulfate was caused by the competition of methane-producing and sulfate-reducing bacteria for common substrates (acetate, CO_2 , H_2). The seasonal variation of entrapped methane in the planted soil signified the interactive impact of sulfate and plant activity. The low entrapped methane during the vegetative stage of the rice plant regardless of sulfate levels was mainly due to CH_4 oxidation in the rhizosphere and emission to the atmosphere. The increase of entrapped methane during the reproductive stage was attributed to the enhanced methane production due to root decay and exudation. The magnitude of increase in methanogenesis was greatest for the 350 ppm sulfate treatment. This suggests that increased root exudation because of better plant growth may override the inhibitory effect of sulfate at low gypsum levels.

ESTIMATION OF RICE LEAF NITROGEN CONCENTRATION USING A CHLOROPHYLL METER: THE INFLUENCE OF LEAF THICKNESS

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The chlorophyll meter (SPAD) provides a simple, quick and non-destructive method to estimate rice (*Oryza sativa* L.) leaf N status but the linear relationship between leaf N concentration (N%) and SPAD values differs between growth stages. This study determined if leaf thickness was responsible for the differences. This study was conducted on IR72 in a nitrogen management experiment at IRRI farm during the 1992 dry season. Leaf N status was estimated using a chlorophyll meter (SPAD-502) and also determined directly by microkjeldahl procedure. Measurements were taken on five uppermost fully-expanded leaves from each plot before N topdressing at mid-tillering, panicle initiation and flowering. Specific leaf weight (SLW), a measure of leaf thickness, which is the ratio of dry weight to leaf area, was calculated. There were linear relationships between N% and SPAD values, but regression lines differed significantly between growth stages. Based on pooled data from all stages, the degree of linear fit was poor ($r^2 = 0.49$). Adjusting SPAD values for SLW (SPAD/SLW) improved the prediction of N% ($r^2 = 0.93$). These results demonstrate that SLW influences the prediction of leaf N status by SPAD, and adjustment of SPAD values for SLW greatly increases the accuracy of prediction.

ENVIRONMENTAL IMPACT OF NEW RICE GROWING TECHNOLOGIES: SOIL MICROBIAL BIOMASS IN WETLAND RICE SOILS

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This study aimed to quantify and establish a mechanistic understanding of the role of soil microbial biomass in soil fertility under intensively cultivated wetland rice. The specific objectives were: a) to quantify the relationships between soil microbial biomass and soil organic carbon content; b) to relate the process of reduction upon flooding to soil organic matter content; and c) to investigate the relationship of soil microbial biomass and soil nitrogen (N) under field conditions.

Soil microbial biomass of wetland soils under aerobic incubation was linearly related to a labile carbon pool in the plough layer rather than total soil organic carbon. Labile carbon in the Ap horizon reflects organic inputs and part of soil organic matter. The rate of reduction upon flooding was related to the C:N ratio of the enriched organic fraction but not total soil organic carbon.

Soil N status was described on a mass basis relative to N uptake by IR72, where the soil N environment was altered by N fertilizer addition. Soil N was measured as exchangeable, soil solution phase and soil microbial biomass N. Soil microbial biomass increased with increasing soil exchangeable and solution phase ammonium resulting in rapid immobilization of large amounts of added fertilizer N by the soil microbial biomass.

These results emphasize the importance of soil microbial biomass in the regulation of soil and fertilizer N supply in flooded soils, highlighting the apparent contrasts in the behavior of the soil microbial biomass under aerobic and anaerobic condition.

ENVIRONMENTAL IMPACT OF NEW RICE GROWING TECHNOLOGIES: THE ROLE OF AQUATIC INVERTEBRATES ON THE DECOMPOSITION OF CROP RESIDUES IN RICEFIELDS

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The aim of this study was to identify the functional role of aquatic invertebrates in the decomposition of crop residues in ricefields. Rice roots and straw were placed in nylon bags with mesh sizes of 4 mm, 0.6 mm and 64 mm to exclude different groups of invertebrates. They were installed at the soil-floodwater interface and in the soil in experimental ricefields subject to different agrochemical regimes.

At 77 DT, mass losses of rice roots and straw were typically in the 40-50% range and 70-90% range, respectively. During the first 14 DT, significantly more root material was lost from the bags incorporated in the soil than those at the soil-floodwater interface. However, by 77 DT the position was reversed. Mass loss of straw was significantly greater at the interface than in the soil throughout the crop season.

Initial mass loss of rice roots was independent of mesh size. Between 14 and 42 DT mass loss rates were fastest in the coarsest mesh, but by 77 DT more of the material in the finest mesh had been lost than in the two coarser meshes. Conversely, mass loss of rice straw increased significantly with increasing mesh size.

No significant effects of insecticide applications were found on the decomposition of rice roots. At 14 and 77 DT mass loss of rice straw was significantly decreased by the application of carbofuran. The broadcast application of N fertilizer significantly increased the mass loss of rice roots and rice straw at 14, 37 and 77 DT, respectively.

EFFECT OF BENOMYL AND CARBOFURAN ON *APHELENCHOIDES BESSEYI* ON RICE

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Two experiments were conducted in the greenhouse to test the efficiency of carbofuran 3G (4 kg ai/ha) applied in the soil and benomyl applied as seed treatment (0.3% by seed weight) and sprayed on rice seedlings using manufacturer's rate in controlling *A. besseyi* when introduced into flood water.

Carbofuran applied one day after transplanting (DAT) or 30 DAT did not control the nematode. Benomyl applied once as spray at 1 DAT reduced greater numbers of *A. besseyi* in seeds than when applied as seed treatment. Two sprayings of benomyl at 1 and 15 DAT in addition to seed treatment resulted in absence of nematodes in the seeds. However, benomyl sprayed five days after inoculation did not control the nematode.

A. besseyi parasitized rice plants and produced infested grains when inoculated into flood water at transplanting, maximum tillering and/or panicle initiation (PI). Seed infestation was lowest ($P > 0.05$ by DMRT) when the nematode was introduced at PI or at transplanting when seeds were given benomyl seed treatment before sowing.

PLANT PARASITIC NEMATODES ASSOCIATED WITH UPLAND RICE AS AFFECTED BY DIFFERENT DURATIONS OF CULTIVATION IN WEST SUMATRA, INDONESIA

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A survey was conducted in 100 fields in 2 upland rice growing areas in West Sumatra (Situang and Kaumang Kuning), Indonesia to determine the frequency of occurrence of plant parasitic nematodes as affected by the duration of cultivation. A total of 1000 root and soil samples were collected at maturity from fields cultivated for 1, 2, 4, 8 and 16 years. *Pratylenchus zae* was detected in 100% of the fields cultivated for 4, 8 and 16 years with increasing population density as duration of cultivation increased. The rice root knot nematode, *Meloidogyne spp.*, was found in 87% of the roots sampled from Kaumang Kuning while only 12% was found in Situang. It occurred in high population densities in both areas. *Helicotylenchus spp.*, *Criconeimella spp.* and *Xiphinema spp.* were found sporadically in fields cultivated from 1 to 4 years but in high population densities. Other genera occurring in low population densities in some of the fields surveyed were *Scutellonema sp.*, *Hoplolaimus sp.* and *Tylenchorhynchus sp.*

Based on the frequency of occurrence, *P. zae* and *Meloidogyne spp.* are considered potentially important nematode pests associated with upland rice especially in fields planted continuously over a long duration.