PADI (Science direct 2011)

1. Tong ZHOU, Li-juan WU, Ying WANG, Zhao-bang CHENG, Ying-hua JI, Yong-jian FAN, Yi-jun ZHOU, Transmission of Rice Black-Streaked Dwarf Virus from Frozen Infected Leaves to Healthy Rice Plants by Small Brown Planthopper (Laodelphax striatellus), Rice Science, Volume 18, Issue 2, June 2011, Pages 152-156, ISSN 1672-6308,

   Abstract: In order to preserve virus for identifying the resistance of rice varieties against rice black-streaked dwarf disease, a simple and reliable method was developed, through which virus-free small brown planthopper (SBPH) acquired rice black-streaked dwarf virus (RBSDV) from frozen infected leaves and the virus was transmitted to healthy rice plants. The experimental results showed that SBPH could obtain RBSDV from frozen infected rice leaves and the virus could be transmitted to a susceptible rice variety. For the ability to acquire RBSDV and transmit the virus to healthy plants by SBPH, there was no significant difference between frozen infected leaves and in vitro infected leaves. The novel method could be applied to identification of rice variety resistance to rice black-streaked dwarf disease, facilitating the breeding process for rice black-streaked dwarf disease resistance.
   Keywords: rice black-streaked dwarf virus; frozen infected leaves; small brown planthopper; methodology

2. Shu YAO, Tao CHEN, Ya-dong ZHANG, Zhen ZHU, Ling ZHAO, Qing-yong ZHAO, Li-hui ZHOU, Cai-lin WANG, Transferring Translucent Endosperm Mutant Gene Wx-mq and Rice Stripe Disease Resistance Gene Stv-bi by Marker-Assisted Selection in Rice (Oryza sativa), Rice Science, Volume 18, Issue 2, June 2011, Pages 102-109, ISSN 1672-6308,

   Abstract: A high-yielding japonica rice variety, Wuyunjing 7, bred in Jiangsu Province, China as a female parent was crossed with a Japanese rice variety Kantou 194, which carries a rice stripe disease resistance gene Stv-bi and a translucent endosperm mutant gene Wx-mq. From F2 generations, a sequence characterized amplified region (SCAR) marker tightly linked with Stv-bi and a cleaved amplified polymorphic sequence (CAPS) marker for Wx-mq were used for marker-assisted selection. Finally, a new japonica rice line, Ning 9108, with excellent agronomic traits was obtained by multi-generational selection on stripe disease resistance and endosperm appearance. The utilization of the markers from genes related to rice quality and disease resistance was helpful not only for establishing a marker-assisted selection system of high-quality and disease resistance for rice but also for providing important intermediate materials and rapid selection method for good quality, disease resistance and high yield in rice breeding.

   Keywords: rice; translucent endosperm mutant gene; rice stripe disease resistance gene; marker-assisted selection

3. Jian-feng CHENG, Han-yan JIANG, Yi-bai LIU, Ting-bo DAI, Wei-xing CAO, Methods on Identification and Screening of Rice Genotypes with High

Nitrogen Efficiency, Rice Science, Volume 18, Issue 2, June 2011, Pages 127-135, ISSN 1672-6308,

Abstract: In order to establish methods for indentification and screening of rice genotypes with high nitrogen (N) efficiency, N absorption efficiency (NAE), N utilization efficiency (NUE) and N harvest index (NHI) in ten rice genotypes were investgated at the elongation, booting, heading and maturity stages under six N levels in a pot experiment with soil-sand mixtures at various ratios. NAE in various rice genotypes firstly increased, peaked under a medium nitrogen rate of 0.177 g/kg and then decreased, but NUE and NHI always decreased with increasing nitrogen levels. NAE in various rice genotypes ever increased with growing process and NUE indicated a descending tendency of elongation stage>heading stage>maturity stage>booting stage. N level influenced rice NAE, NUE and NHI most, followed by genotype, and the both effects were significant at 0.01 level. In addition, the interaction effects of genotype and nitrogen level on rice NAE and NUE were significant at 0.01 level, but not significant on rice NHI. Because the maximum differences of NAE and NUE were found at the elongation stage, it was thought to be the most suitable stage for identification and screening these two paremeters. Therefore, the optimum conditions for identification and screening of rice NAE, NUE and NHI in a pot experiment were the nitrogen rate of 0.157 g/kg at the elongation stage, low nitrogen at the elongation stage, and the nitrogen rate of 0.277 g/kg at the maturity stage, respectively.

Keywords: rice; genotype; identification; screening; high nitrogen efficiency; nitrogen absorption efficiency; nitrogen utilization efficiency; nitrogen harvest index

4. Yu-xiang ZENG, Zhi-juan JI, Liang-yong MA, Xi-ming LI, Chang-deng YANG, Advances in Mapping Loci Conferring Resistance to Rice Sheath Blight and Mining Rhizoctonia solani Resistant Resources, Rice Science, Volume 18, Issue 1, March 2011, Pages 56-66, ISSN 1672-6308

Abstract: Sheath blight (SB) caused by Rhizoctonia solani is one of the three major diseases of rice, and now has become the most severe disease causing rice yield loss in China. Breeding and use of varieties resistant to SB is crucial in controlling the disease, but the advances achieved have been limited due to the lack of highly SB-resistant rice germplasm. Genetic analysis revealed that the SB resistance in rice was a typical quantitative trait controlled by multi-genes. Although many QTLs conferring resistance to SB have been identified in recent years, most of the QTLs only showed small effects and few of them have been evaluated for utilization potential. Many R. solani-resistant resources have been found in wild rice species, microorganisms and other plant species. It is already known that the SB-resistance could be improved in transgenic rice plants by genetic transformation. This paper reviewed the genetic mapping of loci associated with resistance to rice SB, the evaluation of the potential of resistance QTLs, and the resistant resources found in various organisms besides rice. To develop SB-resistant rice varieties, it is important to develop and explore new resistant rice germplasms, fine map and evaluate resistance QTLs, and also to pay attention to various bio-resources showing resistance to R. solani.

Keywords: rice; sheath blight; Rhizoctonia solani; quantitative trait locus; resistance

5. Li-yun CHEN, Dong-yang LEI, Wen-bang TANG, Ying-hui XIAO, Thoughts and Practice on Some Problems about Research and Application of Two-Line Hybrid Rice, Rice Science, Volume 18, Issue 2, June 2011, Pages 79-85, ISSN 1672-6308,

Abstract: The main problems about research and application of two-line hybrid rice were reviewed, including the confusing nomenclature and male sterile lines classification, the unclear characteristics of photoperiod and temperature responses and the unsuitable site selection for male sterile line and hybrid rice seed production. In order to efficiently and accurately use dual-purpose genic male sterile lines, four types, including PTGMS (photo-thermo-sensitive genic male sterile rice), TGMS (thermo-sensitive genic male sterile rice), reverse PTGMS and reverse TGMS, were proposed. A new idea for explaining the mechanism of sterility in dual-purpose hybrid rice was proposed. The transition from sterile to fertile was involved in the cooperative regulation of major-effect sterile genes and photoperiod and/or temperature sensitive ones. The minor-effect genes with accumulative effect on sterility were important factors that affected the critical temperature of sterility transfer. In order to make better use of dual-purpose lines, the characterization of responses to photoperiod and temperature of PTGMS should be made and the identification method for the characterization of photoperiod and temperature responses of PTGMS should also be put forward. The optimal ecological site for seed production could be determined according to the historical climate data and the requirements for the meteorological conditions during the different periods of seed production.

Keywords: two-line hybrid rice; dual-purpose genic male sterile line; photoperiod and temperature characteristics; seed production; seed propagation

6. Wei-guo LI, Hua LI, Li-hua ZHAO, Estimating Rice Yield by HJ-1A Satellite Images, Rice Science, Volume 18, Issue 2, June 2011, Pages 142-147, ISSN 1672-6308

Abstract: As illustrated by the case of Xuyi County, Jinhu County and Hongze County in Jiangsu Province, China, monitoring and forecasting of rice production were carried out by using HJ-1A satellite remote sensing images. The handhold GPS machines were used to measure the geographical position and some other information of these samples such as area shape. The GPS data and the interpretation marks were used to correct HJ-1 image, assist human-computer interactive interpretation, and other operations. The test data had been participated in the whole classification process. The accuracy of interpreted information on rice planting area was more than 90%. By using the leaf area index from the normalized difference vegetation index inversion, the biomass from the ratio vegetation index inversion, and combined with the rice yield estimation model, the rice yield was estimated. Further, the thematic map of rice production classification was made based on the rice yield data. According to the comparison results between measured and fitted values of yields and areas of sampling sites, the accuracy of the yield estimation was more than 85%. The results suggest that HJ-A/B images could basically meet the demand of rice growth monitoring and yield forecasting, and could be widely applied to rice production monitoring.

Keywords: rice; yield; satellite remote sensing image; estimation model

7. Zhi-yu LI, Hong YANG, Feng-xiang LAI, Qiang FU, Yang HU, Occurrence and Population Dynamics of Chironomids in Early-Season Rice Fields, Rice Science, Volume 18, Issue 2, June 2011, Pages 136-141, ISSN 1672-6308, **Abstract:** The chironomid is one of the world wide distributed insects and normally occurs in a great abundance among many kinds of water bodies. Currently, our knowledge about the chironomid in rice fields is limited to the species survey, and it is considered as a group insect at the family level, termed as a kind of the neutral insects. By using the specially designed emergence traps, the species richness and the occurrence of the chironomid in rice fields were studied throughout the early season in Fuyang City, Zhejiang Province, China. There were four species, namely, Tanytarsus formosanus, Chironomus sinicus, Polypedilum nubifer and Tanypus punctipennis of chironomids collected from rice fields. All of them are widely distributed species. T. formosanus and C. sinicus were the most dominant species in rice fields. The succession of chironomids in the early season could be divided into two phases, the early and the late phases. The abundance of the chironomid was higher in the early phase than that in the late phase. It was estimated that there were around 3 million individuals of chironomids emerged from 667 m2 rice field throughout the early season. It was also found that the sex ratio of T. formosanus was female-biased during the early phase, whereas male-biased during the late phase. In contrast, the sex ratio of C. sinicus was male-biased throughout the early season.
Keywords: rice field; chironomid; population dynamic; sex ratio

8. Jing LIN, Wen-yin ZHU, Ya-dong ZHANG, Zhen ZHU, Ling ZHAO, Tao CHEN, Qing-yong ZHAO, Li-hui ZHOU, Xian-wen FANG, Yan-ping WANG, Cai-lin WANG, Detection of QTL for Cold Tolerance at Bud Bursting Stage Using Chromosome Segment Substitution Lines in Rice (Oryza sativa), Rice Science, Volume 18, Issue 1, March 2011, Pages 71-74, ISSN 1672-6308, **Abstract:** The cold tolerance at the bud bursting stage (CTB) was evaluated at 5°C by using a set of 95 chromosome segment substitution lines (CSSLs) derived from an indica rice 9311 and a japonica rice Nipponbare with a genetic background of 9311. The result showed that six CSSLs had slightly stronger effect on CTB than 9311. Total four quantitative trait loci (QTLs) for CTB were preliminary mapped on chromosomes 5 and 7 by substitution mapping. qCTB-5-1, qCTB-5-2 and qCTB-5-3 were mapped in the region of RM267-RM1237, RM2422-RM6054 and RM3321-RM1054, which were 21.3 cM, 27.4 cM and 12.7 cM in genetic distance on rice chromosome 5, respectively. qCTB-7 was mapped in a 6.8-cM region of RM11-RM2752 on rice chromosome 7.
Keywords: chromosome segment substitution lines; cold tolerance; bud bursting stage; substitution mapping; rice

9. Xiao-Juan BAI, Li-Juan LIU, Chun-hua ZHANG, Ying GE, Wang-da CHENG, Effect of H2O2 Pretreatment on Cd Tolerance of Different Rice Cultivars, Rice Science, Volume 18, Issue 1, March 2011, Pages 29-35, ISSN 1672-6308,
Abstract: The effect of H2O2 pretreatment on Cd tolerance and translocation of rice seedlings were studied using two rice cultivars (N07-6 and N07-63) differing in Cd tolerance. The contents of malondialdehyde (MDA), reduced glutathione (GSH), non-protein thiols (NPT), phytochelatins (PCs) and the activity of glutathione S-transferase (GST) were compared between the two cultivars exposed to various treatments. The results showed that 50 μmol/L Cd exposure significantly inhibited rice growth, enhanced the production of GSH,

NPT, PCs and MDA, and increased the activity of GST, and there were significant differences between the two cultivars. More Cd was transported into the shoot of N07-6. The H2O2 pretreatment alleviated Cd toxicity by further increasing GSH, NPT and PCs contents, as well as the GST activity in roots. The increase degrees of these parameters in N07-63 were higher than those in N07-6, suggesting that the tolerance of N07-63 was enhanced more significantly than N07-6. Hydrogen peroxide reduced Cd translocation to rice shoot but affected the Cd content in root differently. From the above results, it may be speculated that there were remarkable differences in the Cd detoxification and response to the H2O2 pretreatment between the two cultivars.
Keywords: cadmium; hydrogen peroxide; pretreatment; rice; tolerance

10. Qun XU, Xiao-ping YUAN, Han-yong YU, Yi-ping WANG, Sheng-xiang TANG, Xing-hua WEI, Mapping QTLs for Drought Tolerance at Seedling Stage in Rice Using Doubled Haploid Population, Rice Science, Volume 18, Issue 1, March 2011, Pages 23-28, ISSN 1672-6308,
Abstract: QTLs for drought tolerance at the rice seedling stage were analyzed using a doubled haploid (DH) population consisted of 251 lines from the cross between a japonica parent Maybelle and an indica parent Baiyeqiu. A genetic linkage map with 226 SSR marker loci was constructed. Single-locus analysis following composite interval mapping (CIM) detected a total of five QTLs located on five different chromosomes of rice. Four QTLs were also detected following two-locus analysis, resolving two pairs of epistatic QTLs (E-QTLs) with positive and additive genetic effects. The results indicated that the alleles from the parent Baiyeqiu contributed DH population to improve drought tolerance at the seedling stage.
Keywords: rice; drought tolerance; doubled haploid population; quantitative trait locus

11. Suwarto, Nasrullah, Genotype × Environment Interaction for Iron Concentration of Rice in Central Java of Indonesia, Rice Science, Volume 18, Issue 1, March 2011, Pages 75-78, ISSN 1672-6308,
Abstract: To explore the effect of genotype and genotype × environment interaction on Fe concentration in rice grains, Fe concentrations of 10 genotypes were analyzed across eight paddy field environments during 2007–2008 using the AMMI-biplot method. Experiments were conducted using a randomized completely block design with three replications in eight environments. Results indicated that environment (E), genotype (G) and genotype × environment interaction (GE) significantly affected Fe concentration in rice grains. Environment explained 74.43% of total (G+E+GE) variation, whereas G and GE captured 5.60% and 19.67%, respectively. Rice genotype Barumun was desirable in terms of the highest ability and stability for Fe concentration in rice grains. Environment in genotype Cilongok was the best representative of the overall environments and the most powerful to discriminate rice genotypes.
Keywords: Fe concentration; genotype; genotype × environment interaction; AMMI-biplot method; rice

12. Jackson MARCONDES, Ana Beatriz GARCIA, Monoclonal Antibody Production and Immunolocalization of a Salinity Stress-Related Protein in Rice (Oryza sativa), Rice Science, Volume 18, Issue 2, June 2011, Pages 95-101, ISSN 1672-6308,
Abstract: Among various physiological responses to salt stress, the synthesis of a lectin-related protein of 14.5 kDa was observed in rice

plants (Oryza sativa L.) under the treatment of 170 mmol/L NaCl. In order to better understand the role of the SALT protein in the physiological processes involving salinity, it was immunolocalized in mesophilic cells of leaf sheath and blade of a rice variety IAC-4440 following monoclonal antibodies produced by hybridome culture technique. This variety turned out to be an excellent model for that purpose, since it accumulates SALT protein even in absence of salt treatment and it has been classified as moderately sensitive to salinity and a superior grain producer. This feature was relevant for this work since it allowed the use of plants without the deleterious effects caused by salinity. Immunocytochemistry assays revealed that the SALT protein is located in the stroma of chloroplasts under non-stressing condition. Since the chloroplast is the main target affected by salinity and considering that the SALT protein does not present any apparent signal peptide for organelle localization, its lectin-like activity seems to play an important role in the establishment of stable complexes, either to other proteins or to oligosaccharides that are translocated to the chloroplast.
Keywords: salt stress; SALT protein; immunocytochemistry; chloroplast; rice

13. Zuo-mei LU, Bao-qin XU, Da-yun SUN, Retesting Early Generation Stability of a Japonica Rice Variety 84–15 by Using Allelic Differences of Two Qualitative Traits, Rice Science, Volume 18, Issue 2, June 2011, Pages 148-151, ISSN 1672-6308,
Abstract: Early generation stability of a japonica rice variety, 84-15, was retested by using the allelic differences of two qualitative traits, i.e., glume tip color and waxy endosperm. Results showed that both glume tip color and waxy endosperm segregated in progenies of single F1 plants derived from two crosses of 84-15/Zi 18 (purple color) and 84-15/Dahuaxiangnuo (waxy). The results denied the conclusion obtained in previous studies that 84-15 had a characteristic of early generation stability. Moreover, it was found that using the coefficient of variation as an indicator of early generation stability was unreasonable by analyzing plant height as an example. Importance of avoiding systematic error in research works was also discussed.
Keywords: japonica rice; qualitative trait; genetic analysis; early generation stability; systematic error

14. Malay Kumar ADAK, Nirmalya GHOSH, Dilip Kumar DASGUPTA, Sudha GUPTA, Impeded Carbohydrate Metabolism in Rice Plants under Submergence Stress, Rice Science, Volume 18, Issue 2, June 2011, Pages 116-126, ISSN 1672-6308,
Abstract: The detrimental effects of submergence on physiological performances of some rice varieties with special references to carbohydrate metabolisms and their allied enzymes during post-flowering stages have been documented and clarified in the present investigation. It was found that photosynthetic rate and concomitant translocation of sugars into the panicles were both related to the yield. The detrimental effects of the complete submergence were recorded in generation of sucrose, starch, sucrose phosphate synthase and phosphorylase activity in the developing panicles of the plants as compared to those under normal or control (i.e. non-submerged) condition. The accumulation of starch was significantly lower in plants under submergence and that was correlated with ADP-glucose pyrophosphorylase activity. Photosynthetic rate was most affected under submergence in varying days of post-flowering and was also related to

the down regulation of Ribulose bisphosphate carboxylase activity. However, under normal or control condition, there recorded a steady maintenance of photosynthetic rate at the post-flowering stages and significantly higher values of Ribulose bisphosphate carboxylase activity. Still, photosynthetic rate of the plants under both control and submerged conditions had hardly any significant correlation with sugar accumulation and other enzymes of carbohydrate metabolism like invertase with grain yield. Finally, plants under submergence suffered significant loss of yield by poor grain filling which was related to impeded carbohydrate metabolism in the tissues. It is evident that loss of yield under submergence is attributed both by lower sink size or sink capacity (number of panicles, in this case) as well as subdued carbohydrate metabolism in plants and its subsequent partitioning into the grains.
Keywords: photosynthesis; sucrose; starch; phosphorylase; grain yield; rice; submergence

15. Xi-feng CHEN, Zhi-min GU, Feng LIU, Bo-jun MA, Hong-sheng ZHANG, Molecular Analysis of Rice CIPKs Involved in Both Biotic and Abiotic Stress Responses, Rice Science, Volume 18, Issue 1, March 2011, Pages 1-9, ISSN 1672-6308,
Abstract: Plant calcineurin B-like (CBL) proteins have been proposed as important Ca2+ sensors and specifically interact with CBL-interacting protein kinases (CIPKs) in plant-specific calcium signaling. Here, we identified and isolated 15 CIPK genes in a japonica rice variety Nipponbare based on the predicted sequences of rice CIPK gene family. Gene structure analysis showed that these 15 genes were divided into intron-less and intron-rich groups, and OsCIPK3 and OsCIPK24 exhibited alternative splicing in their mature process. The phylogenetic analyses indicated that rice CIPKs shared an ancestor with Arabidopsis and poplar CIPKs. Analyses of gene expression showed that these OsCIPK genes were differentially induced by biotic stresses such as bacterial blight and abiotic stresses (heavy metal such as Hg2+, high salinity, cold and ABA). Interestingly, five OsCIPK genes, OsCIPK1, 2, 10, 11 and 12, were transcriptionally up-regulated after bacterial blight infection whereas four OsCIPK genes, OsCIPK2, 10, 11 and 14, were induced by all treatments, indicating that some of OsCIPK genes are involved in multiple stress response pathways in plants. Our finding suggests that CIPKs play a key role in both biotic and abiotic stress responses.
Keywords: rice; CBL-interacting protein kinase family; gene expression; biotic and abiotic stress; bacterial blight

16. Yong-qiang NING, Wo-na DING, Shi-hua ZHU, Hang-wei YU, Hang YU, Kai-xing LU, Genetic Analysis and Gene Mapping of Short Root Mutant Rice ksr1, Rice Science, Volume 18, Issue 1, March 2011, Pages 67-70, ISSN 1672-6308,
Abstract: A short root mutant ksr1 with the Kasalath background was isolated from an EMS-mutagenized population in rice. The root length of 6-day-old ksr1 seedlings was only about 20% of the wild type. Genetic analysis indicated that the short root phenotype of ksr1 was controlled by a recessive mutation in a single nuclear-encoded gene. To map the ksr1 mutation, an F2 population was generated by crossing the ksr1 mutant with Nipponbare. The KSR1 locus was linked to the SSR marker RM1223 on rice chromosome 4. Eight new SSR markers and two InDel markers were developed around this marker. KSR1 gene was further mapped

to a 155 kb region, flanked by the InDel marker 4-24725K and the SSR marker RM17182.
Keywords: rice; short root; gene mapping; molecular marker

17. Xiao-ling LI, Yong-gen LU, Jin-quan LI, Hai-ming XU, Muhammad Qasim SHAHID, Strategies on Sample Size Determination and Qualitative and Quantitative Traits Integration to Construct Core Collection of Rice (Oryza sativa), Rice Science, Volume 18, Issue 1, March 2011, Pages 46-55, ISSN 1672-6308,
Abstract: The development of a core collection could enhance the utilization of germplasm collections in crop improvement programs and simplify their management. Selection of an appropriate sampling strategy is an important prerequisite to construct a core collection with appropriate size in order to adequately represent the genetic spectrum and maximally capture the genetic diversity in available crop collections. The present study was initiated to construct nested core collections to determine the appropriate sample size to represent the genetic diversity of rice landrace collection based on 15 quantitative traits and 34 qualitative traits of 2 262 rice accessions. The results showed that 50–225 nested core collections, whose sampling rate was 2.2%–9.9%, were sufficient to maintain the maximum genetic diversity of the initial collections. Of these, 150 accessions (6.6%) could capture the maximal genetic diversity of the initial collection. Three data types, i.e. qualitative traits (QT1), quantitative traits (QT2) and integrated qualitative and quantitative traits (QTT), were compared for their efficiency in constructing core collections based on the weighted pair-group average method combined with stepwise clustering and preferred sampling on adjusted Euclidean distances. Every combining scheme constructed eight rice core collections (225, 200, 175, 150, 125, 100, 75 and 50). The results showed that the QTT data was the best in constructing a core collection as indicated by the genetic diversity of core collections. A core collection constructed only on the information of QT1 could not represent the initial collection effectively. QTT should be used together to construct a productive core collection.
Keywords: nested core collection; sample size; quantitative traits; qualitative traits; integrated qualitative and quantitative traits; rice germplasm resource

18. Wei WANG, Chao WU, Mei LIU, Xu-ri LIU, Guo-cheng HU, Hua-min SI, Zong-xiu SUN, Wen-zhen LIU, Ya-ping FU, Resistance of Antimicrobial Peptide Gene Transgenic Rice to Bacterial Blight, Rice Science, Volume 18, Issue 1, March 2011, Pages 10-16, ISSN 1672-6308,
Abstract: Antimicrobial peptide is a polypeptide with antimicrobial activity. Antimicrobial peptide genes Np3 and Np5 from Chinese shrimp (Fenneropenaeus Chinensis) were integrated into Oryza sativa L. subsp. japonica cv. Aichi ashahi by Agrobacterium mediated transformation system. PCR analysis showed that the positive ratios of Np3 and Np5 were 36% and 45% in T0 generation, respectively. RT-PCR analysis showed that the antimicrobial peptide genes were expressed in T1 generation, and there was no obvious difference in agronomic traits between transgenic plants and non-transgenic plants. Four Np3 and Np5 transgenic lines in T1 generation were inoculated with Xanthomonas oryzae pv. oryzae strain CR4, and all the four transgenic lines had significantly enhanced resistance to bacterial blight caused by the strain CR4. The Np5 transgenic lines also showed higher resistance to bacterial blight caused by strains JS97-2, Zhe 173 and OS-225. It is

suggested that transgenic lines with Np5 gene might possess broad spectrum resistance to rice bacterial blight.
Keywords: antimicrobial peptide gene; bacterial blight; resistance; transgenic rice

19. Liang Tang, Dian Rong Ma, Zheng Jin Xu, Hua Feng Deng, Wen Fu Chen, Long Ping Yuan, Utilization of weedy rice for development of japonica hybrid rice (Oryza sativa L.), Plant Science, Volume 180, Issue 5, May 2011, Pages 733-740, ISSN 0168-9452,
Abstract: Two representative weedy rice lines, three typical japonica varieties and three typical indica varieties were used for 6 pairs of reciprocal crosses. The morphological traits of twelve F1 hybrid lines, their parents and four elite cultivars were investigated for heterosis over mid-parent (HM), over parent (HP) and competitive heterosis (CH) analysis. Traits detected in weedy rice lines seemed larger than those in cultivars and excellent heterosis was produced in weedy rice crossing with japonica rice. Although weedy rice kept closer relationships with japonica rice compared to indica rice. But the heterosis of reciprocal crosses between weedy rice and japonica was closed to those of crosses between indica rice and japonica rice. In six of one hundred and eighteen weedy rice lines, the fertility restore gene for BT type cytoplasmic male sterility (BT-CMS) were detected. Weedy rice was very valuable germplasm resources with the abundant polymorphism. Meanwhile, the disadvantage, lodging, shattering and incompact plant type, should be modified by hybridization, backcross and multiple cross with japonica rice. Although it is difficult to use weedy rice directly, weedy rice may be available to breed both male sterile line and restorer line through improvement, developing japonica hybrid rice.
Keywords: Hybrid japonica rice; Weedy rice; Heterosis

20. Nilda R. Burgos, Vinod K. Shivrain, Robert C. Scott, Andronikos Mauromoustakos, Yong-In Kuk, Marites A. Sales, Jeremy Bullington, Differential tolerance of weedy red rice (Oryza sativa L.) from Arkansas, USA to glyphosate, Crop Protection, Volume 30, Issue 8, August 2011, Pages 986-994, ISSN 0261-2194,
Abstract: Red rice (Oryza sativa L.), a weedy relative of cultivated rice (O. sativa), is a troublesome weed in rice in the southern United States. It is also very problematic in other world regions where rice is grown. There are many types of red rice. Some have white pericarp. In this paper, the term ‘red rice’ will be used to refer to the weedy types that occur in this region of the southern USA. Because of the great diversity in morphology and phenology of red rice populations in the USA, we hypothesized that these have differential tolerance to glyphosate. Red rice is subjected to selection pressure by glyphosate, which is the principal herbicide used in glyphosate-resistant soybean planted after rice. Two hundred-fifteen red rice accessions were collected in Arkansas, USA between 2002 and 2003 and evaluated for glyphosate tolerance between 2003 and 2006. The commercial dose of glyphosate controlled red rice accessions 81–100% regardless of application timing, by 30 d after treatment. The number of survivors that produced seeds and the seeds produced per survivor differed between accessions. Application of the full dose at the tillering stage was more effective than at the 3- to 4-leaf stages. At half the field dose, 40 to 54% of survivors produced seed, with germination capacity of 30–100%. The lowest dose of glyphosate, 225 g a.e. ha−1, resulted in the widest range of control

ratings from 30 to 100%. The red rice accessions differentiated into six tolerance categories. A tolerance map was generated and will be used in educating growers about the proper use of glyphosate for red rice management.
Keywords: Glyphosate; Application timing; Selection pressure; Red rice management

21. S.M. Haefele, Y. Konboon, W. Wongboon, S. Amarante, A.A. Maarifat, E.M. Pfeiffer, C. Knoblauch, Effects and fate of biochar from rice residues in rice-based systems, Field Crops Research, Volume 121, Issue 3, 3 April 2011, Pages 430-440, ISSN 0378-4290,
Abstract: Although crop residues constitute an enormous resource, actual residue management practices in rice-based systems have various negative side effects and contribute to global warming. The concept of a combined bioenergy/biochar system could tackle these problems in a new way. Rice residues would be used for energy production, thereby reducing field burning and the use of fossil fuels, and the biochar by-product could help to improve soils, avoid methane emissions, and sequester carbon in soils. To examine some of these promises, we conducted field experiments from 2005 to 2008 in three different rice production systems. Objectives were to study the effect of biochar from rice husks on soil characteristics, assess the stability of carbonized rice residues in these different systems, and evaluate the agronomic effect of biochar applications. The results showed that application of untreated and carbonized rice husks (RH and CRH) increased total organic carbon, total soil N, the C/N ratio, and available P and K. Not significant or small effects were observed for soil reaction, exchangeable Ca, Mg, Na, and the CEC. On a fertile soil, the high C/N ratio of CRH seemed to have limited N availability, thereby slightly reducing grain yields in the first three seasons after application. On a poor soil, where the crop also suffered from water stress, soil chemical and physical improvements increased yields by 16–35%. Together with a parallel study including methane and CO2 emission measurements at one site, the results strongly suggest that CRH is very stable in various rice soils and systems, possibly for thousands of years. However, the study also showed that CRH was very mobile in some soils. Especially in poor sandy soil, about half of the applied carbon seemed to have moved below 0.30 m in the soil profile within 4 years after application. We concluded that biochar from rice residues can be beneficial in rice-based systems but that actual effects on soil fertility, grain yield, and soil organic carbon will depend on site-specific conditions. Long-term studies on biochar in field trials seem essential to better understand biochar effects and to investigate its behavior in soils.
Keywords: Biochar; Carbon sequestration; Carbon leaching; Crop residues; Mean residence time; Rice

22. Jian XIE, Xue WU, Jian-jun TANG, Jia-en ZHANG, Shi-ming LUO, Xin CHEN, Conservation of Traditional Rice Varieties in a Globally Important Agricultural Heritage System (GIAHS): Rice-Fish Co-Culture, Agricultural Sciences in China, Volume 10, Issue 5, May 2011, Pages 754-761, ISSN 1671-2927,
Abstract: The traditional rice-fish farming system is selected as a “globally important agricultural heritage system” (GIAHS) by the Food and Agriculture Organization (FAO), United Nations Development Programme (UNDP), and Global Environment Facility (GEF), etc. In Zhejiang Province of China, where the pilot site for this GIAHS farming

system is located, we compared the use of traditional rice varieties in rice-fish co-culture and rice monoculture. Further, we determined how traditional rice varieties were performed in this rice-fish system. Only 19% of the farmers who practiced rice monoculture planted traditional varieties while 52% of farmers who practiced rice-fish co-culture planted traditional varieties. Traditional varieties represented 13% of the total land cultivated under rice in the rice-fish system but only 2% in the rice monoculture system. In the rice-fish system, yield was lower for traditional rice varieties than hybrid varieties but application of fertilizers and pesticides was also lower. In a field experiment in the rice-fish system without pesticides, rice planthopper numbers and sheath blight incidence were lower from three traditional varieties than one hybrid variety; yields were 8 to 32% lower from the traditional varieties than the hybrid. Our results showed that traditional rice varieties can be preserved through conserving GIAHS rice-fish co-culture. Our study also indicated that traditional rice varieties can survive in the rice-fish system because these varieties are helpful to the whole system and beneficial to the farmers.

Keywords: hybrid rice varieties; on-farm conservation; rice monoculture; traditional rice-fish farming

23. Som Bunna, Pao Sinath, Ouk Makara, Jaquie Mitchell, Shu Fukai, Effects of straw mulch on mungbean yield in rice fields with strongly compacted soils, Field Crops Research, Volume 124, Issue 3, 20 December 2011, Pages 295-301, ISSN 0378-4290,

Abstract: In rice-based lowland areas in the Mekong region, the lack of full irrigation water availability for post-rice legume crops and the poor soil physical and chemical conditions are major constraints for development of sound rice/legume double cropping system. In order to improve legume productivity, use of rice straw mulch and various crop establishment methods were examined in two series of mungbean experiments in Cambodia where soils were coarse and strongly compacted. In one set of experiments conducted at four locations in the first year the effect of straw mulch, planting method (manual vs seed drill) and tillage method (conventional vs no-till) was examined. Another set of experiments were conducted in the second year at three locations with four levels of mulch under two planting densities. On average in year 1, mulching of rice straw at 1.5 t/ha increased mungbean crop establishment from 72 to 83%, reduced weed biomass from 164 to 123 kg/ha and increased yield from 228 to 332 kg/ha. Mulch was effective in conserving soil moisture, and even at maturity the mulched area had on average 1% higher soil moisture content. The amount of mulch between 1 and 2 t/ha did not show consistent effects in year 2, partly because some mulch treatments resulted in excessive soil moisture content and were not effective. Rice straw mulch had a significant effect on mungbean yield in 6 out of the 7 experiments conducted in two years, and mean yield increase was 35%. This yield advantage was attributed to better crop establishment, improved growth and reduced weed pressure, but in some cases only one or two of these factors were effective. On the other hand, planting method, tillage method and planting density had only small effects on mungbean yield in most experiments. Only in one location out of four tested, the no-till treatment produced significantly higher yield than the conventional method. Seed drill produced similar mungbean establishment and grain yield to the manual planting suggesting that the planter can be used to save the labour cost which is increasing rapidly in the Mekong region.

Maximum root depth varied little with mulch or planting density, and was shallow (<20 cm) in all three locations where this character was determined. It is concluded that while rice straw mulch increased yield of mungbean following rice, the inability of mungbean roots to penetrate the hard pan is a major constraint for development of a sound rice/mungbean cropping system in the lowlands with compacted soils.

Keywords: Lowland rice field; Mungbean; Straw mulch; Crop establishment; Weed biomass

24. Ma. Carmelita R. Alberto, Reiner Wassmann, Takashi Hirano, Akira Miyata, Ryusuke Hatano, Arvind Kumar, Agnes Padre, Modesto Amante, Comparisons of energy balance and evapotranspiration between flooded and aerobic rice fields in the Philippines, Agricultural Water Management, Volume 98, Issue 9, July 2011, Pages 1417-1430, ISSN 0378-

Abstract: The seasonal and annual variability of sensible heat flux (H), latent heat flux (LE), evapotranspiration (ET), crop coefficient (Kc) and crop water productivity (WPET) were investigated under two different rice environments, flooded and aerobic soil conditions, using the eddy covariance (EC) technique during 2008–2009 cropping periods. Since we had only one EC system for monitoring two rice environments, we had to move the system from one location to the other every week. In total, we had to gap-fill an average of 50–60% of the missing weekly data as well as those values rejected by the quality control tests in each rice field in all four cropping seasons. Although the EC method provides a direct measurement of LE, which is the energy used for ET, we needed to correct the values of H and LE to close the energy balance using the Bowen ratio closure method before we used LE to estimate ET. On average, the energy balance closure before correction was 0.72 ± 0.06 and it increased to 0.99 ± 0.01 after correction. The G in both flooded and aerobic fields was very low. Likewise, the energy involved in miscellaneous processes such as photosynthesis, respiration and heat storage in the rice canopy was not taken into consideration.

25. Average for four cropping seasons, flooded rice fields had 19% more LE than aerobic fields whereas aerobic rice fields had 45% more H than flooded fields. This resulted in a lower Bowen ratio in flooded fields (0.14 ± 0.03) than in aerobic fields (0.24 ± 0.01). For our study sites, evapotranspiration was primarily controlled by net radiation. The aerobic rice fields had lower growing season ET rates (3.81 ± 0.21 mm d−1) than the flooded rice fields (4.29 ± 0.23 mm d−1), most probably due to the absence of ponded water and lower leaf area index of aerobic rice. Likewise, the crop coefficient, Kc, of aerobic rice was significantly lower than that of flooded rice. For aerobic rice, Kc values were 0.95 ± 0.01 for the vegetative stage, 1.00 ± 0.01 for the reproductive stage, 0.97 ± 0.04 for the ripening stage and 0.88 ± 0.03 for the fallow period, whereas, for flooded rice, Kc values were 1.04 ± 0.04 for the vegetative stage, 1.11 ± 0.05 for the reproductive stage, 1.04 ± 0.05 for the ripening stage and 0.93 ± 0.06 for the fallow period. The average annual ET was 1301 mm for aerobic rice and 1440 mm for flooded rice. This corresponds to about 11% lower total evapotranspiration in aerobic fields than in flooded fields. However, the crop water productivity (WPET) of aerobic rice (0.42 ± 0.03 g grain kg−1 water) was

significantly lower than that of flooded rice (1.26 ± 0.26 g grain kg−1 water) because the grain yields of aerobic rice were very low since they were subjected to water stress.

The results of this investigation showed significant differences in energy balance and evapotranspiration between flooded and aerobic rice ecosystems. Aerobic rice is one of the promising water-saving technologies being developed to lower the water requirements of the rice crop to address the issues of water scarcity. This information should be taken into consideration in evaluating alternative water-saving technologies for environmentally sustainable rice production systems.
Keywords: Evapotranspiration; Crop coefficient; Crop water productivity; Heat fluxes; Flooded rice; Aerobic rice

26. Sing-Chung Li, Tsui-Chuan Chou, Chun-Kuang Shih, Effects of brown rice, rice bran, and polished rice on colon carcinogenesis in rats, Food Research International, Volume 44, Issue 1, January 2011, Pages 209-216, ISSN 0963-9969,
Abstract: Rice is a nutritious staple food with health-promoting activity. This study investigated the effects of brown rice, rice bran, and polished rice on 1,2-dimethylhydrazine (DMH)-induced colon carcinogenesis in rats. The colons were examined for preneoplastic lesions and the expression of pro-inflammatory proteins. Lipid peroxidation was determined in livers and plasma; antioxidant-associated parameters were determined in livers. The results showed that consumption of medium-level of rice bran significantly reduced the number of aberrant crypt foci (ACF) and altered their distribution. Brown rice and rice bran significantly reduced cyclooxygenase-2 (COX-2) expression of the middle colon. Brown rice, rice bran, and polished rice had no significant effect on plasma and hepatic lipid peroxides and hepatic antioxidant-associated parameters. Thus, rice bran may be one candidate of the active rice fraction that protects the colon against DMH-induced early carcinogenesis in rats and may be a novel dietary supplement for chemoprevention of colon cancer.
Keywords: Rice; Colon cancer; Aberrant crypt foci; Mucin; Cyclooxygenase-2

27. Daming Li, Manqiang Liu, Yanhong Cheng, Dong Wang, Jiangtao Qin, Jiaguo Jiao, Huixin Li, Feng Hu, Methane emissions from double-rice cropping system under conventional and no tillage in southeast China, Soil and Tillage Research, Volume 113, Issue 2, June 2011, Pages 77-81, ISSN 0167-1987,
Abstract: A field experiment was carried out to investigate the methane emission pattern in a double-rice cropping system under conventional and no tillage in southeast China. The treatments included conventional tillage cultivation in both early rice and late rice (T–T) and conventional tillage in early rice but no-till in late rice (T–NT). The maximum methane emission rate of T–T and T–NT was 21.71 mg m−2 h−1 and 24.70 mg m−2 h−1 in early rice, respectively; and 18.52 mg m−2 h−1 and 7.32 mg m−2 h−1 in late rice, respectively. The seasonal amount of methane emission from the T–T and T–NT was not significantly different in early rice, but significant different (P < 0.05) in late rice, with the values 6.57 g m−2 and 3.04 g m−2, respectively. In

comparison with early rice, the seasonal amount methane flux of late rice was reduced by 29% and 68% in the T–T and T–NT, respectively. The decrease of methane emission in the T–NT was attributed to lower dissolved organic carbon (DOC) content and higher soil bulk density. In conclusion, no tillage practice conducted in rice cropping season will markedly decrease methane emission for the rice cropping system.
Keywords: Methane emission; No-till; Double-rice cropping system; Dissolved organic carbon; Soil bulk density

28. Min Huang, Yingbin Zou, Yuehua Feng, Zhaowei Cheng, Yali Mo, Md. Ibrahim, Bing Xia, Peng Jiang, No-tillage and direct seeding for super hybrid rice production in rice–oilseed rape cropping system, European Journal of Agronomy, Volume 34, Issue 4, May 2011, Pages 278-286, ISSN 1161-0301,
Abstract: No-tillage and direct seeding (NTDS) is an effective crop production method for reducing production costs and soil conservation. In order to understand performance of super hybrid rice under NTDS in rice–oilseed rape cropping system, a researcher-managed trail (2004–2010) and an on-farm research (2002–2005) were conducted to compare different tillage (conventional tillage or no-tillage) and rice establishment methods (transplanting or direct seeding) in super hybrid rice–oilseed rape cropping system. Under researcher-managed condition, grain yields of super hybrid rice under NTDS and conventional tillage and transplanting (CTTP) were equal. Compared with under CTTP, super hybrid rice under NTDS was characterized by more panicle number per m2 but less spikelet number per panicle, and lower aboveground biomass production before heading but higher aboveground biomass accumulated during heading to maturity. Higher maximum tiller number per m2 and lower spikelet production efficiency were responsible for the more panicle number per m2 and less spikelet number per panicle under NTDS, respectively. Under farmer-managed condition, super hybrid rice under NTDS had more panicle number m2 than under CTTP, which resulted in higher grain yield. Labor input under NTDS was lower than that under CTTP. Moreover, adoption of NTDS for super hybrid rice production had no significant impacts on seed yield and yield components of oilseed rape in rice–oilseed rape cropping system. Our study showed that CTTP could be replaced with NTDS to maintain yield and save labor for super hybrid rice production in rice–oilseed rape cropping system.
Keywords: No-tillage and direct seeding; Super hybrid rice; Rice–oilseed rape cropping system; Yield formation; Economics

29. Zhao-wu GUO, Hua-feng DENG, Shu-yuan LI, Lang-tao XIAO, Zhi-yuan HUANG, Qiang HE, Zhi-gang HUANG, He-song LI, Ruo-zhong WANG, Characteristics of the Mesophyllous Cells in the Sheaths of Rice (Oryza sativa L.), Agricultural Sciences in China, Volume 10, Issue 9, September 2011, Pages 1354-1364, ISSN 1671-2927,
Abstract: The photosynthesis of rice sheath plays a significant role to furnish rice yield, and it is accounted for 10 to 20% of the final yield. But, limited studies have been done to address this phenomenon and to characterize the mesophyllous cells of rice sheath and how it may attribute to the rice yield. In this paper, super hybrid rice Liangyoupeijiu, its parents Wumang 9311 and Peiai 64S, and hybrid rice Shanyou 63 were studied as the experimental materials, and the characteristics of the mesophyllous cells of rice sheaths were examined by microscopic and super-microscopic observation as well as chlorophyll absorption spectrums. The results showed that rice sheath was rich in the intact mesophyllous cells full of chloroplasts, grana and

thylakoids, which were much the same as those of rice blade. The absorption spectrum curves of the Chi. a and b of the sheaths were similar to those of the blades. The stomatal density in the outer epidermises of the sheaths was comparable to those in the up- and down-epidermises of the blades. The significant tests proved that the amount of chloroplast per mesophyllous cell of the sheaths was almost the same as those of the blades, and the mesophyllous cells in the sheaths were also rich in chlorophylls. The chlorophyll content of rice sheath reached about 50% of the chlorophyll content of rice blade, and the Pn of the sheath/the blade ranged from 13.60 to 34.57%. Therefore, rice sheath was also full of the intact photosynthetic apparatus similar to those in rice blade, and had capabilities of photosynthesis. The statistical analysis revealed that the physiological senescence of the photosynthetic apparatus in both the sheath and the blade of Liangyoupeijiu was significantly slower than those of the other varieties at the late stages. The profuse grain-filling stage was an inflexion point of the physiological senescence of the chloroplasts and the chlorophylls of both the blades and the sheaths.
Keywords: rice; sheath; mesophyllous cell; characteristic

30. Shuang-He Shen, Shen-Bin Yang, Yan-Xia Zhao, Yin-Long Xu, Xiao-Yan Zhao, Zhu-Yu Wang, Juan Liu, Wei-Wei Zhang, Simulating the rice yield change in the middle and lower reaches of the Yangtze River under SRES B2 scenario, Acta Ecologica Sinica, Volume 31, Issue 1, February 2011, Pages 40-48, ISSN 1872-2032,
Abstract: As one of the most important crops in China, rice accounts for 18% of the country’s total cultivated area. Increasing atmospheric CO2 concentration and associated climate change may greatly affect the rice productivity. Therefore, understanding the impacts of climate change on rice production is of great significance. This paper aims to examine the potential impacts of future climate change on the rice yield in the middle and lower reaches of the Yangtze River, which is one of the most important food production regions in China. Climate data generated by the regional climate Model PRECIS for the baseline (1961–1990) and future (2021–2050) period under IPCC SRES B2 scenario were employed as the input of the rice crop model ORYZA2000. Four experimental schemes were carried out to evaluate the effects of future climate warming, CO2 fertilization and water managements (i.e., irrigation and rain-fed) on rice production. The results indicated that the average rice growth duration would be shortened by 4 days and the average rice yield would be declined by more than 14% as mean temperature raised by 1.5 °C during the rice growing season in 2021–2050 period under B2 scenario. This negative effect of climate warming was more obvious on the middle and late rice than early rice, since both of them experience higher mean temperature and more extreme high temperature events in the growth period from July to September. The significance effect of the enhanced CO2 fertilization to rice yield was found under elevated CO2 concentrations in 2021–2050 period under B2 scenario, which would increase rice yield by more than 10%, but it was still not enough to offset the negative effect of increasing temperature. As an important limiting factor to rice yield, precipitation contributed less to the variation of rice yield than either increased temperature or CO2 fertilization, while the spatial distribution of rice yield depended on the temporal and spatial patterns of precipitation and temperature. Compared to the rain-fed rice, the irrigated rice generally had higher rice yield over the study area, since the irrigated rice was less affected by climate change.

Irrigation could increase the rice yield by more than 50% over the region north of the Yangtze River, with less contribution to the south, since irrigation can relieve the water stress for rice growing in the north region of the study area. The results above indicated that future climate change would significantly affect the rice production in the middle and lower reaches of the Yangtze River. Therefore, the adverse effect of future climate change on rice production will be reduced by taking adaptation measures to avoid disadvantages. However, there is uncertainty in the rice production response prediction due to the rice acclimation to climate change and bias in the simulation of rice yield with uncertainty of parameters accompanied with the uncertainty of future climate change scenario.
Keywords: Rice; ORYZA2000; Yangtze River zone; Climate change

31. Weihua Jiang, Xiaojing Jiang, Jianren Ye, Qiang Fu, Yongbin Feng, Ju Luo, Zhaojun Han, Rice striped stem borer, Chilo suppressalis (Lepidoptera: Pyralidae), overwintering in super rice and its control using cultivation techniques, Crop Protection, Volume 30, Issue 2, February 2011, Pages 130-133, ISSN 0261-2194,
Abstract: Super rice has the potential to deliver very high yields but is also susceptible to attack by the striped rice stem borer, Chilo suppressalis. In this study, surveys and field trials were performed to examine this problem and efficient ways were found to lower the borer's population density. It was found that larger super rice plants provided more refuges for borers to evade insecticide contact and had a longer growth period allowing borers to complete their larval development in an intact environment. The current cultivation regime was shown to favour outbreaks of borers. Super rice is harvested leaving tall field stubbles until the following growing season, thus providing food and cover in which borers may successfully overwinter. We found that borer larvae were distributed to a greater height in the plants of super rice than in common rice, making control through agricultural operations more feasible. Burning fields after harvest, which killed 84.5% of borers, seemed the best remedy, though this practice is forbidden in China for ecological reasons. Leaving short stubbles followed by appropriate treatment of the rice straw killed 74.0% of the borer population. In addition, spring irrigation after the pre-pupation dispersal movements of borers killed more than half of the overwintering population. Pre-winter rotary tillage had little effect on borer numbers but enhanced the population reduction effect of irrigation the following spring. Based on the results obtained, efficient control of borers on super rice can be achieved by harvesting leaving short stubbles, followed by rotary tillage and spring irrigation. This regime can reduce the borer population by more than 98%, minimising chemical use and maximising use of a reduced agricultural workforce.
Keywords: Super rice; Chilo suppressalis; Overwintering; Agricultural control

32. M. Farooq, Kadambot H.M. Siddique, H. Rehman, T. Aziz, Dong-Jin Lee, A. Wahid, Rice direct seeding: Experiences, challenges and opportunities, Soil and Tillage Research, Volume 111, Issue 2, January 2011, Pages 87-98, ISSN 0167-1987,
Abstract: Rice is one of the most important food crops in the world, and staple for more than half of the global population. Looming water crisis, water-intensive nature of rice cultivation and escalating labour costs drive the search for alternative management methods to

increase water productivity in rice cultivation. Direct seeded rice (DSR) has received much attention because of its low-input demand. It involves sowing pre-germinated seed into a puddled soil surface (wet seeding), standing water (water seeding) or dry seeding into a prepared seedbed (dry seeding). In Europe, Australia and the United States, DSR is highly mechanised. The development of early-maturing varieties and improved nutrient management techniques along with increased availability of chemical weed control methods has encouraged many farmers in the Philippines, Malaysia, Thailand and India to switch from transplanted to DSR culture. This shift should substantially reduce crop water requirements, soil organic-matter turnover, nutrient relations, carbon sequestering, weed biota and greenhouse-gas emissions. Still, weed infestation can cause large yield losses in DSR. In addition, recent incidences of blast disease, crop lodging, impaired kernel quality and stagnant yields across the years are major challenges in this regard. In this review, we discuss the experiences, potential advantages and problems associated with DSR, and suggest likely future patterns of changes in rice cultivation.
Keywords: Direct-seeded rice; Resource conservation; Rice production system; Seed priming; Water-saving; Weeds

33. Y.S. Savitha, Vasudeva Singh, Status of dietary fiber contents in pigmented and non-pigmented rice varieties before and after parboiling, LWT - Food Science and Technology, Volume 44, Issue 10, December 2011, Pages 2180-2184, ISSN 0023-6438,
Abstract: Five different varieties of paddy (four pigmented and one non-pigmented) were shelled and milled in pre and post parboiled form, their dietary fiber contents were estimated. Under similar conditions of milling, raw rice showed a high degree of polish (DOP), 9–12 g/100 g and parboiled rice showed low DOP, 4.6–6.6 g/100 g. Dietary fiber content was high in pigmented rice, 9–10 g/100 g compared to non-pigmented, ~6 g/100 g. Soluble fiber content in pigmented head rice (dehusked) varied from 1 to 1.5 g/100 g and in its brokens varied from 0.45 to 1.45 g/100 g. Dietary fiber content was low by about 1% in parboiled rice. In the parboiled rice of pigmented varieties, the total fiber content varied from 7.95 ± 0.15 to 9.05 ± 0.25 g/100 g and the soluble fiber content varied from 0.7 to 0.9 g/100 g. In milled parboiled rice the respective values were 5 ± 0.4 to 6 ± 0.1 g/100 g and 0.85 ± 0.05 to 1.25 ± 0.05 g/100 g. However, the soluble fiber content in the non-pigmented brown rice, IR-64 remained same after parboiling, 0.75 ± 0.5 g/100 g. Milled parboiled rice showed higher soluble dietary fiber compared to milled raw rice. In conclusion, dietary fiber was high in pigmented rice varieties when compared with non-pigmented rice.
Keywords: Pigmented rice; Non-pigmented rice; Parboiling; Shelling; Polishing; Dietary fiber

34. Dominic Glover, Science, practice and the System of Rice Intensification in Indian agriculture, Food Policy, Available online 18 August 2011, ISSN 0306-9192,
Abstract: The System of Rice Intensification (SRI) is claimed to be a novel approach to rice cultivation that is both more productive and more sustainable than conventional methods. Such claims have been

challenged or dismissed by many rice scientists, however. Despite the lack of clear and unequivocal endorsement by science, SRI seems to have spread widely and rather quickly to many rice-growing regions, including various areas of India. This paper discusses how and considers why SRI seems to have attracted the support of diverse stakeholders in Indian rice farming. As such, the SRI phenomenon should be taken seriously. Nevertheless, many scientific questions remain to be answered, concerning the biophysical mechanisms involved in SRI and their effects on plant performance and crop yields, the true spread of SRI practices among farmers and the system's impacts on farm livelihoods, rice production and resource use. Indian enthusiasm for SRI implies a level of dissatisfaction with conventional approaches to rice intensification and a demand for new methods that can address the perceived problems and challenges of agriculture in the future.
Keywords: System of Rice Intensification; SRI; India; Tamil Nadu; IAMWARM; Science

35. Yongle Liu, Xianghong Li, Xiaoling Zhou, Jian Yu, Faxiang Wang, Jianhui Wang, Effects of glutaminase deamidation on the structure and solubility of rice glutelin, LWT - Food Science and Technology, Volume 44, Issue 10, December 2011, Pages 2205-2210, ISSN 0023-6438,
Abstract: The effects of glutaminase on deamidation of rice glutelin were investigated. Water-insoluble rice glutelin was deamidated to the extent of deamidation degree 52.29% in 200 mmol/L sodium phosphate buffer (pH 7.0) at 37 °C for 48 h. Zeta potential analysis indicated that the glutamines of rice glutelin were deamidated into glutamic residues. Size exclusion chromatography results demonstrated that glutaminase deamidation broke the hydrophobic, hydrogen and some intermolecular disulfide bonds in rice glutelin and thereby rearranged the molecular weight distributions without serious cleavage of the peptide bonds. Fourier transform infrared analysis revealed the transformation of α-helix to random coil and β-turn by deamidation and suggested that deamidated rice glutelin maintained more flexible or extended forms. Solubility properties of rice glutelin in mildly acid (pH 5) and neutral buffers (pH 7) were remarkably improved by glutaminase deamidation. These new features of deamidated rice glutelin suggested that glutaminase could be a potential tool for enhancing the usability of rice protein in the food industry.
Keywords: Rice glutelin; Glutaminase; Deamidation; Structure; Solubility

36. Lan-zhi HAN, Mao-lin HOU, Kong-ming WU, Yu-fa PENG, Feng WANG, Lethal and Sub-Lethal Effects of Transgenic Rice Containing cry1Ac and CpTI Genes on the Pink Stem Borer, Sesamia inferens (Walker), Agricultural Sciences in China, Volume 10, Issue 3, March 2011, Pages 384-393, ISSN 1671-2927,
Abstract: Lethal and sub-lethal effects of transgenic rice containing cry1Ac and CpTI genes on the pink stem borer, Sesamia inferens, were studied to collect information for ecological risk assessment on insect-resistance of transgenic rice. In vitro insect-feeding bioassays were conducted to evaluate the lethal and sub-lethal effects of transgenic rice lines (II YouKF6 and KF6) containing cry1Ac+CpTI genes on S. inferens at four different growth stages, viz., seedling, tillering and elongation, booting, and milk and maturing. Transgenic rice at seedling stage showed significantly high lethal effect on S. inferens with the shortest lethal duration for 50 and 100% individuals and the highest corrected mortalities after feeding on transgenic lines

at this stage for 3 and 6 d. Followed by tillering and elongation stage, 50 and 100% S. inferens were dead after feeding on transgenic lines at this stage for 4 and 10 d, respectively. Moreover, corrected mortalities for 6 d feeding on transgenic lines at this stage were significantly higher than that at booting, and milk and maturing stages. Lethal effect of KF6 on S. inferens decreased significantly at booting stage. Lethal duration for 50% S. inferens significantly extended and its corrected mortalities for 6 d feeding also declined remarkably. However, lethal effect of II YouKF6 on S. inferens did not decrease significantly at this stage. Transgenic rice at booting, and milk and maturing stages did not show significant lethal effect to S. inferens and it showed the longest lethal duration for 50% individuals and the lowest corrected mortalities for 3 and 6 d feeding. A few larvae of S. inferens could survive, pupate and emerge on these two transgenic lines at booting, and milk and maturing stages. Sub-lethal effect of two transgenic lines on S. inferens also differed significantly between different developmental stages. Continuously feeding on transgenic rice lines at seedling, and tillering and elongation stages delayed the development of larvae and pupae and decreased pupation rate, but no effect was observed on eclosion rate. Larval development was significantly inhibited after feeding on transgenic rice at booting stage, but no obvious effect was observed in pupal stage, pupation and eclosion rate. There were no significant differences for larval and pupal development, pupation, and eclosion rates between feeding on transgenic and control rice lines at milk and maturing stage. Larval and pupal weights significantly declined, but no influence was observed on fecundity when S. inferens infested on transgenic rice at any stage. These showed that there were significant differences in lethal and sub-lethal effects of transgenic rice on S. inferens among developmental stages, and the effects gradually decreased with the increase of growth stages of rice plant.
Keywords: transgenic rice; Sesamia inferens; lethal and sub-lethal effect

37. Chitnucha Buddhaboon, Attachai Jintrawet, Gerrit Hoogenboom, Effects of planting date and variety on flooded rice production in the deepwater area of Thailand, Field Crops Research, Volume 124, Issue 2, 14 November 2011, Pages 270-277, ISSN 0378-4290,
Abstract: Crop management plays an important role in the transition from a deepwater rice to a flooded rice production system but information about optimum management strategies are currently lacking. The goal of this study was to determine the effect of planting date and variety on flooded rice production in the deepwater area of Thailand. Two experiments were conducted at the Bang Taen His Majesty Private Development Project in 2009 and 2010 to represent conditions prior to flooding (early rainy season) and after flooding (dry season). The early rainy season crop covered the period from May to October 2009, while the dry season crop covered the period from November 2009 to April 2010. The experimental design was a split plot with four main plots and three sub plots replicated four times. The treatments for the main plot were various planting dates, while the treatments for the sub plots were rice varieties. The dates of the critical developmental phases of rice were recorded and biomass was sampled during the growing period. The collected data were statistically analyzed using ANOVA and treatment means were compared to identify the appropriate plating date and the best variety for the area. The highest average yield was obtained for variety PSL2 across transplanting dates from June 19 to

July 23, with an average yield of 3898 kg ha−1. The dry season crop showed that both biomass and yield were affected by the interaction between planting date and variety. The highest yield was obtained for variety PTT1 transplanted on November 9. The research showed that the variety PSL2 is the most suitable variety for early rainy season production with a transplanting date ranging from June 19 to July 23, while the variety PTT1 planted on November 9 was the best management practice for the dry season crop. However, a high yielding flooded rice variety that has a short growth duration is still needed for this area.
Keywords: Deepwater rice; Flooded rice; Growth; Development; Yield

38. Shangxin Song, Guanghong Zhou, Feng Gao, Wei Zhang, Liangyan Qiu, Sifa Dai, Xinglian Xu, Hongmei Xiao, Degradation of transgene DNA in genetically modified herbicide-tolerant rice during food processing, Food and Chemical Toxicology, Available online 19 August 2011, ISSN 0278-6915,
Abstract: In order to assess the effect of food processing on the degradation of exogenous DNA components in sweet rice wine and rice crackers made from genetically modified (GM) rice (Oryza sativa L.), we developed genomic DNA extraction methods and compared the effect of different food processing procedures on DNA degradation. It was found that the purity, quantity and quality of DNA by alkaline lysis method were higher than by CTAB (cetyltrimethylammonium bromide) method. For sweet rice wine, CAMV35S (cauliflower mosaic virus 35S) promoter and NOS (nopaline synthase) terminator were degraded by the third day, whereas the exogenous gene Bar (bialaphos resistance) remained unaffected. For rice crackers, boiling, drying and microwaving contributed to the initial degradations of DNA. Baking resulted in further degradations, and frying led to the most severe changes. These results indicated that the stability of DNA in GM rice was different under different processing conditions. For sweet rice wine, Bar was most stable, followed by NOS, CAMV35S, and SPS. For rice crackers, CAMV35S was most stable, followed by SPS, NOS, and Bar.
Keywords: Genetically modified; Herbicide-tolerant rice; Oryza sativa L.; Transgene DNA; DNA degradation; Food processing

39. Shi-Wen Huang, Ling Wang, Lian-Meng Liu, Shao-Qing Tang, De-Feng Zhu, Serge Savary, Rice spikelet rot disease in China – 2. Pathogenicity tests, assessment of the importance of the disease, and preliminary evaluation of control options, Crop Protection, Volume 30, Issue 1, January 2011, Pages 10-17, ISSN 0261-2194,
Abstract: In recent years, a rice panicle disease—rice spikelet rot, occurred seriously in large rice-growing area in China, causing the rice grains discolor, unfilled and deform. It does not only influence the rice yield, because of the colored pathogens and toxigenic, but also changes the appearance of the rice and reduces its quality. Spikelet rot disease influences on the rice production and market price, and causes harm to the safety and health of human and livestock. This paper makes effort to elucidate the occurrence, epidemic regularity of the disease, the pathogenicity of isolates. Fungicides to control the disease were preliminarily selected in lab and control efficiency test were conducted in field. The investigation results indicate that japonica varieties and their hybrid combination, tighten panicle varieties are easier to be infected by the disease than that of the indica rice varieties with loosen panicles. It was propitious to

the disease occurrence and epidemic when rice late booting to flowering period met the overcast, rainy (high humidity) and warm (25–33 °C) climate. Indoor selection results showed that ketotriazole shows very good restraint effect on the pathogens. Seed treating with fungicide, spraying ketotriazole, carbendazim + thiram mixture or tricyclazole at later booting and/or flowering stage can reached over 70% control efficiency to the disease.
Keywords: Rice spikelet rot; Occurrence and epidemic regularity; Pathogens; pathogenicity; Control

40. Monika Krupa, Kenneth W. Tate, Chris van Kessel, Naeem Sarwar, Bruce A. Linquist, Water quality in rice-growing watersheds in a Mediterranean climate, Agriculture, Ecosystems & Environment, Volume 144, Issue 1, November 2011, Pages 290-301, ISSN 0167-8809,
Abstract: Rice (Oryza sativa L.) agriculture is estimated to cover 161 million ha of land on Earth, with 10% grown in temperate regions. Currently there are strong concerns about surface water nutrient pollution, and the purpose of this study was to determine the impacts of temperate rice cultivation on nutrient dynamics at the small watershed scale. Over the course of the 2008 growing season (May through September), bi-weekly grab samples were collected from outlets of 11 agricultural subwatersheds in California. Samples were analyzed for NO3-N, NH4-N, PO4-P, K, and dissolved organic nitrogen (DON) concentrations, and the average values across all subwatersheds and sampling dates were 0.22, 0.031, 0.047, 1.36, and 0.32 mg L−1, respectively. Linear mixed effects analysis was used to evaluate the magnitude of relationships between nutrient concentration and flux and subwatershed characteristics (i.e. percent soil clay and organic matter, percent rice area, irrigation water reuse, subwatershed discharge, irrigated area, and time, measured as the day in the growing season). For all nutrients, flux decreased over time and increased with discharge. Concentrations of K and DON were highest at the start and end of the growing season. Concentrations of NH4-N were near non-detect levels, with the exception of a peak in mid-July, which corresponds to when many growers top-dress rice fields with N fertilizer. Nitrate-N concentration and flux decreased with percent rice area, whereas PO4-P concentrations increased with percent rice area, indicating that rice area should be considered in future watershed-scale studies of nutrient discharge. In all subwatersheds, the discharge loads of K were smaller than surface water input loads, while NO3-N, NH4-N, PO4-P, and DON discharge loads exceeded input loads when total growing season discharge was greater than 3500–6600 m3 ha−1. This implies that the management of subwatershed discharge can be used to control nutrient export from rice-growing areas.
Keywords: Rice; Nitrogen; Phosphorus; Potassium; Water quality; Nutrient flux

41. R.J. Bryant, A.M. McClung, Volatile profiles of aromatic and non-aromatic rice cultivars using SPME/GC–MS, Food Chemistry, Volume 124, Issue 2, 15 January 2011, Pages 501-513, ISSN 0308-8146,
Abstract: Rice (Oryza sativa L.) is enjoyed by many people as a staple food because of its flavour and texture. Some cultivars, like scented rice, are preferred over others due to their distinctive aroma and flavour. The volatile profile of rice has been explored by other investigators, some of whom have also determined a corresponding aroma using GC/olfactometry. However, little research has been done to

determine if different aromatic rice cultivars produce different flavour volatiles that would make them more desirable than others when cooked. In this study, seven aromatic and two non-aromatic cultivars were examined for their volatile profiles both before and after storage using solid phase microextraction (SPME) fibres in conjunction with gas chromatography/mass spectrometer (GC–MS). Ninety-three volatile compounds were identified, 64 of which had not been previously reported in rice. Differences were found in the volatile compounds of aromatic and non-aromatic rice besides 2-acetyl-1-pyrroline (2-AP). Most of the volatile compounds were present in freshly harvested rice and rice following storage, with very few new compounds being identified only after storage. Dellrose, an aromatic cultivar, and Cocodrie, a non-aromatic cultivar, had the most complex volatile profiles (over 64 volatiles). Sixteen compounds were found only in the aromatic cultivars, and some volatiles were found to be unique to specific aromatic cultivars. However, no distinctive pattern was observed that would identify a cultivar as being derived from Basmati, Khao Dawk Mali 105 (i.e. jasmine), or other sources of aroma. This study showed that there is a great diversity of volatiles in both aromatic and non-aromatic rice cultivars and, with further research, this may lead to a better understanding of the combination of compounds that gives a cultivar a unique flavour.
Keywords: Aroma; Flavour; Oryza sativa L.; Rice; Scented rice; SPME; GC/MS; Volatiles

42. A.K. Chapagain, A.Y. Hoekstra, The blue, green and grey water footprint of rice from production and consumption perspectives, Ecological Economics, Volume 70, Issue 4, 15 February 2011, Pages 749-758, ISSN 0921-8009,
Abstract: The paper makes a global assessment of the green, blue and grey water footprint of rice, using a higher spatial resolution and local data on actual irrigation. The national water footprint of rice production and consumption is estimated using international trade and domestic production data. The global water footprint of rice production is 784 km3/year with an average of 1325 m3/t which is 48% green, 44% blue, and 8% grey. There is also 1025 m3/t of percolation in rice production. The ratio of green to blue water varies greatly over time and space. In India, Indonesia, Vietnam, Thailand, Myanmar and the Philippines, the green water fraction is substantially larger than the blue one, whereas in the USA and Pakistan the blue water footprint is 4 times more than the green component. The virtual water flows related to international rice trade was 31 km3/year. The consumption of rice products in the EU27 is responsible for the annual evaporation of 2279 Mm3 of water and polluted return flows of 178 Mm3 around the globe, mainly in India, Thailand, the USA and Pakistan. The water footprint of rice consumption creates relatively low stress on the water resources in India compared to that in the USA and Pakistan.
Keywords: Rice; Virtual water; Water footprint; Green water; Blue water; Pollution

43. Ioannis Ganopoulos, Anagnostis Argiriou, Athanasios Tsaftaris, Adulterations in Basmati rice detected quantitatively by combined use of microsatellite and fragrance typing with High Resolution Melting (HRM) analysis, Food Chemistry, Volume 129, Issue 2, 15 November 2011, Pages 652-659, ISSN 0308-8146,

Abstract: The aim of this work was to setup a DNA based method coupled with High Resolution Melting (HRM) analysis for rice products traceability using five different microsatellite markers to genotyping Basmati and non-Basmati varieties. We also exploit the obtained information to detect the presence of Basmati varieties in commercial rice products. Additionally we used the 8 bp deletion in badh2 gene in combination with HRM to both DNA-typing of the Basmati and non-Basmati varieties and to quantitate accurately adulteration of Basmati rice products with non-Basmati rice products. HRM proved to be a very sensitive tool to genotype rice varieties and detect admixtures as well as able to detect a ratio of 1:100 of non-fragrance in fragrance rice. In conclusion HRM analysis can be a higher resolution, cost effective, alternative method compared to other techniques that could be extended to quantify adulterations in rice varieties and commercial rice food products.
Keywords: Adulteration; Basmati rice; Fragrance; High Resolution Melting; Microsatellites

44. Kyritsi, C. Tzia, V.T. Karathanos, Vitamin fortified rice grain using spraying and soaking methods, LWT - Food Science and Technology, Volume 44, Issue 1, January 2011, Pages 312-320, ISSN 0023-6438,
Abstract: The objective of this work was to fortify three types of rice grains (brown, white milled and parboiled) with B complex vitamins (B1, B2, B3, B5, B6, B12), using two different physical treatment methods, (1) soaking of whole dehusked or milled rice kernels in vitamin solutions at 90 °C for 15 min and (2) full spraying of whole kernels with vitamin solution at 35 °C, both followed by oven drying. Various nutrient concentrations were added and the vitamin retention of dried fortified as well as of cooked rice were determined. Fortified rice was evaluated based on vitamin retention, estimated as the percentage of vitamin in rice after fortification treatment versus the total amount of added plus its initially vitamin quantity. It was found that the average retention of all vitamins in dried rice was high and varied from 54.3% to 85.3% for the spraying and from 53.5% to 76.2% for the soaking method respectively. After rice cooking, the retention was maintained in sufficient level (>70%) for all vitamins except for B12. When excess of water was used for cooking, the water-soluble vitamins were leached; however a significant amount of vitamins still remained, varying from 13.5% (B12) to 51.2% (B1). The good retention of vitamins, even after cooking, achieved applying these relatively simple techniques, may be attributed to the absorption and diffusion of vitamins in the interior of rice kernels in high concentrations. Dried fortified rice samples properties were evaluated.
Keywords: Fortification; Vitamin retention; Spraying; Soaking; Rice

45. Pei-Yin Lin, Hsi-Mei Lai, Bioactive compounds in rice during grain development, Food Chemistry, Volume 127, Issue 1, 1 July 2011, Pages 86-93, ISSN 0308-8146,
Abstract: The bioactive compounds in two developing rice grains, KFSW (a waxy indica red rice) and TK16 (a non-waxy japonica rice), were investigated. The total phenolics and total flavonoids of two developing rice grains were significantly higher than those in mature seeds. The phenolics extract was further fractionated into three fractions, free, soluble-ester and insoluble-bound; ferulic acid was the most abundant compound in each fraction, in both immature grain and mature seed. α-Tocopherol was the most abundant vitamin E homologue, followed by γ-tocotrienol in KFSW and α-tocotrienol in TK16. High

contents of free and soluble-ester ferulic acids, soluble dietary fibre, total tocols and oryzanols were found in the 15th and 18th DAA (days after anthesis) grains, which were suitable for dehulling, with a reasonable brown rice yield. Immature rice grains, containing a remarkable amount of bioactive compounds with a high reducing power, have a great potential for applications in nutraceutical foods.
Keywords: Developing rice grain; Phenolics; Flavonoids; Reducing power; Tocopherols; Oryzanols

46. J.-H. Huang, P. Fecher, G. Ilgen, K.-N. Hu, J. Yang, Speciation of arsenite and arsenate in rice grain – Verification of nitric acid based extraction method and mass sample survey, Food Chemistry, Volume 130, Issue 2, 15 January 2012, Pages 453-459, ISSN 0308-8146,
Abstract: Arsenite and arsenate speciation was performed in 121 commercially purchased samples of 12 rice types to understand their relative relevance in rice grain. General effectiveness of a recently developed extraction protocol based on 0.28 M nitric acid at 95 °C was verified by checking the recovery of total grain arsenic and by comparing arsenic speciation in NIST-CRM-1568a, NMIJ-CRM-7503a and IMEP-107 with certificated and literature values. The arsenic speciation highlights the predominance of arsenite in 115 and dimethylarsinic acid in six samples and common minor components including arsenate, monomethylarsonic acid and two unknown arsenical species. Our data also indicate potential influences of other trace elements on As speciation in rice grain. Averagely, arsenite accounts for 90% of inorganic grain arsenic regardless of geographic origin, rice type, grain size, cultural practice and polish treatment. The high arsenite predominance indicates an elevated toxic effect of arsenic in rice than is perceived to date.
Keywords: Arsenite; Arsenate; Arsenic speciation; Rice grain; Nitric acid extraction

47. Zhongna Hao, Lianping Wang, Yueping He, Jiangen Liang, Rongxiang Tao, Expression of defense genes and activities of antioxidant enzymes in rice resistance to rice stripe virus and small brown planthopper, Plant Physiology and Biochemistry, Volume 49, Issue 7, July 2011, Pages 744-751, ISSN 0981-9428,
Abstract: The rice variety Tai06-1 is resistant to rice stripe disease and Xiushui63 is a highly susceptible rice variety to this disease. These two varieties were used to analyze the expression patterns of defense genes and antioxidant defense responses at the seedling stage, upon feeding with viruliferous small brown planthopper (SBPH) and nonviruliferous SBPH, respectively. The expression levels of CP (coat protein) gene of rice stripe virus (RSV) were higher upon feeding with viruliferous SBPH in Xiushui63 than in Tai06-1 throughout most of the experimental period, suggesting that RSV replicaiton is disturbed in Tai06-1 but not in Xiushui63, therefore, the resistance to RSV is higher in Tai06-1 than in Xiuhsui63. We found that defense genes PR1a (pathogenesis-related class 1a), PAL (phenylalanine ammonia-lyase), and CHS (chalcone synthase) may play roles in the defense responses to both RSV and SBPH in Tai06-1, and PR4 and PR10a may only participate in defending against SBPH attack but not against RSV infection in Tai06-1. Our data reveal that Gns1 (1,3; 1,4-β-glucanase) may participate in the defense responses to both RSV and SBPH in Xiushui63 but not in Tai06-1, and LOX (lipoxygenase) may only participate in defending against to SBPH in both Tai06-1 and Xiushui63. The antioxidant enzymes superoxide dismutase, peroxidase, catalase, hydrogen peroxide, and malondialdehyde

coordinately participate in the resistance to RSV in Tai06-1, and that oxidative damage is less in Tai06-1 than in Xiushui63.
Keywords: Antioxidant response; Defense gene; Oryza sativa; Rice stripe virus; Small brown planthopper

48. Murali Krishna Gumma, Devendra Gauchan, Andrew Nelson, Sushil Pandey, Arnel Rala, Temporal changes in rice-growing area and their impact on livelihood over a decade: A case study of Nepal, Agriculture, Ecosystems & Environment, Volume 142, Issues 3-4, August 2011, Pages 382-392, ISSN 0167-8809,
Abstract: This study aimed to investigate the changes in rice-growing area over a decade (2000–2009) using remote-sensing techniques in combination with socioeconomic information and national statistics. Temporal rice area and land-use changes in Nepal were mapped using MODIS (MOD09A1) 500 m time-series data and spectral matching techniques (SMTs). This analysis presents mapped agricultural cropland change detected over a large area, where fuzzy classification accuracies range between 67% and 91% for various rice classes, with an accuracy of 82% for field-plot data. The MODIS-derived rice areas for the districts were highly correlated with national statistical data with R2 values of 0.9918. We observed a significant decline (13%) in rice cultivated area in 2006 compared with the average over the remaining years. The higher reduction in rice area was mainly restricted to the rainfed districts of the eastern, central, and midwestern regions due to severe drought incidence, particularly in 2006. The area under the rainfed rice ecosystem continues to predominate, recording the largest share among rice classes across all the years from 2000 to 2009. The use of remote-sensing techniques is a rapid, cost-effective, and reliable measure to monitor changes in rice cultivated area over long periods of time and estimate the reduction in area cultivated due to climatic stress such as drought. Reinforced with methods and information in socioeconomics, these techniques could be used for mapping agricultural land-use changes, production planning, and targeting. Agricultural research and development institutions in Nepal can use these techniques for better planning, regular monitoring of land-use changes, and technology transfer.
Keywords: Rice maps; Temporal changes; MODIS; Drought effect; Nepal; Rice price

49. Li-Jia Zhu, Hulya Dogan, Hyma Gajula, Ming-Hong Gu, Qiao-Quan Liu, Yong-Cheng Shi, Study of kernel structure of high-amylose and wild-type rice by X-ray microtomography and SEM, Journal of Cereal Science, Available online 21 September 2011, ISSN 0733-5210,
Abstract: Rice kernels of a transgenic high-amylose rice line and its wild type were examined by a high-resolution X-ray microtomograph (XMT) and an environmental scanning electron microscope (SEM). Two-dimensional (2-D) cross-sectional images and 3-D objects from XMT were reconstructed and analyzed to elucidate their structural features. The lack of two isoforms of starch branching enzyme, termed SBE and SBEb in high-amylose rice (HAR), resulted in a distinctly different grain inner density than wild-type rice (WTR). HAR had smaller, elongated starch granules with air spaces inside the kernels resulting in an opaque grain, whereas WTR had a tight endosperm with little air space and polygonal starch granules. XMT allowed a full 3-D characterization of the rice kernel structure and revealed that air space distribution was not uniform in the HAR kernel.

Keywords: X-ray microtomography (XMT); Scanning electron microscope (SEM); Rice kernel; Microstructure

50. W.M.W. Weerakoon, M.M.P. Mutunayake, C. Bandara, A.N. Rao, D.C. Bhandari, J.K. Ladha, Direct-seeded rice culture in Sri Lanka: Lessons from farmers, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 53-63, ISSN 0378-4290,
Abstract: About 95% of the rice grown in Sri Lanka is direct-seeded (wet- and dry-seeding). The average rough rice yield in irrigated predominantly direct-seeded dry zone (DZ) is about 5.0 t ha−1and in the wet zone (WZ) it is about 3.3 t ha−1. However the average realizable yield in DZ and WZ are 8 t ha−1 and 5 t ha−1 respectively. A survey was conducted to understand the cultural practices, farmers' perceptions and the reasons for the yield gap in direct-seeded rice culture in Sri Lanka. Farmers' seed rate ranged from 87 to 220 kg ha−1 for intermediate bold-type varieties and from 71 to 176 kg ha−1 for varieties with short round grains. About 90% of the farmers in the DZ and the intermediate zone (IZ) consider both yield potential and duration as criteria in selecting a variety. Among the farmers surveyed, only 21% of the farmers in the DZ, 13% of the farmers in the IZ, and 29% of the farmers in the WZ adhered to the recommended method of basal fertilizer application. Farmers did not adhere to the correct timing of fertilizer application. More than 50% of the cost for rice farming goes to labor, followed by cost of inputs in all climatic zones. Farmers reported that the most important production constraint for direct-seeded rice in the DZ and IZ is the non availability of reliable labor followed by soil problems and weeds. While in the WZ, it is the soil problems specially iron toxicity followed by lower soil fertility. The survey revealed that smaller land holding size, non adherence to the optimum time of farm activity initiation, less efficient use of rain water, higher seed rate and higher cost of production are a few reasons for the existing yield gap. Location-specific technologies for different agro-ecological zones of Sri Lanka should be developed to reduce the cost of production and to increase resource-use efficiency and should be transferred to the farmers to achieve sustainable optimum direct-seeded rice yields.
Keywords: Direct-seeded rice culture; Sri Lanka; Wet-seeded rice; Dry-seeded rice; Farmers' cultural practices

51. Li-Jia Zhu, Qiao-Quan Liu, Jeff D. Wilson, Ming-Hong Gu, Yong-Cheng Shi, Digestibility and physicochemical properties of rice (Oryza sativa L.) flours and starches differing in amylose content, Carbohydrate Polymers, Volume 86, Issue 4, 15 October 2011, Pages 1751-1759, ISSN 0144-8617,
Abstract: Digestibility of starches in four rice samples with amylose content (AC) from 1.7 to 55.4%, including a newly developed high-amylose rice, was investigated. An in vitro enzymatic starch digestion method and an AOAC method were applied to correlate rapidly digestible starch (RDS), slowly digestible starch (SDS), resistant starch (RS), and total dietary fiber (TDF) content with the AC in the samples. SDS content decreased and RS and TDF content increased with the increase in AC. The low-amylose rice (AC = 16.1%) had starch granules with weak crystalline structure and was lower in RS and TDF content even though it had a higher AC compared to waxy rice. The digestibility of the starches was not correlated with granule size or degree of crystallinity. The newly developed high-amylose rice starch exhibited a

predominant B-type X-ray diffraction pattern, a great proportion of long chains in amylopectin, high gelatinization temperature, and semi-compound starch granules which are attributed to its increased resistance to enzyme digestion.
Keywords: Rice; Starch digestibility; Amylose; Resistant starch

52. Alice G. Laborte, Kees (C.A.J.M.) de Bie, Eric M.A. Smaling, Piedad F. Moya, Anita A. Boling, Martin K. Van Ittersum, Rice yields and yield gaps in Southeast Asia: Past trends and future outlook, European Journal of Agronomy, Volume 36, Issue 1, January 2012, Pages 9-20, ISSN 1161-0301,
Abstract: Rice production must increase to meet future food requirements amid strong competition for limited resources. Yield gap analysis is a useful method to examine how large the ranges are between potential, desirable rice yields and those actually realized in farmers' fields. We analyzed farmers' yields in wet and dry seasons in four intensively cropped rice areas in Southeast Asia and explored opportunities for reducing the yield gap to meet future food requirements. We found yield gaps of 2.0–5.0 t ha−1 between average and climatic yield potential and 1.2–2.6 t ha−1 between average and best farmers' yields. In relative terms, average yields varied between 43% and 75% of the climatic yield potential and 61% and 83% of the best farmers' yields. Farmers with best yields were generally more educated, and used fertilizers and labor more efficiently than average farmers. The yield gaps between average and best farmers' yields are higher in rice-importing countries (Indonesia and Philippines) compared with rice-exporting countries (Thailand and Vietnam). Assuming no change in diet, closing the existing yield gap between average and best-yielding farmers can sufficiently cover the yield increase needed for 2050 in the three countries, except for the Philippines, where yield increase must be even higher. Trend analysis of yield increases of a population of farmers in Central Luzon (Philippines), which included a learning curve analysis, well described the process of technology adoption from 1966 to 2008, leading to higher yields. Using this analysis, for the Philippines, we predicted yields to increase (from 2007/2008 to 2050) by only 18% with current cultivars, production technologies, and prevailing conditions. Therefore, structural changes are needed to boost farmers' yields to close the yield gap faster. Investments in technology transfer and institutional arrangements are suggested.
Keywords: Food production; Learning curve; Rice; Southeast Asia; Yield gap

53. Yun-Sang Choi, Ji-Hun Choi, Doo-Jeong Han, Hack-Youn Kim, Mi-Ai Lee, Hyun-Wook Kim, Jong-Youn Jeong, Cheon-Jei Kim, Effects of rice bran fiber on heat-induced gel prepared with pork salt-soluble meat proteins in model system, Meat Science, Volume 88, Issue 1, May 2011, Pages 59-66, ISSN 0309-1740,
Abstract: The technological effects of rice bran fiber on pork salt-soluble meat proteins in a model system were investigated. Rice bran fiber at levels of 0% (control), 0.1%, 0.5%, 1%, and 2% was added at the same time as salt-soluble meat protein to maintain similar moisture levels in all samples. Samples with increasing amounts of added rice bran fiber had higher pH, yellowness, sarcoplasmic and total protein solubilities. The moisture content, myofibrillar protein solubility and water holding capacity were the highest in the treatments containing with 1% rice bran fiber. However, the lightness and redness, textural

properties decreased with increasing rice bran fiber levels. SDS gel electrophoresis did not reveal any changes in proteins regardless different rice bran fiber levels. The apparent viscosity indicated that improvements in water holding capacity and decreased texture due to added rice bran fiber.
Keywords: Heat-induced gel; Rice bran fiber; Model system; Salt-soluble meat protein

54. Midori Okami, Yoichiro Kato, Junko Yamagishi, Role of early vigor in adaptation of rice to water-saving aerobic culture: Effects of nitrogen utilization and leaf growth, Field Crops Research, Volume 124, Issue 1, 9 October 2011, Pages 124-131, ISSN 0378-4290,
Abstract: Early vigor and rapid canopy development are important characteristics in aerobic rice culture, where they are highly susceptible to soil water deficits. To elucidate the response of rice's vegetative growth to water management regimes, we evaluated the leaf growth and the concomitant nitrogen (N) utilization of nine cultivars grown in flooded and aerobic culture in 2 years. In aerobic culture, the soil water potential at a depth of 20 cm frequently reached −60 kPa in 2007, but remained above −30 kPa in 2008. The average leaf area index (LAI) in the middle of the vegetative growth stage, N uptake and leaf N content per unit leaf area (specific leaf N; SLN) in aerobic culture were comparable to those in flooded culture. However, there was a significant cultivar × water regime interaction in LAI: cultivars with higher LAI during the vegetative growth stage achieved higher yield in aerobic rice culture. IR72 and Takanari (high-yielding cultivars of flood-irrigated rice) showed poor leaf growth as well as lower N uptake and higher SLN in aerobic culture compared with flooded culture. Our results show that early vigor is closely associated with yield stability to the soil moisture fluctuations in aerobic rice culture, even if weeds are properly controlled. Greater N uptake from aerobic soil and better balancing between the N demand for leaf growth and the N supply to the leaves under fluctuating soil moisture would be, at least in part, relevant to a rice cultivar's adaptation to aerobic conditions.
Keywords: Aerobic rice; Early plant vigor; Leaf area index; Water-saving technology

55. Jing Fu, Zuanhua Huang, Zhiqin Wang, Jianchnag Yang, Jianhua Zhang, Pre-anthesis non-structural carbohydrate reserve in the stem enhances the sink strength of inferior spikelets during grain filling of rice, Field Crops Research, Volume 123, Issue 2, 14 August 2011, Pages 170-182, ISSN 0378-4290,
Abstract: Sink strength plays an important role in grain filling of cereals but how it is related to the pre-anthesis non-structural carbohydrate (NSC) reserves is not clear. This study investigated if and how an increase in NSC reserves could enhance sink strength, and consequently improve grain filling of later-flowering inferior spikelets (in contrast to the earlier flowering superior spikelets) for rice varieties with large panicles. Two “super” rice varieties (the recently bred high-yielding rice) and two New Plant Type (NPT, named in IRRI for the extra-large panicle) rice lines were compared with two elite inbred varieties under field-grown conditions. Three nitrogen (N) treatments, applied at the stages of panicle initiation, spikelet differentiation or both, were adopted with no N application during the mid-season as control. Both super rice and NPT rice showed a greater yield capacity as a result of a larger panicle than the elite inbred

rice. However, a lower percentage of filled grains limited the realization of higher yield potential in super rice and especially in NPT rice, due to their lower grain filling rate and the smaller grain weight of their inferior spikelets. The low grain filling rate and small grain weight of inferior spikelets are mainly attributed to a poor sink strength as a result of small sink size (small number of endosperm cells) and low sink activity, e.g. low activities of sucrose synthase (SuSase) and adenosine diphosphoglucose pyrophosphorylase (AGPase). The amounts of NSC in the stem and NSC per spikelet at the heading time are significantly and positively correlated with sink strength (number of endosperm cells and activities of SuSase and AGPase), grain filling rate, and grain weight of inferior spikelets. Nitrogen application at the spikelet differentiation stage significantly increased, whereas N application at the panicle initiation or at both panicle initiation and spikelet differentiation stages, significantly reduced, NSC per spikelet at the heading time, sink strength, grain filling rate, and grain weight of inferior spikelets in super rice. The results suggest that pre-anthesis NSC reserves in the stem are closely associated with the sink strength during grain filling of rice, and N application at the spikelet differentiation stage would be a good practice to increase pre-anthesis NSC reserves, and consequently to enhance sink strength for rice varieties with large panicles, such as super rice varieties.
Keywords: Super rice (Oryza sativa L.); Non-structural carbohydrate; Sink strength; Inferior spikelets; Grain filling; Source–sink relationship

56. Wen Sun, Yao Huang, Global warming over the period 1961–2008 did not increase high-temperature stress but did reduce low-temperature stress in irrigated rice across China, Agricultural and Forest Meteorology, Volume 151, Issue 9, 15 September 2011, Pages 1193-1201, ISSN 0168-1923,
Abstract: Climate change is recognized to increase the frequency and severity of extreme temperature events that lead to declining crop yield, but this impact has not been well evaluated in China. We examined the changes in extreme temperature stress over the past five decades by quantifying the indices of temperature stress (TSI) during different growth stages of irrigated rice across mainland China. Our results suggest that the indices of low- or high-temperature stress can be used to explain the year-to-year changes in rice yield. Analysis using the TSI indicated that low-temperature stress (LTS) in the seedling and heading-flowering stages of single rice in northeast China, the seedling stage of early rice and the heading-flowering stage of late rice in the double rice regions has reduced over the period of 1961–2008. No significant trends in LTS were detected during the booting stage. Moreover, global warming did not enhance high-temperature stress (HTS) in the heading-flowering stage over the same period, except in early rice in the mid-lower Yangtze River Valley where the HTS in the 2000s was higher than in previous decades.
Keywords: Global warming; Extreme temperature; Rice production; China

57. Cristina de Simone Carlos Iglesias Pascual, Isabel Louro Massaretto, Fabiana Kawassaki, Rosa Maria Cerdeira Barros, José Alberto Noldin, Ursula Maria Lanfer Marquez, Effects of parboiling, storage and cooking on the levels of tocopherols, tocotrienols and γ-oryzanol in brown rice (Oryza sativa L.), Food Research International, Available online 23 July 2011, ISSN 0963-9969,

Abstract: Vitamin E and γ-oryzanol display a wide range of biological activities including hypocholesterolemic, anti-inflammatory and antioxidant activities. Although white rice is far more popular worldwide, consumption of brown rice is increasing, partially on account of the presence of bioactive compounds; however, the effects of parboiling, storage and cooking on them are not well-characterized. The effects of parboiling and a 6-month storage period on the contents of vitamin E and γ-oryzanol in three brown rice cultivars grown in three different locations in Brazil were investigated. Also, their levels in branded non-parboiled and parboiled brown rice were monitored before and after cooking. Vitamin E homologues and γ-oryzanol were separated by RP-HPLC equipped with PDA and fluorescence detectors. The average levels of total tocols and γ-oryzanol in the raw brown rice cultivars studied were 25 and 188 mg/kg, respectively. Of the vitamin E homologues, γ-tocotrienol contributed with 74% of total tocols, followed by α-tocopherol, α-tocotrienol and γ-tocopherol in minor quantities. The combined processes, parboiling, storage and cooking, led to an approximate 90% reduction in tocols and only γ-tocotrienol was detectable after any of the processes. Parboiling followed by storage resulted in an approximate 40% loss of γ-oryzanol. Cooking had almost no further effect over γ-oryzanol levels in parboiled rice previously stored for 6 months.
Keywords: Brown rice; Parboiling; Cooking; Storage; Vitamin E; γ-oryzanol

58. Aranya Manosroi, Warintorn Ruksiriwanich, Bang-on Kietthanakorn, Worapaka Manosroi, Jiradej Manosroi, Relationship between biological activities and bioactive compounds in the fermented rice sap, Food Research International, Volume 44, Issue 9, November 2011, Pages 2757-2765, ISSN 0963-9969,
Abstract: Various rice (Oryza sativa L. var. indica), including white plain, purple plain, brown plain, white glutinous and purple glutinous rice, were fermented with Look Pang (a mixed culture of yeasts and molds). The sap samples were assayed for the bioactive compounds (unsaturated fatty acids, total phenolic compounds and total anthocyanin) and the biological activities (antioxidative, tyrosinase inhibition, cell proliferation and MMP-2 inhibition activities). The fermented purple plain sap samples at day 6th of the fermentation period showed high antioxidative, the highest tyrosinase inhibition and MMP-2 inhibition activities with low cytotoxicity to normal human skin fibroblast by SRB assay in comparing to other rice sap samples. This study has indicated the strong positive relationship between the bioactive compounds and the biological activities of the purple rice sap which can be further developed as functional foods and cosmetics.
Keywords: Bioactive compounds; Biological activity; Cosmetics; Fermented rice sap; Functional foods; Purple plain rice

59. Aditya Putranto, Xiao Dong Chen, Zongyuan Xiao, Paul A. Webley, Mathematical modeling of intermittent and convective drying of rice and coffee using the reaction engineering approach (REA), Journal of Food Engineering, Volume 105, Issue 4, August 2011, Pages 638-646, ISSN 0260-8774,
Abstract: In order to extend shelf life of rice and coffee, drying can be conducted to minimize water content so that chemical and biological changes can be retarded. Several models have been proposed to model drying of coffee and rice. For design of dryer and evaluation of dryer performance, the effective and physically meaningful drying model

should be implemented. The reaction engineering approach (REA) is applied in this study to model convective drying of coffee as well as convective and intermittent drying of rice. The REA is a unique approach to model drying; the physics of drying is captured by the relative activation energy which can be generated only from one accurate drying experiment. The relative activation energy can be applied to other conditions of drying provided the same material and similar initial moisture content. Results indicate that the REA describes the convective and intermittent drying of rice and coffee very well.
Keywords: Rice; Coffee; Drying; Model; The reaction engineering approach (REA)

60. Jiliang Lü, Peijiang Zhou, Optimization of microwave-assisted FeCl3 pretreatment conditions of rice straw and utilization of Trichoderma viride and Bacillus pumilus for production of reducing sugars, Bioresource Technology, Volume 102, Issue 13, July 2011, Pages 6966-6971, ISSN 0960-8524,
Abstract: In this study, Box-Behnken design (BBD) and response surface methodology (RSM) were used to optimize microwave-assisted FeCl3 pretreatment conditions of rice straw with respect to FeCl3 concentration, microwave intensity, irradiation time and substrate concentration. When rice straw was pretreated at the optimal conditions of FeCl3 concentration, 0.14 mol/L; microwave intensity, 160 °C; irradiation time, 19 min; substrate concentration, 109 g/L; and inoculated with Trichoderma viride and Bacillus pumilus, the production of reducing sugars was 6.62 g/L. This yield was 2.9 times higher than that obtained with untreated rice straw. The microorganisms degraded 37.8% of pretreated rice straw after 72 h. The structural characteristic analyses suggest that microwave-assisted FeCl3 pretreatment damaged the silicified waxy surface of rice straw, disrupted almost all the ether linkages between lignin and carbohydrates, and removed lignin.
Keywords: Rice straw; Microwave-assisted FeCl₃ pretreatment; RSM optimization; Trichoderma viride; Bacillus pumilus

61. Hisashi Kato-Noguchi, Convergent or parallel molecular evolution of momilactone A and B: Potent allelochemicals, momilactones have been found only in rice and the moss Hypnum plumaeforme, Journal of Plant Physiology, Volume 168, Issue 13, 1 September 2011, Pages 1511-1516, ISSN 0176-1617,
Abstract: Plant second metabolites momilactone A and B, which act as potent phytoalexins and allelochemicals, have been found thus far only in rice and the moss Hypnum plumaeforme, although both plants are taxonomically quite distinct. The concentrations of momilactone A and B, respectively, in rice plants were 4.5–140 and 2.9–85 μg/g, and those in H. plumaeforme were 8.4–58.7 and 4.2–23.4 μg/g. Momilactone A and B concentrations in rice and H. plumaeforme plants were increased by UV irradiation, elicitor and jasmonic acid treatments. Rice and H. plumaeforme plants secrete momilactone A and B into the rhizosphere, and the secretion level was also increased by UV irradiation, elicitor and jasmonic acid treatments. In addition, although endogenous concentrations of momilactone A in rice and H. plumaeforme were greater than those of momilactone B, the secretion levels of momilactone B were greater than those of momilactone A in rice and H. plumaeforme, which suggests that momilactone B may be

selectively secreted by both rice and H. plumaeforme. As momilactone A and B exert potent antifungal and growth inhibitory activities, momilactone A and B may play an important role in the defense responses in H. plumaeforme and rice against pathogen infections and in allelopathy. The secretion of momilactone A and B into the rhizosphere may also prevent bacterial and fungal infections and provide a competitive advantage for nutrients through the inhibition of invading root systems of neighboring plants as allelochemicals. Therefore, both plants, despite their evolutionary distance, may use same defense strategy with respect to the momilactone A and B production and secretion, which resulting from convergent or parallel evolutionary processes. In the case of parallel evolution, there may be plant species providing the missing link in molecular evolution of momilactones between H. plumaeforme and rice.
Keywords: Defense mechanism; Elicitor; Momilactone; Jasmonic acid; Pathogen; Phytoalexin; Rice

62. Hyun-Jung Chung, Qiang Liu, Laurence Lee, Dongzhi Wei, Relationship between the structure, physicochemical properties and in vitro digestibility of rice starches with different amylose contents, Food Hydrocolloids, Volume 25, Issue 5, July 2011, Pages 968-975, ISSN 0268-005X,
Abstract: The in vitro digestibility and molecular and crystalline structures of rice starches (Long-grain, Arborio, Calrose, and Glutinous) differing in amylose content were investigated and the relationship between the structure and in vitro digestibility of starch was studied. Long-grain showed the highest amylose content (27.2%), whereas Glutinous showed the lowest amylose content (4.2%). Long-grain had the highest average amylopectin branch chain length (18.8) and proportion (8.7%) of long branch chains (DP ≥ 37), and the lowest proportion (26.9%) of short branch chains (DP 6–12). Among the non-waxy rice starches (Long-grain, Arborio, and Calrose), Calrose had the lowest average chain length (17.7) and the lowest proportion (7.1%) of long branch chains (DP ≥ 37). The relative crystallinity of rice starch followed the order: Glutinous (33.5%) > Calrose (31.4%) > Arborio (31.0%) > Long-grain (29.9%). Long-grain had the highest gelatinization temperature and the lowest gelatinization temperature range, whereas Glutinous showed the highest gelatinization temperature range and gelatinization enthalpy. Arborio had the highest melting enthalpy for amylose–lipid complex among the tested rice starches. Pasting temperature, setback, and final viscosity increased with increasing amylose content, whereas the peak viscosity and breakdown showed negative correlations with amylose content. The rapidly digestible starch (RDS) content of the tested rice starches followed the order: Glutinous (71.4%) > Calrose (52.2%) > Arborio (48.4%) > Long-grain (39.4%). Contrary to this, the slowly digestible starch (SDS) and resistant starch (RS) contents showed an opposite trend compared to RDS. Digestibility (RDS, SDS, and RS) of the rice starches was significantly correlated (p ≤ 0.05) with amylose content, proportions of DP 6–12 and DP 13–24, relative crystallinity, intensity ratio (of 1047 cm−1 to 1022 cm−1 from Fourier transform infrared spectroscopy), swelling factor, amylose leaching, onset temperature of gelatinization, gelatinization temperature range,

gelatinization enthalpy, pasting temperature, peak viscosity, breakdown, setback, and final viscosity.
Keywords: Rice starch; Amylose content; Amylopectin chain length distribution; Crystalline structure; In vitro digestibility

63. Baljeet S. Yadav, Ritika B. Yadav, Mahesh Kumar, Suitability of pigeon pea and rice starches and their blends for noodle making, LWT - Food Science and Technology, Volume 44, Issue 6, July 2011, Pages 1415-1421, ISSN 0023-6438,
Abstract: The physicochemical and pasting properties of pigeon pea and rice starches were studied to assess their suitability for noodle making. Amylose content, solubility and freeze thaw stability of pigeon pea starch were significantly higher than those of rice starch (p < 0.05). The pasting properties of peak viscosity, final viscosity, breakdown and set back showed higher values for pigeon pea starch, whereas hot paste viscosity and pasting temperature were higher for rice starch. Rice starch noodles revealed less cooking time (4 min) and less percent solids loss, whereas pigeon pea starch noodles had higher cooking time (12 min), higher percentage of water absorbed during cooking, more hardness and cohesiveness. Rice starch noodles scored higher for their transparency and slipperiness over pigeon pea starch noodles. Blending of pigeon pea starch with rice starch had significant effects on the cooking and sensory quality of noodles. Among starch blends, 70:30 blend of the pigeon pea and rice starches respectively resulted in good quality of noodles especially in terms of their higher transparency, slipperiness, overall acceptability and cohesiveness values. Blending of pigeon pea starch with 30% rice starch could produce noodles with superior quality as compared to native pigeon pea and rice starch noodles.
Keywords: Pigeon pea; Rice; Starch noodles; Cooking quality

64. Xing Hua Zhou, Ying Dong, Xiang Xiao, Yun Wang, Yong Xu, Bin Xu, Wei Dong Shi, Yi Zhang, Li Jia Zhu, Qiao Quan Liu, A 90-day toxicology study of high-amylose transgenic rice grain in Sprague–Dawley rats, Food and Chemical Toxicology, Available online 24 September 2011, ISSN 0278-6915,
Abstract: A transgenic rice line (TRS) with high amylose level has been developed by antisense RNA inhibition of starch branching enzymes. Compositional analysis of TRS demonstrated that the content of resistant starch (RS) was significantly higher compared to conventional non-transgenic rice. High level of RS is an important raw material in food industry and has various physiological effects for human health. In order to provide the reliable theory basis for field release of TRS rice, we evaluated the potential health effects of long-term consumption of the TRS. The 90-day toxicology feeding experiment was conducted in Sprague–Dawley rats fed with diets containing 70% of either TRS rice flour, its near-isogenic rice flour or the control diet. The clinical performance variables (body weight, body weight gain and food consumption) were measured and pathological responses (hematological parameters and serum chemistry at the midterm and the completion of the experiment, urinalysis profile and serum sex hormone response at the completion of the experiment) were performed. Besides, clinical signs, relative organ weights and microscopic observations were also compared between TRS group and its near-isogenic rice group. The combined data indicates that high-amylose TRS grain is as safe as the conventional non-transgenic rice for rat consumption.

Keywords: Transgenic rice; High amylose; Feeding study; Toxicology; Rat

65. Karrie Kam, Jayashree Arcot, Adesoji A. Adesina, Folic acid fortification of parboiled rice: Multifactorial analysis and kinetic investigation, Journal of Food Engineering, Volume 108, Issue 1, January 2012, Pages 238-243, ISSN 0260-8774,
Abstract: Folic acid fortification of parboiled rice has been systematically studied to obtain quantitative insights into the role of key process variables. Parboiling was conducted with brown rice soaked at 70 °C for 1, 2 and 3 h with four different fortificant concentrations added and dried parboiled rice was milled for three durations (i.e. 0, 60 and 120 s). Both residual folate concentration in treated parboiled rice and pH of the soaking water after soaking stages were measured. Multifactorial model was developed to describe the residual folate retention behaviour and suggested that both soaking and milling were significant factors in folic acid fortification. The optimum soaking time was deduced to be 1.97 h. Folate retention rate followed a 1st order kinetics while the rates of natural rice hydrolysis and folate uptake were both time-dependent.
Keywords: Parboiled rice; Folic acid; Fortification; Folate retention kinetics

66. Mi-Young Yoon, Young Sup Kim, Shi Yong Ryu, Gyung Ja Choi, Yong Ho Choi, Kyoung Soo Jang, Byeongjin Cha, Seong-Sook Han, Jin-Cheol Kim, In vitro and in vivo antifungal activities of decursin and decursinol angelate isolated from Angelica gigas against Magnaporthe oryzae, the causal agent of rice blast, Pesticide Biochemistry and Physiology, Available online 1 September 2011, ISSN 0048-3575,
Abstract: Blast is considered the most important fungal disease of rice due to its wide distribution and destructiveness under favorable conditions. Development of new effective and environmentally benign agents against the causal pathogen, Magnaporthe oryzae, is of great interest. In the course of a search for natural antifungal compounds in medicinal plants, we found that the methanol extract of Angelica gigas roots showed a potent control efficacy against rice blast caused by M. oryzae. We isolated antifungal coumarins from the extract, and they were identified as decursin and decursinol angelate. Antifungal activities of these compounds, along with kasugamycin, were tested on M. oryzae in vivo and in vitro. In an in vivo assay, the three compounds effectively suppressed the development of rice blast at concentrations more than 100 μg/mL. Coumarins showed relatively weak inhibitory effect on fungal mycelial growth when compared to kasugamycin. However, they strongly inhibited M. oryzae spore germination, which was not observed in kasugamycin treatments. This is the first report demonstrating that decursinol angelate can provide control against rice blast and that the two coumarins inhibit M. oryzae spore germination. In addition, the wettable powder formulation of the crude extract of A. gigas prohibited the development of blast symptoms on rice plants more effectively than liquid concentrate formulation of kasugamin, a commercial fungicide. Based on our study, we propose that coumarin compounds as well as the A. gigas root crude extract can be used as natural, benign fungicides for controlling rice blast.
Keywords: Rice blast; Angelica gigas; Decursin; Decursinol angelate; Kasugamycin

67. Takuma Genkawa, Fumihiko Tanaka, Daisuke Hamanaka, Toshitaka Uchino, Incidence of open crack formation in short-grain polished rice during

soaking in water at different temperatures, Journal of Food Engineering, Volume 103, Issue 4, April 2011, Pages 457-463, ISSN 0260-8774,

Abstract: The incidence of open crack formation in short-grain polished rice during soaking in water at different temperatures was investigated. Rice with a moisture content of 10.4% (wet basis) was soaked in distilled water for 90 min at 15 °C, 25 °C or 35 °C, and the rate of open crack formation and the moisture content of the rice during soaking were measured. Results show that the rate of open crack formation increased with decreasing the soaking temperature. A model based on the relationship between the tensile stress calculated from the moisture gradient in a rice grain and the tensile strength calculated from the average moisture content of a rice grain provided a reliable qualitative estimate of the difference in the rate of open crack formation at different temperatures. It can be concluded that water diffusion into rice grains should be accelerated to prevent the formation of open cracks.

Keywords: Open crack; Polished rice; Short-grain rice; Soaking; Moisture gradients

68. Rebecca C. Tucker, Michael J. Zanis, Nancy C. Emery, Kevin D. Gibson, Effects of water depth and seed provenance on the growth of wild rice (Zizania aquatica L.), Aquatic Botany, Volume 94, Issue 3, April 2011, Pages 113-118, ISSN 0304-3770,

Abstract: Annual wild rice (Zizania aquatica L.), a species of conservation concern, is an ecologically and culturally important aquatic grass found in stands in the near shore habitats of lakes and rivers in the Midwest and along the eastern coast of North America. This study examined the effects of water depth and seed provenance on the early growth of three Indiana wild rice stands (collected from two lakes) under greenhouse conditions in 2009. Plants were grown at water depths of 46 cm, 23 cm, 0 cm, or −15 cm and harvested either at the first floating leaf stage or at 48 days after transplanting. Wild rice growth was affected by both water depth and seed provenance. The dry weight of roots, stems, leaves, and inflorescences, total biomass, number of tillers, number of leaves, and total leaf area were the lowest in the −15 cm treatment. These vegetative growth parameters also decreased with increasing water depth from the 0 cm treatment. Differences in growth between seed sources were found, supporting the hypothesis that genetic differences among relatively isolated wild rice stands may influence the success of efforts to conserve this species.

Keywords: Zizania aquatica L.; Wild rice; Water depth; Seed provenance; Restoration; Conservation

69. Bhagirath S. Chauhan, David E. Johnson, Row spacing and weed control timing affect yield of aerobic rice, Field Crops Research, Volume 121, Issue 2, 18 March 2011, Pages 226-231, ISSN 0378-4290,

Abstract: Field experiments were conducted during the wet season of 2009 and dry season of 2010 to determine the effects of row spacing and timing of weed control on weed growth and yield of aerobic rice. Ten weed management treatments were used to identify critical periods of weed competition with aerobic rice grown in three different row spacings (15-cm, 30-cm, and as paired rows 10–20–10-cm). Dominant weed species during both growing seasons were Rottboellia cochinchinensis, Digitaria ciliaris, Echinochloa colona, and Eleusine indica. Rice grown in 30-cm rows had greater weed biomass and less grain yield than in 15-

cm and 10–20–10-cm rows; weed growth and grain yields were similar between 15-cm and 10–20–10-cm rows. Rice yields in the wet season ranged from 170 kg ha–1 where weeds were not controlled throughout the crop duration to 2940 kg ha–1 in weed-free treatment, indicating a 94% yield loss with uncontrolled weed growth. Similarly in the dry season, plots with no weed control (140 kg ha–1) compared to weed-free plots (3640 kg ha–1) indicate a 96% yield loss with no weed control. Gompertz and logistic equations were fitted to yield data resulting from increasing durations of weed control and weed interference, respectively. Critical periods for weed control in the wet season, to obtain 95% of a weed-free yield, were estimated as between 18 and 52 days after sowing (DAS) for crops in rows at 15-cm, 20–51 DAS at 10–20–10-cm, and 15–58 DAS at 30-cm. These intervals in the dry season were 17–56 DAS for crops in rows at 15-cm and 17–60 DAS at 10–20–10-cm and 15–64 DAS at 30-cm. Durations of the critical periods in the wet season were 31 days at 10–20–10-cm, 34 days at 15-cm and 43 days at 30-cm, while in the dry season, these were 43 days at 10–20–10-cm, 39 days at 15-cm and 49 days at 30-cm. In both seasons, crops in the wider spacing (30-cm) were vulnerable to weed competition for the longest period. The information gained from this study suggests that the aerobic rice yields better in 15-cm rows and 10–20–10-cm arrangements than in 30-cm rows and there is very little benefit of weed control beyond 8 weeks after sowing.
Keywords: Weed competition; Critical period; Dry seeded rice; Yield

70. Reena Sellamuthu, Gui Fu Liu, Chandra Babu Ranganathan, Rachid Serraj, Genetic analysis and validation of quantitative trait loci associated with reproductive-growth traits and grain yield under drought stress in a doubled haploid line population of rice (Oryza sativa L.), Field Crops Research, Volume 124, Issue 1, 9 October 2011, Pages 46-58, ISSN 0378-4290,
Abstract: Drought is a major constraint for rice production and yield stability in rainfed ecosystems, especially when it occurs during the reproductive stage. Combined genetic and physiological analysis of reproductive-growth traits and their effects on yield and yield components under drought stress is important for dissecting the biological bases of drought resistance and for rice yield improvement in water-limited environments. A subset of a doubled haploid (DH) line population of CT9993-5-10-1-M/IR62266-42-6-2 was evaluated for variation in plant water status, phenology, reproductive-growth traits, yield and yield components under reproductive-stage drought stress and irrigated (non-stress) conditions in the field. Since this DH line population was previously used in extensive quantitative trait loci (QTLs) mapping of various drought resistance component traits, we aimed at identifying QTLs for specific reproductive-growth and yield traits and also to validate the consensus QTLs identified earlier in these DH lines using meta-analysis. DH lines showed significant variation for plant water status, reproductive-growth traits, yield and yield components under drought stress. Total dry matter, number of panicles per plant, harvest index, panicle harvest index, panicle fertility, pollen fertility, spikelet fertility and hundred grain weight had significant positive correlations with grain yield under drought stress. A total of 46 QTLs were identified for the various traits under stress and non-stress conditions with phenotypic effect ranging from 9.5 to 35.6% in this study. QTLs for panicle exsertion, peduncle length and pollen fertility, identified for the first time in this study,

could be useful in marker-assisted breeding (MAB) for drought resistance in rice. A total of 97 QTLs linked to plant growth, phenology, reproductive-growth traits, yield and its components under non-stress and drought stress, identified in this study as well as from earlier published information, were subjected to meta-analysis. Meta-analysis identified 23 MQTLs linked to plant phenology and production traits under stress conditions. Among them, four MQTLs viz., 1.3 for plant height, 3.1 for days to flowering, 8.1 for days to flowering or delay in flowering and 9.1 for days to flowering are true QTLs. Consensus QTLs for reproductive-growth traits and grain yield under drought stress have been identified on chromosomes 1 and 9 using meta-QTL analysis in these DH lines. These MQTLs associated with reproductive-growth, grain yield and its component traits under drought stress could be useful targets for drought resistance improvement in rice through MAB and/or map-based positional analysis of candidate genes.
Keywords: Rice; Oryza sativa L.; Drought resistance; Reproductive-growth traits; Yield; Meta-analysis; QTLs

71. Narpinder Singh, Nisha Pal, Gulshan Mahajan, Sandeep Singh, Khetan Shevkani, Rice grain and starch properties: Effects of nitrogen fertilizer application, Carbohydrate Polymers, Volume 86, Issue 1, 1 August 2011, Pages 219-225, ISSN 0144-8617,
Abstract: The effects of nitrogen application at different levels (0, 20, 40 and 60 kg/ha) on the characteristics of milled rice and starch from three paddy cultivars were studied. Milled rice was evaluated for physicochemical, cooking and textural properties while starch was evaluated for granule size distribution, structure, thermal and rheological properties. Milled rice from paddy grown with nitrogen application showed lower gruel solids loss and water up take ratio during cooking and higher cooked grain hardness, cohesiveness, and chewiness. Starch from rice grown with application of nitrogen showed lower amylose content and higher pasting temperature, gelatinization transition-temperatures and enthalpy of gelatinization. Principal component analysis indicated that cooked grain hardness and cooking time were closely associated with amylose content and protein content, respectively.
Keywords: Cooking; Milled rice; Nitrogen application; Rheology; Starch; Texture

72. Kanitha Tananuwong, Yuwares Malila, Changes in physicochemical properties of organic hulled rice during storage under different conditions, Food Chemistry, Volume 125, Issue 1, 1 March 2011, Pages 179-185, ISSN 0308-8146,
Abstract: Effects of packaging materials, storage temperatures and time on physicochemical properties of organic hulled red fragrant rice cv. Hom Daeng were investigated. The samples were vacuum-packed in oriented polypropylene/aluminium/linear low-density polyethylene or nylon/linear low-density polyethylene pouches and stored at ambient temperature or 15 °C for up to 12 months. Results from differential scanning calorimetry indicated that onset and peak temperature of gelatinisation of the aged rice samples increased after the 6th month while enthalpy of gelatinisation initially increased and then decreased after the 8th month. Measurements from the Rapid Visco Analyzer revealed that peak viscosity and breakdown of the rice pastes increased within the first 2 months, then decreased after the 6th month, whereas setback

gradually increased during storage. Swelling power, at 70 and 90 °C, of the aged samples, tended to decrease after the 4th month. Lower storage temperature retarded those changes while packaging materials did not influence the changes. Changes in thermal and pasting properties of the aged samples were reversed after adding 2-mercaptoethanol. Hence, an increase in disulphide linkages of oryzenin during storage could play a crucial role in altering those properties. Sensory evaluation indicated a significant increase in hardness of the cooked rice prepared from the longer-aged samples (p □ 0.05). However, the cooked rice samples, deriving from the samples stored at ambient temperature for up to 12 months, were still acceptable for Thai consumers.
Keywords: Organic hulled rice; Storage temperature; Packaging; Thermal properties; Pasting properties

73. Mohammad R. Siahpoosh, Diego H. Sanchez, Armin Schlereth, Graham N. Scofield, Robert T. Furbank, Joost T. van Dongen, Joachim Kopka, Modification of OsSUT1 gene expression modulates the salt response of rice Oryza sativa cv. Taipei 309, Plant Science, Available online 15 January 2011, ISSN 0168-9452,
Abstract: A metabolic depletion syndrome was discovered at early vegetative stages in roots of salt sensitive rice cultivars after prolonged exposure to 100 mM NaCl. Metabolite profiling analyses demonstrate that this syndrome is part of the terminal stages of the rice salt response. The phenotype encompasses depletion of at least 30 primary metabolites including sucrose, glucose, fructose, glucose-6-P, fructose-6P, organic- and amino-acids. Based on these observations we reason that sucrose allocation to the root may modify the rice response to high salt. This hypothesis was tested using antisense lines of the salt responsive OsSUT1 gene in the salt sensitive Taipei 309 cultivar. Contrary to our expectations of a plant system impaired in one component of sucrose transport, we find improved gas exchange and photosynthetic performance as well as maintenance of sucrose levels in the root under high salinity. Two independent OsSUT1 lines with an antisense inhibition similar to the naturally occurring salt induced reduction of OsSUT1 gene expression showed these phenomena but not a more extreme antisense inhibition line. We investigated the metabolic depletion syndrome by metabolomic and physiological approaches and discuss our results with regard to the potential role of sucrose transporters and sucrose transport for rice salt acclimation.
Keywords: Oryza sativa; Rice; Salt stress; Sucrose transporter (OsSUT1); Metabolomics; Metabolite profiling

74. Atsushi Ishihara, Takahito Nakao, Yuko Mashimo, Masatoshi Murai, Naoya Ichimaru, Chihiro Tanaka, Hiromitsu Nakajima, Kyo Wakasa, Hisashi Miyagawa, Probing the role of tryptophan-derived secondary metabolism in defense responses against Bipolaris oryzae infection in rice leaves by a suicide substrate of tryptophan decarboxylase, Phytochemistry, Volume 72, Issue 1, January 2011, Pages 7-13, ISSN 0031-9422,
Abstract: Tryptophan-derived secondary metabolites, including serotonin and its hydroxycinnamic acid amides, markedly accumulate in rice leaves in response to pathogen attack. These compounds have been implicated in the physical defense system against pathogen invasion by being deposited in cell walls. Serotonin is biosynthesized from tryptophan via tryptamine, and tryptophan decarboxylase (TDC) catalyzes the first committed reaction. In this study, (S)-α-(fluoromethyl)tryptophan (S-

αFMT) was utilized to investigate the effects of the inhibition of TDC on the defense responses of rice leaves. S-αFMT, enantiospecifically synthesized from l-tryptophan, effectively inhibited TDC activity extracted from rice leaves infected by Bipolaris oryzae. The inhibition rate increased dependently on the incubation time, indicating that S-αFMT served as a suicide substrate. Treatment of rice seedlings with S-αFMT suppressed accumulation of serotonin, tryptamine, and hydroxycinnamic acid amides of serotonin in a dose-dependent manner in B. oryzae-inoculated leaves. The lesions formed on seedlings treated with S-αFMT lacked deposition of brown materials, and those leaves were severely damaged in comparison with leaves without S-αFMT treatment. Administrating tryptamine to S-αFMT-treated leaves restored accumulation of tryptophan-derived secondary metabolites as well as deposition of brown material. In addition, tryptamine administration reduced damage caused by fungal infection. Accordingly, the accumulation of tryptophan-derived secondary metabolites was suggested to be part of the effective defense mechanism of rice.
Keywords: Rice; Oryza sativa; Gramineae; Tryptophan decarboxylase; Inhibitor; α-Fluoromethyltryptophan; Serotonin; Physical defense; Secondary metabolism

75. Manitra A. Rakotoarisoa, The impact of agricultural policy distortions on the productivity gap: Evidence from rice production, Food Policy, Volume 36, Issue 2, April 2011, Pages 147-157, ISSN 0306-9192,
Abstract: This article explores how production and trade policy distortions affected rice productivity in 33 rice-producing countries. A rice-productivity index is constructed, and a model linking the productivity gap with policy distortions is presented. After controlling for the differences in infrastructure, access to inputs and equipment, openness, and human capital, this article shows that high levels of rice subsidies and protection in rich countries combined with taxation of rice farming in poor countries widened the gap in rice productivity between rich and poor rice countries.
Keywords: Agricultural policies; Trade distortions; Rice productivity

76. Chengmei Liu, Yanjun Zhang, Wei Liu, Jie Wan, Weihua Wang, Li Wu, Naibei Zuo, Yiran Zhou, Zhonglin Yin, Preparation, physico-chemical and texture properties of texturized rice produce by Improved Extrusion Cooking Technology, Journal of Cereal Science, Available online 1 October 2011, ISSN 0733-5210,
Abstract: Using broken rice and rice bran as raw material, texturized rice (TR) was prepared by Improved Extrusion Cooking Technology (IECT) in which gelatinization is formed by means of low temperature and high pressure. The expansion of extrudate was hardly changed so that TR showed similar texture properties and shape with polished rices. The effect of rice bran addition (0% and 4%) and IECT conditions, including feed moisture content (26.6-33.4%), screw speed (20.1-32.6 rpm) and shearing compression metering zone temperature (SCMT, 69.8-120.2 °C) on the physicochemical, texture and nutritional characteristics of TR, were investigated by response surface methodology using Central Composite Design. When the bran addition was 4%, feed moisture content was 30%, screw speed was 26.6 rpm, SCMT was 95 °C, prepared TR contained 16.61 ± 0.02% of total dietary fiber, 9.40 ± 0.04% of protein, 3.68 ± 0.03% of fat, 2.42 ± 0.02 μg/g of thiamin, 0.52 ± 0.01 μg/g of riboflavin and 16.07 ± 0.12 mg/100 g of γ-oryzanol (dry matter content). The content increase of TDF for TR was 15.81% and the content

increases of nutrients for thiamin, riboflavin, and γ-oryzanol were 1.39 μg/g, 0.24 μg/g, and 8.99 mg/g dry matter content, respectively, compared with those of polished rice.
Keywords: Texturized rice; Improved Extrusion Cooking Technology; Broken rice; Rice bran

77. Michel Ruíz-Sánchez, Elisabet Armada, Yaumara Muñoz, Inés E. García de Salamone, Ricardo Aroca, Juan Manuel Ruíz-Lozano, Rosario Azcón, Azospirillum and arbuscular mycorrhizal colonization enhance rice growth and physiological traits under well-watered and drought conditions, Journal of Plant Physiology, Volume 168, Issue 10, 1 July 2011, Pages 1031-1037, ISSN 0176-1617,
Abstract: The response of rice plants to inoculation with an arbuscular mycorrhizal (AM) fungus, Azospirillum brasilense, or combination of both microorganisms, was assayed under well-watered or drought stress conditions. Water deficit treatment was imposed by reducing the amount of water added, but AM plants, with a significantly higher biomass, received the same amount of water as non-AM plants, with a poor biomass. Thus, the water stress treatment was more severe for AM plants than for non-AM plants. The results showed that AM colonization significantly enhanced rice growth under both water conditions, although the greatest rice development was reached in plants dually inoculated under well-watered conditions. Water level did not affect the efficiency of photosystem II, but both AM and A. brasilense inoculations increased this value. AM colonization increased stomatal conductance, particularly when associated with A. brasilense, which enhanced this parameter by 80% under drought conditions and by 35% under well-watered conditions as compared to single AM plants. Exposure of AM rice to drought stress decreased the high levels of glutathione that AM plants exhibited under well-watered conditions, while drought had no effect on the ascorbate content. The decrease of glutathione content in AM plants under drought stress conditions led to enhance lipid peroxidation. On the other hand, inoculation with the AM fungus itself increased ascorbate and proline as protective compounds to cope with the harmful effects of water limitation. Inoculation with A. brasilense also enhanced ascorbate accumulation, reaching a similar level as in AM plants. These results showed that, in spite of the fact that drought stress imposed by AM treatments was considerably more severe than non-AM treatments, rice plants benefited not only from the AM symbiosis but also from A. brasilense root colonization, regardless of the watering level. However, the beneficial effects of A. brasilense on most of the physiological and biochemical traits of rice plants were only clearly visible when the plants were mycorrhized. This microbial consortium was effective for rice plants as an acceptable and ecofriendly technology to improve plant performance and development.
Keywords: Arbuscular mycorrhizal symbiosis; Azospirillum; Drought; PGPR; Rice

78. Hiromi Yoshida, Takaaki Tanigawa, Naoko Yoshida, Isoko Kuriyama, Yuka Tomiyama, Yoshiyuki Mizushina, Lipid components, fatty acid distributions of triacylglycerols and phospholipids in rice brans, Food Chemistry, Volume 129, Issue 2, 15 November 2011, Pages 479-484, ISSN 0308-8146,
Abstract: Endogenous tocochromanols in extracted lipids from rice brans of the five cultivars were determined by high-performance liquid chromatography, and were investigated in relation to the fatty acid (FA) distribution of triacylglycerols (TAG) and phospholipids (PL). The

dominant tocols were α-tocopherol and γ-tocotrienol, followed by α-tocotrienol and with much smaller amounts of γ-tocopherol and δ-tocotrienol. The lipids of these rice brans comprised mainly TAG (80.6–86.0 wt.%), free FA (4.2–9.0 wt.%), and phospholipids (5.5–6.7 wt.%), whilst other components were also detected in minor proportions (0.2–2.1 wt.%). The PL components included phosphatidyl choline (31.8–46.8 wt.%), phosphatidyl ethanolamine (25.0–38.9 wt.%) and phosphatidyl inositol (20.2–23.2 wt.%). Comparison of these different cultivars showed, with a few exceptions, no significant differences (P > 0.05) in FA distribution. FA distribution of TAG among the five cultivars was evident in the rice brans: unsaturated FA were predominantly concentrated at the sn-2 position and saturated FA primarily occupying the sn-1 or sn-3 position. These results suggest that the tocopherol content, lipid component, and FA distribution in rice brans are not dependent on the cultivation areas during the growing season.
Keywords: Fatty acid compositions; Phospholipids; Rice bran lipids; Tocopherols; Tocotrienols; Triacylglycerols

79. Isabel Louro Massaretto, Márcio Fernando Madureira Alves, Nádia Valéria Mussi de Mira, Adriana Karaoglanovic Carmona, Ursula Maria Lanfer Marquez, Phenolic compounds in raw and cooked rice (Oryza sativa L.) and their inhibitory effect on the activity of angiotensin I-converting enzyme, Journal of Cereal Science, Volume 54, Issue 2, September 2011, Pages 236-240, ISSN 0733-5210,
Abstract: Whole rice has been widely studied due to the abundance of bioactive compounds in its pericarp. Some of the beneficial effects of these compounds on human health have been attributed to their antioxidant and other biological activities, such as enzyme inhibition. In this work, we evaluated the contents of total, soluble and insoluble phenolic compounds of 6 red and 10 non-pigmented genotypes of whole rice as well as their inhibitory effect on the activity of angiotensin I-converting enzyme (ACE). The effects of cooking on phenolics and their inhibitory activities were also investigated. Red genotypes showed high content of phenolics, mainly soluble compounds, at an average of 409.7 mg ferulic acid eq./100 g, whereas overall lower average levels (99.4 mg ferulic acid eq./100 g) at an approximate soluble/insoluble compound ratio of 1:1 were observed in non-pigmented rice. Pigmented rice displayed a greater inhibitory effect on ACE than non-pigmented rice. In fact, a significant correlation between the content of soluble phenolics and ACE inhibition was observed ($r = 0.8985$, $p < 0.05$). In addition to significantly reducing the levels of total phenolics and ACE inhibition, cooking altered the soluble/insoluble compound ratio, especially among red rice genotypes.
Keywords: Rice; Phenolic compounds; Angiotensin I-converting enzyme inhibitor; Thermal processing

80. B. Zhang, Z.Q. Rong, Y. Shi, J.G. Wu, C.H. Shi, Prediction of the amino acid composition in brown rice using different sample status by near-infrared reflectance spectroscopy, Food Chemistry, Volume 127, Issue 1, 1 July 2011, Pages 275-281, ISSN 0308-8146,
Abstract: In this study, 279 samples of brown rice grains and their flour, selected from a larger original population, were scanned by NIRSystem model 5000 mono-chromator in these two kinds of sample status for near-infrared reflectance spectroscopy (NIRS) analysis. Spectral pretreatment method 2,8,8,1 combined with SNV + D scatter correction was found suitable for developing calibration equations for

amino acids. Equations for total amino acid content and for all individual amino acids, excluding cystine, methionine and tyrosine, were developed with this spectral pretreatment method. These equations had low SECV (0.010–0.063%) and SEP (0.011–0.066%); with high 1 – VR (0.878–0.960), R2 (0.837–0.947) and SD/SEP (2.421–4.333). The results suggest that equations for the thirteen amino acids from the two sample categories can be directly used to estimate the amino acid composition in brown rice. This indicates once more that NIRS is a powerful technology that could be very useful for the determination of amino acid content in breeding programs that involve brown rice as well as for quality control in the food industry.
Keywords: Brown rice; Calibration equation; Near-infrared reflectance spectroscopy (NIRS); Amino acid; Foodstuff

81. Simone M.L. Rosa, Noor Rehman, Maria Inez G. de Miranda, Sônia M.B. Nachtigall, Clara I.D. Bica, Chlorine-free extraction of cellulose from rice husk and whisker isolation, Carbohydrate Polymers, Available online 31 August 2011, ISSN 0144-8617,
Abstract: This work reports the isolation of cellulose whiskers from rice husk (RH) by means of an environmental friendly process for cellulose extraction and bleaching. The multistep process begins with the removal of pectin, cutin, waxes and other extractives from rice husk, then an alkaline treatment for the removal of hemicelluloses and lignin, and a two-step bleaching with hydrogen peroxide/tetra-acetylethylenediamine (TAED), followed by a mixture of acetic and nitric acids, for further delignification of the cellulose pulp. The techniques of infrared absorption spectroscopy (ATR-FTIR), scanning electron microscopy (SEM), thermogravimetric analysis (TGA), modulated differential scanning calorimetry (MDSC) and X-ray diffraction (XRD) showed that the overall process is adequate to obtain cellulose with high purity and crystallinity. This cellulose was submitted to sulfuric acid hydrolysis with the aim to isolate the whiskers. They showed the typical elongated rod-like aspect as revealed by transmission electron microscopy (TEM) and atomic force microscopy (AFM).
Keywords: Cellulose whiskers; Rice husk; Biomaterials; Microscopy; Peroxide bleaching; Thermal analysis

82. Ling WANG, Wen-Wen HUANG, Lian-Meng LIU, Qiang FU, Shi-Wen HUANG, Evaluation of Resistance to Sheath Blight (Rhizoctonia solani) in Partial Indica Hybrid Rice Combinations from Southern China, Acta Agronomica Sinica, Volume 37, Issue 2, February 2011, Pages 263-270, ISSN 1875-2780,
Abstract: Resistance to sheath blight is generally controlled by polygenes in rice (Oryza sativa L.) and varies greatly among cultivars. At present, very few germplasms can be used as resistant parents in rice breeding. A total of 166 indica hybrid rice combinations collected from 11 provinces in southern China were evaluated for the resistance to sheath blight at seedling stage using artificial inoculation method. According the disease indexes (DIs) to 5 isolates of Rhizoctonia solani, the 166 hybrid combinations were classified into 5 types based on dynamic clustering analysis (DCA), with the ratios of 1.2% for resistance (R), 13.9% for moderate resistance (MR), 36.1% for moderate susceptibility (MS), 43.4% for susceptibility (S), and 5.4% for high susceptibility (HS); but no combination was immune or highly resistant to the disease. K-you 88 and Zhongyou 9801 showed relatively high resistance at seedling stage, but their adult resistance should be further evaluated. The discriminant function for each resistance type

was calculated using Bayes method, and the accuracy rate for discrimination was 96.39%. The average DI ranged from 2.84 to 7.64 with an average of 5.27. The concept of synthetic disease index (SDI) was also introduced to classify the 166 hybrid combinations, which is the overall resistance performance to total isolates tested. Based on SDI grading criteria, the 166 hybrid combinations were also divided into R, MR, MS, S, and HS types with the ratios of 1.2%, 13.3%, 63.3%, 21.7%, and 0.6%, respectively. The SDI classification system was significantly correlated with the DCA system (r = 0.81, P < 0.01), showing that both methods can be used for evaluating the disease resistance. The DCA method is suitable for seedling screening under the uniform growth condition. The SDI method is independent on test time, place, and batch, and thus can be applied in relatively complicated conditions. Twenty-six combinations were identified as resistant (R or MR) indica hybrid rice using both methods. The genetic distances among these combinations ranged from 0.04 to 0.71. Twenty-two of them were grouped in the same clade after cluster analysis using unweighted pair group method with arithmetic mean (UPGMA) method. This result and pedigree analysis showed a narrow genetic background of the resistant hybrid combinations.
Keywords: indica hybrid rice; sheath blight; resistance evaluation; dynamic clustering analysis; synthetic disease index

83. Hong He, Rachid Serraj, Involvement of peduncle elongation, anther dehiscence and spikelet sterility in upland rice response to reproductive-stage drought stress, Environmental and Experimental Botany, Volume 75, January 2012, Pages 120-127, ISSN 0098-8472,
Abstract: Reproductive stage drought stress results in dramatic reduction of spikelet fertility and grain yield of upland rice (Oryza sativa L.). The hypothesis investigated here is that spikelet sterility under pre-anthesis drought is triggered by deficient plant water status that inhibits peduncle elongation, panicle exsertion and anther dehiscence. A set of 45 rice genotypes was grown in an upland field under well-watered and drought-stressed conditions. Irrigation was applied using a drip irrigation system, and the drought stress treatment was initiated differentially for each genotype at 10–15 days before heading. Drought stress substantially reduced grain yield, and the average yield in the drought treatment was only 20% of that of the control. Peduncle elongation rate (PER) was significantly inhibited by drought, simultaneously with the decrease of plant water status parameters. Yield was highly associated with spikelet fertility (r = 0.74***), PER (r = 0.47***), leaf water potential (LWP) (r = -0.4**), and peduncle water potential (PWP) (r = -0.38**). The sensitivity of anther dehiscence to drought stress, as determined by the anatomic structure of anther walls, did not differ among genotypes. Path analysis revealed that spikelet fertility and PER had a major positive effect on yield, while peduncle length and LWP had negative effects. PWP had a small direct effect, but had a high negative indirect effect on yield through spikelet fertility reduction. PER had a high and positive indirect effect on yield under drought through spikelet fertility. It is concluded that PER is key parameter that affects rice yield through the regulation of spikelet fertility by plant water status under drought.
Keywords: Drought; Reproductive stage; Rice; Spikelet sterility; Water status

84. R. Venuprasad, S.M. Impa, R.P. Veeresh Gowda, G.N. Atlin, R. Serraj, Rice near-isogenic-lines (NILs) contrasting for grain yield under lowland drought stress, Field Crops Research, Volume 123, Issue 1, 18 July 2011, Pages 38-46, ISSN 0378-4290,

Abstract: The development of near-isogenic-lines (NILs) is a very important tool for both genetic and physiological dissection of drought resistance in rice. Two pairs of NILs differing for grain yield under drought stress were isolated and characterized for yield, yield related traits, and several physiological traits in a range of contrasting environments. In replicated field trials both NIL pairs differed significantly for grain yield under drought stress but showed similar yield potential, phenology, and yield component traits under non-stress conditions. A polymorphism analysis study with 491 SSRs revealed that both NIL pairs are at least 96% genetically similar. These NILs show that small genetic differences can cause large difference in grain yield under drought stress in rice. In both pairs the drought-tolerant NILs showed a significantly higher assimilation rate at later stages both under stress and non-stress conditions. They also had a higher transpiration rate under non-stress condition. The most tolerant NIL (IR77298-14-1-2-B-10) had significantly higher transpiration rate and stomatal conductance in severe stress conditions. In one pair the tolerant NIL had constitutively deeper roots than the susceptible NIL. In the second pair, which had higher mean root length than the first pair, the tolerant NIL had more roots, greater root thickness, and greater root dry weight than the susceptible NIL. Deeper root length may allow tolerant NILs to extract more water at deeper soil layers. It is concluded that enhanced rooting depth is an important strategy for dehydration avoidance and rice adaptation to drought stress, but root architecture might not be the only mechanism causing the significant yield increase we observed in lowland drought stress environments. To further dissect the drought avoidance mechanisms in rice, analysis of root hydraulic properties may be necessary.
Keywords: Rice; Drought; NILs; Yield; Roots

85. Karim Traore, Anna M. McClung, Ming-Hsuan Chen, Robert Fjellstrom, Inheritance of flour paste viscosity is associated with a rice Waxy gene exon 10 SNP marker, Journal of Cereal Science, Volume 53, Issue 1, January 2011, Pages 37-44, ISSN 0733-5210,

Abstract: Apparent amylose content is a key element for characterizing a rice (Oryza sativa L.) cultivar for cooking quality. However, cultivars with similar apparent amylose content can have widely varying quality attributes, including major parameters of flour paste viscosity. It has been postulated that the presence of a rice Waxy gene single nucleotide polymorphism (SNP) marker is associated with elevated Rapid Visco Analyser (RVA) properties in specific high amylose rice cultivars. A mapping population derived from a cross between two varieties, Cocodrie and Dixiebelle, having similar high apparent amylose contents, but with different paste viscosity properties and Waxy gene markers was analyzed for the genetic segregation of various pasting properties, measured with RVA instrumentation. Marker inheritance analyses revealed that the Waxy exon 10 SNP marker was associated with the proportion of soluble to insoluble apparent amylose and most RVA pasting measurements. Waxy gene markers can be used to efficiently improve the selection of rice with desirable characteristics, particularly for superior parboiling and canning quality.

Keywords: Waxy gene; SNP; RVA; Oryza sativa

86. Gui-Lan Duan, Ying Hu, Wen-Ju Liu, Ralf Kneer, Fang-Jie Zhao, Yong-Guan Zhu, Evidence for a role of phytochelatins in regulating arsenic accumulation in rice grain, Environmental and Experimental Botany, Volume 71, Issue 3, July 2011, Pages 416-421, ISSN 0098-8472,
Abstract: Phytochelatins (PCs) play a crucial role in detoxifying cellular arsenic (As) through complexation of arsenite. Here, we investigated whether PCs influence As accumulation in rice grain by using six rice cultivars varying in grain As accumulation. The cultivars with low grain As had significantly higher PCs concentration in the shoots than the cultivars with high grain As, but lower glutathione concentration. Shoot PCs concentration correlated negatively with grain As accumulation. Foliar sprays with 0.5 mM l-buthionine-sulphoxime (BSO) on rice leaves at grain filling stage decreased GSH and PC accumulation in rice shoots by 40–63% and 20–55%, respectively, but did not significantly affect plant growth. Foliar sprays with BSO decreased shoot As concentration, while increased As concentrations in husk and brown rice significantly. These results suggest that PC complexation of arsenite in rice leaves reduces As translocation from leaves to grains, and implicate that manipulation of PC synthesis might mitigate As accumulation in rice grain.
Keywords: Arsenic; Rice; Phytochelatins; Glutathione; BSO

87. Yukihiro Ito, Thiruvengadam Thirumurugan, Akiko Serizawa, Keiichiro Hiratsu, Masaru Ohme-Takagi, Nori Kurata, Aberrant vegetative and reproductive development by overexpression and lethality by silencing of OsHAP3E in rice, Plant Science, Volume 181, Issue 2, August 2011, Pages 105-110, ISSN 0168-9452,
Abstract: We generated transgenic rice plants overexpressing OsHAP3E which encodes a subunit of a CCAAT-motif binding HAP complex. The OsHAP3E-overexpressing plants showed various abnormal morphologies both in their vegetative and reproductive phases. The OsHAP3E-overexpressing plants were dwarf with erected leaves and similar to brassinosteroid mutants in the vegetative phase. In the reproductive phase, dense panicle was developed, and occasionally successive generation of lateral rachises and formation of double flowers were observed. These phenotypes indicate association of OsHAP3E with determination of floral meristem identity. On the other hand, repression of OsHAP3E by RNAi or by overexpressing chimeric repressor fusion constructs brought about lethality to transformed cells, and almost no transformant was obtained. This suggests that the OsHAP3E function is essential for rice cells. Altogether, our loss-of-function and gain-of-function analyses suggest that OsHAP3E plays important pleiotropic roles in vegetative and reproductive development or basic cellular processes in rice.
Keywords: CCAAT-box; HAP3/NF-YB/CBF-A; Panicle; CRES-T; Rice

88. Junwhan Kim, Jiyoung Shon, Chung-Kuen Lee, Woonho Yang, Youngwhan Yoon, Won-Ha Yang, Yuon-Gyu Kim, Byun-Woo Lee, Relationship between grain filling duration and leaf senescence of temperate rice under high temperature, Field Crops Research, Volume 122, Issue 3, 14 June 2011, Pages 207-213, ISSN 0378-4290,
Abstract: High temperature during grain filling period has been reported to decrease the grain filling duration, leading to the lower grain weight and yield of rice. Two experiments in the phytotron and field were carried out to test the hypothesis that the leaf senescence

of rice plants may determine the grain filling duration under high temperature. In the phytotron experiment in 2008, rice plants of a japonica cultivar "Ilpumbyeo" were subjected to three minimum/maximum (mean) temperature regimes of 11/19 (15), 17/25 (21), and 23/31 °C (27 °C). In the field experiment, rice seedlings of the same rice cultivar were transplanted on May 6th and June 19th in 2009 and the mean temperatures during the grain filling period were 24.4 and 21.9 °C, respectively. Both experiments revealed consistently that high temperature increased the rates of grain filling and leaf senescence while it reduced the durations of them. However, grain filling was terminated earlier than complete leaf senescence, the time gap being greater at higher temperature. In addition, the fraction of dry matter partitioning to the leaf sheath + culm resumed to increase following the termination of grain filling under high temperature, indicating that leaves were still maintaining photosynthetic capacity and supplying assimilates into the other plant tissues except grain even after the termination of grain filling. These findings suggest that an early termination of grain filling in temperate rice under high temperature was not resulted from the lack of assimilate owing to the early leaf senescence but from the loss of sink activity owing to the earlier senescence of panicle.
Keywords: Rice; Grain filling duration; Leaf senescence; Temperature

89. González, S. Armenta, M. de la Guardia, Geographical traceability of "Arròs de Valencia" rice grain based on mineral element composition, Food Chemistry, Volume 126, Issue 3, 1 June 2011, Pages 1254-1260, ISSN 0308-8146,
Abstract: The geographical traceability of rice grain samples involves the use of analytical methodologies that allow their differentiation on the basis of the rice composition, thus confirming their authenticity. In this paper, trace element determination of rice samples by inductively coupled plasma optical emission spectroscopy (ICP-OES) has been addressed to achieve a complete geographical origin classification. Samples (107) from Spain including Valencia, Tarragona, Murcia and Extremadura, Japan, Brazil and India were employed as training set whereas the validation set was formed by 46 samples of the aforementioned geographical origins. Data were processed by linear discriminant analysis (LDA), using as analytical variable the concentration of 32 elements (Al, As, Ba, Bi, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, K, Se, Na, Sr, Tl, Ti, Zn, La, Ce, Pr, Nd, Sm, Eu, Ho, Er and Yb), enabling a 91.30% of correct classification for the validation set.
Keywords: Protected designation of origin; Rice; Trace elements; Chemometrics; Fingerprint; Optical emission

90. J.Y. Wang, J.X. Jia, Z.Q. Xiong, M.A.K. Khalil, G.X. Xing, Water regime–nitrogen fertilizer–straw incorporation interaction: Field study on nitrous oxide emissions from a rice agroecosystem in Nanjing, China, Agriculture, Ecosystems & Environment, Volume 141, Issues 3-4, May 2011, Pages 437-446, ISSN 0167-8809,
Abstract: The comprehensive impacts of agricultural management on nitrous oxide (N2O) emissions are not well documented. Field experiments with 23 factorial designs were conducted to investigate the influence of water regimes, nitrogen fertilizer, and straw incorporation on N2O emissions from rice paddies in Nanjing, China. In addition to the main factorial design, three single factor designs were included: water regime, N rate, and mid-season drainage duration, each

with three levels. The results demonstrate that there were significant differences in the responses of soil N2O emissions to water regime, nitrogen fertilizer, and straw amendment as well as interaction between straw and nitrogen fertilizer. The cumulative seasonal N2O emissions from the treatments with mid-season drainage averaged 0.41 kg N ha−1, ranging from 0.20 to 0.73 kg N ha−1. These emissions were higher than those from continuously flooded treatments, which averaged 0.28 kg N ha−1 and ranged from 0.13 to 0.55 kg N ha−1. The integrated application of straw and nitrogen fertilizer mitigated N2O emissions by approximately 50% under both water regimes. N2O emissions were mainly promoted by the transition period from the upland crop season to the flooded rice season, by nitrogen application, and by depression with straw amendment. Three groups were formed according to a polynomial relationship between seasonal N2O emissions and rice production. The results of this study suggest that the integrated application of straw and nitrogen fertilizer can mitigate N2O emissions from rice agriculture without a decrease in rice production.
Keywords: Crop rotation; Greenhouse gas; Rice production; Straw; Water regime

91. H.-J. Zhang, H. Zhang, L. Wang, X.-N. Guo, Preparation and functional properties of rice bran proteins from heat-stabilized defatted rice bran, Food Research International, Available online 9 September 2011, ISSN 0963-9969,
Abstract: Protein concentrates were prepared from heat-stabilized defatted rice bran and analyzed for their functional properties. Rice bran proteins were prepared by alkaline extracted and Alcalase 2.4 L hydrolysis. The yield of rice bran proteins were 32.9% and 44.79%, respectively. Rice bran proteins had molecular sizes between 0.1 and over 97.4 kDa; maximum solubilities of 72.5% and 84.56% at pH 11.0; maximum emulsifying capacities of 0.149 and 0.634; maximum emulsion stabilities of 24.26 and 25.96 min; maximum foam capacities of 98% and 115%; maximum foam stabilities of 30.6 and 26.9 mL at 30 min; water absorption of 3.71 and 4.4 g/g and oil absorption of 4.24 and 5.13 g/g. These results demonstrate that the extracted rice bran protein has potential as a nutraceutical ingredient in food applications.
Keywords: Rice bran protein; Preparation; Functional properties

92. Manu Agarwal, Amanjot Singh, Dheeraj Mittal, Chandan Sahi, Anil Grover, Cycloheximide-mediated superinduction of genes involves both native and foreign transcripts in rice (Oryza sativa L.), Plant Physiology and Biochemistry, Volume 49, Issue 1, January 2011, Pages 9-12, ISSN 0981-9428,
Abstract: Rice seedlings subjected to heat shock show rapid and transient induction of Oshsp17.4-CI, Oshsp17.9A-CI and OsClpB-cyt/hsp100 transcripts. When the seedlings were pre-treated with protein synthesis inhibitor cycloheximide, levels of the above transcripts during heat shock were more elevated than those seen with heat shock alone. Heat stress and cycloheximide co-treatment resulted in higher transcript accumulation in comparison to cycloheximide pre-treatment followed by heat stress. In transgenic plants raised with OsClpB-cyt/hsp100 promoter driving expression of the reporter gus gene, expression of the gus transcript was subjected to similar superinduction event as was seen with native OsClpB-cyt/hsp100

transcripts in untransformed plants. Yeast cells transformed with variably-sized rice ClpB-cyt/hsp100 promoter driving expression of the lacZ reporter transcript showed that specific sequences of the promoter region may be implicated in superinduction.
Keywords: Cycloheximide; Heat shock; Promoter; Rice (Oryza sativa L.); Superinduction; Transcripts

93. Sanguansri Charoenrein, Orawan Tatirat, Kategunya Rengsutthi, Masubon Thongngam, Effect of konjac glucomannan on syneresis, textural properties and the microstructure of frozen rice starch gels, Carbohydrate Polymers, Volume 83, Issue 1, 1 January 2011, Pages 291-296, ISSN 0144-8617,
Abstract: Repeatedly frozen and thawed rice starch gel loses quality. This study investigated how incorporating konjac glucomannan (KGM) in rice starch gel affects factors used to measure quality. When rice starch gels containing 0–0.5% KGM were subjected to 5 freeze–thaw cycles KGM reduced the % syneresis and moderate increases in gel hardness. SEM of freeze–thaw gels showed starch gel with KGM had smaller pores and less well-defined surrounding matrices than those without KGM. Moreover, CLSM of unfrozen gels without KGM showed densely aggregated swollen starch granules while those in gels with KGM were more evenly distributed. Furthermore, starch pastes with KGM showed higher viscosities than paste without KGM suggesting KGM inhibited granule association. These results suggest that KGM retards rice starch gel retrogradation induced by freeze–thaw treatment and that KGM is effective in preserving quality in freeze–thaw rice starch gels.
Keywords: Konjac glucomannan; Freezing; Texture; Rice starch; Retrogradation; Microstructure; Syneresis

94. Jing Zhang, Quan-Zhi Zhao, Gui-Lan Duan, Yan-Chao Huang, Influence of sulphur on arsenic accumulation and metabolism in rice seedlings, Environmental and Experimental Botany, Volume 72, Issue 1, August 2011, Pages 34-40, ISSN 0098-8472,
Abstract: The influence of sulphur on the accumulation and metabolism of arsenic in rice was investigated. Rice seedlings were grown in nutrient solutions with low sulphate (1.8 μM SO42−) or high sulphate (0.7 mM SO42−) for 12 or 14 d, before being exposed to 10 μM arsenite or arsenate for 2 or 1 d, respectively. In the arsenite exposure treatment, low sulphate-pretreated rice accumulated less arsenite than high sulphate pretreated plants, but the arsenite concentrations in shoots of low sulphate pretreated rice were higher than those of high sulphate pretreated. In the arsenate exposure treatment, the low sulphate pre-treatments also resulted in less arsenite accumulation in rice roots. Sulphur deprivation in nutrient solution decreased the concentrations of non-protein thiols in rice roots exposed to either arsenite or arsenate. The low sulphate-pretreated plants had a higher arsenic transfer factor than the high sulphate-pretreated plants. The results suggest that rice sulphate nutrition plays an important role in regulating arsenic translocation from roots to shoots, possibly through the complexation of arsenite-phytochelatins.
Keywords: Sulphur; Arsenic speciation; Arsenite; Arsenate; Rice (Oryza sativa)

95. Mukund D. Patil, Bhabani S. Das, Pratap B.S. Bhadoria, A simple bund plugging technique for improving water productivity in wetland rice,

Soil and Tillage Research, Volume 112, Issue 1, March 2011, Pages 66-75, ISSN 0167-1987,
Abstract: Seepage and percolation (SP) loss of water is a major reason behind the poor water productivity in wetland rice. Recent studies have indicated that preferential water flow through bunds around rice fields is primarily responsible for high SP loss in rice. To prevent such water loss, we took advantage of a critical observation made by Huang et al. (2003) that the laying of new bunds over existing paddy field retains plow sole in under-bund soil profile, which has the potential to restrict downward percolation through bunds. Accordingly, we developed a simple bund plugging technique to extend the plow sole into the under-bund soil. The method consists of three steps: temporary removal of existing bunds, puddling of under-bund soil, and replacement of bunds above the puddled under-bund soil. The effectiveness of such a bund plugging method was evaluated by measuring physical and hydraulic properties of different soil layers both before and after bund treatment in several pits excavated both on the bunds and within the field. In situ infiltration characteristics were also measured using a tension infiltrometer. Measured bulk density and saturated hydraulic conductivity (Ks) values for under-bund soil before and after bund plugging treatment showed the development of a plow sole in treated under-bund soil. Analysis of tension infiltration data indicated that such a bund plugging treatment could reduce the infiltration flux at near-saturation conditions by about 68%. Similarly, the results of dual permeability modeling showed that the Ks values for soil fracture domain in treated bunds were also reduced by similar magnitude. Comparison of the total amount of water input for the growing seasons in these plots showed that the bund-plugging method could reduce the SP loss by about 50% during the Kharif season (i.e. July–October) and about 22% during the Rabi season (i.e. December–April).
Keywords: Wetland rice; Seepage and percolation; Puddling; Preferential flow; Bund plugging; Bunds

96. P.A.J. van Oort, Tianyi Zhang, M.E. de Vries, A.B. Heinemann, H. Meinke, Correlation between temperature and phenology prediction error in rice (Oryza sativa L.), Agricultural and Forest Meteorology, Available online 18 July 2011, ISSN 0168-1923,
Abstract: For rice (Oryza sativa L.), simulation models like ORYZA2000 and CERES-Rice have been used to explore adaptation options to climate change and weather-related stresses (drought, heat). Output of these models is very sensitive to accurate modelling of crop development, i.e. phenology. What has to date received little attention in phenology calibration is the temperature range within which phenological models are accurate. Particularly the possible correlation between temperature and phenology prediction error has received little attention, although there are indications that such correlation exists, in particular in the study by Zhang et al. (2008). The implication of such correlation is that a phenology model that is accurate within the calibration temperature range can be less accurate at higher temperatures where it can systematically overestimate or underestimate the duration of the phase from emergence to flowering. We have developed a new rice phenology calibration program that is consistent with ORYZA2000 concepts and coding. The existing calibration program DRATES of ORYZA2000 requires an assumption of default cardinal temperatures (8, 30 and 42 °C) and then calculates cultivar specific temperature sums and development rates. Our new program estimates all phenological parameters simultaneously, including the cardinal temperatures. Applied

to nine large datasets from around the world we show that the use of default cardinal temperatures can lead to correlation between temperature and phenology prediction error and temperature and RMSE values in the order of 4–18 days for the period from emergence to flowering. Our new program avoids such correlation and reduces phenology prediction errors to 3–7 days (RMSE). Our results show that the often made assumption of a rapid decrease in development rate above the optimal temperature can lead to poorer predictions and systematic errors. We therefore caution against using default phenological parameters for studies where temperatures may fall outside the range for which the phenological models have been calibrated. In particular, this applies to climate change studies, were this could lead to highly erroneous conclusions. More phenological research with average growing season temperatures above the optimum, in the range of 32–40 °C, is needed to establish which phenological model best describes phenology in this temperature range.
Keywords: Rice; Temperature; Phenology; Calibration; Sensitivity analysis

97. Kenji Yamagishi, Toshiyuki Kimura, Takashi Watanabe, Treatment of rice straw with selected Cyathus stercoreus strains to improve enzymatic saccharification, Bioresource Technology, Volume 102, Issue 13, July 2011, Pages 6937-6943, ISSN 0960-8524,
Abstract: Seventeen Cyathus stercoreus isolates were tested for their ability to treat rice straw for improved enzymatic saccharification. These isolates showed a negative correlation between cellulase and xylanase activity and enzymatic saccharification yields. Incubation of rice straw pretreated at 60 °C for 15 min with strain C. stercoreus TY-2 for 25 days resulted in an enzymatic saccharification yield of 57% as compared to a yield of 11% for the same straw in the absence of the fungus. These findings highlight the potential of this isolate for biological pretreatment of rice straw under conditions of low energy input.
Keywords: Cyathus stercoreus; Rice straw; Enzymatic saccharification yield; Biological pretreatments

98. K.S. Suri, Gursharan Singh, Insecticide-induced resurgence of the whitebacked planthopper Sogatella furcifera (Horvath) (Hemiptera: Delphacidae) on rice varieties with different levels of resistance, Crop Protection, Volume 30, Issue 2, February 2011, Pages 118-124, ISSN 0261-2194,
Abstract: The influences of the insecticides quinalphos, chlorpyriphos, methyl parathion, endosulfan, imidacloprid and deltamethrin applied three times at 10 days intervals at half of their recommended field concentrations to potted plants of a planthopper-susceptible and a planthopper-resistant rice variety, on reproduction and survival of whitebacked planthopper, Sogatella furcifera (Horvath), and on the chemistry of its host plant, were investigated. Methyl parathion, deltamethrin and quinalphos enhanced the fecundity of the hopper (164–211 vs. 131 for the control) and consequently the resurgence ratio (increased up to 1.75 fold). Methyl parathion and deltamethrin significantly increased nymphal survival (59.3 vs. 52.2% for the control) and the growth index (4.8 vs. 4.2 for the control) of the hopper. The sex ratios of adults emerging on methyl parathion- and deltamethrin-treated rice plants increased in favour of females (1.51 vs. 1.15 for the control) on the susceptible variety but was not

altered on the resistant variety. Biochemical analyses of the rice leaves revealed significantly higher quantities of reducing sugars, proteins and amino acids, but lower amounts of total phenols in leaf sheaths and blades of methyl parathion-, deltamethrin- and quinalphos-treated plants of the two varieties. The leaf sheaths and blades of the resistant variety contained more than twice the total phenols present in those of the susceptible variety. The results showed a positive correlation between increased levels of reducing sugars, amino acids and proteins in the rice plants and the fecundity of S. furcifera and a negative correlation between phenol contents of the rice plants and fecundity.

Keywords: Sogatella furcifera; Rice; Insecticides; Fecundity; Resurgence; Biochemical constituents

99. Wei Tang, Yun-Zhi Zhu, Hua-Qi He, Sheng Qiang, Bruce A. Auld, Field evaluation of Sclerotium rolfsii, a biological control agent for broadleaf weeds in dry, direct-seeded rice, Crop Protection, Volume 30, Issue 10, October 2011, Pages 1315-1320, ISSN 0261-2194,

Abstract: The fungal pathogen Sclerotium rolfsii isolate SC64 is being assessed as the basis for a mycoherbicide for biological control of broadleaf weeds in dry-seeded rice fields. Species tested for susceptibility in the field included Cyperus difformis, Lindernia procumbens, Rotala rotundifolia, Ammannia baccifera and Eclipta prostrata. Following preliminary small plot field applications in summer 2008 and 2010, applications of fungus-infested solid substrates (mixture of rice hulls and bran) of 60–140 g m−2 were conducted at two sites, Nantong and Rugao, in Jiangsu province, China in summer 2010. The sites included a one-year fallow field and a wheat-rice rotation field. Plant mortality was recorded 7 and 14 days after inoculation (DAI). Percentage mortality ranged from 50 to 89% and 30–71% in the 2008 and 2010 solarium small plot trials, respectively. At the Nantong site field trial, 30–60% plant mortality and 31–59% fresh weight reduction were recorded at 14 DAI when applied for the first time but the efficacy increased to 39–86% and 42–90% for plant mortality and fresh weight reduction at 14 DAI with a repeated application. Higher levels of plant mortality (42–77%) and fresh weight reduction (52–82%) were achieved at 14 DAI at the Rugao site with a single treatment, due to the lower weed density and more favourable temperature and humidity conditions at the time of pathogen application. Results confirmed that S. rolfsii SC64 is a potential biocontrol agent of some of the broadleaf weeds tested in dry-seeded rice.

Keywords: Mycoherbicide; Sclerotium rolfsii; Isolate SC64; Broadleaf weeds; Dry direct-seeded rice

100. Joselito E. Villa, Amelia Henry, Fangming Xie, Rachid Serraj, Hybrid rice performance in environments of increasing drought severity, Field Crops Research, Volume 125, 18 January 2012, Pages 14-24, ISSN 0378-4290,

Abstract: Hybrid rice provides an option for achieving high yield potential under favorable conditions, but the performance of hybrids under drought stress has not yet been fully evaluated. This study explored the feasibility of using hybrid rice technology in drought-prone rainfed lowland fields. Hybrid lines, parental inbreds, and cultivated varieties as checks were screened for yield potential in well-watered fields and for drought resistance in drained fields at

different stress levels. Nineteen out of 45 hybrid lines showed a yield advantage (on average 20%) over check lines in the three well-watered environments. Classifications of drought stress levels were based on the yield reduction relative to the well-watered environments, with moderate, severe, and very severe stress levels resulting in 54%, 77% and 89% reductions in yield, respectively. The relationship between yield advantage of hybrids and drought severity differed among lines; some hybrids showed more of an advantage under severe drought, whereas others had a greater yield advantage under moderate stress. Some hybrids did not perform as well as parents under drought. In general, the harvest index of hybrids was greater than those of inbred parents and checks, and showed strong correlation with grain yield in the different stress environments. Total dry matter yield of hybrids was correlated with improved yield in all stress environments during dry seasons, and some drought-tolerant hybrids also showed greater tillering efficiency and thousand-grain weight. Twenty-four selected hybrid lines were divided into seven clusters on the basis of yield trends across different drought stress environments. Among the hybrid rice lines, one cluster including IR81954H, IR81955H, and IR81956H stood out as combining high yield potential in both well-watered and drought stress environments. Hybrid IR81954H showed an 8% yield advantage over other hybrids across all studies, as well as stable yield in all the stress environments having an average yield advantage of 22% over other hybrids averaged across drought environments. These results highlight the variability among hybrids in their drought response, and the need for screening of hybrids and parents under drought stress conditions.
Keywords: Rice; Drought; Hybrid; Yield

101. Zhibing Huang, Yang Xu, Hong Zhang, Laisheng Li, Qinghua He, Yanping Li, Simultaneous determination of two Monascus metabolites in red yeast rice by HPLC using fluorescence detection, Food Chemistry, Volume 127, Issue 4, 15 August 2011, Pages 1837-1841, ISSN 0308-8146,
Abstract: A reversed-phase HPLC method with fluorescence detection for the determination of two Monascus metabolites, monasfluore A (MFA) and monasfluore B (MFB), in red yeast rice was carried out. Optimum conditions for the extraction and chromatographic separation were investigated. The method was validated through the following performance criteria: linearity, stability, limit of detection (LOD), quantification (LOQ), etc. This assay was successfully used for determination of the MFA and MFB in 20 samples inoculated from different Monascus sp. The results revealed that significant variations were demonstrated in the contents of the MFA and MFB in these samples. The high contents of both MFA and MFB in sample 13 were found to be 81.400 and 26.300 mg g−1, respectively. The low contents of both MFA and MFB in sample 14 were also found to be 0.010 and 0.003 mg g−1, respectively.
Keywords: Monascus metabolites; Red yeast rice; Fluorescent compounds; High-performance liquid chromatography

102. Ping Lu, You-Lo Hsieh, Preparation and characterization of cellulose nanocrystals from rice straw, Carbohydrate Polymers, Available online 16 August 2011, ISSN 0144-8617,
Abstract: Pure cellulose have been isolated from rice straw at 36% yield and hydrolyzed (64% H2SO4, 8.75 mL/g, 45 °C) for 30 and

45 min to cellulose nanocrystals (CNCs), i.e., CNC30 and CNC45, respectively. CNC45 was smaller (11.2 nm wide, 5.06 nm thick and 117 nm long) than CNC30 (30.7 nm wide, 5.95 nm thick and 270 nm long). Freeze-drying of diluted CNC suspensions showed both assembled into long fibrous structures: ultra-fine fibers

(~400 nm wide) from CNC45 and 1-2 μm wide broad ribbons

interspersed with CNC clusters from CNC30. The self-assembled fibers from CNC30 and CNC45 were more highly crystalline (86.0% and 91.2%, respectively) and contained larger crystallites (7.36 nm and 8.33 nm, respectively) than rice straw cellulose (61.8%, 4.42 nm). These self-assembled fibers had essentially nonporous or macroporous structures with the CNCs well aligned along the fiber axis. Furthermore, the self-assembled ultra-fine fibers showed extraordinary structural stability, withstanding vigorous shaking and prolong stirring in water.

Keywords: Cellulose nanocrystals (CNCs); Ultra-fine fibers; Self-assembly; Rice straw; Sulfuric acid hydrolysis

103. Wen-Hua Chen, Ben-Li Pen, Ching-Tsung Yu, Wen-Song Hwang, Pretreatment efficiency and structural characterization of rice straw by an integrated process of dilute-acid and steam explosion for bioethanol production, Bioresource Technology, Volume 102, Issue 3, February 2011, Pages 2916-2924, ISSN 0960-8524,

Abstract: The combined pretreatment of rice straw using dilute-acid and steam explosion followed by enzymatic hydrolysis was investigated and compared with acid-catalyzed steam explosion pretreatment. In addition to measuring the chemical composition, including glucan, xylan and lignin content, changes in rice straw features after pretreatment were investigated in terms of the straw's physical properties. These properties included crystallinity, surface area, mean particle size and scanning electron microscopy imagery. The effect of acid concentration on the acid-catalyzed steam explosion was studied in a range between 1% and 15% acid at 180 °C for 2 min. We also investigated the influence of the residence time of the steam explosion in the combined pretreatment and the optimum conditions for the dilute-acid hydrolysis step in order to develop an integrated process for the dilute-acid and steam explosion. The optimum operational conditions for the first dilute-acid hydrolysis step were determined to be 165 °C for 2 min with 2% H2SO4 and for the second steam explosion step was to be carried out at 180 °C for 20 min; this gave the most favorable combination in terms of an integrated process. We found that rice straw pretreated by the dilute-acid/steam explosions had a higher xylose yield, a lower level of inhibitor in the hydrolysate and a greater degree of enzymatic hydrolysis; this resulted in a 1.5-fold increase in the overall sugar yield when compared to the acid-catalyzed steam explosion.

Keywords: Rice straw; Dilute-acid pretreatment; Acid-catalyzed steam explosion; Integrated pretreatment process; Enzymatic hydrolysis

104. Z.W. Rang, S.V.K. Jagadish, Q.M. Zhou, P.Q. Craufurd, S. Heuer, Effect of high temperature and water stress on pollen germination and spikelet

fertility in rice, Environmental and Experimental Botany, Volume 70, Issue 1, January 2011, Pages 58-65, ISSN 0098-8472,

Abstract: In future climates, rice could more frequently be subjected to simultaneous high temperature and water stress during sensitive developmental stages such as flowering. In this study, five rice genotypes were exposed to high temperature, water stress and combined high temperature and water stress during flowering to quantify their response through spikelet fertility. Microscopic analyses revealed significant differences in anther dehiscence between treatments and genotypes, with a moderately high association with the number of germinated pollen grains on the stigma. There was a strong relationship between spikelet fertility and the number of germinated pollen on stigmas. Although, all three stress treatments resulted in spikelet sterility, high-temperature stress caused the highest sterility in all five genotypes. A cumulative linear decline in spikelet fertility with increasing duration of independent high-temperature stress and in combination with water stress was quantified. Better anther dehiscence, higher in vivo pollen germination, and higher spikelet fertility were observed in both the N22 accessions compared with IR64, Apo and Moroberekan under high temperature, water stress and combined stress, indicating its ability to tolerate multiple abiotic stresses.

Keywords: Anthesis; High temperature; Pollen germination; Rice; Spikelet fertility; Water stress

105. D. Glover, The System of Rice Intensification: Time for an empirical turn, NJAS - Wageningen Journal of Life Sciences, Volume 57, Issues 3-4, February 2011, Pages 217-224, ISSN 1573-5214,

Abstract: The System of Rice Intensification (SRI) is claimed to be a new, more productive and more sustainable method for cultivating rice. These claims have proved controversial. One dimension of the controversy has centred on the imprecision with which SRI's component practices have been defined. The supporters of SRI suggest that the system has been designed to satisfy the needs of rice itself, implying that it is a set of integrated, mutually reinforcing practices that need to be implemented as a package in order to obtain the best results. However, they also argue that the system should be understood as a suite of flexible principles to be adapted to particular agro-ecological and socio-economic settings – the antithesis of a fixed package. This poses a conceptual and practical challenge for scientific evaluation of SRI methods. However, this apparent difficulty is chiefly an artefact created by conceptualizing agricultural methods as standardized packages. A process of translation is always necessary to convert theoretical models or norms into farming practices. Smallholder farming practices, being intrinsically constrained and contingent, rarely conform precisely to abstract norms. As an alternative, the notion of performance offers a useful way to frame a methodological and analytical approach to understanding what is going on in SRI. Such an approach calls for close technographic observation of farming activities and the interaction between farmers and their fields, plants and tools.

Keywords: System of Rice Intensification; SRI; Practice; Performance; Technography

106. Wenjun Dong, Jin Chen, Bin Zhang, Yunlu Tian, Weijian Zhang, Responses of biomass growth and grain yield of midseason rice to the anticipated warming with FATI facility in East China, Field Crops Research, Volume 123, Issue 3, 12 September 2011, Pages 259-265, ISSN 0378-4290,

Abstract: Crop model projections and historical data analyses have shown that global warming may cause serious decrease in crop productivity, however, many uncertainities remain on the impact quantification due to the unclear understanding of actual crop response. Therefore, we performed a three-year field warming experiment with free air temperature increase (FATI) facility to investigate the actual response of midseason rice growth in East China. There were four treatments (AW: all-day warming; DW: daytime warming; NW: nighttime warming; CK: ambient control) with three replicates. This FATI facility presented a good simulation of the local air temperature pattern with an increase in the daily mean temperature of about 1.1–2.0 °C during rice whole growth duration compared to the ambient control. Warming shortened the pre-heading phase respectively by 3.3 d, 1.7 d and 2.0 d in the AW, DW and NW plots, while the post-heading phase stayed almost unchanged. During the three years, warming slightly decreased the aboveground biomass by an average of 9.1%, 10.3% and 3.3%, and the grain yield by an average of 0.9%, 6.4% and 6.1% in the AW, DW and NW plots, respectively. Warming tended to decrease rice photosynthesis rate and stimulate the nighttime respiration rate. It also enlarged the flag leaf area and increased its chlorophyll content. No significant difference and interaction in the actual response of rice growth were found between the warming regimes. The above evidences suggest that the expected warming less than 2.0 °C may not cause significant decrease in rice productivity in East China.

Keywords: Global warming; Free air temperature increase; Midseason rice; Biomass production; Grain yield; East China

107. Zhiqiang Kong, Fengshou Dong, Jun Xu, Xingang Liu, Jing Li, Yuanbo Li, Yingying Tian, Liqun Guo, Weili Shan, Yongquan Zheng, Degradation of acephate and its metabolite methamidophos in rice during processing and storage, Food Control, Volume 23, Issue 1, January 2012, Pages 149-153, ISSN 0956-7135,

Abstract: The degradation of acephate and its metabolite methamidophos during different stages of commercial processing, homing processing, and storage was assessed. Residues were determined by a simple gas-chromatographic method using a flame photometry detector. Acephate and methamidophos mostly remained in rice hull fractions, and hulling significantly reduced acephate and methamidophos in rice. Commercial processing caused the loss of 86% of acephate and 35.9% of methamidophos from rough brown rice to polished rice, whereas home processing caused the loss of 83.9% of acephate and 70% of methamidophos from polished rice to cooked rice. Washing for 5, 15, and 30 min (with tap water, 0.9% NaCl, and 0.1% Na2CO3) caused an average loss in the range of 9.8%–35.3% of acephate and 9.7%–45.2% of methamidophos. Extending washing time and adding a small amount of soda into the washing solution can efficiently eliminate acephate and methamidophos. The stability of acephate and methamidophos in polished rice was studied at different storage intervals, from 7 to 42 days at ambient temperatures (25 °C). Methamidophos was found to be more persistent than acephate.

Keywords: Rice; Acephate; Methamidophos; Processing; Eliminate

108. Zhaohua Hou, Peiyou Qin, Yan Zhang, Songhuan Cui, Guixing Ren, Identification of anthocyanins isolated from black rice (Oryza sativa L.) and their degradation kinetics, Food Research International, Available online 5 August 2011, ISSN 0963-9969,

Abstract: Black rice is rich in anthocyanins-plant pigments. The aim of this work was to identify anthocyanins in black rice using high-performance liquid chromatography (HPLC)-electrospray ionization — mass spectrometry with diode array detection. Four different anthocyanins (cyanidin-3-glucoside, peonidin-3-glucoside, cyanidin-3,5-diglucoside, cyanidin-3-rutinoside) were identified in black rice. Thermal stability of the four anthocyanins in black rice extract was studied at selected temperatures (80 °C, 90 °C and 100 °C) in the range of pH 1.0–pH 6.0. The results indicated that the thermal degradation of anthocyanins followed the first-order reaction kinetics. The temperature-dependent degradation was adequately modeled on the Arrhenius equation. The calculated values of activation energies (Ea), t1/2 and k were different for the four anthocyanins. The degradation rate of monomeric anthocyanin increased with increasing heating temperature and pH values. Especially, as heating temperature increasing to 100 °C and pH value to 5.0.
Keywords: Anthocyanins; HPLC/DAD/MS; Black rice; Degradation kinetics

109. K. Srilekha Yadav, Shaik Naseeruddin, G. Sai Prashanthi, Lanka Sateesh, L. Venkateswar Rao, Bioethanol fermentation of concentrated rice straw hydrolysate using co-culture of Saccharomyces cerevisiae and Pichia stipitis, Bioresource Technology, Volume 102, Issue 11, June 2011, Pages 6473-6478, ISSN 0960-8524,
Abstract: Rice straw is one of the abundant lignocellulosic feed stocks in the world and has been selected for producing ethanol at an economically feasible manner. It contains a mixture of sugars (hexoses and pentoses).

Biphasic acid hydrolysis was carried out with sulphuric acid using rice straw. After acid hydrolysis, the sugars, furans and phenolics were estimated. The initial concentration of sugar was found to be 16.8 g L−1. However to increase the ethanol yield, the initial sugar concentration of the hydrolysate was concentrated to 31 g L−1 by vacuum distillation. The concentration of sugars, phenols and furans was checked and later detoxified by over liming to use for ethanol fermentation. Ethanol concentration was found to be 12 g L−1, with a yield, volumetric ethanol productivity and fermentation efficiency of 0.33 g L−1 h−1, 0.4 g g−1 and 95%, respectively by co-culture of OVB 11 (Saccharomyces cerevisiae) and Pichia stipitis NCIM 3498.
Keywords: Rice straw; Concentrated hydrolysate; Yeast; Co-culture; Fermentation

110. Aayako Ishii, Eiki Kuroda, Hiroyuki Shimono, Effect of high water temperature during vegetative growth on rice growth and yield under a cool climate, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 88-95, ISSN 0378-4290,
Abstract: Global warming is likely to increase spring temperatures in regions with a cool climate. To examine the effects of this change on rice productivity, we exposed rice plants to a higher (by +2.7 to +2.8 °C) water temperature (Tw) during the vegetative growth period (for 35–50 days) under three levels of N fertilization. High Tw during vegetative growth made the heading stage occur 4–7 days earlier for all levels of N fertilization in both years. The crop growth rate during the treatment period was greatly enhanced by high Tw: by 51–82% in 2008 and by 49–62% in 2009. There was no Tw × N fertilizer interaction. This increased growth was associated with increased leaf

expansion and increased canopy radiation capture rather than with increased radiation-use efficiency. However, the positive effect decreased during subsequent growth stages under all levels of N fertilization, leading to no significant differences in total biomass at maturity. High Tw during vegetative growth greatly reduced SPAD values during the grain-filling stage compared with SPAD values in the control Tw treatment, for all levels of N fertilization, and decreased leaf photosynthesis during the mid-grain filling stage. Grain yield was not significantly affected by high Tw at any N fertilizer level or in either year.
Keywords: Rice; Global warming; Grain yield; Water temperature

111. Chun-Kuang Shih, Chia-Jung Ho, Sing-Chung Li, Shwu-Huey Yang, Wen-Chi Hou, Hsing-Hsien Cheng, Preventive effects of rice bran oil on 1,2-dimethylhydrazine/dextran sodium sulphate-induced colon carcinogenesis in rats, Food Chemistry, Volume 126, Issue 2, 15 May 2011, Pages 562-567, ISSN 0308-8146,
Abstract: This study included F344 rats which were fed AIN-93G-based 14% high-fat diets and were divided into the following six groups: Groups B and N, 14% soybean oil (SO); group P, 14% SO containing 0.04% piroxicam; group L, 5% rice bran oil (RBO) and 9% SO; group M, 9% RBO and 5% SO; and group H, 14% RBO. All the rats—except those in group B—were administered 1,2-dimethylhydrazine/dextran sodium sulphate to induce colitis-related colon carcinogenesis. The rats were sacrificed, and their colons were removed to examine aberrant crypt foci (ACF) and mucin-depleted foci (MDF). The results revealed that the rats from all the RBO group rats exhibited significantly reduced colon tumour formation, MDF, and ACF, especially sialomucin (SIM)-producing ACF. The hepatic antioxidant status, including the glutathione (GSH) and thiobarbituric acid reactive substance levels as well as superoxide dismutase and catalase activities, was superior among the RBO groups, which might contribute to the potential of RBO with respect to delaying colon carcinogenesis.
Keywords: Aberrant crypt foci (ACF); Antioxidant; Colon cancer; Mucin-depleted foci (MDF); Rice bran oil (RBO)

112. Zhen-hua ZHANG, Qiang LIU, Hai-xing SONG, Xiang-min RONG, Abdelbagi M Ismail, Responses of Contrasting Rice (Oryza sativa L.) Genotypes to Salt Stress as Affected by Nutrient Concentrations, Agricultural Sciences in China, Volume 10, Issue 2, February 2011, Pages 195-206, ISSN 1671-2927,
Abstract: The study was conducted to investigate the effects of applying different concentrations of the macronutrients K+, Ca2+, and Mg2+ on the responses of contrasting rice (Oryza sativa L.) genotypes under salt stress. A solution culture experiment was conducted in a phytotron at the International Rice Research Institute (IRRI), under controlled temperature and humidity and natural sunlight. When subjected to salt stress of 100 mmol L-1 using NaCl, the salt tolerant genotypes FL478 and IR651, accumulated less Na+ and maintained lower ratios of Na+/K+, Na+/Ca2+, and Na+/Mg2+ than the sensitive genotypes IR29 and Azucena. These tolerant genotypes also had higher concentrations of K+ in their shoots and greater root and shoot biomass and green leaf area. Tolerant genotypes also maintained much lower concentration of Na+ and lower and more favorable ratios of Na+/K+, Na+/Ca2+, and Na+/Mg2+ in their active and developing tissues. Salt tolerance and shoot and root growth of both tolerant and sensitive genotypes were enhanced considerably when higher concentrations of Ca2+

and Mg2+ were applied in culture solution. The concentration of Na+ and the ratios of Na+/K+, Na+/Ca2+, and Na+/Mg2+ in shoots also declined significantly. The beneficial effects of higher calcium were greater than that of magnesium and application of higher concentration of K+ seems to have minor effects. Responses to salinity in rice can therefore be considerably enhanced through proper nutrient management, by increasing the concentrations of nutrient elements that have favorable effects such as Ca2+ and Mg2+. Calcium is particularly more effective than both magnesium and potassium, and can be applied at relatively larger quantities in salt affected soils.
Keywords: rice (Oryza sativa L.); salt stress; seedling stage; nutrients contents; nutrients distribution; genotypes

113. Naruebodee Srisang, Warunee Varanyanond, Somchart Soponronnarit, Somkiat Prachayawarakorn, Effects of heating media and operating conditions on drying kinetics and quality of germinated brown rice, Journal of Food Engineering, Volume 107, Issues 3-4, December 2011, Pages 385-392, ISSN 0260-8774,
Abstract: Drying of germinated brown rice (GBR) by hot air (HA) in a fluidized bed causes a large amount of fissured kernels. The superheated steam (SHS) drying technique may be an alternative method that can improve quality attributes, but it may affect the other qualities of GBR. The effects of drying media and drying temperatures on the drying kinetics and quality of GBR, i.e. kernel fissuring, glycemic index, textural properties, γ-aminobutyric acid (GABA) content and microorganisms were therefore investigated. The experimental results show that the heating media and drying temperature affected the drying rate and some quality attributes of GBR. The number of fissured kernels was significantly lower in SHS than in HA drying. The drying media and drying temperature did not significantly affect the GABA content and textural properties of cooked GBR, except at 130 °C for HA drying, but affected the glycemic index. After drying with SHS or HA, the number of microorganisms was in the range of acceptable level for food safety.
Keywords: GABA rice; Fluidized bed; Fissure; Glycemic index; Texture; Superheated steam

114. Lulu Zhang, Xiuting Hu, Xueming Xu, Zhengyu Jin, Yaoqi Tian, Slowly digestible starch prepared from rice starches by temperature-cycled retrogradation, Carbohydrate Polymers, Volume 84, Issue 3, 17 March 2011, Pages 970-974, ISSN 0144-8617,
Abstract: The temperature-cycled retrogradation of rice starch used to prepare slowly digestible starch was investigated in this study. Our results showed that a maximum slowly digestible starch content of 51.62% was obtained from waxy rice starch at the optimal tested conditions: temperature cycles of 4/25 °C, at intervals of 24 h, and 7 days of storage. The results also indicated that there was a higher onset temperature (To), a narrower melting temperature range (Tc − To), and a higher ratio (1047 cm−1/1022 cm−1) of the slowly digestible starch products prepared under the temperature-cycled condition than that under the isothermal retrogradation. Furthermore, it was evident that the in vitro glycemic index of slowly digestible starch products with temperature-cycled retrogradation was reduced more than that with isothermal storage. These results suggest that the temperature-cycled

retrogradation is applicable to prepare the high yield of slowly digestible starch from waxy rice starch.
Keywords: Slowly digestible starch; Cycled temperature; Preparation; Starch retrogradation; Waxy rice starch

115. Jheng-Hua Lin, Ciao-Ling Pan, Harinder Singh, Yung-Ho Chang, Influence of molecular structural characteristics on pasting and thermal properties of acid-methanol-treated rice starches, Food Hydrocolloids, Volume 26, Issue 2, March 2012, Pages 441-447, ISSN 0268-005X,
Abstract: Rice starches from TKW1, TNG67 and TCS17 varieties, differing widely in amylose contents (0.1, 18.3 and 29.2%) were treated at 45 °C for 1 h in methanol containing various amounts of HCl. The recovery, pasting properties, thermal behaviors, molecular size and chain length distribution of starch were observed. Starches exhibited widely different pasting and thermal behavior upon acid-methanol treated (AMT). Degradation of starches upon AMT affected the leaching extent and chain length of amylose. No obvious changes were found on chain length and content of chain fractions of amylopectin. The pasting viscosity of rice starch decreased with increasing concentration of HCl, and the pasting profiles depended on the variety of rice. The pasting profile of AMT-TNG67 starch showed a two-step increasing pattern during heating, while TKW1 and TCS17 starches showed smoothly increasing pasting curves. The relationship between pasting patterns of AMT-TNG67 starches with amylose leaching and two stages of swelling behavior of starch granules was investigated. Results indicated that the pasting of starch granules depend on the amount, as well as the chain length, of amylose in granules.
Keywords: Rice starch; Pasting properties; Amylose leaching; Chain length; Acid–methanol treatment

116. Xiaolang Chen, Jie Yu, Zhibin Zhang, Canhui Lu, Study on structure and thermal stability properties of cellulose fibers from rice straw, Carbohydrate Polymers, Volume 85, Issue 1, 22 April 2011, Pages 245-250, ISSN 0144-8617,
Abstract: Cellulose fibers were extracted from the rice straw by a mechanical-high pressure steam technique. The structure, chemical composition and thermal properties of cellulose fibers were investigated by using Fourier transform infrared (FTIR) spectroscopy, wide-angle X-ray diffraction (WAXD), scanning electron microscopy (SEM), and thermogravimetric analysis (TGA). FTIR analysis and chemical composition of fibers demonstrate that this mechanical-high pressure steam treatment can result in partial removal of hemicellulose and lignin from the structure of fibers. WAXD results reveal that this results in improved crystallinity of the fibers. The rice straw fibers are determined to have diameters in the range of 5–10 μm. After mechanical-high pressure steam treatments, the thermal properties of the rice straw fibers from the TGA results are found to increase dramatically after treatments. The degradation temperature of the rice straw fibers reaches over 280 °C, which is reasonably promising for the use of these fibers in reinforced-polymer composites.
Keywords: Rice straw; Cellulose fiber; Chemical structure; Thermal properties

117. Sereewatthanawut, I.I.R. Baptista, A.T. Boam, A. Hodgson, A.G. Livingston, Nanofiltration process for the nutritional enrichment and refining of rice bran oil, Journal of Food Engineering, Volume 102, Issue 1, January 2011, Pages 16-24, ISSN 0260-8774,

Abstract: Crude rice bran is a natural source of γ-oryzanol, a nutritionally valuable phytochemical with antioxidant properties. In the present paper the refining and γ-oryzanol enrichment of rice bran oil was investigated through solvent extraction optimization and nanofiltration processing. Several solvent resistant nanofiltration membranes were screened and successfully applied in a two step membrane cascade with fluxes between 39 and 53 L m−2 h−1. A first membrane stage operation provided the separation between glycerides and γ-oryzanol, promoting the oil enrichment in this phytochemical. In the second membrane stage the oil could be refined to acceptable consumption levels (FFA < 0.20 wt.%) and its γ-oryzanol content was further enhanced. Overall, the integrated process provided a RBO γ-oryzanol enrichment from 0.95 to 4.1 wt.% in oil, which corresponded to more than a two fold increase in the oil's antioxidant capacity. These results demonstrate the potential of organic solvent nanofiltration as a technology to enrich and refine oil based products.

Keywords: γ-Oryzanol; Nanofiltration; Rice bran oil; Organic solvent; Enrichment process

118. Pu SHEN, Dong-chu LI, Ju-sheng GAO, Ming-gang XU, Bo-ren WANG, Xiao-juan HOU, Effects of Long-Term Application of Sulfur-Containing and Chloride-Containing Chemical Fertilizers on Rice Yield and Its Components, Agricultural Sciences in China, Volume 10, Issue 5, May 2011, Pages 747-753, ISSN 1671-2927,

Abstract: Impacts of 33-yr of application of S-containing and Cl-containing chemical fertilizers on rice (Oryza sativa L.) yield and its components were investigated in a red paddy field experiment, south China. The treatments included: 1) adding 302 kg SO42−−S ha−1 yr−1 with application of (NH4)2SO4, K2SO4, and calcium superphosphate (SO42−); 2) adding 56 kg SO42−−S and 176 kg Cl ha−1 yr−1 with application of urea, calcium superphosphate, and KCl (Cl−+SO42−); 3) adding 516 kg Cl ha−1 yr−1 with application of NH4Cl, KCl, and KH2PO4 (Cl−). Under each treatment, the applied N, P, and K nutrients were controlled at conventional rates of 150 kg N ha−1 yr−1, 75 kg P2O5 ha−1 yr−1, 225 kg K2O ha−1 yr−1, respectively. Under the S-containing fertilizer application, soil SO42−−S content showed a first increasing then decreasing trend with years, and was significantly negatively correlated with annual rice yield. Average annual yield significantly declined in an order of Cl−, Cl−+SO42−, and SO42−. Under the Cl− treatment, soil SO42−−S content was maintained at about 26.5 mg kg−1, not showing deficiency. From 1990 to 2000, rice yield declined rapidly under the SO42− treatment, and was significantly lower than that under the Cl− treatment. After then, there was no significant difference in yield among the treatments. Our results demonstrated that long-term application of S-containing fertilizer could result in excessive accumulation of SO42−−S in the red paddy soils of south China, therefore producing a certain threat to rice growth. The Cl-containing fertilizer could be relatively safe.

Keywords: rice (Oryza sativa L.); long-term fertilization; sulfur-containing fertilizer; chloride-containing fertilizer; yield; component

119. Te ZHAO, Chao-yang LIN, Zhi-cheng SHEN, Development of Transgenic Glyphosate-Resistant Rice with G6 Gene Encoding 5-Enolpyruvylshikimate-3-Phosphate Synthase, Agricultural Sciences in China, Volume 10, Issue 9, September 2011, Pages 1307-1312, ISSN 1671-2927,

Abstract: Glyphosate-resistant crops have been a huge economic success for genetic engineering. The creating of new glyphosate-resistant plants would increase the available choices for planting and lower the price of genetically modified crop seeds. A novel G6 gene from Pseudomonas putida that encoded 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) was previously isolated. The G6 gene was transfected into rice via Agrobacterium-mediated transformation. The transgenic rice obtained was confirmed by PCR, Southern, and Western blots. The lab experiment and field trials further confirmed that the transgenic rice can survive glyphosate spraying at a dose of 8 g L−1. In contrast, conventional rice was killed at a weed control glyphosate spray dose of 1 g L−1. Altogether, the present study showed that the G6 gene works well in rice in vivo for glyphosate-resistance.
Keywords: transgenic rice; glyphosate-resistance; EPSPS

120. Myoung Ryoul Park, So-Hyeon Baek, Benildo G. de los Reyes, Song Joong Yun, Karl H. Hasenstein, Transcriptome profiling characterizes phosphate deficiency effects on carbohydrate metabolism in rice leaves, Journal of Plant Physiology, Available online 5 October 2011, ISSN 0176-1617,
Abstract: Phosphorus (P) is a structural component of nucleic acids and phospholipids and plays important roles in plant growth and development. P accumulation was significantly reduced (about 35%) in rice leaves from plants grown under low (32 μM) P compared to 320 μM P grown plants. Genome response to low P was examined using the rice 60K oligonucleotide DNA microarrays. At the threshold significance of |log2| fold > 2.0, 21,033 genes (about 33.7% of all genes on the microarray) were affected by P deficiency. Among all genes on the microarray, 4271 genes were sorted into 51 metabolic pathways. Low P affected 1494 (35.0%) genes and the largest category of genes was related to sucrose degradation to ethanol and lactate pathway. To survey the role of P in rice, 25 pathways were selected based on number of affected genes. Among these pathways, cytosolic glycolysis contained the least number of upregulated but most down-regulated genes. Low P decreased glucose, pyruvate and chlorophyll, and genes related to carbon metabolism and chlorophyllide a biosynthesis. However, sucrose and starch levels increased. These results indicate that P nutrition affects diverse metabolic pathways mostly related to glucose, pyruvate, sucrose, starch, and chlorophyll a.
Keywords: Carbohydrate; Metabolic pathway; Microarray; Phosphate; Rice

121. C.S. Reddy, G.S. Laha, M.S. Prasad, D. Krishnaveni, N.P. Castilla, A. Nelson, S. Savary, Characterizing multiple linkages between individual diseases, crop health syndromes, germplasm deployment, and rice production situations in India, Field Crops Research, Volume 120, Issue 2, 31 January 2011, Pages 241-253, ISSN 0378-4290,
Abstract: Five groups of crop health syndromes, four production situations, and three patterns of germplasm deployment were identified and characterized from a data set consisting of information from 129 Indian districts, which were surveyed in 2005 as part of the Production-Oriented Surveys conducted by the Directorate of Rice Research of the Indian Council of Agricultural Research. ANOVAs and MANOVAs indicated that these groupings from hierarchical cluster analyses correspond to clearly different levels of disease and animal pest injuries (crop health syndromes): of crop rotation, crop management, agricultural resources, and inputs (production situations);

and of deployment of traditional, high yielding, or hybrid plant material (patterns of germplasm deployment). Correspondence analysis and discriminant analyses further indicated that crop health syndromes, and their change, are strongly associated with production situations, and patterns of germplasm deployment. A few specific hypotheses were tested, indicating that false smut is statistically associated with the involvement of hybrid rice in patterns of germplasm deployment. This highlights the need for research on the biology and the epidemiology of this disease in order to develop suitable management tools. Importantly, this work shows that national surveys, such as the Production-Oriented Surveys conducted by the Directorate of Rice Research, generate extremely valuable information to guide research and development through the characterization of production environments, contexts, and crop health responses, in times of unprecedented agricultural change. This work concurs with earlier results obtained at the field level, and thus opens important methodological questions regarding the up- and down-scaling of information between different scales (e.g., field, district). We propose that our ability to predict emerging diseases and crop health syndromes in the face of global and climate change will necessarily entail our ability to link different scales, where a range of different processes, biological and socio-economic, take place.
Keywords: Crop health syndrome; Production situation; Deployment of germplasm; Discriminant analysis; Correspondence analysis; Ustilaginoidea virens; Rice diseases; Rice insects; Emerging diseases; Climate change; Global change