SCIENCE DIRECT 2011
PEMUPUKAN PADI

1. 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

2. 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

3. 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

4. Jing Chen, Yao Huang, Yonghua Tang, Quantifying economically and ecologically optimum nitrogen rates for rice production in south-eastern China, Agriculture, Ecosystems & Environment, Volume 142, Issues 3-4, August 2011, Pages 195-204, ISSN 0167-8809,

Abstract: China consumes 32% of the world's total synthetic fertilizer nitrogen (N). Overuse of fertilizer N has become widespread, resulting in severe environmental problems. Based on a set of statistical models, we quantified the optimum N rates for rice production in terms of economic and ecological benefits. Model fitting results suggested that the dependence of rice yield, N uptake and N loss on fertilizer N application rates can be well determined by a quadratic polynomial function, a logistic function and a power function, respectively. Using these functions, the economically optimum and ecologically optimum N rates in south-eastern China were estimated to be 180–285 kg ha-1 and 90–150 kg ha-1, respectively,

depending on rice subspecies, varieties and cropping systems. A case study in Jiangsu Province, where single rice with conventional japonica varieties is dominated, suggested that current N rates

(~390 kg ha−1) could be cut by 26% and 61% when the

economically and ecologically optimum N rates, respectively, are adopted, saving 189 × 103 and 442 × 103 metric tons per year, respectively. Cutting one-third of the N use would not reduce rice yield but is expected to mitigate negative environmental impact in this province.

Keywords: Fertilizer nitrogen use; Rice production; Economically optimum; Ecologically optimum; Environment; China

5. Lihua Chen, Xingming Yang, Waseem Raza, Jia Luo, Fengge Zhang, Qirong Shen, Solid-state fermentation of agro-industrial wastes to produce bioorganic fertilizer for the biocontrol of Fusarium wilt of cucumber in continuously cropped soil, Bioresource Technology, Volume 102, Issue 4, February 2011, Pages 3900-3910, ISSN 0960-8524,

Abstract: Agro-industrial wastes of cattle dung, vinegar-production residue and rice straw were solid-state fermented by inoculation with Trichoderma harzianum SQR-T037 (SQR-T037) for production of bioorganic fertilizers containing SQR-T037 and 6-pentyl-α-pyrone (6PAP) to control Fusarium wilt of cucumber in a continuously cropped soil. Fermentation days, temperature, inoculum and vinegar-production residue demonstrated significant effects on the SQR-T037 biomass and the yield of 6PAP, based on fractional factorial design. Three optimum conditions for producing the maximum SQR-T037 biomass and 6PAP yield were predicted by central composite design and validated. Bioorganic fertilizer containing 8.46 log10 ITS copies g−1 dry weight of SQR-T037 and 1291.73 mg kg−1 dry weight of 6PAP, and having the highest (p < 0.05) biocontrol efficacy, was achieved at 36.7 fermentation days, 25.9 °C temperature, 7.6% inoculum content, 41.0% vinegar-production residue, 20.0% rice straw and 39.0% cattle dung. This is a way to offer a high value-added use for agro-industrial wastes.

Keywords: Cattle dung; Vinegar-production residue; Trichoderma harzianum; 6-Pentyl-α-pyrone; High value-added

6. Ming LIU, Zhong-pei LI, Tao-lin ZHANG, Chun-yu JIANG, Yu-ping CHE, Discrepancy in Response of Rice Yield and Soil Fertility to Long-Term Chemical Fertilization and Organic Amendments in Paddy Soils Cultivated from Infertile Upland in Subtropical China, Agricultural Sciences in China, Volume 10, Issue 2, February 2011, Pages 259-266, ISSN 1671-2927,

Abstract: From 1990, over 17 years field experiment was carried out in paddy field cultivated from infertile upland to evaluate the response of rice productivity, soil organic carbon (SOC), and total N to long-term NPK fertilization or NPK combined with organic amendments. The field trials included NPK (N, P, K fertilizer), NPKRS (NPK combined with rice straw), NPK2RS (NPK combined with double amount of rice straw), NPKPM (NPK combined with pig manure) and NPKGM (NPK combined with green manure) and the cropping system was rice-rice (Oryza sativa

L.) rotation. Annual rice yield, straw biomass, and harvesting index increased steadily with cultivation time in all treatments. Average annual rice yield from 1991 to 2006 was ranged from 7 795 to 8 572 kg ha−1 among treatments. Rice yields in treatments with organic amendments were usually higher than that in treatment with NPK. Contents of SOC and total N also increased gradually in the cultivation years and reached the level of 7.82 to 9.45 and 0.85 to 1.03 g kg−1, respectively, in 2006. Soil fertilities in treatments with chemical fertilization combined with organic amendments were relatively appropriate than those in treatment with NPK. There was obvious discrepancy between cumulative characters of rice yield and soil organic fertility in newly formed paddy field. Compared with relatively high rate of crop productivity improvement, cumulative rates of SOC and total N were much lower in our study. SOC and total N contents were still less than half of those in local highly productive paddy soils after 17 years cultivation in subtropical China. Present work helps to better understand the development of infertile paddy soils and to estimate the potential of yield improvement in this region.
Keywords: paddy field; rice yield; SOC; total N; long-term field experiment

7. Hiroe Yoshida, Takeshi Horie, Kou Nakazono, Hiroyuki Ohno, Hiroshi Nakagawa, Simulation of the effects of genotype and N availability on rice growth and yield response to an elevated atmospheric CO2 concentration, Field Crops Research, Volume 124, Issue 3, 20 December 2011, Pages 433-440, ISSN 0378-4290,

Abstract: The objective of this study was to identify physiological processes that result in genotypic and N fertilization effects on rice yield response to elevated atmospheric CO2 concentrations ([CO2]). This study conducted growth and yield simulations for 9 rice genotypes grown at 4 climatically different sites in Asia, assuming the current atmospheric [CO2] (360 ppm) and elevated [CO2] (700 ppm) using 5 levels of N fertilizer (4, 8, 12, 16, 20 g m−2 N fertilizer). A rice growth model that was developed and already validated for 9 different genotypes grown under 7 sites in Asia was used for the simulation, integrating additional components into the model to explain the direct effect of [CO2] on several physiological processes. The model predicted that the relative yield response to elevated [CO2] (RY, the ratio of yield under 700 ppm [CO2] to that under 360 ppm [CO2]) increased with increasing N fertilizer, ranging from 1.12 at 4 g m−2 N fertilizer to 1.22 at 20 g m−2 N fertilizer, averaged overall genotypes and locations. The model also predicted a large genotypic variation in RY at the 20 g N treatment, ranging from 1.08 for 'WAB450-I-B-P-38-HB' to 1.41 for 'Takanari' averaged overall locations. Combining all genotypes grown at the 5N fertilization conditions, a close 1:1 relationship was predicted between RY and the relative [CO2] response in spikelet number for crops with a small number of spikelets (less than 30,000 m−2) under the current atmospheric [CO2] (n = 18, r = 0.89***). In contrast, crops with a large number of spikelets under the current atmospheric [CO2] showed a significantly larger RY than the relative [CO2] response for spikelet

number per unit area. The model predicted that crops with a larger number of spikelets under the current atmospheric [CO2] derived great benefit from elevated [CO2] by directly allocating increased carbohydrate to their large, vacant sink, whereas crops with a smaller number of spikelets primarily required an increased spikelet number to use the increased carbohydrate to fill grains. The simulation analyses suggested that rice with a larger sink capacity relative to source availability under the current atmospheric [CO2] showed a larger yield response to elevated [CO2], irrespective of whether genotype or N availability was the major factor for the large sink capacity under the current [CO2]. The model predicted that the RY response to nitrogen was brought about through the N effects on spikelet number and non-structural carbohydrate accumulation. The genotypic variation in RY was related to differences in spikelet differentiation efficiency per unit plant N content. Further model validation about the effects of [CO2] on growth processes is required to confirm these findings considering data from experimental studies.
Keywords: Crop model; Genotype-by-environment interaction; CO₂ effect; Rice

8. 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

9. D.R. Coventry, A. Yadav, R.S. Poswal, R.K. Sharma, R.K. Gupta, R.S. Chhokar, S.C. Gill, V. Kumar, A. Kumar, A. Mehta, S.G.L. Kleemann, J.A. Cummins, Irrigation and nitrogen scheduling as a requirement for optimising wheat yield and quality in Haryana, India, Field Crops Research, Volume 123, Issue 2, 14 August 2011, Pages 80-88, ISSN 0378-4290,

Abstract: Wheat in Haryana (NW India) is grown as a winter crop in an annual sequence with rice, cotton, pearl millet or cluster bean as the main monsoon crops. Higher wheat yields in Haryana are associated with the use of modern varieties, increase in fertiliser use, improved irrigation practice and conservation tillage, and the recommendation to farmers for N fertiliser rates and timing and irrigation practice have an emphasis on optimising yield and input efficiencies. In India the importance to consumers of product quality does exist and, although the market place presently does not actively reward farmers for better quality wheat, the need for creating suitable and targeted marketing opportunities is now recognised. This paper examines aspects of input efficiencies and focuses on combinations of N-fertiliser and irrigation input in wheat crops grown with these four rotations (rice–wheat, cotton–wheat, pearl millet–wheat and cluster bean–wheat). Management practices that optimise grain production as well targeting grain that achieves best chapatti (Indian flat bread) quality are evaluated within a split-plot experiment where 4 irrigation schedule treatments were split with nitrogen management treatments involving a 2-way or 3-way split of N fertiliser. With the rice–wheat system, there were no differences between different split timings of N with grain yield, however with the 3 other wheat systems the 3 way split of N-fertiliser application, with N applied equally at N-fertiliser applied at seeding, early tillering and first node stage, always gave the highest yield. With all 4 rotations the highest protein level was achieved (range 11.8–12.5%) with this 3-way N application split. Grain yield increased in a step-wise manner as additional irrigation was implemented with all rotations and the highest protein outcomes were achieved with the least irrigations. The apparent recovery of N fertiliser applied was similar and highest with the 3-way split, and the 2-way split that did not include a basal N fertiliser application. Different rates of N fertiliser were included in separate experiments using the 3-way split of N application, and with the rice–wheat rotation the GreenSeeker instrument was used to establish the rate for the third application of N. The application of extra N-fertiliser with the non rice–wheat rotations produced no additional grain yield with an increase in the N-fertiliser input beyond 150 kg N ha−1, although protein and N-content increased incrementally. Grain hardness and chapatti score trended higher with increases in N-fertiliser input but the increases were relatively small. The use of the GreenSeeker instrument with the rice–wheat rotation resulted in N saving of 21–25 kg N ha−1 with similar grain yield, protein and grain hardness to that provided by using the recommended 150 kg N ha−1. Where the GreenSeeker was used the apparent recovery was 70–75% compared with 60% with the wheat receiving the recommended 150 kg N ha−1, suggesting farmers are likely to be over-fertilising their wheat crop. The best yields obtained in these experiments were about 5.5–6.0 t ha−1 and these yields are consistent with a decade-long attainable yield identified for wheat in rice–wheat rotation for Haryana. If farmers can achieve market recognition for chapatti quality, and with the use of

appropriate varieties, then farmers can assume that the best practice outlined here for optimising grain yield with integrated nutrient and soil management will be the same practice that optimises chapatti quality.
Keywords: N fertiliser; Split applications; Apparent recovery; Attainable yields; Chapatti quality

10. Sukallaya Kasem, Gopal B. Thapa, Crop diversification in Thailand: Status, determinants, and effects on income and use of inputs, Land Use Policy, Volume 28, Issue 3, July 2011, Pages 618-628, ISSN 0264-8377,

Abstract: Following the national policy, the Department of Agriculture of Thailand has implemented a crop diversification program in several provinces of the country. This study, which was conducted in Nakhon Pathom Province, analyzed the extent of crop diversification and its determinants using primary information collected from 245 farm households using a structured questionnaire, and from selected farmer leaders and agricultural development officials. The study also assessed the effects of crop diversification on income and the inputs used. The findings of the study revealed that nearly three fourths of the land is still being used for rice mono-cropping, indicating little success in the promotion of the crop diversification program. Paddy fields, including farms for cultivating rice under mono-cropping and diversified system, still account for 90% of the total farmland in the country. The limited impact of the program on the farming sector is attributed primarily to the variation in land and labor resources available at the farmers' disposal as well as soil suitability. The farmers' attendance in training and interaction with farmer groups are the other influential factors. Although cropping diversification has provided attractive financial return particularly to the small farmers, it has also accelerated the use of inorganic fertilizers and pesticides. Broad policy instruments are therefore suggested for the effective implementation of future crop diversification programs in Thailand and perhaps elsewhere in Southeast Asia.
Keywords: Crop diversification; Rice mono-crop; Vegetables; Financial return; Inorganic fertilizers and pesticides; Organic fertilizers; Bio-pesticides; Thailand

11. P. Schmitter, G. Dercon, T. Hilger, M. Hertel, J. Treffner, N. Lam, T. Duc Vien, G. Cadisch, Linking spatio-temporal variation of crop response with sediment deposition along paddy rice terraces, Agriculture, Ecosystems & Environment, Volume 140, Issues 1-2, 30 January 2011, Pages 34-45, ISSN 0167-8809,

Abstract: In tropical mountainous regions of South East Asia, intensive cultivation of annual crops on steep slopes makes the area prone to erosion resulting in decreasing soil fertility. Sediment deposition in the valleys, however, can enhance soil fertility, depending on the quality of the sediments, and influence crop productivity. The aim of the study was to assess (i) the spatio-temporal variation in grain yield along two rice terrace cascades in the uplands of northern Viet Nam, (ii) possible linkage of sediment deposition with the observed variation in grain yield, and (iii) whether spatial variation in soil water or nitrogen availability influenced the obtained yields masking the effect of inherent soil fertility using carbon isotope (13C) discrimination and 15N natural abundance techniques. In order to evaluate the impact of seasonal conditions, fertilizer use and sediment

quality on rice performance, 15N and 13C stable isotope compositions of rice leaves and grains taken after harvest were examined and combined with soil fertility information and rice performance using multivariate statistics. The observed grain yields for the non-fertilized fields, averaged over both cascades, accounted for 4.0 ± 1.4 Mg ha−1 and 6.6 ± 2.5 Mg ha−1 in the spring and summer crop, respectively, while for the fertilized fields, grain yields of 6.5 ± 2.1 Mg ha−1 and 6.9 ± 2.1 Mg ha−1 were obtained. In general, the spatial variation of rice grain yield was strongly and significantly linked to sediment induced soil fertility and textural changes, such as soil organic carbon (r 0.34/0.77 for Cascades 1 and 2, respectively) and sand fraction (r −0.88/−0.34). However, the observed seasonal alteration in topsoil quality, due to sediment deposition over two cropping cycles, was not sufficient to fully account for spatial variability in rice productivity. Spatial variability in soil water availability, assessed through 13C discrimination, was mainly present in the spring crop and was linearly related to the distance from the irrigation channel, and overshadowed in Cascade 2 the expected yield trends based on sediment deposition. Although δ15N signatures in plants indicated sufficient N uptake, grain yields were not found to be always significantly influenced by fertilizer application. These results showed the importance of integrating sediment enrichment in paddy fields within soil fertility analysis. Furthermore, where the effect of inherent soil fertility on rice productivity is masked by soil water or nitrogen availability, the use of 13C and 15N stable isotopes and its integration with conventional techniques showed potential to enhance the understanding of the influence of erosion – sedimentation and nutrient fluxes on crop productivity, at toposequence level.
Keywords: Paddy rice; Productivity; Sedimentation; Soil fertility; ¹³C discrimination and ¹⁵N natural abundance

12. Guan GUAN, Shu-xin TU, Jun-cheng YANG, Jian-feng ZHANG, Li YANG, A Field Study on Effects of Nitrogen Fertilization Modes on Nutrient Uptake, Crop Yield and Soil Biological Properties in Rice-Wheat Rotation System, Agricultural Sciences in China, Volume 10, Issue 8, August 2011, Pages 1254-1261, ISSN 1671-2927,

Abstract: Rational application of nitrogen (N) fertilizers is an important measure to raise N fertilizer recovery rate and reduce N loss. A two-year field experiment of rice-wheat rotation was employed to study the effects of N fertilization modes including a N fertilizer reduction and an organic manure replacement on crop yield, nutrient uptake, soil enzyme activity, and number of microbes as well as diversity of microbes. The result showed that 20% reduction of traditional N fertilizer dose of local farmers did not significantly change crop yield, N uptake, soil enzyme activity, and the number of microbes (bacteria, actinomycetes, and fungi). On the basis of 20% reduction of N fertilizer, 50% replacement of N fertilizer by organic manure increased the activity of sucrose, protease, urease, and phosphatase by 46-62, 27-89, 33-46, and 35-74%, respectively, and the number of microbes, i.e., bacteria, actinomycetes, and fungi by 36-150, 11-153, and 43-56%, respectively. Further, organic fertilizer replacement had a Shannon's diversity index (H) of 2.18, which was higher than that of other modes of single N fertilizer application. The results suggested that reducing N fertilizer by 20% and applying

organic manure in the experimental areas could effectively lower the production costs and significantly improve soil fertility and biological properties.
Keywords: rice-wheat rotation; N fertilization mode; organic manure replacement; soil enzyme activity; microbial diversity

13. 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

14. Li MA, Lin-Zhang YANG, Li-Zhong XIA, Ming-Xing SHEN, Shi-Xue YIN, Yun-Dong LI, Long-Term Effects of Inorganic and Organic Amendments on Organic Carbon in a Paddy Soil of the Taihu Lake Region, China, Pedosphere, Volume 21, Issue 2, April 2011, Pages 186-196, ISSN 1002-0160,

Abstract: A long-term experiment set up in 1980 compared the effects of applying manures and chemical fertilizers on a paddy soil in the Taihu Lake region, China. Of the fourteen randomly distributed treatments consisting of different combinations of organic manure, inorganic nitrogen (N), phosphorus (P), and potassium (K), and rice straw, eight were selected for the present study in 2007. Application of organic manure plus straw significantly increased soil organic carbon (SOC) content of the topsoil (0-10 cm) compared to that of chemical fertilizers alone. The content of SOC was relatively stable in the 10-30 cm layer in the chemical fertilizer treatments and in the 20-40 cm layer in the manure treatments. The stable carbon isotope ratio (δ13C) ranged from −24% to −28% and increased gradually with depth. The content of SOC was significantly (P < 0.05) negatively correlated

with d13C. In the 0-20 cm layer, the d13C value significantly decreased in the treatments of manure alone (M), manure and chemical N and P fertilizers (MNP), manure and chemical N, P, and K fertilizers (MNPK), manure, rice straw, and chemical N fertilizer (MRN), and chemical N fertilizer and rice straw (CNR), as compared with the no-fertilizer control. In the 30-50 cm layer, however, the ratio significantly increased in all the treatments except Treatment CNR. Mineralization of organic C peaked in the first 2-4 d of incubation and gradually leveled off thereafter over the first 3 weeks, being faster in the manure treatments than the chemical fertilizer treatments. The average rate of mineralization varied from 55.36 to 75.46 mL CO2 kg−1 d−1 and that of stable mineralization from 10 to 20 mL CO2 kg−1 d−1. In eight weeks of incubation, cumulative mineralization was always higher in the manure treatments than the chemical fertilizer treatments, being the highest in Treatment MRN. Combined humus in the soil was mainly (over 50%) composed of tightly combined fraction. The loosely combined humus and its ratio of humic acid (HA) to fulvic acid (FA) significantly increased with long-term application of organic manure and chemical fertilizers. It could be concluded that the cycle of organic C in the paddy soil ecosystem studied was stable over the long-term application of fertilizers and continued cultivation.
Keywords: chemical fertilizer; humus; mineralization; organic manure; stable carbon isotope ratio

15. 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

16. 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

17. Yoshiaki Kamiji, Hiroe Yoshida, Jairo A. Palta, Tetsuo Sakuratani, Tatsuhiko Shiraiwa, N applications that increase plant N during panicle development are highly effective in increasing spikelet number in rice, Field Crops Research, Volume 122, Issue 3, 14 June 2011, Pages 242-247, ISSN 0378-4290,

Abstract: Efficient use of nitrogen fertilizer is critical in improving yield stability in rice. The objective of this study was to determine the effect of nitrogen (N) top-dressing on the number of total spikelet (fertile plus sterile) production and evaluate the effect among rice cultivars. We analyzed 136 sets of experimental data on growth and spikelet production for three lowland cultivars, grown under various regimes of N over 10 seasons at Kyoto, Ibaraki and Kanagawa, Japan. In each season, one to three of the lowland cultivars, Nipponbare (japonica), Koshihikari (japonica) and Takanari (indica), were studied. In 1986, 1995 and 1999–2001, the N regimes included basal application only, light basal and heavy top-dressing from the panicle initiation stage onward, heavy basal and heavy top-dressing from the spikelet formation stage onward, and no applications. In 2002 and 2005–2008, we set up experimental plots with varied time of N top-dressing, with or

without N basal application. Takanari had the largest spikelet number averaged over all plots and was considered better efficient in spikelet production per applied N than the other cultivars. Although the trend is not clear, the effect of time of top-dressing on spikelet number was generally the greatest when N was top-dressed from 35 to 30 days before heading. The variation of observed spikelet number was analyzed with a linear regression of plant N 14 days before heading and by a model that estimates spikelet production accounting for plant N 14 days before heading and crop growth rate (CGR) during the 14-day period preceding heading. For the variation of spikelet number within each cultivar, the linear function model expressed the observed spikelet number than the two function model with R2 0.43** versus 0.13*–0.28** for the former and later models, respectively. When the results of all cultivars were combined, the two function model was much better for estimation of spikelet number than the linear function model (R2 = 0.36** vs. 0.20*). This indicates that yearly and varietal variation of spikelet number was caused mainly by plant N status at the late spikelet differentiation stage. The varietal variation in spikelet production efficiency is explained by CGR during this 14-day period. We concluded that N applications that increase plant N 14 days before heading is highly effective in maximizing spikelet production among cultivars.
Keywords: Crop growth rate; Low land rice cultivars; N top-dressing; Plant N; Spikelet production efficiency

18. 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

19. 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

20. 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

21. X. Jiang, Alan L. Wright, X. Wang, F. Liang, Tillage-induced changes in fungal and bacterial biomass associated with soil aggregates: A long-term field study in a subtropical rice soil in China, Applied Soil Ecology, Volume 48, Issue 2, June 2011, Pages 168-173, ISSN 0929-1393,
Abstract: The composition and function of the soil microbial community can be strongly influenced by soil structure and tillage. Soil total microbial biomass C (MBC), microbial biomass N (MBN), and fungal and bacterial biomass associated with different soil aggregate-size fractions were measured for a long-term no-till subtropical rice soil ecosystem to determine how tillage shifts microbial community structure and to detect the spatial scale at which microorganisms are the most sensitive to disturbance. Surface soil (0–20 cm) was fractionated into aggregate-sizes (>4.76 mm, 4.76–2.0 mm, 2.0–1.0 mm, 1.0–0.25 mm, 0.25–0.053 mm, <0.053 mm) under three tillage regimes. Soil MBC, MBN, fungal biomass and bacterial biomass were significantly higher under no tillage (NT) than conventional tillage (CT) and CT flooded paddy field (FPF) in whole soil (p < 0.05). Microbial biomass C, N and fungal biomass were significantly higher under NT than CT and FPF for all aggregate sizes. No significant tillage effects on microbial biomass C:N ratio were observed, but analysis of soil aggregates revealed significant differences due to tillage. Microbial biomass C:N ratio averaged 8.8, 8.5, and 8.4 for CT, NT, and FPF, respectively, while the ratio was significantly higher under CT than NT for macroaggregates >1.0 mm, indicating a tillage-induced N limitation in macroaggregates. The fungal:bacterial biomass ratio ranged from 0.5 to 4.5, and was highest in 4.76–2 mm aggregates for all tillage regimes. Fungal:bacterial ratios were significantly higher for aggregate sizes >1.0 mm (2.4) than for <1.0 mm aggregates (0.7). Tillage effects on fungal over bacterial dominance were not significant for whole soil and most aggregate sizes. The NT regime increased microbial biomass, but this increase was proportional for both bacteria and fungi. The soil microbial biomass and community structure was likely controlled by particle size at the aggregate-scale (0.05–5.0 mm), while tillage played a role in regulating the microbial community structure.
Keywords: Soil aggregates; No-tillage; Soil organic carbon

22. S. Delmotte, P. Tittonell, J.-C. Mouret, R. Hammond, S. Lopez-Ridaura, On farm assessment of rice yield variability and productivity gaps between organic and conventional cropping systems under Mediterranean climate, European Journal of Agronomy, Volume 35, Issue 4, November 2011, Pages 223-236, ISSN 1161-0301,
Abstract: Organic rice production is characterised by high yield variability and substantial productivity gaps with respect to conventional systems. Variability may be accentuated in areas of erratic climate, such as in the Mediterranean region of La Camargue in southern France. While management recommendations for organic cropping systems are not readily available, innovative farmers develop strategies to achieve high, and less variable, yields. The objectives of this study were to identify the main factors affecting yield

variability and the farmer management strategies used to sustain crop productivity while reducing input use. Participatory monitoring of farmer fields for yields, yield components, soil condition, weeds and management practices from 1992 to 2009 resulted in a database of more than 380 entries. These data included continuous, discrete and nominal variables. They were explored using classification and regression trees to describe management strategies under conventional and organic systems and to identify and categorise the main variables associated with rice yield variability. Rice yields varied between 0.5 and 10 t ha−1 under conventional and between 0 and 9 t ha−1 under organic management. Weed competition was the main factor affecting yield for both conventional and organic systems. The gap between current average yields and the estimated yield potential of 10 t ha−1 was on average 2.7 t ha−1 under conventional and 5 t ha−1 under organic management. The latter can be largely attributed to the effect of weed competition. The productivity gap between conventional and organic management fluctuated between c. 1 t ha−1 under conducive conditions and c. 4 t ha−1 under limiting conditions (e.g., severe salinity problems). Strategies to attain high yields under conventional and organic management differed: Under conventional management, a low initial plant stand associated with early sowing was compensated by high tillering rates induced through N fertilisation, while weeds were controlled by herbicides. Under organic management, late sowing allowed a higher initial plant density due to higher temperatures during emergence. This higher density ensured greater competition with weeds and sufficient number of panicles per unit area at harvest. If organic rice production is to be further promoted in Mediterranean regions, such innovations should be supported by technical means such as short cycle varieties adapted to late sowing under high latitudes. Other alternatives to outcompete and/or control weeds without the need for herbicides, notably through irrigation water management, crop rotation or use of cover crops must also be explored. These results indicate that farmer innovations may show possible pathways towards the ecological intensification of current agriculture.
Keywords: Yield gap; Farmer innovation; Classification and regression tree; Long-term crop productivity; Weed competition; Ecological intensification

23. Y. Singh, V.P. Singh, G. Singh, D.S. Yadav, R.K.P. Sinha, D.E. Johnson, A.M. Mortimer, The implications of land preparation, crop establishment method and weed management on rice yield variation in the rice–wheat system in the Indo-Gangetic plains, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 64-74, ISSN 0378-4290, **Abstract:** The implications of adopting alternative seeding methods for rice and wheat establishment were examined at three geographically separate sites in the rice–wheat system of the Indo-Gangetic plains, across northern India. Rice yields in cultivated plots, established by either wet or dry seeding methods, were evaluated in comparison to yields from zero-tillage plots and under conventional transplanting methods. In the same trials, the effects of crop establishment methods in wheat were assessed both on wheat yields and rice yields. Rice crop establishment methods markedly influenced the emerging weed flora and attainable yields were measured in relation to intensity of weed management. Over four years, average rice grain yields in the absence of weed competition were greatest (6.56 t ha−1) under wet seeding (sowing pre-germinated rice seed on puddled soil), and similar

to those from transplanted rice (6.17 t ha−1) into puddled soil, and dry seeded rice after dry soil tillage (6.15 t ha−1). Lowest yields were observed from dry seeded rice sown without tillage (5.44 t ha−1). Rice yield losses due to uncontrolled weed growth were least in transplanted rice (12%) but otherwise large (c. 85%) where rice had been sown to dry cultivated fields or to puddled soil, rising to 98% in dry seeded rice sown without soil tillage. Weed competition reduced multiple rice yield components, and weed biomass in wet seeded rice was six-fold greater that in rice transplanted into puddled soil and twice as much again in dry seeded rice sown either after dry tillage or without tillage. Wheat grain yields were significantly higher from crops sown into tilled soil (3.89 t ha−1) than those sown without tillage (3.51 t ha−1), and also were elevated (5% on average) where the soil had been dry cultivated in preparation for the previous rice crops rather than puddled. The method of wheat cultivation did not influence rice yield. Soil infiltration rates in the wheat season were least where the land had been puddled for rice (1.52 mm h−1), and greater where the soil had been dry-tilled (2.63 mm h−1) and greatest after zero-tillage (3.54 mm h−1).

24. Bhagirath S. Chauhan, Virender P. Singh, Avnish Kumar, David E. Johnson, Relations of rice seeding rates to crop and weed growth in aerobic rice, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 105-115, ISSN 0378-4290,
Abstract: Aerobic rice describes a management adaptation to reduced irrigation water supplies but, due to reduced intervals of flooding in this system, this requires revised weed management approaches to reduce costs and provide effective weed control. One approach is to make the crop more competitive and reduce the effects of weeds on the crop by using higher rice seeding rates. A study was conducted in the Philippines and India in 2008 and 2009 to assess the relations of seeding rates (15–125 kg ha−1) of hybrid and inbred varieties to crop and weed growth in aerobic rice. Plant densities, tillers, and biomass of rice increased linearly with increased in seeding rates under both weedy and weed free environments. Weed biomass decreased linearly with increasing seeding rates from 15 to 125 kg ha−1. Panicles and grain yields of rice in competition with weeds increased in a quadratic relation with increased seeding rates at both locations; however, the response was flat in the weed free plots. A quadratic model predicted that seeding rates of 48–80 kg ha−1 for the inbred varieties and 47–67 kg ha−1 for the hybrid varieties were needed to achieve maximum grain yield when grown in the absence of weeds, while rates of 95–125 kg seed ha−1 for the inbred varieties and 83–92 kg seed ha−1 for the hybrid varieties were needed to achieve maximum yields in competition with weeds. On the basis of these results, seeding rates greater than 80 kg ha−1 are advisable where there are risks of severe weed competition. Such high seeding rates may be prohibitive when using expensive seed, and maximum yields are not the only consideration for developing recommendations for optimizing economic returns for farmers. Results of the present study do suggest however that increasing seeding rates of aerobic rice does suppress weed growth and reduce grain yield losses from weed competition. This information could be incorporated in integrated crop management packages to manage weeds more effectively.

Keywords: Plant density; Competition; Biomass; Yield; Philippines; India; Irrigation; Cultural control

25. Yoichiro Kato, Amelia Henry, Daisuke Fujita, Keisuke Katsura, Nobuya Kobayashi, Rachid Serraj, Physiological characterization of introgression lines derived from an indica rice cultivar, IR64, adapted to drought and water-saving irrigation, Field Crops Research, Volume 123, Issue 2, 14 August 2011, Pages 130-138, ISSN 0378-4290,
Abstract: Water scarcity threatens sustainable rice production in many irrigated areas around the world. To cope with the scarcity, aerobic rice culture has been proposed as a promising water-saving technology. The objective was to elucidate the physiological attributes behind the performance of rice introgression lines in water-saving culture. We evaluated yield potential and physiological adaptation traits to water deficit of BC3-derived lines with the genetic background of an elite indica cultivar, IR64, in the field and in pot experiments. One line, YTH183, had 26% higher yield than IR64 under non-stress conditions (895 vs. 712 g m−2 on average). This was attributed to enlarged sink capacity due to large grain size, which contributed to more efficient use of assimilates and hence a higher harvest index. YTH183 also showed better dehydration avoidance under intermittent soil drying, due to the adaptive response of deep rooting to water deficiency. The grain yield of YTH183 exceeded that of IR64 by 92–102% under moderate water deficit caused by limited irrigation in aerobic rice culture (143 vs. 72 g m−2). Two introgressed segments on chromosomes 5 and 6 might, at least in part, confer the higher yield potential and greater dehydration avoidance in YTH183 simultaneously. Advanced backcross breeding combined with molecular genetics and physiological characterization of introgressed segments would be effective for developing new rice cultivars with high yield potential and drought adaptation traits.
Keywords: Drought adaptation; Oryza sativa; Root system architecture; Yield potential

26. Ke Min Wang, Jian Guo Wu, Guan Li, Da Peng Zhang, Zhong Wei Yang, Chun Hai Shi, Distribution of phytic acid and mineral elements in three indica rice (Oryza sativa L.) cultivars, Journal of Cereal Science, Volume 54, Issue 1, July 2011, Pages 116-121, ISSN 0733-5210,
Abstract: Three indica rice cultivars with different grain shapes were selected to determine the milling characteristics and distribution of phytic acid (PA) and six mineral elements including magnesium (Mg), calcium (Ca), manganese (Mn), iron (Fe), zinc (Zn), and selenium (Se). Milling characteristics were quite different among the rice cultivars with different physical dimensions. Similar milling times did not necessarily result in the same degree of milling (DOM) for different rice cultivars. The concentrations of phytic acid and minerals decreased with an increased DOM. These results also showed that phytic acid and minerals except for Zn and Se were not evenly distributed and highly concentrated in the outer layer (0% < DOM < 15%) of the rice kernel. In contrast, Zn and Se seem to be relatively evenly distributed in the grain. Optimum DOM of about 14% was detected for Zhenong 7 (long and slender grain); 10% was found for Zhenong 60 (medium-grain) and 9% for Zhenong 34 (short and round grain). The information generated in this experiment could be useful to optimize milling procedures for maximum removal of phytic acid, minimum mineral losses and weight loss in indica rice cultivars with different grain shapes.
Keywords: Degree of milling; Phytic acid; Minerals; Distribution

27. Allan T. Showler, Julien M. Beuzelin, Thomas E. Reagan, Alternate crop and weed host plant oviposition preferences by the Mexican rice borer (Lepidoptera: Crambidae), Crop Protection, Volume 30, Issue 7, July 2011, Pages 895-901, ISSN 0261-2194,
Abstract: The Mexican rice borer, Eoreuma loftini (Dyar), is the key pest of sugarcane, Saccharum hybrids, in south Texas, having largely displaced the sugarcane borer, Diatraea saccharalis (F.), and it is moving into rice- and sugarcane-growing areas of east Texas and Louisiana. While a number of alternative weed and crop hosts have been reported, the extent to which they might support Mexican rice borer populations is unknown. This study involved choice assays that compared oviposition preference for and larval infestations of five mature graminaceous weed species. Levels of infestation between sugarcane and corn, Zea mays L., crop hosts and between corn and sorghum, Sorghum bicolor (L.) Moench, were also assessed. We determined that the average number of larval entry holes in sudangrass stems was ≥2.5-fold more than for any of the other four weed host plants, that corn had ≥5.9-fold more larval entry holes than sorghum and ≥8.2-fold more than sugarcane. Greater oviposition and infestation of one non-crop host over another was not related to numbers of stems per plant, but was associated with the greater stem diameter and abundance of dry leaf tissue found in Sudangrass, Sorghum bicolor (L.) Moench ssp. drummondi (Nees ex Steud.) de Wet & Harlan, johnsongrass, S. halepense (L.) and barnyardgrass, Echinochloa crus-galli (L.) P. Beauv.; relative to the other weed species in this study. In terms of the crop plants, stalk diameter and quantity of dry leaf tissue were not associated with numbers of eggs or larval entry holes in the choice assays between corn and sorghum, and between sugarcane and corn. While corn has been known as a host of the Mexican rice borer for at least 84 yr, its role in area-wide population dynamics and control efforts has likely been greatly underestimated.
Keywords: Corn; Eoreuma loftini; Infestation; Sorghum; Sugarcane; Weeds

28. S. Lin, M.S. You, G. Yang, L.L. Chen, Can polycultural manipulation effectively control rice planthoppers in rice-based ecosystems?, Crop Protection, Volume 30, Issue 3, March 2011, Pages 279-284, ISSN 0261-2194,
Abstract: Rice planthoppers (mainly Nilaparvata lugens (Stål) and Sogatella furcifera Horvath) are the most destructive rice pests throughout southeastern and eastern Asia. Planthopper feeding often causes “hopper burn” and reduces rice yields. Currently, insecticide use is the sole pest management option available to most Chinese farmers. Because pesticide use may have undesirable effects, environmentally sound and sustainable management alternatives are urgently needed. In a two-year field study at the Wuyishan Experimental Station of the Institute of Applied Ecology (IAE), Fujian Agriculture and Forestry University (FAFU), we evaluated the effects of polycultural manipulation on the abundance, sexual differentiation and wing dimorphism of rice planthoppers. The polycultural manipulation was arranged in mosaic patterns of paddy plots intercropped with non-paddy plots including chili pepper, ginger, maize and peanut plants. Monocultural fields of paddy plants were used as controls. Polycultural manipulation significantly reduced the abundance of total planthoppers and nymphs of N. lugens and S. furcifera. The number of overall planthoppers decreased on average by 49% and 55% in 2007 and 2008,

respectively. However, polycultural manipulation had no impact on the proportions of female or macropterous planthoppers. The resource concentration and associational resistance hypotheses may explain these results. In polycultural fields, non-rice species may mask the chemical or visual attractants of rice, making them less apparent, and microhabitat differences in the levels of secondary compounds or in plant quality may also disrupt planthopper orientation.
Keywords: Mosaic arrangement; Nilaparvata lugens (Stål); Sogatella furcifera Horvath; Ecologically-based pest management; Resource concentration; Associational resistance

29. Suchit Shrestha, Folkard Asch, Michael Dingkuhn, Mathias Becker, Cropping calendar options for rice–wheat production systems at high-altitudes, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 158-167, ISSN 0378-4290,

Abstract: The onset of rains during dry to wet transition fallow periods in rice–wheat production systems in Nepal cause substantial losses of soil nitrogen if the system is improperly managed. To make use of available nutrients and water, this transition period can either be shortened by early rice planting, or be extended by late planting, allowing a third crop to be grown. Shifting planting dates would require rice genotypes adapted to the different environments. Crop duration is influenced by both vegetative and reproductive development, which in turn is influenced by the photo-thermal environment and genotypic responses to it. An experiment was conducted to derive genotypic photo-thermal constants from phenological observations on diverse rice cultivars, which were then applied to the concept of the phenological model RIDEV to design cropping calendar options. Environmental effects on variation of crop duration were determined by planting at different dates. The risk of yield losses to sterility caused by low temperatures was estimated by simulation. Thirty-one different genotypes of rice were planted at 8 dates in 15-day intervals starting 27 April 2004 at the experimental field of the Regional Agriculture Research Station, Lumle, Nepal. The shortest duration to flowering was observed for planting dates in late May and early June. Simulation of flowering dates with RIDEV yielded correct results only for the early planting dates. For later planting dates simulated flowering dates showed an increasing deviation from the observed. In most cultivars, minimum air temperature below 18 °C during booting to heading stages caused near-total spikelet sterility and a specific delay in flowering. However, the chilling tolerant cultivars Chomrong and Machhapuchre-3 cultivated at high altitude showed less than 30% spikelet sterility even at 15 °C. Simulating crop durations with the derived thermal constants allowed evaluating the different calendar options for high altitude systems.
Keywords: Cold sterility; Nepal; Oryza sativa; Photo-thermal constants; RIDEV

30. MiaoZhen Cai, ShuNa Zhang, ChengHua Xing, FangMei Wang, Wang Ning, Zhu Lei, Developmental characteristics and aluminum resistance of root border cells in rice seedlings, Plant Science, Volume 180, Issue 5, May 2011, Pages 702-708, ISSN 0168-9452,
Abstract: The developmental characteristics of root border cells (RBCs) and their role in protection of root apices of rice seedling from Al toxicity were evaluated in two rice (Oryza sativa L.) cultivars

differing in Al tolerance. Root elongation and RBCs viability were used as indicators for Al effects. The formation of RBCs and the emergence of the root tip occurred almost simultaneously. Treatment of the root with Al inhibited root elongation and increased Al accumulation in the root tips. Physical removal of RBCs from root tips resulted in a more severe inhibition of root elongation and a higher Al accumulation in the root tips. These effects were more pronounced in the Al-sensitive rice cultivar (II You 6216) than that in the Al-tolerant rice cultivar (II You 838). The relative viability of attached and detached RBCs decreased with increasing Al concentrations. Al also induced a thicker mucilage layer surrounding attached RBCs of both cultivars, and detached RBCs did not. Maintaining the abundant live RBCs encapsulated root tip and enhancing their mucilage secretion, appear to be important in alleviating Al toxicity and in allowing exclusion of Al from the rice root apex.
Keywords: Al toxicity; Oryza sativa L.; Root border cells; Cell viability

31. O.P. Choudhary, B.S. Ghuman, Bijay-Singh, N. Thuy, R.J. Buresh, Effects of long-term use of sodic water irrigation, amendments and crop residues on soil properties and crop yields in rice–wheat cropping system in a calcareous soil, Field Crops Research, Volume 121, Issue 3, 3 April 2011, Pages 363-372, ISSN 0378-4290,

Abstract: One of the options to ameliorate the deleterious effects of sodic water irrigation is to apply gypsum to soil. We examined whether the application of organic manures or crop residue can reduce the need for gypsum in calcareous soils. A long-term field experiment with annual rice–wheat cropping rotation was conducted for 15 years (1991–2006) on a non-saline calcareous sandy loam soil (Typic Ustochrept) in northwestern, India. The irrigation water treatments included good quality canal water (CW) and sodic water (SW) with residual sodium carbonate (RSC) of 10 mmolc L−1 from 1991 to 1999 and of 12.5 mmolc L−1 from 2000 onwards. Gypsum was applied at 0, 12.5, 25, and 50% of the gypsum requirement (GR), to neutralize RSC of the SW. Three organic material treatments consisted of application of farmyard manure (FYM) at 20 Mg ha−1, Sesbania green manure (GM) at 20 Mg ha−1, and wheat straw (WS) at 6 Mg ha−1. The organic materials were applied every year to the rice crop. Continuous irrigation with sodic water for 15 years without gypsum or organic materials resulted in a gradual increase in soil pH and exchangeable sodium percentage (ESP), deterioration of soil physical properties, and decrease in yields of both rice and wheat. The cumulative yield loss in SW irrigated plots without gypsum and organic materials remained <1.5 Mg ha−1 for up to eight years in the case of rice and up to nine years in the case of wheat. Thereafter, marked increase in pH and ESP resulted in further depression in yields of rice by 1.6 Mg ha−1 year−1 and wheat by 1.2 Mg ha−1 year−1. Application of gypsum improved physical and chemical properties of the soil. The beneficial effects on crop yields were visible up to 12.5% GR in rice and up to 50% GR in wheat in most of the years. All the organic materials proved effective in mobilizing Ca2+ from inherent and precipitated CaCO3 resulting in decline in soil pH and ESP, increase in infiltration rate, and a increase in the yields of rice and wheat crops. Although the application of organic materials resulted in comparable reductions in pH and ESP, the increase in yield with SW was higher for both crops

with FYM. Pooled over the last six years (2000–2006), application of FYM resulted in 38 and 26% increase in rice and wheat yields, respectively, over SW treatment; corresponding increases in 50% GR treatment (recommended level) was 18 and 19%. During these years, application of GM and WS increased wheat yields by 20%; for rice, GM resulted in 22% increase compared to 17% in WS amended SW irrigated plots. Combined application of gypsum and organic materials did not increase the yields further particularly in the case of FYM and GM treated plots. This long-term study proves that organic materials alone can be used to solubilize Ca from inherent and precipitated CaCO3 in calcareous soils for achieving sustainable yields in sodic water irrigated rice–wheat grown in annual rotation. The results can help reduce the dependency on gypsum in sodic water irrigated calcareous soils.

Keywords: Residual sodium carbonate; pH; Exchangeable sodium percentage; Bulk density; Infiltration rate; Organic manures; Wheat straw; Gypsum

32. Sudhir -Yadav, Tao Li, E. Humphreys, Gurjeet Gill, S.S. Kukal, Evaluation and application of ORYZA2000 for irrigation scheduling of puddled transplanted rice in north west India, Field Crops Research, Volume 122, Issue 2, 18 May 2011, Pages 104-117, ISSN 0378-4290,

Abstract: Water-saving technologies that increase water productivity of rice are urgently needed to help farmers to cope with irrigation water scarcity. This study tested the ability of the ORYZA2000 model to simulate the effects of water management on rice growth, yield, water productivity (WP), components of the water balance, and soil water dynamics in north-west India. The model performed well as indicated by good agreement between simulated and measured values of grain yield, biomass, LAI, water balance components and soil water tension, for irrigation thresholds ranging from continuous flooding (CF) to 70 kPa soil water tension.

Using weather data for 40 different rice seasons (1970–2009) at Ludhiana in Punjab, India, the model predicted that there is always some yield penalty when moving from CF to alternate wetting and drying (AWD). With an irrigation threshold of 10 kPa, the average yield penalty was 0.8 t ha−1 (9%) compared with CF, with 65% irrigation water saving, which increased to 79% at 70 kPa with a yield penalty of 25%. The irrigation water saving was primarily due to less drainage beyond the root zone with AWD compared to CF, with only a small reduction in evapotranspiration (ET) (mean 60 mm).

There were tradeoffs between yield, irrigation amount and various measures of WP. While yield was maximum with CF, water productivity with respect to ET (WPET) was maximum (1.7 g kg−1) for irrigation thresholds of 0 (CF) to 20 kPa, and irrigation water productivity (WPI) increased to a maximum plateau (1.3 g kg−1) at thresholds ≥30 kPa.

Because of the possibility of plant stress at critical stages known to be sensitive to water deficit (panicle initiation (PI) and flowering (FL)), treatments with additional irrigations were superimposed for 2 weeks at one or both of these stages within the 10, 20 and 30 kPa AWD treatments. Ponding for two weeks at FL was more effective in reducing the yield penalty with AWD than ponding at PI, but the biggest improvement was with ponding at both stages. This reduced the average

yield loss from 9% (0.8 t ha−1) to 5% (0.5 t ha−1) for AWD with thresholds of 10 and 20 kPa. However, maximum WPI (1.1 g kg−1) was achieved with an irrigation threshold of 20 kPa combined with more frequent irrigation at FL only, but with a greater yield penalty (8%). Thus the optimum irrigation schedule depends on whether the objective is to maximise yield, WPET or WPI, which depends on whether land or water are most limiting. Furthermore, the optimum irrigation schedule to meet the short term needs of individual farmers may differ from that needed for sustainable water resource management.

Keywords: Alternate wetting and drying; Water savings; Evapotranspiration; Deep drainage; Water productivity

33. Hiroyuki Shimono, Earlier rice phenology as a result of climate change can increase the risk of cold damage during reproductive growth in northern Japan, Agriculture, Ecosystems & Environment, Volume 144, Issue 1, November 2011, Pages 201-207, ISSN 0167-8809,

Abstract: The present study analyzed the impact of earlier rice phenology as a result of climate change on the risk of cold damage during reproductive growth using the historical temperature record from 1961 to 2010 at four locations in northern Japan. During this period, heading date has become 0.7–1.9 days earlier per 10 years. Air temperatures during the booting stage (6–15 days before heading) decreased by 0.18 °C per 10 years even though the air temperature on a given calendar date has increased slightly. The estimated potential yield losses caused by cold damage have increased since the start of the study period. Thus, the advance in phonological events as a result of global warming is likely to increase the risk of future yield losses, and this has important implications for future adaptation strategies (breeding new cultivars and changing crop management strategies) to reduce the risk of cold damage.

Keywords: Cold damage; Global warming; Phenological development; Risk analysis; Rural–urban temperature gradient; Simulation model

34. Chol Gyu Lee, Takeshi Watanabe, Yutaka Sato, Jun Murase, Susumu Asakawa, Makoto Kimura, Bacterial populations assimilating carbon from 13C-labeled plant residue in soil: Analysis by a DNA-SIP approach, Soil Biology and Biochemistry, Volume 43, Issue 4, April 2011, Pages 814-822, ISSN 0038-0717,

Abstract: In this study, 13C-labeled rice callus was prepared as a model material for rice straw and was subjected to a DNA-SIP (stable isotope probing) experiment in which the bacterial population was monitored in a soil sample containing decomposing dried callus. Rice callus (13C = 78%) contained the more water-soluble organic carbon and less cellulose and lignin carbon than rice straw. The callus in the soil was 37% decomposed after 56 d of incubation in upland moisture conditions. PCR-DGGE analysis demonstrated that the bacterial community in the soil with the callus changed over time, showing a distinct difference between the first (up to 7 d) and second (14 d and later) stages. After isopycnic centrifugation, DNA in the fractions with a buoyant density between 1.759 and 1.734 g ml−1 was subjected to population analysis (13C-assimilating populations). Diverse groups of bacterial sequences were retrieved from the 13C-labeled DNA fractions: Actinobacteria, Bacilli, γ-Proteobacteria, Chloroflexi, Sphingobacteria, Flavobacteria, Clostridia, Acidobacteria, Cyanobacteria and Candidate Division. Bacilli were detected mainly in the first stage, and Actinobacteria were detected throughout the

incubation period. Several DGGE bands in the light fractions became more prominent in the soil with callus, which suggested that the addition of callus promoted the growth of bacteria that fed on soil organic matter, including α-Proteobacteria, γ-Proteobacteria, Bacilli, Actinobacteria, Nitrospira and Gemmatimonadetes.
Keywords: Actinobacteria; Bacterial community; Callus; Clostridium; Denaturing gradient gel electrophoresis; Oxic soil; Plant residue; Stable isotope probing

35. Manuel Tejada, Concepción Benítez, Isidoro Gómez, Juan Parrado, Use of biostimulants on soil restoration: Effects on soil biochemical properties and microbial community, Applied Soil Ecology, Volume 49, September 2011, Pages 11-17, ISSN 0929-1393,
Abstract: Four biostimulants (BS): WCDSs, wheat condensed distiller solubles; PA-HE, hydrolyzed poultry feathers; CGHE, carob germ enzymatic extract; and RB, rice bran extract were applied annually at 4.7 t organic matter (OM) ha−1 for a 3-year period to a Xerollic Calciorthid soil to evaluate their efficiency in soil restoration. Their effects on the plant cover, soil enzymatic activities and the structure of the soil microbial community by analysing phospholipid fatty acids (PLFAs) were determined. Application of BS that contain higher amounts of protein and higher percentage of peptides under 3 kDa had a greater effect on the soil biological properties, possibly due to the low molecular weight protein content can be easily assimilated by soil microorganisms. Following 3 years of successive soil amendment, the dehydrogenase activity was 4.6, 9.6, and 17.6% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. The urease activity was 5.3, 14.5, and 28.8% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. The phosphatase activity was 8, 15.3, and 20.2% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. The arylsulfatase activity was 16, 21.1, and 27.2% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. Total soil phospholipid fatty acid (PLFA) concentration was significantly (p < 0.05) higher in BS-amended soil than control soil. Principal component analysis discriminated between the BS-amended soils, mainly based on content of lower molecular weight peptides. Thus, PA-HE and RB were grouped and differentiated from CGHE and WCDS, respectively. After 3 years of treatment, vegetal cover was 11.4, 17.7, 24.1, and 85.8% higher in PA-HE-amended soils than in the RB, CGHE, WCDS treatments and control soil. These results suggested that under semiarid climatic conditions the application of BS with higher amounts of protein (>50%) and a higher percentage of peptides under 0.3 kDa (>60%) notably increased the soil enzymatic activities, induced changes in microbial community because the protein with lower molecular weight can be more easily absorbed by soil microorganisms, and also favoured the establishment of vegetation, which will protect the soil against erosion and will contribute to its restoration.
Keywords: Soil restoration; Biostimulants; Soil enzymatic activities; Soil microbial community

36. B.Y. CHUNG, C.H. SONG, B.J. PARK, J.Y. CHO, Heavy Metals in Brown Rice (Oryza sativa L.) and Soil After Long-Term Irrigation of Wastewater Discharged from Domestic Sewage Treatment Plants, Pedosphere, Volume 21, Issue 5, October 2011, Pages 621-627, ISSN 1002-0160,

Abstract: A pot experiment was conducted in a plastic film house to evaluate the translocation and uptake of heavy metals (Pb, Cd, Cu, and Zn) into brown rice (Oryza sativa L.) and the heavy metals residues in soils which had previously been irrigated with domestic wastewater for a long time (3 years). The range of Pb, Cd, Cu, and Zn was 5.10 ± 0.01, 0.105 ± 0.017, 5.76 ± 0.42, and 23.56 ± 1.40 mg kg−1, respectively in the domestic wastewater-irrigated soil, and 0.370 ± 0.006, 0.011 ± 0.001, 0.340 ± 0.04, and 2.05 ± 0.18 mg kg−1, respectively, in the domestic wastewater-irrigated brown rice. The results indicated that application of domestic wastewater to arable land slightly increased the levels of Pb, Cd, Cu, and Zn in soil and brown rice (P < 0.01). The concentrations of heavy metals in brown rice were lower than the recommended tolerable levels proposed by the Joint FAO/WHO Expert Committee on Food Additives. However, the continuous monitoring and pollution control of hazardous materials from domestic wastewater are needed in order to prevent excessive build-up of heavy metals in the food chain.

Keywords: accumulation; domestic wastewater; ground water irrigation; P₂O₅; total N

37. Fan-rong ZENG, Fu-sheng ZHAO, Bo-yin QIU, You-nan OUYANG, Fei-bo WU, Guo-ping ZHANG, Alleviation of Chromium Toxicity by Silicon Addition in Rice Plants, Agricultural Sciences in China, Volume 10, Issue 8, August 2011, Pages 1188-1196, ISSN 1671-2927,

Abstract: The alleviatory effect of silicon (Si) on chromium (Cr) toxicity to rice plants was investigated using a hydroponic experiment with two Cr levels (0 and 100 μmol L−1), three Si levels (0, 1.25, and 2.5 mmol L−1) and two rice genotypes, differing in grain Cr accumulation (Dan K5, high accumulation and Xiushui 113, low accumulation). The results showed that 100 μmol L−1 Cr treatment caused a marked reduction of seedling height, dry biomass, soluble protein content, and root antioxidant enzyme activity, whereas significantly increased Cr concentration and TBARS (thiobarbituric acid reactive substances) content. However, the reductions of seedling height, dry biomass, and soluble content were greatly alleviated due to Si addition to the culture solution. Compared with the plants treated with Cr alone, Si addition markedly reduced Cr uptake and translocation in rice plants. No significant differences were observed between the two Si treatments (1.25 and 2.5 mmol L−1) in shoot Cr concentration and Cr translocation factor. Under the treatment of 100 μmol L−1 Cr+2.5 mmol L−1 Si, higher root Cr concentration but lower shoot Cr concentration and Cr translocation factor were observed in Dan K5 than those in Xiushui 113, indicating that the beneficial effect of Si on inhibiting Cr translocation was more pronounced in Dan K5 than in Xiushui 113. Si addition also alleviated the reduction of antioxidative enzymes (superoxide dismutase (SOD) and ascorbate peroxidase (APX) in leaves; catalase (CAT) and APX in roots) and the increase of TBARS content in the Cr-stressed plants. Furthermore, the beneficial effects of Si on activities of antioxidative enzymes under Cr stress were genotype-dependent. The highest activities of SOD, POD (guaiacol peroxidase), CAT, and APX in leaves occurred in the treatment of 100 μmol L−1 Cr+2.5 mmol L−1 Si for Xiushui 113 and in the treatment of 100 μmol L−1 Cr+1.25 mmol L−1 Si for Dan K5. The beneficial effect of Si on alleviating oxidative stress was much more pronounced in Dan K5 than in Xiushui 113. It may be concluded that Si alleviates Cr toxicity mainly through inhibiting the uptake and translocation of Cr and enhancing the capacity of defense against oxidative stress induced by Cr toxicity.

Keywords: antioxidant enzyme; chromium; lipid peroxidation; Oryza sativa L.; silicon; translocation

38. Ali Ashraf Amirinejad, Kalpana Kamble, Pramila Aggarwal, Debashis Chakraborty, Sanatan Pradhan, Raj Bala Mittal, Assessment and mapping of spatial variation of soil physical health in a farm, Geoderma, Volume 160, Issues 3-4, 15 January 2011, Pages 292-303, ISSN 0016-7061,
Abstract: Productivity rating systems are important tools to quantitatively assess soil health. In precision farming such information is required for planning appropriate soil and crop management strategies. In order to demonstrate a proper procedure for assessing the soil physical health of a farm, an experiment was conducted in a rice–wheat field. Spatial variability analysis of soil physical properties measured on a rectangular grid (30 m × 45 m) was carried out by using geostatistical analyst extension of Arc GIS software. Indicators for soil physical health assessment included bulk density (BD), field saturated hydraulic conductivity (Kfs), available water retention capacity (AWRC), organic carbon content (OC) and non capillary porosity (NCP). Rating values of soil physical parameters were different for wheat and rice as the optimum physical environment for both systems were different. Physical rating index (PI) at each sampling point was determined by multiplying the rating values for all five parameters. Results revealed that for BD, Kfs, OC and soil physical health index (PI), major and minor ranges of semivariogram varied between 300–380 m and 55–90 m, respectively. Whereas for NCP and AWRC, they were relatively short (major range between 114–140 m and minor around 60 m). Results also revealed that BD and PI for both surface and subsurface layers showed strong spatial dependence whereas the rest of the parameters showed moderate spatial dependence. Rating maps of mentioned parameters for wheat and rice cultivations were prepared as series of coloured contours by using kriging or other appropriate interpolation techniques and suitable semivariogram models. Overall soil physical health of the farm was medium to good for paddy cultivation but was not suitable for succeeding wheat crop mainly because of increased BD and reduced Kfs, NCP and AWRC of the farm during wheat growth. Correlations between PI and grain yield of both wheat and rice were fairly good (r2 = 0.67). The results thus supported earlier findings that good soil physical health is essential for optimum sustained crop production.
Keywords: Soil physical health; Spatial variability analysis; Physical rating index

39. Dongyang Liu, Ruifu Zhang, Hongsheng Wu, Dabing Xu, Zhu Tang, Guanghui Yu, Zhihui Xu, Qirong Shen, Changes in biochemical and microbiological parameters during the period of rapid composting of dairy manure with rice chaff, Bioresource Technology, Volume 102, Issue 19, October 2011, Pages 9040-9049, ISSN 0960-8524,
Abstract: Various parameters were measured during the period of composting of dairy manure and rice chaff in different ratios (dairy manure/rice chaff = V/V, pile 1: 75/25; pile 2: 80/20; pile 3: 85/15) to evaluate their suitability as indicators for the composting process. The temperature in pile 1 increased rapidly and remained above 60 °C for 30 days, while the temperature in pile 3 increased slowly relative to the other two piles. Furthermore, the degradation of organic substrates, as indicated by the reduction of

C/N ratio, was rapid in pile 1 (below 20% 28 days after beginning of the composting). The major fluctuations of various water-soluble fractions in all piles were observed during the first 3 weeks, and the results in general showed that the highest microbial populations and enzymatic activities also appeared in this phase. Various parameters indicated that the rapid composting method was a feasible one for treating agricultural wastes.
Keywords: Composting; Dairy manure; Water soluble fraction; Enzymatic activity; Microbial groups

40. N. Subash, H.S. Ram Mohan, K. Banukumar, Comparing water-vegetative indices for rice (Oryza sativa L.)–wheat (Triticum aestivum L.) drought assessment, Computers and Electronics in Agriculture, Volume 77, Issue 2, July 2011, Pages 175-187, ISSN 0168-1699,
Abstract: Drought indices (DI) are an useful tool for assessing different sectarian droughts. Standardized Precipitation Index (SPI) has been used worldwide to assess/monitor the onset, active phase, cessation and severity of drought. Normalized Difference Vegetation Index (NDVI) provides a comprehensive vegetation dynamics, which directly linked with rainfall received in a particular region. Indo-Gangetic Region (IGR), providing employment and livelihood to tens of millions of rural families directly or indirectly and rice (Oryza sativa L.)–wheat (Triticum aestivum L.) (RW) system of the Indo-Gangetic Plains (IGP) contributes 80% of the total cereal production and is critical to food security of the region. This study tries to verify the applicability of water-vegetative indices viz., SPI, Rainfall Index (RI) and NDVI for drought assessment of rice–wheat system productivity over IGR-India. The relationship between monsoon rainfall and NDVI shows that at around 1100 mm rainfall, the NDVI reached saturation point and no further significant increase in NDVI with increase of rainfall is noticed. Even though, there was a positive correlation of seasonal monsoon rainfall and average NDVI, conflicting results are noticed between monthly distribution of rainfall and monthly anomaly of NDVI over IGR States. It is noticed that June dif NDVI (actual NDVI–mean NDVI) contributes more to rice productivity followed by July. However, the combined effect of June, July and August, explains 15% of the variation of Kharif Rice Productivity Index (KRPI). As far as wheat is concerned, statistically significant relation was found between Wheat Productivity Index (WPI) and anomaly NDVI during December–March. This explains 35% of the variability in WPI.
Keywords: Normalized Difference Vegetation Index; Productivity; Drought assessment; Rainfall Index; Drought index; Anomaly NDVI

41. X. Jiang, Alan L. Wright, X. Wang, F. Liang, Tillage-induced changes in fungal and bacterial biomass associated with soil aggregates: A long-term field study in a subtropical rice soil in China, Applied Soil Ecology, Volume 48, Issue 2, June 2011, Pages 168-173, ISSN 0929-1393,
Abstract: The composition and function of the soil microbial community can be strongly influenced by soil structure and tillage. Soil total microbial biomass C (MBC), microbial biomass N (MBN), and fungal and bacterial biomass associated with different soil aggregate-size fractions were measured for a long-term no-till subtropical rice soil ecosystem to determine how tillage shifts microbial community structure and to detect the spatial scale at which microorganisms are the most sensitive to disturbance. Surface soil (0–20 cm) was fractionated

into aggregate-sizes (>4.76 mm, 4.76–2.0 mm, 2.0–1.0 mm, 1.0–0.25 mm, 0.25–0.053 mm, <0.053 mm) under three tillage regimes. Soil MBC, MBN, fungal biomass and bacterial biomass were significantly higher under no tillage (NT) than conventional tillage (CT) and CT flooded paddy field (FPF) in whole soil (p < 0.05). Microbial biomass C, N and fungal biomass were significantly higher under NT than CT and FPF for all aggregate sizes. No significant tillage effects on microbial biomass C:N ratio were observed, but analysis of soil aggregates revealed significant differences due to tillage. Microbial biomass C:N ratio averaged 8.8, 8.5, and 8.4 for CT, NT, and FPF, respectively, while the ratio was significantly higher under CT than NT for macroaggregates >1.0 mm, indicating a tillage-induced N limitation in macroaggregates. The fungal:bacterial biomass ratio ranged from 0.5 to 4.5, and was highest in 4.76–2 mm aggregates for all tillage regimes. Fungal:bacterial ratios were significantly higher for aggregate sizes >1.0 mm (2.4) than for <1.0 mm aggregates (0.7). Tillage effects on fungal over bacterial dominance were not significant for whole soil and most aggregate sizes. The NT regime increased microbial biomass, but this increase was proportional for both bacteria and fungi. The soil microbial biomass and community structure was likely controlled by particle size at the aggregate-scale (0.05–5.0 mm), while tillage played a role in regulating the microbial community structure.
Keywords: Soil aggregates; No-tillage; Soil organic carbon

42. S. Delmotte, P. Tittonell, J.-C. Mouret, R. Hammond, S. Lopez-Ridaura, On farm assessment of rice yield variability and productivity gaps between organic and conventional cropping systems under Mediterranean climate, European Journal of Agronomy, Volume 35, Issue 4, November 2011, Pages 223-236, ISSN 1161-0301,
Abstract: Organic rice production is characterised by high yield variability and substantial productivity gaps with respect to conventional systems. Variability may be accentuated in areas of erratic climate, such as in the Mediterranean region of La Camargue in southern France. While management recommendations for organic cropping systems are not readily available, innovative farmers develop strategies to achieve high, and less variable, yields. The objectives of this study were to identify the main factors affecting yield variability and the farmer management strategies used to sustain crop productivity while reducing input use. Participatory monitoring of farmer fields for yields, yield components, soil condition, weeds and management practices from 1992 to 2009 resulted in a database of more than 380 entries. These data included continuous, discrete and nominal variables. They were explored using classification and regression trees to describe management strategies under conventional and organic systems and to identify and categorise the main variables associated with rice yield variability. Rice yields varied between 0.5 and 10 t ha−1 under conventional and between 0 and 9 t ha−1 under organic management. Weed competition was the main factor affecting yield for both conventional and organic systems. The gap between current average yields and the estimated yield potential of 10 t ha−1 was on average 2.7 t ha−1 under conventional and 5 t ha−1 under organic management. The latter can be largely attributed to the effect of weed competition. The productivity gap between conventional and organic management fluctuated between c. 1 t ha−1 under conducive conditions and c.

4 t ha−1 under limiting conditions (e.g., severe salinity problems). Strategies to attain high yields under conventional and organic management differed: Under conventional management, a low initial plant stand associated with early sowing was compensated by high tillering rates induced through N fertilisation, while weeds were controlled by herbicides. Under organic management, late sowing allowed a higher initial plant density due to higher temperatures during emergence. This higher density ensured greater competition with weeds and sufficient number of panicles per unit area at harvest. If organic rice production is to be further promoted in Mediterranean regions, such innovations should be supported by technical means such as short cycle varieties adapted to late sowing under high latitudes. Other alternatives to outcompete and/or control weeds without the need for herbicides, notably through irrigation water management, crop rotation or use of cover crops must also be explored. These results indicate that farmer innovations may show possible pathways towards the ecological intensification of current agriculture.
Keywords: Yield gap; Farmer innovation; Classification and regression tree; Long-term crop productivity; Weed competition; Ecological intensification

43. Y. Singh, V.P. Singh, G. Singh, D.S. Yadav, R.K.P. Sinha, D.E. Johnson, A.M. Mortimer, The implications of land preparation, crop establishment method and weed management on rice yield variation in the rice–wheat system in the Indo-Gangetic plains, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 64-74, ISSN 0378-4290,
Abstract: The implications of adopting alternative seeding methods for rice and wheat establishment were examined at three geographically separate sites in the rice–wheat system of the Indo-Gangetic plains, across northern India. Rice yields in cultivated plots, established by either wet or dry seeding methods, were evaluated in comparison to yields from zero-tillage plots and under conventional transplanting methods. In the same trials, the effects of crop establishment methods in wheat were assessed both on wheat yields and rice yields. Rice crop establishment methods markedly influenced the emerging weed flora and attainable yields were measured in relation to intensity of weed management. Over four years, average rice grain yields in the absence of weed competition were greatest (6.56 t ha−1) under wet seeding (sowing pre-germinated rice seed on puddled soil), and similar to those from transplanted rice (6.17 t ha−1) into puddled soil, and dry seeded rice after dry soil tillage (6.15 t ha−1). Lowest yields were observed from dry seeded rice sown without tillage (5.44 t ha−1). Rice yield losses due to uncontrolled weed growth were least in transplanted rice (12%) but otherwise large (c. 85%) where rice had been sown to dry cultivated fields or to puddled soil, rising to 98% in dry seeded rice sown without soil tillage. Weed competition reduced multiple rice yield components, and weed biomass in wet seeded rice was six-fold greater that in rice transplanted into puddled soil and twice as much again in dry seeded rice sown either after dry tillage or without tillage. Wheat grain yields were significantly higher from crops sown into tilled soil (3.89 t ha−1) than those sown without tillage (3.51 t ha−1), and also were elevated (5% on average) where the soil had been dry cultivated in preparation for the previous rice crops rather than puddled. The method of wheat cultivation did not influence rice yield. Soil infiltration rates in the wheat season were least where the land had been puddled for rice (1.52 mm h−1),

and greater where the soil had been dry-tilled (2.63 mm h−1) and greatest after zero-tillage (3.54 mm h−1).

These studies demonstrated at research managed sites across a wide geographic area, and on farmers' fields, that yields of dry seeded rice sown after dry cultivation of soil were broadly comparable with those of transplanted rice, providing weed competition was absent. These results support the proposition that direct seeding of rice could provide an alternative to the conventional practice of transplanting, and help address rising costs and threats to sustainability in the rice–wheat rotation. Further, analysis of patterns of long-term rainfall data indicated that farmers reliant on monsoon rainfall could prepare fields for dry direct seeded rice some 30 days before they could prepare fields for either transplanting or seeding with pre-germinated seed. Dry, direct seeding of rice contributes a valuable component of an adaptive strategy to address monsoonal variability that also may advance the time of wheat establishment and yield. Whilst the results illustrate the robustness, feasibility and significant potential of direct seeded rice, they also highlight the critical nature of effective weed control in successful implementation of direct seeding systems for rice.

Keywords: India; Monsoon; Zero-tillage; Infiltration; Sustainability

44. Bhagirath S. Chauhan, Virender P. Singh, Avnish Kumar, David E. Johnson, Relations of rice seeding rates to crop and weed growth in aerobic rice, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 105-115, ISSN 0378-4290,

Abstract: Aerobic rice describes a management adaptation to reduced irrigation water supplies but, due to reduced intervals of flooding in this system, this requires revised weed management approaches to reduce costs and provide effective weed control. One approach is to make the crop more competitive and reduce the effects of weeds on the crop by using higher rice seeding rates. A study was conducted in the Philippines and India in 2008 and 2009 to assess the relations of seeding rates (15–125 kg ha−1) of hybrid and inbred varieties to crop and weed growth in aerobic rice. Plant densities, tillers, and biomass of rice increased linearly with increased in seeding rates under both weedy and weed free environments. Weed biomass decreased linearly with increasing seeding rates from 15 to 125 kg ha−1. Panicles and grain yields of rice in competition with weeds increased in a quadratic relation with increased seeding rates at both locations; however, the response was flat in the weed free plots. A quadratic model predicted that seeding rates of 48–80 kg ha−1 for the inbred varieties and 47–67 kg ha−1 for the hybrid varieties were needed to achieve maximum grain yield when grown in the absence of weeds, while rates of 95–125 kg seed ha−1 for the inbred varieties and 83–92 kg seed ha−1 for the hybrid varieties were needed to achieve maximum yields in competition with weeds. On the basis of these results, seeding rates greater than 80 kg ha−1 are advisable where there are risks of severe weed competition. Such high seeding rates may be prohibitive when using expensive seed, and maximum yields are not the only consideration for developing recommendations for optimizing economic returns for farmers. Results of the present study do suggest however that increasing seeding rates of aerobic rice does suppress weed growth and reduce grain yield losses from weed

competition. This information could be incorporated in integrated crop management packages to manage weeds more effectively.
Keywords: Plant density; Competition; Biomass; Yield; Philippines; India; Irrigation; Cultural control

45. Yoichiro Kato, Amelia Henry, Daisuke Fujita, Keisuke Katsura, Nobuya Kobayashi, Rachid Serraj, Physiological characterization of introgression lines derived from an indica rice cultivar, IR64, adapted to drought and water-saving irrigation, Field Crops Research, Volume 123, Issue 2, 14 August 2011, Pages 130-138, ISSN 0378-4290,
Abstract: Water scarcity threatens sustainable rice production in many irrigated areas around the world. To cope with the scarcity, aerobic rice culture has been proposed as a promising water-saving technology. The objective was to elucidate the physiological attributes behind the performance of rice introgression lines in water-saving culture. We evaluated yield potential and physiological adaptation traits to water deficit of BC3-derived lines with the genetic background of an elite indica cultivar, IR64, in the field and in pot experiments. One line, YTH183, had 26% higher yield than IR64 under non-stress conditions (895 vs. 712 g m−2 on average). This was attributed to enlarged sink capacity due to large grain size, which contributed to more efficient use of assimilates and hence a higher harvest index. YTH183 also showed better dehydration avoidance under intermittent soil drying, due to the adaptive response of deep rooting to water deficiency. The grain yield of YTH183 exceeded that of IR64 by 92–102% under moderate water deficit caused by limited irrigation in aerobic rice culture (143 vs. 72 g m−2). Two introgressed segments on chromosomes 5 and 6 might, at least in part, confer the higher yield potential and greater dehydration avoidance in YTH183 simultaneously. Advanced backcross breeding combined with molecular genetics and physiological characterization of introgressed segments would be effective for developing new rice cultivars with high yield potential and drought adaptation traits.
Keywords: Drought adaptation; Oryza sativa; Root system architecture; Yield potential

46. Ke Min Wang, Jian Guo Wu, Guan Li, Da Peng Zhang, Zhong Wei Yang, Chun Hai Shi, Distribution of phytic acid and mineral elements in three indica rice (Oryza sativa L.) cultivars, Journal of Cereal Science, Volume 54, Issue 1, July 2011, Pages 116-121, ISSN 0733-5210,
Abstract: Three indica rice cultivars with different grain shapes were selected to determine the milling characteristics and distribution of phytic acid (PA) and six mineral elements including magnesium (Mg), calcium (Ca), manganese (Mn), iron (Fe), zinc (Zn), and selenium (Se). Milling characteristics were quite different among the rice cultivars with different physical dimensions. Similar milling times did not necessarily result in the same degree of milling (DOM) for different rice cultivars. The concentrations of phytic acid and minerals decreased with an increased DOM. These results also showed that phytic acid and minerals except for Zn and Se were not evenly distributed and highly concentrated in the outer layer (0% < DOM < 15%) of the rice kernel. In contrast, Zn and Se seem to be relatively evenly distributed in the grain. Optimum DOM of about 14% was detected for Zhenong 7 (long and slender grain); 10% was found for Zhenong 60 (medium-grain) and 9% for Zhenong 34 (short and round grain). The information generated in this experiment could be useful to optimize milling procedures for maximum removal of phytic acid, minimum mineral

losses and weight loss in indica rice cultivars with different grain shapes.
Keywords: Degree of milling; Phytic acid; Minerals; Distribution

47. Allan T. Showler, Julien M. Beuzelin, Thomas E. Reagan, Alternate crop and weed host plant oviposition preferences by the Mexican rice borer (Lepidoptera: Crambidae), Crop Protection, Volume 30, Issue 7, July 2011, Pages 895-901, ISSN 0261-2194,
Abstract: The Mexican rice borer, Eoreuma loftini (Dyar), is the key pest of sugarcane, Saccharum hybrids, in south Texas, having largely displaced the sugarcane borer, Diatraea saccharalis (F.), and it is moving into rice- and sugarcane-growing areas of east Texas and Louisiana. While a number of alternative weed and crop hosts have been reported, the extent to which they might support Mexican rice borer populations is unknown. This study involved choice assays that compared oviposition preference for and larval infestations of five mature graminaceous weed species. Levels of infestation between sugarcane and corn, Zea mays L., crop hosts and between corn and sorghum, Sorghum bicolor (L.) Moench, were also assessed. We determined that the average number of larval entry holes in sudangrass stems was ≥2.5-fold more than for any of the other four weed host plants, that corn had ≥5.9-fold more larval entry holes than sorghum and ≥8.2-fold more than sugarcane. Greater oviposition and infestation of one non-crop host over another was not related to numbers of stems per plant, but was associated with the greater stem diameter and abundance of dry leaf tissue found in Sudangrass, Sorghum bicolor (L.) Moench ssp. drummondi (Nees ex Steud.) de Wet & Harlan, johnsongrass, S. halepense (L.) and barnyardgrass, Echinochloa crus-galli (L.) P. Beauv.; relative to the other weed species in this study. In terms of the crop plants, stalk diameter and quantity of dry leaf tissue were not associated with numbers of eggs or larval entry holes in the choice assays between corn and sorghum, and between sugarcane and corn. While corn has been known as a host of the Mexican rice borer for at least 84 yr, its role in area-wide population dynamics and control efforts has likely been greatly underestimated.
Keywords: Corn; Eoreuma loftini; Infestation; Sorghum; Sugarcane; Weeds

48. S. Lin, M.S. You, G. Yang, L.L. Chen, Can polycultural manipulation effectively control rice planthoppers in rice-based ecosystems?, Crop Protection, Volume 30, Issue 3, March 2011, Pages 279-284, ISSN 0261-2194,
Abstract: Rice planthoppers (mainly Nilaparvata lugens (Stål) and Sogatella furcifera Horvath) are the most destructive rice pests throughout southeastern and eastern Asia. Planthopper feeding often causes “hopper burn” and reduces rice yields. Currently, insecticide use is the sole pest management option available to most Chinese farmers. Because pesticide use may have undesirable effects, environmentally sound and sustainable management alternatives are urgently needed. In a two-year field study at the Wuyishan Experimental Station of the Institute of Applied Ecology (IAE), Fujian Agriculture and Forestry University (FAFU), we evaluated the effects of polycultural manipulation on the abundance, sexual differentiation and wing dimorphism of rice planthoppers. The polycultural manipulation was arranged in mosaic patterns of paddy plots intercropped with non-paddy plots including chili pepper, ginger, maize and peanut plants. Monocultural fields of paddy plants were used as controls. Polycultural

manipulation significantly reduced the abundance of total planthoppers and nymphs of N. lugens and S. furcifera. The number of overall planthoppers decreased on average by 49% and 55% in 2007 and 2008, respectively. However, polycultural manipulation had no impact on the proportions of female or macropterous planthoppers. The resource concentration and associational resistance hypotheses may explain these results. In polycultural fields, non-rice species may mask the chemical or visual attractants of rice, making them less apparent, and microhabitat differences in the levels of secondary compounds or in plant quality may also disrupt planthopper orientation.
Keywords: Mosaic arrangement; Nilaparvata lugens (Stål); Sogatella furcifera Horvath; Ecologically-based pest management; Resource concentration; Associational resistance

49. Suchit Shrestha, Folkard Asch, Michael Dingkuhn, Mathias Becker, Cropping calendar options for rice–wheat production systems at high-altitudes, Field Crops Research, Volume 121, Issue 1, 28 February 2011, Pages 158-167, ISSN 0378-4290,
Abstract: The onset of rains during dry to wet transition fallow periods in rice–wheat production systems in Nepal cause substantial losses of soil nitrogen if the system is improperly managed. To make use of available nutrients and water, this transition period can either be shortened by early rice planting, or be extended by late planting, allowing a third crop to be grown. Shifting planting dates would require rice genotypes adapted to the different environments. Crop duration is influenced by both vegetative and reproductive development, which in turn is influenced by the photo-thermal environment and genotypic responses to it. An experiment was conducted to derive genotypic photo-thermal constants from phenological observations on diverse rice cultivars, which were then applied to the concept of the phenological model RIDEV to design cropping calendar options. Environmental effects on variation of crop duration were determined by planting at different dates. The risk of yield losses to sterility caused by low temperatures was estimated by simulation. Thirty-one different genotypes of rice were planted at 8 dates in 15-day intervals starting 27 April 2004 at the experimental field of the Regional Agriculture Research Station, Lumle, Nepal. The shortest duration to flowering was observed for planting dates in late May and early June. Simulation of flowering dates with RIDEV yielded correct results only for the early planting dates. For later planting dates simulated flowering dates showed an increasing deviation from the observed. In most cultivars, minimum air temperature below 18 °C during booting to heading stages caused near-total spikelet sterility and a specific delay in flowering. However, the chilling tolerant cultivars Chomrong and Machhapuchre-3 cultivated at high altitude showed less than 30% spikelet sterility even at 15 °C. Simulating crop durations with the derived thermal constants allowed evaluating the different calendar options for high altitude systems.
Keywords: Cold sterility; Nepal; Oryza sativa; Photo-thermal constants; RIDEV

50. MiaoZhen Cai, ShuNa Zhang, ChengHua Xing, FangMei Wang, Wang Ning, Zhu Lei, Developmental characteristics and aluminum resistance of root border cells in rice seedlings, Plant Science, Volume 180, Issue 5, May 2011, Pages 702-708, ISSN 0168-9452,

Abstract: The developmental characteristics of root border cells (RBCs) and their role in protection of root apices of rice seedling from Al toxicity were evaluated in two rice (Oryza sativa L.) cultivars differing in Al tolerance. Root elongation and RBCs viability were used as indicators for Al effects. The formation of RBCs and the emergence of the root tip occurred almost simultaneously. Treatment of the root with Al inhibited root elongation and increased Al accumulation in the root tips. Physical removal of RBCs from root tips resulted in a more severe inhibition of root elongation and a higher Al accumulation in the root tips. These effects were more pronounced in the Al-sensitive rice cultivar (II You 6216) than that in the Al-tolerant rice cultivar (II You 838). The relative viability of attached and detached RBCs decreased with increasing Al concentrations. Al also induced a thicker mucilage layer surrounding attached RBCs of both cultivars, and detached RBCs did not. Maintaining the abundant live RBCs encapsulated root tip and enhancing their mucilage secretion, appear to be important in alleviating Al toxicity and in allowing exclusion of Al from the rice root apex.
Keywords: Al toxicity; Oryza sativa L.; Root border cells; Cell viability

51. O.P. Choudhary, B.S. Ghuman, Bijay-Singh, N. Thuy, R.J. Buresh, Effects of long-term use of sodic water irrigation, amendments and crop residues on soil properties and crop yields in rice–wheat cropping system in a calcareous soil, Field Crops Research, Volume 121, Issue 3, 3 April 2011, Pages 363-372, ISSN 0378-4290,
Abstract: One of the options to ameliorate the deleterious effects of sodic water irrigation is to apply gypsum to soil. We examined whether the application of organic manures or crop residue can reduce the need for gypsum in calcareous soils. A long-term field experiment with annual rice–wheat cropping rotation was conducted for 15 years (1991–2006) on a non-saline calcareous sandy loam soil (Typic Ustochrept) in northwestern, India. The irrigation water treatments included good quality canal water (CW) and sodic water (SW) with residual sodium carbonate (RSC) of 10 mmolc L−1 from 1991 to 1999 and of 12.5 mmolc L−1 from 2000 onwards. Gypsum was applied at 0, 12.5, 25, and 50% of the gypsum requirement (GR), to neutralize RSC of the SW. Three organic material treatments consisted of application of farmyard manure (FYM) at 20 Mg ha−1, Sesbania green manure (GM) at 20 Mg ha−1, and wheat straw (WS) at 6 Mg ha−1. The organic materials were applied every year to the rice crop. Continuous irrigation with sodic water for 15 years without gypsum or organic materials resulted in a gradual increase in soil pH and exchangeable sodium percentage (ESP), deterioration of soil physical properties, and decrease in yields of both rice and wheat. The cumulative yield loss in SW irrigated plots without gypsum and organic materials remained <1.5 Mg ha−1 for up to eight years in the case of rice and up to nine years in the case of wheat. Thereafter, marked increase in pH and ESP resulted in further depression in yields of rice by 1.6 Mg ha−1 year−1 and wheat by 1.2 Mg ha−1 year−1. Application of gypsum improved physical and chemical properties of the soil. The beneficial effects on crop yields were visible up to 12.5% GR in rice and up to 50% GR in wheat in most of the years. All the organic materials proved effective in mobilizing Ca2+ from inherent and precipitated CaCO3 resulting in decline in soil pH and ESP, increase in infiltration rate, and a increase in the yields of rice and wheat crops. Although the

application of organic materials resulted in comparable reductions in pH and ESP, the increase in yield with SW was higher for both crops with FYM. Pooled over the last six years (2000–2006), application of FYM resulted in 38 and 26% increase in rice and wheat yields, respectively, over SW treatment; corresponding increases in 50% GR treatment (recommended level) was 18 and 19%. During these years, application of GM and WS increased wheat yields by 20%; for rice, GM resulted in 22% increase compared to 17% in WS amended SW irrigated plots. Combined application of gypsum and organic materials did not increase the yields further particularly in the case of FYM and GM treated plots. This long-term study proves that organic materials alone can be used to solubilize Ca from inherent and precipitated CaCO3 in calcareous soils for achieving sustainable yields in sodic water irrigated rice–wheat grown in annual rotation. The results can help reduce the dependency on gypsum in sodic water irrigated calcareous soils.

Keywords: Residual sodium carbonate; pH; Exchangeable sodium percentage; Bulk density; Infiltration rate; Organic manures; Wheat straw; Gypsum

52. Sudhir -Yadav, Tao Li, E. Humphreys, Gurjeet Gill, S.S. Kukal, Evaluation and application of ORYZA2000 for irrigation scheduling of puddled transplanted rice in north west India, Field Crops Research, Volume 122, Issue 2, 18 May 2011, Pages 104-117, ISSN 0378-4290,

Abstract: Water-saving technologies that increase water productivity of rice are urgently needed to help farmers to cope with irrigation water scarcity. This study tested the ability of the ORYZA2000 model to simulate the effects of water management on rice growth, yield, water productivity (WP), components of the water balance, and soil water dynamics in north-west India. The model performed well as indicated by good agreement between simulated and measured values of grain yield, biomass, LAI, water balance components and soil water tension, for irrigation thresholds ranging from continuous flooding (CF) to 70 kPa soil water tension.

Using weather data for 40 different rice seasons (1970–2009) at Ludhiana in Punjab, India, the model predicted that there is always some yield penalty when moving from CF to alternate wetting and drying (AWD). With an irrigation threshold of 10 kPa, the average yield penalty was 0.8 t ha−1 (9%) compared with CF, with 65% irrigation water saving, which increased to 79% at 70 kPa with a yield penalty of 25%. The irrigation water saving was primarily due to less drainage beyond the root zone with AWD compared to CF, with only a small reduction in evapotranspiration (ET) (mean 60 mm).

53. Hiroyuki Shimono, Earlier rice phenology as a result of climate change can increase the risk of cold damage during reproductive growth in northern Japan, Agriculture, Ecosystems & Environment, Volume 144, Issue 1, November 2011, Pages 201-207, ISSN 0167-8809,

Abstract: The present study analyzed the impact of earlier rice phenology as a result of climate change on the risk of cold damage during reproductive growth using the historical temperature record from 1961 to 2010 at four locations in northern Japan. During this period, heading date has become 0.7–1.9 days earlier per 10 years. Air temperatures during the booting stage (6–15 days before heading) decreased by 0.18 °C per 10 years even though the air temperature

on a given calendar date has increased slightly. The estimated potential yield losses caused by cold damage have increased since the start of the study period. Thus, the advance in phonological events as a result of global warming is likely to increase the risk of future yield losses, and this has important implications for future adaptation strategies (breeding new cultivars and changing crop management strategies) to reduce the risk of cold damage.

Keywords: Cold damage; Global warming; Phenological development; Risk analysis; Rural–urban temperature gradient; Simulation model

54. Chol Gyu Lee, Takeshi Watanabe, Yutaka Sato, Jun Murase, Susumu Asakawa, Makoto Kimura, Bacterial populations assimilating carbon from 13C-labeled plant residue in soil: Analysis by a DNA-SIP approach, Soil Biology and Biochemistry, Volume 43, Issue 4, April 2011, Pages 814-822, ISSN 0038-0717,

Abstract: In this study, 13C-labeled rice callus was prepared as a model material for rice straw and was subjected to a DNA-SIP (stable isotope probing) experiment in which the bacterial population was monitored in a soil sample containing decomposing dried callus. Rice callus (13C = 78%) contained the more water-soluble organic carbon and less cellulose and lignin carbon than rice straw. The callus in the soil was 37% decomposed after 56 d of incubation in upland moisture conditions. PCR-DGGE analysis demonstrated that the bacterial community in the soil with the callus changed over time, showing a distinct difference between the first (up to 7 d) and second (14 d and later) stages. After isopycnic centrifugation, DNA in the fractions with a buoyant density between 1.759 and 1.734 g ml−1 was subjected to population analysis (13C-assimilating populations). Diverse groups of bacterial sequences were retrieved from the 13C-labeled DNA fractions: Actinobacteria, Bacilli, γ-Proteobacteria, Chloroflexi, Sphingobacteria, Flavobacteria, Clostridia, Acidobacteria, Cyanobacteria and Candidate Division. Bacilli were detected mainly in the first stage, and Actinobacteria were detected throughout the incubation period. Several DGGE bands in the light fractions became more prominent in the soil with callus, which suggested that the addition of callus promoted the growth of bacteria that fed on soil organic matter, including α-Proteobacteria, γ-Proteobacteria, Bacilli, Actinobacteria, Nitrospira and Gemmatimonadetes.

Keywords: Actinobacteria; Bacterial community; Callus; Clostridium; Denaturing gradient gel electrophoresis; Oxic soil; Plant residue; Stable isotope probing

55. Manuel Tejada, Concepción Benítez, Isidoro Gómez, Juan Parrado, Use of biostimulants on soil restoration: Effects on soil biochemical properties and microbial community, Applied Soil Ecology, Volume 49, September 2011, Pages 11-17, ISSN 0929-1393,

Abstract: Four biostimulants (BS): WCDSs, wheat condensed distiller solubles; PA-HE, hydrolyzed poultry feathers; CGHE, carob germ enzymatic extract; and RB, rice bran extract were applied annually at 4.7 t organic matter (OM) ha−1 for a 3-year period to a Xerollic Calciorthid soil to evaluate their efficiency in soil restoration. Their effects on the plant cover, soil enzymatic activities and the structure of the soil microbial community by analysing phospholipid fatty acids (PLFAs) were determined. Application of BS that contain higher amounts of protein and higher percentage of peptides under 3 kDa had a greater effect on the soil biological

properties, possibly due to the low molecular weight protein content can be easily assimilated by soil microorganisms. Following 3 years of successive soil amendment, the dehydrogenase activity was 4.6, 9.6, and 17.6% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. The urease activity was 5.3, 14.5, and 28.8% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. The phosphatase activity was 8, 15.3, and 20.2% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. The arylsulfatase activity was 16, 21.1, and 27.2% higher in PA-HE-amended soils than in the RB, CGHE and WCDS-amended soils, respectively. Total soil phospholipid fatty acid (PLFA) concentration was significantly (p < 0.05) higher in BS-amended soil than control soil. Principal component analysis discriminated between the BS-amended soils, mainly based on content of lower molecular weight peptides. Thus, PA-HE and RB were grouped and differentiated from CGHE and WCDS, respectively. After 3 years of treatment, vegetal cover was 11.4, 17.7, 24.1, and 85.8% higher in PA-HE-amended soils than in the RB, CGHE, WCDS treatments and control soil. These results suggested that under semiarid climatic conditions the application of BS with higher amounts of protein (>50%) and a higher percentage of peptides under 0.3 kDa (>60%) notably increased the soil enzymatic activities, induced changes in microbial community because the protein with lower molecular weight can be more easily absorbed by soil microorganisms, and also favoured the establishment of vegetation, which will protect the soil against erosion and will contribute to its restoration.
Keywords: Soil restoration; Biostimulants; Soil enzymatic activities; Soil microbial community

56. B.Y. CHUNG, C.H. SONG, B.J. PARK, J.Y. CHO, Heavy Metals in Brown Rice (Oryza sativa L.) and Soil After Long-Term Irrigation of Wastewater Discharged from Domestic Sewage Treatment Plants, Pedosphere, Volume 21, Issue 5, October 2011, Pages 621-627, ISSN 1002-0160,
Abstract: A pot experiment was conducted in a plastic film house to evaluate the translocation and uptake of heavy metals (Pb, Cd, Cu, and Zn) into brown rice (Oryza sativa L.) and the heavy metals residues in soils which had previously been irrigated with domestic wastewater for a long time (3 years). The range of Pb, Cd, Cu, and Zn was 5.10 ± 0.01, 0.105 ± 0.017, 5.76 ± 0.42, and 23.56 ± 1.40 mg kg−1, respectively in the domestic wastewater-irrigated soil, and 0.370 ± 0.006, 0.011 ± 0.001, 0.340 ± 0.04, and 2.05 ± 0.18 mg kg−1, respectively, in the domestic wastewater-irrigated brown rice. The results indicated that application of domestic wastewater to arable land slightly increased the levels of Pb, Cd, Cu, and Zn in soil and brown rice (P < 0.01). The concentrations of heavy metals in brown rice were lower than the recommended tolerable levels proposed by the Joint FAO/WHO Expert Committee on Food Additives. However, the continuous monitoring and pollution control of hazardous materials from domestic wastewater are needed in order to prevent excessive build-up of heavy metals in the food chain.
Keywords: accumulation; domestic wastewater; ground water irrigation; P₂O₅; total N

57. Fan-rong ZENG, Fu-sheng ZHAO, Bo-yin QIU, You-nan OUYANG, Fei-bo WU, Guo-ping ZHANG, Alleviation of Chromium Toxicity by Silicon Addition in Rice Plants, Agricultural Sciences in China, Volume 10, Issue 8, August 2011, Pages 1188-1196, ISSN 1671-2927,

Abstract: The alleviatory effect of silicon (Si) on chromium (Cr) toxicity to rice plants was investigated using a hydroponic experiment with two Cr levels (0 and 100 µmol L−1), three Si levels (0, 1.25, and 2.5 mmol L−1) and two rice genotypes, differing in grain Cr accumulation (Dan K5, high accumulation and Xiushui 113, low accumulation). The results showed that 100 µmol L−1 Cr treatment caused a marked reduction of seedling height, dry biomass, soluble protein content, and root antioxidant enzyme activity, whereas significantly increased Cr concentration and TBARS (thiobarbituric acid reactive substances) content. However, the reductions of seedling height, dry biomass, and soluble content were greatly alleviated due to Si addition to the culture solution. Compared with the plants treated with Cr alone, Si addition markedly reduced Cr uptake and translocation in rice plants. No significant differences were observed between the two Si treatments (1.25 and 2.5 mmol L−1) in shoot Cr concentration and Cr translocation factor. Under the treatment of 100 µmol L−1 Cr+2.5 mmol L−1 Si, higher root Cr concentration but lower shoot Cr concentration and Cr translocation factor were observed in Dan K5 than those in Xiushui 113, indicating that the beneficial effect of Si on inhibiting Cr translocation was more pronounced in Dan K5 than in Xiushui 113. Si addition also alleviated the reduction of antioxidative enzymes (superoxide dismutase (SOD) and ascorbate peroxidase (APX) in leaves; catalase (CAT) and APX in roots) and the increase of TBARS content in the Cr-stressed plants. Furthermore, the beneficial effects of Si on activities of antioxidative enzymes under Cr stress were genotype-dependent. The highest activities of SOD, POD (guaiacol peroxidase), CAT, and APX in leaves occurred in the treatment of 100 µmol L−1 Cr+2.5 mmol L−1 Si for Xiushui 113 and in the treatment of 100 µmol L−1 Cr+1.25 mmol L−1 Si for Dan K5. The beneficial effect of Si on alleviating oxidative stress was much more pronounced in Dan K5 than in Xiushui 113. It may be concluded that Si alleviates Cr toxicity mainly through inhibiting the uptake and translocation of Cr and enhancing the capacity of defense against oxidative stress induced by Cr toxicity.
Keywords: antioxidant enzyme; chromium; lipid peroxidation; Oryza sativa L.; silicon; translocation

58. Ali Ashraf Amirinejad, Kalpana Kamble, Pramila Aggarwal, Debashis Chakraborty, Sanatan Pradhan, Raj Bala Mittal, Assessment and mapping of spatial variation of soil physical health in a farm, Geoderma, Volume 160, Issues 3-4, 15 January 2011, Pages 292-303, ISSN 0016-7061,
Abstract: Productivity rating systems are important tools to quantitatively assess soil health. In precision farming such information is required for planning appropriate soil and crop management strategies. In order to demonstrate a proper procedure for assessing the soil physical health of a farm, an experiment was conducted in a rice–wheat field. Spatial variability analysis of soil physical properties measured on a rectangular grid (30 m × 45 m) was carried out by using geostatistical analyst extension of Arc GIS software. Indicators for soil physical health assessment included bulk density (BD), field saturated hydraulic conductivity (Kfs), available water retention capacity (AWRC), organic carbon content (OC) and non capillary porosity (NCP). Rating values of soil physical parameters were different for wheat and rice as the optimum physical environment for both systems were different. Physical rating index (PI) at each sampling point was determined by multiplying the rating values for all five parameters.

Results revealed that for BD, Kfs, OC and soil physical health index (PI), major and minor ranges of semivariogram varied between 300–380 m and 55–90 m, respectively. Whereas for NCP and AWRC, they were relatively short (major range between 114–140 m and minor around 60 m). Results also revealed that BD and PI for both surface and subsurface layers showed strong spatial dependence whereas the rest of the parameters showed moderate spatial dependence. Rating maps of mentioned parameters for wheat and rice cultivations were prepared as series of coloured contours by using kriging or other appropriate interpolation techniques and suitable semivariogram models. Overall soil physical health of the farm was medium to good for paddy cultivation but was not suitable for succeeding wheat crop mainly because of increased BD and reduced Kfs, NCP and AWRC of the farm during wheat growth. Correlations between PI and grain yield of both wheat and rice were fairly good (r2 = 0.67). The results thus supported earlier findings that good soil physical health is essential for optimum sustained crop production.
Keywords: Soil physical health; Spatial variability analysis; Physical rating index

59. Dongyang Liu, Ruifu Zhang, Hongsheng Wu, Dabing Xu, Zhu Tang, Guanghui Yu, Zhihui Xu, Qirong Shen, Changes in biochemical and microbiological parameters during the period of rapid composting of dairy manure with rice chaff, Bioresource Technology, Volume 102, Issue 19, October 2011, Pages 9040-9049, ISSN 0960-8524,
Abstract: Various parameters were measured during the period of composting of dairy manure and rice chaff in different ratios (dairy manure/rice chaff = V/V, pile 1: 75/25; pile 2: 80/20; pile 3: 85/15) to evaluate their suitability as indicators for the composting process. The temperature in pile 1 increased rapidly and remained above 60 °C for 30 days, while the temperature in pile 3 increased slowly relative to the other two piles. Furthermore, the degradation of organic substrates, as indicated by the reduction of C/N ratio, was rapid in pile 1 (below 20% 28 days after beginning of the composting). The major fluctuations of various water-soluble fractions in all piles were observed during the first 3 weeks, and the results in general showed that the highest microbial populations and enzymatic activities also appeared in this phase. Various parameters indicated that the rapid composting method was a feasible one for treating agricultural wastes.
Keywords: Composting; Dairy manure; Water soluble fraction; Enzymatic activity; Microbial groups

60. N. Subash, H.S. Ram Mohan, K. Banukumar, Comparing water-vegetative indices for rice (Oryza sativa L.)–wheat (Triticum aestivum L.) drought assessment, Computers and Electronics in Agriculture, Volume 77, Issue 2, July 2011, Pages 175-187, ISSN 0168-1699,
Abstract: Drought indices (DI) are an useful tool for assessing different sectarian droughts. Standardized Precipitation Index (SPI) has been used worldwide to assess/monitor the onset, active phase, cessation and severity of drought. Normalized Difference Vegetation Index (NDVI) provides a comprehensive vegetation dynamics, which directly linked with rainfall received in a particular region. Indo-Gangetic Region (IGR), providing employment and livelihood to tens of millions of rural families directly or indirectly and rice (Oryza sativa L.)–wheat (Triticum aestivum L.) (RW) system of the Indo-Gangetic Plains (IGP) contributes 80% of the total cereal production

and is critical to food security of the region. This study tries to verify the applicability of water-vegetative indices viz., SPI, Rainfall Index (RI) and NDVI for drought assessment of rice–wheat system productivity over IGR-India. The relationship between monsoon rainfall and NDVI shows that at around 1100 mm rainfall, the NDVI reached saturation point and no further significant increase in NDVI with increase of rainfall is noticed. Even though, there was a positive correlation of seasonal monsoon rainfall and average NDVI, conflicting results are noticed between monthly distribution of rainfall and monthly anomaly of NDVI over IGR States. It is noticed that June dif NDVI (actual NDVI–mean NDVI) contributes more to rice productivity followed by July. However, the combined effect of June, July and August, explains 15% of the variation of Kharif Rice Productivity Index (KRPI). As far as wheat is concerned, statistically significant relation was found between Wheat Productivity Index (WPI) and anomaly NDVI during December–March. This explains 35% of the variability in WPI.
Keywords: Normalized Difference Vegetation Index; Productivity; Drought assessment; Rainfall Index; Drought index; Anomaly NDVI