IPNI CHINA PROGRAM NEWSLETTER 2015

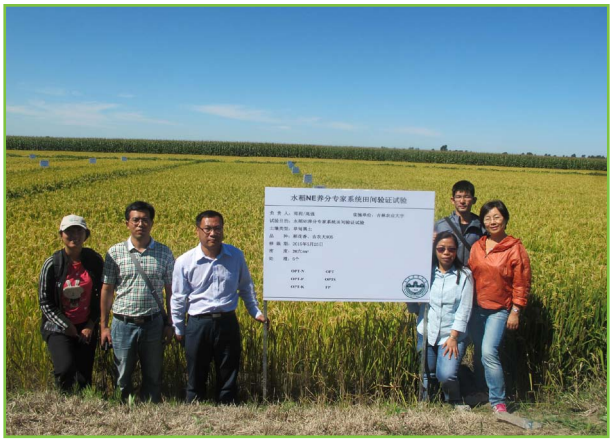
IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Agronomic Research

Advances in NE Wheat, Maize, Rice and Soybean

Crop yield response reflects soil fertility after fertilization. Researcr The scientific basis for Nutrient Expert (NE)isfrom agronomic database compiled from numerous fertilizer field experiments, soil indigenous supply, and relationships between yield and response and agronomic efficiency. The Nutrient Expert considers soil indigenous nutrient supplies including nutrients from deposition and precipitation, and nutrients from organic fertilizer sources and crop residues. Crop rotation is also considered when making fertilizer recommendations using the site-related information. The NE is an easy to use method and can make fertilizer recommendations with and without soil testing.

In 2015, field validation and large scale demonstration for NE Wheat and Maize continued in Heilongjiang, Jilin, Hebei, Henan, Shandong and Shanxi. Through agronomic analysis from large database, field validation and consulting and discussion meeting, version 1.0 for Nutrient Expert for rice and soybean has been developed. Field validation was also conducted for NE Rice and Soybean including 74 trials for single season rice, early rice, middle rice, and late rice, and 33 trials for soybean in Northeast China. Results from field validation trials indicated that Nutrient Expert for Rice can achieve higher yield (8.9 t/ha) with 157-67-65 kg N-P_2O_5-K_2O/ha, compared to grain yield of 7.9 t/ha with 161-64-86 kg N-P_2O_5-K_2O/ha for farmer's practice (FP) and grain yield of 8.4 t/ha with 167-61-93 kg N-P_2O_5-K_2O/ha for soil testing. In addition, NE



obtained highest recovery efficiency of N (REN) and agronomic efficiency of N (AEN) up to 44% and 20 kg/kg, respectively, 18 percent and 13 percent higher for REN, and 4 kg/kg and 3 kg/kg higher for AEN than FP and soil testing, respectively. similarly, Nutrient Expert for Soybean, improved grain yield up to 2.9 t/ha with 40-55-53 kg N-P_2O_5-K_2O/ha, compared to grain yield of 2.6 t/ha with 50-68-45 kg N-P_2O_5-K_2O/ha for FP, and grain yield of 2.8 t/ha with 53-65-59 kg N-P_2O_5-K_2O/ha for soil testing. Moreover, NE Soybean achieved 12.9% and 3.6% more profit than FP and soil test, respectively.

The above results demonstrated that the NE could maintain grain yield and nutrient use efficiency through 4R nutrient stewardship including the right source, right rate and right time, and with other best management s practices. It was proved that the NE approach is a user friendly and easy to use method with a promising future for small farms in China.

NE availability

- Versions of Nutrient Expert® have been developed for different crops (maize, wheat, rice, soybean) and field-validated versions are available for free download at http://china-zh.ipni.net/library/nutrient-expert
- For iPhone and iPad end user, NE for wheat can be free downloaded from Apple store

Future opportunities

- Wide scale dissemination of the field-validated versions
- Web-based applications, development of a compatible ICT platform
- Compatibility with smart phones and tablets
- New crops (e.g. potato, cash crops, vegetables and fruit trees)

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Agronomic Evaluation of CRU

Cereals

- **Maize and Rice in Heilongjiang**

Field experiments were conducted in Heilongjiang to study the effect of blending controlled release Urea (CRU) and regular urea (RU) on maize and rice in 2015. The results obtained indicated that under 100% of N rate, two combinations of CRU with RU had no significant differences in grain yield for maize as compared with same N rate of RU and higher rate N of farmer's practice (FP) and soil testing with one additional N splitting. However, all treatments with 20% less N application reduced grain yield. It was indicated that combination of 60 to 75% CRU with RU, with 17.3% and 6.7% less N, maintained the same yield as compared with FP and soil test with one additional N splitting. The CRU treatments with 100% of N rate also achieved higher agronomic efficiency (AE) and recover efficiency of N. The experiment also tested that NE is a promising fertilizer recommendation method with the right fertilizer recommendation that can be used when soil testing is not available.

Another CRU experiment in rice with same treatments conducted Qingan county, Heilongjiang, demonstrated that combination of 75% CRU and 25% of RU under 100% of N rate was the best treatment with higher grain yield and N efficiency parameters, which performed significantly better than FP and OPTS.

- **Rice in Hubei**

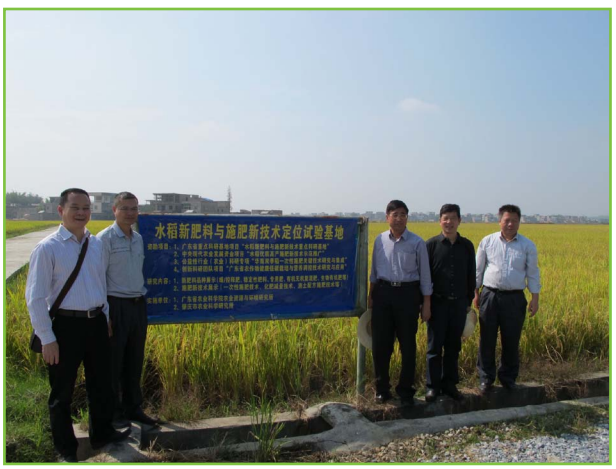
Under the support of IPNI China program, Wuhan Botanical Garden of CAS conducted the field experiments in Hubei in 2015. The field experimental results showed that compared with regular urea, application of CRU saved 15-30 labors per hectare, increased crop yield, nitrogen fertilizer use efficiency and agronomy efficiency. For rice, the grain yield in applied receiving the same rate of CRU reached 10,118 kg/ha and increased by 17.3% over regular urea treatment. When reducing nitrogen application rate by 20%, CRU treatment also increased yield by 9.6% and net economic benefit USD 150/ha over regular urea treatment.

CRU trial in rice in Honghu of Hubei

- **Rice in Guangdong**

A long-term field experiment, initiated in 2011, aimed to investigate effects of consecutive applications of controlled release urea (CRU) versus regular urea (RU) on yields of early and late rice in Guangdong province of China. The experiments consisted of four treatments including CK (no N), urea, 60 d- and 90 d-effective CRU and repeated for three times. The fertilizer rates used were 180-56-156 kg N-P_2O_5-K_2O/ha for each rice season. The CRU was a polymer coated urea (42% N) and RU was purchased from local market (46% N). The urea was split as basal application and topdressings at tillering stage and earing stage, while the CRU was used as basal application only.

Results obtained from the past five years indicated rice yields of all the treatments fluctuated from



year to year. In a given year, a higher early rice yield caused a lower late rice and vice versa like playing see-saw. Application of CRU once in a rice season usually produced significantly higher rice yield (114-1639 kg/ha) than using RU with three splits, being slightly better on late rice. The 60 d-effective CRU always performed better than the 90 d-effective CRU on rice yields, implying the former could be the right polymer coating thickness for early rice and late rice in the province.

Cash Crop

- **Tomato and Sunflower**

The purpose of this study was to demonstrate the appropriate ratio of control release urea (CRU) and regular urea (RU) in processing tomato and sunflower production.

Nitrogen application increased processing tomato yield by 49.5 to 95 t/ha (71% to 137%) over control without N. At the recommended N rate, 60% N as CRU basally plus equally splitting application of 40% N as RU at flowering and fruiting stages produced higher fruit yield than totally basal application of RU alone, similar to CRU alone basally and 70% of N as CRU basally plus 30% of N as RU at flowering stage. At 80% recommended N rate, there was no significant difference in fruit yield between treatments either application of RU and CRU alone or their combinations, but fruit yield of all the treatments was significantly lower than 60% N as CRU basally plus equally splitting application of 40% N as RU at flowering and fruiting stages in full N recommendation. The N agronomic efficiency (AEN) from CRU or CRU plus RU was 74 to 157 kg/kg N higher and the N recovery efficiency (REN) was 15 to 22 percentage point higher than RU alone. Also, the REN at 80% recommended N was 13 to 20 percent point higher than 100% N recommendation. From economic and environmental aspects the best management practice of N was basally apply 60% N as CRU plus equally splitting application of 40% N as RU at flowering and fruiting stages in 100% N recommendation.

Nitrogen increased seed yield of edible sunflower by 477 to 1173 kg/ha (19.7% to 48.5%) over control without N. At the recommended N rate, basal application of RU alone produced similar seed yield to basal application of CRU alone, but significantly lower than basal application of combined CRU with RU or splitting application of RU. At 80% recommended N rate, there were no significant difference in seed yield between basal application of CRU alone or its combinations with RU and basal application of RU alone whose yield was lower than basal application CRU alone or its combinations with RU in 100% N recommendation. The AEN from basally CRU or CRU plus RU was 1.2 to 2.9 kg/kg N higher and REN was 6 to 23 percentage point higher than basal application RU alone. The REN at 80% recommended N was 14 to 20 percentage point higher than 100% N recommendation. From economic and environmental aspect the best management of N for edible sunflower was basal application of 40% N as CRU and 60% N as RU in 80% N recommendation.

- **Eggplant in Hubei**

Under the support of IPNI China program, the field experiments were conducted in Hubei in 2015. The field experimental results showed that compared with regular urea, application of CRU saved 15-30 labors per hectare, increased crop yield, nitrogen fertilizer use efficiency and agronomy efficiency. For eggplant, the yield receiving the same rate of CRU reached 67,095 kg/ha and it increased yield by 20.1% and 33.8% over regular urea treatment and local farmer's common

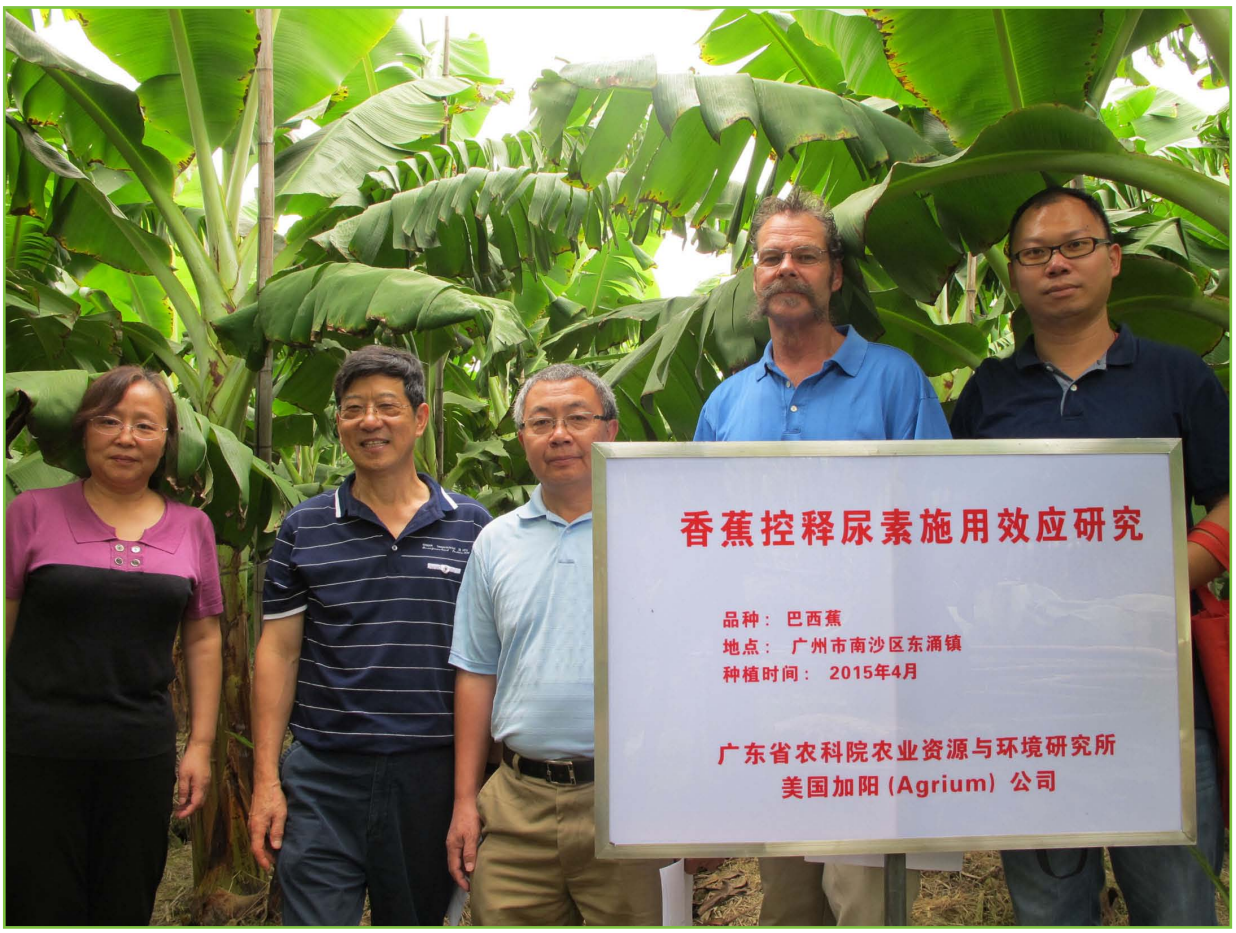
practice, increased net economic benefit by USD 8,870/ha and 12,916/ha.

CRU trial in eggplant

- **Banana in Guangdong**

Nitrogen losses from farmlands through volatilization, leaching and denitrificationare a growing concern as environmental risks and induced low crop yields. Searching for solutions to minimize N losses has long been the focus of fertilizer technology development and plant nutrition research. Controlled release urea (CRU) is considered as both an environment-friendly and enhanced efficiency N fertilizer in crop production. The objectives of the studies reported here were to examine the optimal rates and timing of CRU (Yi Duo Bao (YDB) manufactured by Agrium, Calgary, Alberta, Canada) to banana and to evaluate its influence on crop yield and quality in China. The experiment consisted of 9 treatments including three N rates, two blends of CRU and regular urea (RU) and two application timings were testedagainst RU in currently recommended rate and application times in the same ratooning banana field from 2013 to 2015.

The results showed that use of CRU can significantly reduce times of N fertilizer applications and increase banana yield. The times of CRU fertilization can be reduced to 2 to 3 times and banana yield can be increased by 5-10% compared to RU in three years. In the first two years of experiment the CRU 80% produced higher banana yield than the RU100%



but terminated in year three. Blends of 80% CRU with 20% RU produced lower banana yield than the RU100% in year one but this was reversed from year two. Agronomic efficiency of CRU, however, no matter it was used alone, in reduced rate or in combination with RU, was always significantly higher than the RU. The results further revealed that CRU is an ideal enhanced N fertilizer to banana, because it can reduce fertilization times for 3-4times, improve banana yield by 5-10% and agronomic efficiency by 8-21%, and protect environment from lost N from farmlands. In the medium N fertility soils, it is cautious that CRU rates can be reduced by 20% but no longer than 3 years in order to maintain a good stable banana yield

Nitrogen Cycling and Balance for Wheat in China

The N input and output for wheat production system were collected from the year 2000 to 2011 to evaluate the nutrient cycling and balances in North Central China (NC), the Middle and Lower Reaches of the Yangtze River (MLRYR) and Northwest China (NW). The results showed that N fertilizer application rates for each region were 170, 183 and 150 kg N/ha, the N carried over from previous crop residues was 74.6, 7.6 and 8.1 kg N/ha, and that from seeding was 4.9, 4.2 and 3.5 kg N/ha, respectively. The N input from asymbiotic fixation, atmospheric deposition and irrigation in NC was 7.5, 12.9 and 9.9 kg N/ha, while that in MLRYR was 7.5, 14.5 and 10.6 kg N/ha, and that in NW was 7.5, 9.4 and 7.7 kg N/ha, respectively. The N uptake by harvest in above-ground plant in NC, MLRYR and NW was 174.3, 144.4 and 122.3 kg N/ha, and the ammonia volatilization, N_2O emission and N leaching was 19.9, 2.6 and 11.8 kg N/ha in NC, 9.4, 2.4 and 15.5 kg N/ha in MLRYR, and 3.4, 0.7 and 0 kg N/ha in NW, respectively. As a result, the N balances in these three regions showed surplus by 71.2, 55.7 and 59.8 kg N/ha for NC, MLRYR and NW respectively. Therefore it is urgently in great need to reduce N fertilizer application wheat production areas in China to avoid the negative impact on the environment. regions showed surplus by 71.2, 55.7 and 59.8 kg N/ha for NC, MLRYR and NW respectively. Therefore it is urgently to reduce N fertilizer application race in wheat production areas in China to avoid the negative impact on the environment. Detail information please refer to Chuan LM, He P, et al. published in Chinese Journal of Applied Ecology (2015, 26(1):76-86).

Estimating Nutrient Uptake Requirements for Rice in China

Accurate knowledge of the nitrogen (N), phosphorus (P), and potassium (K) requirements for rice in China is essential to quantitatively estimate optimal fertilizer application regimes to maximize crop yield and increase nutrient use efficiency. Recently, IPNI China Program published a scientific paper entitled "Estimating nutrient uptake requirements for rice in China"in Field Crops Research (2015, 180: 37-45). The paper collected on-farm experiments in China's major rice-producing regions from 2000 to 2013, to determine the relationship between grain yield and nutrient uptake in the above-ground plant dry matter using the quantitative evaluation of the fertility of tropical soils (QUEFTS) model. The large datasets obtained which covered broader rice growing areas and ecology types in China. The QUEFTS model provides a scientific foundation for filtering high-yielding and high-efficiency variety, optimizing fertilizer application rate and developing nutrient management strategies to increase yield and nutrient use efficiency. This is the first report on comparison of the nutrient uptake of different ecology types in rice production area of China using QUEFTS model and test their feasibility through field validation. The information from the paper is used to develop the Nutrient Expert for Rice in China, a useful tool to make fertilizer recommendation for rice in China.

Yield Gap, Indigenous Nutrient Supply and Nutrient Use Efficiency for Maize in China

Great achievements have been attained in agricultural production of China, while there are still many difficulties and challenges ahead that call for put more efforts to overcome to guarantee food security and protect environment simultaneously. Recently, IPNI China Program published a peer-reviewed journal paper in PLOS One on analyzing yield gap and nutrient use efficiency for maize in China. On-farm datasets from 2001 to 2012 with 1,971 field experiments for maize were collected in four maize agro-ecological regions of China, and the optimal management (OPT), farmers' practice (FP), a series of nutrient omission treatments were used to analyze yield gap, nutrient use efficiency and indigenous nutrient supply by adopting meta-analysis and ANOVA analysis. Across all sites, the average yield gap between OPT and FP was 0.7 t/ha, the yield response to nitrogen (N), phosphorus

(P), and potassium (K) were 1.8, 1.0, and 1.2 t/ha, respectively. The soil indigenous nutrient supply of N, P, and K averaged 139.9, 33.7, and 127.5 kg/ha, respectively. As compared to FP, the average recovery efficiency (RE) of N, P, and K with OPT increased by percentage point of 12.2, 5.5, and 6.5, respectively. This study indicated that there would be considerable potential to further improve yield and nutrient use efficiency in China, and will help develop and inform agricultural policies and strategies, while some management measures such as soil, plant and nutrient are necessary and integrate with advanced knowledge and technologies. If you want detail information about this research, please refer to full paper published by Xu X, Liu X, He P, Johnston AM et al. in PLOS ONE (2015, 10(10): e0140767. doi:10.1371/ journal.pone.0140767)

Research on 4R Potassium Management Practices for Sunflower

Trials of K application on sunflower, effect of source and timing of K application and the interactions between water regimes and KCl (MOP) rates on sunflower yield and quality were conducted for 4R K management in sunflower.

K fertilization increased seed yield of oil sunflower in Gansu by mean of 11.1%, 14 of 20 sites showed positive increase, and increased head diameter, 1000-seed weight, kernel rate, oil content, unsaturated fatty acid, oleic acid, linoleic acid, linolenic acid. Potassium also increased edible sunflower seed yield in Inner Mongolia (IMAR) by mean of 6.6%, 19 of 20 sites showed positive increase, and increased 1000-seed weight, kernel rate and oil content, saturated, unsaturated fatty acid and minerals.

K source and application time in sunflower in Gansu

Interactions between water regimes and MOP rates on sunflower in Gansu

K source and application time in sunflower in IMAR

Interactions between water regimes and MOP rates on sunflower in IMAR

The average agronomic efficiency of K was 4.0 kg seed/kg K_2O for oil sunflower in Gansu sites and 3.2 kg seed/kg K_2O for edible sunflower in IMAR sites. Average of 4.7 kg N, 2.8 kg P_2O_5, 16.0 kg K_2O was required for producing 100 kg oil sunflower seeds, and a mean of 3.3 kg N, 1.7 kg P_2O_5, 10.8 kg K_2O was required for producing 100 kg edible sunflowe seeds.

For oil sunflower in Gansu no significant differences existed between K sources for seed yield, total K uptake, disk diameter, 1000-seed weight and kernel rate. Basal application of K fertilizer resulted in more plant K accumulation and higher 1000-seed weight than split applications. For edible sunflower in IMAR Interactions between water regimes and MOP rates on sunflower in IMAR source and timing of K application did not significantly influenced seed yield and its components except that K_2SO_4 (SOP) resulted in more kernel rate than MOP. Source and timing of K application did not affect oil content and its components, amino acid and fiber contents for both oil and edible sunflower.

For oil sunflower in Gansu rainfed plastic mulched system was superior to rainfed and/or flooding irrigation without mulch in seed yield, 1000-seed weight, kernel rate, total uptake K, agronomic efficiency, oil content and fatty acid components. 1000-seed weight, kernel rate, total Cl uptake, oil content, unsatyrated fatty acid, oleic acid increased with the increased MOP rate. The treatment of rainfed with plastic mulch applied MOP at 120 kg K_2O/ha was the best practice. For edible sunflower in IMAR, seed yield, disk diameter, 1000-seed weight was in the sequence of drip irrigation > rainfed plastic mulched practices ≥ rainfed without mulch. Drip irrigation resulted in more K and Cl accumulation than rainfed or rainfed with plastic mulch, and increased with MOP rate. Seed yield and yield components increased with increase of MOP rate. Good water conditions did not affect oil content and the components of oil fatty acid.

Ratio of KCl Application in Potassium Fertilization for Processing Tomato and Influence on Paste Quality and Chloride Accumulation in Soilin Xinjiang

The objectives of this study are to determine the appropriate ratio of KCl application in fall by evaluating the yield/quality of processing tomato, and Cl- residue in the soil profile.

Plot experiment indicated that equally splitting application of recommended K as KCl (MOP) alone at flowering and fruiting stages produced more total dry matter of aboveground plants, single fruit weight, and fruit yield as well as less total acid content than combination of MOP with K_2SO_4 (MOP) or SOP alone. 50% or 70% of the recommended K as MOP in fall plus the remaining K as SOP at fruiting stage produced similar fruit yield to farmer practice (FP) with splitting application of SOP alone. Partly application (30% or 50%) of recommended K as SOP at fruiting stage increased fruit yield and fruit solid content over application K at flowering stage. Combination of MOP at fall with SOP at fruiting stage got similar income to FP. Equally splitting application of MOP alone at flowering and fruiting stages got more income over Combination of MOP with SOP or FP. The more the MOP applied the more Cl contents in 0-60 cm soil layer and Cl content in soil profile increased with soil depth.

Further field demonstration showed that 70% of recommended K as MOP applied basally together with topdressing 30% of recommended K as SOP at fruiting stage produced more dry matter of total aboveground plants, fruit yield and economic income than the treatments with 30% K as SOP applied at flowering stage and FP. MOP application did not negatively affected tomato fruit quality, reduced dynamic viscosity instead, good for paste quality. Combined application of MOP and SOP did not affect fruit K and Cl content nor caused Cl accumulation in soil.

In summary, basal application of 70% recommended K as MOP at fall combined with the remaining K as SOP topdressing at fruiting stage could resulted in better tomato fruit yield/quality, more benefit and no great Cl accumulation in soil, therefore can be a recommended practice in K management in drip-irrigated processing tomato production in Xinjiang.

Effect of KCl Rate on Kiwi Yield and Quality in Shaanxi

Field experiment conduced in Meixian County of Shaanxi province indicated that appropriate rate of Cl application produced similar or higher kiwi fruit yield than control without Cl addition. The highest (48.7 t/ha) fruit yield among the treatments was obtained when 170 kg Cl/ha was applied, significantly increased by 26.5% over the control without Cl addition. Further increase

Cl rate up to 1481 kg Cl/ha with both KCl and NH_4Cl did not significantly affected fruit yield compared with control. Application of Cl at the rate of less than 911 kg/ha improved fruit quality and low rate of 170 and 340 kg Cl/ha had better effect than higher Cl rates. At harvest, the Cl content in surface soil layer (0-20 cm) applied Cl was similar to control without Cl addition, but Cl in deep soil layer (40-100 cm) increased with increase in rate of Cl. Therefore, caution must be paid when applying Cl more than 340 kg/ha.

Trial on Cl rate in kiwi in Shaanxi

Effect of Different Fertilization Patterns to Weed Community in Rice Field

The negative effects of long term unbalanced fertilization to ecological environment and organic fertilization has been paid more attention by scientists and public in recent years. To study the affect mechanism of organic fertilization on farmland weed community, and forecast the effect of weed succession potential to farmland environment, the project cooperators of IPNI China program in Wuhan Botanical Garden of CAS conducted this research based on a long term field fertilization experiment in Jiangxi province in recent years under the support of IPNI China program.

The results showed that: the weed community features are closely related to soil organic matter, soil available N, available P and light transmittance. Balanced fertilization significantly reduced the number of dominant species of weed community. The weed biodiversity of organic fertilizer treatment was between the treatments of NPK fertilizers (NPK) and no fertilization (NF). In all of the treatments, weed biodiversity was positively related to soil available K ($p<0.05$), negatively related to light transmittance ($p<0.01$) and "U type" correlated with soil organic matter content, available N and P contents, significantly. The results indicated that combined and rational use of organic manure and chemical fertilizers can not only obtain higher crop yield, but also can regulate farmland weed community into a better shape with better weed biodiversity and reduce the number of dominant weed species.

Responses of Different Cotton Genotypes to Water and Potassium Stresses at Flowering Stage

Cotton is a potassium nutrition sensitive crop. It is always a key problem that how to increase soil indigenous potassium use and potash use efficiency in agriculture, especially in China. Under the support of IPNI China program, Wuhan Botanical Garden of CAS conducted the research on the mechanism of high efficient uptake and use of potassium by cotton and better potash application technology, by using the cotton genotypes with high and low potassium use efficiency under water and potassium stresses condition in recent years.

Our greenhouse pot experiment result showed that drought significantly reduced the cotton yield with lower cotton net photosynthetic rate, stomatal conductance and transpiration rate, and then led to buds or bolls falling and potassium use efficiency decreasing. The water use efficiency (WUE) of low K use efficiency genotype (LEG) was significantly and positively correlated with K rates, whereas the high K use efficiency genotype (HEG) was on the contrary. Potassium stress also

reduced the net photosynthetic rate and transpiration rate of HEG, but they were not as serious as LEG, and the decrease of net photosynthetic rate was much lower than the decrease of transpiration rate. Higher transpiration rate showed great benefit on increased cotton net photosynthetic rate, reduced buds and bolls falling, potassium uptake and translocation.

Research on the Fertilizer Recommendation Incotton Technology for Winter Rapeseed

Commercial fertilizers played important role in rapeseed production of China, therefore, how to efficiently use commercial fertilizers is always considered as top priority of rapeseed farming. As the project cooperator of IPNI China program, the Environment and Resources College of Huazhong Agricultural University studied the better recommended fertilization rates for winter rapeseed through 60 field experiments in Yangtze River valley in recent years. According their recommended application rates (180kg N/ha, 90kg P_2O_5/ha, 120kg K_2O/ha), the commercial fertilizer contribution to rapeseed yield were N 40.4%, P 23.1% and K 11.5% respectively. Compare with farmers' common practice, recommend fertilization increased rapeseed yield by average 29.1%. Especially when the rapeseed yields in omission N or P plots and the seed yield lower than 2000 kg/ha and 1500 kg/ha, the authors recommend rates showed best responses. The winter rapeseed yield responses from field omission plots showed better relationship than soil testing in this region.

Atlas of Litchi Nutrient Deficiencies Developed

Litchi, one of the most favorable tropical fruits, has a long history of cultivation in China. However, there is up to date no atlas of litchi nutrient deficiencies available for on-site diagnosis in litchi nutrient management, obviously a blank to be filled. Prof. Lixian Yao and her team in South China Agricultural University, based on many years' research in litchi nutrition, have developed a hydroponic nutrient solution for litchi seedling culture. Using this culture solution and corresponding nutrient omission treatments, they conducted both hydroponic and sand cultures to observe and record the evolution process of deficiency symptoms of N, P, K, Ca, Mg and S occurred in litchi seedlings. Results showed that K deficiency symptom first appeared in litchi leaves among the nutrients tested. Ca deficiency symptom in leaves, however, seemed to be more susceptible to environment stress such as high temperatures during the hot summer season and shown as necrotic young leaf tips. Similar to other non-leguminous plants, growth of litchi seedlings under N deficiency suffered most and resulted in stunted plants with pale or yellow leaves. When P was omitted from the culture solution, the litchi seedling growth was only affected slightly with greener leaves than the control. The nutrient deficiency symptoms for other secondary and micronutrients affected growth of litchi seedlings at different degrees. The following photos showing deficiency symptoms for N, P and K in litchi seedlings.

Scientific exchange

IPNI China Program Annual Meeting

IPNI China Program annual meeting was held in Beihai, Guangxi Province on February 11-12, 2015. About 70 participants including governmental leaders, representatives from IPNI member companies, IPNI cooperators were involved in this event. IPNI China Program Director, Dr. Ping He chaired the opening ceremony. Dr. Quanbao YE, Deputy Division Chief of American and Oceanian Affairs, Department of International Cooperation, MOA, Dr. Feng Dongxin, Deputy Director General, Department of International Cooperation, CAAS, Dr. Xu Minggang, Deputy Director General, Institute of Agricultural Resources and Regional Planning, CAAS, reviewed 25 years of IPNI cooperation and gave high value of IPNI in China during the past 25 years. During the morning section, Dr.

Adrian Johnston gave a presentation on IPNI Global Strategy and China Program Priority, and Dr. Ping He made a presentation on Nutrient Expert Based Fertilizer Recommendation. Dr. Shihua TU, Dr. Fang Chen and Dr. Shutian Li presented the progress of IPNI research projects in the southwest China, progress of potassium research in China, and 4R Potassium Nutrient Management for Main Crops in Northwest China. After the main course presentations, cooperators from different provincial research

institutions presented their 2014 results on Nutrient Expert for wheat, maize, soybean and rice, Ecological Nutrient management, 4R nutrient management and CRU field results. A very comprehensive discussion was conducted on the above topics. IPNI Scholar Awards were presented to 5 recipients from China. This meeting also provided a very good opportunity for IPNI member company staff (Agrium, Mosaic, Uralkali) to come to the meeting and interacted with our cooperators during the meeting.

Workshop on Nutrient Management for Soybean

On Sept 7-8, 2015, symposium on nutrient management and fertilizer recommendation on soybean was held in Harbin, Heilongjiang province. Dr. Dan WEI, Director of Soil and Fertilizer Institute, Heilongjiang Academy of Agricultural Sciences hosted this symposium and she also made a presentation on soybean production and fertilization representing the Chief soybean scientist involved in soybean national research group. Dr. Ping He, IPNI China Program Director, talked about Nutrient Expert based fertilizer recommendation method and progress made in the last 3-4 years. Interesting questions related to Nutrient Expert were discussed and positive response was given from the group to Nutrient Expert. About 20 scientists from different soybean production regions from Heilongjiang, Jilin and Liaoning involved in this event.

Before the discussion meeting, the group visited Nutrient Expert field validation on Soybean, rice and maize.

Dr. Ping He Participated 2015 ASA Meeting in Minneapolis

Invited by Dr. Tony Vyn from Purdue University and Dr. Jim Gaffney from DuPont Pioneer, Dr. Ping He made two presentations entitled 'Nutrient Expert, an Environmental Friendly Fertilizer Recommendation Tool, Improves Crop Productivity and Nutrient Efficiency' and 'Management Systems for Improved Yields and Yield Stability with Climate Variability in China' at two different session at annual ASA meeting in Minneapolis, MN, US. Before ASA meeting, Dr. He introduced EI treatment as the best management practices to increase the resiliency to abiotic condition. Dr. He attended the Drought Research Council meeting of Pioneer as a council a member. It is a good opportunity to introduce IPNI Nutrient Expert and Ecological Intensification work with outside scientists at ASA meeting.

IPNI Annual Staff Meeting

From June 7-15, 2015, IPNI annual Staff meeting was held in Kona, Hawaii, USA. IPNI regional Directors and Deputy Directors participated this meeting as routinely. The objectives of this meeting were to update regional programs and working groups, and discuss next year plan. IPNI China Program staff participated six working groups including Ecological Intensification for Global Maize, Soybean Nutrient Management, 4R Nutrient Management, Fertilizer BMPs and Nutrient Cycling, Nutrient and Environment, and Precision Nutrient Management.

Dr. Ping He Received the Award as Out-standing Scientist from MOST and MOA

Dr. Ping He was awarded the leading talent honor from the Ministry of Science and Technology after high competitive screening process. Dr. Ping He and her nutrient management team was also involved in outstanding scientists and excellence innovation team from the Ministry of agriculture.

As the national 973 Program chief scientist, and the International Plant Nutrition Institute China Program Director, Dr. He developed Nutrient Expert (NE) based fertilizer recommendation in China. The NE fertilizer decision support tools have been applied in main wheat, maize and rice areas and the results from field validation showed that the NE can save 20% - 30% of nitrogen and phosphorous fertilizers, and significantly improve N fertilizer use efficiency and reduce the environmental risks caused by excessive fertilization. Dr. He has been in charged of over 15 national projects, and published over 100 scientific papers.

Field Visit to 4R Nutrient Management in Inner Monggolia

From August 17-19, Dr. Ping He, together with Dr. Adrian Johnston, and Dr. Shutian Li visited 4R field experiments on sunflower and processing tomato in Bayannaoer, Wuyuan, Wuchuan, Inner Mongolia. On August 19, they visited Inner Mongolia Academy of Agricultural and Animal Husbandry Sciences. Dr. He made a presentation entitled 'Nutrient Expert based fertilizer recommendation' which attracted great attention from the staff there and had a hot discussion on fertilizer recommendation.

Platform

First Committee Meeting of CAAS-IPNI Joint Lab for Plant Nutrition Innovation Research

On April-20, 2015, the first Committee Meeting of CAAS-IPNI Joint-Lab was held in Beijing. There were more than 16 participants involved in this meeting.
The meeting was chaired by Dr. Feng Dongxin, Deputy Director General, International Cooperation Department, CAAS. First, the introduction and global cooperation overview of CAAS and IARRP was introduced by Dr. Feng Dongxin and Dr. Xu Minggang, Deputy Director General, IARRP. Then, Dr. Terry Roberts, President of IPNI, made an introduction about IPNI global themes. Afterwards, three brief introductions about IPNI management, science communication and message transfer and IPNI China strategy were presented by IPNI Vice Presidents, Mr. Steve Couch, Dr. Rob Mikkelsen and Dr. Adrian Johnston, respectively. Finally, Dr. He Ping made a presentation on Joint Lab operation including progress and future plan about the innovation research, scientific exchange, personnel training and education, etc. How to seek funding for Joint Lab operation and how to make solid exchange channels and connection for graduate students were deeply cliscussed and agreement was reached. during the committee meeting.

Other participants included Dr. Shen Jianbo, China Agricultural University, Ms. Zhai Lin, Deputy Division Chief of Department of International Cooperation, CAAS, Dr. Yang Peng, Division Chief of Research Management, IARRP, CAAS, Dr. Tu Shihua, and Dr. Li Shutian, IPNI China Program.

Ms. Qian Zhang Was Selected to Study in Oregon State University under the Support of CAAS-IPNI Joint Lab

Through strict qualification review by Science Committee of CAAS-IPNI Joint Lab for Plant Nutrition Innovation Research, Ms. Qian Zhang, doctorate student from Institute of Agricultural Resources and Regional Planning, CAAS, successfully passed the professional interview and the English test of Oregon State University, to carry out a period of 6 months of study in Oregon State from April 1st-September 30th, 2016 in the United States.

Ms. Zhang has been studied as a master student of plant nutrition innovation team since 2012. Due to the outstanding achievements for her master program, Ms. Zhang had the opportunity to direct transferring into a doctorate course. Up to now, she has published three scientific papers in journals of Applied Soil Ecology, PLoS One and Soil and Science Society American of Journal as the first author.

Technology Transfer and Training activities

Nutrient Expert Training

On June 26th, Drs. He and Li was invited to Sinofert Beijing Office to meet Mr. Feng Mingwei, Deputy General Director, Mr. Xu Shuang, Deputy General Manager of Market Dept, Mr. Gao Lei from Strategy and Marketing Dept. to discuss on strategic cooperation plan. After the meeting, Dr. Ping He made a training program on Nutrient Expert based fertilizer recommendation, and Dr. Shutian Li gave a presentation on 4R nutrient management for their marketing groups in different provincial branches of China. They had very interests in our presentation, especially on Nutrient Expert and present many questions.

On December 16, 2015, Dr. Ping He was invited to make a presentation to staff and students from Huazhong Agricultural University on Nutrient Expert based fertilizer recommendation method, a very good opportunity to introduce the Nutrient Expert to a more wider audiences in University.

Nutrient Expert for Rice and Soybean Field Visit in China

From Sept 5-12, Dr. Ping He, together with Dr. Mirasol Pampolino, and Dr. Fuqiang Yang, Postdoc of Dr. He visited Nutrient Expert (NE) field validation for Rice and Soybean. From North to South, they visited single season rice in Heilongjiang and Jilin, middle rice in Anhui and Hubei, early and late rice in Hunan and Jiangxi. Although no final grain yield results were obtained, all the sites supported from field appearance that no obvious differences existed among NE, soil test recommendation and farmers' practice with more fertilizer input, which verified that NE is a very good option to make fertilizer recommendation when soil testing is not available or timely.

During the visit, on Sept 5 and 12, Dr. Ping He made a Nutrient Expert presentation at a Nutrient Expert Soybean consulting meeting in Soil and Fertilizer Institute, HeilongjiangAAS. Ten scientists from national soybean working group was involved and gave so many positive comments on Nutrient Expert for Soybean. Again at Jinxian, Jiangxi Province, Dr. He also made a Nutrient Expert presentation to the staff at the Jiangxi Red Soil Research Institute and great interest received from the staff.

Activities of Balance Fertilization Demonstration

Dr. Fang Chen provide comment for Sinofert 2015 potash demonstration activity plan in Zhejiang province and SE region of China in early 2015.

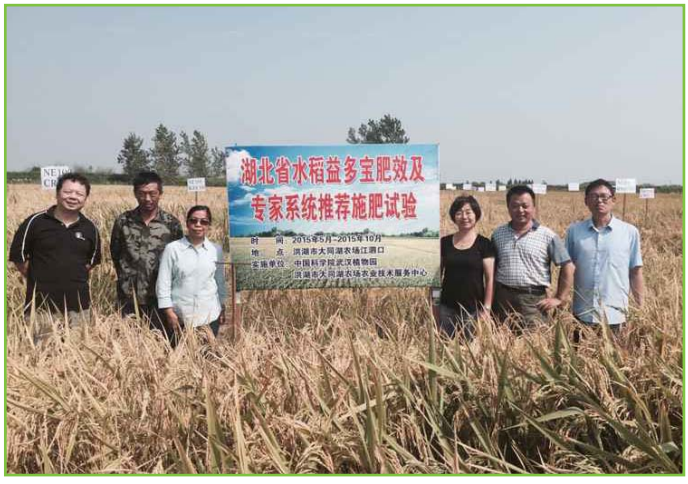
On January 29, 2015, invited by the Soil and Fertilizer Institute, Anhui Academy of Agricultural Science, Dr. Fang Chen gave a presentation with titles 'Globel fertilizer resources and key plant nutrition management problems' and 'Response of farmland weed community to fertilization patterns' in the institute. The presentation mainly introduced 4R nutrient stewardship, Nutrient Management system, and some information about the 16th and 17th International Plant Nutrition Colloquim.

March 27-29, 2015, invited by Huazhong Agricultural University, Dr. Fang Chen attended the annual meeting of 'Research Center of Micronutrient Elements'. Total 85 participants attended the meeting and 16 of them gave oral presentations, include Dr. Fang Chen. This meeting mainly discussed the effects and mechanisms of B, Mo, Fe, Zn on main crops such as cotton, rice, rapeseed, maize, peanut, wheat, citrus and soybean. Dr. Fang Chen introduced some research and demonstration progress and positive results of IPNI China program on high efficient fertilization and the mechanism of plant high efficient use of plant nutrition in recent years.

On April 18, 2015, Dr. Fang Chen attended the 'Annual meeting of Chinese Society of Plant Nutrition and Fertilizers' which was organized by Branch Committee of Chemical Fertilizer and held in Huazhong Agricultural University. Total about 120 participants attended the meeting and 15 of them gave oral presentations.

May 14-16, 2015, Dr. Fang Chen attended the annual committee member meeting of the Chinese Society of Plant Nutrition and Fertilizers in Tai'an city of Shangdaong province. There were total 35 society leaders and committee member participant in the meeting. This meeting was co-organized and financial supported by one of the largest commercial fertilizer producers in Shangdong province, named 'Nongda Feiye'.

On July 22 and September 10, Dr. Fang Chen visited the rice control release urea (CRU) and Nutrient Expert (NE) system field experiment in Honghu county of Hubei province, together with Dr. Ping He and Dr. Mira Pampolino of IPNI, and project cooperators in Hubei province. The field experiment showed that compared with farmers' common practice and soil testing based fertilizer recommendation treatments, the rice grew better in the application CRU treatment and NE system treatment.



On November 24, 2015, invited by International Training Department of Hubei Biological Science and Technology College, Dr. Fang Chen gave a lecture to the 21 trainees in the Training Class of Agricultural Management Officer of Bangladesh. All of these trainees are the officers of the Ministry of Agriculture of Bangladesh, and the training program was supported by both Chinese and Bangladesh governments. Dr. Chen's lecture titled 'Nutrient management in modern agriculture'. In the lecture he introduced the concepts and technologies of balance fertilization, 4R nutrient stewardship and Nutrient Expert System for the main crops. The audiences showed great interest and asked many questions about nutrient management strategy and technology.

On December 9, 2015, Dr. Fang Chen gave a presentation to global audience with title 'Rice production and nutrient management in China' through IPNI webinar, and answered some questions from audience.

On December 10, 2015, invited by the Horticulture and Forestry College, Huazhong Agricultural University, Dr.Fang Chen gave a lecture to about 50 young

teachers and students at the college lecture and meeting room at 19:00-21:00. The lecture titled 'Theoretics and practices of plant nutrition efficient management', Dr. Chen has answered some questions from the students and discussed some interest issues with the audience.

Achievements and Publications

Two issues of Better Crops China were published in 2015 including a special issue on 4R nutrient managementin crops including 9 articles and 13 modules/case studies to show you how to use fertilizer at the right source, right rate, right time and right placement.

Total of 12 scientific papers on nutrient management were published in 2015 from China Northwest region. 'Nutrient management and high efficient fertilization in main crops in Gansu Province-research and demonstration' obtained the Second Class Award of Gansu Science and Technology recognized by Gansu government. Selected papers are as following:

1) Li S, Duan Y, Guo TW, Zhang PL,He P, Johnston A, Shcherbakov A. 2015. Potassium management in potato production in Northwest region of China. Field Crops Research 174: 48–54.

2) Li ST, Xing SL, Cui RZ, Zhang Y. 2015. Soil potassium supply capacity in relation to cotton yield and quality in major cotton producing areas in north China. Cotton Science, 27(5): 445-453. (in Chinese)

3) Li ST, Zhang Y, Cui RZ, Xing SL. 2015. 4R Potassium Management Practices for Cotton in Northern China. Better Crops, 99 (2): 21-23.

4) Li S, Cui R, Tong Y, Wang R. 2015. Effect of rate and timing of potash application on apple fruit yield, quality and orchard potassium balance. Better Crops China, 35: 15-21. (in Chinese)

5) Tang XR, Zhang Y, Hu W, Hu GZ, Li QJ. Study on nitrogen fertilizer rate and N nutrient diagnosis in processing tomato. Journal of China Soil and Fertilizer, 2015, 4: 82-87.(in Chinese)

6) Li QJ, Zhang Y, Wang JX, Li N. 2015. Effects of fertilization on dry matter accumulation, nutrientuptake and yield of cotton under drip irrigation. Xinjiang Agricultural Sciences, 52 (7) 1292-1298. (in Chinese)

7) Guo TW, Zhang PL, Xie YC. 2015. Effect of various planting and fertilization patterns on soil moisture and water use efficiency of upland spring maize. Journal of Soil and Water Conservation, 2015, 29 (5): 231-238. (in Chinese)

8) Zhang PL, GuoTW, Li ST. 2015. Effect of various plastic mulching and fertilization on soil moisture dynamics and yield of upland maize. Agricultural Research in Arid Area, 6: 151-158. (in Chinese)

9) Zhang SF, Duan Y, Tuo DB. 2015. Sunflower response to N fertilizer application and N recommendation. China Food Safety Magazine, 3: 67-69.(in Chinese)

10) Lu YL, Yang XL, Li R, Li SL, Tong YA. 2015. Effect of K application time on yield and quality of Fuji apple. Chinese Journal of Applied Ecology, 26 (4): 1179-1185.(in Chinese)

11) Duan Y, Zhang J, Wang B, Yao JQ. 2015. Effect of K source and application time on potato quality. In: Technique Approaches for High Yield of Five Major Crops. Selling and Marketing Press. pp: 396-405.(in Chinese)

IPNI Scholar Award

The International Plant Nutrition Scholar Awards are open to applicants who are graduate students attending a degree granting institution located in any country with an IPNI program. Priority is given to the relevance of the proposed research in support of IPNI's mission. Students in the disciplines of soil and plant sciences including agronomy, horticulture, ecology, soil fertility, soil chemistry, crop physiology, and other areas related to plant nutrition are encouraged to apply. Awards of US $2,000 each will be awarded to winners. Review of applications will be conducted on a regional basis, including the following: North America, Latin America, Eastern Europe & Central Asia, China, South Asia, Southeast Asia, Australia/New Zealand, and Africa. The IPNI Scholar Award Program has once again expended its reach by awarding scholarships to 37 graduate students from the world in 2015, among which 4 graduate students from China received the Award. They are Mr. Li Jifu, from Huazhong Agricultural University; Mr. Wang Jidong, from Institute of Soil Science, Chinese Academy of Science; Mr. Zhou Zijun, from Institute of Soil Science, Chinese Academy of Science; Ms. Jin Kemo, from China Agricultural University.

Mr. Li Jifu

Ms. Jin Kemo

Mr. Wang Jidong

Mr. Zhou Zijun

April 30th will be the deadline for the application of 2016 IPNI Scholar Award. Anyone who has interests, please check the IPNI website: www.ipni.net for application process.

The International Plant Nutrition Institute (IPNI) is a not-for-profit, science-based organization dedicated to the responsible management of plant nutrition for the benefit of the human family. IPNI began operating in January of 2007 and now has active programs in Africa, Australia/New Zealand, Brazil, China, Eastern Europe/Central Asia and Middle East, Latin America-Southern Cone, Mexico and Central America, Northern Latin America, North America (Canada and U.S.A.), South Asia, and Southeast Asia.

As a global organization, IPNI has initiatives addressing the world's growing need for food, fuel, fiber, and feed. There is widespread concern for issues such as food security and the relationship of crop production to the environment and ecosystems. IPNI programs are achieving positive results in many areas. The program coordinators and IPNI regional directors are Ph.D. scientists. Through cooperation and partnering with respected institutions around the world, IPNI adds its strengths to agronomic research, education, demonstrations, training, and other endeavors. Best management practices for nutrient stewardship encourage the concept of applying the right product (source), at the right rate, at the right time, and in the right place.

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