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for

INTERNATIONAL COLLABORATION

(Clockwise from upper left) Paddy fields where harvesting and seeding are done simultaneously; Building site of vinyl house; Management of fruit tree seedlings; Food tasting of starfruits at the Yaeyama Industrial Festival (Photos by T. Hayashi)

In This Issue

JIRCAS
JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Role of the Okinawa Subtropical Station as Tropical Agriculture Research Front; Technological Information Dispatch Base

1) Toward the reformation of Okinawa Subtropical Station

The Commission on Policy Evaluation and the Evaluation of Independent Administrative Institutions - Agricultural Subcommittee, Administrative Management Bureau, in its Fiscal Year 2004 evaluation of the Okinawa Subtropical Station, and as directed by the Ministry of Internal Affairs, indicated that the Station should revise its experimental and research duties in the country's southernmost part, making full advantage of the subtropical weather and the geographical location of the island and should focus on agricultural, forestry and fisheries research similar to those carried out in overseas regions with highly similar weather and geographic conditions as Okinawa. The same idea will be reflected in the Next Mid-Term Target Plan.

Since the institutionalization of the Incorporated Administrative Agencies (IAAs), it has become necessary to strictly distinguish the various responsibilities among the IAAs. However, even if we recognize the existence of some overlapping of roles between the Okinawa Subtropical Station and the Kyushu Okinawa Agricultural Research Center in their activities in the Nansei Islands (Okinawa), analyzing this point thoroughly still fails to reveal their separate identities as independent organizations. What outputs have been produced so far and how they should be utilized to produce far-reaching effects have not been very clear. This situation puts the very existence of the Okinawa Subtropical Station in question.

2) Research capitalizing on the advantage of Okinawa Subtropical Station

Research fields utilizing its subtropical island environment:

There are several research areas where the Okinawa-Ishigaki's subtropical island environment can be tapped advantageously. The first one, taking advantage of its natural island conditions, involves research on material recycling based on zero emission concept. It deals with the quality of water from various sources including forest soils, grasslands, pastures and arable lands (above and below rivers), water estuaries and coral reefs of coastal areas as well as with material circulation. Likewise, it develops models and soil- and water-saving management (fertilizer- and water-saving) technology which will constitute the main focus of research relating to islands agricultural production environment. In the subtropical islands, factors such as low fertility soil, soil erosion, water shortages, intense summer heat and salt damage cause adverse production environment, thus making it necessary to develop appropriate technology to deal with the stress problem. The second one comprises basic and advanced research on stress tolerance of crops to address the problem of unstable crop production environment caused by various stresses such as high temperature, water shortage, etc. Basically, it deals with the development of stress tolerant crops for breeding purposes and of cultivation technology for quality improvement and for increasing crop productivity. Also, utilizing high temperature and strong sunlight conditions, advancement in crop development research through rapid generation technology is anticipated.

The third one, which utilizes equipped experimental fields and completed technology support systems, relates to research involving framing-up of technology development, field testing and modeling. Except for dryland agricultural technology, actual field trials and preliminary tests can be comprehensively executed for development of technology suitable for overseas tropical islands. In other words, the Station has the necessary trial sites for overseas application. The Station also has the distinct advantage of having one of the few high precision lysimeters available in the country, as well as well-equipped laboratory facilities such as glasshouses for transgenic plants, crop environment evaluation certification facility and isolation greenhouses.

These facilities and equipments are utilized for the "open laboratory", not only for the integrated collaborative research among the different JIRCAS research divisions, but also with both domestic and foreign research institutes. Utilizing its research front function for technology development research suitable for overseas needs, it can play its role well as a frontline base for the systematization of technology and for on-site testing.

3) The Tropical Agriculture Research Front as a base for international collaborative research

Through the cooperation and collaboration between the different JIRCAS research divisions and the regional research organizations (Ishigaki Branch of Seikai National Fisheries Research Institute, University of Ryukyus - Tropical Biosphere Research Center, Forest Tree Breeding Center-Iriomote Tropical Tree Breeding Garden, International Coral Reef Research and Monitoring Center of the Ministry of Environment, etc.), other domestic and international research institutes and universities, Okinawa Prefecture, Ishigaki City and other governmental organizations, together with the participation of foreign researchers in the various fellowship programs such as the JIRCAS Visiting Research Fellowship Program, JSPS Fellowship Program, etc., the Station can promote international collaborative research, acting as a frontline for technological development research on agriculture suitable for tropical and subtropical islands in developing regions as well as for technology systematization and domestic field trials. Both in name and reality, it can shoulder its role as the information dispatch base for tropical islands agricultural research, which include the establishment of network with other administrative organs. Now, all the constituents of the Okinawa Subtropical Station including researchers, administration and technical support staff, including part-time employees, are joining hands together anew bearing this thought in mind.

Toshihiro Senboku
Director, Okinawa Subtropical Station, JIRCAS

Seasonal Prevalence of *Helicoverpa armigera* (Lepidoptera: Noctuidae) and its Natural Enemies in Kenya

In view of the recent interest in the use of sustainable and environment-friendly methods to control crop pests, there is an increasing focus on using indigenous natural enemies for biological control.

Helicoverpa armigera is one of the most serious pests of vegetables, cereals and cash crops worldwide. Based on our several field surveys in Kenya, this species is also abundant in the fields, but is regularly attacked by various natural enemies, including several species of parasitoids.

We established an experimental field of pigeon pea (*Cajanus cajan*) at Nairobi in Kenya and conducted weekly collections of *H. armigera* larvae to obtain information on the pest and the occurrence of its natural enemies throughout the year. Collected larvae were kept individually, provided with an artificial diet, and observed for any development and parasitization. Data on seasonal occurrences, percentage parasitism and host stages when attacked were compiled between February 2002 and September 2004.

Our results showed the most important mortality factor of the collected *H. armigera* larvae to be parasitization by the gregarious *Drino zonata* and the solitary *Linnaemya longirostris*, both of which are parasitoid flies in the tachinid family (Figs. 1 and 2). Parasitization by the two species peaked at different times of the year. Total parasitism per month and per week sometimes exceeded 50% (Fig. 1) and 75%, respectively.

Our laboratory experiments also revealed that *D. zonata* required relatively high temperatures to develop since they could not survive at temperatures below 15°C, which might be one of the reasons for the decrease in the percentage parasitism by this particular parasitoid between May and January (Fig. 2(b)). These months represent minimum temperatures lower than 15°C.

Competition between the two species within a host was also investigated in the laboratory, since one species parasitized on the day-1 last instar larva of *H. armigera*, 48 hours before the other (all the clutch sizes were regulated as 1). We found no absolute winner in any case, or of any unsuccessful parasitization, defined as both parasitoids dying within the host's body (Fig. 3).

Drino zonata showed high parasitization rates in early months of the year but *L. longirostris* showed the same rate all year through. They did not exhibit scramble-type competition, but co-existed in the same environment. We conclude that these two parasitoid species are good potential candidates as biological control agents of *H. armigera*.

Satoshi Nakamura
Crop Production and Environment Division, JIRCAS

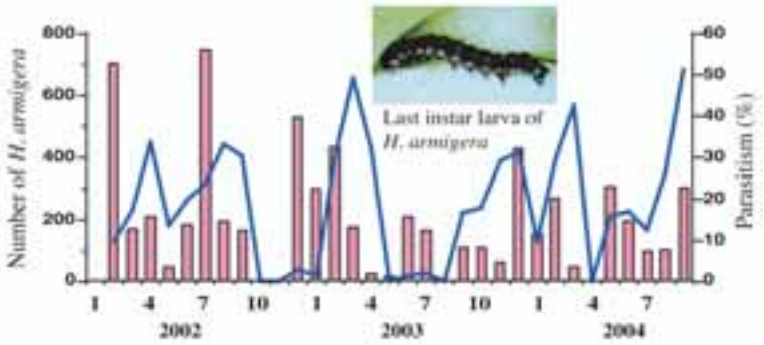

Fig. 1. Monthly changes in the number of *H. armigera* larvae collected in the field (Bars) and total percentage parasitism by the two tachinid species *L. longirostris* and *D. zonata* (Lines) from February 2002 to September 2004.

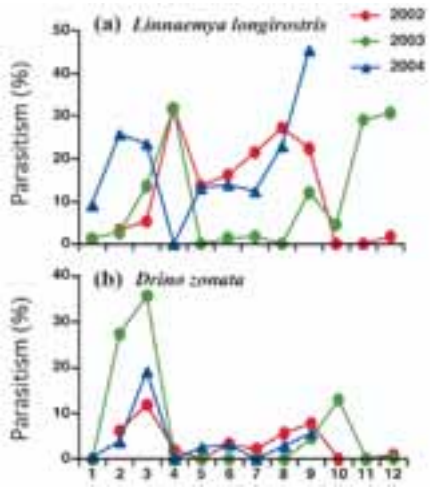

Fig. 2. Monthly changes in the percentage parasitism of *H. armigera* by *L. longirostris* (a) and *D. zonata* (b) from February 2002 to September 2004.

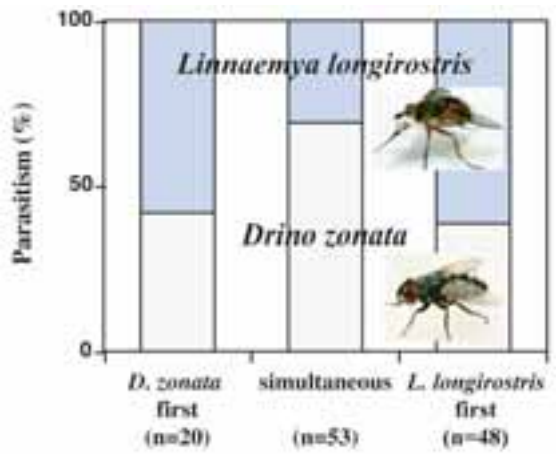

Fig. 3. Percentage of adult emergence of tachinid flies (*L. longirostris* and *D. zonata*) wherein one tachinid species parasitized on the day-1 last instar larva of *H. armigera*, 48 hours before the other species (clutch sizes were regulated as one).

NERICA Cultivation in Guinea and JIRCAS Rice Research

Seven cultivars of the upland rice NERICA, derived from crossing between *Oryza sativa* L. and *O. glaberrima* Steud, have rapidly become widespread mainly over West Africa since 2000, and are now being cultivated in many African countries. In 2005, 11 new NERICA cultivars were added, and four new paddy rice cultivars were developed through crossing and breeding between new rice varieties with characteristics different from upland NERICA cultivars.

Among the African countries, rice production technology has been introduced earlier in Guinea, and in 2003, rice cultivation was done in approximately 52,000 hectares of arable land, which was equivalent to about half of cultivated acreage, giving 84,000 tons of production. Compared to other countries, NERICA rice was introduced earlier to Guinea, which started cultivating them in rice fields in 1996.

The NERICA productivity in the seed production farm trials conducted by the Ministry of Agriculture was, on the national average, ranging from 1.7 t/ha in 2002 to 2.5 t/ha in 2003. Generally, when compared with the yield of traditional upland rice (1.0- 1.5 t/ha), the NERICA yield is found to be higher. But, when compared with improved varieties, depending on the cultivar, there is only a little difference.

In 2003, of the NERICA cultivars planted to more than 14,000 hectares, NERICA 3 and 4 were mainly used. The reason seems to be their high yielding characteristic and disease resistance, but the nature of these characteristics has yet to be scientifically elucidated. Presently, the main cultivation problems include bird damage due to early heading, grain threshing difficulties, post-harvest drying methods, etc.

In our collaboration with the Guinean Agriculture Research Institute (IRAG), we have placed great attention to understanding the characteristics of interspecific hybridization progenies from varietal crosses, including those NERICA varieties, as well as of those of the parent species, *O. glaberrima* and will be promoting advanced research on the verification of their adverse environment tolerance and the mechanism behind it.

Since approximately more than 90% of Guinea's rainfed rice areas are suffering from unstable water supply, the possibility for rice plants to encounter water stress is considered high. It is perceived that the main causes of water stress are water shortage due to drought, or excessive water due to flooding.

For these reasons, both problems were taken up in our research project. Various experiments are being carried out to address the former problem through the elucidation of the effect of deep-rooting on improved drought stress tolerance, and the latter, through the identification of important flood resistance and evasive characteristics.

To date, the deep-rooting of rice plants in rainfed farms differs depending on field conditions. It was also shown that there is a possibility that the soil hardpan formation renders penetration resistance which restricts the expansion of the root system.

The ability of the upland NERICA's roots to overcome penetration resistance due to soil hardening was clarified to be small. Although generally under submerged conditions of rainfed paddies, the (FF) flash flood resistance of *O. glaberrrima* is presumed to be weak, it was shown to have high-growing ability under long term submergence.

Also, potential lines with strong FF tolerance have been identified among the hybrid paddy rice varieties. It is believed that varietal characteristics, i.e. flooding tolerance ability shown in the control of shoot elongation on the ground, and recovery ability shown in the accumulation of plants' carbohydrates, are deeply involved in the improvement of FF tolerance. Hereafter, important traits related to water stress tolerance will be further clarified and their mechanism will be applied in the post-NERICA development.

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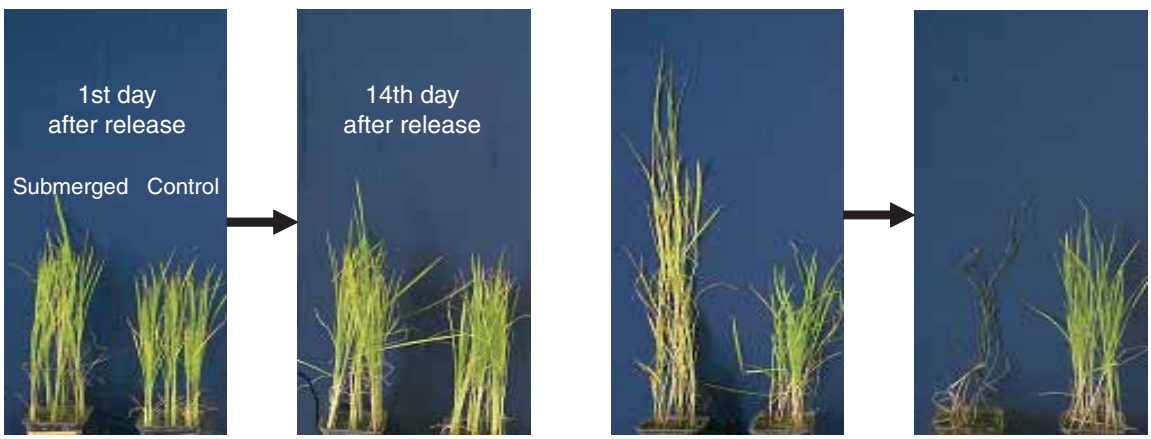

Fig. 1. 1 to 14 days after release from submergence, changes in growth above ground.

Effective Marking Method Using Fluorescent Powder for Dispersal Study of the Citrus Psyllid, *Diaphorina citri*

The Asian citrus psyllid, *Diaphorina citri* Kuwayama, is a vector of Asian citrus greening disease caused by the bacterium, *Candidatus* Liberibacter asiaticus, which is spreading not only in Asia, including Japan, but in both North and South America. Citrus greening disease or "Huanglongbing," referred to as HLB hereafter, is the most destructive disease affecting citrus cultivation, causing reduction of both the yield and fruit quality. There appears to be three possible ways to control HLB: direct control of the pathogen, control of the psyllid, and management control of the interaction between the pathogen and its vector. At present, the second option may be the most practical because the method based on the first or third option does not exist at the moment. Therefore, the planting of disease-free seedlings and subsequent application of systemic chemicals against vector psyllids are usually conducted.

Ecological and ethological studies on the psyllid are required for the establishment of control methods for this insect. Several studies have been conducted on the transmission of the pathogen and on the biology of the psyllid. However, limited information is available regarding the dispersal of other species of the psyllid. The lack of data regarding the dispersal of the psyllid is apparently due to the absence of studies reporting effective marking methods for this insect. Hence, we evaluated the effectiveness of a marking method for psyllids by using fluorescent powder.

Firstly, we examined the persistence of the pinkish fluorescent powder on the bodies of psyllids (Fig. 1), and its effects on their survival, fecundity, and flight activity in the laboratory. After confirming the effectiveness of the marking agents, its availability in the field was examined.

In the laboratory, the marks on the bodies of psyllids reduced considerably with time. However, the marks were detected visually after 40 days, when the relatively marked area was less than 30% on average. Thus, the marking on the psyllids was confirmed visually without collecting the insects during one and half month in the laboratory.

Equal numbers of marked and non-marked psyllids were then released 2 m in front of the light. The number of collected marked psyllids near the light was significantly lower than that of non-marked psyllids within 4 h after the release. After 6 h, no significant difference was observed (Fig. 2). No significant differences were detected between the two groups either in mortality during 40 days or number of eggs laid on orange jasmine, *Murraya exotica* L., within 5 days after marking.

One hundred marked psyllids were released in an orange jasmine field (18 m×18 m). During the experiment, the total precipitation was 289 mm. This condition was hard for both the psyllids and the fluorescent marks. However, the marked insects were detected visually, and the proportion was 30% after 20 days and 20% after 40 days, respectively (Fig. 3).

Marking methods can be useful for dispersal studies. Various dye agents have been used to mark insects. The marking agents should satisfy most of the following conditions: 1) marking should not affect the activity of insects, 2) marked insects should be easily and clearly distinguishable, 3) the marks should be persistent on the insects during the study period, and 4) marking should be environmentally safe, cost-effective, and easy to use. The marking agent developed in our study was able to satisfy most of the above-mentioned 4 conditions, so its utilization is possible.

These results indicate that the marking method using fluorescent powder does not affect the mortality or fecundity of psyllids, and it can be used for approx. 6 weeks in the field. Thus, the dust marking method can be used for the detection of psyllids for 40 days even in rainy season and for longer duration during dry season. This method will thus contribute to the ecological and ethological field studies of the psyllids.

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Fig. 1. Marked and non-marked psyllids on orange jasmine.

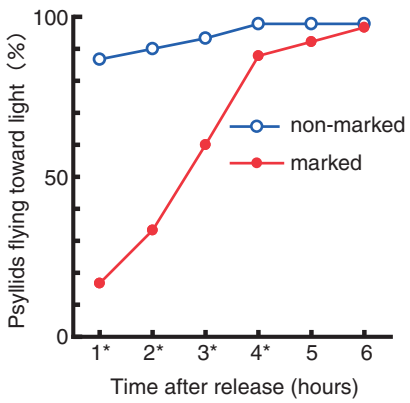

Fig. 2. Accumulative proportion of psyllids that flew to the light source after their release at time 0.

Non-marked and marked groups are designated by open (blue) and closed (red) circles, respectively, and asterisks indicate the time when a significant difference was observed in the proportion between these two groups.

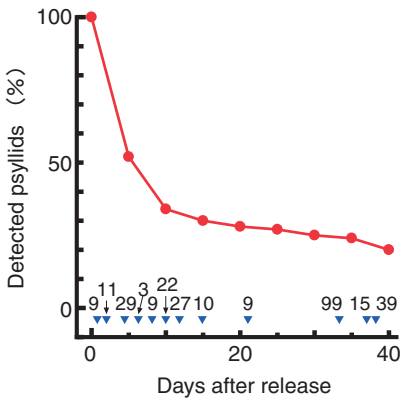

Fig. 3. The proportion of detected psyllids after the release.

The proportion of marked psyllids that were released (100 at the beginning) in the field, and later detected visually on the orange jasmines from February 18, 2005 to March 30, 2005. Inverted triangles (▼) and numerals placed above them indicate the occurrence of rainfall and the precipitation (mm), respectively.

Runoff of Nutrients Causes Decreasing Crop Yield in Fields with Lower Infiltration Rates in Southern Mali

In Southern Mali, over a distance of approximately 300 km or for every 2° difference in latitude, annual precipitation decreases by 600 mm, from 1,400 mm to 800 mm, within the recent few decades. Local farmers are liable to believe that the reduction in precipitation is the only cause of recently decreasing and unstable crop production. However, we were able to analyze that runoff of fertilizer elements due to precipitation decreased crop yield in fields having low infiltration rates in the region. The research had been conducted with budgetary support from the Japanese Ministry of Education within a period of three years from 2000.

The region is located on one of the old geological plates, where soils are divided into two distinct types during its long history. The first type is gravelly soil, with a high infiltration rate, located mainly in highland areas where erosion occurs. The other type is clayey soil, with a low infiltration rate, located mainly in lowland areas, where deposition occurs. In the first type of soil, rainwater infiltrates rapidly into the subsoil, while in the second type, rainwater runoff on the soil surface is high.

We hypothesized that either type of water movement could cause loss of nutritive elements and thereby result in reduced yield. We tested this hypothesis first by examination of the infiltration rate. Analysis showed that at least 614 mm of precipitation and 90 days were spent before the water capacity of the soil at a depth of 60 cm was completely filled up, from the beginning of the rainy season (Fig. 1).

According to the result, over 90% of the water from precipitation was calculated to be lost due to soil surface runoff and evaporation. Growth of maize, millet, sorghum and cotton was visually estimated from standing plants, and was analyzed regarding its relationship with the infiltration rates in twenty-one fields in Diou. For measurement of the infiltration rate, a cylinder with a 20 cm^2 cross-sectional area and 10 cm in height was inserted into the soil down to a depth of 2.5 cm, and then 5 cm of water was poured into the cylinder. Crop growth was poor in fields where infiltration rates were either lower at under 0.04 mm/sec or higher at over 1.00 mm/sec than the average range (Fig. 2).

Root distribution maps of maize were drawn from three fields with low, medium, and high infiltration rates, respectively. Crops in fields with soils having low infiltration rates showed signs of mild water stress early in the cropping period. Crops in fields with soils having high infiltration rates showed signs of restricted root development later in the cropping period. These results

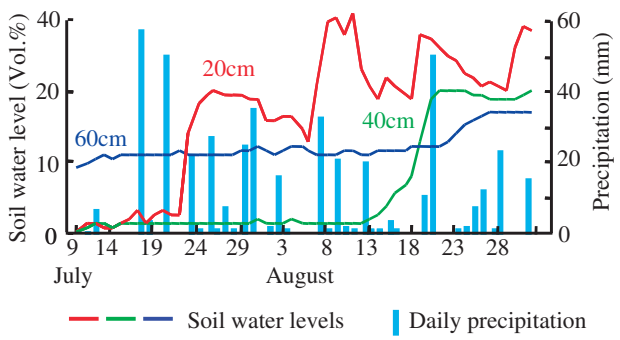

Fig. 1. Changes in soil water levels at different depths and in relation to daily precipitation in Niessemana, Mali

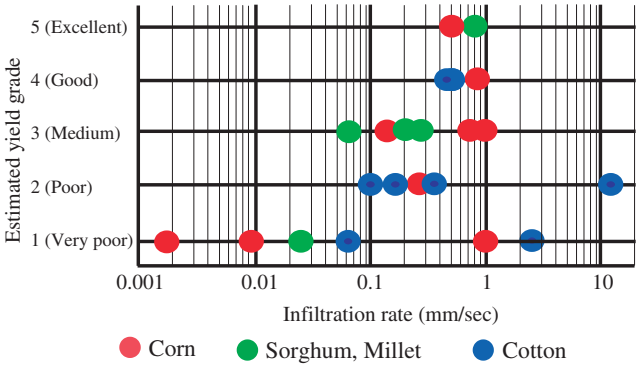

Fig. 2. Relationship between the infiltration rate in soil surface and estimated yield grade.

show that runoff of water and nutritive elements from the soil surface, as well as leaching into the subsoil, collectively result in poor growth.

To verify the above hypothesis experimentally, effects on cotton yield of quick-acting and slow-acting fertilizers were compared. Cotton yield in plots receiving slow-acting fertilizer was higher in fields with soils having lower infiltration rates (Table 1). This shows that the lack of nutritive elements due to rainwater runoff on the soil surface decreased water use efficiency in the field with lower infiltration rate even in this region where overall water shortage already limits crop production.

Table 1. Effects of additional application of urea and coated urea on cotton ball yield in fields with different infiltration rates

Infiltration rate in fields	Conventional application	Urea additional application	Coated urea additional application
(mm/sec)	(t/ha)	(t/ha)	(t/ha)
0.56	1.30±0.17	1.43±0.11	1.35±0.14
	a	N.S.	N.S.
0.04	0.58±0.07	0.53±0.06	0.98±0.05
	b	N.S.	***

Different alphabets show a significant difference.
N.S.: No significant difference from conventional application
***: Significant difference between conventional and coated urea application, P>0.1%

Practices to decrease nutritive element runoffs on soil surfaces, including split application of fertilizer, construction of levees surrounding fields, and drainage canals could be useful in fields with lower infiltration rates. The infiltration rates of 12% of fields in the region were under 0.04 mm/sec.

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[2]Development Research Division, JIRCAS
[3]Institut d'Economie Rurale (IER), Mali

Scenes of Research Activities

Animal Production and Grassland Division

Agro-pastoral system experimental field in Paraguay
Foreground: Soybean field Background: Guinea grass pasture

Diversified agro-pastoral farm in Paraguay

Water hyacinths which float along the waterway are feed for pigs in Vietnam

Water spinach is supplied to the pig in Vietnam

Food Science and Technology Division

Investigation into the functionality of promising common Thai vegetables

Common Thai vegetables

Fresh market in Northeast Thailand

Taking apart a jackfruit

JIRCAS Visiting Research Fellowship Program (FY2004-FY2005) at Tsukuba and Okinawa

Since 1992, JIRCAS has been implementing the "Visiting Research Fellowship Program," under which promising researchers from developing countries are invited to conduct collaborative research to address various problems confronting developing regions on a global scale, which include the critical situation of food production, desertification and the gradual disappearance of genetic resources, as well as to enhance their capacity-building to enable them to respond effectively to their countries' development needs. Under the FY 2004 - FY2005 Program, a total of 23 researchers were invited, 10 of which carried out research at JIRCAS HQ in Tsukuba, 9 at Okinawa Subtropical Station, and 4 at NIAS in Tsukuba. They are listed below.

Long-term Program at JIRCAS Tsukuba (December 2004-November 2005)

No.	Name	Nationality	Affiliation	Division in JIRCAS
1	Cemal Atici	Turkey	Adnan Menderes University	Development Research Division
2	Zhijie Wang	P. R. China	China National Engineering Research Center for Information Technology in Agriculture	
3	Feng Qin	P. R. China	Tsinghua University	Biological Resources Division
4	Sobrizal	Indonesia	National Nuclear Energy Agency	
5	Trimurtulu Nunna	India	Acharya NG Ranga Agricultural University	Crop Production and Environment Division
6	Andrew Kalyebi	Uganda	Namulonge Agricultural and Animal Production Research Institute	
7	Subramaniam Gopalakrishnan	India		
8	Mohamed Faize	Morocco		Animal Production and Grassland Division
9	Syeda Shahnaz Parvez	Bangladesh		Food Science and Technology Division
10	Ashraf Suloma Mahmoud	Egypt	Cairo University	Fisheries Division

Long-term Program at JIRCAS Okinawa (December 2004-November 2005)

No.	Name	Nationality	Affiliation	Laboratory in Okinawa Subtropical Station
1	Robert Bellarmin Zougmore	Burkina Faso	Institut de l'Environnement et de Recherches Agricoles (INERA)	Islands Environment Management Laboratory
2	Saleh Mahmoud Ismail Ibrahim	Egypt	Assiut University	
3	Peruma Vidhana Arachchige Lal	Sri Lanka	University of the Ryukyus	International Collaborative Research Section
4	Jilin Tian	P. R. China	Shanghai Academy of Agricultural Sciences	Environmental Stress Laboratory
5	Ashok Kumar	India	CCS Haryana Agricultural University	
6	Xueqin He	P. R. China	Inner Mongolia Agricultural University	Crop Breeding Laboratory
7	Bambang Sugiharto	Indonesia	University of Jember	
8	Mustad Maulid Macha	Tanzania	Sokoine University of Agriculture	Tropical Fruit Crop Laboratory
9	Mohammad Abul Kashem Chowdhury	Bangladesh	Patuakhali Science and Technology University	

Short-term Program at NIAS (November 2005-March 2006)

No.	Name	Nationality	Affiliation	Laboratory in NIAS
1	Talaat Abdel-Fattah Ahmed	Egypt	Assiut University	Plant Biotechnology Department
2	Haifei Zhou	P. R. China	Chinese Academy of Sciences	Genetic Diversity Department
3	Suphawat Sinsuwongwat	Thailand	Chiangmai University	Genetic Diversity Department
4	Momtaz Mohamed Yehya Hegab	Egypt	Cairo University	Gene Bank

Tsukuba fellows and staff of International Relations Section of JIRCAS

Okinawa fellows

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