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Contents

Guidelines and Style for IRRN Contributors

Articles for publication in the International Rice Research Newsletter (IRRN) should observe the following guidelines and style.

Guidelines

- Contributions should not exceed two pages of double-spaced typewritten text. Two figures (graphs, tables, or photos) may accompany each article. The editor will return articles that exceed space limitations.
- Contributions should be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analyses should be done.
- Announcements of the release of new rice varieties are encouraged.
- Pest survey data should be quantified. Give infection percentage, degree of severity, etc.

Style

- For measurements, use the International System. Avoid national units of measure (cavan, rai, etc.).
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha, 2 h/d.
- Express yield data in tonnes per hectare (t/ha). With small-scale studies, use grams per pot (g/pot) or g/row.
- Express time, money, and common measures in number, even when the amount is less than 10. For example: 8 min, $2, 3 kg/ha, 2-wk intervals.
- Write out numbers below 10 except in a series containing 10 or higher numbers. For example: six parts, seven tractors, four varieties. *But* There were 4 plots in India, 8 in Thailand, and 12 in Indonesia.
- Write out numbers that start sentences. For example: Sixty insects were put in each cage. Seventy-five percent of the yield increase is attributed to fertilizer.
- Place the name or denotation of chemicals or other measured materials near the unit of measure. For example: 60 kg N/ha, not 60 kg/ha N; 200 kg seed/ha, not 200 kg/ha seed.
- Use common names — not trade names — for chemicals.
- The US$ is the standard monetary unit in the IRRN. Data in other currencies should be converted to US$.
- When using acronyms, spell each out at first mention and put the specific acronym in parentheses. After that, use the acronym throughout the paper. For example: The brown planthopper (BPH) is a well-known insect pest of rice. Three BPH biotypes have been observed in Asia.
- Abbreviate names of months to three letters: Jun, Apr, Sep.
- Define in the footnote or legend any nonstandard abbreviations or symbols used in a table or figure.
- Do not cite references or include a bibliography.

Genetic Evaluation and Utilization

OVERALL PROGRESS

Ethyl methane sulfonate (EMS)-induced micromutation in a tall indica rice

E. H. Mallick, Rice Research Station, Bankura 722101; N.G. Hajra and S.G. Hajra, Regional Rubber Research Institute, Agartala, Tripura (West), India

We induced mutations in quantitatively inherited traits of rice by presoaking seeds of Dahar Nagra, a tall indica variety in 1% aqueous, freshly prepared, nonbuffered solution of EMS for 4, 6, and 8 h. Number of tillers per plant, panicle length, number of filled grains per panicle, 1000-grain weight, and yield per plant were reduced in the M_2 (Table 1) and M_3 (Table 2). Weight of 1,000 filled grains increased after EMS treatment.

Table 1. Mean and estimates of genetic parameters of 5 quantitative characters in the M_2 of Dahar Nagra after EMS treatment. Burdwan University Crop Research Farm, India.

Treatment	Mean of genetic character	Genotypic variance	Genotypic coefficient of variation (%)	Heritability (broad sense) percentage	Genetic advance (% of mean)
			Tillers (no./plant)		
Control	21.38	0	0	0	0
4 h	17.38	1.048	5.8	15.4	1.82
6 h	14.11	3.255	12.7	24.2	12.94
8 h	12.94	5.377	17.9	27.1	19.19
			Panicle length (cm)		
Control	28.81	0	0	0	0
4 h	25.33	0.090	1.1	5.5	0.57
6 h	23.66	0.564	3.1	18.4	2.79
8 h	23.07	0.998	4.3	22.8	4.26
			Filled grains (no./panicle)		
Control	160.88	0	0	0	0
4 h	147.33	3.014	1.1	3.9	0.47
6 h	139.22	1.844	2.0	8.6	1.20
8 h	134.27	11.700	2.5	11.4	1.76
			Weight of 1000 filled grains (g)		
Control	19.19	0	0	0	0
4 h	19.43	0.028	0.8	10.8	0.58
6 h	19.70	0.030	0.8	11.2	0.60
8 h	19.77	0.031	0.8	11.5	0.62
			Yield per plant (g)		
Control	25.61	0	0	0	0
4 h	24.41	0.243	2.0	8.6	1.21
6 h	23.28	1.372	5.0	22.1	4.86
8 h	22.93	1.695	5.6	23.6	5.67

Table 2. Mean and estimates of genetic parameters of 5 quantitative characters in the M_3 of Dahar Nagra after EMS treatment. Burdwan University Crop Research Farm, India.

Treatment	Mean	Genotypic variance	Genotypic coefficient of variation (%)	Heritability (broad sense) percentage	Genetic advance (% of mean)
			Tillers (no./plant)		
Control	18.61	0	0	0	0
4 h	15.55	0.711	5.4	20.1	4.99
6 h	13.55	1.700	9.5	26.1	10.10
8 h	13.22	3.433	14.0	29.3	15.60

continued on next page

Table 2 continued.

Treatment	Mean	Genotypic variance	Genotypic coefficient of variation (%)	Heritability (broad sense) percentage	Genetic advance (%ofmean)
			Panicle length (cm)		
Control	26.35	0	0	0	0
4h	25.13	0.047	0.8	7.5	0.48
6h	22.88	0.355	2.6	22.9	2.56
8h	22..41	0.877	4.1	28.1	4.55
			Filled grains (no./panicle)		
Control	160.38	0	0	0	0
4h	146.94	10.970	2.2	15.7	1.83
6h	129.72	23.833	3.7	21.9	3.62
8h	126.16	24.435	3.9	22.1	3.78
			Weight of 1000 grains (g)		
Control	19.16	0	0	0	0
4h	19.32	0.006	0.4	3.0	0.14
6h	19.53	0.016	0.6	7.1	0.35
8h	19.58	0.018	0.6	7.8	0.39
			Yield per plant (g)		
Control	24.62	0	0	0	0
4h	22.97	0.724	3.7	13.6	2.81
6h	22.31	1.340	5.1	18.6	4.59
8h	22.01	2.145	6.6	22.3	6.46

EMS treatment induced genetic variability and genetic advance in the five quantitative traits. The longer the treatment, the higher the estimated genetic parameter. EMS treatment could be used to select improved plant types on the basis of induced polygenic variability, particularly in the M_3.

ERRATUM

IRRN 11:3 (Jun 1986) p. 25. On the item titled *Efficacy of slow-release N fertilizers on rice in coastal soils of Karnataka,* the author list was garbled. It should read: A.M. Krishnappa, K. Kenchaiah, B.N. Patil, Badrinath, K. Balakrishna Rao, and N.A. Janardhana Gowda. Mr. Badrinath's name was omitted.

Improved White Ponni released in Tamil Nadu

M. Subramanian, V. Sivasubramanian, and S. Chellaiah, Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Improved White Ponni has been released as a new variety for Tamil Nadu. It yields 300 kg/ha more than the local White Ponni but resembles it in all other characteristics.

Improved White Ponni, with 135-140 d maturity, is suitable for Sep-Oct and Jan-Feb plantings. At 130-135 cm tall, it is prone to lodging. Maximum yield was 6.3 t/ ha. In 1984 data from 170 places in 11 districts, Improved White Ponni outyielded IR20 in 8 districts with an average 4.2 t/ ha, 5.8% more than IR20 (Table 1). Average yield of Improved White Ponni is 4.5 t/ ha. Maximum yield potential is 9.2 t/ ha. Improved White Ponni gives a straw yield of 7.4 t/ ha (moisture-free basis) compared to 4.5 t/ ha for IR20 and 5.0 t/ ha for CO 43.

The improved variety is moderately resistant to tungro (RTV), leaf

Table 1. Performance of Improved White Ponni in farmers' fields. Tamil Nadu, India.

District	Locations (no.)	Yield (t/ha)	
		Improved White Ponni	IR20
Thanjavur	39	3.3	2.2
Trichirappalli	7	5.8	4.6
Pudukkottai	8	3.9	3.6
Madurai	10	3.6	4.0
Ramanathapuram	2	3.0	3.7
Tirunelveli	24	4.1	2.9
Kanyakumari	4	4.1	4.0
Coimbatore	16	5.4	5.9
Salem	32	4.8	4.9
Dharmapuri	3	4.8	4.1
Chingleput	25	3.8	3.7
Total	170		
Mean		4.2	3.9

Table 2. Reaction [a] of Improved White Ponni to diseases and insects. Tamil Nadu, India.

Variety	RTV		Leaf yellowing (field)	B1		BB (field)	Sheath rot (field)	Grain discoloration (field)	Leaffolder (field)	Mite (field)	GLH (inoculated)
	Field	Inoculated		Field	Inoculated						
Improved White Ponni	3 (R)	5 (MR)	3-5 (MR)	5 (MR)	5 (MR)	3-5 (MR)	3 (R)	3 (R)	5-7 (MS)	5 (MR)	5 (MR)
IR20	8 (S)	9 (S)	7 (S)	7 (MS)	5-7 (MS)	3-5 (MR)	3 (R)	3 (R)	5 (MR)	5 (MR)	5 (MR)
CO 43	7 (S)	8 (S)	7 (S)	3 (R)	5 (MR)	3-5 (MR)	5-7 (MS)	5 (MS)	5 (MR)	5 (MR)	–

[a]R = resistant, MR = moderatley resistant, MS = moderately susceptible, S = susceptible.

yellowing, blast (Bl), and bacterial blight (BB), and resistant to grain discoloration in farmers' fields. Under artificial inoculation, it was moderately resistant to RTV and Bl. In 1984, when all other medium-duration varieties succumbed to an epidemic outbreak of leaf yellowing, Improved White Ponni tolerated the stress throughout Tamil Nadu. It is moderately resistant to mite and green leafhopper (GLH), the vector for transmitting RTV (Table 2).

Cooking quality is very good, protein content is 9.88%.

Genetic Evaluation and Utilization

AGRONOMIC CHARACTERISTICS

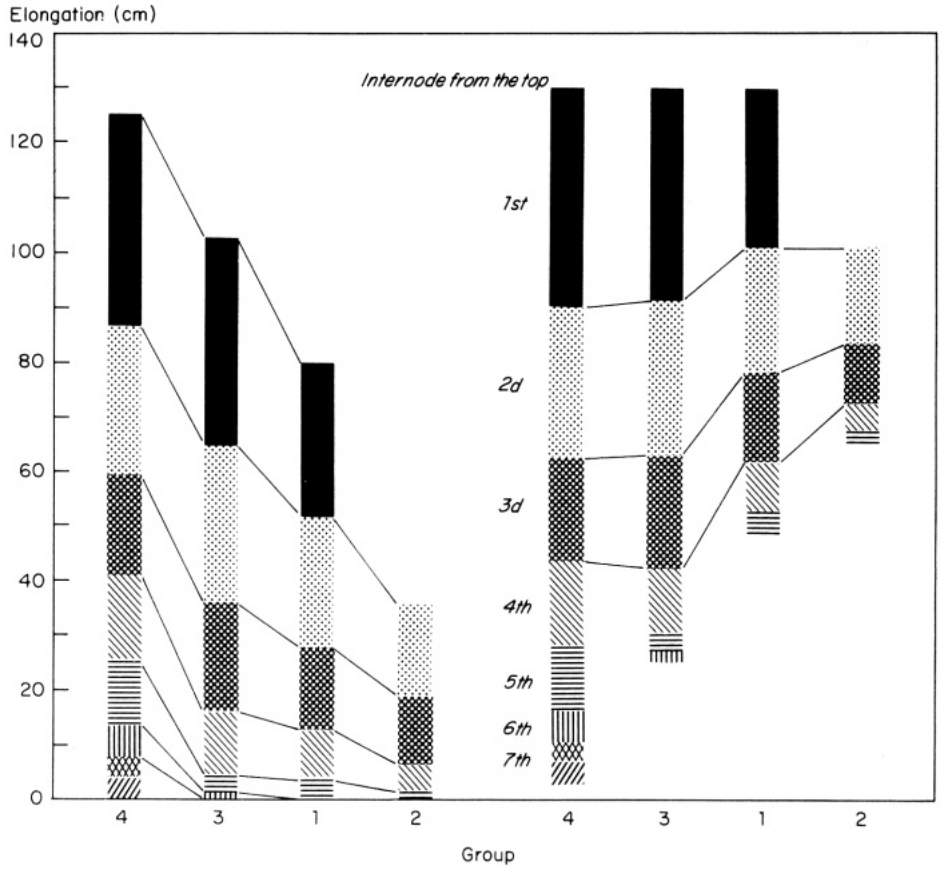
No first intemode found in Nepalese varieties

G.L. Shrestha, National Rice Improvement Program (NRIP), Parwanipur, Birganj, Nepal

Four groups of Nepalese local cultivars were measured for internode elongation at maturity. Group 1 consisted of 15 local rice varieties that are tall, photoperiod insensitive, and mature within 110 d. Group 2 consisted of seven Gamadi-type local varieties in which the panicle does not exsert from heading to maturity but remains enclosed in the flag leaf sheath. Other names for the Gamadi-type are Garvey, Dulhaniya, Kaniya, Thagiya, Sathi, and Satha. These varieties are dwarf type and mature within 100 d. Group 3 consisted of 36 local upland rice cultivars that are tall and mature in 100-110 d. Group 4 consisted of 20 local cultivars that are tall and photoperiod sensitive.

Direct seeding of groups 1, 2, and 3 was on 7 Apr and of group 4 on 15 Jun 1985 in the main plot under normal cultural conditions. Ten main culms were randomly sampled from 10 plants of each variety and culm length, panicle length, and length of each elongated upper internode measured.

All groups except group 2 showed normal elongation of the upper internodes, although total culm length varied significantly (see figure). In group 2, the first internode from the top was absent but the rest of the upper internodes showed normal elongation. This absence of the first internode from the top coincided with panicle enclosure within the flag leaf sheath and is important in the evolution of rice from the wild stage to cultivation.



Internode elongation of Nepalese local germplasm.

Screening for dormancy in 39 rice varieties

H. P. Sikder, Rice Research Station, Chinsurah, Hooghly, West Bengal, India

The 39 varieties screened had these maturity characteristics: 2 early maturing aus, photoperiod insensitive, 90-100 d maturity; 16 early maturing aman, photoperiod sensitive, 140-148 d; 12 medium maturing aman, photoperiod sensitive, 160-165 d, and 9 medium-late and late maturing aman. photoperiod sensitive, more than 165 d.

Seeds for three replications were thoroughly dried in the sun, cleaned, and kept in the laboratory in thin cloth bags at room temperature. Germination tests were started 10 d after harvest at regular intervals until dormancy was completely broken.

Seeds were germinated in petri dishes on moist blotting paper for 6 d. When necessary, they were incubated at 30° C to avoid adverse effects of atmospheric low temperatures.

The varieties were classified by dormancy (time to 80% germination) as follows: nondormant, seed dormancy broken 10 d after harvest (DH); weakly dormant, dormancy broken 40 DH; moderately dormant, dormancy broken 60 DH; and strongly dormant, more than 60 d to break dormancy.

Long dormancy (80 to 100 d) was found more in medium and late maturing varieties (see table).

Exceptions were the early maturing Dular with moderate dormancy (60 d) and very late maturing Baok with no dormancy.

Dormancy in 39 rice varieties. Hooghly, West Bengal, India.

Maturity group	Nondormant (10 d)	Weak dormancy (40 d)	Moderate dormancy (60 d)	Strong dormancy (80-100 d)
Early aus	Satika	–	Dular	–
Early aman	CR205	EMH3 CR201 AC517 Dudhkati CR205	Badkalamkati 65 Churnakati Malsira Jhulur Asuda Badkalamkati T-1	Dudhraj KXI-36 Sankarkalma
Medium aman	–	Rupsail	Bhasamanik Kalma 222 Dudhsar Nagra Indrasail	Latisail Patnai 23 Jhingasail SR26B Radhunipagal Badsabhog
Medium-late and late aman	Baok	NC1281	Gabura OC1393	NC678 Kumargore Tilakkachari Achra FR43B

Effect of gamma-radiation on germination and seedling growth

N. Kumar and S.S. Malik, Haryana Agricultural University, Regional Research Station, Uchani (Karnal), India

Four rice varieties — Sonalee, Prasad, IR36, and Tetep — and the F_2 of Sonalee/Prasad, Sonalee/IR36, and Sonalee/Tetep were irradiated with 30 and 40 krad gamma rays from ^{60}Co source and germinated in the incubator at 37° C.

Germination and root shoot length were measured at 10 d. All treatments reduced germination (see table). Lowest germination was shown by Sonalee at 30 krad (63%) and 40 krad (59%). IR36 exhibited maximum germination. Germination in Sonalee/Prasad was higher than that of either parent but was less in Sonalee/ IR36 and Sonalee/Tetep.

Root and shoot length decreased as irradiation increased in all populations; the lowest values were for Tetep with 40 krad. Radiation affected roots more than it did shoots.

The hybrid Sonalee/Prasad had shorter roots than either parent; the hybrid Sonalee/Tetep had longer roots than either parent. In Sonalee/IR36, root length was intermediate.

Shoots of Sonalee/IR36 and Sonalee/Tetep populations were longer than those of the parent varieties; in Sonalee/ Prasad, shoot length was intermediate.

Effect of radiation on germination and seedling growth. Karnal, India.

Genotype	Germination (%)	Root length (mm)	Shoot length (mm)
	No radiation		
Sonalee	81	13.60	7.10
Prasad	90	14.27	12.30
Sonalee/Prasad	100	12.64	11.09
IR36	95	15.89	11.24
Sonalee/IR36	81	15.45	13.77
Tetep	100	14.46	12.10
Sonalee/Tetep	81	16.85	14.83
	30 krad		
Sonalee	63	4.67	9.81
Prasad	85	4.34	8.00
Sonalee/Prasad	90	8.23	9.20
IR36	90	10.93	11.46
Sonalee/IR36	72	9.88	11.12
Tetep	72	7.92	10.92
Sonalee/Tetep	72	9.77	8.37
	40 krad		
Sonalee	59	1.95	4.94
Prasad	72	3.24	6.26
Sonalee/Prasad	85	2.57	5.59
IR36	85	3.62	5.31
Sonalee/IR36	70	6.95	7.21
Tetep	81	1.31	1.86
Sonalee/Tetep	70	3.86	4.87

Genetic Evaluation and Utilization
DISEASE RESISTANCE

Reaction of short-duration rice varieties to leaf yellowing

M. Subramanian, A.P.M.K. Soundararaj, and V. Sivasubramanian, Tamil Nadu Rice Research Institute, Aduthurai 612101, India

An unusual epidemic form of leaf yellowing associated with stunted growth in 1984 was identified as tungro virus in interaction with Fe toxicity and H_2S injury. Promising short-duration varieties were screened and rated for resistance to leaf yellowing and stunting: highly resistant, 0-10% affected; resistant, 11-25% affected; moderately resistant, 26-50% affected; susceptible, 51-75%affected; and highly susceptible, 100% affected.

Many of the Tamil Nadu and IET varieties were susceptible; IRRI varieties or cultures IR50, IR52, IR56, IR58, IR62, IR29725-3-1-3-2, IR29725-109-1-2-1, and Sri Lankan BG367-4 were highly resistant (see table). Tamil Nadu entries AD85001, TNAU80058, TNAU801803, and ACM 10 were resistant. IRRI varieties IR30, IR40, IR60, and IR64 were moderately susceptible.

Resistance of short-duration rice varieties to leaf yellowing. Aduthurai, India.

Variety, cultivar	Rating
IR50, IR52, IR56, IR58, IR62, IR29725-3-1-3-2, IR29725-109-1-2-1, and BG367-4	Highly resistant
AD85001, ACM10, TNAU80058, TNAU801774, TNAU801803, TNAU801837, IR28, IR29, IR36, IR13429-150-3-2-1-2, IR14735-52-2-1, IR25924-51-2-3, IR29602-65-2-3, IET7985, and IET8715	Resistant
TKM9, PY3, TM4865, TNAU801790, TNAU801793, TNAU801798, TNAU801801, TNAU801824, TNAU801877, IR30, IR40, IR60, IR18348-36-3-3 (IR64), IR25571-31-1, IR28224-3-2-3-2, KAU1727, IET7984, IET7988, IET7989, IET8052, and IET9267	Moderately resistant
ADT36, AS688, TM8089, AD9246, TM4660, AS25370, AS13744, Cauvery, TNAU (AD) 103, TNAU801776, TNAU801786, TNAU801804, TNAU801807, TNAU801808, TNAU801838, TNAU801846, TNAU83023, TNAU83054, TNAU83068, TNAU83080, TNAU83081, TNAU83095, TNAU83106, TNAU83108, TNAU83113, UPR238-42-2-3, TCA1, UPR254-35-3-2, DPR34-2-1-2, IR9729-67-3, KAU2084, IET1722, IET5961, IET7625, IET7713, IET7721, IET8099, IET8114, IET8122, IET8649, IET8608, IET8893, IET9266, and IET9268	Susceptible
ADT31, Co 33, Co 37, Kannagi, AD24155, TNAU83079, TNAU801870, TNAU83025, TNAU83079, TNAU83082, TNAU83134, IET1444, IET4786, IET7569, IET7727, IET8098, IET8161, IET8191, and IET8686	Highly susceptible

Genetic Evaluation and Utilization
INSECT RESISTANCE

Resistance to whitebacked planthopper (WBPH) at flowering stage

K. S. Kushwaha and R. Singh, H.A.U. Rice Research Station, Kaul 132021, Kurukshetra, Haryana, India

Four fields with Jaya, PR106, and HKR101 transplanted during the first week of Jul 1985 and Pusa 33 transplanted during the last week, with recommended fertilizer, were evaluated for yield losses to WBPH *Sogatella furcifera* attack at flowering. Three healthy and three hopperburned 5 × 4 m patches were harvested and threshed separately. Grain was sun-dried to equal moisture content.

Data showed significant yield losses (see table).

Yield losses caused by whitebacked planthopper in tall and dwarf rice varieties.

Variety	Replication	Healthy patch		Hopperburned patch		Yield loss		
		Yield (t/ha)	Grain moisture (%)	Yield (t/ha)	Grain moisture (%)	t/ha	Average (t/ha)	Percent
Jaya	1	7.9	13.2	4.1	12.2	3.8	2.8	42.4
	2	5.9	12.7	3.6	11.7	2.3		
	3	6.0	13.0	3.7	11.1	2.3		
PR106	1	9.0	13.8	2.4	13.6	6.6	6.6	71.5
	2	9.2	13.9	2.2	13.7	7.0		
	3	9.5	13.8	3.4	13.4	6.1		
HKR101	1	8.5	13.6	1.7	12.5	6.8	6.7	79.8
	2	8.0	14.0	1.6	12.4	6.4		
	3	8.7	13.6	1.8	13.1	6.9		
Pusa 33	1	5.0	13.2	2.4	12.2	2.6	2.6	54.2
	2	4.3	12.9	2.0	12.3	2.3		
	3	5.0	13.3	2.0	12.1	3.0		
F Test		Sig. ***		Sig.***				
S EM ±		0.5		0.2				
CD (P = 0.05)		1.2		0.5				
CV %		0.8		1.6				

Resistance of recommended and traditional varieties to gall midge (GM)

M. N. Ukwungwu, Rice Research Programme, National Cereals Research Institute, Badeggi, P.M.B. 8, Bida, Nigeria

Resistance to rice GM *Orseolia oryzivora* H & G was tested in the field at Edozhigi, Nigeria, during the 1984 wet season. Ten recommended and 10 traditional varieties were planted in four 10-hill rows, 15- × 20-cm spacing, with 3 replications. Susceptible check FARO 13 was planted every 20 rows. Plots were fertilized to induce tillering. Number of onion shoots among total tillers was assessed 45 d after transplanting. The tillers were clipped to induce fresh tillering and reinfestation damage assessed at 25 d after clipping. Rating was by the *Standard evaluation system for rice.*

All entries were damaged (see table). Seven traditional and 3 recommended varieties recorded less than 5% damage.

Gall midge damage at Edozhigi, Nigeria, 1984 wet season.

Variety	Onion shoots[a] (%)	Reaction[b]
	Traditional	
Farin Karuwa	7.3	5
Dan Maizadum	0.6	1
Jan Iri Gari	1.5	3
Babu Rashi	6.4	5
Dan Manu	3.9	3
Dan Sakutaman	16.2	7
Dan Gyanga	1.2	3
Dan Dauda	0.3	1
Abraka Kwambe	5.4	3
Jatau	3.4	3
	Improved	
FARO 15	6.3	5
FARO 27	7.9	5
FARO 29	7.5	5
FARO 11	6.1	5
FARO 8	5.6	5
FARO 7	2.9	3
FARO 14	4.2	3
FARO 26	2.2	3
FARO 19	8.7	5
FARO 13	18.0	7

[a] Mean of 6 replications. [b] Resistance rating where 0 = no damage, 1 = resistant, 3 = moderately resistant, 5 = moderately susceptible, 7 = susceptible, and 9 = highly susceptible.

IET6012 (ACM8) — a promising gall midge-resistant rice culture

S. Jeharaj, G. Soundrapandian, and M.S. Venugopal, Tamil Nadu Agricultural University, Madurai 625104, Tamil Nadu, India

Since 1983, 60 genotypes of rice received from the All India Coordinated Rice Improvement Project have been screened for gall midge (GM) resistance by growing them under unprotected conditions in the endemic area. IET6012, IET7250, and Surekha were found resistant to GM under laboratory and field conditions. IET6012 (ACM8) is a medium-duration variety (120 d) with fine grain and high yield potentials. It has yielded an average of 4.9 t/ ha, 26% more than IR20 (see table). IET6012 (ACM8) was relatively free from GM incidence.

Performance of GM-resistant cultures in Tamil Nadu, India.

Entry	Parentage	Days to 50% flowering	Mean yield (t/ha) under unprotected conditions	Panicle length (cm)	Reaction to GM	
					Greenhouse (0-9)	Field (% silvershoots)
IET6012 (ACM8)	IR8/W1263	88	4.9	19.64	0	Nil
IET7250	RP348/ARC6079	105	4.2	17.72	3	Nil
Surekha	–	113	2.7	21.64	0	Nil
Co 37	TN1/Co 29	89	3.8	20.08	7	27.6
IR20	IR262/TKM6	108	3.9	18.06	7	27.4

Genetic evaluation against rice brown planthopper (BPH) at Cuttack

P.S. P. Rao, Central Rice Research Institute (CRRI), Cuttack, 753006 India

Part of the nearly 20,000 rice germplasm accessions available at CRRI was systematically evaluated in 1975-80 using BPH 1st-instar nymphs mass-reared in the greenhouse. About 700 CRRI accessions (AC), 350 Assam rice collections (ARC), 50 Manipur Rice collections (MNP), 50 Jeypore Botanical Survey Collections (JBS), and 100 others were screened using the free-choice seedling bulk screening technique and scored on the 0-9 scale of the *Standard evaluation system,for rice.*

Of 1,250 rices screened, 59 cultivars and 15 cultures were resistant (see table). Among them are 31 AC, 20 ARC, 1 MNP, 1 JBS, and 6 from other sources. Of these, 12, (ARC14529, ARC14766, ARC14766-A, ARC10550, ARC14342, AC3376, AC3747, Ptb 19, Ptb 21, Ptb 33, T1415, T1426) had been reported resistant in different parts of India. The rest are newly identified potential donors.

Rices identified resistant to BPH at Cuttack.

AC7, AC33, AC34, AC94, AC108, AC131, AC199, AC255, AC357, AC369, AC424[a], AC562, AC577, AC578, AC584, AC592, AC595, AC596, AC600, AC608, AC618, AC1125, AC1165, AC1224,[a] AC1364, AC1373, AC1619, AC1771, AC3090, AC3376, AC3747

ARC1017-6[a], ARC5984, ARC7289, ARC10176[a], ARC10550, ARC12627[a], ARC14342[a], ARC14529[b], ARC14729, ARC14736, ARC14766[b], ARC14766-A[a], ARC14810, ARC15223[a], ARC15228, ARC15284, ARC15821, ARC15831[a], ARC18529

MNP76

JBS770

PTB10, PTB21, PTB33, T1415, T1425, T1426

CR157-392-175, CR57-MR 1523[a], CR94-MR 1550 (white)[a], CR157-393-107, CR157-392-41-112[a], IR2071-636-5-5, IR801-3-5-2, IR2070-439-3-4-3, IR2070-439-6-5, ORSJR 214, CR157-392-11-4, CR157-392-107-175[a], CR157-389-12-90[a], CR157-389-43-120[a], S11-52-626[a]

[a] Damage score of 1.1 to 2.0. [b] Damage score of 0.1 to 1.0.

Breeding japonica lines with brown planthopper (BPH) resistance

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Two BPH resistance genes (*Bph* 1 and *bph* 2) have been introduced from indica into japonica varieties by backcross breeding.

Kanto PL4 inherited the *Bph* 1 gene from Mudgo through F_5 324 (Hoyoku/Mudgo//Kochikaze/3/IR781-1-94/4/Hoyoku). It has a high level of antixenosis similar to Mudgo and shows antibiosis similar to or slightly weaker. Kanto PL4 was registered in 1984 as Rice Norin PL3, a new germplasm of the *Bph* 1 gene, by the Ministry of Agriculture, Forestry, and Fisheries (MAFF).

Kanto PL5 was selected from the cross Asominori/IR1154-243//2* Asominori. The early maturing IR1154-243 was a donor of the resistance gene *bph* 2. Kanto PL5 was registered in 1985 as Rice Norin PL4, the germplasm of *bph* 2.

The antibiosis of Kanto PL5 to BPH biotypes 1 and 2 is similar to or slightly weaker than that of IR1154-243. At every stage of growth, Kanto PL5 shows an inhibitive effect on BPH survival and population increase.

While Kanto PL4, with *Bph* 1, suffers severe damage from BPH biotype 2, the seedling growth of Kanto PL5 is not suppressed by nymphs of biotypes 1 and 2, but is attacked by biotype 3.

Kanto PL4 and Kanto PL5 are promising donors of BPH resistance for Japanese varieties. Lines with *Bph* 3 and *bph* 4 are being developed from Tukushibare/3/Tukushibare*3/Rathu Heenati//Tukushibare and Tukushibare*2/Babawee.

Varietal reaction to thrips

R. Rajendran, Centre for Plant Protection Studies, Tamil Nadu Agricultural University (TNAU), Coimbotore, India

Fifty-one rice cultivars from AICRIP were screened for resistance to thrips *Stenchaetothrips biformis* (Bagnall) in the field in Sep 1985. Each cultivar was planted in a 4-m-long row at 20- × 15-cm spacing. One row of susceptible check TN1 was planted for every 10 cultivars. The experiment was replicated twice and damage was evaluated by counting total leaves and damaged leaves in plants selected at random 30 d after sowing. The mean percentage of infestation was calculated and damage was scored: 0-10% infestation = resistant (R), 11-20% = moderately resistant (MR), 21-50% = moderately susceptible (MS), 51-100% = susceptible (S).

Nine cultivars showed good resistance, with damage ranging from 1.1 to 9.9% (see table). Another 28 exhibited moderate resistance, with damage ranging from 11 to 20%.

Reactions of rice cultivars to thrips, Coimbatore, India.

Cultivar	Infestation (%)	Reaction
IET9705	1.1	R
IET9709	4.1	R
IET9719	5.8	R
IET9711	6.7	R
IET9727	7.6	R
IET9725	8.7	R
IET9723	9.3	R
IET9720	9.8	R
IET9710	9.9	R
IET9724	11.1	MR
IET9278	11.4	MR
IET9718	11.4	MR
IET8654	11.5	MR
IET8653	11.8	MR
IET9726	12.0	MR
IET9293	12.1	MR
IET8891	12.2	MR
IET7575	12.6	MR
IET9722	12.9	MR
IET9281	12.9	MR
IET8362	14.1	MR
IET9266	15.0	MR
IET9721	15.3	MR
Phalguna	15.8	MR
IET8892	16.3	MR
IET9266	16.4	MR
IET9702	16.4	MR
IET9265	16.6	MR
IET9273	16.7	MR
Rasi	17.3	MR
IET9704	17.8	MR
IET8394	18.0	MR

Table continued.

Cultivar	Infestation (%)	Reaction
IET9706	18.1	MR
IET9703	18.4	MR
IET9269	19.6	MR
IET9708	19.8	MR
IET9714	20.1	MR
IET9716	20.9	MS
IET9276	21.0	MS
IET8649	21.3	MS
IET9712	21.4	MS
IET9564	21.5	MS
IET9715	21.8	MS
IET9283	22.2	MS
IET9563	23.0	MS
IET9707	23.4	MS
IET9277	23.4	MS
IET9380	24.7	MS
IET9717	27.4	MS
IET9280	27.8	MS
IET9713	30.0	MS
TN1 check	61.7	S

Sources of resistance to green leafhopper (GLH)

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Heavy populations of GLH *Nephotettix virescens* (Distant) caused hopperburn to rice varieties in Periyar district, Tamil Nadu, in 1984. Using the seedbox screening test in the greenhouse, 50 rice accessions were evaluated for GLH resistance. Ptb 33 was the resistant check and TN1 the susceptible check.

Rices were sown in seedboxes (60 × 40 × 10 cm) in 5 replications. Seven days after sowing, seedlings were thinned to 20/accession and infested with 4 to 5 third instars per seedling. When all plants in the susceptible check died, accessions were rated using the *Standard evaluation system for rice* 0-9 scale.

Ten accessions (AD85001, BG367-4, IET7301, IET7303, IR54, IR58, IR62, IR64, TNAU 80042, TNAU 801793) had damage ratings of 1. IR62 and IR64, which were resistant to GLH, also have high levels of resistance to brown planthopper and whitebacked planthopper.

Genetic Evaluation and Utilization
ADVERSE SOILS TOLERANCE

Selecting for alkali soils

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Severely deteriorated alkali soils of the Indo-gangetic plain, are characterized by high pH (usually more than 9.0), sodicity (exchangeable sodium percentage often exceeding 30), calcium carbonate precipitation, Zn deficiency, and poor physical properties. Groundwater is good.

Progress toward combining superior tolerance with good yield potential is slow, largely because of nonavailability of reliable and efficient selection criteria. Selecting directly for grain yield under edaphic stress is limited by low heritability of observed variation and failure to distinguish between yield potential and capacity to cope with specific stress factors.

For indirect selection for yield ability under alkali soil conditions, 30 rice varieties were studied in specially designed 3 m × 3 m × 1 m test plots with 2 alkali soil grades (pH 9.3 and 9.6) and in nonstress productive soil over 3 seasons. The experiment was laid out in a randomized block design with four replications. N, P, K, and Zn were applied at 150, 26, 33, and 9 kg/ha. Irrigation followed a specified schedule.

Heritability of 12 characteristics of rice varieties grown in alkali (sodic) soils, and their correlation with grain yield and alkali stress resistance index.[a] Karnal, India.

Characteristic	Heritability	Correlation	
		Grain yield	Alkali stress resistance index
Seed germination percentage	30.64	0.14	0.09
Germination rate index	39.81	0.19	0.27
Seedling growth rate	36.25	0.39	0.41
Foliar damage score	45.07	0.37	0.44
Plant height	38.54	0.28	0.29
Vegetative growth rate index	49.86	0.46	0.48
Biomass yield	64.91	0.67	0.71
Panicle-bearing tillers/plot	29.10	0.30	0.29
Grains/plant (no.)	37.29	0.38	0.32
1000-grain weight	35.47	0.41	0.37
Panicle weight	81.10	0.73	0.79
Harvest index	21.17	0.13	0.11

[a] n = 720 (30 varieties, 2 alkali soils, 4 replications, 3 yr). *'r'* value required for 0.01 level of significance = 0.25.

Because grain yield corresponds to product of biomass or total dry matter production (growth rate × growth duration) and harvest index, correlations of 12 characteristics with grain yield under stress conditions *per se* as well as with the "stress resistance index" (average grain yield under stress in relation to corresponding controls taken as one) were computed and variances and heritability of parameters estimated (see table).

Total biomass and panicle weight correlated highly with grain yield under alkali soil conditions as well as with the stress resistance index. A simultaneous consideration of correlation coefficients and heritability estimates of different traits showed that indirect selection for grain yield in alkali soils via panicle weight and biological yield (cf. harvest index in case of high productivity environment) was likely to be effective.

The product of a variety's yield response index (computed by dividing the particular variety's grain yield by overall mean yield of all varieties under all stress environments) and its stress resistance index provided a more useful index for measuring varietal ratings (rankings) than either index alone.

Genetic Evaluation and Utilization
DEEP WATER

A simple technique for measuring internode elongation of deep water rice

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There are two problems in measuring elongation ability of deep water and floating rice.

Measurement is best some 70 d after broadcast seeding, but this requires fairly deep tanks. But for savings in time and water, most tests are carried out at 30 d after seeding, and in water no more than 100-150 cm deep.

In genetics work, it is essential to do progeny tests on all individuals, including those found unable to elongate. Plants in the latter category, however, are destroyed in all current tests.

We tested a new approach to elongation testing by forcing test plants in a horizontal position, except for their upper parts.

Six varieties were selected: TCA4, TCA177 (floating rice), Janki (deep water rice, submergence tolerant), IR11141-6-1-4 (modern deep water rice variety, elongation ability), IR42 (MV rice), and Lal Dhan (tall traditional rice).

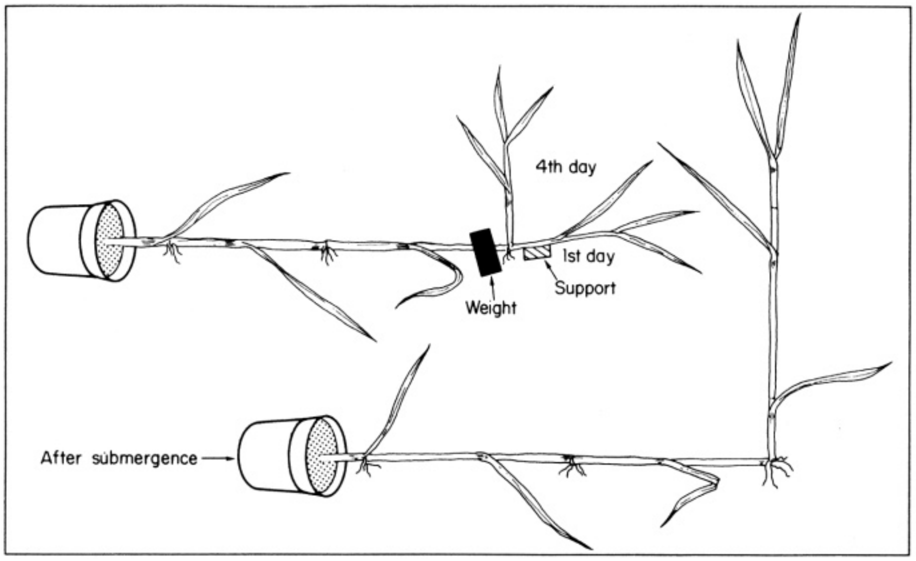
Five 8-wk-old plants of each variety were grown in small (5- × 5-cm) plastic pots. Only the main tillers were maintained. Plants were placed horizontally in trays, and a weight was applied at the uppermost node and a support ventrally under this node (see figure), to stimulate vertical growth of the upper portion of the plant.

Four days after treatment, TCA4, TCA177, Janki, and IR11141-6-1-4 showed excellent kneeing, while IR42 and Lal Dhan were not able to knee, possibly because of the absence of sufficiently developed internodes.

Plants were then submerged for 6 d, initially keeping the leaves partly above the water. IR42 and Lal Dhan had no internode elongation at all, but the other varieties developed two internodes while partially submerged, with the first internode being smaller. TCA4 had the longest average total internode elongation of 34.6 cm/plant, followed by TCA177 (32.6 cm). Janki elongated 12.4 cm and IR11141-6-1-4 had 10.4 cm total elongated internodes.

This method has the following advantages: it minimizes the need for deep flooding to induce elongation, it does not destroy any entry, and it allows scoring (in cm internode length) on a continuous scale between no elongation and very good elongation.

We will evaluate this method for use in elongation genetics work.



Sketch of horizontally placed plant, with top part being forced to grow vertically.

Genetic Evaluation and Utilization
HYBRID RICE

Relation of cross seed set and fertility in rice hybrids

R.N. Kaw, IRRI; and H.P. Moon and J.D. Yae, Crop Experiment Station (CES), R.D.A. Suweon and Chuncheon, Korea, respectively

While breeding for cold tolerance at IRRI, crosses were made with nine japonica and eight indica (including two indica-type derivatives of indica/japonica crosses) cold-tolerant female parents from diverse sources, and six improved plant type, high yielding indica IRRI lines as pollen parents. The cross seeds per panicle and per cross were recorded. Varying degrees of sterility were indicated by seed set of the cross combinations. We tried to find out if the seed set in 102 cross combinations was related to the fertility of the F_1 hybrids.

A total of 299,539 spikelets were emasculated in Feb-Apr 1984 and pollinated using 6 pollinators: 50,864 with IR8866, 48,001 with IR8455-K2, 48,666 with IR15889, 51,439 with IR7167, 48,253 with IR29506, and 52,316 with IR9202. Total seed set was 165,000.

To determine F_1 fertility, 102 hybrids were grown in different environments: in the experimental field, in pots in the screenhouse and in the concrete bed at IRRI, and at CES, Chuncheon, in the 1984 rice growing season. Twenty seedlings of each F_1 were transplanted in single-plant hills, with 25 cm between plants and rows in the field and in the concrete bed, and 5 seedlings in the pots. The main culm panicle of each plant was harvested and placed in a separate envelope shortly before full maturity to avoid shattering. Spikelet fertility was measured in one panicle per plant, for a maximum of 15 F_1 plants/ hybrid combination in Chuncheon, 10 plants in the field and the concrete bed, and 5 plants in pots at IRRI.

The table summarizes the seed set and F_1 fertility data by common indica male parent. The overall mean cross seed set ranged from 53.3% in IR7167 array to 58.8% in IR29506 array with an overall mean of 55.8%. Samgangbyeo and K332 represented the extremes in cross seed set with means of 78.4% and 39.6% among the female parents. Samgangbyeo was followed by Silewah, ARC6000, Shoa-Nan-Tsan, Suweon 287, all indica types. The highest mean F_1 fertility was also recorded in Samgangbyeo (80.2%),

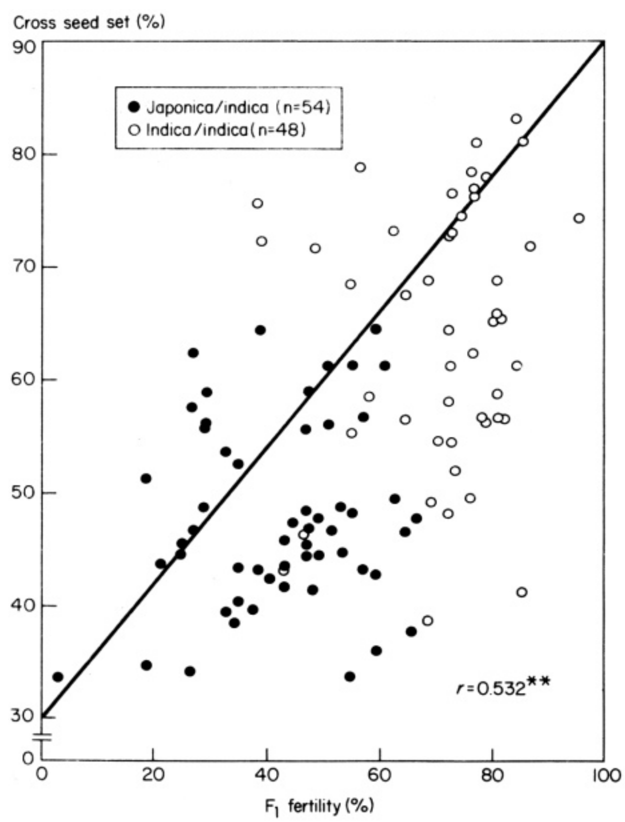
Mean cross seed set and fertility of the F_1 hybrids.

Female parent	Male parent: IR8866 Seed set (%)	IR8866 Fertility (%)	IR8455-K2 Seed set (%)	IR8455-K2 Fertility (%)	IR15889 Seed set (%)	IR15889 Fertility (%)	IR7167 Seed set (%)	IR7167 Fertility (%)	IR29506 Seed set (%)	IR29506 Fertility (%)	IR9202 Seed set (%)	IR9202 Fertility (%)	Mean Seed set (%)	Mean Fertility (%)
Indica group [a]														
Suweon 287 (I/J)	76.4	73.1	61.3	72.5	65.3	81.5	58.5	73.2	65.1	80.3	54.8	73.5	63.6	75.7
Samgangbyeo (I/J)	78.0	79.1	83.1	84.2	80.8	76.7	68.7	79.2	78.6	76.3	81.1	85.6	78.4	80.2
China 988	41.5	85.8	56.6	82.1	56.6	64.9	46.4	66.1	65.8	82.0	62.2	76.9	54.9	76.3
K39-96	56.5	79.9	52.0	73.7	49.7	76.2	43.3	72.8	74.3	95.6	57.7	81.5	55.6	80.0
Leng Kwang	58.1	72.4	48.1	72.2	49.2	69.6	55.3	74.5	61.2	84.2	38.9	69.0	51.8	73.7
Shoa-Nan-Tsan	68.8	81.0	76.2	77.2	64.5	72.9	62.4	73.7	70.2	86.8	54.8	70.4	66.2	77.0
Silewah	72.0	48.3	75.8	38.5	78.8	56.4	74.8	57.0	78.3	56.8	68.6	55.3	74.7	52.1
ARC6000	73.0	61.6	72.9	72.9	72.4	39.4	76.9	87.3	67.6	62.3	72.7	72.7	72.6	66.0
Mean	65.5	72.6	65.7	71.7	64.7	67.2	60.8	73.0	70.1	78.0	61.4	73.1	64.7	72.6
Japonica group														
Suweon 235	45.6	25.5	43.7	43.1	47.3	44.4	45.3	47.1	48.9	53.8	37.8	65.9	44.8	46.6
SR5204-91-4-1	64.3	38.1	56.6	28.1	55.7	46.4	58.9	46.9	64.7	59.1	60.1	60.7	60.1	46.7
SR3044-78-3	46.7	27.0	52.7	34.5	44.7	46.8	40.6	42.7	44.8	53.9	49.3	63.1	46.5	44.7
Barkat	57.1	27.3	58.8	30.0	53.9	32.6	56.0	29.7	48.6	47.1	44.6	49.2	53.2	36.0
K332	43.9	21.7	34.8	18.0	34.3	26.1	39.7	33.3	41.7	43.0	42.9	59.2	39.6	33.6
Shimokita	43.0	38.6	48.8	28.6	41.3	47.8	39.9	37.7	33.9	54.6	46.0	59.5	42.2	44.5
Stejaree 45	42.3	40.6	44.9	24.9	43.2	57.0	43.3	34.6	48.1	55.6	47.7	66.2	44.9	46.5
Anna	33.7	3.7	51.4	18.9	40.4	35.5	38.6	35.5	46.7	47.7	46.7	51.9	42.9	32.2
K84	47.8	48.9	62.3	26.9	61.2	51.2	56.8	45.0	61.6	55.1	46.6	64.3	56.1	48.6
Mean	47.2	30.2	50.4	28.2	46.9	43.1	46.6	39.2	48.8	52.2	46.9	60.0	47.8	42.2
Overall mean	55.8	50.2	57.6	48.6	55.3	54.4	53.3	55.1	58.8	64.4	53.7	66.2	55.8	56.5

[a]I/J = indica type derivatives of indica/japonica crosses.

followed by K39-96, Shoa-Nan-Tsan, China 988, and Suweon 287, all indica types. Anna had the lowest mean fertility (32.2%); K332, Barkat, Shimokita, and SR3044-78-3, all japonica types, followed in that order.

The figure shows the relation between cross seed set and F_1 spikelet fertility for the 102 cross combinations. The highly significant and positive association and the scatter of points suggest that japonica/indica cross combinations with a certain range of low seed set also had low F_1 fertility. and indica/indica combinations having a higher range of seed set also produced hybrids with high fertility. Thirteen of the 102 hybrids had approximately normal F_1 fertility (>80%) with K39-96/IR29506 showing 95.6% fertility, but only 3 combinations — Samgangbyeo/IR8455-K2, Samgangbyeo/IR9202, and Samgangbyeo/IR15889 — had more than 80% cross seed set, all in the indica/indica group. The low and



Relation between cross seed set and fertility of F_1 hybrids. IRRI and Korea, 1985.

variable range of seed set in the indica, indica/japonica, and japonica lines in crosses with indica pollinators may have been due to some genetically controlled incompatibility system, depending upon the degree of affinity between the parental varieties used in this study. Such a system has been reported to explain the intervarietal hybrid sterility in rice.

Diversification of cytoplasmic male sterility in rice

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Segregating lines of crosses between varieties of diverse origin were examined for male steriles occurring naturally.

In six of the seven male steriles isolated, sterility was found to be genetic. Cytological studies of these genetic male steriles showed regular meiosis, indicating pollen abortion in postmeiotic stages.

The other male sterile plant isolated from the F_2 of Ratna/Rajai had multiple pistils and whitish rudimentary anthers. This plant was propagated through stubbles and crosses were made. Spikelet fertility in the F_1s showed three classes of F_1 — completely sterile, partially fertile, and fertile — indicating that male sterility is conditioned by cytoplasmic-genetic factors.

Crosses were made with high yielding donors for resistance to disease and stress. In the F_1 hybrids, most varieties had varying fertility restoration ability. Maintainers of sterility were less common. Of the 40 hybrid combinations studied, only IET4699 and Surekha were identified as maintainers. Ratna, Kalinga III (CR237-1), and IET7302 were strong restorers. Utkal Prava (CR1030), Ta-poo-che-ze, and Rasi were weak maintainers.

Backcrosses with IET4699 and Surekha were made to transfer cytoplasmic sterility into their nuclear background.

Heritability of compact panicle and stigma color

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Heritability of compact and lax panicle was examined in the F_1 and F_2 of a cross of Dee-gee-woo-gen (lax) and BU-I (compact).

BU-I is a mutant isolated from X-ray irradiated NC1626. The compact panicles of this mutant have fewer secondary branches and shorter pedicel, resulting in closely attached spikelets. The primary branches also are closely attached with the main axis of the panicle.

The F_1 hybrids had intermediate panicles, resembling the female parent Dee-gee-woo-gen. The F_2 plants showed 3 distinct panicle types: compact (like BU-I): intermediate (like F_1); and lax (like Dee-gee-woo-gen), in a 1:2:1 ratio (Table 1). This indicates that this panicle character is controlled by a partially dominant gene.

To study stigma color, three strains (BJ-I, CRM6-5-90, BU-3) with black stigma and two strains (Dee-gee-woo-gen, IR8) with white stigma were crossed in these combinations: Dee-gee-woo-gen/BJ-I, Dee-gee-woo-gen/BU-3, IR8/CRM-6-5-90, and IR8/BU-3.

In the F_1, all hybrids had black stigma. F_2 plants had black and white stigma in a 3:1 ratio (Table 2). This indicates black stigma is controlled by a apiculus color.

Table 1. Chi-square analysis of F_2 of Dee-gee-woo-gen/BU-I for compact panicle. West Bengal, India.

Panicle trait	Frequency	x^{2a}	Ratio
Lax	117		
Intermediate	237	1.696	1:2:1
Compact	102		

[a] d.f. = 1 at 5% level = 3.841 ; at 1% level = 6.635.

Table 2. Analysis of F_2 of 4 crosses for stigma color. West Bengal, India.

Cross	Stigma color	Frequency	x^{2a}	Ratio
Dee-gee-woo-gen/BJ-I	Black	440	0.349	3:1
	White	155		
Dee-gee-woo-gen/BU-3	Black	232	0.068	3:1
	White	80		
IR8/CRM	Black	910	0.444	3:1
	White	290		
IR8/BU-3	Black	256	0.004	3:1
	White	84		
Pooled	Black	1633	0.325	3:1
	White	529		

[a] d.f. = 2 at 5% level = 5.991.

Root systems in hybrid rice

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Chinese scientists reported that strong and active root systems efficiently used applied fertilizers in hybrid rice. We studied the root system of hybrid rice by the root pulling force method developed at IRRI. The method assumes a correlation between the force required to pull seedlings or plants and strong, deep root systems which may confer drought tolerance. The results indicated that F_1 hybrids were significantly superior in root pulling force to their parents and check

Table 1. Root pulling force of hybrids. their parents, and check varieties. 1983 summer.

Hybrid, variety	Root pulling force (kg)
F_1 hybrids	
V20A/IR50	24.05*
V20A/IR54	25.15*
Z97A/IR50	23.98*
Z97A/IR54	25.10*
297A/IR2307-247-2-2-3	22.90*
Z97A/IR13420-6-7-3-1	24.95*
Mean	24.36
Parents	
IR50	18.15
IR54	22.95
IR2307-247-2-2-3	17.90
IR13420-6-3-3-1	19.43
V20B	14.95
Z97B	17.15
Mean	18.43
Checks	
CR44-35	17.18
Sita	21.43
Mean	19.31
CD at 5%	1.23

varieties (Table 1). The highest root pulling force of 25.15 kg was for V20A/IR54, followed by 25.10 kg for Z97A/IR54 and 24.95 kg Z97A/IR13420-6-7-3-1.

All F_1 hybrids showed positive heterosis, heterobeltiosis, and standard heterosis for root pulling force (Table 2). Highest heterosis and heterobeltiosis values were observed in V20A/IR50 and maximum standard heterosis value in Z97A/IR13420-6-7-3-1. A strong, deep, and active root system in hybrid rice may also have potential for its adaptation in rainfed uplands and lowlands.

Table 2. Expression of heterosis, heterobeltiosis, and standard heterosis for root pulling force. 1983 summer.

Hybrid	Heterosis (%)	Heterobeltiosis (%)	Standard heterosis (%)
V20A/IR50	44.9	32.5	40.0
V20A/IR54	33.1	9.6	17.4
Z97A/IR50	35.5	32.1	39.6
Z97A/IR54	24.9	9.4	17.1
Z97A/IR2307-247-2-2-3	30.9	21.9	33.3
Z97A/IR13420-6-7-3-1	36.4	28.4	45.2

Isolation of fertility restorers and maintainers for cytoplasmic genetic male sterile line

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Development of hybrid rice is possible only if the effective fertility restorers for cytoplasmic genetic male sterile (CMS) lines are identified or developed. Isolation of maintainers for CMS lines is necessary for the development of new CMS lines.

We used the Chinese CMS line V20A as common female parent in crosses with standard varieties and elite breeding lines. Percent spikelet fertility of F_1 hybrids was used as fertility index. Lines that restored 80% or more spikelet fertility were classified as complete restorers, those restoring between 20% and 79% fertility were partial restorers, and those with less than 20% were classified as maintainers (see table).

List of complete restorers, partial restorers, and maintainers identified for CMS line V20A at Agricultural Research Institute, Patna, India, 1984.

Complete restorers	Partial restorers	Maintainers
CR289-1208	CR407-6-2	ADT30
CR75-93-Mut. 11-4	CR401-7	Bala
IR9703-4-1-3-3-1	CR167-7	CR407-19
IR2307-247-2-2-3	CR157-22-1900	CR200-788-3
Madhu	IR60	Dhaneshwar
	Pusa 205-15-1	Jikoku Sernai
	RP1451-2266-55-22	MR365
	RP732-26-2	Pusa 2-21
		Ramchure

Genetic Evaluation and Utilization
OTHER PESTS

Reaction of rice varieties to root nematode *Hirschmanniella* spp. in the field

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Seventeen rice varieties were evaluated for resistance to root nematode. The average initial population of *Hirschmanniella* spp. extracted from soil samples of the experimental field before planting was 145 nematodes/300 cc soil.

Each test variety was seeded and transplanted into 3 rows at 25- × 25-cm spacing, 10 hills/row.

At 60 d after transplanting, the final population of nematodes was extracted from soil taken from around the root zone in the middle row of each variety.

Reaction for each variety was determined by the ratio of final population to initial population. Five varieties showed resistance to *Hirschmanniella* spp. in the field: Kao Paung Klang, Kao Paung, Kao Tah Jue, Kao Yaun, and Kao Klang Pee (see table).

Field reaction of rice varieties to *Hirschmanniella* spp. Patumthani Rice Research Center, Thailand.

Variety	Nematodes [a] (no./300 cc soil)	*Pf/Pi* [b]	Reaction [c]
Kao Paung Klang	224 a	1.54	R
Kao Paung	237 a	1.63	R
Kao Tah Jue	254 a	1.75	R
Kao Yaun	258 ab	1.78	R
Kao Klang Pee	288 ab	1.98	R
RD9	319 a	2.20	I
Tah Lee	322 ab	2.22	I
Mali Thong	351 abc	2.42	I
Kao Tah Ex	390 abc	2.69	I
Tah Chue	438 abc	3.02	I
IR45	530 abc	3.65	I
Kao Nam Kem	579 abc	3.99	I
TN1	707 bc	4.87	I
Kao Kun Na	785 abc	5.41	S
Kao Pla Lai	896 bc	6.17	S
IR26	1012 c	6.97	S
Kao Ko Dew	1524 c	10.50	S

[a]Av of 4 replications. [b] *Pf* = final population at 60 d after transplanting, *Pi* = initial population. [c] Based on *Pf/Pi:* R = < 2.0, I = 2.1 - 5.0, and S = > 5.0.

Pest Control and Management
DISEASES

Bacterial sheath brown rot (BSBR) in Latin America

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In rice, disease symptoms identical to those of BSBR, caused by *Pseudomonas fuscovaginae,* have been observed in Guatemala, Panama, Colombia, Surinam, Peru, and Brazil for 10 years. Symptoms include 2-5 mm wide longitudinal brown necrosis of the sheath, sometimes extending its full length. In some cases the lesions extend to the leaf margin or midrib, producing a pronounced stripe (see figure). All leaves of a tiller may be affected.

On some varieties, symptoms are more diffuse, resulting in a brown to maroon blotching with no apparent leaf blade symptoms. The sheath margin often withers. When the flag leaf sheath is affected, water-soaking may occur.

Preemergence and postemergence panicles from affected flag leaf sheaths invariably show substantial glume discoloration with severely discolored often unfilled grains. Panicles may not emerge completely from affected sheaths.

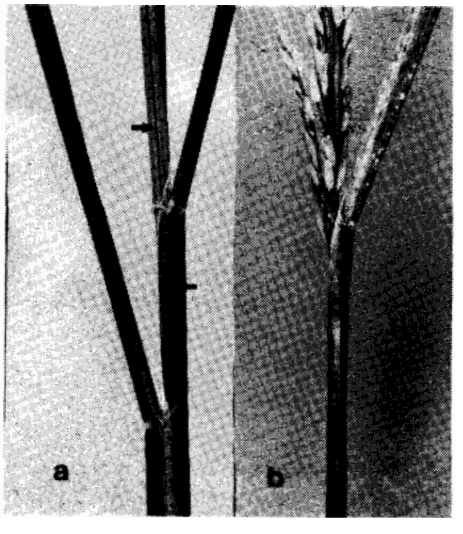
A rodshaped, multiflagellate (polar) bacterium producing fluorescent pigments on King's B medium was consistently isolated from plants exhibiting these symptoms. Inoculating healthy plants grown from healthy, heat-treated seed with the isolates reproduced the symptoms. Subsequent characterization and pathogenicity tests showed the pathogen to be indistinguishable from *Pseudomonas fuscovaginae.*

When inoculated on 15- and 40-d-old plants, isolates formed longitudinal necrotic lesions, blotched sheaths, and discolored seed and induced longitudinal necrosis in sheath and leaves. When inoculated on plants in the boot stage by leaf-clip or stem injection, the same isolates induced sheath blotching and severe grain discoloration without longitudinal necrosis.

Some varieties apparently recovered following inoculation, with leaf symptoms diminishing on new leaves as they emerged. However, even when the boot was symptomless, the panicle emerged with discolored grain, from which the pathogen could be reisolated. Similar cases have been observed in farmers' fields.

Seed from plants showing glume discoloration, washed and incubated on King's B medium, yielded the pathogen. Up to 100% of the seed from affected plants yielded fluorescent bacteria. When discolored seed was planted without prior breaking of dormancy with dry heat, seedlings showed symptoms within 30 d of emergence.

The pathogen also was consistently recovered from symptomless leaves prior to symptom expression. Severely affected seedlings died, but most survived to flowering. Seed



a) Necrotic stripe symptoms caused by *P. fuscovaginae.* b) Discoloration and necrosis of sheath caused by *P. fuscovaginae.* CIAT, Cali, Colombia. Necrosis extends to the margin of the flag leaf. Note similarity to sheath rot caused by *Sarocladium oryzae (Acrocylindrium).*

transmission exceeded 75% in some experiments.

Results of experiments to evaluate heat therapy's ability to eradicate the pathogen from infected seed are presented in the table. Moderate dry heat therapy substantially reduced pathogen recovery from seed, but 65°C for 6 d was required to completely eradicate it. No deleterious effect on germination was detected by even higher heat treatment (70° C, 6 d).

Although this is the first report of sheath rot and grain discoloration caused by *Pseudomonas* spp. in Latin America, BSBR has probably been in the region for some time. BSBR has been reported in Japan and in high-altitude rice in Burundi, East Africa. A disease with identical symptomatology, but attributed to an unidentified bacterium, has been reported in southern Brazil (bacterial brown stripe). Reports of dirty panicle, glume discoloration, and manchado de grano have been increasing around the world.

The striking similarity between the sheath symptoms described and those attributed to *Sarocladium oryzae* (sheath rot), combined with the difficulty researchers often encounter reisolating *S. oryzae* from the grain, suggest that symptoms attributed to the fungus in some cases may be caused by *P. fuscovaginae.* In Colombia, symptomatology and the association of this bacterium with dirty panicle suggest that it is among the primary causal agents.

CIAT has detected the pathogen in seed received in routine international germplasm exchanges from Asia and Africa. At CIAT, all seed received from and seed sent to national and international programs is treated with dry heat at 65° C and monitored to ensure that it is free of the bacterium.

Effect of heat treatment on recovery of *P. fuscovaginae* from spotted seed of 2 varieties.[a] CIAT, Cali, Colombia

Temperature (°C)	Recovery of P. fuscovaginae					
	1 d		3 d		6 d	
	Infected seed (no.)	Total seed (no.)	Infected seed (no.)	Total seed (no.)	Infected seed (no.)	Total seed (no.)
			CICA8			
55	107	396	235	418	24	333
60	153	591	56	443	9	350
65	22	584	2	227	0	401
Control (untreated seed)	233	339	235	396	280	431
			Oryzica 1			
55	102	421	105	338	12	374
60	47	377	38	369	5	234
65	18	375	12	375	0	403
Control (untreated seed)	318	400	115	327	115	383

[a] Infection identified by pathogenic fluorescent bacteria on King's B medium.

In vitro response of maize and rice isolates of *Rhizoctonia solani* to antibiotics and fungitoxicants

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We tested the effect of two antibiotics and five fungitoxicants on *Rhizoctonia solani* f. sp. *sasakii* using the food-poison technique and maize (R_1) and rice (R_6) isolates. Radial growth was measured at 24-h intervals.

Carbendazim, benodanil, and thiabendazole at 25-30 µg ai/ml completely inhibited growth of both isolates and showed fungistatic effects (see table). Both isolates were less sensitive to thiophanate-M, dichloroline, and aureofungin. Isolate

Fungitoxicant and antibiotic effect on radial growth of 2 *R. solani* isolates in vitro.[a]

Fungitoxicant, antibiotic	Concentration (µg/ml)	Growth reduction (%)	
		Maize isolate	Rice isolate
Validamycin A	30.0	24.0	22.0
	36.0	24.5	24.5
	45.0	27.0	22.0
Aureofungin	3.0	39.5	56.0
	6.0	41.0	45.3
Benodanil	25.0	100.0	100.0
	37.5	100.0	100.0
	50.0	100.0	100.0
Carbendazim	25.0	100.0	100.0
	31.5	100.0	100.0
	50.0	100.0	100.0
Dichloroline	30.0	30.0	42.0
	60.0	30.0	39.0
	120.0	33.0	39.0
Thiabendazole	30.0	100.0	100.0
	45.0	100.0	100.0
	60.0	100.0	100.0
Thiophanate-methyl	35.0	100.0	45.0
	56.5	100.0	32.0
	70.0	100.0	30.0

[a]Av of 3 replications.

R_1 was more sensitive to thiophanate-M than was isolate R_6.

A special effect was observed with validamycin-A (30% EC, Takeda Chemical Industries Ltd., Japan). Radial growth of *R. solani* was restricted, resulting in the formation of an atypical colony.

In an additional test, benodanil, carbendazim (5, 10, 15, 20 μg ai/ ml), and thiobendazole (3, 6, 9, 12, µg ai/ml) inhibited growth of 4 maize isolates (R_1-R_4) and 2 rice isolates (R_5-R_4).

Serological identification of tungro viruses in isolates from 4 states of India

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We collected tungro isolates from Coimbatore and Aduthurai, Tamil Nadu; Cuttack and Simliguda, Orissa; Patna and Pusa, Bihar; and Barrackpore, Burdwan, Malda, and Hooghly, West Bengal, and inoculated them into 15-d-old Jaya seedlings. For serological identification, different isolates preserved under insect-proof conditions were inoculated to 20-d-old Taichung Native 1 (TN1) seedlings at 5 leafhoppers/plant. One week after inoculation, the second leaf of each seedling was crushed in a pestle and mortar with 1 ml of Tris buffer (0.05 M)/10 mg leaf tissue. After homogenation, the sap was refrigerated 1/2 h to settle host particles. The supernatant sap (50 µl) mixed with an equal amount of latex suspension sensitized with antisera to RTBV or RTSV was rigorously shaken for about 1 h.

One drop of this suspension was observed under a microscope (100 ×) and scored based on clumping of latex particles.

A positive reaction for both RTSV and RTBV was found in all isolates, indicating that these two viruses are involved in causing tungro epidemics in India.

Horizontal and vertical spread of rice sheath blight (ShB)

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Horizontal and vertical development of ShB has been documented, but little is known about disease spread from a single inoculated spot in a field. Highly susceptible Lebonnet was drill-planted in 2.3- × 3.7-m plots with 4 replications. At 20 cm between rows, plant population was 3,500,000/ha.

One plant per plot was inoculated at floodwater level with 1-10 pregerminated (in water agar for 12 h) sclerotia. Horizontal and vertical ShB progression were recorded in centimeters and number of infected leaf sheaths at 5-d intervals starting 7 d after inoculation. Five plants within and next to the hill with the inoculated plant were used to measure vertical ShB development.

All sclerotia initiated infection on the inoculated plant. Horizontal and vertical ShB spread increased from 7 to 22 d after inoculation (DI) (Table 1, 2). The spread was faster from row to row than within row. But the increase was larger within row. At 22 DI, horizontal ShB development reached 93.3 cm within row for some treatments and 90.0 cm between rows.

Inoculum number had no significant effect on spread. All treatments were similar in causing and spreading ShB. It is not clear why the spread from row to row was faster than within row.

Table 1. Horizontal spread of ShB within row. [a]

Sclerotia (no./plant)	Distance[b] (cm) from point of inoculation			
	7 DI	12 DI	17 DI	22 DI
0	0 a	0 a	0 a	0 a
1	0 a	3.2 ab	8.5 ab	22.0 a
2	0.5 a	2.2 a	9.2 ab	37.2 abc
3	0 a	4.5 ab	11.2 abc	18.5 a
4	0.5 a	3.7 ab	14.7 abcd	27.3 ab
5	0 a	1.5 b	6.3 ab	14.5 a
6	0 a	15.3 b	33.8 cd	86.0 bc
7	0.5 a	5.2 ab	19.5 abcd	41.0 abc
8	0.5 a	7.7 ab	23.7 abcd	48.8 abc
9	0.5 a	7.3 ab	29.3 bcd	82.5 bc
10	0.8 a	15.5 b	31.2 d	93.3 c
CV	47.1	25.3	20.3	20.5

[a] Means with the same letter are not significantly different by the Duncan-Waller multiple range test. DI = days after inoculation. [b] 3-yr means (1980-82).

Table 2. Horizontal (H, between rows) and vertical (V) spread of ShB.[a]

Sclerotia (no./plant)	Distance[b] (cm) from point of inoculation							
	7 DI		12 DI		11 DI		22 DI	
	H	V	H	V	H	V	H	V
0	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
1	6.7 b	0.3 b	16.7 b	1.3 b	23.3 a	2.2 bc	26.7 b	3.2 b
2	20.0 c	1.0 bcd	23.3 b	1.5 bc	33.3 ab	2.7 bc	50.7 c	3.5 b
3	13.3 bc	0.7 ab	23.3 b	2.0 bc	30.0 ab	3.2 c	43.3 bc	3.5 b
4	16.7 c	0.8 bc	26.7 bc	1.8 bc	33.3 ab	2.7 bc	50.0 bc	3.5 b
5	13.3 bc	0.7 ab	23.3 b	1.5 bc	40.0 abc	2.0 b	50.0 bc	2.8 b
6	20.0 c	0.7 ab	36.7 cd	1.7 bc	63.3 d	2.5 bc	90.0 d	3.0 b
7	16.7 c	0.8 bc	23.3 b	2.0 bc	46.7 abcd	3.0 c	66.0 cd	4.0 b
8	20.0 c	1.0 bcd	40.0 d	1.7 bc	38.3 ab	3.8 bc	70.0 cd	4.0 b
9	20.0 c	1.3 d	36.7 cd	2.0 bc	53.3 bcd	3.0 c	63.3 cd	3.7 b
10	20.0 c	1.2 cd	40.0 d	3.2 c	60.0 cd	3.2 c	55.7 c	3.5 b
CV	34.6	40.3	34.2	36.7	45.6	29.7	42.6	30.0

[a] Means with the same letter are not significantly different by the Duncan-Waller multiple range test. [b] 3-yr means (1980-82).

Chemical control of brown spot (BS) and sheath rot (ShR) in Tamil Nadu

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To test the efficiency of seven fungicides and three spraying schedules against BS and ShR, a trial with IR20 was laid out in factorial randomized blocks with three replications. Spray schedules were a) 3 on 30, 50, and 70 d after transplanting (DT), b) 2 on 40 and 70 DT, c) need-based, given whenever disease level exceeded grade 3 on the *Standard evaluation system for rice* The disease level exceeded grade 3 at 77 DT.

Final disease evaluation was taken on 20 samples a week before harvest. Disease severity (DS) was calculated as:

$$DS = \frac{\text{sum of all numerical ratings} \times 100}{\text{leaf or plant no.} \times \text{maximum scale grade (9)}}$$

and arcsine transformation was used for statistical analysis.

Table 1. Chemical control of BS and ShR on IR20. Tamil Nadu, India.

Chemical	Disease severity[a] (%)		Grain yield (t/ha)
	BS	ShR	
Carbendazim 0.1%	25.4 (30.2)	31.0 (33.8)	4.2
Isopruthiolane 0.1%	27.6 (31.7)	31.3 (34.0)	4.2
Captafol 0.125%	28.1 (32.0)	29.3 (32.8)	4.3
Thiophanate 0.1%	31.8 (34.3)	36.2 (37.0)	4.0
IBP 0.1%	26.1 (30.7)	30.9 (33.7)	4.1
Copper oxychloride 0.25%	32.3 (34.6)	34.5 (36.0)	3.9
Ziram-L 0.3%	33.9 (35.6)	37.9 (38.0)	3.9
No spray	44.3 (41.7)	48.9 (44.4)	3.6
CD (P = 0.05)	1.2	1.1	0.3

[a]Figures in parentheses are transformed values.

Table 2. Spraying schedule and control of BS and ShR on IR20. Tamil Nadu, India.

Spraying schedule	Disease severity[a] (%)		Grain yield (t/ha)
	BS	ShR	
30-50-70 DT	28.7 (32.4)	32.7 (34.9)	4.1
40-70 DT	31.7 (34.3)	35.1 (36.3)	4.0
At need (77 DT)	32.7 (34.9)	36.9 (37.4)	4.0
CD (P = 0.05)	0.7	0.7	0.2

[a]Av of 7 treatments with different chemicals. Figures in parentheses are transformed values.

The interaction between chemicals and spray schedules was not significant. Captafol 0.125% had the lowest ShR seventy (29.3%) and maximum yield. (4.3 t/ha) (Table 1). Carbendazim 0.1% had the lowest BS severity, 25.4%. Yields were not significantly different.

Spraying 30, 50, and 70 DT controlled disease severity the best (Table 2). Differences in yield were not significant.

Reaction of tungro (RTV) isolates on Taichung Native 1

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Five RTV isolates from Aduthurai (Tamil Nadu). Pusa (Bihar-). Cuttack (Orissa) and Malda and Hooghly (West Bengal) were collected and maintained on rice cultivar Jaya. Twenty 15-d-old TN1 seedlings were inoculated with each isolate at 1 and 5 leafhoppers/seedling. In another experiment, 20-d-old TN1 seedlings were inoculated with each isolate at 5 insects/seedling. The seedlings were transplanted in galvanized iron trays. Percentage of reduction in plant height and tiller number were measured 60 d after inoculation. Plants with typical symptoms were selected for each isolate and serologically indexed for virus infection.

RTBV (bacilliform) and RTSV (spherical) particles were present in all plants infected with each isolate. There was not much difference in infection at 1 and 5 leafhoppers per plant, except in the Malda isolate, which had lower infection (see table). The isolates from Pusa and Cuttack caused more severe stunting and reduced the number of tillers. Stunting and tiller reduction were less in the Aduthurai isolate. The Hooghly and Malda isolates showed intermediate stunting. The isolates have been tentatively designated RTV-1 (Aduthurai), RTV-2 (Pusa and Cuttack), and RTV-3 (Hooghly and Malda).

Reaction of TN1 to infection with RTV isolates. Cuttack, India.

	Leafhoppers (no.) used for inoculation	Reaction (%) to RTV isolates				
		Pusa	Aduthurai	Cuttack	Hooghly	Malda
Infection	1	75	83	70	78	48
	5	100	100	100	100	100
Stunting	5	94	28	82	43	35
Reduction in tiller number	5	98	27	92	67	50

Nonrice hosts of the causal agent of bacterial sheath brown rot (BSBR) in Latin America

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BSBR, caused by *Pseudomonas fuscovaginae,* is characterized by brown to maroon blotchy lesions on leaf sheaths and boot. When the boot is affected, panicles may emerge poorly. Grain is frequently discolored and may be poorly filled. The pathogen has been closely linked to discoloration (*manchado de grano,* dirty panicle) in Latin America and may be a primary causal agent of a problem with an unclear etiology.

Pseudomonas fuscovaginae is seedborne and seed-transmitted. Seed treatment at 65° C dry heat for 6 d eradicates it from most samples. This is a useful method to ensure the health of experimental and breeder seed. If breeder or foundation seed is treated, with no subsequent re-infection, the following generations should remain clean.

Pseudomonas fuscovaginae is closely related to *P. marginalis* and may infect a range of nonrice hosts. At least eight graminaceous hosts of *P. fuscovaginae* have been reported in Japan. A wide host range, combined with alternative means of plant-to-plant spread, could confound control measures based only on clean seed.

To determine if potential nonrice reservoirs of *P. fuscovaginae* exist in the flora of tropical America, controlled inoculations of common weed and pasture species were conducted. The species tested were distinct from the temperate species tested in Japan. Seed or healthy seedlings were planted in sterile soil, inoculated by stem-puncture and leaf-clip with virulent isolates of *P. fuscovaginae* (10^9 colony-forming units/ml), and incubated 7 d at 18-25° C, 100% relative humidity. Roots of all inoculated plants were sampled for the pathogen.

A wide range of plants common in

Susceptibility of common weed and pasture species to *Pseudomonas fuscovaginae*.[a] CIAT, Cali, Colombia.

Species	Susceptibility [b]		Reisolation from roots [c]
	Leaf-clip	Stem-puncture	
Monocotyledoneae			
Butomaceae			
Limnocharis flava (L.) Buchen	–	–	+
Commelinaceae			
Commelina diffusa Burn F.	++	+	++
Cyperaceae			
Cyperus difformis Vahl.	–	+	–
C. ferax L. C. Rich.	+	++	++
C. macrocephalus Liebm.	+	++	++
C. surinamensis Vahl.	–	–	+
C. rotundus L.	–	+	...
Cyperus sp.	–	+	...
Cyperus sp.	–	++	+++
Cyperus sp.	–	++	+++
Kyllinga brevifolia Rottb.	–	–	+
Gramineae			
Andropogon gayanus Kunth.	–	+	+++
Brachiaria brizantha (Hoechst ex A. Rich) Stapf.	++	+	++
B. decumbens Stapf.	–	++	+++
B. dictyoneura Stapf.	+	+	+
B. eminii Mez.	+	+	...
B. humidicola (Rendle) Schweickt.	++	++	+
B. jubata (*B. Soluta*)	+	++	+++
B. mutica (Forsk.) Stapf.	–	–	+
B. nigropedata (Munro) Stapf.	+++	++	+
B. ruziziensis Germ & Evrard.	+	+	+++
Chloris gayana Kunth.	++	++	–
Chloris sp.	–	+	++
Cynodon dactylon (L.) Pers.	+	+	...
Digitaria decumbens Stent.	–	++	+
Echinochloa colonum (L.) Link.	+	+	–
Echinochloa crus-galli (L) Beauv.	+	+	...
Eleusine indica (L.) Gaertn.	+	++	+
Eriochloa sp.	+++	+++	++
Ischaemum rugosum Salisb.	–	++	...
Leptochloa filiformis (Lam.) Beauv.	+	+	+
Panicum maximum Jacq.	+++	+++	+++
Paspalum paspalodes (Michx.) Scribn	++	++	+++
Pennisetum purpureum Schum.	++	+++	+++
Rottboellia exaltata L. F.	+	+	...
Sorghum sudanense (Piper) Stapf.	++	+++	++
Trichachne insularis (L.) Nees.	+	+	...
Pontederiaceae			
Heterantera reniformis R. et P.	–	+++	++
Dicotyledoneae			
Amaranthaceae			
Amaranthus sp.	–	–	+
Compositae			
Eclipta alba (L.) Hasek	+	–	+++
Euphorbiaceae			
Euphorbia hypericifolia L.	–	–	+
Caperonia palustris (L) St. Hil.	+	...	...
Lythraceae			
Ammannia coccinea Rottb.	–	–	–
Portulacaceae			
Portulaca oleracea L.	+	–	+
Scrophulariaceae			
Lindernia pyxidaria L.	–	–	+

[a] Inoculated by leaf-clip and stem-puncture methods. [b] +++ = progressive necrotic lesion 5 mm after 7 d, ++ = progressive necrotic lesion 2-5 mm after 7 d, + = necrotic lesion 2 mm after 7 d, – = no necrosis. [c] +++ = 50% root samples infected, ++ = 25-50% root samples infected, + = 1-25% root samples infected, – = no root samples infected, ... = not done.

tropical American rice-growing areas is susceptible to the BSBR pathogen (see table). Previous reports limited the host range to the Gramineae; however, our results show that species from other families within the Monocotyledoneae may be hosts as well. The bacterium was weakly pathogenic on a few dicots. Roots of most inoculated plants harbored the pathogen, usually in large amounts.

How rapid, or by what means plant-to-plant transmission may occur in the field is unclear and the extent to which fields planted with clean seed may be recontaminated is unknown. Weeds may harbor the pathogen and the high recovery rate of the pathogen from roots suggests that plant debris in the soil also may serve as an inoculum source or survival site.

Weeds as alternate hosts of *Thanatephorus cucumeris* (Frank) Donk in Cuba

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Many graminicolous weeds of ricefields have been reported to host *Thanatephorus cucumeris.* The resistance to *T. cucumeris* of some weeds was investigated under controlled and field conditions. Plants were inoculated under the leaf sheath with a 3-mm-diameter disk of PDA-grown culture of the fungus and covered with PVC bands to avoid desiccation.

Table 1. Reactions of weeds inoculated with *T. cucumeris* under controlled condition. RRS, Sancti Spiritus, Cuba.

Weed	Infestation (%)	Length of lesions (mm)
Echinochloa crus-galli	50	37.1
Leptochloa fascicularis	30	33.2
Brachiaria mutica	10	20.0
E. colona	10	20.0
Cynodon dactylon	10	3.5

Under controlled conditions, *Echinochloa crus-galli* and *Leptochloa fascicularis* were most susceptible and *Cynodon dactylon* most resistant (Table 1). In the field, *E. crus-galli* was very susceptible and *C. dactylon* and *Eleusine indica* resistant (Table 2). Inoculations in the field were more effective than in controlled conditions.

Table 2. Reaction of weeds inoculated with *T. cucumeris* in the field. RRS, Sancti Spiritus, Cuba.

Weed	Infestation (%)	Length of lesions (mm)
Echinochloa crus-galli	100	80.3
Paspalum distichum	100	40.3
Leptochloa fascicularis	100	25.0
E. colona	100	20.5
Oryza latifolia	100	20.0
Ischaemum rugosum	100	10.4
Brachiaria mutica	70	10.1
Eleusine indica	50	9.2
Cynodon dactylon	40	18.0

Evaluation of decamethrin concentrations for tungro disease and vector control

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Different concentrations of decamethtin were evaluated under field conditions in a randomized block design. Taichung Native 1 (TN1) (susceptible) and Ratna (tolerant) were planted in 3- × 3-m plots. Decamethrin and cypermethrin were sprayed at 10-d intervals from 15 d after transplanting (DT) to 45 DT. Carbofuran was broadcast at 15-d intervals from 15 DT to 45 DT. Three tungro-infected plants of cultivar Jaya were introduced into each plot just before the first spraying. The vector population was recorded at 30 and 42 DT and disease incidence at 49 DT.

In TN 1, disease incidence was low in

Efficacy of decamethin concentrations on tungro disease incidence and vector density in TN1 and Ratna.[a] CRRI, Orissa, India.

Insecticide	Dose (g ai/ha)	Disease incidence (%)		Grain yield (t/ha)		Leafhoppers[b] (no./120 hills)			
						TN1		Ratna	
		TN 1	Ratna	TN 1	Ratna	Adults	Nymphs	Adults	Nymphs
Decamethrin	200	3 a	2 a	3.3 a	4.7 a	3	0	1	0
Decamethrin	100	4 a	2 a	3.1 a	4.3 ab	5	2	1	0
Decamethrin	50	5 ab	4 b	2.6 b	4.0 bc	5	3	5	1
Decamethrin	25	6 b	5 bc	2.4 b	3.8 bcd	7	4	6	1
Decamethrin	12	10 c	5 bc	2.4 b	3.4 d	8	4	8	2
Decamethrin	6	81 e	5 bc	0.7 b	3.4 d	16	13	7	4
Cypermethrin	100	6 b	2 a	2.6 b	3.6 cd	3	2	2	1
Carbofuran	2 kg	19 d	12 d	1.4 c	3.5 cd	9	22	13	34
Control	–	100 f	44 e	0.2 e	2.4 e	51	152	43	104

[a] Separation of means in each column by Duncan's multiple range test at the 5% level. [b] Av values of 30 and 42 DT.

plots treated with decamethrin at higher than 12 g ai/ ha (see table). In Ratna, disease incidence was almost negligible at all concentrations. Cypermethrin equaled carbofuran and 6, 12, 25 g ai/ ha decamethrin. Yields in the control were significantly less than in insecticide-treated plots. The trends in vector population (adults and nymphs) in both cultivars was similar to that of disease incidence.

The conclusion is that 12 g ai/ ha of decamethrin in susceptible TN1 and 6 g ai/ ha in tolerant Ratna seem to be the lowest possible doses to reduce disease incidence.

Evaluation of some new synthetic pyrethroids for tungro (RTV) disease and vector control

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Some new synthetic pyrethroids were evaluated against RTV in the field. Cypermethrin, decamethrin, and carbofuran were included as checks.

Synthetic pyrethroids were sprayed at 10-d intervals from 15 d after transplanting (DT) and to 45 DT. Carbofuran was broadcast at 15-d intervals. Test cultivars were TNl (susceptible) and Ratna (tolerant). Design was a randomized block in 3- × 3-m plots with 3 replications for each cultivar. RTV source was artificially induced. Leafhopper population was recorded at 30 DT, disease incidence at 51 DT, and grain yield at harvest.

Decamethrin + buprofezin (200 g ai/ ha), tralomethrin (20 g ai/ ha), cypermethrin (50 g ai/ ha), and decamethrin (12 g ai/ ha) were equally effective in reducing RTV incidence and vector leafhopper populations in cultivar TN1 (see table). In cultivar Ratna, carbofuran and S-423 (1000 g ai/ha) also were effective in reducing RTV incidence and leafhopper population.

Effect of some new synthetic pyrethroids on RTV and vector populations in TN1 and Ratna.[a] CRRI, India.

Insecticide	Concentration (g ai/ha)	Disease incidence (%)		Grain yield (t/ha)		Leafhoppers/20 hills at 30 DT			
						TN1		Ratna	
		TN1	Ratna	TN1	Ratna	Adults	Nymphs	Adults	Nymphs
Decamethrin +	100	42 b	8 bc	0.8 c	3.5 cde	15 ab	11 bc	12 bcde	4 ab
buprofezin (S-534)	200	20 a	6 ab	1.4 a	4.3 ab	9a	7 abc	9 abcd	2a
Tralomethrin	10	44 b	10 c	0.8 c	3.7 bcd	19 bc	12 bc	6 abc	7b
(S-528)	20	22 a	4a	1.4 a	4.2 abc	10 a	3a	5 ab	2a
S-399	125	100 c	39 f	0.2 e	2.6 f	42 e	91 f	30 g	41 e
	250	96 c	24 e	0.2 e	2.9 ef	42 e	71 ef	19 efg	21 d
S-423	500	97 c	15 d	0.2 e	3.3 def	34 de	23 d	20 fg	13 c
	1000	57 b	8 bc	0.4 d	4.1 abc	30 cde	14 cd	16 def	6 ab
Cypermethrin	50	21 a	4a	1.5 a	4.3 ab	12 ab	5 ab	3a	3 ab
Decamethrin	12	20 a	5a	1.5 a	4.3 ab	12 ab	7 abc	6 abc	3 ab
Carbofuran	2 kg	41 b	11 cd	1.3 b	4.7 a	25 cd	55 e	14 cdef	14 c
Control	–	100 c	42 f	0.2 e	2.9 ef	49 e	120 g	29 g	59 f

[a]Values followed by the same letter do not differ significantly at the 5% level.

Relation between rice sheath blight (ShB) and yield

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A generalized relationship between ShB level and yield loss has not been established across rice-growing environments, mainly because of differences in disease evaluation methods, cultivars used, and disease pressures encountered.

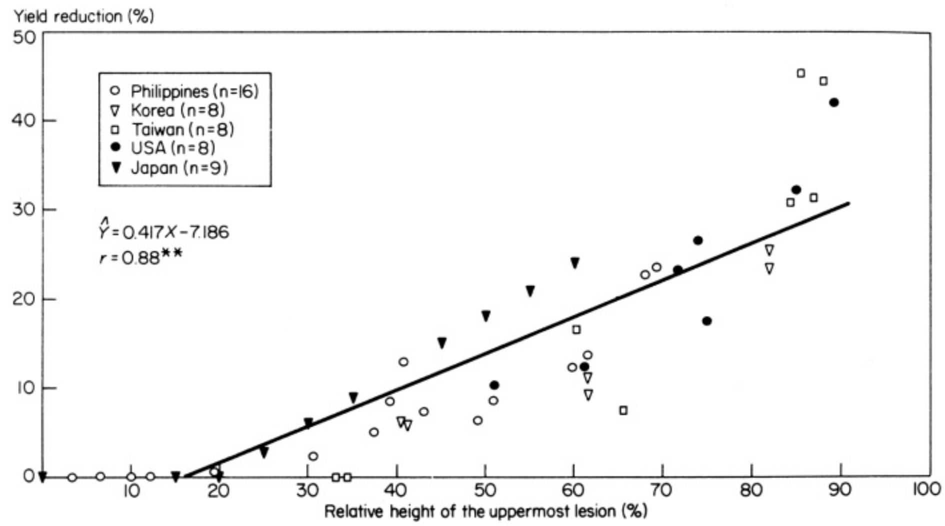
To assess the disease more efficiently, data sets from national reports were analyzed. All data on disease measurement were transformed to relative lesion height (RLH) (ratio of vertical lesion height of the uppermost leaf or sheath lesion to plant height). Disease severities in scales or range were transformed to mid-RLH values.

Despite divergent environments and different cultivars used, a positive and highly significant linear relationship between RLH of ShB and yield reduction was obtained (see figure). That linear relationship can be expected under moderate disease pressure.

Although lesions may reach the same height, extent of lesion area may differ with weather conditions.

No significant yield reduction was found when RLH was less than 20%. If lesion reached the 3d sheath from the sheath bearing the flag leaf, and if RLH was about 30% a significant yield loss was seen.

Additional loss would occur during milling if yield reduction in paddy rice was over 10% (USA data). A 46% yield loss is possible in milled rice if ShB lesion reaches 90% of RLH.



Relation between relative height of the uppermost ShB lesion and yield reduction in paddy rice (observations from national reports).

Pest Control and Management

INSECTS

Alang-alang gall midge potential as an alternate host for parasitoids

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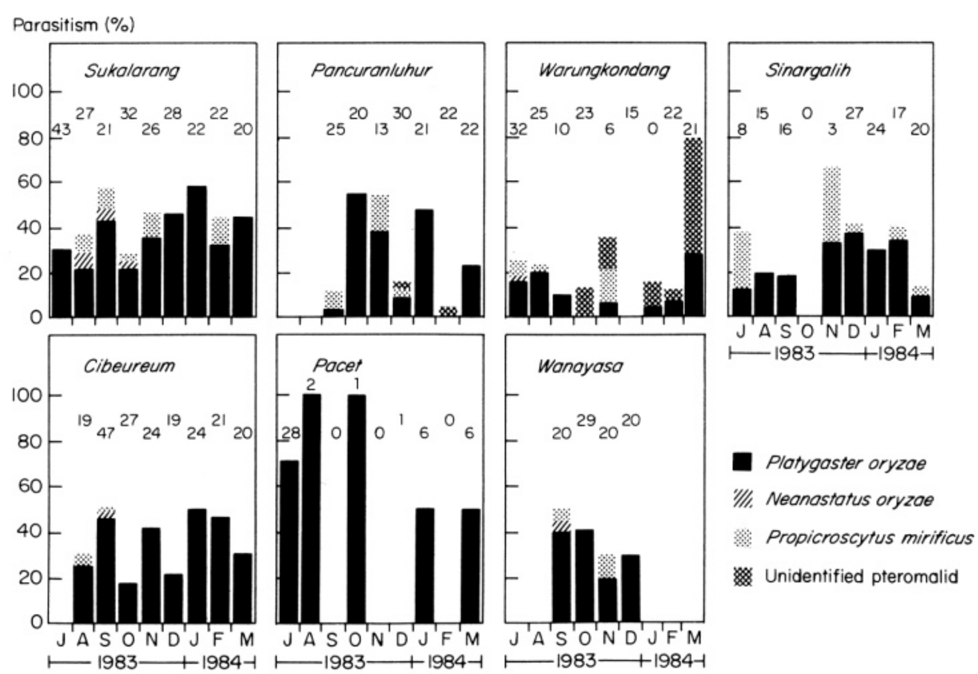
Alang-alang *Imperata cylindrica* is a natural weed on the dikes of lowland ricefields. The Alang-alang gall midge (AGM) *Orseoliella javanica* Kieffer is its most important insect pest. In hilly and highland regions (altitude: 300-800 m), where the dikes on one side are 1-1.5 m high and 20-40 m long, AGM is abundant, especially where the weed is regularly cut for cattle feed.

Although the rice gall midge (RGM) *Orseolia oryzae* (Wood-Mason) does not attack Alang-alang and the AGM does not attack rice, both belong to the family Cecidomyiidae. Alang-alang with AGM in the RGM habitat does not directly affect RGM. But AGM may be an important alternate host of RGM parasitoids. In mountainous regions, RGM infestation is commonly low.

Six species of hymenopterous parasitoids of RGM have been found in Java and Bali, but only three are important: *Platygaster oryzae* (egg-larval parasitoid), *Neanastatus oryzae* (pupal parasitoid), and *Propicroscytus mirificus* (syn. *Obtusiclava oryzae*) (larval parasitoid). *P. oryzae* and *N. oryzae* are commonly present in ricefields. Parasitism rates may reach 95% for *P. oryzae* and 50% for *N. oryzae.*

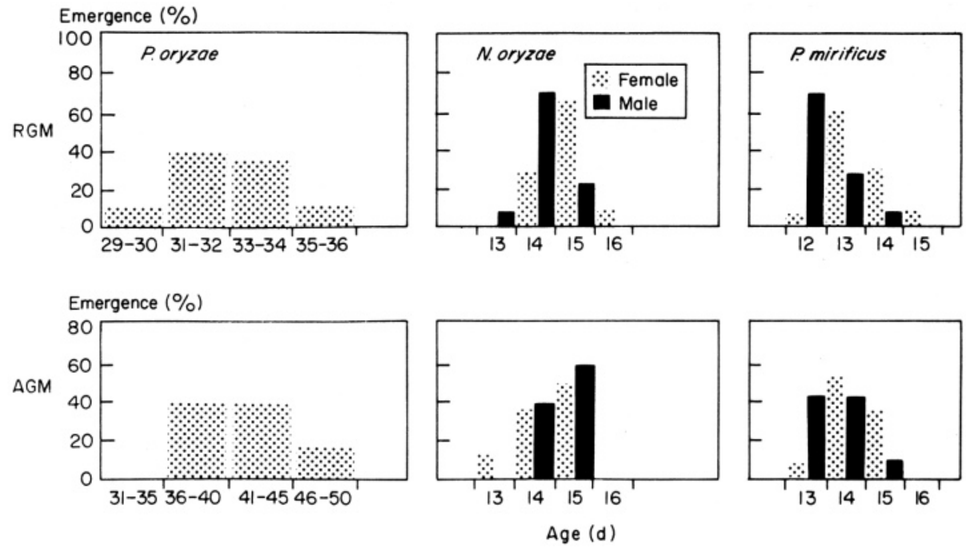
The life cycle of *P. oryzae,* in general. synchronizes with the life cycle of RGM (28-32 d). To study the biology of the RGM parasitoids, 1,032 samples of AGM were taken from 9 locations in West Java during 9 mo in 1983-84. Parasitoids, particularly larval and



1. Fluctuation of Alang-alang GM and its parasitoids in 7 locations in West Java. Jul 1983-Mar 1984. Figures above the columns indicate number of silvershoots taken in 1 h of monthly sampling time.

pupal, were present in AGM and were often found where the insect occurred (Fig. 1). The life cycles of the larval and pupal parasitoids are relatively the same as those which live in RGM (Fig. 2). The life cycle of *P. oryzae* synchronizes with the life cycle of the host. The life cycle of AGM is relatively longer (5-7 wk) than that of RGM (4-5 wk); the life cycle of *P. oryzae* on AGM is also longer than that on RGM (Fig. 2).

Based on biology and behavior, the *Platygaster* sp., which occurs as a dominant parasitoid of AGM, is now considered the complex of the *P. oryzae* of RGM. It attacks larvae of RGM, but attacks pupae of AGM because the parasite deposits eggs only when silvershoots of AGM emerge.



2. Time of emergence of rice GM parasitoids.

Response of leaffolder (LF) *Cnaphalocrocis medinalis* G. to extracts of resistant *Oryza sativa* and *O. brachyantha*

E. B. Medina and E. H. Tryon, Entomology Department, IRRI

Extracts of rice and wild rice cultivars with LF resistance were obtained by steam distillation of leaves followed by diethyl ether extraction. The oily extract was diluted with acetone.

Freshly laid eggs were dipped in a 2,000-ppm solution and excess liquid drained. The eggs were incubated in petri dishes lined with moistened filter paper and the number of hatched and unhatched eggs recorded.

To assess larval response, 15-cm-diam petri dishes were divided into 6 compartments labeled alphabetically clockwise. Leaf pieces dipped in each variety's extract were placed in A, C, and E compartments; leaf cuts dipped in acetone were placed in compartments B, D, and F. Twenty-four 1st-instar larvae were placed at the center of each dish. After 24 h, the larvae settling on each leaf piece were counted.

Three-hour-starved 3d-4th instar larvae were offered leaves treated with the diluted oily extract and larval mortality determined.

TKM6 extract significantly reduced hatching, 57% unhatched eggs compared to only 8% unhatched eggs for the solvent alone (Table 1). Cultivars Kamalbhog, Darukasail, and TKM6 showed 32-36% larval mortality, significantly greater than the 2% mortality in control. The odor of TN1 did not influence orientation or settling response of the larvae, but on other cultivars, more insects responded to the odor of the control (Table 2).

Based on antibiosis, most of the observed cultivars are LF resistant. The chemicals are active against LF eggs and larvae.

Table 1. Effects of extracts obtained from rice and wild rice varieties on LF. IRRI, 1986.

Source of extract	Accession no.	Unhatched eggs (%)	Larval mortality (%)
O. brachyantha	101231	24 b	16 bc
O. brachyantha	101233	35 b	12 bcd
O. brachyantha	101234	39 b	8 d
O. sativa			
Darukasail	45493	20 b	32 a
Kamalbhog	49020	30 b	34 a
TKM6 (resistant check)	231	57 a	36 a
TN1 (susceptible check)	105	22 b	4 cd
Control (solvent only)	–	8 c	0 d

Table 2. Attraction of LF to leaves treated with steam distillate oils obtained from *Oryza* species. IRRI, 1986.

Cultivar	Accession no.	Insects (no.) after 24 h		Difference
		Treated with extract	Control	
O. brachyantha	101231	22	63	41**
O. brachyantha	101233	32	44	12**
O. brachyantha	101234	39	46	7 ns
O. sativa				
Darukasail	45493	24	41	23**
Kamalbhog	49020	20	51	31**
TKM6	237	10	60	44**
TN1	105	37	57	19 ns

Effects of flooding on insect pests and spiders in a rainfed rice environment

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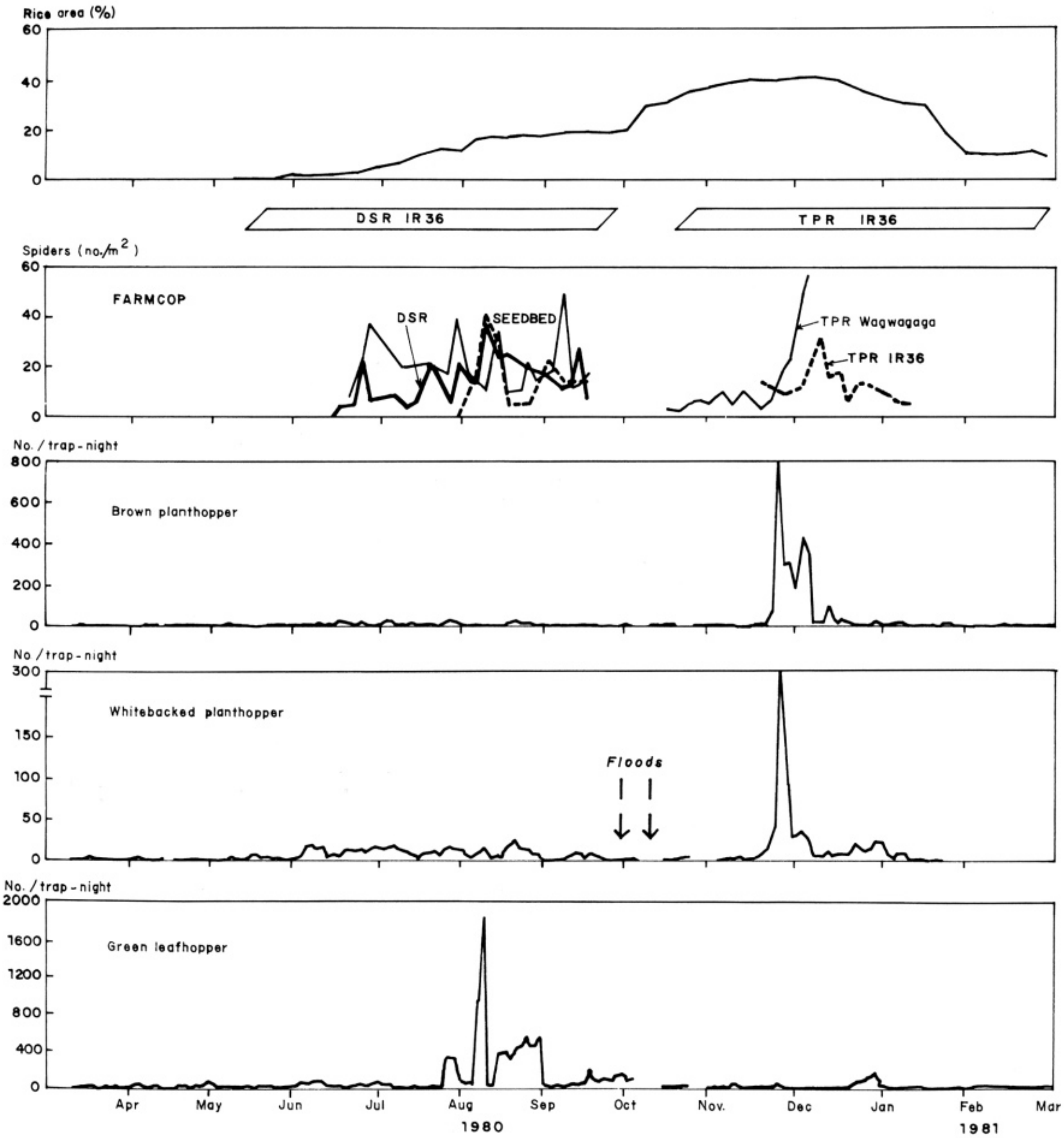
We studied a 1,000-ha tract of rainfed rice along the Cagayan River in northeastern Luzon, Philippines, planted to photoperiod-sensitive, traditional, Wagwag varieties. Farmers do not use fertilizers or pesticides. A kerosene light trap monitored daily changes in insect populations; FARMCOP suction samples were taken from 20 hills in each of 4 experimental, double-cropped modern variety fields twice a week. Moisture status (soil surface dry or wet or depth of flooding) of 20 fields and rainfall were recorded daily.

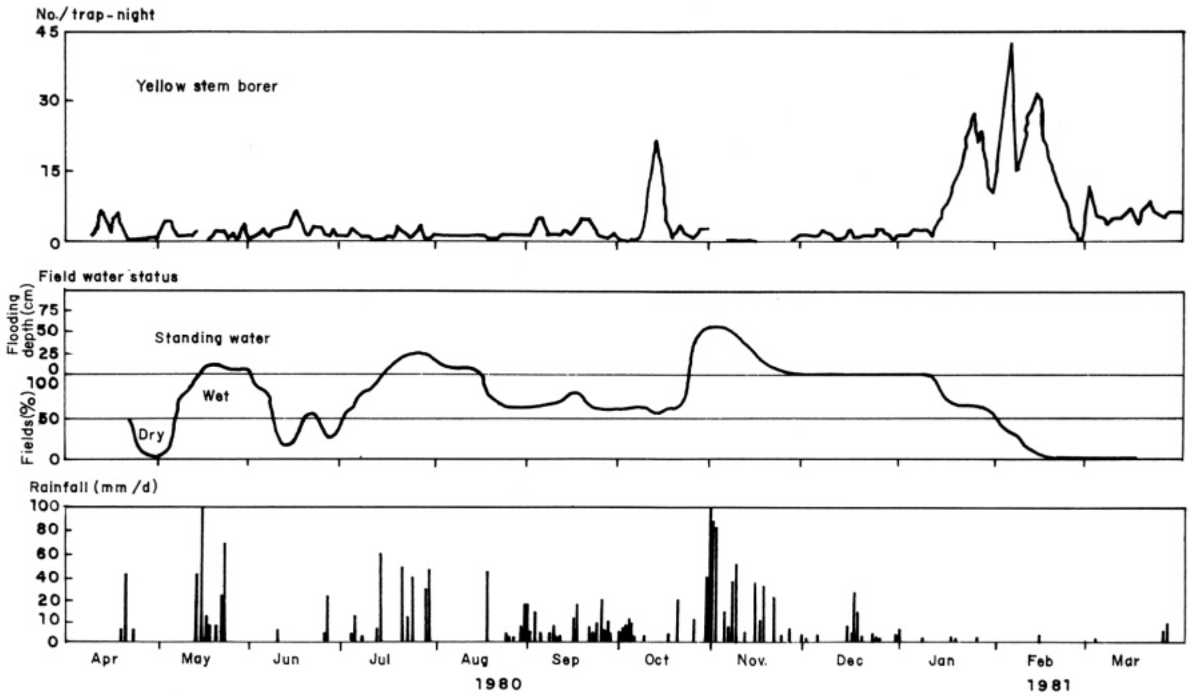
Rainfall necessary for land preparation was erratic, causing transplanting of the single crop to span Jun-Dec. Most planting was done in Nov, after two typhoons in late Oct and early Nov. Flooding from those typhoons averaged 0.5 m for several weeks.

At the onset of flooding, *Solenopsis geminata* ants prevalent in rice bunds formed melon-sized balls of workers protecting their reproductives, and these floated away with the floodwaters. Spiders spun masses of webs on shrubs along embankments at the edge of the floodwaters.

Field collections of hoppers and spiders were low after flooding (see figure). Migratory brown planthopper *Nilaparvata lugens* and whitebacked



Insect pest and spider predator numbers measured by FARMCOP suction machine in experimental direct-seeded (DSR) and transplanted (TPR) double rice crops compared to light trap catches reflecting the traditional single crop. Two typhoons caused flooding from the last week of October through the first 2 wk in Nov. Solana, Cagayan, Philippines, 1980-81.



planthopper *Sogatella furcifera* recolonized the area after the floods and numbers exploded with the minimal natural enemy pressure. The high numbers collected in the light trap 2 mo after the floods represented 2 generations of hopper buildup. Hopperburn occurred in 30 ha of traditional rice. Spiders recolonized too late to prevent planthopper resurgence.

The less migratory green leafhopper *Nephotettix* spp. were slow to recolonize. Also decimated by the floods, their numbers did not resurge after flooding.

Yellow stem borer (YSB) *Scirpophaga incertulas* represented 99% of the stem borers (SB) from dissected stems in this flood-prone environment. YSB larvae can survive in rice tillers underwater; larvae of other SB species perish. Maximum numbers of YSB collected in the light trap near harvest probably represent an emigrant dispersal flight in response to crop senescence and dry fields. YSB does not aestivate during the dry season but recolonizes from tracts of irrigated rice 10 km away. Low numbers of YSB were collected in the light trap throughout the year.

Effect of ratoon rice crop on populations of green leafhopper *Nephotettix virescens,* brown planthopper *Nilaparvata lugens,* whitebacked planthopper *Sogatella furcifera,* and their predators

C. G. dela Cruz and J.A. Litsinger, Entomology Department, IRRI

A 50- to 60-d-old ratoon rice crop following a 120-d-old transplanted crop extends the effective period of insect pest buildup from 3 to 5 generations. Because insect numbers increase exponentially with each generation, hoppers which are not restricted to specific crop stages might be favored by a ratoon crop. A ratoon crop also may create a favorable environment for hopper predators after harvest of the main crop because it does not involve habitat-disturbing land preparation.

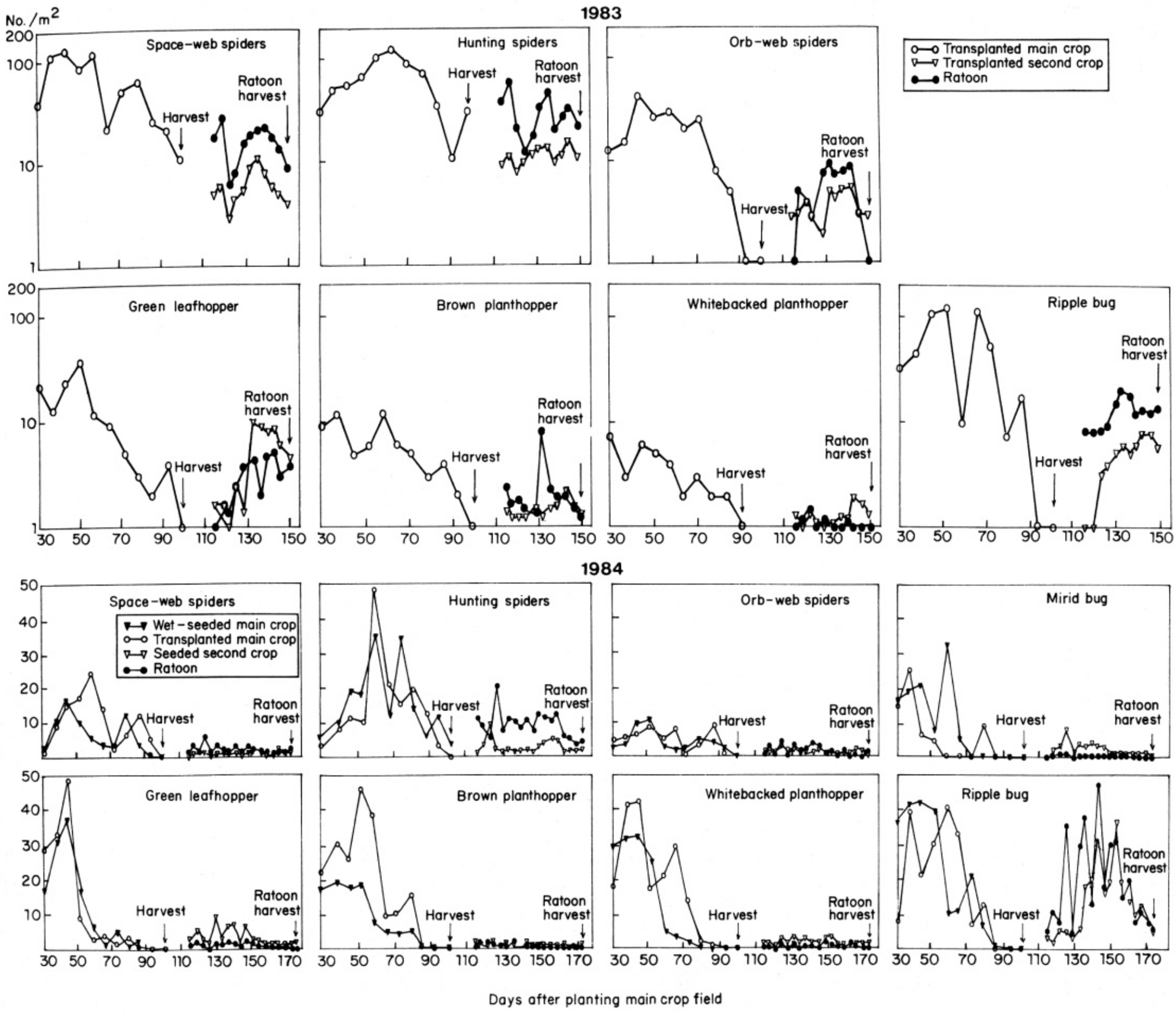
Two successive field trials were conducted at IRRI to study populations of major hopper species and their predators in the main crop, ratoon crop, and second transplanted crop.

Mature plants of IR1917 (insect-susceptible but rice tungro virus-resistant) were ratooned by cutting stalks 15 cm above the ground. No insecticide was used on any crop, but fertilization, irrigation, and weeding were done as recommended. Hoppers and their predators were sampled intensively using a FARMCOP suction machine.

As the main crop matured, hopper populations declined naturally because of outward migration and natural enemy activity (see figure). Space-web and hunting spiders were most abundant in the first crop and were more prevalent than orb-web spiders.

On the subsequent ratoon, all spider groups were generally higher than on the second crop. Possibly, the spiders foraged from the ratooned plots to the second transplanted crop, explaining why hopper numbers in general were low in all second crops.

Hunting spiders, dominated by *Lycosa pseudoannulata,* maintained



Population dynamics of hoppers and their predators on the main rice crops, ratoon, and seeded second crops. IRRI, 1983 and 1984 wet seasons.

higher numbers throughout the ratoon crop. Space-web spider *Atypena formosana* numbers declined as the ratoon matured. Because it makes its webs at the base of tillers, *A. formosana* and the highly mobile hunting spider can readily colonize a new crop or remain unaffected during harvest and growth of a ratoon.

Orb-web spiders *Tetragnatha* spp. and *Dyschiriognatha* sp. spin webs in tall foliage. They become abundant during later growth stages, but decline at main crop harvest when hoppers disperse to colonize younger crops.

Microvelia ripple bug declines with crop age in a first crop but can rapidly colonize newly planted fields. *Microvelia* was highly abundant in the first crop and in both ratoon and second transplanted crop.

Cyrtorhinus was not able to rebuild its population, probably because its eggs were removed with the straw at harvest of the first crop. But it was more abundant in the second transplanted crop than in the ratoon, perhaps in response to higher green leafhopper numbers.

Evidently, ratoon is a refuge for spiders and ripple bugs. These predators were better able to respond to colonizing hoppers. Ratoon cropping may enhance early biocontrol activity.

Suitability of ratoon rice as host to insects

C. G. dela Cruz and J.A. Litsinger, Entomology Department, IRRI

Ratoon rice and transplanted rice (TPR) were compared as hosts for four vegetative and five reproductive stage insect pests. Host suitability was determined by insect survival, developmental period, and weight of insects reared on 3-wk-old ratoon and comparable TPR.

All vegetative pests except *Rivula atimeta* had low survival on ratoon (see table). Except for the yellow stem borer (YSB), reproductive stage pests were unaffected by ratoon. Developmental periods of all rice pests were similar on ratoon and TPR.

Ratoon was clearly less nutritious than TPR; surviving insects were smaller except for the whitebacked planthopper (WBPH). Vegetative stage pests — particularly whorl maggot, caseworm, and green semilooper —were least suited to ratoon. Reproductive stage pests were less affected. YSB actually survived better on ratoon, probably because of larger diameter stems, but the insects were smaller. WBPH developed equally on ratoon and TPR.

Suitability of transplanted (TPR) and ratoon (R) IR1917 rice for development of rice insect pests.[a] IRRI greenhouse, 1983.

Pest	Crop establishment method[b]	Survival[c] (%)	Developmental period[d]		Insects[e]	
			Days	Insects (no.)	Wt (mg)	no.
	Vegetative stage					
Whorl maggot *Hydrellia philippina*	TPR	40	24.0	31	0.98	19
	R	17	24.5	12	0.32	19
	Diff.	**	ns		**	
Caseworm *Nymphula depunctalis*	TPR	65	28.3	41	10.70	32
	R	32	29.7	27	6.87	29
	Diff.	*	ns		**	
Green hairy caterpillar *Rivula atimeta*	TPR	88	17.8	48	16.06	57
	R	93	17.8	45	9.68	42
	Diff.	ns	ns		**	
Green semilooper *Naranga aenescens*	TPR	37	14.9	36	22.57	43
	R	25	14.2	27	13.40	35
	Diff.	**	ns		*	
	Reproductive stage					
Yellow stem borer *Scirpophaga incertulas*	TPR	27	32.3	12	10.32	48
	R	52	31.5	19	4.13	36
	Diff.	**	ns		*	
Leaffolder *Cnaphalocrocis medinalis*	TPR	55	26.2	43	21.80	40
	R	60	25.8	51	16.06	42
	Diff.	ns	ns		**	
Brown planthopper *Nilaparvata lugens*	TPR	78	15.1	51	1.04	54
	R	82	14.9	49	0.91	30
	Diff.	ns	ns		*	
Whitebacked planthopper *Sogatella furcifera*	TPR	76	13.7	45	0.72	54
	R	70	13.7	46	0.63	42
	Diff.	ns	ns		ns	
Green leafhopper *Nephotettix virescens*	TPR	57	17.9	37	1.04	42
	R	62	18.4	42	0.58	37
	Diff.	ns	ns		*	

[a]Av of 6 replications, 10 insects/replication. Significance is at the .05 (*) and .001 (**) levels. ns = nonsignificant. [b]Plants infested 21 d after ratooning or transplanting. [c]For all insects except whorl maggot (where mature eggs were used), plants were artificially infested with first-instar larvae or nymphs, which were allowed to develop to adulthood. [d]Only surviving insects were considered. [e]Larvae or nymphs allowed to develop on plants 10 d before weighing.

Snail predators of the rice caseworm

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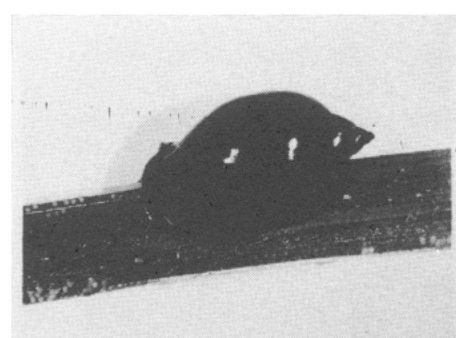
Attempts to artificially infest rice plots at IRRI with rice caseworm eggs laid on floating cut leaves failed. Numerous snails were observed in the field plots, predominantly *Radix quadrasi* (Mollendorf) (Lymnagidae) (see figure). After 3 d, 67% of 375 caseworm eggs laid on rice leaves were missing. There were 50 snails/3 rice hills.

To determine whether the eggs were dislodged or killed, caseworm eggs were submerged in 6 cm of water. Snails were introduced into 1/2 of the test basins.

Over 25% of the submerged eggs in containers without snails developed into larvae which made cases from rice leaves. None developed cases in containers with snails.

We conclude that the caseworm eggs were killed by the snails. As snails showed no preference for leaves with caseworm eggs, we conclude that egg mortality is due to inadvertent disturbance and not to predation. Snails grazing on algae growing on submerged rice foliage dislodge caseworm eggs laid on the undersides of floating leaves, killing them.



Caseworm moths lay eggs on the surface of underwater rice leaves. Snail movement dis lodges the eggs (seen along the leaf margin ahead of the snail), preventing them from hatching.

Modeling for size of damage-causing generation of rice leaffolder (LF)

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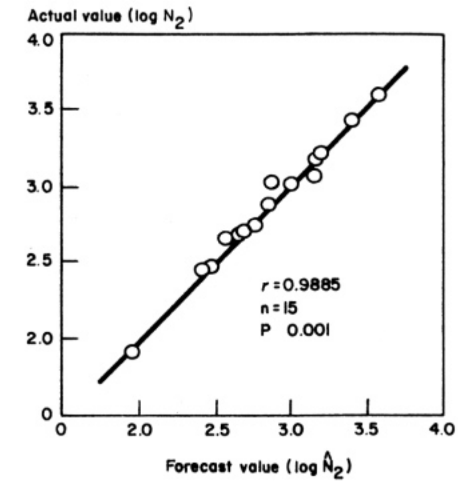
Second-generation LF *Cnaphalocrocis medinalis* Guenée (Jun-10 Jul) is the most damaging in Jiangxi Province, Yangtze River region. To predict the size of this generation, we used error analysis (or key factor analysis) to select in sequence environmental factors. The selection criterion is a correlation coefficient larger than 0.53. The model's multiple regression formula is:

$$\log N_2 = -6.6025 + 0.7387 \log N_1 - 7.1912 \log T_4 + 17.3500 \log S_5 - 2.0791 \log W_8 + 1.0313 \log M_4 + 0.9988 \log T_5 - 0.7634 \log P_{12} - 0.2267 \log R_5.$$

N_2 is emergence size of second generation, N_1 is emergence size of first generation, T_4 is average air temperature in Apr, S_5 is sea temperature in No. 25 region of Northwest Pacific in May, W_8 is back spot site of subtropical air pressure in late Aug, M_4 is terrestrial magnetism index in Apr, T_5 is minimum temperature in May, P_{12} is water vapor pressure in late Dec, and R_5 is total monthly rainfall in May. Correlation coefficient of the formula is 0.9885, $F = 9.19$, $df = 7.7$, $P < 0.001$.

The figure shows the emergence size in 1965-79 and predicted size of second-generation LF.



Emergence size and predicted size of second-generation LF at Jian prefecture, Jiangxi Province, China, 1965-79.

Brain cells and chromosomes of the brown planthopper *Nilaparvata lugens* (Stål)

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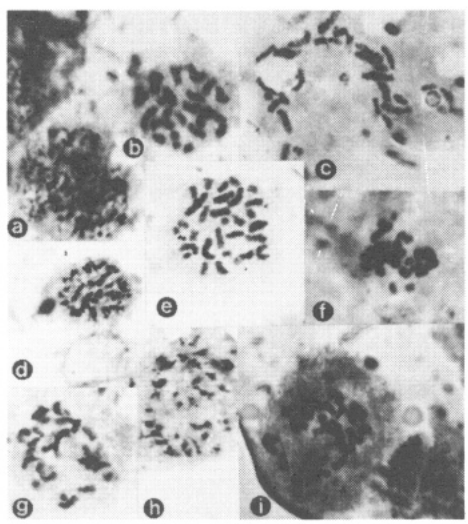
Standard air-drying techniques with lacto-aceto-orcein staining were used to observe the mitotic brain cells and chromosomes of fourth-instar *N. lugens* nymphs (Fig. 1). From 100 individuals, the mean number of cells undergoing mitosis was 487; the mean number of nondividing cells was 247, for a 67% mitotic index.



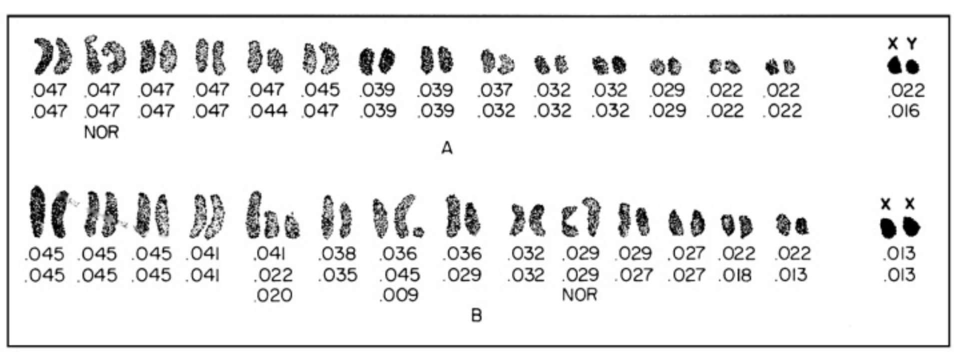
1. Brain cells and chromosomes of *N. lugens* biotype 1. IRRI, 1986. Magnification 1000X (oil immersion).

Premetaphase chromosome counts established the normal diploid complement at 2n = 30. The karyotype included 28 autosomes and an XX (female) or XY (male) sex chromosome system. The sex chromosomes were heterochromatic and maximally contracted. The XX or XY tandem consisted of chromosomes which were smaller than or equal to some autosomes. The X and the Y chromosomes usually had different shapes; the X-chromosome was always bigger than the Y-chromosome.

Early metakinetic chromosomes (Fig. lb, c, e, f, g, and i) were short and rod-shaped; each chromosome had two chromatids. The sister chromatids comprising the chromosomes were barely observable because of the lack of a distinct centromere. They appeared to have diffuse or scattered spindle attachments, implying that *N. lugens* chromosomes are holokinetic. At metaphase, the chromosomes occupied the spindle body with the chromosomal long axis at right angles to the polar axis.

Total chromatin was 11.90 μ in female and 5.74 μ in male *N. lugens.* Females possessed longer chromosomes (Fig. 1c) than males (Fig. 1b and e). However, the reverse was the case in relative mean lengths.

In karyotype analysis of



2. Relative mean lengths of premetaphase brain chromosomes of male (A) and female (B) *N. lugens* biotype 1. IRRI, 1986. Magnification l000X (oil immersion).

premetaphase chromosomes of males, the relative length of autosomes ranged from 0.022 to 0.047. The NOR measured 0.047; the X-chromosome, 0.022; and the Y, 0.016 (Fig. 2A). The relative length of autosomes in females ranged from 0.013 to 0.045. The relative length of NOR was 0.029, that of the X-chromosome was 0.013 (Fig. 2B).

Very few cells (3/individual) were detected undergoing anaphase immediately after metaphase. Anaphase occurred so fast that it was least trapped in fixed brain tissue. In contrast, the frequency of telophase cells was high (30 cells/ individual). Later, cytokinesis ensued and formed two daughter nuclei. The first prophase nucleus measured 7.05 μ by 5.88 μ. Each nucleus had a circular nucleolus I .76 μ in diameter. Seven more variations of prophase nuclei were found (see table).

During the regular mitotic cycle in *N.* lugens biotype 1, prophase was the longest stage, followed by telophase and metaphase; anaphase was the shortest.

Some brain cell nuclei displayed either an increase (agmatoploidy) or decrease (hypoploidy) in chromosome numbers. Hypoploidy resulted from somatic chromosomal fusions (Fig. 1f). Agmatoploidy resulted from chromosomal fragmentations, leading to the appearance of extra chromosomes, such as m-chromosomes. On the whole, hypoploidy was more frequent than agmatoploidy in *N. lugens* biotype 1.

Prophase forms of brain cells of *N. lugens* biotype 1.

Prophase form	Length (μ)	Width (μ)	Remarks
II	8.23	7.64	Nuclear membrane present; nucleolus present; chromosomes granulated
III	11.17	10.58	Nuclear membrane and nucleolus disintegrating; chromosomes granulated
IV	15.29	13.52	Nuclear membrane disappearing; nucleolus absent; chromosomes appeared as intertwined threads
V	17.64	14.11	Same as above
VI	11.76	7.06	Nuclear membrane disappeared; chromosomes elongated
VII	8.23	7.06	Chromosomes condensed into irregular forms and scattered all over the nucleus
VIII	17.64	10.58	Irregular scattered chromosomes

Parasitoids of the rice gall midge (GM) in Indonesia

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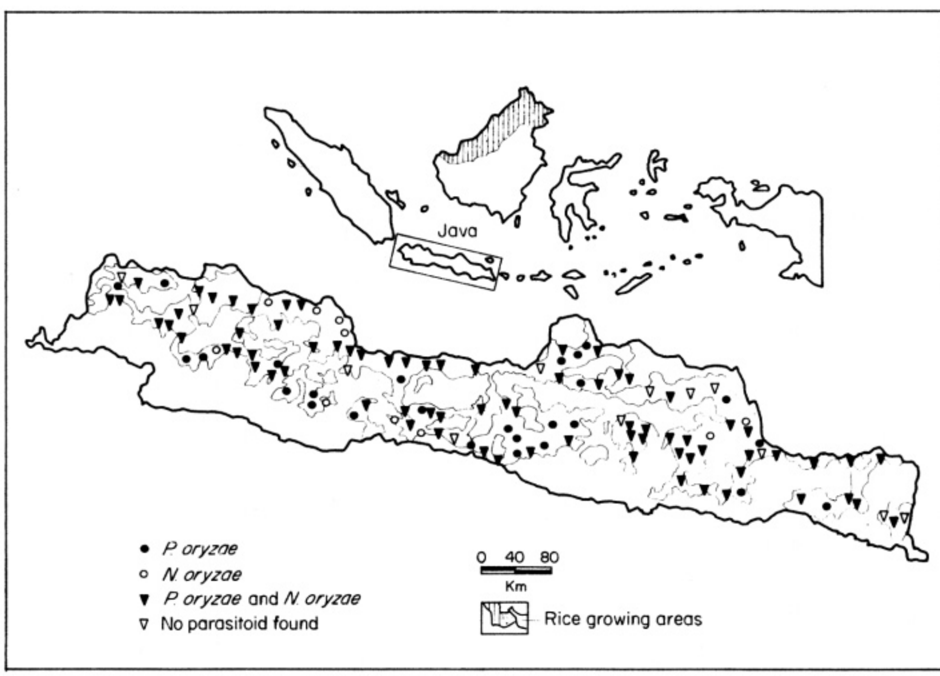
Several hymenopterous parasitoids of GM *Orseolia oryzae* (Wood-Mason) have been recorded in Java and Bali (see figure):

Egg-larval parasitoid:
- *Platygaster oryzae* Cameron (Platygasteridae)

Larval parasitoids:
- *Propiccroscytus mirificus* (Girault) (Pteromalidae)
- *Eurytoma setitibia* Gahan (Eurytomidae)
- *Trichorpia* sp. (Diapriidae)
- *Terrastichus* sp. *nyemitawus* Rohwe groups (Eulophidae)

Pupal parasitoid:
- *Neanastatus oryzae* Ferriere (Eupelmidae)

Only *P. oryzae, N. oryzae,* and *P. mirificus* are considered important. In surveys during 3 consecutive years, *P. oryzae* and *N. oryzae* were normally found; *P. mirificus* was found only with intensive observation. *P. oryzae* was found in 91% and *N. oryzae* in 70% of the locations where silvershoots were sampled. The degree of parasitation vaned, but ranged from 30 to 70%. Based on the number of parasitized hosts, the ratio of *P. oryzae* to *N. oryzae* ranged from 3.3:1 to 6.8:1.



Distribution of *P. oryzae* and *N. oryzae* in Java, Indonesia

Some new insect pests of rice in Uttar Pradesh, India

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Surveys conducted during 1981-84 revealed the presence of several insect pests not previously reported on upland rice in the hills of Uttar Pradesh (see table). Most of these pests have recorded low economic loss, but their occurrence indicates that they could become serious pests under favorable climatic conditions,

Of the insects found, shootfly caused 22-25% deadhearts in the nursery in 1983. Small grasshoppers were abundant throughout the 1984 season. Other insects remained at a low level.

The Commonwealth Institute of Entomology, London, confirmed the insect identification.

Some new insect pests of rice in Uttar Pradesh hills, India.

Insect and year when first recorded	Order:Family	Damage
Horned caterpillar *Melanitis leda* Linnaeus 1981[a]	Lepidoptera:Satyridae	Larvae feed on leaf blade.
Tussock caterpillar *Euproctis* sp. probably *Virguncula* Walker 1981	Lepidoptera:Lymantriidae	Larvae are defoliators.
Bombay locust *Patanga succincta* (Linnaeus) 1982	Orthoptera:Acrididae	Nymph and adults feed on leaves.
Small grasshopper *Oxya japonica japonica* (Thunberg) 1982	Orthoptera:Acrididae	Nymphs and adults feed on leaves.
Aphid *Hysteroneura setariae* (Thomas) 1982	Homoptera:Aphididae	Feeds on shoots and developing panicles.
Green leafhopper *Nephotettix nigropictus* (Stal) 1981	Homoptera:Cicadellidae	Nymphs and adults suck sap from leaves.
Leafhopper *Psammotettix striatus* (Linne) 1981	Homoptera:Cicadellidae	Nymphs and adults suck sap from leaves in nursery seedlings.
Leaf fly *Oscinella* sp. 1981	Diptera:Chloropidae	Larvae cause whitish hollow outgrowths of interval leaf.
Earwig *Elaunon bipartitus* (Kirby) 1981	Dermaptera:Forficulidae	Adults observed on panicles.
Flea beetle *Chaetocnema basalis* (Baly) 1982	Coleoptera:Chrysomelidae	Adults feed on leaves by biting holes in them.
Shootfly *Atherigona oryzae* Mall. 1983	Diptera:Muscidae	Maggots feed on central shoot of seedlings.
Pollen beetle *Chiloloba acuta* (Wiedemann) 1982	Coleoptera:Scarabaeidae	Adults are observed as pollen feeders.

The International Rice Research Newsletter (IRRN) invites all Scientists to contribute concise summaries of significant rice research for publication. Contributions should be limited to one or two pages and no more than two short tables, figures, or photographs. Contributions are subject to editing and abridgment to meet space limitations. Authors will be identified by name and research organization.

Predators of rice caseworm

N. Chantaraprapha, Entomology and Zoology Division, Department of Agriculture, Bangkok, Thailand; and J.A. Litsinger, Entomology Department, IRRI

The leaf tube constructed by rice caseworm *Nymphula depunctalis* protects the larvae from natural enemies. Larval parasitization is always below 5%. The role of aquatic predators was assessed in greenhouse trials.

Caseworm larvae caged in potted plants immersed in water were offered as prey to a range of aquatic insects collected from reservoirs, canals, and ricefields. Two predatory groups were revealed. The larvae of *Sternolophus rufipes* (Fabricius), a hydrophilid, stalk caseworm larvae underwater and seize them as they stretch out of their protective cases while swimming. Sometimes the predator entered the case to locate the caseworm. The larva of *Cybister tripunctatus orientalis* Gschwendtner, a dytiscid, holds onto a submerged object waiting for prey to swim overhead. It rises quickly to the surface and seizes the outstretched caseworm larva. Younger dytiscids enter the case while older ones seize the case with powerful, sickle-shaped mandibles, forcing the caseworm larvae out.

Single dytiscid or hydrophilid larvae that were offered caseworm larvae of a range of ages in no-choice tests showed preference for older prey (see table).

Capacity of aquatic beetle larvae to prey on rice caseworm larvae in no-choice tests. IRRI greenhouse, 1984.

Caseworm larval instar	Caseworm larvae consumed (no./d)		
	Hydrophilid[a] instar IV	Dytiscid[b]	
		Instar II	Instar IV
I	2.2 c	4.8 b	4.0 b
II	2.8 bc	4.8 b	4.0 b
III	4.5 ab	8.4 ab	9.0 ab
IV	5.2 ab	10.0 ab	10.8 a
V	6.1 a	11.6 a	11.4 a

[a]Av of 5 replications; single predator larva offered 15 prey. [b]Av of 6 replications; single predator larva offered 25 prey.

The hydrophilid larva consumed up to 6.7 fifth-instar caseworm larvae daily, but only 2-3 of first- or second-instar larvae. Regardless of age, the dytiscid preferred older prey. It was also more voracious, consuming more than 11 fifth-instar caseworm larvae daily.

Aquatic predators may explain why caseworm is more prevalent in rainfed than in irrigated wetlands. Rice irrigated from rivers, reservoirs, or canals would already contain dytiscids and hydrophilids. Delayed dispersal flights of predators to rainfed fields could allow greater survival of the caseworm, which attacks a young crop before the aquatic predators can initiate a new infestation.

Major insect pests of rice in Cuba

R.Meneses-Carbonell, Rice Experiment Station "Sur del Jibaro," Sancti Spiritus, Cuba

Rice planthopper *Sogatodes orizicola,* the hoja blanca virus vector, is the principal insect pest of rice in Cuba (see table). Life cycle of adult males is 14-24 d; that of females, 27-31 d. The cycle from egg to adult is about 25 d. *S. orizicola* needs high temperatures (25-27° C) for optimum development. Higher insect activity and population densities are Apr-Nov.

The most difficult insect pest to control is the rice water weevil, with a 50-d cycle from oviposition to adult emergence. Adults live an average 714 d. *Lissorhoptrus brevirostris* population is highest in Apr-Nov, with large damages to ricefields.

Other important pests are rice stink bug *Oebalus insularis* and fall armyworm *Spodoptera frugiperda.*

Other insects are sporadic pests of rice in Cuba.

Major insect pests of lowland rice in Cuba, 1976-84.

Scientific name	Growth stage	Damage	Infestation (%)
Sogatodes orizicola (Muir) (Homoptera: Delphacidae)	Emergence to maximum tillering	Leaf sucking (nymphs and adults)	2-12
Sogatodes cubanus (Crawford) (Homoptera: Delphacidae)	Emergence to maximum tillering	Leaf sucking (nymphs and adults)	
Lissorhoptrus brevirostris (Suffr.) (Coleoptera: Curculio nidae)	Emergence to maximum tillering	Root feeding (larvae) Leaf feeding on leaves (adults)	10-28
Spodoptera frugiperda (F. Smith) (Lepidoptera: Noctuidae)	Emergence to maximum tillering	Leaf feeding (larvae) May eat entire plant	6-10
Hortensia similis (Walk.) (Homoptera: Cicadellidae)	Emergence to maximum tillering	Leaf sucking (nymphs and adults)	
Draeculacephala cubana (M & B) (Homoptera: Cicadellidae)	Emergence to maximum tillering	Leaf sucking (nymphs and adults)	
Hydrellia sp. (Diptera: Ephydridae)	Emergence to panicle initiation	Feeding on tissue along the inner margins of emerging leaves (larvae)	New pests
Diatraea saccharalis (F.) (Lepidoptera: Pyralidae)	Emergence to panicle initiation	Feeding within the stem, severing the vascular system (larvae)	
Caulopsis cuspidatus (Scud.) (Orthoptera: Acrididae)	Panicle initiation to heading	Feeding on the leaf blade	
Conocephalus [=*Xiphidium*] *fasciatus* (De Geer) (Orthoptera: Tettigoniidae)	Panicle initiation to heading	Leaf feeding (nymphs and adults)	
Conocephaloides obscurelus (De Geer) (Orthoptera: Tettigoniidae)	Panicle initiation to heading	Leaf feeding (nymphs and adults)	
Schistocerca pallens (Thunb.) (Orthoptera: Acrididae)	Panicle initiation to heading	Defoliate plants	
Oebalus insularis (Stal) (Hemiptera: Pentatomidae)	Milk stage	Sucking each grain (nymphs and adults)	3-17

First meiotic chromosomes of male *Nephotettix* malayanus

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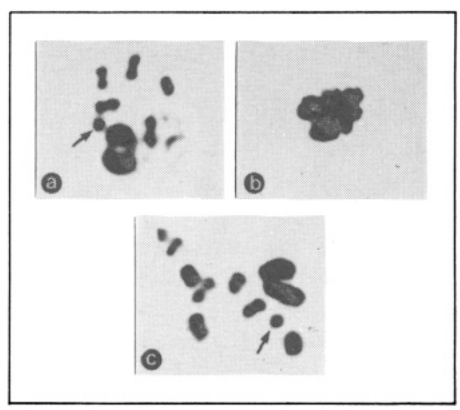
During growth phase of spermatogenesis in the green leafhopper *N. malayanus,* the primary spermatocytes undergo the first meiotic division. At diakinesis (Fig. 1a), the maximum condensation and coiling of holokinetic chromosomes results in 6 synapsed homologs plus a univalent X-body.

The male *N. malayanus* therefore has the normal diploid complement, 2n = 13 ($6II_A$ + XO). The prospective haploid sperm cells are of two types: ($6I_A$ + X) and ($6I_A$). The darkly stained, unpaired X-chromosome measured 1.18μ in length and width, and was usually isolated from the bivalent autosomes.

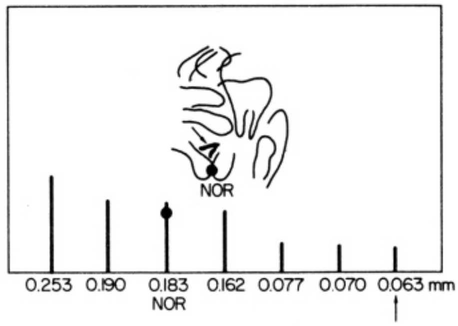
In pachytene analysis of meiotic chromosomes, the mean total



1. Chromosomes of male *N. malayanus* at a) diakinesis showing 2n = 13, and b) metaphase I. Spontaneous aberration may result in c) an agmatoploid cell with 2n = 19 (911 + X). IRRI, 1985-86. Arrow indicates the sex chromosome. Magnification 1500X (oil immersion).

chromatin length (142 mm) ranged from 10 mm to 36 mm (Fig. 2). The X-body was 9 mm long while the nucleolar organizing region (NOR) was 26 mm long. The relative mean length of the 7 linkage groups was 0.063 mm; NOR measured 0.183 mm.

These chromosomes condensed maximally during premetaphase, with these diameters: 4.1 μ, 3.5 μ, 3.5 μ, 2.9 μ, 2.6 μ, 2.4 μ, and 2.3 μ. One autosome was distinctly large (4.12 μ long and 3.5 μ wide) and was termed macro-autosome. Later, during metaphase 1 (Fig. 1b), the X-body fused



2. Camera lucida drawing of pachytene chromosomes of *N. malaynus* and their idiogram. IRRI, 1985-86. Sex chromosome is indicated by an arrow. Magnification 1250X (oil immersion).

with the autosomes at the equatorial plate. The corresponding chromosome volumes were 0.029 μ^3 (NOR), 0.018 μ^3 (NOR), 0.018 μ^3, 0.01 μ^3, 0.005 μ^3, and 0.0007 μ^3 (X).

N. malayanus has a mean meiotic index of 0.56, mean number of meiocytes 203, and mean number of nonmeiocytes 157.

During diakinesis, spontaneous chromosomal aberrations were shown by cells. In 100 cells, 10% had reduced chromosome numbers and 5% had increased chromosome numbers (Fig. 1c).

Population dynamics of the brown planthopper (BPH) in irrigated lowland areas of West Java, Indonesia

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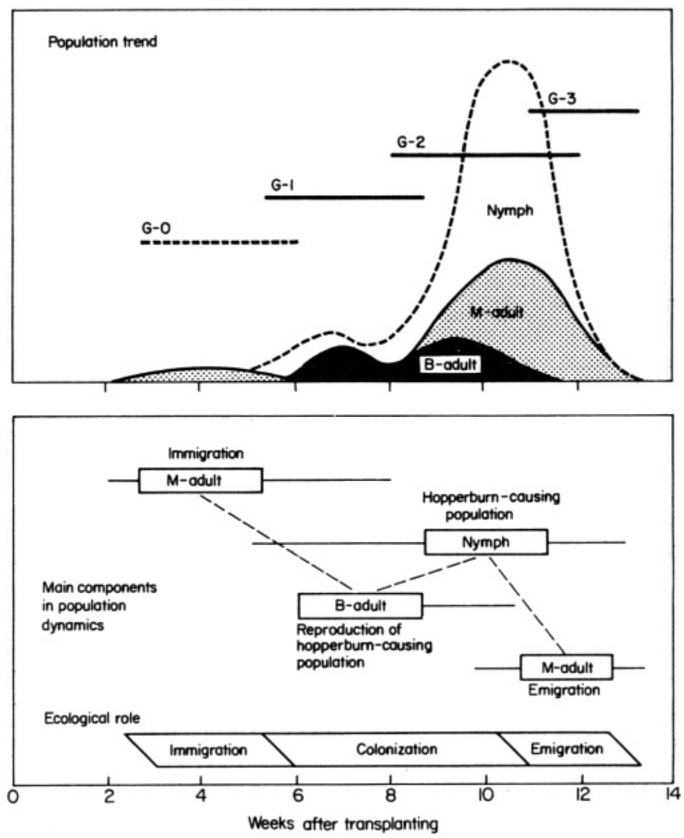
Population dynamics of the BPH were studied in six consecutive crop seasons (1983 dry season to 1985-86 wet season).

BPH- susceptible, high-yielding Pelita I/1 was planted in 10- × 10-m paddy plots. BPH population density and composition were visually counted weekly in 20- to 210-hill samples, depending on growth stage. Percentage of brachyptery was monitored weekly by sampling 5th-instar nymphs.

Although BPH populations varied considerably across the crop seasons, insect generations within a season more or less overlapped, a basic pattern of BPH population dynamics. Three ecological stages were associated with wing dimorphism (see figure):

Immigration: BPH population was initiated in newly transplanted rice fields with the immigration of a small number of macropterous adults. Immigration usually started at 3 wk after transplanting (WT) and was discontinuous throughout vegetative growth.



Basic trend of BPH population development in irrigated lowland ricefields in Jatisari West Java, and important components and stages of a population cycle. G-0 to G-3 = generation, B = brachypterous, M = macropterous.

Colonization: Nymphs from the immigrant founders appeared at 5-6 WT. The population increased strikingly when second-generation nymphs emerged, reaching its peak at heading to flowering 9-11 WT. Before the surge in nymph population, brachypterous females emerged at 6–8 WT, indicating the shift of generation.

Wing form monitoring showed that almost all the adults that emerged before 8 WT were brachypterous, indicating that first-generation nymphs from macropterous immigrants emerged mostly as brachyptera to contribute directly to colony growth.

Emigration: Adults emerging 10 WT from the peak nymph population were predominantly macropterous and emigrated. The population usually collapsed after that emigration.

Population density was highest at 9-11 WT, regardless of population pattern. Hopperburn depended on the nymph density at its climax. Most hopperburn-causing nymphs were considered to have come from the brachypterous females emerging 6–8 WT. Those brachypterous females emerged from the progeny of macropterous immigrants arriving at 315 WT. The densities of macropterous females at 3-5 WT and of brachypterous females at 6-8 WT, seem to be important parameters for predicting hopperburn on paddy crops at ripening.

Host range and biology of three rice caseworms

N. Chantaraprapha, Entomology and Zoology Division, Department of Agriculture, Bangkok, Thailand; and J.A. Litsinger, Entomology Department, IRRI

Three pyralid caseworms are commonly collected in light traps at IRRI. *Nymphula depunctalis* (Guenée) is a known pest of rice. The pest status of *Paraponyx* (= *Nymphula*) *fluctuosalis* (Zeller) and *Paraponyx* (= *Nymphula*) *diminutalis* (Snellen) was determined using rice and 61 ricefield weeds as hosts. Vegetative stage plants were used as caseworm attacks occur only during the first month after transplanting.

The plants were collected at IRRI and offered as food to newly hatched first-instar larvae. During the first round of screening, free-choice tests reduced the number of potential hosts to 28 (Table 1). Caseworm development was further evaluated in no-choice tests from the first larval stage through adulthood.

On all development parameters, rice was the most nutritious host; 85% larvae pupated and 67% emerged as adults. The polyphagous rice caseworm developed on 23 plant species representing 18 genera and 2 families. Survivorship to adulthood was low (2-36%) on the 22 nonrice hosts.

The larval growth index includes two developmental parameters: survival and days to pupation. A high growth index occurs with high survival and short developmental period. More than 20% of adults reared on *Leptochloa chinensis, Polytrias amaura, Chrysopogon aciculatus, Leersia hexandra,* and *Ischaemum muticum* emerged.

Neither *P. fluctuosalis* nor *P. diminutalis* survived on rice. They are true aquatic caseworms (they remain underwater during their entire larval period). *N. depunctalis* larvae are semiaquatic, ascending rice plants at night to feed.

The most suitable host of *P. fluctuosalis* and *P. diminutalis* was the

Table 1. Host plant range of 3 species of caseworms found in ricefields.[a] IRRI, 1983.

Plant[b]	Larval growth index[c]		
	N. depunctalis	*P. fluctuosalis*	*P. diminutalis*
Poaceae: Gramineae			
Oryza sativa	6.35 a	0	0
Leptochloa chinensis	1.92 b	1.5 c	0
Polytrias amaura	1.51 c	0	0
Echinochloa colona	1.50 c	0.6 f	0
Chrysopogon aciculatus	1.43 cd	0	0
Leersia hexandra	1.31 d	0	0
Ischaemum muticum	1.11 e	0	0
Phragmite vulgaris	1.04 ef	0	0
Digitaria ciliaris	1.01 ef	0	0
Paspalurn paspalodes	0.94 fg	0.3 gh	0
Echinochloa glabrescens	0.83 gh	0	0
Echinochloa crus-galli spp. *hispidula*	0.75 hi	0	0
Paspalidium flavidum	0.74 ij	0	0
Dactyloctenium aegyptium	0.58 ijk	0	0
Cynodon dactylon	0.55 jk	0	0
Chloris barbata	0.43 klm	0	0
Eleusine indica	0.28 mn	0	0
Panicum repens	0.25 n	0	0
Paspalum conjugatum	0.20 n	0.6 f	0.1 e
Cyperaceae			
Cyperus brevifolius	0.74 ij	2.4 b	0.2 e
C. rotundus	0.46 kl	0.7 f	0.9 d
C. difformis	0.36 lmn	0.2 h	0.8 d
Fimbristylis miliaceae	0.30 lmn	0.4 g	0.3 e
Hydrocharitaceae			
Hydrilla verticillata	0	3.3 a	5.2 a
Blyxa echinosperma	0	0.9 e	0.8 d
Ottelia alismoides	0	0.1 f	2.0 c
Characeae			
Chara vulgaris	0	1.4 cd	2.6 b
Commelinaceae			
Commelina diffusa	0	1.3 d	0.7 d

[a] Av of 4 replications, 25 larvae/replication. [b] These plants were not hosts to any caseworm species: *Alternanthera sessilis, Amaranthus spinosus* (Amaranthaceae); *Pistia stratiotes* (Araceae); *Ageratum conyzoides, Eclipta prostrata, Tridax procumbens* (Asteraceae); *Azolla caroliniana Azolla microphylla, Azolla pinnata* (Azollaceae); *Cleome rutidosperma* (Capparidaceae); *Pithophora* sp. (Cladophoraceae); *Commelina benghalensis* (Commelinaceae); *Ipomoea aquatica, Ipomoea triloba,* (Convolvulaceae); *Cyperus iria* (Cyperaceae); *Euphorbia hirta, Phyllonthus niruri* (Euphorbiaceae), *Marsilia minuta* (Marsileaceae); *Mimosa pudica* (Mimosaceae); *Ludwigia octovalvis* (Onagraceae); *Aeschynomene indica, Calopogonium mucunoides, Macroptilium lathyroides* (Papilionaceae); *Ceratopteris thalictroides* (Parkeriaceae); *Peperomia pellucida* (Piperaceae); *Imperata cylindrica, Polytrias amaura, Rottboellia exaltata* (Poaceae); *Eichhornia crassipes, Monochoria vaginalis* (Pontederiaceae); *Portulaca oleraceae* (Portulaceae); *Borreria ocymoides, Hedyotis biflora* (Rubiaceae); *Lindernia anagallis* (Scrophulariaceae); *Sphenoclea zeylanica* (Sphenocleaceae). [c] Growth index = pupation (%) divided by larval development (d).

aquatic weed *Hydrilla verticillata,* which occurs in more permanent bodies of water such as reservoirs and canals. Several of the needle-shaped leaves are tied together by the larva to make a case. The rearing method for both aquatic caseworms was less than ideal on *Hydrilla;* only 40-50% survived to adulthood. They pupate out of water on plant vegetation.

The host range of *P. diminutalis* was three times less than *N. depunctalis* and overlapped entirely with *P. fluctuosalis,* which accepted three more plant hosts. All three caseworms shared five host plants, four of them sedges: *Fimbristylis miliacea, Cyperus brevifolius, C. difformis, C. rotondus,* and *Paspalum conjugatum.*

All these caseworms are similar in size and fertility (Table 2). *P. diminutalis* has four larval instars, one less than *P. fluctuosalis* and *N. depunctalis;* matures about 10 d earlier than the 2; and has a longer egg incubation period. The sex ratio favored the development of females in *P. diminutalis* and *P. fluctuosalis,* probably because of the lack of a better rearing method. The present rearing method seemed to favor larger individuals, which were mostly females.

Table 2. Life histories of *P. diminutalis* and *P. fluctuosalis* on *Hydrilla verticillata* and of *N. depunctalis* on *Oryza sativa* (IR36).[a] IRRI headhouse, 1983.

Character	*P. diminutalis*	*P. fluctuosalis*	*N. depunctalis*
Fertility (no. eggs/female)[b]	130	125	117
Egg incubation period (d)	5.5	4.5	4.5
Larval developmental period (d)			
First stadium	2.5	3.0	3.5
Second stadium	3.3	3.9	3.8
Third stadium	3.3	4.5	4.1
Fourth stadium	4.0	4.5	4.5
Fifth stadium	–[c]	5.3	5.8
Pupal period (d)	6.9	9.6	7.9
Male longevity (d)	4.2	3.1	3.0
Female longevity (d)	4.3	3.9	5.0
Sex ratio (male:female)	1:1.5	1:1.2	1:1
Developmental period from egg to adult[d] (d)	29.8	39.2	39.1

[a]Av of 20 replications except when indicated otherwise. [b] Av of 5 pairs. [c] No fifth stadium. [d] Female.

Chromosomes of the primary spermatocytes of *Nephotettix nigropictus* (Stål)

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The testicular primary spermatocytes of newly emerged green leafhopper *N. nigropictus* contained first meiotic holocentric chromosomes. At diakinesis (Fig. la), the genomic complement consisted of 7 bivalent autosomes plus a univalent X-chromosome. Therefore, the diploid chromosome number of male *N. nigropictus* is 2n = 15 ($7II_A$ + XO).

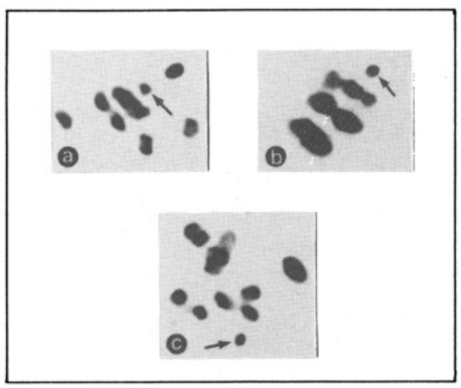
The prospective spermatozoa are of 2 types: n = 8 ($7I_A$ + X) and n = 7 ($7I_A$ + 0). During metaphase I (Fig. 1b), the heterochromatic X-body can be seen isolated from autosomes at the equatorial plate.

Pachytene analysis showed that the whole genome of males consisted of eight linkage groups (Fig. 2). The longest autosome was almost double the shortest. The relative mean lengths of chromosomes ranged from 0.062 to 0.165. The sex chromosome measured 0.062 and the autosome with the nucleolar organizing region (NOR) 0.155.

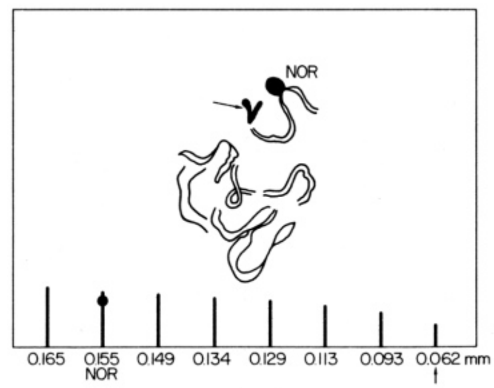
The chromosomes condensed maximally during premetaphase into dumbbels of bivalents measuring 3.9 μ, 3.3 μ (NOR), 2.7 μ, 2.5 μ, 2.4 μ, 2.1 μ, 2.0 μ, and 1.6 μ (X). Their corresponding chromosome volumes were 0.025 μ^3. 0.015 μ^3, 0.009 μ^3, 0.007 μ^3, 0.007 μ^3, 0.004 μ^3, 0.003 μ^3, and 0.001 μ^3.

The mean meiotic index approximated 0.61, the mean number of dividing spermatocytes was 227, the number of nondividing cells was 147.

Of 100 cells at diakinesis, 24% contain a reduced number of bivalents and 5% possessed an increased number of chromosomes (Fig. 1c).



1. Chromosomes of male *N. nigropictus* at a) diakinesis showing 2n = 15, b) metaphase I. Spontaneous aberration may result in c) an agmatoploid cell with 2n = 19 (911 + X). IRRI, 1985-86. The sex chromosome is indicated by an arrow. Magnification 1500X (oil immersion).



2. Camera lucida drawing of pachytene chromosomes of *N. nigropictus* and their idiogram. IRRI, 1985-86. The sex chromosome is indicated by an arrow. Magnification 1250X (oil immersion).

Incidence of the yellow stem borer (YSB) on deep water rice in the Mekong delta, Vietnam

Nguyen Van Huynh, Nguyen Ngoc Pho, and Nguyen Trung Truc, University of Can Tho, Hau Giang, SR. Vietnam

In 1983, YSB *Scirpophaga incertulas* damage as whiteheads was recorded at five sites in Mekong delta at different depths of floodwater. There was no significant difference in whiteheads among various water depths and whitehead incidence was quite low (Table 1).

In 1984, whitehead damage on the 3 most popular varieties in Chau Phu was similar, about 5% whiteheads, with no significant difference among varieties. However, infestation found by dissecting 50 plants randomly collected for each variety at flowering, hard dough, and fully ripe stages were much higher: 30-44% (Table 2).

Table 1. YSB incidence in deep water rice, Mekong delta, Vietnam, 1983.

Location[a]	Whiteheads (%)	Water depth (cm) at scoring	Highest water depth (cm)
An Giang province			
Chau Thanh	4.3	50	130
Chau Phu	4.6	60	160
Thoai Son	4.8	50	150
Dong Thap province			
Dong Cat	5.3	30	110
Thap Muoi	4.2	40	130

[a]Varieties not recorded.

Table 2. YSB infestation in dissected plants at Chau Phu, An Giang, Vietnam, 1984.

Variety	Infestation at different growth stages and water depth					
	Flowering		Hard dough		Fully ripe	
	90 cm	110 cm	70 cm	90 cm	30 cm	50 cm
	Infested plants (%)					
Chet Cut	36	38	36	34	38	34
Nang Choi	32	36	32	38	36	44
Nang Tay Dum	30	38	36	32	36	40
	Larvae (no./50 plants)					
Chet Cut	10	8	4	5	5	5
Nang Choi	8	9	3	5	6	4
Nang Tay Dum	7	9	4	6	3	3
	Pupae and pupal exuvate (no./50 plants)					
Chet Cut	2	5	6	4	6	4
Nang Choi	3	3	7	5	4	6
Nang Tay Dum	2	4	3	4	5	7

Resistance of rice accessions to green leafhopper (GLH) *Nephotettix virescens* and rice tungro virus (RTV)

C.A. Kumar and S. Chelliah, Tamil Nadu Agricultural University, Tamil Nadu Rice Research Institute, Aduthurai 612101, Thanjavur Dr., Tamil Nadu, India

Rice accessions resistant to GLH were identified and reaction to RTV evaluated.

Using the seedling bulk test, 27 accessions were screened for GLH resistance in the greenhouse. Damage was scored at 6 d after infestation by the IRRI *Standard evaluation system for rice* (SES). Selected 15-d-old resistant seedlings were inoculated with RTV. Seedling infection was recorded 20 d after inoculation. TN1 was the susceptible check for both vector and virus.

Of 27 rice accessions, IR24, IR29, IR54, ASD4, and Ponmani (CR1009) were found resistant to GLH (Table 1). Resistant accessions IR24, IR54, ASD4, and Ponmani and moderately resistant Vellai Ponni were tested for resistance to RTV. Only IR54 was resistant (Table 2). This suggests that resistance to the vector is independent of resistance to the virus.

Table 1. GLH resistance of rice accessions. Tamil Nadu, India.

Accession	Damage rating[a]
IR24	3
IR29	3
IR54	3
ASD4	3
Ponmani	3
IR20	5
IR50	5
ASD11	5
ASD 15	5
Ponni	5
Vellai Ponni	5
IR36	7
ASD3	7
ASD13	7
Co 42	7
Co 44	7
Punithavathi	7
Puduvai Ponni	7
IR42	9
ADT3 1	9
ADT36	9
ASDl0	9
Co 40	9
Co 41	9
PY2	9
TKM6	9
TKM9	9
TN1 (susceptible check)	9

[a]By the IRRI SES.

Table 2. Reaction of selected rice accessions to RTV. Tamil Nadu, India.

Accession	Infection (%)	Evaluation[a]
IR54	20	R
Ponmani	40	MR
Vellai Ponni	50	MR
ASD4	70	S
IR24	80	S
TN1	100	S

[a]R = resistant, MR = moderately resistant, S = susceptible.

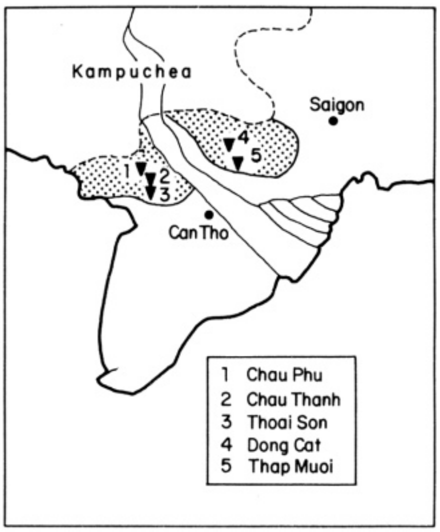
Insect and vertebrate pests of deep water rice in the Mekong Delta, Vietnam

Nguyen Van Huynh, Nguyen Ngoc Pho, and Nguyen Trung Truc, University of Can Tho, Hau Giang, SR. Vietnam

In 1984, 400,000 ha in 5 districts of 2 provinces was surveyed for insect and vertebrate pests (see figure). Five farmers' fields in each district were surveyed at 3 wk after seed germination, middle of flooding (Aug), and from flowering to harvest time. The data were confirmed by farmer interviews and general observations.

The most serious pest from booting to soft dough stage is the yellow stem borer *Scipophaga incertulas,* with a whitehead incidence of 4-10% (see table). The incidence of *Rattus argentiventer,* a serious vertebrate pest, depends on yearly flooding, with a high incidence in years of late and low flood. *Mus musculus homourus,* another rodent species, causes damage in some areas. *R. argentiventer* and the mole cricket *Gryllotalpa africana* are serious pests at preemergence and early seedling stages because most deep water rice is direct seeded with ungerminated seeds.

Chemical control by treating soil or seeds at seeding is the main practice for pest management in deep water areas; later stages are seldom sprayed. Cultural practices such as fallow, stubble burning, and cultivation of mungbean and sesame are followed in some areas.



Deep water rice area (dotted) and sites of pest survey in Vietnam, 1984.

Major insect and vertebrate pests of deep water rice in the Mekong Delta, Vietnam. 1984.

Pest species	Pest importance[a]		
	Preflooding	Flooding	After flowering
Gryllotalpa africana	++		
Stenchaetothrips biformis	+ – ++		
Nilaparvata lugens	+		
Sogatella furcifera	+ – ++	+	
Chilo spp.	+		
Scirpophaga incertulas	+	+	++
Nephotettix virescens	+	+	
Scotinophara coarctata	+	+	
Chaphalocrocis medinalis	+	+	++
Rattus argentiventer	++	+	++

[a]+ = minor, ++ = major.

Survival of adult *Nephotettix virescens* in test tube

M.M. Rahman, M.A. Ali, S.A. Miah, Plant Pathology Division, Bangladesh Rice Research Institute, Dhaka, Bangladesh

To screen for tungro virus (RTV) resistance in rice, the variety, whether it is susceptible to the vector, is not preferred, or has antibiosis, must be exposed to the vector for at least the minimum duration required for successful plant inoculation. Even when confined, the vector may avoid nonpreferred and resistant plants and may not initiate the sustained feeding necessary for RTV transmission.

On the other hand, prolonged desiccation and/or food deprivation may kill the vector. How long the RTV vector green leafhopper *Nephotettix virescens* can survive without food and water is not known.

We used 7-d-old TN1 rice seedlings as the food plant and caged newly emerged insects at the rate of 1 adult/test tube in 3 treatments: no water, no plant; water with no plant; water and plant. Each treatment was replicated twice with 40 insects/ treatment. Surviving adults were counted at 6-h intervals the first day and at 24-h intervals subsequently.

When deprived of both food and water, 75% adults died within 6 h and all died within 24 h (see table). When only water was provided, 71% adults survived the first 24 h and 37% survived up to 48 h. When both food and water were available, all adults survived at least 1 d, and 59% survived 7 d.

The results show that at least some individuals can survive for 1-2 d in test tubes without feeding on nonpreferred or resistant plants. Such plants could escape infection by insects placed inside the test tubes for inoculation feeding.

Surviving *N. virescens* **adults in food and water deprivation test.[a] Bangladesh Rice Research Institute, Dhaka, Bangladesh.**

Treatment	Surviving insects (%) at indicated hours after confinement								
	6 h	12 h	24 h	48 h	72 h	96 h	120 h	144 h	168 h
No plant, no water	25	9	0						
Water with no plant	99	90	71	37	19	12	7	4	3
Water and plant	100	100	100	95	92	84	82	75	59

[a]Means of 2 replications.

Pest Control and Management

WEEDS

Integrated weed control in upland rice

J.K. Kehinde and S.O. Fagade, National Cereals Research Institute, P.M.B. 5042, Ibadan, Nigeria

An experiment in 1983 determined the effect of single and combination weed control methods on weed growth, yield, and cost.

Chemical weed control or hand weeding was used singly, combined with each other, and combined with 2 spacings: 30 × 30 cm and 20 × 20 cm. The nine treatments were laid out in a randomized complete block design with three replications. Cost of land preparation and crop maintenance was assumed to be equal for all treatments.

Propanil was applied at 2.8, 3.0, and 3.6 kg ai/ha.

Major grass species found in experimental fields were *Digitaria horizontalis* and *Eleusine indica;* major broadleaf weeds were *Ageratum conyzoides* and *Boerhavia diffusa.*

A single application of propanil at 3.0 or 2.8 kg ai/ ha with 1 hand weeding 40 d after sowing (DAS) was as good as the weed-free control and 2 hand weedings (see table).

These two treatments controlled weeds better than a single application of propanil at 3.6 kg ai/ ha. With the 20 × 20 cm spacing, propanil at 3.0 kg ai/ ha controlled weeds better than weeding once 21 DAS.

All treatments involving weeding were relatively expensive because of labor costs. Although one weeding combined with 2.8 kg ai propanil/ha at the 30 × 30 cm spacing gave the highest yield, application of 3.6 kg ai propanil/ha alone gave the highest return.

Effect of weed control method on upland rice (Faro 11).[a] Ibadan, Nigeria.

Treatment[b]	Application		Fresh weed wt (g/m^2)	Yield (t/ha)	Cost of treatment[c] ($/ha)	Value of yield ($/ha)	Marginal benefit-cost ratio
	Rate (kg ai/ha)	Time (DAS)					
Propanil, 20 × 20 cm	3.0	14	106.7 b	1.24 a	125	930.00	12.4
Propanil	3.6	14	191.7 c	1.25 a	120	937.50	13.4
Propanil + weeding	3.0	14 & 40	46.7 ab	1.49 a	175	1117.50	8.9
Propanil + weeding	2.8	14 & 40	80.0 b	1.56 a	172	1170.00	9.6
Weeding, 20 × 20 cm	–	21	185.0 c	0.74 b	150	555.00	5.6
2 weedings	–	14 & 40	68.3 a	1.42 a	190	1065.00	7.6
20 × 20 cm	–	–	288.3 d	0.02 c	65	15.00	1
Weedy check	–	–	380.0 e	0 c	50	0.00	0
Weed free	–	14, 35 & 56	17.3 a	1.47 a	235	1102.50	6.0

[a] Separation of means in a column by DMRT at the 5% level. [b] Where not stated, spacing was 30 × 30 cm. [c] Does not include cost of land preparation and crop maintenance. Cost of propanil = $6/liter. Cost of weeding = $5/man day.

Machinery Development and Testing

Developing an animal-driven pump to draw groundwater

M. A. Baqui, Agricultural Engineering Division, Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Bangladesh

An animal-driven groundwater pump with a positive displacement pumping unit draws and delivers water through reciprocating pistons. The power principle is similar to that used by an animal-driven sugarcane crusher, with a 1:5 speed ratio.

The pump consists of four 15-cm-diameter cylinders fitted with leather-lined bucket pistons. A crankshaft operates the pistons.

The pump was tested by installing it on a 5-cm-diameter, 30-m-deep tubewell. At a bullock speed of 3.8 km/h, the pump discharged 170 liters/min. At a buffalo speed of 5 km/h, it delivered 225 liters/min (Table 1).

The average draft (28 kg) was very low compared to the draft capability of a typical bullock (60 kg).

Table 1. BRRI animal-driven pump performance.[a]

Animal employed	Av discharge (liters/min)	Av animal speed (km/h)	Av static water level (m)	Av draft (kg)
Bullock	169.72	3.78	2.95	27.1
Buffalo	224.93	4.98	3.0	27.8

[a] Mean of 5 observations.

A pump with a PVC tubewell (estimated cost: US$188) could replace more expensive shallow tubewells. The cost of irrigation is about 3.5 times less (Table 2). The pump also saves the 350 liters of diesel per hectare required by shallow, engine driven tubewells.

The pump is dependable and uses inexpensive fabrication materials available, even in remote areas.

Table 2. Irrigation costs of BRRI animal-driven pump and engine-operated shallow tubewell.

Equipment	Av measured discharge (liter/s)	Irrigation requirement (m^3/ha)	Total pumping period (h/ha)	Total cost of irrigation (US $/ha)	Command area (ha/season, rice)
BRRI animal-driven pump	2.8	10,000	980	27.8	1.2
Shallow tubewell	12.0	10,000	232	103.0	4.9

Inverted-T multicrop seeder for rice-based cropping systems

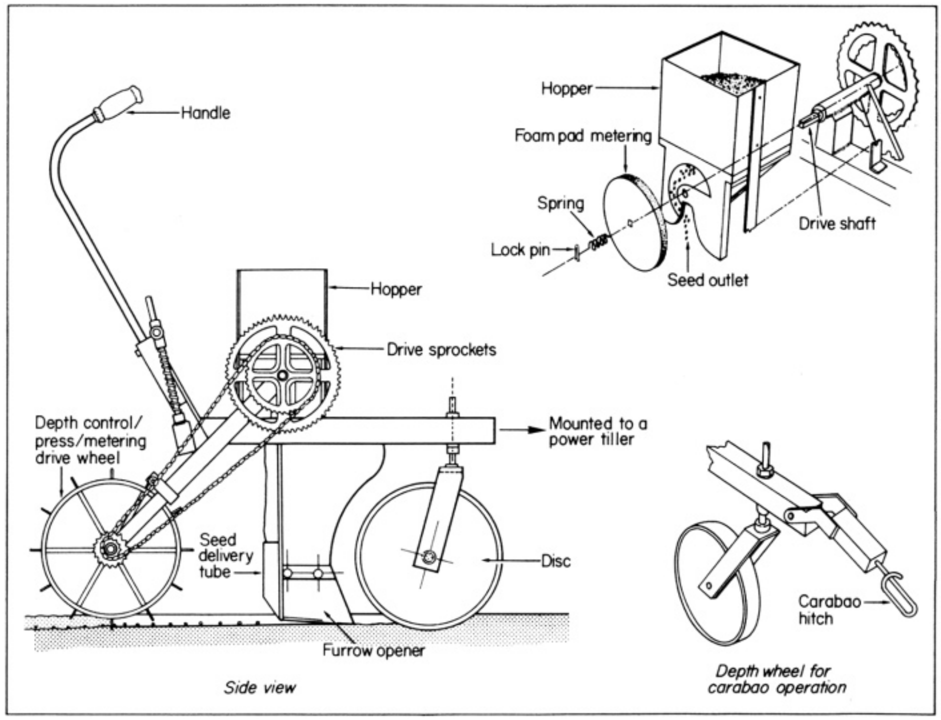
M.A. Choudhary and M. Aban, Agricultural Engineering Department, IRRI

A new multicrop seeder utilizes a mechanical design developed on the basis of soil physical requirements for improved seed germination and seedling emergence.

The seeder (see figure) incorporates an inverted-T opener, which creates seed microenvironments tolerant of a wide range of field conditions in both previously tilled and untilled soil conditions. The subsurface soil shattering created by the inverted-T seeder facilitates shoot and root proliferation and improves in-grove moisture availability.

A depth wheel ensures proper seed depth. It also serves as a presswheel to provide seed cover and to improve seed-soil contact, enhancing moisture conductivity at the seed-soil interface. The wheel also drives the seed metering unit.

The seeder utilizes a seed metering assembly originally designed by Aitchison Industries, New Zealand, which provides a high degree of metering and delivery accuracy with minimum periodicity and no seed damage. Almost all crop seeds — maize, beans, rice, peanuts — can be satisfactorily metered and sown. A horizontally mounted circular foam pad attached to a steel pad rotates along the vertical plate of the plastic hopper base. Seeds are delivered down through a throat-type opening mounted on the hopper base. The galvanized sheet iron hopper is attached directly over the plastic base.



Inverted-T multicrop seeder. IRRI, 1986.

The single-row unit model can be mounted on a two-wheel tractor for seeding in both previously tilled and untilled upland and lowland soils. A simple and easily attached drag arm in front of the seeder allows it to be operated by animals.

Production cost of the seeder, manufactured by small metalworking shops, is estimated to be less than US$100.

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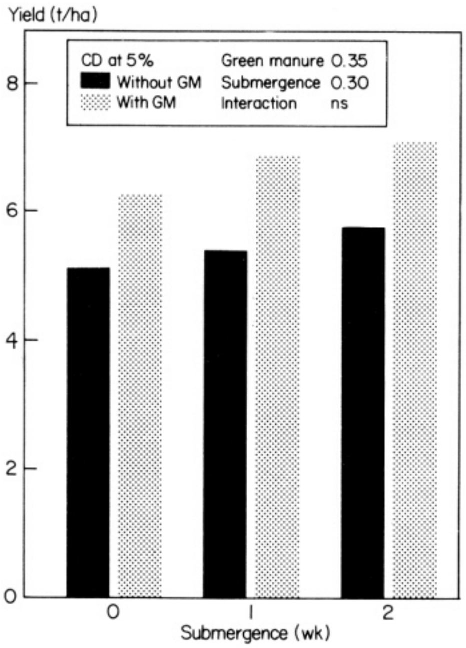
Soil and Crop Management

Effect of pretransplanting submergence and green manure on yield and sodic soil improvement

A. Swarup, Central Soil Salinity Research Institute (CSSRO, Karnal, India

A field experiment in split-plot design evaluated the effect of 0, 1, and 2 wk field submergence before transplanting with and without green manure on yield and sodic soil improvement. The experiment was replicated three times.



Response of rice to pretransplanting submergence with and without *Sesbania* green manure. CSSRI, Karnal, India.

The highly sodic soil of the test plots had pH 10.25, exchangeable sodium percentage (ESP) of 86, 0.48 meq of exchangeable Ca + Mg/100 g soil, 0.21% organic C, 2.85% $CaCO_3$, 10.8 meq CEC/100 g soil, and 20 t gypsum requirement/ha.

Gypsum was applied at 10 t/ha in all 40-m^2 plots and water was ponded for 1 wk before sowing *Sesbania aculeata* (10 May 1985). The green manure crop was irrigated as required. Plots without a green manure crop were irrigated at the same time.

Sesbania was incorporated at 50 d and plots were submerged 0, 1, and 2 wk before transplanting Jaya rice in standing water (12 Jul). Plots were kept submerged throughout rice crop growth. Urea at 150 kg N/ha and $ZnSO_4$ at 40 kg/ ha were applied to all treatments. Half the N and all the Zn were applied at transplanting. The remaining N was topdressed in 2 equal splits at 3 and 6 wk. The crop was harvested 30 Oct.

Green manuring significantly enhanced yield (see figure), contributing 111.6 kg N/ha. One week of submergence with incorporated green manure significantly improved yield over no flooding and equaled 2 wk submergence. Yield with pretransplanting submergence without green manure was significant only with 2 wk submergence. Continuous submergence improved the sodic soil and green manuring further decreased pH and exchangeable sodium (see table).

Effect of presubmergence and green manure on N contribution to rice crop, soil pH, and ESP at 0-15 cm soil depth.[a] CSSRl, Karnal, India.

Treatment		Biomass (t/ha)	N tumed in (t/ha)	At transplanting		After harvest	
N source	Presurbmergence (wk)			Soil pH	ESP	Soil pH	ESP
No green manure, 150 kg N/ha	0	–	–	9.6	45	9.4	36
	1	–	–	9.6	42	9.3	34
	2	–	–	9.5	42	9.3	34
Green manure, 150 kg N/ha	0	3.8	111.5	9.3	35	9.0	30
	1	3.8	110.8	9.2	32	8.9	28
	2	3.9	112.6	9.1	32	8.8	25
LSD (0.05)	Biomass and N	NS	NS	–	–	–	–
	Green manure	–	–	0.22	3.2	0.20	2.4
	Submergence	–	–	0.12	1.5	0.11	1.2

[a]Initial soil pH 10.25, ESP 86. Gypsum was applied at 10 t/ha before sowing *S. aculeata.*

Response of rice to different N fertilizers

S. Rajagopalan and M. Subramanian, Paddy Experiment Station, Ambasamuduram 627401, Tamil Nadu, India

The relative efficiency of slow-release N fertilizers was studied in 1984 rabi (Oct-Feb) and 1985 kharif (Jun-Sep). Test varieties were IR20 (135 d) in rabi and TKM9 (110 d) in kharif.

The experimental field was sandy loam, with pH 4.9 and 288 kg N, 33 kg P, and 112 kg K/ha available nutrients. In the split-plot design, replicated three times, four N sources were applied at two levels in the main plot and two application methods were compared in subplots. P and K were applied to all plots at transplanting. Urea supergranule (USG) was placed in alternate rows as basal and topdresed; prilled urea (PU), neem cake-blended urea, and coal tar-coated urea were incorporated just before transplanting (basal) and broadcast at the time of topdressing.

Application methods were 100% N applied as basal and incorporated just before transplanting and 50% N applied as basal and 50% N as topdressing in 2 equal splits at active tillering and panicle initiation.

During kharif, the interaction of N level and sources significantly influenced yield. USG at 75 kg N/ ha gave the maximum yield (6.15 t/ ha) (see table). During rabi, application method and the interaction of N level and source were significant. At 100 kg N/ ha, USG gave the maximum yield (4.05 t/ha), equal to yields with coal tar- and neem cake-coated urea and with USG applied at 75 kg N/ ha. Split application of N was best.

In kharif, USG, urea coated with neem cake (20%), and coal tar (1%) at higher N levels produced significantly higher yields than PU. In rabi, USG placement at lower N levels produced yields equal to those with neem cake, coal tar, and USG applied at higher N levels, resulting in 25% N savings.

Influence of different N sources and levels on rice grain yield. Tamil Nadu, India.

N level (kg/ha) and sources	Yield (t/ha)		
	100% basal	50% basal + 50% split	Mean
TKM9 in kharif			
50 kg N/ha			
PU	5.4	5.5	4.50
Neem cake-blended (20%)	5.5	5.5	5.50
Coal tar-coated (1%)	5.4	5.5	5.45
USG	5.7	5.8	5.75
75 kg N/ha			
PU	5.6	5.8	5.70
Neem cake-blended (20%)	6.0	6.2	6.10
Coal tar-coated (1%)	5.9	6.2	6.05
USG	6.2	6.1	6.15
Mean	5.7	5.8	
IR20 in rabi			
75 kg N/ha			
PU	3.5	3.6	3.55
Neem cake-blended (20%)	3.7	3.7	3.70
Coaltar-coated (%)	3.5	3.7	3.60
USG	4.0	3.9	3.95
100 kg N/ha			
PU	3.6	4.0	3.80
Neem cake-blended (20%)	3.8	4.0	3.90
Coal tar-coated (1%)	4.0	4.1	4.05
USG	4.0	4.1	4.05
Mean	3.76	3.88	

CD at 5%	*1984 rabi*	*1985 kharif*
N × source	0.22	0.29
Application method	0.09	ns
N × sources × application method	ns	ns

Integrated organic and inorganic nitrogen fertilizer in lowland rice

S. Elankumaran and G. S. Thangamuthu, Agronomy Department, Tamil Nadu Agricultural University (TNAU), Coimbatore 641003, India

The effectiveness of urea or urea supergranules (USG) applied alone or in combination with azolla or rice straw was evaluated during 1984 kharif. The experiment was laid out in a randomized block design with four replications. Soil was clay loam with a pH of 8.2, 1.10% organic matter, 201 kg available N/ ha, 5 kg available P/ ha, and 427 kg available K/ha.

Urea and USG were compared at 58 and 87 kg N/ha. Azolla and straw were used to substitute for 29 kg N/ha. P and K were applied basally at 22 kg P/ ha and 42 kg K/ ha.

Fresh azolla was incorporated 1 d before transplanting. To ensure proper decomposition, straw was chopped and incorporated 15 d before transplanting. Urea was applied 1 /3 basal, 1/ 3 at tillering, and 1/3 at flowering. USG was deep placed 1 wk after transplanting.

N level significantly influenced yield (see table). Deep placement of USG was significantly superior to urea at all N levels. Yield was highest with deep placement of USG at 87 kg N/ ha.

The relatively lower yield with broadcast application of urea was presumably due to losses of N through ammonia volatilization and denitrification. Incorporating azolla with USG was as good as USG alone. Incorporating straw with USG was as effective as USG alone. The N and P fertilizers might have enhanced response to straw incorporation.

Azolla or straw combined with urea did not increase yield.

The net income and return on investment were highest with deep placement of USG at 87 kg N/ ha. Deep placed USG was more profitable than split applied urea at all levels of N. Incorporation of azolla or straw with either urea or USG resulted in lower net income and return on investment than complete application of urea or USG. Azolla and straw involved high cultivation costs.

Effect of source and level of N on yield and return on investment. Coimbatore, India.

Source	N (t/ha)	Yield (t/ha)	Return on investment (%)
Control	0	2.8	51
PU	58	3.5	80
USG	58	4.2	106
PU + azolla	29 29	3.3	66
PU + straw	29 29	3.3	46
USG + azolla	29 29	3.5	72
USG + straw	29 29	3.4	50
PU	87	4.3	113
USG	87	5.2	147
PU + azolla	58 29	4.2	104
PU + straw	58 29	4.1	76
USG + azolla	58 29	5.0	138
USG + straw	58 29	4.9	108
SEd.		155.8	
CD (P = 0.05)		315.9	

Evaluating rate, timing, and method of N application using tracer technique

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To study rate, timing, and method of N application, ammonium sulfate enriched at 5% atom excess level with N-15 was used as a tracer. The field trial was conducted on clay alluvial soil with pH 8.4, 1.77% organic matter, 1,940 ppm tota1 N, 37.2 ppm in organic N, 16.8 ppm Olsen's P, 580 ppm ammonium acetate extracted K, EC 1.21 dS/ m, and 53% $CaCO_3$. The experiment was a complete randomized design with four replications. All plots received a blanket application of P and K.

Yield, and conventional and isotopic analyses of plant material indicate that grain and straw yields, as well as total N uptake, increased with rate of N application up to 108 kg/ ha (see table). All timing and methods of N application — banding in dry soil, point placement 10 cm deep in soil, topdressing 2/3 at 35 d after transplanting (DT) + 1/3 at panicle initiation (PI) and banding 2/ 3 in dry soil + 1/ 3 at PI — gave roughly comparable results. However, point placement was superior. Yields with N broadcast in water before leveling and topdressing 2/3 15 DT and 1/3 at PI were lower.

The % N derived from fertilizer increased as the rate of application increased up to 108 kg N/ha. However, the difference between 72 and 108 kg N/ ha was insignificant. Point placement treatment was best, broadcasting N in water before leveling was least effective.

Amount of fertilizer N taken up by the plant showed similar patterns.

Recovery of fertilizer N ranged from 9.6 to 39.4%. Values for point placement and topdressing 2/3 at 35 DT and 1/3 at PI were highest, those for the traditional treatment of N broadcast in water before leveling were lowest.

Effect of rate, timing, and method of N application on yield and N uptake. Giza, Egypt.

N rate (kg/ha)	Time and method of application	Yield (t/ha)		Total N uptake (kg/ha)	% N derived from fertilizer	Fertilizer N uptake (kg/ha)	Recovery (%)
		Grain	Straw				
–	--	4.7	4.8	68.71	–	–	–
36	Banded in dry soil	6.3	6.8	87.53	7.15	6.26	17.4
72	Banded in dry soil	7.5	9.4	120.69	16.01	19.33	26.9
108	Banded in dry soil	8.7	9.1	128.54	18.19	23.36	21.6
72	Broadcast in water before leveling	6.3	7.9	89.78	7.74	6.94	9.6
72	Point placement 10 cm deep 10 DT	7.6	9.5	115.17	24.59	28.33	39.4
72	2/3 banded in dry soil + 1/3 at PI	6.6	8.2	105.28	14.18	14.93	20.7
72	2/3 topdressed 15 DT + 1/3 at PI	6.0	6.2	87.17	14.82	12.92	17.9
72	2/3 topdressed 35 DT + 1/3 at PI	7.3	7.7	105.66	20.51	21.68	30.1
	LSD 5%	0.9	2.4	21.51	–	5.58	–

Response of flooded rice to different levels and placement methods of urea and urea supergranule

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The efficiency of urea and urea supergranules (USG) at different N rates and placement methods in flooded lowland transplanted rice was studied during 1982 kharif. Jaya variety 25-d-old seedlings were transplanted at 20- × 20-cm spacing in 5- × 4-m plots in a randomized block design with 3 replications. The soil (Beni silty clay loam) classified as Aquic Hapludoll had 8.2 pH, 0.76% organic C, 33 kg available P/ ha, and 229 kg available K/ ha.

Urea was broadcast and incorporated (B&I) at transplanting and topdressed in two equal splits at tillering and panicle initiation. USG was B&I at transplanting, placed 8-10 an deep in the center of 4 hills in alternate rows 10 d after transplanting (DT), and B&I at transplanting and topdressed in splits at tillering and panicle initiation. All plots received 40 kg P/ ha as single superphosphate and 20 kg K/ ha as muriate of potash. $ZnSO_4$ was applied at 2.5 kg/ ha.

Based on plant height, USG was superior to urea at all N rates and application methods (see table). Split placement showed the highest plant height, followed by basal placement and B&I split. Similar results were observed with panicles/ m^2, panicle length, panicle weight, and grain filling. The interaction of N source, rate, and placement method significantly influenced grain and straw yield.

Influence of N source, level, and placement method on growth, yield components, and yield. Pantnagar (U. P.) India.

Treatment (kg N/ha)	Height (cm)	Panicles/m^2	Panicle length (cm)	Panic1e wt (g)	Filled grains/ panicle	Yield (t/ha)	Straw (t/ha)
0 Control	61	157	19.7	1.8	81	2.7	3.4
60 urea B&I, basal	62	167	20.5	2.1	89	3.9	4.5
60 USG B&I, basal	64	186	21.0	2.3	96	3.7	4.6
60 USG deep placed, basal	68	203	21.5	2.5	108	3.9	5.4
60 urea B&I, split	64	181	20.7	2.1	91	3.5	4.0
60 USG B&I, split	66	198	21.2	2.4	102	3.6	4.4
60 USG deep placed, split	67	218	21.7	2.6	113	3.4	4.8
90 urea B&I, basal	68	180	21.6	2.7	116	4.2	5.3
90 USG B&I, basal	71	217	22.5	3.2	135	4.2	5.2
90 USG deep placed, basal	75	229	23.5	3.0	153	4.3	6.3
90 urea B&I, split	70	192	22.0	2.9	125	3.6	4.4
90 USG B&I, split	74	225	23.0	3.4	144	4.1	4.9
90 USG deep placed, split	76	236	24.0	3.8	163	4.1	5.2
120 urea B&I, split	80	250	24.5	4.1	174	4.4	5.1
120 USG deep placed, split	83	265	25.0	4.5	185	4.7	7.4
CD (5%)	3	11	0.3	0.1	5	0.6	0.9

Response of rainfed rice to farmyard manure placement and soil compaction

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We studied the response of rainfed rice (VRS163) to farmyard manure (FYM) incorporated at 10-cm soil depth, placed in 10-cm deep furrows, and placed 10 cm below soil surface. Two levels of soil compaction — no compaction (bulk density of 1.36 g/cm^3) and interrow compaction (bulk density of 1.54 g/cm^3) — also were studied.

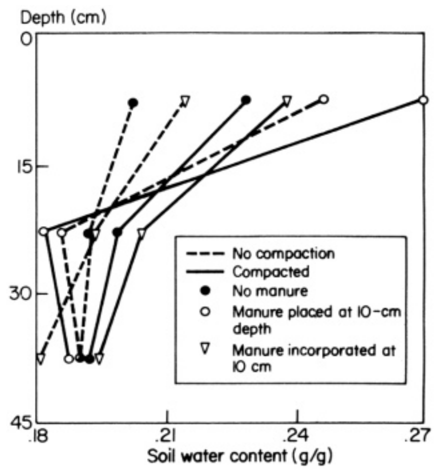
The soil was a silt loam with 0.93% organic C and available moisture content of 14% (wt/wt). The crop received a basal dose of 40-18-33 kg NPK/ha. Rice was sown 5 Jul 1985 in rows 23 cm apart. Manure was applied at 10 t/ha.

Yields were significantly higher with surface incorporation and placement at 10-cm depth (see table). Interrow soil compaction increased yield 9%. Weed growth was reduced by about 64% in soil compacted plots.

Surface layer soil moisture retention was increased by soil compaction and FYM placement (see figure). Profile moisture in the compacted plots was about 2 cm higher than in the uncompacted plots.

Influence of soil compaction and FYM placement on yield and weed growth. Almora, India.

	Yield (t/ha)		Weed growth (g/m^2)	
	Not compacted	Compacted	Not compacted	Compacted
No manure	1.86	2.04	20.2	7.5
Manure incorporated at 10 cm	2.14	2.36	21.7	7.5
Manure furrow-placed	2.01	2.04	19.0	6.7
Manure placed 10 cm deep	2.19	2.34	18.2	6.9
CD 5%		Grain	Weed	
Compaction		ns	5.62	
FYM placement		0.26	1.65	
Interaction		ns	ns	



Soil water content at 70 d after sowing with compaction and FYM placement. Almora, India

Improved management of urea in rice

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Experiments on N fertilizer management were conducted for four seasons (1983-85 kharif and summer 1984) on red sandy loam soil (Alfisols). The soil had pH 6.5, 0.65% organic C, 16.1 kg available P/ha, and 230 kg available K/ha. Loss of N through volatilization (static trap method) and leaching (using soil water samples tubes) was determined in the field. Test variety was IR20. The crop was raised using all the recommended practices under irrigated conditions. Neem cake-coated urea (NCCU) used (32% N) was prepared in a locally fabricated machine by using dehydrated neem cake (30% urea by weight) and a one-part coal tar (1% urea by weight) and 2 parts kerosene oil solution (available locally).

Effect of improved management of urea on yield.[a] Mandya, India.

Treatment[b]	N loss (kg/ha)	N uptake (kg/ha)	Yield (t/ha)
Recommended practice: 100 kg N/ha as urea in 3 splits (50-25-25)	31.3	78.3	4.6
Improved practice: 80 kg N/ha through NCCU, all basal	20.7	84.1	5.4
Improved practice: 80 kg N/ha through 80% N as NCCU basal followed by 20% N as urea topdressed at tillering	16.2	96.3	6.1
No N (control)	8.8	44.1	2.7
'F' Test		**	**
CD (0.01)		15.2	0.6
CV (%)		9.3	10.1

[a]Av of 4 seasons. [b]All treatments received 22 kg P as single superphosphate and 41 kg K/ha as muriate of potash

NCCU significantly reduced N loss (34%) and increased yield (17%) as a consequence of better uptake (7%) of N. The result was a 20% savings in fertilizer over the recommended practice (see table). Efficiency increased substantially with 80% N applied as NCCU, basal, followed by 20% N as prilled urea topdressed at tillering. N losses were significantly less (48%) and yields higher (32%) because of higher N uptake (23%), resulting in 20% savings in the fertilizer over the recommended practice.

Evaluation of urea forms in thaladi rice (IR20)

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We compared the performance of 75 kg N/ ha as urea supergranules (USG), sulfur-coated urea (SCU), lac-coated urea (LCU), and gypsum-coated urea (Gyp-U) to split application (50% N basal, 25% N at tillering, and 25% N at panicle initiation) of prilled urea (PU). USG was point-placed at the center of 4 hills 2 d after transplanting. SCU, LCU, and Gyp-U were broadcast and incorporated before planting.

P and K (22 kg P/ ha, 42 kg K/ ha) were applied basally. Soil was clay loam, low in available N, medium to high in available P and K contents. The trial was conducted during 1985-86 thaladi (Sep-Feb) with IR20) seedlings transplanted at 20- × 19-cm spacing. Grain yield was computed at 14% moisture.

SCU yielded over 1.9 t/ ha more than control and gave 70 kg grain/kg N. A11 other forms of urea yielded more than split application of urea (see table).

Comparative yield with different forms of urea in 1985-86 thaladi. Aduthurai, India.

Urea form	Yield[a] (t/ha)	Yield increase (t/ha)	N efficiency (kg grain/ kg N)
Control	3.36 b	–	–
PU	4.34 a	0.98	58
USG	4.84 a	1.48	65
SCU	5.26 a	1.90	70
LCU	4.44 a	1.08	59
Gyp-U	4-40 a	1.04	59

[a]Means followed by a common letter are not significantly different at 5% level by DMRT.

Response of Magsanaya upland rice in an acidic upland area to lime and fertilizer

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The effects on Magsanaya upland rice of lime and different kinds of fertilizer were studied in a split-plot design. Soil was an Ultisol, clay loam with pH 4.0, 4% organic matter, 6 ppm available P (Olsen), and 60 ppm H_2SO_4 extractable K.

Liming at 6 t/ ha was assigned to the main plot. Different fertilizers were assigned to the subplots (see table).

Lime, chicken dung, and azolla were broadcast and incorporated 1 mo before planting. Other fertilizers were applied just before planting.

Applying lime did not significantly increase yield. Chicken dung and azolla were not as good as commercial NPK, either alone or in mixture (see table).

Yield response of Magsanaya upland rice to lime and various fertilizers. Panay Island, Philippines.

Fertilizer	Yield[a] (t/ha) No lime	Yield[a] (t/ha) 6 t lime/ha
35-35-35 kg NPK/ha	2.20 b	2.30 a
28-28-28 kg NPK+ 100 kg commercial organic fertilizer	2.08 b	2.02 b
28-28-28 kg NPK + 1.8 t bat cave rock phosphate mixed with bagasse ash	2.50 a	2.43 a
10 t dried chicken dung	1.17 c	1.39 c
20 t fresh azolla	0.54 d	.86 d
No fertilizer	0.43 d	.72 d
CV (%)	Main Plot – 12.81 (ns)	
	Subplot – 6.3 (s.)	

[a]Separation of means by Duncan's multiple range test at the 5% level.

Rice-Based Cropping Systems

A suitable cropping system for Thambiraparanj region in Tamil Nadu

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In Thambiraparanj region of Tirunelveli District in Tamil Nadu, a two-crop system — a short-duration rice during first season (Jun-Sep) and a medium-duration rice during second season (Oct-Feb) — is generally followed. We conducted an experiment to find a suitable three-crop system, by raising a third crop of pulses and oil seeds during summer depending on available soil moisture and summer showers. We tested five crops (Table 1).

Black gram, green gram, and soybean seeds were dibbled without land preparation and groundnut seeds were dibbled after land preparation. Spacing was 30 cm between rows for all, and 10 cm between plants for black gram and soybean and 15 cm for green gram and groundnut. Seed rate was 20 kg/ ha for black gram and soybean, 37.5 kg/ ha for green gram, and 100 kg/ ha for groundnut. Gingelly seeds were broadcast after land preparation at

Table 1. Crops tested in the summer season, 1984-85, Paddy Experiment Station, Ambasamuduram, Tamil Nadu, India.

Crop	Variety	Duration (d)	Sowing date
Black gram *(Vigna mungo)*	Co. 5	76	17 Feb 1985
Green gram *(Vigna radiata)*	Co. 4	92	17 Feb 1985
Soybean *(Glycine max)*	Co. 1	94	17 Feb 1985
Groundnut *(Arachis hypogaea)*	Co. 2	112	19 Feb 1985
Gingelly *(Sesamum indicum)*	Co. 1	96	6 Mar 1985

5 kg/ha. Rainfall during the crop season (Feb-Jun) was 104 mm but only 32 mm was received within 42 d after sowing.

Table 2 shows the mean grain yield in a decreasing order of 0.53 t for black gram, 0.41 t for soybean, 0.33 t for groundnut, 0.28 t for green gram, and 0.21 t/ha for gingelly. Better performance of black gram was ascribed to its shorter duration, uniform and synchronous flowering, and completion of harvest in two pickings. The results indicated that a third crop of pulse would fit in a commonly used two crop rice - rice rotation.

Table 2. Grain yield of first, second, and third crops during 1984-85, Paddy Experiment Station, Ambasamuduram, Tamil Nadu, India.

Cropping pattern	Grain yield (t/ha)		
	First crop	Second crop	Third crop
TKM9-IR20-Black gram	4.52	4.11	0.53
TKM9-IR20-Green gram	4.38	4.18	0.28
TKM9-IR20-Soybean	4.33	4.26	0.41
TKM9-IR20-Gingelly	4.57	4.01	0.21
TKM9-IR20-Groundnut	4.28	4.11	0.34
IR20-ADT36-Black gram	3.28	3.34	0.52
IR20-ADT36-Green gram	3.17	3.37	0.27
IR20-ADT36-Soybean	3.08	3.45	0.40
IR20-ADT36-Gingelly	3.04	3.47	0.20
IR20-ADT36-Groundnut	3.05	3.70	0.32
CD (5%)	0.41	0.55	–

Organic manures as a nitrogen source in a rice - wheat rotation

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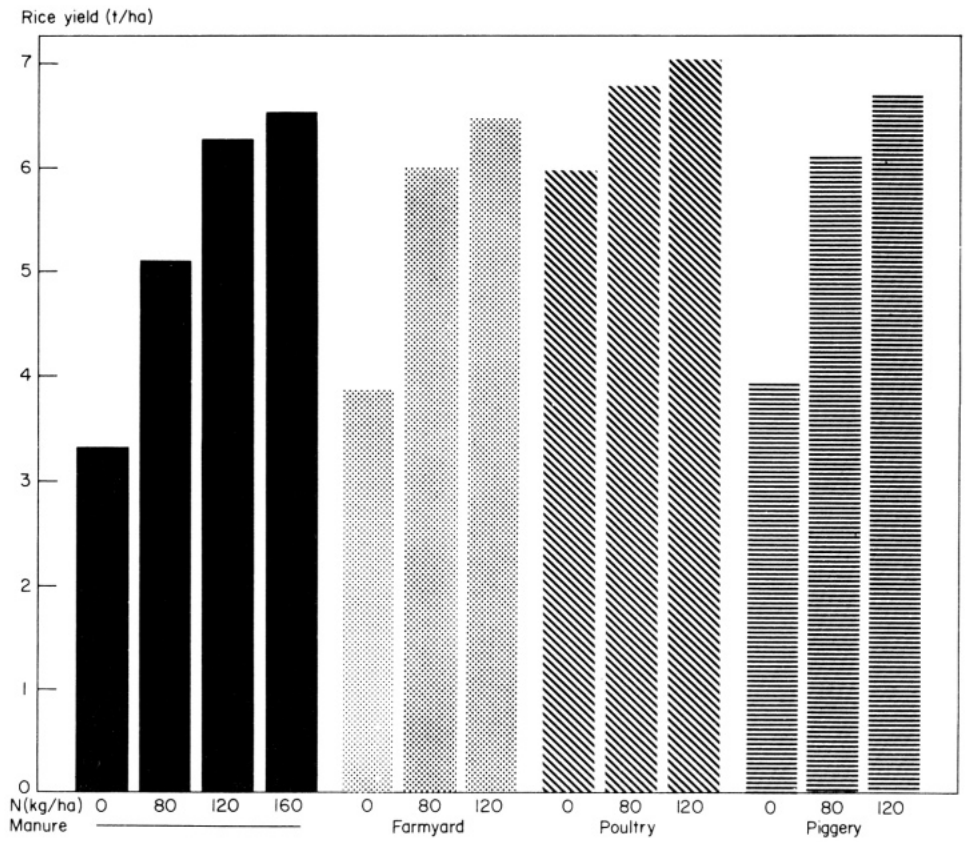
The effect of poultry, piggery, and farmyard manures as substitute N was evaluated at the PAU farm during kharif 1984 and 1985. The soil (pH 8.5, EC 0.15 dS/m, organic C 0.25%, total N 0.03%) of the experimental field is loamy sand (Typic Ustochrept) with an average percolation rate of 5 mm/h. The rice variety was PR106.

Poultry, piggery, and farmyard manures containing 1.50, 1.36, and 0.51% N were applied at 5.0, 5.5, and 15 t/ha, each adding about 75 kg N/ha. The manures also were supplemented with 2 levels (80 and 120 kg N/ha) of urea N applied in 3 equal splits: at transplanting and at 21 and 42 d after transplanting. A basal dose of 13 kg P and 12.5 kg K/ha was applied at last puddling.

Yields with poultry manure without fertilizer N were twice as high as those with other manures (see figure). With fertilizer N, poultry manure also outyielded farmyard and piggery manures. Yields with poultry manure and 80 kg N/ha were as high as those with 160 kg N/ha alone. Yields with farmyard and piggery manures and 80 kg N/ ha were almost equal to those with 120 kg N/ha alone. The results suggest that substituting organic manure for 40 to 80 kg fertilizer N/ha is feasible, depending upon the nature of the organic manure.



Rice yields with organic manures substituting for N (mean of 2 yr).

The residual effects of these manures on a following wheat crop (with 90 kg N and 13 kg P/ha underdose) also were compared. With poultry manure applied to the previous rice crop, wheat yield was 1180 kg/ ha more; with farmyard manure, 770 kg/ ha more; with piggery manure, 660 kg/ha more. These yields were comparable to yield with the recommended 120 kg N and 26 kg P/ha applied to the wheat crop. Results indicate that application of any one manure to rice gives a residual effect equivalent to 30 kg N and 13 kg P/ha in wheat. Poultry manure had the largest residual effect.

Effect of Sesbania green manure on water management and yield of lowland rice

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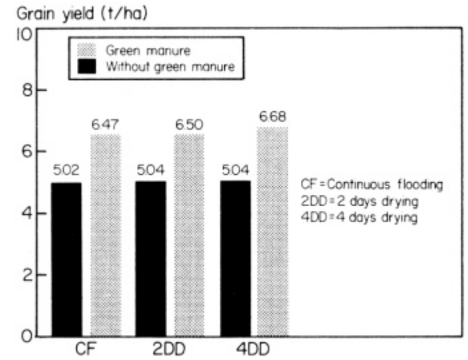
The importance of green manure in increasing soil productivity has been recognized from early times. The benefits credited to them include supply of organic matter and N, mobilization of soil P and other nutrients, and improvement in the microbiological and physical properties of soils. Recent research at the PAU farm has shown that apart from supplying green matter equivalent to 120 kg N/ ha in rice, 2-mo-old Sesbania *(Sesbania aculeata)* incorporated into the soil lowered bulk density and significantly increased infiltration rate of the soil. This promoted our interest to study the effect of Sesbania green manure on water management because irrigation is a costly input in rice production in Punjab. We realized the importance of this because of the present recommendation of applying irrigation 2-4 d after the ponded water has infiltrated into the soil where green manure is not applied in rice culture.

The soil was loamy sand (Typic Ustochrept) with a percolation rate 5 mm/h, pH 8:4, EC 0.15 mmho/cm, 0.34% organic carbon, and 0.06% of total N. Sesbania green manure crop was grown on a separate piece of land from May to Jul 1985. The crop was harvested, chopped, and incorporated into the experimental plots 1 d before transplanting on 20 Jul 1985. All but the no-green-manure plots received Sesbania at 25 t green matter/ ha, equivalent to 125 kg N/ha. The experiment was a split-plot design with water regimes as main plots and green manure and N levels as subplots, in three replications. The water regimes were continuous flooding (CF), 2 d drying (DD), and 4 DD. Urea N levels were zero and 120 kg N/ha applied in 3 equal splits: at transplanting, 21 and 42 d after transplanting. At last puddling, 26 kg P and 50 kg K/ha were applied to all plots. In the drying treatments, continuous flooding was maintained for 3 wk after transplanting and thereafter irrigation was applied 2 or 4 d after the ponded water had infiltrated into the soil of plots with and without green manure. This was carried out up to 2 wk before maturity to



Effect of water management in the presence of sesbania green manure on yield of lowland rice.

facilitate harvesting. The crop was harvested at maturity and grain yield determined at 14% moisture content.

Averaged for water regimes, grain yield data indicated that Sesbania green manure alone gave 5.8 t/ ha yield as compared to 6.3 t/ha by applying 120 kg N/ ha as urea. Furthermore, averaged for N levels, grain yields of the three irrigation treatments were on par with and without green manure treatments (see figure). This suggests that irrigating the plot 4 d after the ponded water has infiltrated into the soil can be safely practiced even with Sesbania green manure in lowland rice.

Barley as a second crop in rice areas of Kizilirmak Valley, Turkey

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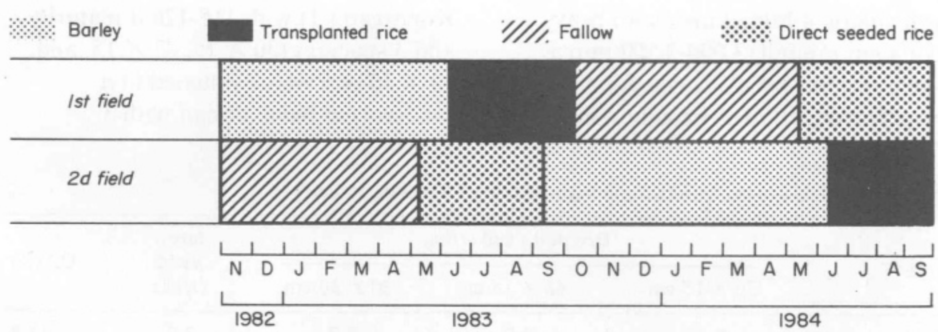
In Turkey, direct-seeded rice is sown in May and harvested in Sep-Oct. Depending on the region, winter cereals are sown in Oct and harvested in early Jul. Because direct-seeded rice cannot follow winter cereals, rice must be transplanted to use the fields which are fallow Oct-May.

Experiments to evaluate rice seeding methods that would allow growing barley as a second crop were carried out in farmers' fields at Çorum-kargi,



Use of experimental fields in Kizilirmak Valley, Turkey.

Kizilirmak Valley, an important rice-growing location.

The experiments started with barley in fall 1982 and ended with rice in 1984 (see figure). The experimental design was split plot with four replications. Main plots were rice cultivars Krasnodarsky 424 and Ribe; subplots were P rates (0, 18, 35, and 53 kg P/ ha). Rice planting methods were direct seeding and transplanting.

The soil of the experimental field was heavy textured and slightly alkaline (pH = 8.0), with medium lime (10.5%)

and low total N (0.34%). Available P was 11-13 ppm (Olsen's method).

P rates did not affect the rice yields significantly (see table). In the second year, higher yields of transplanted rice were attributed to short and good stand, synchronized ripening, lower sterility, and lower weed density.

The results showed that barley could follow transplanted rice. The yields of rice - barley were close to those of the main crops grown by local farmers.

Effect of planting method on grain yield of 2 rice cultivars in Çorum, Turkey.[a]

P rate (kg/ha)	Yield (t/ha)					
	Direct seeded			Transplanted		
	1983	1984	Mean	1983	1984	Mean
			Ribe			
0	7.2	3.2	5.2	5.5	4.5	5.0
18	7.4	2.8	5.1	5.5	3.8	4.6
35	6.9	3.2	5.1	5.5	4.3	4.9
53	7.3	3.2	5.3	6.0	4.3	5.2
Mean	7.2	3.1	5.2	5.6	4.2	4.9
			Krasnodarsky 424			
0	9.3	5.9	7.6	6.9	6.5	6.7
18	9.1	5.9	7.5	6.9	6.9	6.9
35	9.6	5.6	7.6	6.7	6.8	6.8
53	10.3	6.3	8.3	6.8	7.2	7.0
Mean	9.6	5.9	7.8	6.7	6.9	6.8

[a] In both planting methods and years: P rates – ns, CV (%) – 8.54 in 1983, 10.20 in 1984, P × cultivar – ns, CV (%) – 6.11 in 1983, 6.71 in 1984.

Irrigated peanut following rice in Konkan, India

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In Konkan, a humid area with heavy monsoon rainfall (3,000–3,500 mm a year), rice has been a single Jun-Oct crop. Introduction of irrigation in the dry season has created opportunities for double cropping.

We evaluated peanut varieties and optimal spacing. The legume oil seed crop has high market value in the area.

Combinations of five peanut varieties (TG-1, M-13, Shulamith, SB-11, and Kopargaon-1) with 115-120 d maturity and 3 spacings (30 × 15, 45 × 15, and 30 × 30 cm) were evaluated in a randomized block design with 3 replications. The soil was medium black, fertilized with 25 kg N and 22 kg P/ha at sowing the last week of December and irrigated every 10-12 d with 50 mm of water at each of 10 irrigations.

Shulamith yielded significantly more dry pods than TG-1 and Kopargaon-l (see table). SB-11 had the highest oil content. Spacing at 30 × 15 cm yielded significantly more dry pods. SB-11 at 30 × 15 cm produced the highest dry pod yield.

Dry pod yield of peanut varieties and plant spacing.[a] **Konkan, India.**

Variety	Dry pod yield (t/ha)			Mean yield (t/ha)	Oil (%)
	30 × 15 cm	45 × 15 cm	30 × 30 cm		
TG- 1	2.7	2.9	2.7	2.8	47.8
M-13	3.1	2.9	2.8	2.9	48.3
Shulamith	3.4	3.3	2.5	3.1	46.2
SB-11	3.6	2.6	2.5	2.9	51.4
Kopargaon-1	2.4	2.5	2.4	2.4	48.8
Mean	3.1	2.8	2.6	–	–

	CD at 5%
Variety	0.2
Spacing	0.2
Variety × Spacing	0.4

[a] 1978-80 pooled averages.

High productivity varietal combinations in a rice - wheat rotation in Chhattisgarh, India

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The Chhattisgarh area of Madhya Pradesh is a slightly moist hot zone with a moisture index between -20 and 0, and a mean annual temperature between 25°C and 18°C. Annual rainfall ranges from 1,000 to 1,500 mm, mostly concentrated in Jun-Sep. Soil type represents the red-yellow group, clay loam to clay. Rice, the principal crop, is grown mainly during the monsoon season, followed by linseed, lathyrus, urid, moong, gram, rape, mustard, and groundnut. Wheat is a recent second-crop introduction.

A 3-yr experiment to find the best varietal combination for high productivity in a rice -wheat rotation was initiated during 1978 kharif. Early, medium, and late duration rice varieties were followed by early, medium, and late duration wheat varieties in all combinations. Rice varieties were J.R.16-15-1-1 (90–100 d), Ratna (120-125 d), and Jaya (130-135 d). Wheat varieties were Sonalika (110 d), Jairaj (115 d), and K. Sona (125 d).

The experiment was a randomized block design with nine treatment combinations and four replications.

Each crop was supplied 120 kg N, 26 kg P, and 50 kg K/ ha.

Productivity was highest with Ratna, a medium duration rice, followed by Sonalika, an early duration wheat (see table). The next best varietal combination was Jaya rice followed by Sonalika. Medium and late wheat varieties did not petform well.

Productivity of varietal combinations in rice - wheat rotations. Chhatisgarh, India.

Rice	Yield (t/ha) 1977-78	Yield (t/ha) 1978-79	Yield (t/ha) 1979-80	Mean	Wheat	Yield (t/ha) 1977-78	Yield (t/ha) 1978-79	Yield (t/ha) 1979-80	Mean
J.R.16-15-1 (early)	5.05	3.99	5.34	4.79	Sonalika (early)	4.13	3.63	2.81	3.52
	5.03	3.80	5.05	4.63	K. Sona (late)	3.77	0.72	2.25	2.25
	4.91	4.05	5.11	4.69	Jairaj (medium)	2.93	0.56	1.75	1.75
Ratna (medium)	4.81	6.51	5.24	5.52	Sonalika	4.73	3.66	4.19	4.19
	5.11	5.94	5.12	5.39	K. Sona	4.23	0.88	2.56	2.89
	5.02	4.95	5.12	5.03	Jairaj	3.59	0.38	1.98	1.98
Jaya (late)	5.7 5	4.95	5.49	5.39	Sonalika	3.74	3.68	3.71	3.71
	5.79	5.56	5.19	5.51	K. Sona	3.91	1.01	2.46	2.46
	5.97	6.36	5.52	5.95	Jairaj	2.76	0.87	1.82	1.82

Announcements

Reorganized GEU rice team in Taiwan

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Rice breeding in Taiwan was reorganized in 1985. Major modifications are: 1) A rice breeding team consisting of all District Agricultural Improvement Stations (DAIS) and scientists of several disciplines at TARI and Chiayi Agricultural Experiment Station (AES)/TARI, a project led by a senior rice breeder of TARI; 2) TARI and Chiayi AES/TARI responsible for germplasm conservation, crossing, and handling of hybrid materials up to establishment of strains; 3) DAIS test for specified traits of lines or strains and undertake yield trials and culture method tests; 4) Taichung DAIS responsible for indica rice breeding; and promising strains are tested for yield only at Taichung, Tainan, and Kaoshiung DAIS; 5) new varieties identified by all-provinces coordinated rice breeding program will be designated with numbers prefixed by Taikeng (japonica) or Taken (indica), commencing with the yield trials in 1986. No new varieties will be released by individual rice breeding stations.

Amir Khan/international Inventor

Amir U. Khan, head of IRRI's Agricultural Engineering Department, received the International Inventors Award (IIA) for Industry 13 Jun 1986 in Stockholm. The award, modeled after the Nobel Prize, was presented by H.M. King Carl Gustaf of Sweden.

Sweden instituted the IIA to recognize outstanding innovations in water, forestry, and industry. Dr. Khan received the prestigious award for his contributions toward developing the farm machinery industry in developing nations. One of his inventions. the axial-flow thresher, is being produced in eight Asian countries, where local manufacture has generated substantial employment.

Other IRRI scientists recognized

Also honored by the Swedish Inventor's Association on 14 Jun in Stockholm were Yong Woon Jeon, Leonides S. Halos, and Clarence W. Bockhop, IRRI Agricultural Engineering Department. Their innovation, warehouse dryer using nonconventional energy sources, received an honorable mention diploma and the Swedish Inventor's Association plaquette in the energy field.

Classic soils work recognized

The Institute for Scientific Information selected a paper by Dennis J. Greenland, deputy director general, as the Citation Classic for the 2 Jun 1986 issue of *Current contents: agriculture, biology and environmental sciences.* His paper, Interaction between clays and organic compounds in soils. Part II. Adsorption of soil organic compounds and its effect on soil properties, was first published in *Soils Fert.* 28:521-532, 1965. A Citation Classic is a highly cited publication as identified by Science Citation Index.

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