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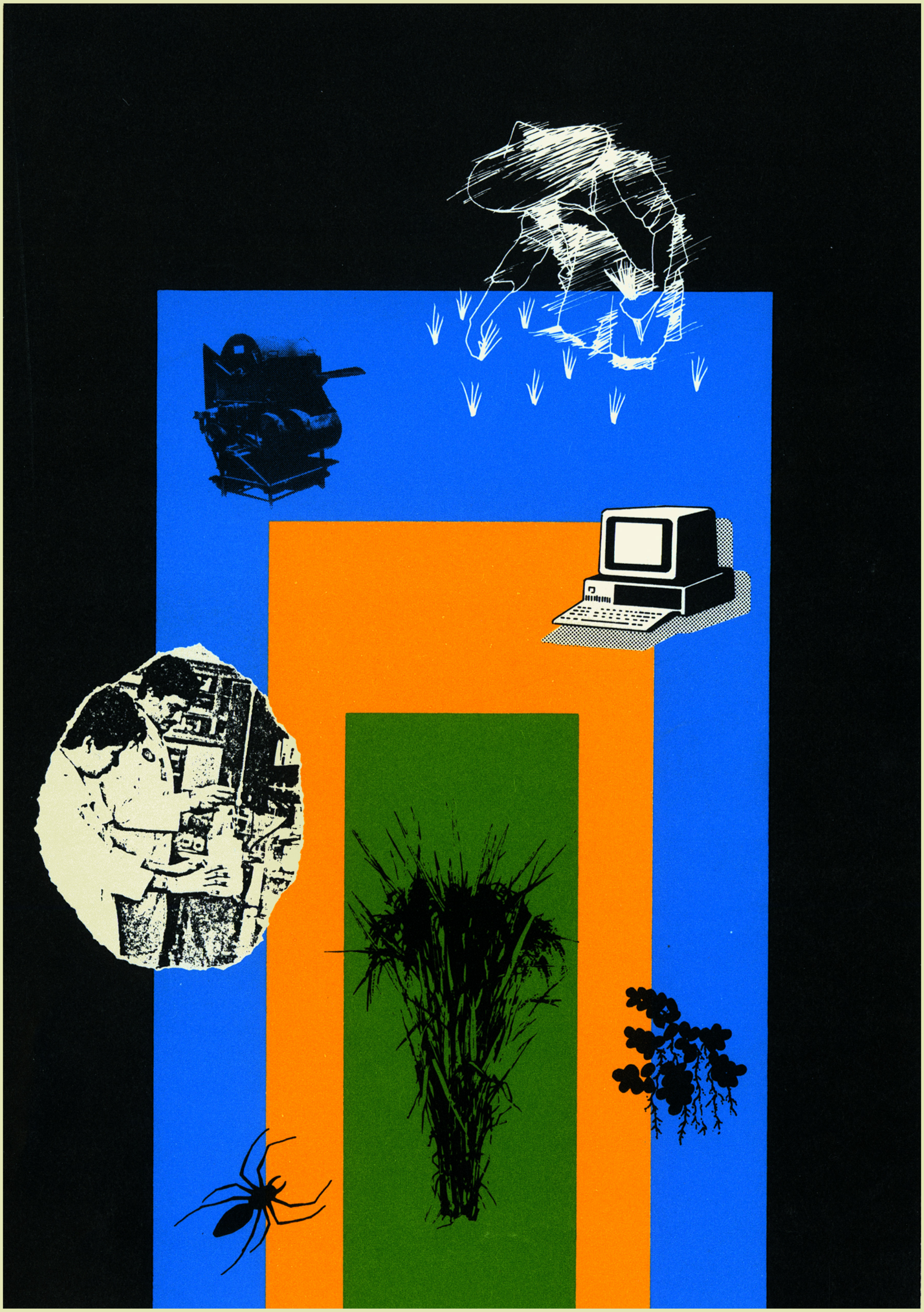

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IRRN GUIDELINES

The *International Rice Research Newsletter* objective is:

"To expedite communication among scientists concerned with the development of improved technology for rice and for rice-based cropping systems. This publication will report what scientists are doing to increase the production of rice, inasmuch as this crop feeds the most densely populated and land-scarce nations in the world . . . IRRN is a mechanism to help rice scientists keep each other informed of current research findings."

The concise reports contained in IRRN are meant to encourage rice scientists and workers to communicate with one another. In this way, readers can obtain more detailed information on the research reported.

Please examine the criteria, guidelines, and research categories that follow.

If you have comments or suggestions, please write the editor, IRRN, IRRI, P.O. Box 933, Manila, Philippines. We look forward to your continuing interest in IRRN.

Criteria for IRRN research report

- has international, or pan-national, relevance
- has rice environment relevance
- advances rice knowledge
- uses appropriate research design and data collection methodology
- reports appropriate, adequate data
- applies appropriate analysis, using appropriate statistical techniques
- reaches supportable conclusions

Guidelines for contributors

The International Rice Research Newsletter is a compilation of brief reports of current research on topics of interest to rice scientists all over the world. Contributions should be reports of recent work and work-in-progress that have broad, pan-national interest and application. Only reports of work conducted during the immediate past three years should be submitted.

Research reported in IRRN should be verified. Single season, single trial field experiments are not accepted. All field trials should be repeated across more than one season, in multiple seasons, or in more than one location, as appropriate. All experiments should include replication and a check or control treatment.

All work should have pan-national relevance.

Reports of routine screening trials of varieties, fertilizer, and cropping methods using standard methodologies to establish local recommendations are not accepted.

Normally, no more than one report will be accepted from a single experiment. Two or more items about the same work submitted at the same time will be returned for merging. Submission at different times of multiple reports from the same experiment is highly inappropriate. Detection of such submissions will result in rejection of all.

Please observe the following guidelines in preparing submissions:

- Limit each report to two pages of double-spaced typewritten text and no more than two figures (graphs, tables, or photos).
- Do not cite references or include a bibliography.
- Organize the report into a brief statement of research objectives, a brief description of project design, and a brief discussion of results. Relate results to the objectives.
- Report appropriate statistical analysis.
- Specify the rice production environment (irrigated, rainfed lowland, upland, deepwater, tidal wetlands).
- Specify the type of rice culture (transplanted, wet seeded, dry seeded).
- Specify seasons by characteristic weather (wet season, dry season, monsoon) and by months. Do not use local terms for seasons or, if used, define them.
- Use standard, internationally recognized terms to describe rice plant parts, growth stages, environments, management practices, etc. Do not use local names.
- Provide genetic background for new varieties or breeding lines.
- For soil nutrient studies, be sure to include a standard soil profile description, classification, and relevant soil properties.
- Provide scientific names for diseases, insects, weeds, and crop plants. Do not use common names or local names alone.
- Quantify survey data (infection percentage, degree of severity, sampling base, etc.).
- When evaluating susceptibility, resistance, tolerance, etc., report the actual quantification of damage due to stress that was used to assess level or incidence. Specify the measurements used.
- Use generic names, not trade names, for all chemicals.
- Use international measurements. Do not use local units of measure. Express yield data in metric tons per hectare (t/ha) for field studies and in grams per pot (g/pot) or per specified length (in meters) row (g/row) for small scale studies.
- Express all economic data in terms of the US$. Do not use local monetary units. Economic information should be presented at the exchange rate US$:local currency at the time data were collected.
- When using acronyms or abbreviations, write the name in full on first mention, followed by the acronym or abbreviation in parentheses. Thereafter, use the abbreviation.
- Define any nonstandard abbreviations or symbols used in a table or graph in a footnote or caption/legend.

Categories of research published

GERMPLASM IMPROVEMENT
genetic resources
genetics
breeding methods
yield potential
grain quality
pest resistance
- diseases
- insects
- other pests

stress tolerance
- drought
- excess water
- adverse temperature
- adverse soils

integrated germplasm improvement
- irrigated
- rainfed lowland
- upland
- deepwater
- tidal wetlands

seed technology

CROP AND RESOURCE MANAGEMENT
soils
soil microbiology
physiology and plant nutrition
fertilizer management
- inorganic sources
- organic sources

crop management
integrated pest management
- diseases
- insects
- weeds
- other pests

water management
farming systems
farm machinery
postharvest technology
economic analysis

ENVIRONMENT

SOCIOECONOMIC IMPACT

EDUCATION AND COMMUNICATION

RESEARCH METHODOLOGY

CONTENTS

Request for biotechnology notes

Biotechnology is making significant contributions to rice breeding programs. It enables scientists to achieve results faster and more efficiently and to reach goals that are not attainable with conventional techniques.

IRRN encourages scientists to submit notes about biotechnology in rice research. This is a part of IRRI's initiative to make biotechnology more visible and to help rice scientists keep each other informed about current research findings and techniques. Guidelines and criteria for submissions are printed on the inside front cover of each IRRN issue.

IRRN: New look, new name

Regular readers will notice some differences in IRRN beginning in 1993. While the initials will be the same, the name will be changed to better describe the IRRN's role. The new name is International Rice Research Notes. A new cover design will symbolize the change. The content has been expanded to include notes of important rice science activities and announcements of training opportunities.

As a cost-cutting measure, the IRRN will come out quarterly rather than bimonthly, so each issue will be larger.

For nearly two decades, the International Rice Research Newsletter (IRRN), published by the International Rice Research Institute, has been an iimportant medium for rice scientists to share information with their colleagues. IRRN is not a journal, but it represents the best in rice science. TYhe research notes cover a wide range of disciplinary interests, and are by scientists from around the world.

Comments for continuing to improve the IRRN are always welcome as are contributions of research articles and announcements. Continued support from rice scientists will make it better serve rice science in the decades ahead.

GERMPLASM IMPROVEMENT

Genetics

Genetic nature of some agronomic traits in two elite lines of rice

Bui Chi Buu and Phung Ba Tao, Cuulong Delta Rice Research Institute, Omon, Cantho, Vietnam

We studied the genetic nature of some agronomic traits using elite lines A 69-1 (P1) and IR31868-64-2-3-3-3 (P2) to efficiently exploit the variation in breeding materials. P1 combines well for salt tolerance. P2 is a high-yielding variety with good grain quality and resistance to major pests and diseases.

Thirty plants from the F_2 between the lines were randomly chosen. Each was backcrossed to its parents and to the F_1. The families of the P1, P2, F_1, F_2, BC_1 (F_1/P1), and BC_2, (F_1/P2) were studied. We transplanted and raised 10 plants from seeds of nonsegregating materials and 30 from seeds of segregating ones. The field experiment was laid out in a completely randomized block design and replicated three times. Plants were spaced at 20 × 20 cm and fertilized at 80-40-0 kg NPK/ha.

Means of the studied traits were lower for F_2 than for F_1 and the better parent (Table 1). Backcrosses to the better parent produced higher values for all traits than backcrosses to the poorer parent. Results indicate scope for selecting parents and the possibility of getting heterotic lines.

Estimates of gene effects indicate highly significant dominance effects (Table 1). Additive × additive was significant among the epistasis effects.

Because dominance × dominance is large and negative and dominance large and positive, the estimates of additive, additive × additive, and additive × dominance should be mentioned without duplicate type of nonallelic interaction.

High variation occurs because of dominance and epistatic effects for all these traits. Selection in later generations would be better to diminish dominance effects.

We tested for linkage by comparing the grand means of triple testcross families $\bar{L}_1$(F_2/P1), $\bar{L}_2$(F_2/P2), and $\bar{L}_3$(F_2/F_1) and those of the basic generations $\overline{BC}_1$, $\overline{BC}_2$, and $\bar{F}_2$. Linked epistatic genes were present for all characters except grain yield (Table 2). The significant differences in grain yield expressed a linked digenic interaction. ■

Table 1. Means of the basic generations and estimates of the genetic components.[a]

Generation	Yield (g/plant)	Panicles (no./hill)	Filled grains (no./panicle)	1000-grain wt (g)	Panicle length (cm)	Plant height (cm)	Growth duration (d)
P1	19.6	9	95	30.2	27.4	114.0	135
P2	20.2	14	78	21.7	23.8	94.2	124
F_1	33.5	14	119	27.3	26.2	114.9	133
F_2	21.3	13	87	25.9	25.8	100.8	130
BC_1	28.1	14	107	27.3	26.4	112.4	133
BC_2	26.3	16	92	24.9	25.5	100.3	128
Estimate							
Mean	21.3**	13.1**	87.4**	25.9**	25.8**	100.8**	129.5**
Additive	1.8	–2.5	14.6	2.4*	0.9	12.1	4.5
Dominance	37.2**	10.1**	81.5**	2.2*	1.4**	33.0**	8.2*
Additive × additive	23.6**	7.6**	48.4**	0.8	0.5	22.2**	4.2*
Additive × dominance	2.0	0.0	5.9	–1.9	4.9	2.2	–1.0
Dominance × dominance	–25.6**	–16.5**	–35.3**	1.3	–0.7	–9.6*	–2.4

[a]* and ** = significant at 5 and 1% levels.

Table 2. Equality test between the means of triple testcross families and basic generations.[a]

Test	Yield	Panicles/hill	Filled grains/panicle	1000-grain wt	Panicle length	Plant ht	Growth duration
$\bar{L}_1-\overline{BC}_1$	2.47*	0.85ns	–0.80ns	–0.20ns	0.38ns	–2.30ns	–0.90ns
$\bar{L}_2-\overline{BC}_2$	–0.66ns	–1.10ns	–0.90ns	0.00ns	0.10ns	0.40ns	–0.20ns
$\bar{L}_3-\bar{F}_3$	4.35**	2.04**	3.90ns	–1.00**	–0.20ns	–0.10ns	–1.40ns

[a]* and ** = significance at 5 and 1% levels, ns = nonsignificant.

Stability analysis for irrigated rice yield

S. S. Ali, S. J. H. Jafri, F. A. Faiz, S. Mehmood, and M. A. Butt, Rice Research Institute, Kala Shah Kaku, Pakistan

We evaluated the stability of the performance of 14 medium-grain advanced lines and varieties from 1989 to 1991. The experiment was laid out in a randomized complete block design with three replications. Thirty-day-old seedlings were transplanted on 10 Jul 1989, 12 Jul 1990, and 10 Jul 1991. Plots were 2 × 6.25 m^2, with 30 cm between plants and rows. Recommended agronomic and plant protection measures

Mean grain yield (t/ha) and estimates of stability parameters for 14 rice genotypes over 3 yr.[a]

Genotype	$\bar{X}$	bi	Sd^{2-}	r^2
PK3699-43	3.33	1.1452	0.0718	0.0577
PK3717-9	4.33	0.9737	0.0659	0.0721
PK3717-12	4.19	1.9294	0.7997	0.0235
PK3727-2	3.92	1.4145**	0.0409**	0.0224
PK3727-5	3.73	2.0643**	0.1195**	0.0304
PK3732-8	3.41	0.9639	0.0242	0.0285
PK3733-7	3.19	0.7764	0.0287	0.0508
PK3737-10	3.39	0.6054	0.0223	0.0641
PK3737-11	3.51	1.1380	0.0406	0.0339
PK3801-18	3.53	1.1779	0.0450	0.0351
PK3917-33	3.60	1.1082	0.0686	0.0588
PK3849-18	3.66	0.9441	0.0648	0.0752
IR6	3.19	–0.0787	0.0537	0.9059
KS282	4.13	–0.1677	0.5099	0.9529
Av	3.65	1.0000		0.1722

[a]** = significantly different from 0 at 0.01 level of probability.

were followed. We recorded yield at 14% moisture level.

The regression of genotypes for average yield on the environmental index resulted in regression coefficients (b) ranging from -0.1677 to 2.0643 (see table). The coefficient of determination (r^2) ranged from 0.0224 to 0.9529. The deviation from regression mean squares (S^2 d), a true measure of genotypic stability, ranged from 0.0223 to 0.7997.

PK3717-9, PK3727-2, PK3717- 12. PK3727-5, PK3849- 18, and KS282 showed higher yields than the pooled means, but they had varied responses to environmental fluctuations. PK3727-2 and PK3727-5 were unstable for yield because of the significant values of bi and S^2 d. PK3717-9, PK3717-12, and PK3849-18 yielded higher than the pooled mean. These genotypes also showed non-significant values for bi and S^2 d, indicating stable genotype interaction over three environments. They can be recommended for use in breeding programs aiming to develop cultivars with high yield potential and better adaptability. □

Genetic studies for allogamous traits in *oryza sativa* L.

S. S. Ali. S. J. H. Jafri, M. G. Khan, and M. A. Butt. Rice Research Institute, Kala Shah Kaku, Lahore. Pakistan

We studied the nature of the gene action of two traits—anther length and pollen grain size—in F_1 from a diallel cross involving the rice varieties and lines Basmati 370, Basmati 385, Basmati 198, and 4048.

We laid out the experiment during 1991 kharif in a randomized complete block design, with three replications, and a spacing of 30 cm between rows and plants. We measured anther length and pollen grain size using a binocular microscope and recorded 10 observations for both traits from each of the main panicles of 10 plants per replication for each genotype.

The components of variation (see table) revealed that additive component (D) exceeded the dominance components H1 and H2 for anther length. indicating additive type of gene action for increased anther length. The inverse, however, was true for pollen grain size. Recessive alleles were important for anther length whereas more dominant alleles were observed for pollen grain size in parent varieties. HI and H2 were not similar in both traits, showing that positive and negative allele frequencies were unequal.

The mean degree of dominance, 0.81 and 2.83, indicated partial dominance for anther length and overdominance for pollen grain size. The ratio of H2 to 4H1 (0.14, 0.20) showed unequal positive and negative allele frequencies for both traits. The ratio h^2 to H2 indicated that no dominant gene was controlling anther length whereas at least one gene controlling pollen grain size exhibited some dominance. This information will be useful in designing future hybrid rice breeding programs. □

Estimates of components of variation with their standard errors for anther length and pollen grain size in rice.

Anther length (mm)		Pollen grain size (µ)
D ± SE (D) = 0.0236 ± 3.1623		1.2795 ± 1.2669
F ± SE (F) = –0.0197 ± 8.124		1.3540 ± 3.2546
H1 ± SE (HI) = 0.0155 ± 9.1924		10.2192 ± 3.6826
H2 ± SE (H2) = 0.0090 ± 8.4853		8.0473 ± 3.3993
h^2± SE (h) = 4.0015 ± 5.8310		4.5319 ± 2.3305
E ± SE (E) = 0.002 ± 0.4142		0.727 ± 0.5666
Derived values		
$\sqrt{H_1/D}$	= 0.8102	2.8261
$H_2/4H_1$	= 0.1457	0.1969
$[\{4DH\}^{1/2}+F]/[\{4DH\}^{1/2}-F]$	= 0.32	1.512
h^2/H	= –0.163	0.563

Inheritance of aroma in two aromatic rice varieties

Huang He Qing and Zou Xue Ying, Hunan Rice Research Institute (HRRI), Changsha, China

Jin-Long Dao and 80-66 are two later maturing aromatic rice varieties developed by HRRI. We made reciprocal crosses between these scented varieties and nonscented rice varieties HA8857 and Xiang Zao Xian no. 1 and 3 in 1989 to study aroma inheritance.

We sowed the F_1 and F_2 progeny and the parents from these crosses in Apr 1990 and transplanted them in May 1990. Thirty plants of each parent, 30 F_1 plants from each reciprocal cross, and about 200 F_2 plants of each cross from the four

Scent ratings of F_1, F_2, and parents, HRRI, Changsha, China, 1990.

Entry	Plants (no.)			χ^2	P
	Total	Nonscented	Scented	(3:1)	
Parent					
Jin-Long Dao	30	0	30		
80-66	30	0	30		
Xiang zao Xian no. 1	30	30	0		
Xiang zao Xian no. 3	30	30	0		
HA8557	30	30	0		
F_1					
Jin-Long Dao/Xiang zao Xian no. 1	30	30	0		
Jin-Long Dao/Xiang zao Xian no. 3	30	30	0		
Jin-Long Dao/HA8557	30	30	0		
Xiang zao Xian no. 1/Jin-Long Dao	30	30	0		
Xiang zao Xian no. 3/Jin-Long Dao	30	30	0		
HA8557/Jin-Long Dao	30	30	0		
80-66/Xiang zao Xian no. I	30	30	0		
80-66/Xiang zao Xian no. 3	30	30	0		
80-66/HA8557	30	30	0		
Xiang zao Xian no. 1/80-66	30	30	0		
Xiang zao Xian no. 3/80-66	30	30	0		
HA8557/80-66	30	30	0		
F_2					
Jin-Long Dao/Xiang zao Xian no. 1	186	143	43	0.2580	0.50-0.75
Jin-Long Dao/Xiang zao Xian no. 3	160	124	36	0.4083	0.50-0.75
80-66/Xiang zao Xian no. 1	142	105	37	0.0375	>0.90
80-66/HA8557	161	124	37	0.4083	0.50-0.75

crosses were evaluated. We placed 2-g leaf blades from each plant in 10 ml of 1.7% KOH solution according to the method of Sood and Siddiq. Samples were smelled and evaluated for aroma after 10 min.

F_1 plants from all the reciprocal crosses were nonaromatic, indicating that a recessive nuclear gene controls aroma in Jin-Long Dao and 80-66. The F_2 plant scent evaluation indicated a 3:1 (non-aroma:aroma) segregation (see table). □

Breeding methods

Heterosis and inbreeding depression in rice

T. Ram, Central Agricultural Research Institute, Port Blair 744101, India

Ten divergent parents—Mahsuri, Adamchini, IET4140, IET7562, Kanakjeera, IR50, IR52, Dhaneswar, Pawanpeer, and TAU18-were crossed in all possible combinations, excluding reciprocals, to study the extent of heterosis, heterobeltiosis, and inbreeding depression for yield and yield components.

Parents and their 45 F_1 and 45 F_2 were grown in a completely randomized block design, with three replications. Plants were spaced at 20 × 15 cm, with one row of 20 plants for parents and F_1 and six rows of 20 plants for F_2. Observations were recorded for 10 randomly selected plants from parents and F_1, and 50 plants from F_2.

The genotypic correlation coefficient indicated that grain yield was positively and significantly correlated with number of effective tillers/plant (r = 0.38) and number of grains/panicle (r = 0.45). Other characters, such as days to panicle emergence, plant height, panicle length, and 100-grain weight, showed either negative or nonsignificant positive correlations with yield.

The cross combinations exhibiting more than 20% heterobeltiosis for grain yield are in the table. Crosses showing more than 40% heterobeltiosis for grain yield were Kanakjeer/IR50, IR50/ Pawanpeer, IET4140/TAU 18, Adamchini/TAU 18, Adamchini/ Pawanpeer, Adamchini/IET7562, and Adamchini/IR50. Crosses showing better negative heterobeltiosis for days to panicle emergence were Adamchini/ IET7562 and Adamchini/IR50, IET7562/ IR52; for plant height, they were Adamchini/IET7562, Adamchini/ Pawanpeer, Adamchini/IR50, IET4140/ TAU18, and Kanakjeera/IR52.

Only 11 of 54 crosses showed positive significant heterobeltiosis for number of effective tillers/plant. Crosses with appreciable heterobeltiosis were Mahsuri/Kanakjeera, IET4140/IR52, and IR50/Pawanpeer.

The crosses with high heterobeltiosis for grains/panicle were IET4140/ TAU 18, IET4140/IR50, IR50/ Pawanpeer, IET7562/IR52, IET4140/ IR50, IR50/Pawanpeer, IET7562/IR52, and IET7562/TAU18. The crosses Mahsuri/IET4140 and IET7562/IR50 expressed better heterobeltiosis for 100-grain weight.

Out of 45 crosses, 31 showed significant inbreeding depression for plant height, 32 for days to panicle emergence, 41 for panicle length, 42 for tillers/plant, 31 for grains/panicle, 41 for 100-grain weight, and 42 for grain yield. Some crosses had high heterosis with high inbreeding depression, some showed more heterosis and medium inbreeding depression, and some had high heterosis with low inbreeding depression. □

Heterobeltiosis and inbreeding depression for yield and its components in promising hybrids. [a]

Cross	Days to panicle emergence		Plant height (cm)		Effective tillers/plant (no.)		Grains/panicle (no.)		Grain yield/ plant	
	HBT (%)	ID (%)	HBT (%)	ID (%)	HBT (%)	ID (%)	HBT (%)	ID (%)	HBT (%)	ID (%)
Mahsuri/IET7562	–14.5**	–6.3**	3.9**	1.0	–9.0	20.2**	–30.7**	30.4**	34.9**	50.8**
Mahsuri/Kanakjeera	0.1	5.4**	3.8**	13.6**	31.6**	41.1**	–36.7**	26.2**	44.7**	61.7**
Mahsuri/Pawanpeer	–4.3**	13.9**	–1.9	–9.8**	11.3**	49.9**	–36.8**	35.5**	34.3**	56.6**
Mahsuri/TAU18	–7.0**	–2.8*	–2.1	8.8**	–6.5	23.0**	–19.9**	32.8**	20.7**	38.3**
Adamchini/IET7562	–24.6**	–11.9**	–27.7**	–9.2**	–19.0**	32.6**	14.9**	34.0**	54.6**	55.5**
Adamchini/IR50	–17.3**	4.7**	–13.6**	4.4**	–9.3	0.4	–11.2**	2.1	45.0**	22.2**
Adamchini/ Pawanpeer	–10.5**	5.7**	–22.7**	15.3**	0.2	18.3**	–40.0**	9.1**	57.4**	17.6**
Adamchini/TAU18	–6.9**	5.3**	7.6**	7.4**	13.4**	26.8**	–9.2**	6.9**	57.5**	28.4**
IET4140/Kanakjeera	–0.1	3.1	–12.9**	9.1**	–5.6	17.1**	38.2**	–52.4**	28.4**	20.9**
IET4140/IR50	4.0**	11.5**	–2.8*	–30.3**	–42.3**	0.5	46.0**	11.3**	41.7**	13.3**
IET4140/IR52	14.1**	5.0**	1.4	10.0**	33.1**	11.1**	–6.4**	8.4**	20.7**	39.7**
IET4140/Pawanpeer	–0.2	2.4*	2.7	12.2**	12.5**	26.1**	14.9**	4.1*	20.4**	15.0**
IET4140/TAU18	0.8	1.4	–15.5**	2.6	2.7	10.7	52.1**	21.4**	70.4**	23.7**
IET7562/Pawanpeer	0.2	2.0	19.0**	1.5	–3.3	31.0**	3.1*	16.3**	34.0**	55.9**
Kanakjeera/IR50	2.2*	6.2**	–1.4	19.6**	–14.9**	18.8**	–15.5**	7.5**	160.4**	50.4**
Kanakjeera/TAU18	3.9**	3.8**	6.4**	6.1	–17.2**	5.2	17.2**	28.6**	33.8**	37.2**
IR50/Pawanpeer	–0.7	7.7**	24.5**	11.6**	22.8**	29.8**	61.3**	44.7**	98.7**	61.1**
IR50/TAU18	–4.1**	–1.5	–15.1**	–3.0*	–1.3	33.7**	–3.2*	5.2**	24.1**	16.3**
Pawanpeer/TAU18	7.3**	6.4**	–5.7**	10.2**	–10.5	13.4*	–0.0	6.2**	35.2**	29.8**
SE	1.3	1.3	1.4	1.5	0.6	0.4	2.4	2.5	1.1	0.8

[a] * = significance at P = 5%. ** = significance at P = 1%. HBT = heterebeltiosia, ID = inbreeding depression

Zinc increases rate of twin seedlings of rice

Huang Yiqiang, Tan Zhijun, and Deng Hongde, Hunan Hybrid Rice Research Center, Changsha 410125, China

We studied how Zn affected the rate of twin seedlings in polyembryonic rice varieties: indicas Shuang 3 and Shuang 13, and japonica Lu 52.

Three hundred dehulled seeds per treatment were soaked in different concentrations of Zn^{2+} ($ZnSO_4$) solution at 37°C for 1 d. The check was soaked in distilled water. The seeds were then sterilized in 0.1 % mercuric chloride for 10 min and placed in the same solution at 25°C to hasten germination. Twin seedling rates were calculated 4 d later.

Effects of Zn^{2+} concentrations on rate[a] of twin seedlings germination percentage[b] in 3 varieties.

Zn^{2+} concn (M)	Shuang 3 (indica)		Shuang 13 (indica)		Lu 52 (japonica)	
	Twin seedling rate (%)	Germination (%)	Twin seedling rate (%)	Germination (%)	Twin seedling rate (%)	Germination (%)
Control	30.9	90.3	3.3	81.0	4.5	72.9
1×10^{-6}	33.2	82.3	6.6	80.7	5.4	77.2
1×10^{-5}	41.8	90.1	6.8	77.8	7.0	76.0
1×10^{-4}	34.7	90.7	6.0	82.1	5.9	77.8
1×10^{-3}	31.4	87.9	4.5	86.6	5.1	80.6
1×10^{-2}	34.0	92.7	5.0	74.3	6.1	72.3
1×10^{-1}	0	0	0	0	0	0

[a]Number of twin seedlings (including triplets) ÷ no. of total seeds × l00. [b](Number of twin seedlings + no. of single seedlings) + no. of total seeds × 100.

The optimum concentration of Zn^{2+} was 1×10^{-5} M, at which the twin seedlings frequency of Shuang 3 increased by 10.9%. The twin seedling rate of Shuang 13 increased by 3.5% and that of Lu 52, 2.5% (see table). The results also indicated that Zn^{2+} concentrations of 1×10^{-1} M restricted seedling development.

Zn^{2+} increases the twin seedling rate because it is related to the synthesis of IAA and protein and stimulates N metabolism. ☐

Restorers and maintainers for five CMS lines

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Isolation of restorers and maintainers for different cytoplasmic-genetic male sterile (CMS) lines is important to develop appropriate hybrid combinations and new CMS lines for hybrid rice breeding programs.

Twenty-one locally adapted, high-yielding elite breeding lines were used as pollen parents for crossing five CMS lines developed at CRRI (Kiran A, Krishna A, Deepa A, Madhuri A [WA source], and Krishna A [Kalinga-I source]). We randomly collected anthers from 10-15 spikelets of three panicles from individual F_1 plants during anthesis. They were examined under a microscope using Lugol's iodine solution; pollen sterility was estimated. Spikelet fertility was estimated on two to three panicles that had been bagged on each of the hybrid plants.

Varieties were classified as effective restorers (spikelet fertility more than 80%), partial restorer (spikelet fertility 25-79%), weak maintainers (spikelet fertility less than 25%), and effective maintainers (spikelet fertility less than 1%).

We found most of the varieties to be partial restorers for the CMS lines of wild abortive (WA) and Kalinga I cytoplasmic sources. Aswathi, Punjab Basmati, and Ratna were found to be effective maintainers for Krishna A (Kalinga I); Aswathi, an effective restorer for Krishna A (WA); and Ratna, a partial restorer for Kiran A, Krishna A, Deepa A, and Madhuri A (WA).

Varieties IR9828-91-2-3 and Mahsuri were found to be effective restorers for 4 WA CMS lines (Kiran A, Madhuri A, Krishna A, or Deepa A) while they were partial restorers for Krishna A (Kalinga I) (see table). Like IR9828-91-2-3 and Mahsuri, Tetep was an effective restorer for Deepa A (WA), but a partial restorer for Krishna A (Kalinga I).

The variety Kalinga I was an effective restorer for CMS lines Krishna A (WA), Deepa A (WA), Madhuri A (WA), and Krishna A (Kalinga I) and a partial restorer for CMS line Kiran A (WA).

These findings indicate that the cytoplasm of Krishna A (Kalinga I source) may be different from that of Krishna A (WA) and other CMS lines of WA source. The behavior of a few varieties for the CMS lines from the same cytoplasmic source (WA) was sometimes different, possibly because of the nuclear and cytoplasmic interaction between the varieties and the CMS lines or the heterozygosity of the pollen parents. ☐

Restorer or maintainer reaction of elite lines in crosses with 5 CMS lines possessing WA and Kalinga I cytoplasms, 1991 dry season.[a]

Male parent	Reaction of elite lines				
	Kiran A (WA)	Krishna A (WA)	Deepa A (WA)	Madhuri A (WA)	Krishna A (Kalinga I)
Annapurna	PR	PR	PR	PR	PR
ARC5961	–	–	–	–	PR
Archana	PR	–	–	–	–
Aswathi	–	R	–	–	M
Bhavani	–	–	–	–	WM
CR142-38	PR	PR	–	–	PR
CR386-9-3	–	–	–	WM	–
IR36	–	–	–	–	PR
IR9828-91-2-3		R	–	R	PR
Kalinga I	PR	R	R	R	R
Kranti	PR	–	–	–	PR
Kumar	–	–	–	R	–
Mahsuri	R	–	R	R	PR
Pokkali	PR	–	PR	PR	–
Ptb 10	–	–	–	–	WM
Punjab Basmati	–	–	–	–	M
Prakash	–	–	–	–	PR
Prasad	PR	–	–	–	–
Ratna	PR	PR	PR	PR	M
Tetep	–	–	R	–	PR
Vijaya	WM	PR	–	–	–

[a]R = restorer, PR = partial restorer, WM = weak maintainer, and M = maintainer.

Yield potential

Morphophysiological parameters of three irrigated rice varieties

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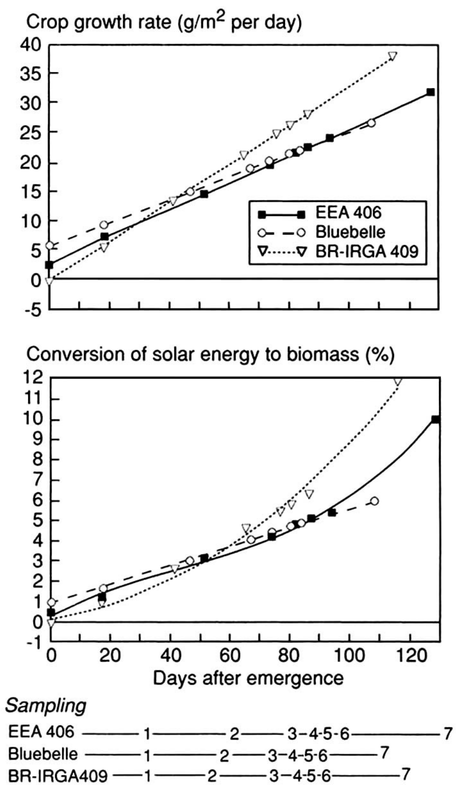
We evaluated the morphophysiological parameters for differentiating the productivity potential of irrigated rice varieties EEA406 (traditional type), Bluebelle (intermediate type), and BR-IRGA409 (semidwarf type) through quantitative analysis of plant growth.

We evaluated plant growth during the cropping cycle by measuring dry matter and total leaf area at seven growth stages (see figure). We determined the parameters of crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR), and leaf area index (LAI) using modern or functional methodology. Conversion of solar energy to biomass (Ec) was calculated as



Crop growth rate and conversion of solar energy to Biomass for 3 irrigated rice varieties during 7 growth stages, Brazil.

$$100 \times (CGR \times 3.7)/(RS \times 0.45)$$

where RS is the incident solar energy, 3.7 is the energy (kcal) per gram of dry matter, and 0.45 is the fraction of RS used in photosynthesis.

The CGR and Ec were the morphophysiological parameters that permitted the differentiation of the three varieties.

BR-IRGA409 showed higher CGR than the other varieties; Bluebelle showed less. After the flag leaf appeared, BR-IRGA409 was the most efficient in Ec, followed by EEA406 and then Bluebelle. This explained the greater observed yield, which had the same rank order as CGR and Ec. □

Grain quality

A method to synthesize the aroma of certain varieties of fragrant Indian rice

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Only one fragrance component, 2-acetyl-1-pyrroline (AP), of boiled Basmati rice has been identified. We have noticed that an aroma completely different from AP is produced at a lower temperature. It closely resembles the sweet odor of four varieties of indigenous unboiled rice. This aroma molecule has the same R_f value as do unboiled rice of those strains but it is very different from that of AP.

Results were variable when we tried to produce the aroma using a mechanical mixture of proline, silica, and sucrose heated at a lower temperature. We instead tried aqueous solutions of sucrose and proline in a new series of experiments. Results were best when 1.1 g proline and 3.4 g sucrose were dissolved in 6 ml water into which 3 g silica was then mixed. This formed a paste that was heated to 128-135°C. Within 15-20 min, an aroma of good quality rice was produced. A solution of proline or sucrose alone yields no such aroma.

Good aroma was also produced using 1.5 g proline, 1 g fructose, 3 ml water, and 2.5 g silica heated to the same temperature range. The reaction temperature is sharply defined; no aroma is produced at 124°C. The rate of AP synthesis is poor, as is the yield of aroma.

By fitting a bent tube to the reaction vessel, an alkaline aqueous fluid can be collected. When trapped in acid-water and thus rendered alkaline, it produces a different odor that is later converted into a rice aroma.

After collecting a sufficient amount of the aroma, gas chromatograph-mass spectrometer analysis can be performed to establish the formula of this new component. □

Pest resistance—diseases

Characteristics of some rice varieties resistant to *Pyricularia oryzae* Cav.

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We evaluated 25 blast-resistant rice varieties from seven regions in China to determine resistance characteristics. Three susceptible varieties served as controls.

Seeds were sown in plastic pots that were filled with soil. We selected uniform rice seedlings and inoculated them 3 wk after sowing with 50 monoconidial isolates of *P. oryzae* from 20 races. Spore suspension was sprayed at a concentration of 1-2 × 10^5 conidia/ml. Inoculated plants were incubated in a dew chamber for 24 h at 25°C and then kept in a humid room with an automatic mister for 1 wk at 24-28°C before we assessed the disease using the Standard evaluation system for rice.

Seedlings inoculated with isolate ZB_1 (85-14) were used to assess relative

Table 1. Type, origin, and R+M% of rice varieties tested for blast resistance.

Type and variety	Region	Races (no.) producing given reaction[a]					R+M (%)[b] (0-4)
		HR 0	R 1-2	M 3-4	S 5-7	HS 8-9	
Japonica							
Dangen 1	Liaoying	49	1	0	0	0	100
Chente 232	Zhejiang	45	0	2	3	0	94
A36 line 16	Jiling	45	2	0	3	0	94
Dushouxi 1	Jiling	39	2	5	4	0	92
1344	Jiling	38	6	2	3	1	92
Jiangxinu	Jiangsu	41	2	3	4	0	92
Ji 86A-48	Jiling	37	3	6	5	0	90
C102	Liaoying	43	2	0	4	1	90
Jiahu 5	Zhejiang	42	0	3	4	1	90
Guizaoshen	Jiling	34	5	4	7	0	86
Nonghu 6 (check)	Zhejiang	4	2	4	35	5	20
Indica							
Xiangya 1	Jiangsu	47	1	1	1	0	98
Suweon 290	Korea	47	1	1	1	0	98
Shuanzao 25	Guangdong	44	1	4	1	0	98
528-4	Hunan	47	0	1	1	1	96
Zhi 20-5	Guangdong	46	1	1	1	1	96
81005	Guangdong	44	1	2	3	0	91
Ming 119	Fujian	37	3	5	4	1	90
Mingnu 706	Fujian	37	5	3	5	0	90
Zhuke 2	Zhejiang	38	2	5	4	1	90
Jiannongzao 9	Fujian	39	3	2	5	1	88
Xiangzhou 5	Hunan	36	1	7	6	1	86
Zhe 852	Zhejiang	38	3	1	8	0	84
Sanyangai 1	Guangdong	33	2	7	8	1	82
Erjiufeng	Zhejiang	37	1	3	8	1	82
Zhefu 802	Zhejiang	36	2	2	6	4	80
Guangluai 4 (check)	Zhejiang	16	4	4	20	6	48
Yuanfengzao (check)	Zhejiang	9	1	2	31	7	24

[a]HR = highly resistant (SES blast score 0), R = resistant (1-2), M = moderate (3-4), S = susceptible (5-7). HS = highly susceptible (8-9). [b]R+M% = percent with SES scores 0-4.

Table 2. Some components of resistance to *P. oryzae* strain ZB_1 (85-14) in rice varieties.

Variety	Relative infection efficiency: Total lesions/ plant (no.)	Relative infection efficiency: Sporulating lesions/plant (no.)	Lesion size (mm^2)	Difference in infectivity (%)
1344	3.00	1.33	0.46	18.8
C102	3.00	2.00	0.84	12.5
Ji 86A-48	6.60	2.25	0.43	15.5
Dushouxi1	4.22	2.33	0.40	56.3
Guizaoshen	3.89	2.00	0.74	75.0
Jiangxinu	5.86	3.67	0.65	31.8
Nonghu 6 (check)	18.93	15.50	3.55	100.0
Mingnu 706	1.33	1.33	0.48	15.8
Jiannongzao 9	1.75	1.00	0.39	21.1
Shuanzao 25	1.50	1.17	0.61	40.0
Zhefu 802	2.67	2.00	0.64	17.6
Xiangzhou 5	4.00	2.00	0.80	50.0
Ming I19	3.20	1.50	0.57	26.3
Sanyangai 1	3.50	2.13	0.59	60.0
Erjiufeng	5.00	4.00	2.30	33.3
81005	6.50	3.33	1.39	22.2
Zhuke 2	13.00	10.17	2.37	100.0
Guangluai 4 (check)	7.47	5.71	3.70	96.2
Yuanfengzao (check)	11.44	7.67	3.62	100.0

infection efficiency (RIE, based on lesions per plant), lesion size (LS), and difference in infectivity ([DIE], the percentage of infected plants 7 d after inoculation).

The 25 varieties showed a broad spectrum of resistance, with R+M% >80% for the 50 isolates tested (Table 1).

Studies on some components of partial resistance to the isolate ZB_1 (85-14) found that this isolate did not infect nine varieties, thus showing vertical resistance to the isolate. The 16 other varieties were infected by the isolate, but had less RIE, smaller LS, and lower DIE than the susceptible varieties, indicating partial resistance to the isolate (Table 2). □

Inducing rice blast (Bl) resistance by inoculating with an incompatible race of *Pyricularia oryzae* Cav.

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We studied the ability of an incompatible Bl race to induce resistance to a compatible race in the greenhouse using rice variety Zhenlong 13.

We mixed the incompatible and compatible races and inoculated the plant at the 4-leaf stage. Inoculation density of the compatible race was 10^5 conidia/ml; that of the incompatible race varied (Table 1).

In a second experiment, plants were inoculated first with the incompatible race, followed by the compatible race 1, 2, and 3 d later. Disease intensity was assessed 7 d after inoculation.

The experiments were repeated twice with three replications each.

The incompatible race induced resistance to the compatible race only when it was introduced before or simultaneously with the compatible race (Table 2). □

Table 1. Effect of mixed inoculation with compatible and incompatible Bl races on lesion number, lesion length, and blast score. Hangzhou, China. [a]

Incompatible race (x 10⁵)	Compatible race (x 10⁵)	Lesions (no.)	Lesion length (mm)	Blast score [b]
1	0	0 (0)	0 (0)	0 (0)
1	1	12.9 (38)	0.97 (45)	3.8 (58)
2	1	10.7 (32)	0.90 (42)	3.4 (52)
4	1	8.3 (25)	0.68 (32)	2.6 (40)
8	1	8.1 (24)	0.73 (34)	2.4 (37)
16	1	8.2 (24)	0.66 (31)	2.6 (40)
0	1	33.6 (100)	2.15 (100)	6.5 (100)

[a] Figures in parentheses are percentages relative to the positive check. [b] By the *Standard evaluation system for rice* scale of 0-9.

Table 2. Pathogenic reactions in interval inoculation with compatible and incompatible races. Hangzhou, China. [a]

Incompatible race	Compatible race	Interval (d)	Lesions (no.)	Lesion length (mm)	Blast score [b]
ZA63	0	1	0 (0)	0 (0)	0 (0)
ZA63	ZB1	1	20.2 (105)	0.72 (82)	4.3 (81)
0	ZB1	1	19.3 (100)	0.88 (100)	5.3 (100)
ZA63	0	2	0 (0)	0 (0)	0 (0)
ZA63	ZB1	2	15.8 (86)	0.47 (57)	3.3 (69)
0	ZB1	2	18.4 (100)	0.83 (100)	4.8 (100)
ZA63	0	3	0 (0)	0 (0)	0 (0)
ZA63	ZB1	3	12.5 (84)	0.65 (79)	3.8 (95)
0	ZB1	3	14.8 (100)	0.82 (100)	4.0 (100)

[a] Figures in parentheses are percentages relative to the positive check. [b] By the *Standard evaluation system for rice* scale of 0-9.

Pest resistance—insects

Evaluation of leaf and panicle blast (Bl) in lines distributed by CIAT to national programs in Latin America

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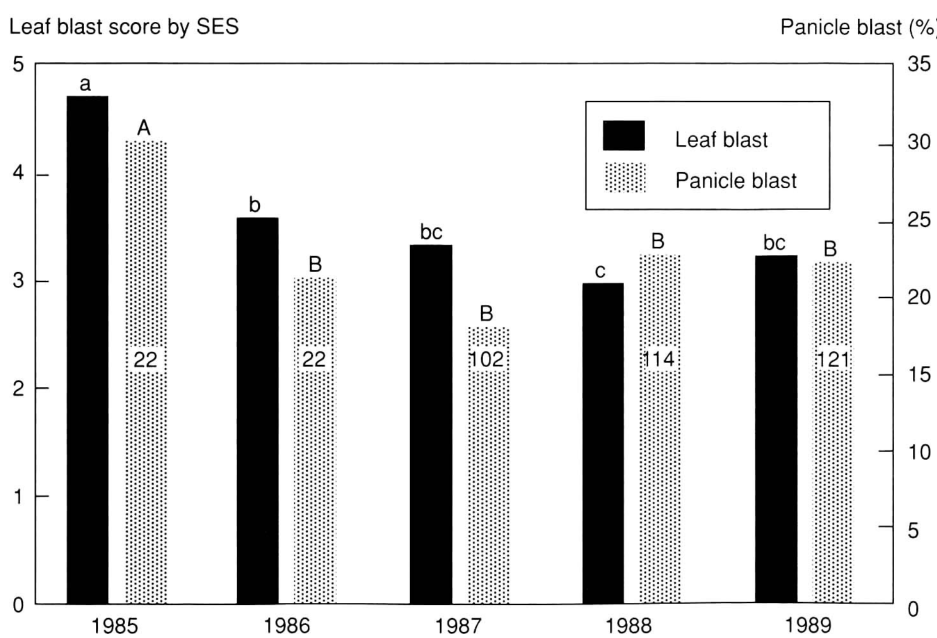
Developing germplasm with a high level of Bl resistance is one of the major objectives of CIAT's rice program. Lines are evaluated and selected in a disease-prone area, the Santa Rosa Experimental Station in Villavicencio, Colombia (333 m elevation, 4° N, 73° W on alluvial soils). This germplasm is distributed mainly to national partners in the region through the International Observational Nursery for Latin America (VIOAL), organized by the International Network for the Genetic Evaluation of Rice (INGER).

We conducted a trial to evaluate the 638 CIAT lines included in the VIOAL nurseries from 1985 to 1989. The experiment was laid out in an augmented design with 11 blocks and checks Ceysvoni, CICA8, Metica 1, Oryzica 1, and Oryzica Llanos 4 planted twice, 15 d apart.

Leaf and panicle Bl were scored using the *Standard evaluation system for rice.* Three evaluations per line were made for leaf Bl at 35, 45, and 55 d after planting. The highest score observed was used to characterize the material's reaction.

Panicle Bl data were taken on 20 samples in each line. Panicles rating 25 were classified as susceptible and 53 as resistant. The percentage of susceptibility for each line was calculated as the number of panicles classified as susceptible divided by the sample size, multiplied by 100. Data were averaged per year to represent the percentage of mean reaction of the VIOAL.

The results indicate that CIAT seems to be producing lines with more resistance to leaf B1 (see figure). The major improvement in resistance to date was between 1985 and 1986. The level of resistance to panicle Bl increased in 1986 and has remained at the same level since then. The results suggest that CIAT's breeding approach has resulted in lines with improved Bl resistance. □



Distribution of leaf and panicle blast reactions obtained from VIOAL nurseries from 1985 to 1989 in Latin America. Number of lines evaluated is in the bars. Different letters on top of the bars indicate statistical differences at 5% level using DMRT. SES = *Standard evaluation system for rice.*

Evaluation of Asian gall midge (AGM)-resistant varieties for the African rice gall midge (ARGM)

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We screened 88 AGM-resistant varieties for the ARGM *Orseolia oryzivora* Harris and Gagne, a major insect pest of lowland rice in Nigeria. The trial was carried out under field conditions at NCRI during the 1989 wet season. Seedlings were transplanted 21 d after seeding at 20- × 20-cm spacing in one 20-hill row/entry, replicated twice. ARGM damage was scored at 45 d after transplanting (DT).

Twenty-four of the 88 entries were rated highly to moderately resistant (see table).

Nineteen of the resistant entries and a set of 11 AGM-resistant varieties were screened in the screenhouse during the 1991 wet season. Susceptible variety FARO 37 was grown in half of' the screenhouse. We released hundreds of ARGM adults, reared from young galls collected from field-infested plots, in the screenhouse for 2 wk (from 7 d after treatment [DAT]). When the test entries were transplanted at 60 DAT, infestation level was 30.2% on FARO 37. The test entries were planted as in the field. with four replications, in the other half of the screenhouse. ARGM damage was scored at 45 DAT.

Only Aganni and NHTA 8 were moderately resistant. All other entries showed susceptible reactions (see table). ☐

Reaction [a] of Asian GM-resistant varieties to the ARGM. Badeggi, Nigeria.

Variety	Infestation: Field (1989) %	Field (1989) Score	Screenhouse (1991) %	Screenhouse (1991) Score	Origin
ARC5848	0.0	HR	18.8	S	India
ARC5911	0.0	HR	10.9	S	India
ARC5984	0.0	HR	14.5	S	India
ARC6015	0.0	HR	11.3	S	India
ARC6087	0.0	HR	9.7	MS	India
ARC6607	0.0	HR	7.7	MS	India
ARC7255	0.0	HR	12.5	S	India
ARC7316	0.0	HR	9.9	MS	India
ARC7317	0.0	HR	21.4	S	India
ARC10272	0.0	HR	12.5	S	India
ARC11074	0.0	HR	7.6	MS	India
ARC11210	0.0	HR	16.4	S	India
ARC13564	0.0	HR	11.8	S	India
PTB19	0.0	HR	10.0	S	India
AC1423	4.8	MR	–	–	India
ARC6618	2.9	MR	8.0	MS	India
ARC7329	2.8	MR	–	–	India
ARC10331	3.4	MR	–	–	India
ARC10660	4.3	MR	12.0	S	India
ARC13902	2.4	MR	–	–	India
ARC15159	3.0	MR	12.2	S	India
ARC18596	2.9	MR	13.3	S	India
PTB28	2.6	MR	7.9	MS	India
Muey Nawng 62 M	3.0	MR	–	–	Thailand
Cisadane	–	–	15.7	S	Indonesia
ARC6157	–	–	15.2	S	India
Kalijira	–	–	14.6	S	Bangladesh
Phodum	–	–	16.4	S	India
OR143-7	–	–	18.8	S	India
Aganni	–	–	4.9	MR	Not known
Parakulan	–	–	6.2	MS	Not known
NHTA8	–	–	4.3	MR	Not known
Chekhalopoiretal	–	–	11.3	S	Not known
CR57-MR1523	–	–	14.5	S	India
OB677	–	–	29.3	HS	Sri Lanka
FARO 37 (susceptible check)	26.4	HS	46.7	HS	IITA, Nigeria

[a] Score based on the *Standard evaluation system for rice* where HR = highly resistant, MR = moderately resistant, MS = moderately susceptible, S =susceptible, and HS = highly susceptible.

Screening for resistance to brown planthopper (BPH) and whitebacked planthopper (WBPH) in rice germplasm in Hunan, China

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We screened 4,261 and 3,477 germplasm accessions, respectively, for resistance to BPH *Nilaparvata lugens* Stål and WBPH *Sogatella furcifera* (Horvath). TN1, Mudgo, and N22 were the susceptible and resistant checks.

We sowed the seed in wooden seedboxes in the greenhouse during 1986-91. Each seedling was infested at the 3- and 4-leaf stage with seven to eight 2d-instar nymphs. Damage was scored using the *Standard evaluation system for rice.*

One hundred eighty-one germplasm accessions were resistant to BPH, 236 to WBPH, and 18 to both BPH and WBPH (see table). These accessions can be used in breeding programs. ☐

Resistance of Hunan rice germplasm to BPH and WBPH. China, 1986-91.

Accession no.	Cultivar	Damage score [a] BPH	WBPH
1437	Xiang Zhan	5	5
1653	Huang Yang Zhan	5	5
2064	Xiong Gui Yang	5	5
2068	Long Tan Zhan	5	5
2702	Da Yi Su	5	5
2738	Liu Er Ma	3	5
2739	Hong Mi Mao Zhan	5	5
2743	Er Hao He	3	5
2781	Huang Pi Nuo	5	5
2784	Hong He Nuo	1	3
2793	Bai Mi Nan Yue Zhan	5	3
2910	Da Shui Zhan	5	5
4032	Jiang Xi Zao	1	5
6795	Bai Mi Nuo	5	5
7015	HA79317-4	3	5
7016	HA79317-7	3	3
7207	Guang San Nuo	3	5
A384	Xiang Kang 32-5	3	5
	TN1	9	9
	N22	7	3
	Mudgo	1	–

[a] By the *Standard evaluation system for rice.*

Stress tolerance—excess water

Rapid and nondestructive screening technique for elongation in deepwater rice (DWR) using gibberellic acid (GA_3)

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Present techniques for assessing plant elongation ability are potentially destructive because poorly elongated rice plants die when flooded for prolonged periods.

We compared two nondestructive procedures using GA_3 treatment and short-duration flooding at seedling stage to overcome this problem. GA_3 induces the elongation response of DWR during flooding. We seeded 48 entries in two experiments in completely randomized design with three replications. Entries included modern variety (MV) nonelongating types, MV elongating types, tall traditional, tall elongating, deepwater varieties, and floating types from several countries. Plants were thinned at the 3-leaf stage and then allowed to grow.

In the first experiment, we sprayed plants at the 4-leaf stage with 500 or 1,000 ppm GA_3 at the rate of about 0.3 ml/plant. GA_3 was initially dissolved in ethyl alcohol with final concentrations of 0.05 wt/vol for the 500 ppm GA_3 and 0.1 wt/vol for the 1,000 ppm GA_3 treatment. The same ethanol concentration was used for the control.

Another complete set of the entries was submerged for 7 d at 21 d after seeding (DAS). We computed plant elongation by subtracting plant height before flooding from that after treatment.

GA_3 treatment produced no significant differences in internode length. We grouped entries into categories based on the average internode length at the 5- to 6-wk stage: good elongation (1-3), medium elongation (5), and poor elongation (7-9). Results suggest that internodes of floating rices are more sensitive to GA_3 than are those of

Plant elongation measured by plant height increase after 7 d flooding and by internode length in nonflooded plants after different doses of GA_3.

Variety	Country or origin	Plant elongation during flooding (cm)	Internode elongation (cm)				Elongation score[a]
			GA_3 1000 ppm	GA_3 500 ppm	Av	Control (no GA_3)	
Nonelongating type							
Dulhabhog	Bangladesh	33	51	35	43	0	9
Safri 17	India	37	38	44	41	0	9
Jaya	India	34	38	61	49	0	9
IR5	IRRI	30	31	55	43	0	9
IR42	IRRI	28	48	45	46	0	9
Mahsuri	Malaysia	38	49	47	48	0	9
TN1	Taiwan	44	52	61	57	0	5
Av		35	44	50	47	0	
Tall traditional							
Ashini	Bangladesh	41	42	37	39	0	9
Rajasail	Bangladesh	44	29	43	36	0	9
Maliabanger	Bangladesh	40	40	35	37	0	9
Patnai 23	India	45	53	40	46	0	9
Manoharsali	India	38	32	38	35	0	9
NC492	India	37	31	47	39	0	9
NDGR207	India	34	36	49	43	1	9
Sugapankhi	India	30	59	42	50	0	7
Nam Sagui 19	Thailand	46	65	44	55	0	5
Av		39	43	41	42	0	
Deepwater and MV elongating types							
Girmi	Bangladesh	55	55	54	54	0	5
Jaisaria	Bangladesh	51	55	67	61	0	5
Bhadoia 293	Bangladesh	47	70	54	62	1	5
Bhainslot	India	58	43	57	51	0	5
NDGR150	India	45	51	80	66	0	3
IR11141-6-1-4	IRRI	42	67	92	80	0	3
IR11288-B-B-69-1	IRRI	38	57	55	56	0	5
Walihandiran	Sri Lanka	27	68	53	61	0	5
BKNFR76106-16-0-I	Thailand	11	61	70	66	0	3
RD19	Thailand	50	62	89	75	0	3
Pan Tawng	Thailand	39	47	65	56	0	5
Pin Gaew 56	Thailand	38	55	49	52	0	5
Av		42	58	65	57	0	
Tall elongating type							
Rayada 16-05	Bangladesh	54	58	45	51	0	5
Rayada 16-06	Bangladesh	52	56	10	63	0	5
Sran Kraham	Cambodia	44	53	77	65	3	3
TCA148-3	India	53	78	52	65	4	5
Chakia 59	India	52	61	80	71	8	3
IR40905-11-3-1-5-3-3	IRRI	54	73	55	64	4	5
Av		52	61	64	57	3	
Floating type							
Sarsari	Bangladesh	87	86	122	104	9	1
BR516-48-3	Bangladesh	80	94	111	103	26	1
Khama	Bangladesh	80	99	105	102	13	1
Bhadoia 303	Bangladesh	78	123	101	112	32	I
Chamard	Bangladesh	69	75	80	78	6	3
Baishbish	Bangladesh	66	74	71	73	3	3
Digha	Bangladesh	60	90	51	70	0	3
Rayada 16-04	Bangladesh	50	87	75	81	0	1
Bazail65	Bangladesh	47	97	80	89	9	1
Vear sar	Cambodia	71	53	80	66	6	3
Anlong Phnom	Cambodia	51	51	79	65	6	5
Jalmagna	India	77	122	123	123	26	1
Chhota Bhawalia	India	68	105	98	102	16	1
LMN111	Thailand	75	92	103	98	14	1
Av		68	89	87	88	12	
Comparison		SED	LSD (0.05)				
2-mxs mean		7.51	14.88				
r^2		0.40					

[a] Score for av internode length. 1 = >80 cm, 3 = 65-79 cm, 5 = 50-64 cm, and 7-9 = <50 cm.

nonfloating rices (see table). Among floating rice varieties, plants with good elongation ability were more sensitive than those with moderate ability. The r^2 values for the correlation between elongation following flooding relative to internode length with GA_3 treatment was 0.40.

The GA_3 treatment did not reflect elongation ability during submergence in some cases. Submergence-tolerant variety BKNFR76106-16-0-1, for example, had an exceptionally high internode length of 66 cm after GA_3 treatment, but it elongated the least among entries in the flooding treatment.

Plant elongation from short-duration flooding at early seedling stage was usually comparable to that with GA_3 treatment except in cases where elongating and nonelongating MVs did not differ much from the other.

Findings suggest that plant sensitivity to GA_3 may differ between floating and nonfloating rice varieties during at least the 5-6 wk stage.

Foliar application of 500 ppm GA_3 could be used during the seedling stage to distinguish floating rices possessing good elongation ability from those having poor elongation ability and from nonfloating rices. ☐

Integrated germplasm improvement—irrigated

Basmati 385 approved for cultivation in Punjab, India

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Basmati 385 was introduced from Pakistan. We evaluated it in the Punjab for yield, morphological traits, grain quality, and disease and insect resistance. Basmati 385 produced about 30% more rice than Basmati 370, but it was outyielded by Pusa Basmati 1 by about 4% in research and adaptive trials.

Yield data for the varieties under different N levels and dates of transplanting (Table 1) showed that 60 kg N/ha is optimum for Basmati 385 and Basmati 370, while 90 kg N/ha is optimum for Pusa Basmati 1 under normal soil fertility. The optimum time for transplanting is the first fortnight of July for Basmati 385 and Basmati 370 and the second fortnight of June for Pusa Basmati 1.

Table 1. Yield of Basmati 385, Basmati 370, and Pusa Basmati 1 under different N levels and transplanting dates, 1991 wet season.

Treatment	Yield (t/ha)		
	Basmati 385	Basmati 370	Pusa Basmati 1
N level (kg N/ha)			
0	3.2	2.1	3.5
60	4.3	3.3	4.6
90	4.3	3.2	4.9
120	4.3	3.1	5.0
Mean	4.0	3.1	4.5
Transplanting date			
15 Jun	3.9	3.1	4.4
30 Jun	4.3	3.3	4.8
15 Jul	4.1	4.2	3.8
25 Jul	3.4	2.3	3.6
Mean	4.1	3.2	4.1

Morphological and grain quality traits for the varieties are in Table 2. Grain shape and cooking quality of Basmati 385 are similar to those of Basmati 370. Although grains of Pusa Basmati 1 are longer and more slender than the rice of Basmati 370 and Basmati 385, cooking quality and head rice recovery of Pusa Basmati 1 is slightly inferior to that of the others. Pusa Basmati 1 received the lowest score of the three in a consumer acceptability test for cooking and eating quality of rice. Grain quality of Basmati 38.5 meets requirements for export to the Middle East, Europe, and the United States.

Basmati 385 matures earlier than Basmati 370 and Pusa Basmati 1. It has short plant height and sturdier stems than Basmati 370, but is taller than Pusa Basmati 1. The three varieties are equally susceptible to bacterial blight and stem borer, the two most serious pests of rice in the Punjab.

Table 2. Morphological and grain quality characters of Basmati 385, Basmati 370, and Pusa Basmati 1.

Character	Basmati 385	Basmati 370	Pusa Basmati 1
Plant height (cm)	140	165	100
Days to maturity (no.)	135	150	140
Panicle-bearing tillers (no./m^2)	234	243	273
Spikelets (no./panicle)	210	140	168
Head rice recovery (%)	61.60	62.20	60.50
1000-grain wt (g)	15.80	15.70	16.50
Grain length (mm)	7.15	7.15	7.52
Grain breadth (mm)	1.65	1.63	1.56
Length-breadth ratio	4.33	4.39	4.82
Grain elongation ratio	1.94	1.95	1.80
Volume expansion	4.00	4.00	3.90
Amylose content (%)	23.52	23.48	22.85
Aroma	Strong	Strong	Mild

Because of its good grain quality and superiority in yield potential, earliness, and short plant height, the State Variety Approval Committee has approved Basmati 385 for general cultivation in the Punjab, India. ☐

Krasnodarsky 86, a modern variety for use without pesticides in Kuban and Crimea, Russia

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Krasnodarsky 86 is a modern, multiple-resistant rice variety. The Russian Ministry of Agriculture released it in 1990 for the Kuban area (Krasnodarsky Territory and Republic of Adygea) and in 1992 for Crimea. It is already planted on 20,000 ha.

The variety was developed by individual selection and biotechnological methods from 40 lines segregated from Krasnodarsky 424 variety.

Krasnodarsky 86 belongs to the japonica subspecies. It is more resistant to lodging, blast, insects, and weeds than Krasnodarsky 424 and is recommended for cultivation without pesticides.

Duration is 115 d and the height 115-130 cm. Panicles are droopy, compact, straw yellow in color, 20 cm long, and have five spikelets/cm. Yield is 8.0-10.0 t/ha and 1.000-grain weight is 34 g. Hulling recovery is 79%, milling recovery 74%, and head recovery 64-73%. Its pericarp is white and its endosperm is translucent. Grain length is 7 mm with 1.8:1 length-to-breadth ratio. Protein content in polished rice is 8-9%. ■

CROP AND RESOURCE MANAGEMENT

Fertilizer management—organic

Sesbania rostrata mutant with long vegetative phase

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S. rostrata Brem. produces N-fixing nodules on the main stem, branches. and roots. It reportedly can produce as much as 250 kg N/ha in 52 d. It is sensitive to short photoperiod and grows poorly, nodules sparsely, flowers early, and produces insufficient phytomass. We tried to improve this plant by developing a fast-growing, day-neutral type through the induced mutation approach.

An M_2 generation (gamma ray treated) of *S. rostrata* was planted in Dec 1989. The control and most of the plants flowered 30-40 d after planting (DP). One plant, however, flowered at 10 mo in Oct 1990. Seeds of this late-flowering mutant (LFM) and the parent were sown in 1-m-long rows at a 30-d interval from Dec 1990 to Sep 1991.

In a different experiment, three sets of 15 plants/pot were exposed to an 8-h photoperiod for 10 d at 15, 45, and 60 DP. A set of 15 plants and a LFM kept in the field served as control. We recorded flowering time and height at parent flowering.

The LFM flowered later than the parent in all 10 of the staggered sowings (see figure). Flowering time of the parent differed depending on sowing time. But LFM flowered only during mid-Oct to Nov, regardless of sowing time. The shortest vegetative phase of the parent was 35 d (Dec sowing); for LFM, it was 70 d (Sep sowing). LFM sown during Dec-Feb flowered with the next cycle of short days.

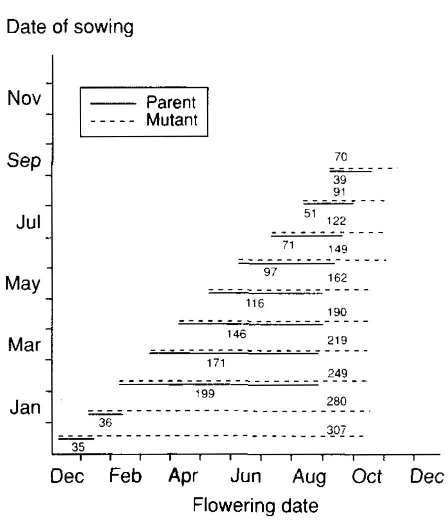
Short-day exposure for 10 d at three growth stages induced early flowering in the parent (see table), while LFM was insensitive to short days up to 60 d after sowing (DAS). LFM exposed to short days flowered from 222 to 227 DAS as did the controls. Both experiments show that LFM is insensitive to the critical short photoperiod up to at least 60 DAS. Plant height indicated that the growth of the LFM was similar to that of the parent, or better.

The LFM can be grown to obtain sufficient phytomass year-round because it is insensitive to the inductive photoperiod for a longer period than its parent. ■

Days to flowering and plant height after exposure of *S. rostrata* and LFM to short photoperiod.

Age at exposure (DAS)	Days to flowering (no.)		Plant height (cm)	
	Parent[a]	Mutant	Parent	Mutant
15	37 (12)	222	116 ± 2	102 ± 2
45	64 (9)	227	156 ± 3	171 ± 5
60	86 (15)	226	170 ± 4	190 ± 11
Control	151	217	353 ± 18	368 ± 21

[a]Figures in parentheses are the no. of days from completion of short-day exposure to flowering.



Date of sowing, date of flowertng, and number of days to flowering (figures on and below the lines) of *S. rostrata* parent and mutant.

Integrated pest management—diseases

Detection of *Xanthomonas oryzae* pv. *oryzae* (Xoo) with the monoclonal antibody-based biotin-avidin enzyme-linked immunosorbent assay (ABC-MAb-ELISA)

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We have generated 15 hybridoma cell lines that stably secrete monoclona1 antibodies (MAbs) by fusing mouse myeloma cells (SP2/0-Ag14) and spleen cells derived from BALB/c mice immunized with a preparation of Xoo strains Ks-6-6, Os-213, Yz-32, and Yz-34. The MAbs were used to detect Xoo using the double antibodies sandwich enzyme-linked immunosorbent assay (DAS-ELISA) technique. The sensitivity of ELISA was improved by adding the biotin-avidin system. This technique, called ABC-MAb-ELISA, was compared with DAS-ELISA, DAS-ABC-ELISA, indirect ELISA (ID-ELISA), and ID-ABC-ELISA, which use the MAbs as either the primary or secondary antibody. ■

Table 1. Sensitivity of MAb-ELISA in the detection of Xoo. [a]

Technique	Sensitivity at given strain concentration (cells/ml)						
	10^6	10^5	10^4	10^3	10^2	10^1	PBS (check)
DAS-ELISA	+	–	–	–	–	–	–
DAS-ABC-ELISA	+	+	–	–	–	–	–
ID-ELISA	+	+	–	–	–	–	–
ID-ABC-ELISA	+	+	+	+	–	–	–

[a] + = positive = no. OD_{490} is twice that of check. – = negative.

Table 2. Specificity of MAb-ELISA in the detection of Xoo.

Technique	Specificity							
	Xoo	*X.o.* pv. *oryzicola*	*X.c.* pv. *malvacearum*	*X.c.* pv. *campestris*	*E. carotovora* subsp. *carotovora*	*P. solanacearum*	*C. sepedonicum*	*A. tumefaciens*
DAS-ELISA	+	–	–	–	–	–	–	–
DAS-ABC-ELISA	+	–	–	–	–	–	–	–
ID-ELISA	+	–	–	–	–	–	–	–
ID-ABC-ELISA	+	–	–	–	–	–	–	–

The cultures of Xoo were diluted into different concentrations (cells/ml) and tested using four methods. The sensitivity of ABC-MAb-ELISA was higher than that of ELISA; ID-ABC-ELISA had the highest (Table 1). In our experiments, the sensitivity of ID-ELISA was higher than that of DAS-ELISA.

We detected some important plant pathogenic bacteria belonging to different genera or species. Negative reactions were observed on *Elwinia carotovoru* subsp. *carotovora, Pseudomonas solanacearum, Corynebacterium sepedonicum,* and *Agrobacterium tumefaciens.* We also observed negative reactions on the same species but of different pathogenic types: *X. campestris* pv. *campestris, X. campestris* pv, *malvacearum,* and *X. oryzae* pv. *oryzicola* (Table 2).

Our experiment showed that by adding the biotin-avidin system to the ELISA, the sensitivity of reaction could be improved without changing specificity. ABC-MAb-ELISA will be useful in detecting Xoo. □

Distribution of sheath rot (ShR) in six agroclimatic zones of Assam, India

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ShR was confined to the rice-growing areas of Cachar district in Assam during the early 1980s, but it has gradually spread to other regions. We surveyed 17 rice-growing districts representing the state's six agroclimatic zones to better understand the current status of the disease. Fields planted to different cultivars of transplanted rice located along the national highways were inspected at booting stage during the 1989 and 1990 wet seasons (Jul-Oct). We assessed all the hills in a 1-m^2 area at each site. ShR incidence was calculated as number of infected tillers divided by total tillers × 100.

The highest incidences of ShR were in Karimganj and Cachar districts of the Barak Valley zone (see table). Lowest incidences (4%) were in the two districts of the hill zone. No zone, however, was disease-free. Jaya and IR20 had higher infection incidence than other commonly cultivated rice. □

Sheath rot incidence in 6 agroclimatic zones of Assam, India, 1989-90.

Agroclimatic zone	District	Fields surveyed (no.)	Range of incidence (%)	Agroclimatic zone	District	Fields surveyed (no.)	Range of incidence (%)
Upper Brahmaputra Valley	Dibrugarh	4	21-30	Hill zone	Karbi Anglong	4	<5
	Sibsagar	3	11-20		North Cachar	3	<5
	Jorhat	4	31-40	North Bank Plain	Lakhimpur	3	31-40
	Golaghat	2	11-20		Sonitpur	2	11-20
					Darag	41-10	
Central Brahmaputra Valley	Nowgong	2	11-20	Barak Valley	Karimganj	4	>50
	Marigaon	2	11-20		Cachar	3	41-50
Lower Brahmaputra Valley	Kamrup	3	11-20		Total	52	
	Borpeta	2	1-10				
	Kokrajhar	4	11-20				
	Goalpara	3	1-10				

Chemical control of neck blast (Bl) through granular fungicides

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Bl caused by *Pyricularia oryzae* Cav. is a serious constraint to the production of scented rice in Haryana. We evaluated granular fungicides pyroquilon, chlobenthiazone, and IBP and a soil application of a recommended spray fungicide (edifenphos). Susceptible cultivar Pakistani Basmati was transplanted in Jul 1986. The experiment was laid out in a randomized block design with 5- × 3-m^2 plots. Each treatment was replicated three times.

Fungicides were broadcast at disease initiation prior to panicle initiation. We applied pyroquilon, chlobenthiazone, and IBP at 30 and 40 kg/ha and edifenphos at 5 liters of the formulated product in 60 kg sand/ha. Disease incidence was recorded as the percent infected panicles in 250 randomly selected tillers/plot 20 d after the last application of fungicide.

Effect of fungicides on neck B1 incidence and yield of Pakistani Basmati.

Treatment	Rate of application/ha (on formulation basis)	Disease incidence (%)	Disease control over check (%)	Yield (t/ha)	Increase in yield over check (%)
Pyroquilon	30 kg DI + 40 kg PI[a]	12.7	69.8	3.2	16.3
Chlobenthiazone	30 kg DI + 40 kg PI	6.0	85.7	3.1	13.9
IBP	30 kg DI + 40 kg PI	29.3	30.2	2.9	4.0
Edifenphos	5 liters in 60 kg sand DI + 5 liters in 60 kg sand PI	18.0	57.1	3.0	7.1
Check	-	42.0	-	2.8	-
LSD 0.05		4.7			

[a]DI = at disease initiation. PI = at panicle initiation.

All of the fungicides significantly reduced neck Bl incidence. Chlobenthiazone proved most effective and reduced incidence by 85.7%, increasing yield by 13.9%. Soil application of edifenphos was the least effective (see table). □

Rice yellow dwarf (RYD) disease in Assam, India

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RYD symptoms have been noticed in rainfed lowland, transplanted autumn rice (Mar/Apr to Aug) in the Barak Valley Zone of Assam since 1989. Plants showed pronounced stunting, profuse tillering, uniform, pale yellow leaves, and lack of panicle development. Panicles were short with chaffy grains if they emerged. Similar symptoms were observed in ratoon crops.

We observed 7.50 indigenous entries from the autumn rice germplasm collection of RARS during 1991. Of these, 179 showed RYD symptoms, with 3-12% of the plants infected. Recommended varieties—DR92, Cauvery, Rasi, Culture 1, and Akashi—exhibited similar symptoms.

RYD had never been reported before in this zone and therefore had to be confirmed. We conducted transmission studies using green leafhopper (GLH) during 1991 kharif. We gave 2d- and 3d-instar GLH nymphs acquisition access feeding for 24 h on apparently RYD-infected Cauvery plants. After 30 d of incubation, the viruliferous insects were allowed inoculation access feeding for 24 h on 11-d-old seedlings for each variety. Visible symptoms of RYD appeared in all the test varieties 22-27 d after inoculation.

Spraying RYD-infected plants with a 250-ppm solution of oxytetracycline twice at a 15-d interval caused a remission of the symptoms. These results confirmed the occurrence of RYD in Assam. □

Integrated pest management—insects

Fall-off rates of *Nilaparvata lugens* (Stål) and efficiency of the predator *Limnogonus fossarum* (F.)

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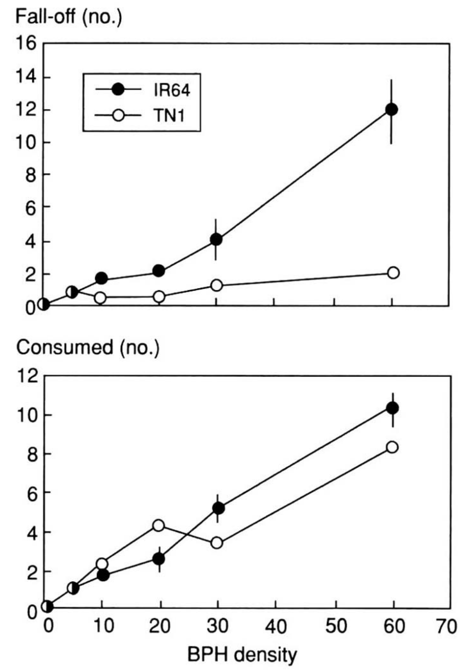
The water strider *Limnogonus fossarum* (F.) (Hemiptera: Gerridae) is common in wetland ricefields. It often feeds on brown planthoppers (BPH) that fall off the rice plants. We determined fall-off rates of the BPH and efficiency of *L. fossarum* in attacking those BPH that fell off.

BPH-resistant IR64 and susceptible TN 1 grown in the laboratory were used. The experimental arena consisted of a potted rice plant (35 d old) trimmed to five tillers and placed in a plastic container filled with water and enclosed in a cylindrical mylar cage (17 cm diameter, 50 cm high). The water level was kept at 1 cm above the brim of the pot.

In the fall-off study, 1-d-old BPH females were introduced into the experimental arena at densities of 5, 10, 20, 30, and 60, each replicated five times. BPH in the water were recorded 24 h later.

The predation rate of *L. fossarum* was measured in a different experiment replicated five times using the same BPH densities. We released a 1-d-old female *L. fossarum* inside the experimental arena containing 1-d-old BPH females. We recorded the BPH consumed after 24 h.

The number of BPH that fell off the plants was related to density (see figure). Fall-off was highest at density 60, and was significantly higher in IR64 than in TN1. The rate of BPH consumption by *L. fossarum* increased with density. The number of BPH attacked was significantly higher in IR64 than in TN1 at the higher densities.



Rate of fall-off of BPH and consumption by *L.fossarum* at different BPH densities.

Number of BPH consumed and fall-off were not correlated, however. The number consumed, especially at lower BPH densities, was generally higher than the number of those falling off. This indicates that the water strider did not only prey on BPH that fell into the water, but that it also attacked BPH on the plant. Consumption was higher with the resistant cultivar IR64, suggesting that the fall-off also increased BPH consumption by *L. fossarum.* □

Weed control in wet seeded rice (WSR) in Bangladesh

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Farmers in Bangladesh generally cultivate boro (dry season irrigated) rice as a transplanted crop. Uprooting and subsequent transplanting of seedlings are labor-intensive. Transplanting shock also increases crop growth duration. Rice sown as pregerminated seed on puddled soil and irrigated a few days later has outyielded transplanted rice in many rice-producing countries.

We conducted trials at BRRI, Joydebpur, during boro season to determine WSR performance with regard to weed components and labor requirements for weeding.

Treatments were two planting methods, direct seeding and transplanting, and three weed control methods: hand weeding, herbicidal control with oxadiazon at 0.5 kg ai/ha, and no weed control. The experiment was laid out in a randomized complete block design with three replications. Plots were 4 m^2.

We transplanted 48-d-old BR14 seedlings on 25 Jan 1990 and 58-d-old seedlings on 6 Feb 1991 at 20- x 20-cm spacing. Pregerminated seeds were broadcast on the same days. Seed rates were 45 kg/ha for transplanting and 90 kg/ha for wet seeding. Irrigation water was applied when necessary. Plots were weeded at 20 and 40 d after planting (DP) in both years. Herbicide was applied at 7 DP.

Fertilizer was applied at 80-26-33-40 kg NPKS/ha as urea, triple superphosphate (TSP), muriate of potash (MP), and gypsum. One-third urea, all TSP, MP, and gypsum were basally applied before planting. The rest of the urea was applied in two equal splits at active tillering and panicle initiation stages. An extra 13 kg P/ha was applied at 54 DP in 1990 because of P deficiency. Carbofuran at 15 kg/ha was applied at maximum tillering to control stem borers.

Grain yield of boro rice and labor requirements as influenced by cultivation methods. [a]

Cultivation method	Weed control method	Weed density (no./m^2)		Weed weight (g/m^2)		Labor and seed costs [b] ($/ha)				Grain yield (t/ha)	
						Weeding/ spray		Total production costs [c]			
		1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
Transplanting	Hand	176 a	361 a	56.3 a	54.5 a	72	67	147	138	3.5 a	3.7 a
Directsowing	Hand	153 a	438 a	68.3 a	56.3 a	117	111	144	139	3.7 a	3.4 a
Transplanting	Herbicide	–	–	–	–	2	1.5	76	74	3.3 a	3.5 a
Direct sowing	Herbicide	–	–	–	–	2	1.5	30	29	3.8 a	3.5 a
Transplanting	None	296 b	412 a	298.2 b	158.1 c	–	–	72	72	2.2 b	2.2 b
Direct sowing	None	312 b	576 a	311.9 b	146.6 b	–	–	26	26	2.3 b	2.4 b
CV (%)		6.5	12.2	28.5	1.7					10.0	7.1

[a] Letters in a column compare means at $P_{0.05}$ level by Duncan's multlple range test. [b] Labor cost @ $1.0.25/person-day: seed cost @ $0.269/kg. [c] Labor required for seedling uprooting, transplanting/sowing, herbicide spraying, and hand weeding; includes seed cost.

Labor required for seedling uprooting. transplanting or sowing, herbicide spraying, and weeding was recorded. Weeds from 1 m^2 were collected prior to weeding , cleaned, and densities determined. Weed dry weights were recorded after oven-drying at 70°C for 72 h. Grain yields from the whole plot were recorded and adjusted to 14% moisture content.

Cynodon dactylon, Fimbristylis miliacea, Marsilea crenata, Monochoria vaginalis, Cyperus difformis, Anagallis arvensis, and *Scirpus mucronatus* were the dominant weed species.

Weed density and weed weight in 1990 were higher in WSR and TPR weedy check than in the other treatments (see table). Cost of hand weeding in WSR was about twice as much as for transplanted rice. Production costs were similar in both systems (see table). A similar trend was observed in 1991, but there was no significant difference in weed density.

Crop establishment techniques produced no significant yield difference in 1990 (see table). Though the unweeded check had the lowest grain yield, the mean grain yield did not vary because of methods of crop establishment and weed control.

Boro rice can be cultivated as WSR. □

Farming systems

Particle boards from paddy straw

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Rice straw is a cheap, readily available material in rice-growing areas. It is sometimes used as cattle feed or roof thatch, or is returned to the soil. Most rice straw, however, is simply wasted; it is thrown on roads or burned.

We studied an alternative: using rice straw as the basic raw material for particle boards.

Dry straw was cut into small pieces, finely ground using a commercial grinder, and then sieved. Uniform-sized particles were blended with resin and a hardener. It was then molded into a board and oven-dried under pressure at 45-50°C for 5-6 h. Particle boards were cooled and then subjected to quality tests.

Results indicate that rice straw can be used to produce particle boards that conform to several Indian standards (No. IS-3129/1965, IS-3087/1965, and IS-3478/1966 [see table]).

Rice straw can be used to make soft and hard boards, insulation (for low

Results of quality tests of particle boards from rice straw.

	Raw materials	Density (kg/m^3)	Modulus of rupture[a] (kg/cm^2)
1	Rice straw + resin + hardener (5% by wt)	331	135
2	Rice straw + resin + hardener (10% by wt)	680	325
3	Rice straw + resin + hardener (15% by wt)	780	360
4	Rice straw + resin + hardener (20% by wt)	950	389
5	Boards from coconut husk [b]	1310	254
6	Boards from wood dust [b]	890	324
	Requirements of IS-3129/1965	< 400	15
	Requirements of IS-3087/1965	500-900	90
	Requirements of IS-3478/1966	> 900	225

[a]Modulus of rupture was assessed for 1-cm-thick boards. [b]Source: Indian Plywood Industries Research Institute. Bangalore 22.

temperature), glazed boards, chop boards, and blockboards. Boards with a density of up to 950 kg/m^3 were made by altering the resin type, resin:straw ratio, and pressure while drying. It was possible to produce glazed boards by using resin abundantly on the surface. Veneer boards can also be manufactured by pressing a resin and straw mixture between two layers of thin wooden boards.

Rice straw boards have low density and are lightweight when compared with boards from wood dust and coconut husk, yet attain higher modulus of rupture (Table 1).

Production costs can be substantially reduced using rice straw as the raw material compared with other materials. Total cost in $\$/m^2$ of a 1-cm-thick board is \$2.53 for rice straw, \$3.68 for coconut husk, and \$3.14 for wood dust. □

Evaluation of suitable rice and pigeonpea varieties for intercropping under upland conditions in Orissa, India

D. Chandra, Agronomy Division, Central Rice Research Institute (CRRI), Cuttack 753006. Orissa; A. R. Raju, Central Institute for Cotton Research, Nagpur, Maharashtra; and U. D. Singh, Plant Pathology Division, CRRI, India

We initiated a trial during 1990 wet season to determine suitable rice and pigeonpea varieties for intercropping under upland conditions in Cuttack. We intercropped rice varieties Annada (105 d duration) and Safed Heera (75 d) with pigeonpea varieties ICPL 85010 (120 d), Bahar (280 d), and T-7 (287 d). We used the recommended fertilizer level of 60-13-25 kg NPK/ha for rice and 20-26-25 kg NPK/ha for pigeonpea. All of the P and K and half of the N were applied in the furrows at seeding. The remaining N was topdressed in sole crops but placed in furrows and mixed into the soil in intercrops.

Based on recommendations of the International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, short-duration ICPL 85010 was planted in a 1:1 ratio of rice-pigeonpea and long-duration pigeonpea varieties Bahar and T-7 were used in a 3:1 rice-pigeonpea ratio; all were sown on 11 Jun 1990.

The 11 treatment combinations were randomly allocated in a randomized block design with three replications. The soil of the experimental field is sandy loam alluvial (Inceptisol).

Grain yield, land-equivalent ratio, and net monetary returnsunder different rice + pigeonpea intercropping systems.

Rice + pigeonpea system	Mean grain yield (t/ha)		Land-equivalent ratio	Net monetary returns (\$/ha)
	Main crop	Intercrop		
Safed Heera + ICPL 85010	1.6	0.3	1.56	57.79
Safed Heera + Bahar	1.6	0.8	1.74	194.88
Safed Heera + T-7	1.8	0.6	1.74	157.33
Annada + ICPL 85010	2.2	0.3	1.69	110.93
Annada + Bahar	1.9	0.8	1.64	206.81
Annada + T-7	2.4	0.8	1.88	251.55
Safed Heera alone	1.9	–	1.00	49.13
Annada alone	2.4	–	1.00	86.51
ICPL 85010 alone	0.4	–	1.00	68.53
Bahar alone	0.9	–	1.00	194.84
T-7 alone	0.9	–	1.00	193.86

Yield data indicated that Annada (CR222, MW10) intercropped with T-7 produced the highest yields, showed the greatest land-equivalent ratio, and had the maximum net monetary return of \$251.55/ha. It gave an extra net benefit of \$57.70/ha compared with growing T-7 alone. Intercropping rice with the other pigeonpea varieties neither produced higher yields nor extra monetary returns (see table).

The Safed Heera rice crop had more weeds when it was intercropped with pigeonpea. More than 60% of the Safed Heera crop suffered from sheath blight (ShB) when intercropped with pigeonpea ICPL 85010 in a 1:1 ratio. This increased ShB incidence may be due to increased humidity inside the crop canopies.

Intercropping Annada and T-7 under the studied agroclimatic conditions can be beneficial. □

Space limitations prevent IRRN from publishing solely yield and yield component data from fertilizer field trials that are not conducted for at least two cropping seasons or at two differing sites. Publication of work in a single season or at one site is limited to manuscripts that provide either a) data and analysis beyond yield and yield components (e.g., floodwater parameters, microbial populations, soil mineral N dynamics, organic acid concentrations, or mineralization rates for organic N sources), or b) novel ways of interpreting yield and yield component data across seasons and sites.

EDUCATION AND COMMUNICATION

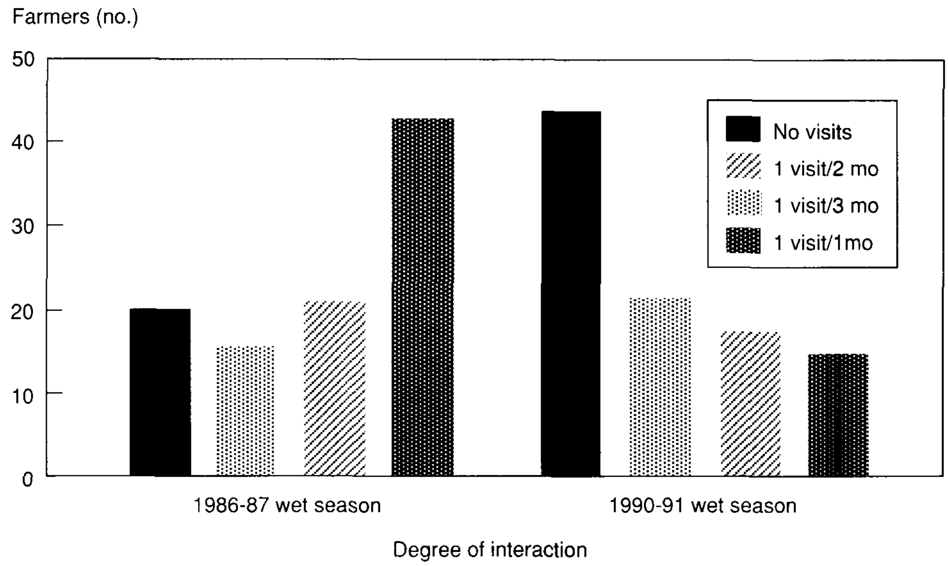
Two systems of extension coverage in southern Sri Lanka

M. Wijeratne, Agricultural Economics Department, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

The Training and Visit (T&V) System for agricultural extension was introduced in Sri Lanka in 1979-80. Village extension workers (VEWs) of the Department of Agriculture had been carrying out village-level agricultural extension programs until 1990 when the VEWs were transferred to decentralized provincial councils. This study compares the extension coverage under the two systems in the southern rice-growing district of Matara.

We collected data for the main cropping seasons of 1986-87 and 1990-91 by interviewing 100 randomly selected rice farmers during each season.

Degree of interaction between VEWs and farmers was classified into no interaction, one interaction in 3 mo, one in 2 mo, and one in 1 mo (see figure). The number of farmers who did not interact with a VEW increased significantly under the new system. Farmers who had one interaction/month declined over the reference period. The c^2 test implies that a significant difference at 0.01 level exists between the two extension systems in terms of degree of interaction. The shift from T&V to the provincial council system resulted in declining extension contacts. ■



Extension coverage under different management sytems, Matara, Sri Lanka.

RESEARCH METHODOLOGY

Validation of BLASTSIM.2 model in IRRI blast (Bl) nursery and Cavinti, Laguna, Philippines

S. B. Calvero, Jr., and P. S. Teng, IRRI

We simulated leaf Bl epidemics under tropical conditions using BLASTSIM.2, a computer-based simulation model programed in FORTRAN. The model is potentially useful to understand development of Bl epidemics in different tropical rice management systems.

The model follows the typical leaf Bl monocycle consisting of stages (the state variables in the model) of spore production, spore release, spore deposition, latency, penetration and colonization, lesion production, and lesion development. Several interacting climatic,

Results of regression, correlation, and pooled-variance analyses of observed versus model-predicted lesion number/hill, lesion size/hill, and % disease severity/hill, 1989 WS and 1991 DS.[a]

Treatment	State variable	R^2	r	F	Pooled variance
		Cavinti, 1989 WS			
Low epidemic	Lesion no.	0.77	0.88**	255.08**	301.15 ns
	Lesion size	0.86	0.92**	460.96**	3.23 ns
	Severity	0.91	0.95**	797.37**	1.17 ns
Medium epidemic	Lesion no.	0.55	0.74**	95.92**	2673.87**
	Lesion size	0.61	0.78**	122.63**	20.44**
	Severity	0.73	0.86**	215.41**	8.91**
High epidemic	Lesion no.	0.76	0.87**	251.80**	2426.10*
	Lesion size	0.95	0.97**	1414.71**	15.21 ns
		IRRI, 1991 DS			
10-cm spacing	Lesion no.	0.86	0.93**	516.31**	8669.35 ns
	Lesion size	0.94	0.97**	1409.70**	59.44 ns
	Severity	0.92	0.96**	990.07**	2.69 ns
20-cm spacing	Lesion no.	0.72	0.85**	215.23**	5.82 ns
	Lesion size	0.72	0.85**	217.34**	1254.83*
	Severity	0.77	0.88**	276.32**	0.07 ns

[a]ns = no significant difference, * = significant difference at 5%, ** = significant difference at 1%.

edaphic, and agronomic factors (the driving variables in the model) affect each stage and greatly influence the rate at which the monocycle moves.

BLASTSIM.2 has two main components: the Bl simulation, where state variable values are computed, and the dew period estimation, which predicts the dew period and amount per day using DEWFOR, which was developed in the Netherlands. Simulation uses a daily time step process, invoking several driving functions at each time step to act on the state variables.

In BLASTSIM.2, crop variables such as plant height, leaf width, and leaf area are inputted as data sets to act as driving functions in B1 development. Simulation of epidemics was improved with the incorporation of genetics of host-pathogen relationship through the receptivity factor (RF), which is the ratio of the number of successful lesions/number of successful penetrations of germ tube.

BLASTSIM.2 has 12 modules and 1 graphics routine. The model requires two directory files (WTH.DIR for weather and BLEXP.DIR for treatment/experiment file), three input files (two files for weather variables and one file for crop variables), three coefficient files for lesion expansion (LESLEN.BL), sporulation potential (SPORES.BL), and receptivity factor of specific host variety/pathogen isolate (H/P) combination (RECEPF.BL). The graphics interface files, FGRAPH.FI and FGRAPH.FD, and font file HELVB.FON, which come with the FORTRAN software, are also needed. BLASTSIM.2 runs in any microcomputer equipped with at least a 540K base memory, a math-coprocessor, a hard disk, and an EGA or VGA graphics adapter.

We validated the current version of BLASTSIM.2 using disease data from 1989 wet season (WS) at Cavinti for upland variety UPLRi-5 and from 199 1 dry season (DS) IRRI B1 nursery experiments for Bl-susceptible lowland cultivar IR72. Weather variables and crop data from each site were inputted along with RF values at different crop ages for these varieties interacting with *Pyricularia grisea* isolate PO6-6. Dew duration was estimated in model runs whenever leaf wetness data were not available.

Each simulation run was started with the observed number of lesions per leaf on a specific date. Differences between simulated and observed lesion number and development and % disease severity expressed in per hill basis were analyzed using regression, correlation, and pooled variance tests.

The model accurately simulated leaf B1 progression in both Cavinti and IRRI B1 nursery trials (see table). Graphical displays showed close relationships between the field data and simulations in terms of curve shape and turning point. High values of R^2 and correlation coefficient (r) and highly significant F estimates suggest that simulated and observed disease variables for all treatments at either site did not differ. Although a pooled variance analysis gave highly significant variances in one treatment from Cavinti, the majority of treatments from the two experiments showed almost similar values and trends for model-predicted and field-measured variables.

It can be inferred that BLASTSIM.2 mimics the rice-leaf Bl pathosystem, but further validation is needed to confirm this at other sites. Scientists interested in cooperating in this project are urged to write to the second author for a copy of the model and user document. Please specify microcomputer type and disk size. □

ANNOUNCEMENTS

IRRI announces group training courses for 1993

The IRRI Training Center will be offering a variety of courses on rice-related subjects in 1993. Courses are held at IRRI headquarters unless otherwise noted. For information about a course, contact the Head, Training Center, International Rice Research Institute, P.O. Box 933. Manila 1099, Philippines. Fax: 63-2-818-2087. Space is available for trainees in the following courses:

Date	Course	Trainees (no.)
11-22 Jan	Rice Production for IRRI Staff	30
1 Feb-21 May	Hybrid Rice Breeding	28
1 Feb-26 Mar	International Network on Sustainable Rice Farming	20
26 Apr- 4 Jun	Engineering for Rice Agriculture	39
7 Jun-30 Jul	Weed Control (Direct-Seeded Rice)	9
19 Jul-10 Sep	Integrated Pest Management	25
23 Aug- 1 Oct	Irrigation and Water Management	25
4 Oct-26 Nov	Rice Production Research *Thailand*[a]	25
4 Oct-26 Nov	Rice Biotechnology[a]	15
4 Oct- 5 Nov	Rice Seed Health	8
15-26 Nov	Gender Analysis[a]	25
15-26 Nov	Research Management[a]	15

[a]Special project-funded course.

Postdoctoral research fellow positions at IRRI

The International Rice Research Institute invites Ph D applicants for research fellow positions in the following fields:

Molecular biology. To improve soil N use efficiency through rice genotype selection, breeding, and soil management practices in the irrigated environment. The work involves tagging genes with molecular markers for higher biological N fixation, N uptake, and N use efficiency, and studying the mechanisms associated with those traits.

Candidates should have a Ph D degree in soil science, agronomy, plant genetics, or breeding with research experience in molecular biology. Place of work: IRRI headquarters in Los Baños. UNDP/World Bank-funded

research project. Send biodata, university transcripts, and three letters of recommendation to Ning Huang, Division of Plant Breeding, Genetics, and Biochemistry, IRRI, P.O. Box 933, Manila 1099, Philippines. Fax: 63-2-818-2087.

Soil and water sciences. To work on analysis of drought and quantification of its effects on dry seeded rice in the rainfed lowland rice ecosystem. The successful candidate will carry out laboratory and field experiments at IRRI headquarters in Los Baños and at experimental sites in the Philippines to study the effects of drought on soil moisture extraction at the root zone, evapotranspiration, and yield of dry seeded rice; and to select or develop suitable models linking environmental parameters (soil and climatic) to soil water status and to rice performance.

Candidates should be well acquainted with laboratory and field experimental techniques for soil-water-plant interaction studies in rice, and should have a good background in agrohydrology and soil physics. They must be familiar with mathematical models that simulate soil water movement and on-farm water balance.

Initial appointment is for 1 yr, renewable for a second year upon mutual agreement.

Application deadline is 30 Nov 1992. Send curriculum vitae, date of availability, and names of two referees to T.P. Tuong, Soil and Water Sciences Division, IRRI, P.O. Box 933, Manila 1099, Philippines. Fax: 63-2-817-8470.

Plant pathology. To investigate the interaction among N application strategies, plant N status and seasonal dynamics; N dynamics; and disease epidemiology in irrigated rice ecosystems. The goal of the work is to understand how N supply affects the need for disease control measures in the context of integrated pest management.

Candidates should have a good background in plant pathology with academic and research experience in plant physiology or agronomy. Experience with quantitative epidemiology and fluency in English are desirable. Joint appointment between the Division of Plant Pathology and Division of Agronomy, Plant Physiology, and Agroecology, at IRRI headquarters, Los Baños. UNDP-funded position. Initial appointment for 1 yr with expected second year extension.

Send biodata, university transcripts, and three letters of recommendation to T.W. Mew, Division of Plant Pathology, IRRI, P.O. Box 933, Manila 1099, Philippines. Fax: 63-2-818-2087. □

IRRI group training courses for remainder of 1992

For information about a course, contact the Head, Training Center, International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines. Fax: 63-2-818-2087. Space is available for trainees in the following courses:

2-27 Nov	IRRI-UNDP Training Course on Methane Emission from Ricefields: Principles and Methodologies
16-27 Nov	Gender Analysis and Its Application to Rice-based Farming Systems Research
16-27 Nov	IRRI-International Service for National Agricultural Research- University of the Philippines at Los Baños Research Management □

Rice dateline[a]

11-13 Nov	Sri Lanka Work Plan Meeting at IRRI. Contact F.A. Bernardo/ D. Senadhira/G.L. Denning, IRRI.
16-20 Nov	International Workshop on Women in Rice Farming Systems, Chiang Mai, Thailand. Contact V.R. Carangal/T. Paris, IRRI
25-27 Nov	Bhutan-IRRI Workplan Meeting. Contact F.A. Bernardo/ G.L. Denning, IRRI.
9-11 Dec	INGER Global Advisory Committee Meeting. Contact F.A. Bernardo/S.V. Durvasula, IRRI.

[a]Address for all IRRI contacts: International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines. Telex (ITT) 40890 RICE PM. Fax: 63-2-818-2087.

Call for news

Individuals, institutions, and organizations are requested to inform the editor about upcoming events in rice research or related fields for the Rice Dateline. Send announcements to the Editor, IRRN, International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines. □

NEWS ABOUT RESEARCH COLLABORATION

Can we keep it up? IRRI, NARS scientists investigate yield decline

In the past 30 yr, farmers have achieved increased rice production by adopting high-yielding, early-maturing varieties. Because modern rice varieties ripen quickly, farmers often can grow 2-3 crops per year, thus keeping food supply abreast of population growth.

But IRRI scientists have discovered a disturbing phenomenon. ‘‘Long-term experiments show that yields from irrigated fields that have continually supported 2-3 rice crops a year have declined by as much as 40% over the past 25 yr,” says Dr. Ken Cassman, IRRI agronomist. “This yield decline occurs in both high- and low-input

systems, both on and off the IRRI farm."

Known diseases, insect pests, and weed problems do not account for this drop in yield.

"We have started a joint effort with our colleagues in the national agricultural research systems (NARS) to try to understand why this is happening," Cassman said. With this knowledge, rice agronomists will develop management strategies that sustain high yields while preserving the land. □

Botanical pest control experts meet for workshop

Twenty experts met at IRRI in late July 1992 to review recent advances and specific accomplishments in botanical pest control, concentrating mainly on neem.

Workshop participants acknowledged that many aspects of botanical pest control need further investigation, including more research on their effects on nontarget organisms, the possibility of pest resurgence and development of resistance, their persistence in soil, potential hazards from residues in food crops, use in integrated pest management, socioeconomic studies on neem at the industry level, and a survey of farmers' knowledge, attitude, and use of other plants with pest control potential.

Sixteen research papers were presented; H. Larew of United States Agency for International Development was the keynote speaker. This was the final workshop of the IRRI-ADB Project on Botanical Pest Control-Phase II.

For information about obtaining a copy of the workshop proceedings, contact workshop convenor D. Bottrell, Entomology Division, IRRI. □

Rice stripper-harvester saves grain, time, effort, and money

A new stripper-gatherer system being developed at IRRI can help farmers harvest rice with less labor and less grain loss, at less cost and in less time, says Dr. Graeme Quick, head of IRRI Agricultural Engineering Division.

To harvest and thresh a hectare of rice in a day, a farmer normally needs 26 laborers. With the new SG800 stripper-gatherer, only 11 laborers are needed to do the same job. The upward spinning action of the stripper rotor lifts fallen panicles; thus grain losses in overripe crops are lower than with other methods.

The machine weighs only 190 kg. Workers can carry it into fields away from main roads. The purchase cost is about US$1,200 per unit, compared with $2,700 for an imported mechanical reaper. The stripper-gatherer system is an Overseas Development Administration-funded project conducted in collaboration with the Silsoe Research Institute of the United Kingdom. □

Dutch Government continues support for collaborative systems analysis and simulation project

Thanks to the Dutch Goverment, multidisciplinary teams in 16 national agricultural research centers (NARCs) in nine Asian countries are using simulation modeling to solve local rice production problems.

"In 1984, the Netherlands began funding the Systems Analysis and Simulation for Rice Production (SARP) network," says Dr. Martin J. Kropff, IRRI crop modeler and network coordinator. "Until then crop modeling was not widely used in Asian rice research."

SARP is a collaborative project among the 16 Asian teams, the Dutch organizations Center for Agrobiological Research (CABO-DLO) and Department of Theoretical Production Ecology of the Wageningen Agricultural University, and IRRI. The aim is to strengthen the systems analysis and crop simulation capabilities of NARCs that work on rice-based farming systems. Participating NARCs developed skills and adapted modeling programs to their areas in the first two SARP phases.

Continuing its full support for SARP, the Ministry for Development Cooperation of the Netherlands made a US$3 million grant to fund the final phase: the application of modeling to actual research problems. Researchers will identify suitable ricelands and appropriate crop and pest management practices. They will also build data bases and advisory systems for regional planning. □

IRRI, Asian GIS specialists look at remote sensing

Geographic information systems (GIS) are providing agricultural researchers and policymakers with the answers to problems that directly affect farmers. GIS can spot areas in a country with suitable soils for rice, or areas where soil erosion is accelerating, or even where to locate an irrigation system to serve the most farmers.

GIS specialists from five countries came to IRRI in July to explore ways to add satellite-based remote sensing to their resources. The 3-day seminar was sponsored by IRRI and the Services de Consultance en Observation de la Terre (SCOT CONSEIL), a French-based organization that uses and distributes information gathered through satellite-based remote sensing.

"Developments in remote sensing are moving at a fast pace," said Dr. Eleazer D. Hunt, IRRI GIS specialist. "We are working on proposals for joint research to use new remote sensing technology in rice." Of particular interest to Asian GIS specialists is a new satellite whose radar collects data through cloud cover. In the humid tropics, clouds cover the terrain for large parts of the year, thwarting other types of sensors.

"GIS are computer programs used by researchers to graphically present location-specific information," Hunt explained. "These visual presentations

make it much easier to analyze large volumes of data."

GIS typically uses data gathered from maps and aerial photographs, Hunt said. Using remote satellite sensing and on-the-ground verification, GIS specialists can rapidly gather up-to-the-minute data on crop attributes and characterize large agricultural areas. □

Japanese scientists set up *Azolla* genebank

Dr. Iwao Watanabe of Mie University, working with Osaka Prefecture University, recently obtained a grant from the Nissan Science Foundation to establish an *Azolla* germplasm collection in Japan.

Watanabe and other Japanese researchers will use the latest biochemical methods to characterize the aquatic ferns and their symbionts, the blue-green algae that fix nitrogen. IRRI, which keeps the world's largest collection of *Azolla* strains, will help set up the Japanese collection.

The Japanese may give *Azolla* a new environmentally friendly role, this time in pollution control. They will test *Azolla* as a water decontaminant to soak up nitrogen, phosphorus, and toxic heavy metals.

Watanabe started IRRI's biofertilizer germplasm collection in 1975 while he was head of the institute's soil microbiology department. □

IRRI biotechnology: a common legacy

IRRI's long-standing commitment to the free exchange of breeding techniques and genetic material is guiding the institute's adoption of biotechnology as a tool to develop modern rice varieties. This strategy was described by Dr. Klaus Lampe, IRRI director general, in a major Philippine biotechnology symposium in June.

Lampe noted that commercial firms using biotechnology to develop new plants and techniques routinely seek intellectual property protection to safeguard their ownership of their genetically engineered products. He said that IRRI will not seek such patents, except where it is necessary to ensure that developing countries have free access to the new technologies.

Biotechnology at IRRI and the international agricultural research centers (IARCs) also enriches biodiversity, according to Lampe. Genes that have no chance of being introduced into rice by conventional breeding can now be tapped through biotech. Rice scientists worldwide can be confident of access to the rich pool of varieties held in trust in rice and biofertilizer genebanks or being developed by IRRI scientists. □

Transgenic cotton may lead to flood-tolerant rice

Rice plants that can survive many days under water would greatly benefit farmers who often lose their crops when heavy rains flood their fields.

To develop such plants, IRRI scientists have imported more than 100 transgenic cotton calli from the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia. The calli contain naturally occurring flood-tolerance genes from maize and cotton.

"These flood-tolerance genes also naturally occur in rice," said Dr. Tim L. Setter, IRRI plant physiologist. We are working to greatly increase the number of these genes in rice, thereby increasing the crop's flood tolerance." He believes it will take 1-2 yr to develop flood-tolerant rice plants.

Like animals, plants may drown underwater because they cannot get enough oxygen, Setter said. This stops the metabolic processes that provide the energy needed by plants to live and grow. The flood-tolerance genes work by allowing the plant to obtain energy without relying on oxygen—in this case, by converting available sugars to alcohol. □

Boosting production in the Mekong Delta: Vietnamese institute, IRRI sign agreement in Hanoi

Large-scale irrigation projects have turned Vietnam's Mekong River Delta into a rice-surplus area. Farmers in the delta produce 45% of the country's rice. Irrigation has increased their rice production from 5.3 million tons in 1980 to 9.7 million tons in 1990.

But by the year 2000, Vietnam's growing population will require an extra 2.6 million tons of rice annually. Much of it will have to be grown in the delta. The extra gains needed in the next 8 yr may not be as easy to achieve as were the accomplishments of the past decade.

Innovative research and farmer training must be conducted to increase rice production in the area. To address these needs, the Cuu Long Rice Research Institute (CLRRI), which is in the delta's Hau Giang Province, and IRRI signed a memorandum of agreement in Hanoi on 4 June.

"Vietnam has many good scientists, a diverse ecology, and many good varieties," said Dr. Vu Tuyen Hoang, vice minister for the agriculture and food industry. "We need continued support from IRRI in research and training to prepare for the future." □

Rare Philippine wild rice may help control tungro disease

Filipino and IRRI scientists have discovered a rare wild rice species near Lake Apo in the southern Philippine island of Mindanao. It is the only known Philippine population of the wild rice *Oryza rufipogon,* reports Dr. Duncan Vaughan, IRRI associate geneticist, and is resistant to the highly damaging tungro virus.

Scientists of the Philippine Rice Research Institute (PhilRice) and IRRI are incorporating this wild rice's resistance to the virus disease into modern high-yielding varieties. Ms. Teresita Borromeo and Mr. Paul Sanchez of PhilRice, together with Vaughan, found the wild rice. □

IRRI plans collaborative research with China

IRRI prepared new collaborative work plans with the Chinese Academy of Agricultural Sciences (CAAS) and the Chinese Academy of Agricultural Mechanization Sciences (CAAMS) in May.

Professor Liang Keyong, CAAS vice-president, and Mr. Li Weimin, CAAMS assistant director, headed delegations that prepared new 2-yr work plans between their organizations and IRRI.

Scientists from China and IRRI will study the effects of enhanced ultraviolet-B radiation and atmospheric carbon dioxide on the growth and production of rice. The 2-yr work plans include degree and nondegree training of Chinese scientists, using biotechnology to increase resistance to rice blast disease, advancing biological control of rice diseases, conserving rice germplasm, and developing systems approaches and simulation models for agricultural research. □

INGER proves its worth in Africa

Farmers in 22 African countries are planting 83 rice varieties that originated from the pool of breeding lines shared by researchers through the International Network for Genetic Evaluation of Rice (INGER).

Thirty-four of the adopted INGER varieties were developed in Africa. The 49 other varieties were bred by IRRI or by IRRI-assisted irrigated or rainfed lowland rice breeding programs in Asia.

Yields of the released varieties range from 4.4-5.6 t/ha, reports Dr. Krishna Alluri, IRRI liaison scientist and INGER coordinator in Africa. □

Madagascar targets increased rice production

Madagascar is counting on increased agricultural production to spur its economic activity and growth, said Mr. Claude Andreas, Madagascar minister of agriculture, during a visit to IRRI in late May. Increased rice production is a priority in this buildup.

The minister came to see how the Philippine Government is implementing its Rice Action Program. The program goal is for farmers to produce yields of 5 t/ha in irrigated and favorable rainfed environments.

A team of four IRRI scientists is working with Malagasy researchers and extension workers in a 5-yr USAID-funded project that aims to introduce high-yielding varieties, develop suitable rice and rice-based farming technologies, and provide training to enhance research capabilities. □

Cambodian farmers adopt Thai deepwater varieties

Cambodian farmers are enthusiastic about three Thai deepwater rice varieties, reports Dr. Donald W. Puckridge, IRRI deepwater rice program leader stationed in Thailand. Their high yield and excellent grain quality are the main reasons for the popularity of Don, Khao Tah Petch, and Tewada varieties. They were brought into the country by the Cambodia-IRRI Rice Project (CIRP), then released to farmers last year after extensive on-farm adaptability trials.

According to Puckridge, several thousand tons of seed were grown by farmers during the 1991-92 wet and dry seasons. CIRP has proposed a scheme for national seed multiplication, handling, and distribution of these new varieties.

Since 1988, four IRRI scientists stationed in Cambodia have been helping their local colleagues rehabilitate the national rice research system. The Australian Government provided financial support. □

ERRATUM

The postage price for *A Century of Rice Improvement in Burma* in the April 1992 issue should be $5.00 for airmail and $1.50 for surface mail. □

ISBN 971-22-0024-8

GENETIC EVALUATION & UTILIZATION OF RICE

A Century of Rice Improvement in Burma

U KHIN WIN

1992. 162 pages. 15.24 x 22.86 cm. Paperback. HDC US$14.50, LDC US$3.75 plus airmail (US$4.50) or surface mail (US$1.50) postage.

Rice dominates the Burma (Myanmar) economy and is interwoven into the social and economic fabric of its people's lives.

U Khin Win, a visiting scientist at IRRI 1987-1989, drew on almost four decades of professional work and an intimate knowledge of rice to write *A century of rice improvement in Burma*.

His analysis of patterns of rice production in Burma over the last 100 years identifies the forces that generated production growth and how that growth affected the lives of the Burmese people. He also suggests technological approaches that could trigger a second wave of development.

Scientists and policymakers will find the book valuable for analysis of developmental processes in Southeast Asia.

IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE

ISBN 0-7923-1774-2

SOIL AND CROP MANAGEMENT FOR RICE

Biological Nitrogen Fixation for Sustainable Agriculture

Edited by

J.K. LADHA, T. GEORGE, AND B.B. BOHLOOL

1992. 209 pages. 17.78 x 25.40 cm. HDC US$22.50, LDC US$5.00 plus airmail (US$8.00) or surface mail (US$2.00) postage.

This book is an outcome of the symposium "Role of Biological Nitrogen Fixation in Sustainable Agriculture" jointly organized by the International Society of Soil Science and the International Rice Research Institute at the 13th International Congress of Soil Science, Kyoto, Japan, 1990.

The volume was published by Kluwer Academic Publishers in the Netherlands with IRRI cooperation. IRRI distributes the paperback edition; Kluwer distributes both the paperback and hardbound editions.

Contents of *Biological Nitrogen Fixation for Sustainable Agriculture*

IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE

ISBN 971-104-051-4

FARM LEVEL AND EXTENSION

A Farmer's Primer on Growing Rice, revised edition

BENITO S. VERGARA

1992. 219 pages. 15.24 x 22.86 cm. Paperback. HDC US$18.00, LDC US$3.25 plus airmail (US$6.00) or surface mail (US$1.50) postage.

In less than 30 years, the earth will be home to 8 billion people; two-fifths of them will depend on rice for their staple food. To feed them will require a 74% increase in global rice production, from today's 518 million tons to 900 million tons.

More than ever, rice farmers, technicians, teachers, and scientists need to understand the whys and hows of modern rice production. But recommendations given to farmers often do not answer questions such as how to increase the efficiency of nitrogen fertilizer, how to lessen the chance of lodging, or why modern varieties are usually superior.

IRRI Plant Physiologist Benito S. Vergara conceived the idea for the original primer while teaching rice production courses at IRRI. He became aware of the lack of simple but precisely written information that clearly explained good rice-growing practices.

Forty-eight editions of the original *A farmer's primer on growing rice* have been published since 1979 in 40 languages in more than 20 countries in Asia, Africa, and Latin America. Vergara has revised the primer to update and improve the presentation of the information.

For details on the availability of the original *A Farmer's Primer* in a specific language, or for information on how to copublish IRRI books in languages other than English, write to:

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