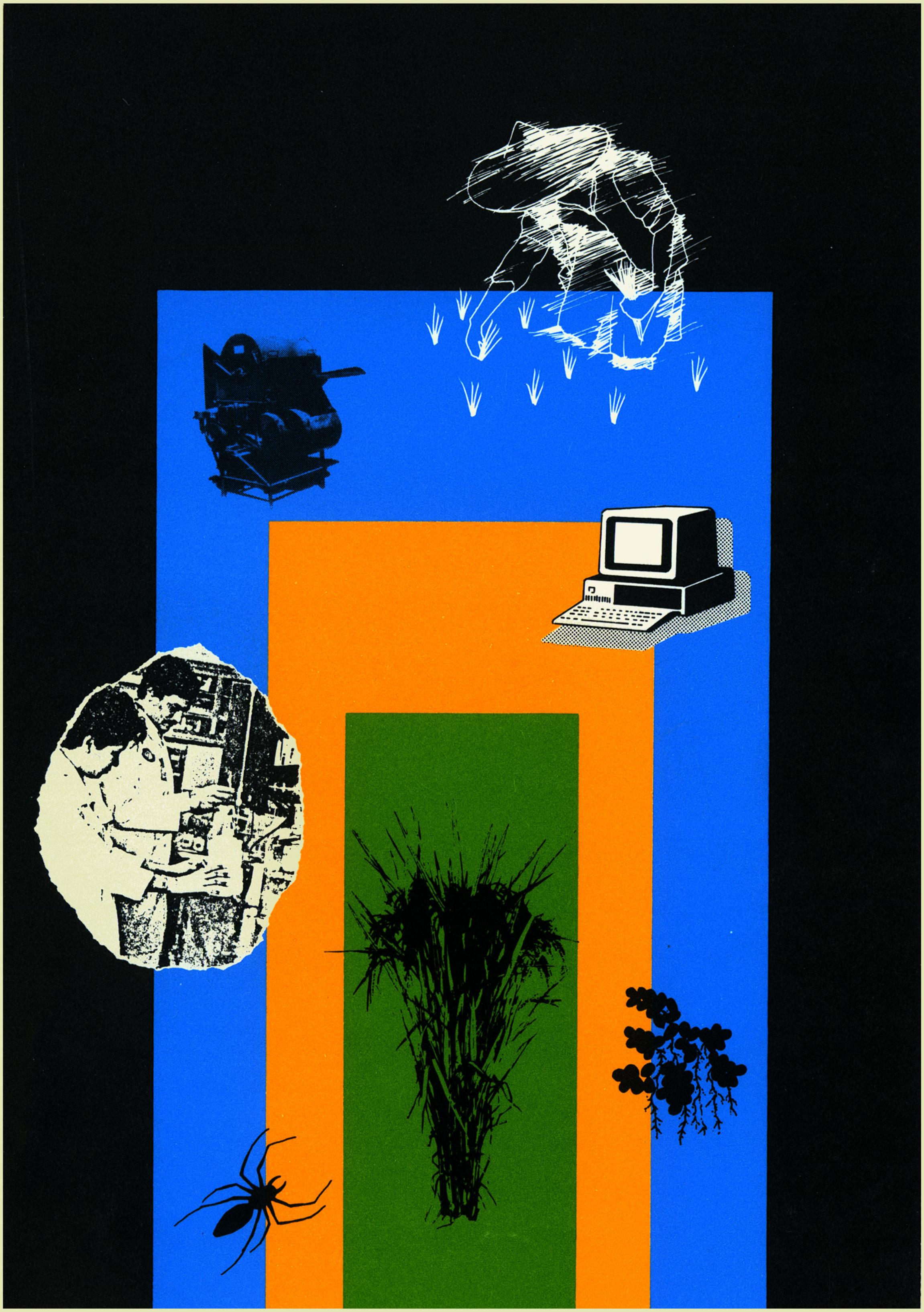
INTERNATIONAL RICE RESEARCH NEWSLETTER

VOLUME 15 NUMBER 1

FEBRUARY 1990



PUBLISHED BY THE INTERNATIONAL RICE RESEARCH INSTITUTE, P.O. BOX 933, MANILA, PHILIPPINES

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 reports

- 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 (revised)

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 RESOURCES 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

GERMPLASM IMPROVEMENT

Genetic resources

Pigmentation and awning patterns of summer rice cultivars in Assam

T. Ahmed and K. K. Sharma, Regional Agricultural Research Station, Titabar 785630, Assam, India

A wide range of variability occurs in characters of traditional summer (ahu) rice varieties. Classification on the basis of pigment distribution is useful documentation for identifying the germplasm. We mapped pigmentation patterns of four floral parts—sterile lemmas, lemma and palea, apiculus, and stigma—and the awning patterns of 797 cultivars.

Table 1. Distribution of pigment in 4 floral parts of summer traditional varieties of Assam, India.

Color	Floral parts (no.)			
	Lemma and palea	Sterile lemma	Apiculus	Stigma
No pigmentation (straw)	507	780	685	559
Brown	34	–	–	–
Deep brown	9	–	–	–
Brown spots on straw	8	–	–	–
Brown furrows on straw	6	–	–	–
Purple	11	17	71	238
Light purple	5	–	34	–
Black	217	–	7	–
Total	797	797	797	797

Nonpigmented organs were more frequent. Some variation in coloration was observed, and it was highest in the lemma and palea (flowering glumes), followed by the apiculus (Table 1). Awning patterns are presented in Table 2. □

Table 2. Awning patterns of the summer traditional varieties of Assam, India.

Type	Frequency (no.)
Awn absent	515
Short, partly awned	108
Short, fully awned	30
Long, partly awned	113
Long, fully awned	11
Total	797

Genetics

Studies on blast (Bl) resistance genes in indica rice

He Zuhua and Shen Zongtan, Agronomy Department, Zhejiang Agricultural University, Hanghou, China

Work on the genetics of resistance to rice Bl disease caused by *Pyricularia oryzae* Cav. has identified 13 resistance genes. In general, a single dominant or two duplicate dominant genes govern resistance; in some cases, recessive genes and interactions of genes and gene linkage are found.

We studied the resistance genes for Chinese Bl fungus races ZC3 and ZG1 in 10 indica rice cultivars. F_1, F_2, and B_1F_1 plants from crosses of susceptible (S)/resistant (R) cultivars and R/R cultivars were inoculated with the B1 races.

The results indicate that in these cultivars, a single dominant or two duplicate dominant genes govern resistance (see table). Eleven dominant genes (*P-1* to *P-11*) were found. When the same plants were inoculated with both races, some genes did not segregate independently. Parental types were more frequent than recombinant types. This result indicates that some resistance genes are linked (e.g., *P-1* and *P-6* in Tetep).

The results also show that expression of resistance might be affected by some modifier genes or that there might be multiple alleles confirming different levels of resistance at the same locus. If more races were used, more resistance genes would be identified. Inheritance analysis of rice Bl resistance could be done easily and effectively, using only a few common fungus races. □

Genes for resistance to 2 rice Bl races in 10 cultivars. Hangzhou, China.

Race	Resistance gene in each cultivar									
	Tetep	Chai-tang	Ai-mei-zao 3	IR36	IR58	Suweon 300	Hong-yang-ai 4	Ai-jiao-bai-mi-zi	IR9782	Guo-ji-you-zha
ZC3	*P-1*	*P-1*	*P-1*	*P-1*	*P-1*	*P-1, P-2*	*P-1*	*P-1, P-2*	*P-3*	*P-4, P-5*
ZG1	*P-6*	*P-6*	*P-6*	*P-8*	*P-9*	*P-6, P-7*	*P-6, P-7*	*P-7*	*P-8*	*P-14, P-11*

Genetic studies of the F_2 and F_3 of tall × semidwarf rice varieties

K. Ganesan and M. Subramanian, Rice Research Station, Tamil Nadu Agricultural University, Ambasamudram, Tamil Nadu, India

We evaluated several genetic variables in F_2 and F_3 of three crosses involving tall indica variety ASD1 and semidwarf varieties Co 33, ADT36, and IR50 (Table 1). Phenotypic correlations were computed between single-plant yield and yield components.

In the F_2, phenotypic and genotypic variability were high for tiller numbers, grains/panicle, and plant yield; low for days to panicle emergence and 100-grain weight; and moderate for plant height. In the F_3, variability was moderate for single-plant yield and low for other traits.

Additive gene action had more influence than environment on the traits. Days to panicle emergence had high broad-sense heritability with low genotypic coefficient of variability and genetic advance in both generations, indicating nonadditive gene action. Changes between generations might be due to changes in gene frequency resulting from selection.

Correlations of number of productive tillers, harvest index, and dry matter production with single-plant yield were highly significant and positive for the F_2 and F_3 of almost all crosses (Table 2). These results indicate that high yielding ability might be associated with these three yield components.

Among the yield components, there was close positive association between panicle length and grain numbers/panicle. Grain number also correlated positively with harvest index and dry matter production, indicating its importance in rice improvement.

The difference in direction and magnitude of correlations might be attributed to differences in gene association in the parental lines. The change in direction between F_2 and F_3 might be due to differential segregation and recombination.

In a path coefficient analysis of the direct and indirect effects on yield of nine characters, total correlation of dry matter production, harvest index, and number of productive tillers (except in the F_3 of ASD1/Co 33 and ASD1/DR50) with single-plant yield was highly significant in the F_2 and F_3 (Table 3).

Table 1. Genetic parameters of the F_2 and F_3 of tall/semidwarf crosses in Tamil Nadu.

Character	Cross	Generation	Mean	SD	PCV[a]	GCV[b]	h^2[c]	GA[d]	GA (% of mean)
Days to panicle emergence	ASD1/Co 33	F_2	83.6	4.0	4.8	4.4	83.9	6.9	8.3
		F_3	80.2	1.6	1.9	1.7	79.2	2.5	3.1
	ASD1/ADT36	F_2	86.9	3.5	4.1	3.5	72.9	5.3	6.1
		F_3	78.9	1.6	2.1	1.9	83.0	2.8	3.5
	ASD1/IR50	F_2	86.1	3.5	4.1	3.6	77.6	5.6	6.5
		F_3	78.6	1.4	1.8	1.6	80.4	2.3	3.0
Plant height (cm)	ASD1/Co 33	F_2	102.3	15.2	14.8	13.6	84.1	26.1	25.5
		F_3	109.6	12.0	11.0	10.9	98.4	24.4	22.2
	ASD1/ADT36	F_2	116.9	15.6	13.4	12.2	83.0	26.7	22.8
		F_3	105.3	12.0	11.4	11.4	98.6	24.5	23.2
	ASD1/IR50	F_2	106.5	15.3	14.3	13.1	83.4	26.2	24.6
		F_3	112.2	7.8	7.0	6.8	96.6	15.5	13.8
Number of productive tillers	ASD1/Co 33	F_2	8.6	4.0	45.8	33.9	54.6	4.5	51.6
		F_3	6.3	0.7	11.3	8.0	52.7	0.8	12.0
	ASD1/ADT36	F_2	7.9	3.7	46.7	36.5	61.3	4.7	59.0
		F_3	7.4	0.9	12.1	10.3	73.1	1.3	18.2
	ASD1/IR50	F_2	9.2	3.9	41.7	31.7	57.7	4.6	57.9
		F_3	8.0	0.9	10.7	8.5	63.6	1.1	14.0
Panicle length (cm)	ASD1/Co 33	F_2	22.3	2.9	13.0	10.6	66.9	4.0	17.9
		F_3	22.8	0.9	4.1	3.2	61.6	1.2	5.2
	ASD1/ADT36	F_2	23.5	2.4	10.4	7.9	56.2	2.9	12.4
		F_3	22.4	0.9	4.0	2.5	40.0	0.7	3.3
	ASD1/IR50	F_2	22.8	2.7	11.8	9.7	68.0	3.8	16.5
		F_3	22.2	0.8	3.4	1.9	30.0	0.5	2.1
Grain no./panicle	ASD1/Co 33	F_2	90.2	34.5	40.0	32.6	66.5	49.4	54.8
		F_3	104.8	9.3	8.9	8.3	86.1	16.5	15.8
	ASD1/ADT36	F_2	87.7	27.8	31.7	21.4	45.7	26.2	29.8
		F_3	87.0	7.6	8.7	7.8	80.0	12.4	14.3
	ASD1/IR50	F_2	83.7	30.2	36.1	26.0	51.9	32.3	37.6
		F_3	92.0	9.8	10.6	9.9	87.2	17.6	19.1
100-grain weight	ASDl/Co 33	F_2	2.3	0.3	11.3	9.7	74.4	0.4	17.3
		F_3	2.3	0.3	11.9	11.4	91.5	0.5	22.4
	ASD1/ADT36	F_2	2.4	0.2	8.6	7.1	66.8	0.3	11.9
		F_3	2.4	0.1	5.6	4.0	51.2	0.1	5.9
	ASD1/IR50	F_2	2.5	0.2	8.8	6.9	62.4	0.3	11.3
		F_3	2.3	0.2	6.7	5.5	68.4	0.2	9.4
Single-plant yield	ASDl/Co 33	F_2	12.4	6.0	48.1	41.2	73.3	9.0	72.7
		F_3	10.2	1.9	18.3	15.2	69.1	2.7	26.0
	ASDl/ADT36	F_2	12.5	6.3	50.6	41.9	68.6	8.9	71.5
		F_3	9.7	1.3	13.0	9.8	56.3	1.5	15.1
	ASD1/IR50	F_2	13.8	6.6	47.9	36.7	58.6	8.0	57.8
		F_3	9.1	1.8	19.4	16.6	72.9	2.6	29.2

[a]Phenotypic coefficient of variability. [b]Genotypic coefficient of variability. [c]Broad-sense heritability. [d]Genetic advance.

Table 2. Phenotypic correlations between yield and yield components in F_2 and F_3 of tall/semidwarf rice crosses in Tamil Nadu.

Character	Cross	Plant height		Number of productive tillers		Panicle lenght		Grain no./ panicle		100-grain weight		Harvest index		Dry matter production		Single-plant yield	
		F_2	F_3	F_2	F_3	F_2	F_3	F_2	F_3	F_2	F_3	F_2	F_3	F_2	F_3	F_2	F_3
Days to panicle emergence	ASD1/Co 33	–0.16	–0.01	–0.38*	–0.06	–0.09	–0.01	0.16	–0.26	–0.26	0.11	–0.08	–0.09	–0.08	0.09	–0.07	–0.01
	ASD1/ADT36	0.11	–0.04	0.26	0.46*	0.01	0.09	–0.10	–0.03	–0.04	0.40*	0.14	0.13	0.27	0.13	0.29	0.24
	ASD1/IR50	–0.17	0.01	0.06	0.02	0.14	0.04	0.03	–0.01	0.10	0.39*	0.02	0.20	0.11	–0.05	0.10	0.09
Plant height	ASD1/Co33			0.04	0.25	0.18	0.23	–0.06	0.32	0.18	0.11	–0.06	–0.07	0.09	0.57**	0.08	0.35
	ASD1/ADT36			–0.30	0.01	0.17	0.28	–0.29	0.31	–0.05	0.22	–0.16	0.01	–0.28	0.21	0.30	0.21
	ASD1/IR50			–0.05	–0.10	0.17	0.29	–0.24	0.46*	–0.15	0.01	–0.08	0.44*	0.03	0.83**	–0.01	0.89**
Number of productive tillers	ASD1/Co 33					0.22	0.07	0.19	0.40**	0.29	–0.05	0.48*	0.11	0.37*	0.24	0.48**	0.25
	ASD1/ADT36					0.36	–0.02	0.28	–0.07	0.06	0.32	0.46*	–0.08	0.93**	0.49**	0.96**	0.38*
	ASD1/IR50					0.27	–0.17	0.46*	0.09	0.01	–0.16	0.44*	0.10	0.83**	0.31	0.89**	0.30
Panicle length	ASD1/Co 33							0.17	0.43*	0.32	–0.02	0.21	0.05	–0.18	0.42*	–0.09	0.33
	ASD1/ADT36							0.13	0.45*	–0.30	0.08	0.13	–0.20	0.37*	0.24	0.36*	0.03
	ASD1/IR50							0.26	0.04	–0.30	0.08	0.02	–0.23	0.25	–0.14	0.25	–0.29
Grain no./panicle	ASD1/Co33									0.13	–0.17	0.23	0.02	0.32	0.44*	0.29	0.32
	ASD1/ADT36									0.22	0.15	0.21	0.07	0.08	0.11	0.18	0.15
	ASD1/IR50									–0.19	–0.04	0.33	0.13	0.39*	0.19	0.40*	0.21
100–grain weight	ASD1/Co 33											0.12	–0.12	0.13	0.08	0.20	–0.03
	ASD1/ADT36											0.13	0.24	0.07	0.04	0.07	0.28
	ASD1/IR50											0.11	–0.02	–0.03	0.01	0.01	–0.03
Harvest index	ASD1/Co 33													0.46*	–0.01	0.61**	0.70**
	ASD1/ADT36													0.31	–0.35	0.54**	0.54**
	ASD1/IR50													0.24	0.04	0.48**	0.70**
Dry matter production	ASD1/Co 33															0.96**	0.71**
	ASD1/ADT36															0.96**	0.59**
	ASD1/IR50															0.95**	0.73**

*Significant at 5% level. **Significant at 1% level.

Dry matter production made the highest contribution to the yield, with a high positive direct effect in both generations of all crosses. The indirect effect of dry matter production via harvest index was positive except in F_3 of ASD1/ADT36 and ASD1/Co 33.

The direct effect of harvest index on single plant yield ranged from moderate to high in both generations. Harvest index showed a moderate to high-positive indirect effect via dry matter production. ☐

Space limitations prevent IRRN from publishing solely yield data and yield component data from routine germplasm screening trials. Publication is limited to manuscripts that provide either a) data and analysis beyond yield and yield components (e.g., multiple or unique resistances and tolerances, broad adaptability), or b) novel ways of interpreting yield and yield component data across seasons and sites.

Table 3. Direct effect and indirect effect of yield components on single-plant yield through harvest index and dry matter production in F_2 and F_3 of tall/semidwarf rice crosses. Tamil Nadu, India, 1986-87.

Characters	Cross	Direct effect		Indirect effect: Harvest index		Indirect effect: Dry matter production		Phenotypic correlation value with single-plant yield	
		F_2	F_3	F_2	F_3	F_2	F_3	F_2	F_3
Harvest index	ASD1/Co 33	0.18	0.70	--	--	0.40	–0.01	0.61**	0.70**
	ASD1/ADT36	0.25	0.84	--	--	0.27	–0.31	0.54**	0.54**
	ASD1/IR50	0.24	0.68	--	--	0.19	0.03	0.48**	0.70**
Dry matter production	ASD1/Co 33	0.87	0.73	0.08	–0.01	--	--	0.96**	0.71**
	ASD1/ADT36	0.86	0.88	0.08	–0.30	--	--	0.96**	0.59**
	ASD1/IR50	0.77	0.70	0.06	0.02	--	--	0.95**	0.73**
Days to panicle emergence	ASD1/Co 33	0.08	–0.01	0.01	–0.06	–0.07	0.07	–0.07	–0.01
	ASD1/ADT36	0.02	–0.01	0.03	0.11	0.24	0.12	0.29	0.24
	ASD1/IR50	0.01	–0.01	0.01	0.14	0.08	–0.03	0.10	0.09
Plant height	ASD1/Co 33	–0.01	–0.02	–0.01	–0.05	0.08	0.42	0.08	0.35
	ASD1/ADT36	–0.01	0.01	–0.04	0.01	–0.24	0.19	–0.30	0.21
	ASD1/IR50	0.01	0.03	–0.06	–0.05	0.12	0.02	0.06	–0.01
Number of productive tillers	ASD1/Co 33	0.09	0.01	0.09	0.08	0.32	0.17	0.48**	0.25
	ASD1/ADT36	0.01	0.01	0.12	–0.07	0.80	0.43	0.95**	0.38*
	ASD1/IR50	0.16	0.02	0.11	0.07	0.64	0.22	0.89**	0.30
Panicle length	ASD1/Co 33	–0.01	–0.01	0.04	0.04	–0.15	0.31	–0.09	0.33
	ASD1/ADT36	–0.01	–0.03	0.03	–0.17	0.31	0.21	0.36*	0.03
	ASD1/IR50	0.02	0.01	0.01	–0.19	0.19	–0.10	0.25	–0.29

continued on next page

Table 3 continued

Characters	Cross	Direct effect		Indirect effect: Harvest index		Indirect effect: Dry matter production		Phenotypic correlation value with single-plant yield	
		F_2	F_3	F_2	F_3	F_2	F_3	F_2	F_3
Grain no./panicle	ASD1/Co 33	–0.07	–0.01	0.04	0.01	0.28	0.32	0.29	0.32
	ASD1/ADT36	0.06	0.01	0.05	0.06	0.07	0.09	0.17	0.15
	ASD1/IR50	–0.06	0.01	0.08	0.09	0.30	0.13	0.40**	0.21
100-grain weight	ASD1/Co 33	0.08	–0.01	0.02	–0.08	0.11	0.06	0.20	–0.03
	ASD1/ADT36	–0.03	0.03	0.03	0.20	0.06	0.04	0.07	0.27
	ASD1/IR50	–0.01	0.01	0.03	–0.02	–0.02	0.01	0.01	–0.03
	Residual effect	F_2	F_3						
	ASD1/Co 33	0.16	0.06						
	ASD1/ADT36	0.12	0.09						
	ASD1/IR5O	0.17	0.07						

**Significant at the 1% level. *Significant at 5% level.

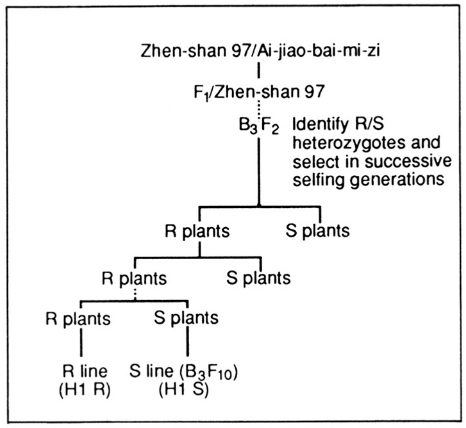
Near-isogenic pairs of indica rices with blast (Bl) resistance genes

He Zuhua and Shen Zongtan, Agronomy Department, Zhejiang Agricultural University, Hangzhou, China

Rice Bl-resistant near-isogenic pairs involving resistant lines with different genes and corresponding susceptible lines facilitate systematic genetic analysis and molecular study of Bl resistance. Each pair has a highly uniform genetic background; they presumably differ only in the resistance genes.

We crossed resistant cultivars Ai-jiao-bai-mi-zi, Tetep, and IR58 with the susceptible recurrent parent Zhen-shan 97. Plants segregating for resistance to Chinese Bl races ZB15 and ZC15 were selected for successive selfing generations to produce resistant and susceptible lines (see figure). Reactions to Chinese Bl races ZB15, ZC15, and ZF1 of 10 near-isogenic pairs differed (see table).

Studies on the molecular biology of rice B1 resistance are under way using the pairs. □



Procedure for selecting near-isogenic pair H1 R and H1 S. Lines were backcrossed three times then BC_3 plants were selfed 9 times to produce BC_3F_{10}R and S lines. Selection of other pairs was similar. R = resistant, S = susceptible.

Reaction of near-isogenic pairs to 3 Chinese rice Bl fungus races. Hangzhou, China.

Isogenic pairs	Resistance donor	Reaction[a]: ZB15	Reaction[a]: ZC15	Reaction[a]: ZF1
H1 R and H5 R	Ai-jiao-bai-mi-zi	R	R	S
H1 S and H5 S		S	S	S
H2 R and H3 R		R	R	R
H2 S and H3 S		S	S	S
H4 R and H6 R		R	R	R
H4 S and H6 S		S	S	R
H7 R	Tetep	R	R	R
H7 S		S	S	S
H8 R	IR58	R	R	R
H8 S		S	S	R
H9 R		R	R	S
H9 S		S	S	R
H10 R		S	R	R
H10 S		S	S	S

[a] R = resistant, S = susceptible.

Breeding methods

Anther culturability of rice lines bearing cytoplasmic male sterility

B. Courtois, IRAT-CIRAD, 97170 Petit-Bourg, Guadeloupe, France; and J. Taillebois, CNPAF-EMBRAPA, CP 179, 74000 Goiania, Goias, Brazil

An increase of anther culturability in cytoplasmic male sterile lines relative to male fertile varieties has been reported in wheat and tobacco. We did a similar study in rice.

The wild abortive cytoplasm (WA), which usually promotes microspore abortion at the uninucleate stage, and the Chinsurah Boro II cytoplasm (BT), which usually triggers a late degeneration of the pollen grains between the binucleated and trinucleated stage, were introduced by successive backcrosses into upland rice varieties IRAT313, IRAT103, and IRAT177.

Cytological observations showed apparently identical aspects of the microspores excised from male sterile and male fertile panicles at the anther plating stage (i.e., the mid-uninucleate stage).

The callus-forming ability of the anthers of the male sterile lines appears to be related to the stage of pollen abortion (see table). When late abortion occurs (BT cytoplasm), the anther culturability of the male sterile lines is either slightly decreased or not significantly different from control. When male sterility is due to early microspore degeneration (WA cytoplasm), a dramatic decrease in callus production occurs, because the microspore population that undergoes the androgenesis pathway is consistently reduced.

Induction ability of male sterile rice lines and their male fertile homologue lines. Goias, Brazil.

Genotype	Cytoplasm	Callus-forming anthers/anther inoculated [a] (%)	Pollen sterility just before anthesis [b] (%)	Spikelet sterility [c] (%)
IRAT313	Normal	5 a	7	21
CNA-IRAT1A	WA	0 b	98	100
IRAT103	Normal	25 a	3	12
CNA-IRAT6A	WA	8b	37	100
CNA-IRAT4A	BT	22 a	5	99
IRAT177	Normal	29 a	3	17
CNA-IRAT12A	BT	15 b	3	100

[a] Mean percentages of 2 replications of 600 anthers each. Means followed by a common letter are not significantly different at the 5% level. [b] Mean percentages of 3 observations of 100 pollen grains each. [c] Mean percentages of 3 bagged panicles.

This decrease in anther culturability of lines bearing the male sterile cytoplasm is the reverse of reports of anther culturability in wheat and tobacco. □

Hybrid sterility in interracial and interspecific rice crosses

W. W. Manuel, S. Palanisamy, T. B. Ranganathan, and S. R S. Rangasamy, Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India

Hybrid sterility in early generations of interracial and interspecific rice crosses is due to genic and cryptic structural hybridity. We examined the F_1s from eight japonica/indica, six japonica/japonica-indica, and two interspecific crosses during Jun-Sep 1988.

Spikelet sterility at harvest was 37.5-91.6%. Grain fertility was 8.4-62.5% (see table). Grain fertility of the parents was 85.9-95.5%. In crosses involving the same parent as male or female, grain fertility differed greatly because of gene interaction.

Derivatives of japonica/indica crosses crossed with japonicas behaved like indicas and did not improve grain fertility, except in Nakate Shinsenbon/Ponni (fertility = 62.5%).

Hybrid sterility in the F_1 makes it difficult to generate large numbers of F_2 plants with desirable characters. Anther culture of F_1 hybrids to capture difficult-to-recover plant characters and to gain quick homozygosity is being attempted using F_1 stubbles of these interracial and interspecific crosses. □

Fertility in the F_1 of interracial, interspecific rice crosses. Coimbatore, Tamil Nadu, India, 1988.

Cross	F_1 grain fertility (%)
Japonica/indica	
Norin 8/TKM6-35 kr.	42.1
Norin 8/IR50	21.0
Zuhio/ASD16	8.4
Zuhio/CO 37	11.1
Zuhio/IR50	12.1
Oozora/CO 37	47.6
Oozora/IR50	11.3
Nakate Shinsenbon/IR50	26.2
Japonica/japonica-indica	
Norin 6/Ponni	10.7
Norin 6/Ponni dwarf	14.8
Norin 8/White Ponni	39.8
Norin 8/Ponni dwarf	13.4
Oozora/Ponni	19.1
Nakate Shinsenbo/Ponni	62.5
Interspecific	
O. sativa f. spontanea/ADT 37	11.7
O. sativa f. spontanea/ Ponni dwarf	14.1

Using metroglyph analysis to study variability in early generations of rainfed lowland rice

S. M. Ibrahim, A. Ramalingam, and M. Subramanian, Agricultural Botany Department, Agricultural College and Research Institute (ACRI), Madurai 625104, Tamil Nadu, India

We studied the morphological variations in 12 F_2 families obtained from 9 parents under semidry conditions in 1988. Panicle length, tillers per plant, plant height, and single plant yield were recorded from 50 single plants per family selected for extreme differences (see table).

Variability in the F_2 populations was expressed in metroglyph analysis using score indices. A scatter diagram was plotted using plant height as the ordinate and single plant yield as the abscissa. Variation in other characters was represented by range and direction (see figure).

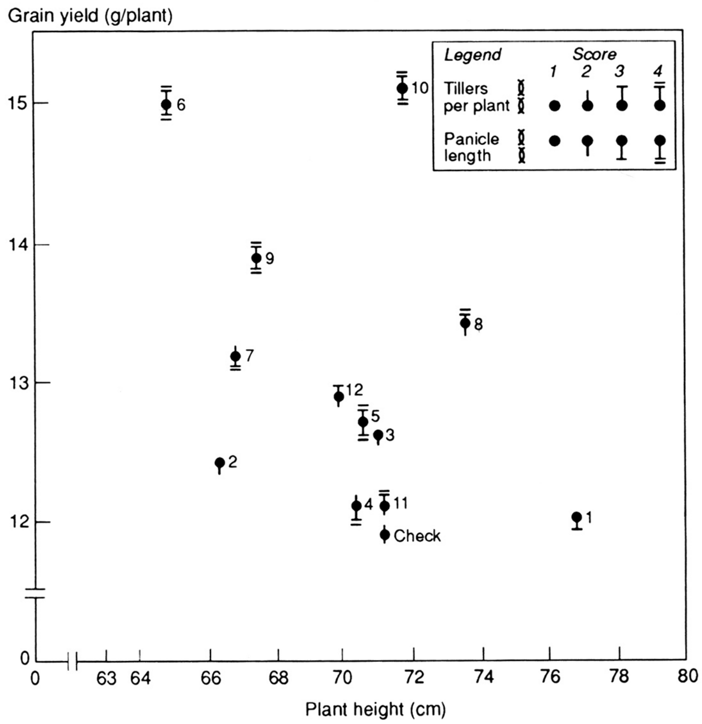
Index values for the range of variability were partitioned into four groups using class intervals. The range of variation was wider in Norungan/IR50 (index value 15) and IR29/IR50 (index value 13).

Twenty-four single plants falling in the range from $\overline{X}$ + 1 SD to $\overline{X}$ + 2 SD that also were better than check variety PMK1 in all characters were selected to forward to the F_3.

Metroglyph analysis could identify crosses and plants likely to produce superior progenies in early generations. The technique can be used while excising unidirectional selection in variable populations. □

Index score for different traits.

	Tillers per plant (no.)	Panicle length (cm)	Plant height (cm)	Single-plant yield (g)
Range of means	5.2 - 11.2	17.0 - 23.7	64.8 - 76.8	11.9 - 15.1
Score 1 value <	6.7	18.7	67.8	12.75
Score 2	6.8 - 8.2	18.8 - 20.3	67.8 - 70.8	12.76-13.5
Score 3	8.3 - 9.7	20.4 - 22.0	70.9 - 73.8	13.6 - 14.25
Score 4 value >	9.8	22.1	73.9	14.25
$\overline{X}$	8.8	21.3	70.03	13.1
X + l SD	8.93	23.15	73.23	14.11
SE	0.04	0.56	0.96	0.31
CV (%)	1.5	8.67	4.57	7.7



Scatter diagram of metroglyph analysis using 12 crosses. ACRI, Tamil Nadu. India, 1988. l-Norungan/MDUl, 2-Charumpuncha/MDUl (5), 3 - ZR29/PMK1 (7), 4 - Arurakari/IR20 (11), 5 - Moongil samba/lR50 (11), 6 - IR29/IR50 (13), 7 - Charumpuncha/IR50 (9), 8 - MDUl/PMKl (12), 9 - MDU1/IR50 (12), 10 - Norungan/ IR50 (15), 11 - W1263/MDU1 (11), 12 - Moongil samba/MDU1 (8), C - PMKl (check) (6). Figures in parentheses denote score index values.

Anther culturability of rice plants treated with male gametocide chemicals

V. Beaumont and B. Courtois, IRAT/CIRAD, 97170 Petit-Bourg, Guadeloupe, France

We evaluated the callus-forming abilities of anthers derived from F_1 rice plants of the japonica/indica hybrid IRAT13/H105 treated with the chemical hybridization agent G5 at 0.5 and 1.0 g/liter at 2 stages of panicle development (before and after meiosis). G5 is known to be effective on wheat and, to a lesser degree, on rice.

The number of anthers forming calli was three times higher in anthers treated with 1.0 g G5/liter before meiosis than in control (see table). Time of appearance of the first callus also was 6-8 d earlier. However, regenerability of induced calli did not differ significantly from that of the control.

The gametocidal effect of G5 on rice pollen sterility measured just before anthesis increased with increased application but remained weak. Spikelet sterility with 1.0 g G5/liter was 30-40% higher than control.

These results agree with results obtained in wheat.

The same experimental protocol was followed to assess the effect of ethephon at 2 and 4 g/liter on callus-forming abilities of treated anthers. In this case, discrepancies were noted among the results of the three replications. Spraying ethephon on donor plants does not appear to be a reliable way to increase rice anther culturability. □

Effect of male gametocide chemicals on callus formation ability of rice anthers.

Treatment	Callus-forming ability[a] (%)	
	Before meiosis	After meiosis
Distilled water (control)	5.6 a	5.4 a
0.5 g gametocide/liter	13.1 a	4.9 a
1.0 g gametocide/liter	17.8 b	3.8 a

[a]Avof 2 replications, 1000 anthers each treatment. Means followed by a common letter are not significantly different at the 5% level by DMRT.

Yield potential

Sources of variability in rice seed quality

C. P. Thiagarajan, Seed Technology Department, Tamil Nadu Agricultural University, Coimbatore 641003, India

An inherent heterogeneity in rice seed quality exists between tillers of a plant and between plants in a population. When a variety is grown in different agroecological situations, seed quality also varies.

We studied the variability in seeds produced from different tillers in a plant, between plants in a population, and between populations produced in different parts of the Cauvery Delta Zone. Five varieties were tested: short-duration IR50, ADT36, and TKM9; medium-duration IR20; and long-duration CR1009.

Ten locations were selected, with 10 fields sampled in each location. For tiller and plant analysis, 10 clumps/field were used.

Seeds were collected at maturity and germinated in the laboratory. Percentage germination and seedling length were multiplied to calculate the vigor index. The results were pooled by location.

Between tillers and plants, variability was higher in seedling vigor than in germination. Variability in both germinability and seedling vigor was almost equal across locations, irrespective of variety. Mean variability in germination and seedling vigor was 8.4 and 18% among tillers, 5 and 10% among plants in a population, and 23 and 24% among locations.

The higher variability between tillers than between plants might be due to different times of tillering (varying with water level) and times of anthesis and seed maturation. The difference among locations might be due to different soil conditions, dates of sowing, and other environmental components.

Among the varieties, variability in seed germination among tillers was highest in CR1009; that among locations was highest in AD736 (Table 1). Variability in seedling vigor between tillers was highest in TKM9 (Table 2). □

Table 1. Variation in seed germination between tillers of a plant, plants in a population, and production locations. Tamil Nadu, India.

Variety	Variation (%) in seed germination		
	Between tillers	Between plants	Between locations
IR50	7	5	21
ADT36	10	6	28
TKM9	4	2	24
IR20	7	6	20
CR1009	14	5	22
Mean	8.4	5	23
LSD: 3			

Table 2. Variation in seedling vigor between tillers of a plant, plants in a population, and location. Tamil Nadu, India.

Variety	Variation (%) in seedling vigor		
	Between tillers	Between plants	Between locations
IR50	18	10	22
ADT36	16	9	21
TKM9	22	14	36
1R20	16	8	20
CR1009	18	10	23
Mean	18	10	24
LSD: 4			

Minimizing intravarietal variation in rice experiments

S. Mallik, A. M. Aguilar, and B. S. Vergara, Plant Physiology Department, IRRI

Large variations in many morphological characters are observed within rice cultivars in field and greenhouse trials, even under uniform growing conditions. One reason may be differences in seed quality. We experimented with seeds of three varieties.

Bulk seeds of IR30, IR32385-37-3-3, and IR28211-43-1-1 (105-110 d) were harvested in 1988 dry season. Dried seeds were graded into poor, good, and high-density (HD) grains using distilled water and salt solutions of varying specific gravity. Seeds of each grade were separated into embryo, endosperm, and hull.

Total grain weights were similar, except in IR28211-43-1-1 (Table 1). Embryo weights of HD grains were significantly heavier than those of poor grains in all cultivars. In IR28211-43-1-1, embryo weights of the grades differed significantly: large, heavy seeds had heavy embryos. Endosperm weights did not differ between good and HD grains, but were significantly heavier for both grades than for poor grain. Hull weight differed among grades in IR30 and IR28211-43-1-1.

Seeds of the three grades were sown in 4-liter pots containing 3 kg of Maahas clay soil with added fertilizers, in a randomized block design with three replications and raised in the greenhouse.

At 25 DAS, seedlings from good and HD grains were significantly taller than those from poor grains. For most characters, the trends in IR30 and IR32385-37-3-3 were similar. In

Table 1. Characteristics of seeds of different quality.[a]

Grain grade[b]	Weight (mg) per 100 grains			
	Embryo	Endosperm	Hull	Total
		IR30		
Poor	13.2 a	341.6 a	350.8 a	705.6 a
Good	17.9 b	1385.7 b	403.2 b	1807.3 b
High density	18.4 b	1549.6 b	438.0 c	2005.5 b
		IR32385-37-3-3		
Poor	23.7 a	908.3 a	351.4 a	1283.4 a
Good	25.5 ab	1481.9 b	407.9 b	1915.3 b
High density	27.1 b	1600.2 b	419.7 b	2047.0 b
		IR28211-43-1-1		
Poor	16.8 a	884.6 a	384.3 a	1285.7 a
Good	25.0 b	1626.2 b	441.0 b	2092.2 b
High density	29.4 c	1909.1 b	498.7 c	2437.2 c

[a]Means followed by a common letter in a column are not significantly different at the 5% level by DMRT. [b]Poor = sp gr ≤ 1.0, good = sp gr > 1.0- ≤ 1.20, high density = sp gr > 1.20.

IR28211-43-1-1, all characters but leaf dry weight differed significantly among grades. Differences in IR28211-43-1-1 were greater because differences among embryo weights were larger.

Mean data show significant differences among grades for all traits except plant height and specific leaf weight. The coefficient of variation for growth parameters was much lower for HD grains (Table 2) than for poor and good grains. This indicates that intravarietal or intragenotype variation can be lessened by planting HD grains. □

Table 2. Coefficient of variation for growth parameters of different grain grades at 25 d after sowing.

Grain grade	Coefficient of variation						
	Plant height	Tiller no.	Leaf area	Specific leafweight	Leaf dry weight	Culm dry weight	Total dry weight
				IR30			
Poor	13.2	48.0	33.6	31.6	30.4	31.2	30.8
Good	10.1	35.6	31.7	25.8	27.1	26.4	26.7
High density	11.3	22.1	27.2	20.2	20.3	22.3	21.3
				IR32385-37-3-3			
Poor	12.0	34.4	40.1	40.0	76.3	38.2	57.2
Good	4.4	16.1	21.5	16.7	16.5	17.5	17.0
High density	6.7	17.3	18.2	17.4	16.8	17.1	16.9
				IR288211-13-1-1			
Poor	23.0	21.7	25.1	21.0	21.1	21.1	25.1
Good	6.1	18.4	23.4	19.1	19.9	18.3	23.9
High density	3.5	15.8	16.8	16.1	19.2	13.1	13.1

Path analysis of rice grain yield under rainfed lowland conditions

S. M. Ibrahim, A. Ramalingam, and M. Subramanian, Agricultural Botany Department, Agricultural College and Research Institute, Madurai 625104, Tamil Nadu, India

We examined direct and indirect associations of four yield components with grain yield in drought-tolerant lines MDU1, Brown gora, BR319-1, OS4, E45, C22, OS6, IR12979-24-1-8, UPLRi-5, UPLRi-7, Azucena, N22, and Kalakeri and local check PMKl grown in semidry conditions in 1988. The trial was laid out in a randomized block design with three replications.

Productive tillers had high direct effects on grain yield (see table). Panicle length and flowering duration had moderate direct effects. The effect of plant height was slightly negative.

Productive tillers appear to be the most reliable character to use in selecting genotypes under rainfed condition. □

Path analysis showing direct and indirect effects of yield components on grain yield under rainfed lowland semidry conditions.[a] Madurai, Tamil Nadu, India, 1988.

Variable	Flowering duration	Plant height	Panicle length	Productive tillers	Total correlation with yield
Flowering duration	<u>0.250</u>	0.006	0.161	-0.255	0.162
Plant height	-0.085	<u>-0.016</u>	-0.150	-0.109	-0.361
Panicle length	0.130	0.008	<u>0.310</u>	-0.598	-0.150
Productive tillers	-0.063	0.002	-0.183	<u>0.992</u>	0.748**

[a] Residual effect = 0.471. Underlined correlations indicate direct effects. ** = significant at P = 0.01.

Varietal differences in rice ratoon performance

K. Srinivasan, National Pulses Research Centre, Pudukkottai 622303; and S. Purushothaman, Agricultural College, Madurai 625104, India

The success of rice ratooning depends primarily on the variety used. We compared medium-duration rice varieties Ponni and Bhavani in sandy clay loam soils during the wet season.

The main crop was harvested 15 cm from ground level and the stubble fertilized with 100-50-50 kg NPK/ha.

Bhavani was significantly superior to Ponni on all growth and yield attributes (see table). The Bhavani ratoon crop yielded 2.8 t/ha—50% of its main crop yield. Ponni produced 1.8 t/ha, 38% of its main crop yield. Straw yield in Bhavani ratoon was also higher. □

Growth and yield attributes of rice ratoon crop in Madurai, India during the wet season.

Variety	Plant height (cm)	Ratoon tillers/ hill	Productive tillers/ m^2	Filled grains/ panicle	Thousand-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
Ponni	69.7	9.4	319.2	59.4	15.5	1.8	2.3
Bhavani	74.0	11.9	414.2	66.2	20.8	2.8	3.4
LSD (0.05)	1.7	0.4	9.5	2.6	0.11	0.2	0.3

Differences in ratooning ability among rice cultivars

Tan Zhenbo, Rice Research Institute, Sichuan Academy of Agricultural Sciences, Luzhou; and Li Shefei, Agronomy Department, Sichuan Agricultural University, Yaan Sichuan, China

We screened 24 rice hybrids, varieties, and breeding lines for ratoon tillers/hill and ratoon tillers/node 10 d after cutting at the first (top) node.

The experiment was laid out in a randomized block design with three replications. Plants were transplanted at 16.7- × 23.3-cm spacing at 2 seedlings/hill.

Most of the hybrids had good ratooning ability (see table). Hunanzaishengdao, Dyou 10, and Minghui 63 grew tillers from all nodes. Jiang 86-419 and Shanyou 66 formed tillers mainly from the lower nodes. Aiyou 1 developed tillers mainly from the higher nodes. Jiang 86-697 and Jiang 86-315 regenerated tillers mainly from mid-nodes. □

Average numbers of ratoon tillers on different nodes in 24 rice hybrids, varieties, and breeding lines.[a] Zigang, Sichuan, China, 1987.

Variety	Ratoon tillers/hill	Ratoon tillers/node[b]			
		2	3	4	5
Dyou 10 [c]	30.1 a	6.5 ab	7.9 a	10.3 a	5.3 c
Shanyou 66 [c]	29.5 a	1.3 c	4.5 b	10.3 a	13.3 a
Minghui 63 [c]	29.1 a	6.7 ab	8.1 a	7.9 bc	6.5 bc
Dyou 63 [c]	26.7 ab	2.9 bc	6.2 ab	9.5 ab	8.1 bc
Shanyou 63 [c]	25.9 ab	3.9 bc	7.1 ab	9.4 ab	5.5 c
Feigai 63 [c]	25.6 ab	7.0 ab	8.2 a	8.7 ab	1.7 d
40-1	25.2 ab	5.7 ab	5.3 b	7.1 bc	7.1 bc
Jiang 86-842	25.1 ab	7.4 a	7.2 ab	7.4 bc	3.1 cd
Xieyou 63 [c]	25.1 ab	4.5 ab	6.3 ab	8.4 b	5.8 bc
Aiyou 1 [c]	22.9 b	3.7 bc	6.9 ab	4.4 d	2.5 cd
Jiang 86-808	21.8 bc	2.0 c	5.3 b	7.7 bc	7.0 bc
Jiang 86-419	21.5 bc	0.0 c	2.0 c	8.5 ab	10.9 ab
Jiang 86-357	19.8 bc	0.4 c	3.5 bc	7.1 bc	8.7 b
Hunanzaishengdao	19.1 bc	5.0 b	3.9 bc	5.7 cd	4.5 cd
85-3304	17.6 c	4.8 b	6.3 ab	5.6 cd	0.9 d
Gangai 63 [c]	17.5 c	3.7 bc	6.9 ab	4.4 d	2.5 cd
86-6052	17.1 c	0.7 c	6.9 ab	6.3 c	3.1 cd
Jiang 86-313	17.0 c	0.3 c	6.4 ab	5.7 cd	4.8 cd
86-6046	16.9 c	1.9 c	7.3 ab	5.8 cd	1.9 d
Jiang 86-315	16.5 c	1.1 c	7.7 a	6.3 c	1.5 d
86-6058	15.6 c	1.3 c	5.9 ab	6.1 cd	3.1 cd
Jiang 86-334	15.1 c	2.1 c	7.2 ab	5.1 cd	0.7 d
Jiang 86-697	14.7 c	0.9 c	5.9 ab	6.5 c	1.4 d
Jiang 86-333	14.6 c	0.7 c	6.5 ab	6.1 cd	1.3 d

[a]In a column, means followed by the same letter are not significantly different at the 5% level. [b]2, 3, 4,5 indicate node number counting from top to bottom. [c]Hybrids.

Grain quality

Physicochemical characters of some rice cultivars of West Bengal

S. Gupta, Rice Research Station, Chinsurah, India

The grain quality characters of 15 popularly cultivated rice varieties of West Bengal grown in 1986 wet season were evaluated after grain storage under ambient condition.

Length was 5.45-7.14 mm and length/breadth ratio was 3.47-2.31 (see table). The alkali spreading value ranged between 7 (CN776-U6-B2-II) and 3 (IET4786).

Physicochemical characters of some rice cultivars. West Bengal, India, 1986 wet season.

Variety	Endosperm chalkiness [a]	Brown rice			L/B ratio	1000-grain wt (g)	Milled rice				
		Length (mm)	Breadth (mm)	Thickness (mm)			Alkali spreading value	Amylose (%)	Elongation ratio	Volume expansion ratio	Water uptake (ml/l00 g of rice)
IR42	3	6.78	2.20	1.58	3.08	16.3	6.0	24.5	1.44	3.81	200.0
IET2254	1	6.36	2.09	1.64	3.04	15.5	4.8	18.6	1.52	4.73	222.5
IET4094	0	7.14	2.06	1.60	3.47	15.3	5.0	34.7	1.73	4.71	218.5
IET4786	0	5.66	1.64	1.56	3.38	12.8	3.0	19.5	1.64	4.00	212.5
CN776-U6-B2-II	5	7.03	2.12	1.75	3.33	18.2	7.0	20.5	1.50	4.67	222.5
IET1444	0	5.94	2.29	1.88	2.59	15.8	5.5	25.6	1.56	5.39	288.0
Jaya	7	6.51	2.39	1.83	2.72	20.7	7.0	31.1	1.44	4.93	287.5
CR237-1	1	6.87	1.95	1.73	3.52	16.4	4.0	29.4	1.22	4.47	252.5
IET2815	0	7.14	2.06	1.70	3.08	16.9	5.6	28.8	1.47	4.50	250.0
IR30	3	5.45	2.23	1.79	2.44	15.9	6.2	25.9	1.61	4.73	221.5
IR20	0	6.71	2.03	1.69	3.30	16.5	5.0	25.3	1.54	4.83	220.0
CN747-8-1	0	6.72	1.90	1.64	2.54	16.1	5.0	27.2	1.70	5.45	252.5
IET6141	1	6.36	1.90	1.61	3.38	16.0	5.2	34.5	1.62	4.72	237.5
IR36	1	6.78	2.08	1.66	3.26	16.7	4.0	26.3	1.74	5.26	262.5
CSR4	7	5.53	2.39	1.64	2.31	14.2	4.1	29.1	1.72	5.04	175.0

[a] *Standard evaluation system for rice.*

Amylose content was highest in IET4094 and lowest in IET2254. The elongation ratio of milled rice ranged between 1.74 (IR36) and 1.22 (CR237-1).

Highest volume expansion during cooking was in the CN747-8-1 and highest water uptake was in IET1444. IR42 expanded least and had low water uptake. □

Grain characteristics of some aromatic rice varieties of Assam

K. K. Sarma, T. Ahmed, and D. K Baruah, Regional Agricultural Research Station, Titabar, Assam, India

Scented rice is grown by farmers in Assam for the preparation of special holiday foods. We studied awning, pigmentation, length/breadth (L/B) ratio, and 1,000-grain weight of 43 traditional scented varieties in 1988. Thirteen possessed awns and 23 were pigmented. Grain length was 5.66-9.94 mm, breadth 1.80-2.96 mm, L/B ratio 2.44-4.33, and 1,000-grain weight 8.44-25.48 g. □

Pest resistance – diseases

Blast (Bl) resistance in tidal swamp rices of Indonesia

M. Hamda, Banjarbaru Research Institute for Food Crops, P.O. Box 31, Banjarbaru, South Kalimantan, Indonesia

We evaluated field resistance to B1 caused by *Pyricularia oryzae* in 158 rices during the 1988 wet season.

Each line was transplanted at 20- × 20-cm spacing. Plots were fertilized with urea and triple superphosphate at 120-26 kg NP/ha. Disease scoring was one 30 d after transplanting.

None of the varieties tested were resistant; 33 were moderately resistant (MR) (see table). □

Reaction of tidal swamp rices to Bl. Unit Tatas, Central Kalimantan, Indonesia, 1988 wet season.

Line	Disease score	Reaction
BRB4-29-3	3	MR
BR51-120-2	3	MR
BWl00	3	MR
BW295-4	3	MR
BW295-5	3	MR
B3240 ENG 4	3	MR
Cisadane	3	MR
CR1002	3	MR
IR13149-3-2-2	3	MR
IR13149-43-2	3	MR
IR13423-17-1-2-1	3	MR
IR21820-154-3-2-2-3	3	MR
IR2307-247-2-2-3	3	MR
IR28222-9-2-2-2-2	3	MR
IR28223-399-5-6	3	MR
IR31662-47-2-1	3	MR
IR4-11	3	MR
IR4417-179-1-5-2	3	MR
IR4422-480-2-2-3	3	MR
IR4432-52-6-4	3	MR
IR5785-188-2-1	3	MR
IR9217-6-2-2-2-3	3	MR
P1277-7-14M-5-1B	3	MR
P1342-6-10M-3-1B	3	MR
ROHY B15-WAR-3-3	3	MR
ROK5	3	MR
IR28288-12-3-1-1-2	3	MR
B4460H-MR-6	3	MR
IR19661	3	MR
Kapuas	3	MR
Cisanggarung	3	MR
BRB50-13-2-1	3	MR
DWCB-B-27-2	3	MR

Pest resistance–insects

Reaction of rice varieties to gall midge (GM)

M. P. Singh, Entomology Department, Manipur Agricultural College, Iroisemba, Imphal 795001, Manipur, India

We field-tested 137 rice varieties and breeding lines for resistance to GM during 1987-88 wet seasons. Seedlings were transplanted 1 mo after seeding in two 4-m rows/variety at 20- × 20-cm spacing. Susceptible check TN1 was planted every 20 rows. Local recommended agronomic practices were followed.

GM incidence and damage were recorded 30 and 50 d after transplanting. Susceptible check TN1 had an average 75% infested hills and 29% silvershoots at 50 d after transplanting.

Eleven entries were found to be highly resistant to GM, three showed moderate resistance (see table).

Rice GM resistance in Manipur, India, 1987-88 wet seasons.

Cultivar	Cross	Resistance rating [a]
R320-300	Asha/Kranti	0
R321-108	Samridhi/IR36	0
RP2436-79-22-2	IR50/WGL 22508	0
WGL 18011-15	CR44/WGL 12708	0
WGL 20471-97	BC5/WGL 12708	0
WGL 26358	IR20/WGL 12708	0
BPT3624	BPT3361/WGL 26888	0
W1263	MTU15/Eswarakora	0
Aganni	Donor	0
T1477	Donor	0
Banglei	Donor	0
WGL 3011-120	WGL 22509/IR50	3
WGL 47998	Obs 677/IR2070	3
R320-101	Asha/Kranti	3
TN1	Susceptible check	9

[a] Scale 0-9 based on *Standard evaluation system for rice.*

Effect of temperature and storage on yellow stem borer (YSB) egg hatchability and larval survival

V. D. Viajante and R C. Saxena, Entomology Department, IRRI

Routine YSB cultures on caged plants sometimes cannot supply enough newly emerged larvae for yield-loss studies. Egg masses produced by females collected in light traps are needed. To synchronize larval emergence with experimental needs, embryonic development must be suspended. We experimented to determine the temperature regime during incubation that would not affect egg hatchability and larval survival.

Newly emerged YSB moths reared in the field on caged IR46 rice plants were collected daily and caged for oviposition on 30-d-old IR36 plants. Egg masses of uniform size were collected daily and placed singly in test tubes with a moist cotton pad at the bottom. One egg mass represented one replication. The test tubes with egg masses were plugged and placed inside incubators at 8, 12, 15, 17, and 20 ºC temperatures for 0, 1, 3, 6, 10, 15, and 21 d.

Four test tubes with egg masses per treatment were exposed at room temperature for embryonic development. The dates on which eggs hatched were recorded. Emerged larvae were counted after 4 d and egg masses were dissected to determine the number of unhatched eggs.

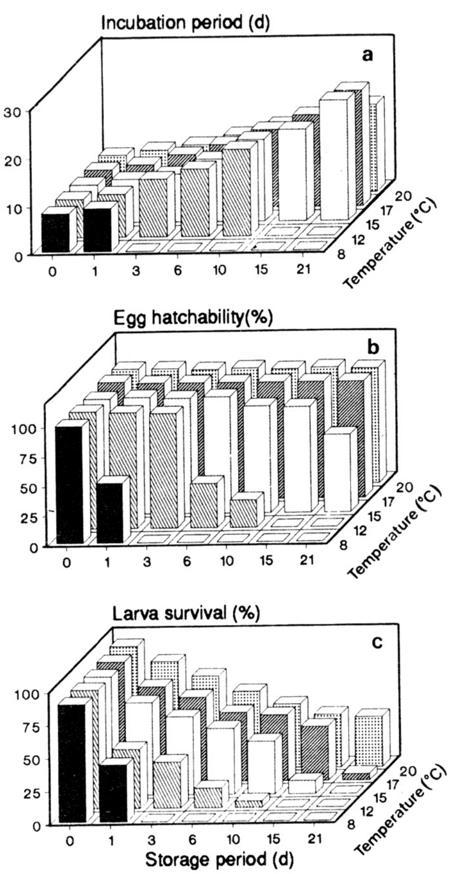
Ten larvae from each egg mass were caged on potted IR36 plants at the booting stage. At 24 d after infestation, the plants were dissected and larvae surviving counted.

During the cool months (Dec-Feb), YSB eggs hatched normally 8 d after oviposition. Handling delayed hatching by 1 d, regardless of incubation temperature (Fig. la).

Hatching could be delayed 25 d when eggs were incubated at 15 ºC, and 23 d at 17 ºC (Fig. 1b). Eggs stored at 8 ºC for 3, 6, 10, 15, and 21 d, and at 12 ºC for 15 and 21 d did not hatch.

Larval survival decreased drastically with a progressive increase in storage period at low temperatures; it was least affected when eggs were incubated at 20 ºC (Fig. 1c).

For optimum hatchability and larval survival, storage of YSB egg masses should not exceed 10 d at 15 ºC. □



Incubation period, egg hatchability, and larval survival of YSB as affected by storage period at different temperature regimes.

Phenolic compounds, reducing sugars, and free amino acids in rice leaves of varieties resistant to rice thrips

B. Thayumanavan, R. Velusamy, and S. Sadasivam, Tamil Nadu Agricultural University, Coimbatore 641003, India; and R. C. Saxena, IRRI

Rice varieties differ in susceptibility to the rice thrips *Stenchaetothrips biformis.* We examined concentrations of phenolic compounds, reducing sugars, and free amino acids in the leaves of seven susceptible and six resistant varieties.

Leaves of 30-d-old healthy and infested rice plants were analyzed, with two replications per analysis. Catechol was the standard for colorimetric assay. Total phenols were separated and estimated by silica-gel thin-layer chromatography (TLC). Salicylic acid was separated using ch1oroform:acetic acid (9:1 vol/vol) solvent system. Chlorogenic and gallic acids were separated using methano1:acetic acid:water (9:1:1 vol/vol) solvent system. Co-chromatography with authentic samples indicated that most of the phenols belonged to benzoic and cinnamic acid derivatives.

Resistant varieties possessed significantly higher content of total phenols (Table 1). Salicylic acid was higher in susceptible varieties, but concentrations of chlorogenic and gallic acids were higher in resistant varieties (Table 2). Reducing sugars were significantly higher in susceptible varieties. Free amino acid content was generally higher in susceptible varieties. □

Table 1. Phenols, reducing sugars, and free amino acids in healthy (H) and thrips-infested (I) plants of resistant and susceptible rice varieties.

Variety	mg/g fresh weight of leaves					
	Phenols		Reducing sugars		Free amino acids	
	H	I	H	I	H	I
Resistant						
Ptb 21	5.45	5.50	4.20	4.60	3.65	4.55
Mozhikaruppu	5.05	4.95	3.55	4.50	2.75	4.45
Kandagasalai	6.35	5.70	3.85	4.53	3.35	4.40
CO 3	5.05	5.45	2.98	3.55	2.95	3.70
TNR1	5.40	5.25	3.13	3.28	2.70	3.30
IR62	4.80	4.55	2.25	2.98	2.95	3.20
Mean	5.35	5.23	3.33	3.90	3.06	3.93
Susceptible						
Bhavani	3.30	3.05	6.03	5.40	3.10	3.95
ADT38	3.80	3.65	7.43	7.88	3.85	4.40
IR26	3.00	2.80	5.13	5.78	2.85	3.75
IR34	3.10	3.05	4.90	5.15	3.90	4.30
IR8	3.05	2.75	5.03	5.28	3.65	4.50
Vani	3.45	3.40	7.40	7.68	3.30	4.10
CO 43	3.45	3.15	6.08	6.35	3.25	4.10
Mean	3.31	3.12	6.00	6.36	3.41	4.16
LSD values						
Healthy vs infested	0.17**		0.36**		0.54**	
Resistant vs susceptible	0.17***		0.36***		0.54*	
Between varieties	0.12**		0.26**		0.39*	

Table 2. Salicylic, chlorogenic, and gallic acids in healthy (H) and thrips-infested (I) plants of resistant and susceptible rice varieties.

Variety	mg/g fresh weight of leaves					
	Salicylic[a]		Chlorogenic[b]		Gallic[b]	
	H	I	H	I	H	I
Resistant						
Ptb 21	0.22	0.30	2.40	2.32	0.84	1.16
Mozhikaruppu	0.20	0.33	2.48	2.80	1.20	0.96
Kandagasalai	0.31	0.29	1.92	2.80	1.20	0.60
CO 3	0.30	0.25	2.48	2.48	1.00	1.00
TNRl	0.27	0.28	2.56	1.84	0.96	0.64
IR62	0.31	0.30	2.32	1.84	0.80	0.60
Mean	0.27	0.29	2.36	2.35	1.00	0.83
Susceptible						
Bhavani	0.64	0.60	1.44	1.30	0.40	0.36
IR8	0.76	0.77	1.36	1.34	0.40	0.41
IR26	0.60	0.59	1.44	1.40	0.40	0.38
IR34	0.56	0.57	0.94	1.10	0.38	0.32
ADT38	0.61	0.63	1.48	1.00	0.60	0.50
CO 43	0.55	0.57	1.52	1.60	0.38	0.42
Vani	0.68	0.69	1.04	1.24	0.24	0.30
Mean	0.63	0.63	1.32	1.28	0.40	0.38

[a]Salicylic acid separated and estimated through silica-gel TLC using chloroform: acetic acid (9:1 vol/vol) solvent system. [b]Chlorogenic and gallic acids separated on silica-gel using methanol: acetic acid: water (9:1:1 vol/vol) solvent system.

Resistance to rice gall midge (GM) in Kerala, India

N. Rema Bai, R. Devika, S. Leenakumary, and C. A. Joseph, Rice Research Station (RRS), Kerala Agricultural University, Moncompu, India

We evaluated 135 varieties against GM *Orseolia oryzae.* Damage was very severe during 1988 wet season (Jun-Jul to Oct-Nov) in the nursery and in the field and during 1989 dry season (Dec-Jan to Apr-May) in the field.

Test varieties were grown in 10-m^2 plots with two replications. Recommended agronomic practices were followed. Silvershoots in 10 randomly selected hills from each replication were counted at 30 d after transplanting.

IET10745 (C1924/RP9-4) showed high resistance, 10 lines showed moderate resistance (see table).

Resistance to rice GM in Kerala, India, 1988-89.

Line	Parentage	Score[a]		
		1988 wet season	1989 dry season	Mean
IET11070	Pusa 2-21/WGL 28171	3	2	2.5
IET11581	Rajendra/IR30	3	3	3.0
IET10745	C1924/RP9-4	0	0	0
IET10750	Asha/Kranthi	3	2	2.5
IET10726	Phalgune/Ptb 21	3	1	2.0
IET10314	IR62/Parmel	3	3	3.0
IET10847	PR106/OBS528	3	1	2.0
IET11451	Vikram/Mashin	3	2	2.5
IET11160	Ratna/ARC10659	3	3	3.0
IET11464	Ratna/ARC5984	3	2	2.5
IET11465	Ratna/ARC5984	3	1	2.5
	TN1 (susceptible check)	9	9	9

[a] *Standard evaluation system for rice* 0-9 scale: 0 = no damage, 9 = more than 25% infected tillers.

Resistance of rice to green leafhopper (GLH) *Nephotettix virescens* in free-choice and no-choice tests

A. N. M. Rezaul Karim and R. C. Saxena, Entomology Department, IRRI

To identify resistance to planthoppers and leafhoppers, rice germplasm is commonly screened under a free-choice bulk seedling test that easily separates highly resistant and susceptible germplasm. However, the test is not completely reliable in differentiating genetic resistance from “pseudoresistance” resulting from escape or uneven distribution of insects in the seedling trays.

We compared free-choice and no-choice tests using the reactions of 28 rice varieties with known or unknown genes for GLH resistance. TN1 was the susceptible check.

Seeds were sown in 70- × 50- × 10-cm wooden trays in 12-cm-long rows with 6 cm spacing between rows. Each tray had three strips of rows. Seedlings were thinned at 7 d to 15/row and infested with 3d-instar nymphs. Each tray represented a replication.

The free-choice test involved two approaches. In one, seedlings in each tray were infested by tapping GLH nymph-infested TN1 plants so that each seedling tray received about 5 nymphs/seedling. Infested seedlings were kept uncovered. In the second approach, each seedling tray was covered with a 70- × 50- × 70-cm nylon mesh cage. A precise number of 3d instars (5 nymphs/seedling) were introduced using a glass-blowing tube.

In test one, nymphs could move to different varieties in the tray and could move out of the tray. In test two, nymphs were forced to choose among the varieties within the enclosed tray.

Nymphs were counted at 1 and 3 d after infestation (DAI) and damage was recorded at 10 d on a row basis. TN1 was completely killed after DAI.

In the no-choice test, 10 pregerminated seeds/row were sown for each variety. At 7 d, each row was covered with a 13- × 4- × 27-cm rectangular mylar cage with nylon mesh windows on the sides and top. Rows were infested with 5 3d-instar nymphs/seedling. Damage was recorded at 10 DAI.

In both the open and covered free-choice tests, nymphs settled in uneven numbers (see table). Significantly more nymphs were counted on susceptible varieties. Jingasail, Ptb 8, and IR42 showed moderate resistance.

In the covered test, however, Jhingasail, Ptb 8, and IR42 that had numbers of nymphs comparable with that on susceptible TN1 and showed susceptible reactions. More nymphs were recorded on varieties in the covered test and damage ratings differed significantly for varieties Jhingasail, Godalki, IR8, Ptb 8, ARC7012, TAPL 796, IR36, and Moddai Karuppan.

Damage in the open tests was lower because fewer nymphs settled on those varieties. Damage increased when the varieties were infested with nymphs at a density that killed TN1. Damage ratings between covered free-choice and no-choice tests were comparable, except for IR22 which was susceptible in covered test and highly susceptible in no-choice test.

Our results show that the no-choice test is useful for identifying true resistance. However, the method is laborious and unsuitable for mass evaluation. One procedure would be to screen for most of the susceptible germplasm using the open free-choice test, then verify the resistance of selected entries in the no-choice test. The no-choice test also is useful in studies of inheritance, where the ratios of resistant to susceptible plants or lines are critical for analyzing the mode of inheritance. □

GLH nymphs settling on seedlings of susceptible and resistant rice varieties grown in a free-choice test with open and covered seedboxes, and damage ratings in free-choice tests and no-choice tests where seedling rows were separated by mylar film cages.[a] IRRI, 1988.

Variety	Resistance gene	Nymphs setttled (no./15 seedlings)*				Damage ratings at 10 DAI**		
		Free choice				Free choice		No choice
		Open		Covered		Open	Covered	
		1 DAI	3 DAI	1 DAI	3DAI			
Pankhari 203	3 *Glh* 1	10 f-h	6 hi	28 fg	13 k-m	1.7 a	2.3 a	1.7 a
Jhingasail	*Glh* 1	20 c-e	24 b	87 ac	66 ad	5.0 b	8.3 a	8.3 a
ASD 7	*Glh* 2	17 c-f	12 d-g	13 j-l	15 j-1	3.0 a	3.0 a	3.0 a
Palasithari 601	*Glh* 2	10 gh	13 c-f	33 f	21 ij	3.0 a	3.0 a	3.0 a
Godalki	*Glh* 2	20 c-e	28 b	55 de	46 c-f	6.3 b	9.0 a	9.0 a
H5	*Glh* 3	24c	19 b-d	89 ab	68 a-c	6.3 a	8.3 a	8.3 a
IR8	*Glh* 3	22 cd	26 b	56 de	47 c-f	5.7 b	9.0 a	9.0 a
DNJ 97	*Glh* 3	42 b	45 a	77 b-d	79 ab	7.7 a	9.0 a	8.3 a
Ptb 8	*glh* 4	25 c	25 b	76 b-d	72 ab	5.0 b	7.7 a	7.7 a
IR42	*glh* 4	20 c-e	28 b	49 e	68 a-c	5.7 a	7.7 a	7.7 a
ARC7012	*glh* 4	24 c	18 b-e	61 b-e	51 b-e	5.0 b	8.3 a	8.3 a
ASD8	*Glh* 5	17 c-g	18 b-e	91	13 k-m	3.0 a	3.0 a	3.0 a
Bhawalia	*Glh* 5	19 c-e	13 c-f	26 fg	22 hi	5.0 a	5.0 a	5.7 a
TAPL 796	*Glh* 6	21 c-e	12 e-g	32 fg	33 f-h	4.3 b	5.7 a	6.3 a
IR36	*Glh* 6	23 cd	15 c-f	56 de	44 d-f	3.0 b	6.3 a	6.3 a
Ptb 18	*Glh* 1+6	6 i	5 i	14 j-1	6 p	1.7 a	2.3 a	3.0 a
Moddai Karuppan	*Glh* 7	14 d-h	20 bc	59 c-e	38 e-g	4.3 b	5.7 a	5.0 a
Bazal	*Glh* 2+5	16 c-g	12 e-g	51 de	36 e-g	5.0 a	4.3 a	5.0 a
Lasane	*Glh* 2+5	14 d-h	11 fg	29 fg	27 g-i	3.0 a	3.7 a	3.0 a
Laki 659	*Glh* 3+5	9 h	11 fg	11 kl	8 n-p	3.0 a	3.0 a	2.3 a
IR22	No gene	56 ab	51 a	67 b-e	64 b-d	8.3 ab	7.0 b	9.0 a
IR62	?	16 c-g	15 c-f	16 i-k	14 kl	3.7 a	3.0 a	3.0 a
IR64	?	17 c-f	10 fg	14 jk	13 k-m	3.0 a	3.0 a	3.0 a
IR66	?	13 e-h	11 fg	11 kl	9 m-o	3.0 a	3.0 a	3.0 a
IR68	?	15 c-g	13 c-f	17 h-j	11 l-n	3.0 a	3.0 a	3.0 a
IR70	?	14 d-h	13 c-f	23 f-h	19 i-k	3.0 a	3.0 a	3.0 a
IR72	?	8 h	8 gh	101	7 op	3.0 a	3.0 a	3.0 a
IR74	?	20 c-e	18 b-e	21 g-i	18 i-k	3.0 a	3.7 a	3.0 a
TN1	No gene	71 a	60 a	126 a	101 a	9.0 a	9.0 a	9.0 a

[a]Values having a common letter in a column (*) or row (**) are not significantly different at the 5% level by DMRT.

Multiple resistance of rice varieties to major insect pests at Pondicherry, India

B. Rajendran and D. Adiroubane, Krishi Vigyan Kendra, Pondicherry 605009, India

Resistant rice varieties form the core of integrated management of insect pests. We screened 87 promising advanced breeding lines against insect pests during the 1986 wet season and 71 lines in 1987. Lines were planted in two rows of 20 hills each with one skip row

Multiple resistance of rice varieties to BPH and LF. Pondicherry, India, 1986 and 1987 wet seasons.

Variety	1986		1987		Pests (no.) to which variety was resistant	Seasons (no.) during which variety showed resistance	Multiple resistance index
	BPH (no./hill)	LF (%)	BPH (no./hill)	LF (%)	(a)	(b)	(a x b)
KD14-1-39	8	9.5	9	4.6	2	2	4
RP2068-18-3-5	7	14.1	2	2.5	2	2	4
CR333-5-2-3	–	–	10	7.2	2	1	2
MO 5	–	–	5	10.6	2	1	2
RP1579-58	9	14.8	6	9.5	2	2	4
RP1579-1633	9	10.4	7	10.0	2	2	4
RP2199-34-37-55-3			10	10.2	2	1	2
TNAULFR831311	4	0.5	3	7.5	2	2	4
TN1 (check)	71	15.5	40	18.5	0	2	0
IR50 (check)	48	6.2	58	9.1	1	2	2
PY3	6	16.0	3	18.4	1	2	2

between varieties, with two replications. A single row of check variety TN1 was included after every 10 test lines.

Planting of 3 1/2-wk-old seedlings was timed for the vegetative and flowering phases to coincide with major insect pest incidences. Fertilizer was applied according to local recommendations, except more N was topdressed to attract higher brown planthopper (BPH) *Nilaparvata lugens* and leaffolder (LF) *Cnaphalocrocis medinalis* infestations. Damage was assessed during peak incidence of pests.

LF damage was assessed by counting total leaves and damaged leaves on 10 hills/variety; and BPH population/hill was counted.

KD14-1-39, RP2068-18-3-5 (SwarnadhanVelluthacheera), RP1579-58 and RP1579-1633 (Phalguna/ARC6650), and TNAULFR831311 (Co 41/Vaizaipoosamba) showed multiple resistance to BPH and LF in both the wet seasons (see table). □

Resistance of brown planthopper (BPH)-resistant rice cultivars to yellow stem borer (YSB) and gall midge (GM)

R Devika, N. Rema Bai, A. Regina, and C. A. Joseph, Kerala Agricultural University, Rice Research Station, Moncompu, India

We evaluated four rice varieties and eight prerelease cultures with resistance to BPH against GM *Orseolia oryae* and YSB *Scirpophaga incertulas* during 1987 and 1988 wet seasons (Jun-Ju1 to Oct-Nov), when there was severe insect pressure in the field. IR50 and TKM6 were the susceptible and resistant checks for YSB, Jaya and Mahaveera the susceptible and resistant checks for GM.

Ten plants from nonreplicated plots of each cultivar were selected randomly. Deadhearts (DH) were counted at maximum tillering and whiteheads (WH) at maturity. Silvershoots were counted 30 d after transplanting and related to tillers/plant for percentage incidence. DH were related to total tillers/plant and WH to productive tillers/plant.

MO 5 (Asha) and KAU129 were found to be resistant to YSB; others showed moderate resistance (see table). Seven cultivars showed moderate resistance to GM. □

Reaction of rice cultivars to YSB and GM incidence in Kerala, India. [a]

IET no.	Variety	Parentage	YSB Deadhearts (%)	YSB Whiteheads (%)	GM silvershoots (%)
	MO 4 (Bhadra)	IR8/Ptb20	27.4	12.1	15
	MO 5 (Asha)	IR11/Kochuvithu	15.6	8.3	4
8132	MO 6 (Pavizham)	IR8/Karivennel	22.2	18.3	3.5
8133	MO 7 (Karthika)	Triveni/IR1539	21.8	12.1	9.3
9287	KAU93	Jaya/Ptb 33	28.6	16.7	4.5
9266	KAU126	Jaya/Ptb 33	36.8	15.4	4.7
9288	KAU129	Jaya/Ptb 33	19.9	9.6	3.8
9267	KAU168	ARC6650/Jaya	26.7	15.4	4.2
9268	KAU170	ARC6650/Jaya	21.8	11.3	3.9
9381	KAU200	IR1561/Ptb 33	22.5	14.2	10.2
9384	KAU204	IR1561/Ptb 33	27.4	12.5	11.6
9380	KAU153-1	IR1561/Ptb 33	25.6	15.4	11.3
	IR50		100	100	18.0
	TKM6		21.4	18.8	9.2
	Mahaveera		25.2	15	0.4
	Jaya		49.2	30.5	52

[a] Pooled mean data for 1987 and 1988 wet seasons.

Stress tolerance – excess water

Plant elongation potential of some advanced deepwater rice lines

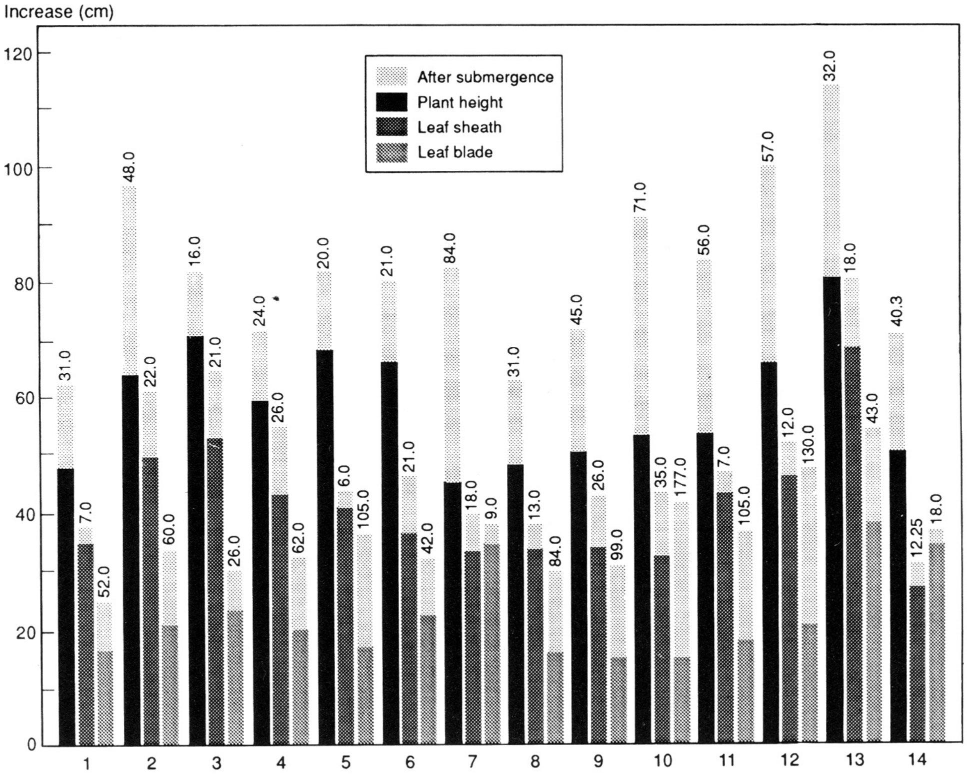
O. P. Verma, J. L. Dwivedi, and R V. Singh, Crop Research Station, Ghagharaghat, Bahraich 271901, India

When excess water stays in the field for more than 1 mo, rice plant survival depends on a variety's ability to elongate above the water level. Total elongation during submergence involves three components: leaf blade, leaf sheath, and internode.

We evaluated 14 entries, including checks Jalmagna and IR36, for elongation ability. Five seeds of each entry were soaked in 50-ml beakers for 24 h, then incubated at room temperature for 24 h. Uniformly sprouted seeds were sown in pots and plants raised for 40 d. Seedlings were submerged 1 m deep for 6 d.

The main culm of each plant was used to measure plant height and leaf sheath, leaf blade, and internode elongation before and after submergence. Increases in plant height, leaf blade, and leaf sheath are given in the figure.

Plant height in IR48310-5-3, IR54300-50, IR48279-71-3, and IR33284-4-502-1-3-2-2 increased more than 50 mm/d (see table). Leaf blades in IR54300-50 and IR48310-5-3 increased 44 mm/d. Maximum leaf sheath elongation (20 mm/d) was observed in Jalmagna and IR33284-4-



Elongation potential of different plant parts in some advanced deepwater rice lines. Ghagharaghat, Bahraich, India. Values over the columns are increase in percentage.

Increase in plant height, leaf sheath, and leaf blade in some advanced IRRI deepwater lines and checks.

Variety or line	Elongation (mm/d)			Survival score [a]
	Plant height	Leaf blade	Leaf sheath	
IR31142-14-1-1-3-1-1-2	24	14	4	9
IR33284-4-502-1-3-2-2	52	21	20	5
IR33284-4-503-1-1-2-3-3	20	10	18	7
IR39509-46-3-2-2	23	21	19	9
IR39657-B-B-B-1	23	32	4	9
IR48279-42-2	23	16	16	9
IR48279-71-3	63	5	10	9
IR48279-73-2	25	22	7	9
IR48279-75-2	37	25	15	7
IR48310-5-3	63	44	10	3
IR5135-3-4	50	32	5	7
IR54300-50	62	44	19	5
Jalmagna	43	27	20	5
IR36	34	3	7	9

[a] *Standard evaluation system for rice.*

502-1-3-2-2. Internode elongation was not pronounced except in Jalmagna, IR33284-4-502-1-3-2-2, and IR33284-503-1-1-2-3-3.

IR48310-5-3 and IR54300-50 had the highest plant elongation potential, with survival scores of 3 and 5, respectively. □

Surveys of disease or insect incidence/severity in one environment are useful only if the information is related to other variables (e.g., climatic factors, crop intensification, cultivars, management practices, etc.). By itself, information on incidence in one environment does not increase scientific understanding.

Stress tolerance – adverse temperature

Effect of low temperature on winter rice in Andhra Pradesh

N. Kulkarni and H. S. Nagaraj Rao, Agricultural Research Institute, Andhra Pradesh (AP) Agricultural University, Hyderabad 500030, India

Sudden rice leaf yellowing and turning to orange were noticed in popular cultivars Tella Hamsa, Satya, Rasi, IR36, and WGL 48684 the last week of Feb 1989 in Telangana region, AP. Extensive surveys established that this had occurred within 2 d.

We examined the temperature data. On 19 and 20 Feb, the maximum temperature at Hyderabad was 34.4 °C. On 19 Feb, the minimum temperature was 16 °C. But on 20 Feb, minimum temperature was 7 °C. The sudden drop in temperature lasted 2 d. The rice cultivars were in different growth phases and were affected differently.

- IR36 had severe cold injury.
- Tella Hamsa and Rasi were in the vegetative phase, and had little cold injury.
- Tella Hamsa, in panicle initiation and boot leaf stages, had normal leaves. But 2 wk later, panicles were found to be chaffy. Pollen grains examined under the microscope were sterile.
- Low temperatures of 7-12 °C lasted 10 d. Severity of cold injury was proportionate to the variation in temperature.
- Plants in the shade exhibited the least cold injury symptoms.
- All cultivars affected by cold in the vegetative phase recovered when temperatures rose to more than 16 °C. The recovery of WGL 48684 was fast. Cold injury due to low temperatures observed in thousands of hectares necessitates a program for breeding cold-tolerant cultivars for the Telangana region. □

Integrated germplasm improvement—irrigated

An IR13240-108-4-2-3 line with leaf blast (Bl) and brown planthopper (BPH) biotype 2 resistance in Angiang, Vietnam

Le Hieu Huu, Angiang Rice Research Station, Longxuyen, Angiang; Nguyen Thuran Khiet, Agricultural Section of Chomoi District, Angiang and Vo Van Mieng, Advanced Farmer, Chomoi, Angiang, Vietnam

IR13240-108-4-2-3, a promising line from IRRI introduced in Angiang Province in 1983 and named MTL 58 by Cantho University, had good yields but was susceptible to leaf B1 and BPH biotype 2.

In the 1985 leaf Bl screening nursery at My Hoi Dong Village, Chomoi District, Angiang, three plants showed high resistance to leaf B1. We transplanted them, collected seeds, and multiplied at high speed. MTL 58 Tuyen (tuyen means selected) has good plant type, high tolerance for lodging, compact panicles, and long grain.

In farmers' field trials, it yielded 6-8 t/ha in the dry season and 5-6 t/ha in the wet season- 1 t/ha more than other varieties (see table).

It is resistant to lodging, has high response to N fertilizer, and is suitable for direct seeding and intensive farming.

It is susceptible to sheath blight and bacterial wilt, moderately susceptible to yellow stem borer. It has long and slender grains and its cooking quality is acceptable to local consumers.

In the 1987 BPH nursery at Cantho University, MTL 58 Tuyen was resistant to BPH biotype 2.

MTL 58 Tuyen was released to farmers at the end of 1987. It has become the main variety in Angiang, planted on 80% of the irrigated and high yield area (200,000-240,000 ha/yr). □

MTL 58 Tuyen performance in dry season and wet season yield trials, Binh Duc, Angiang, Vietnam, 1987.

Characteristic	Dry season		Wet season	
	MTL 58 Tuyen	Mn 6A (check)	MTL 58 Tuyen	Mn 6A (check)
Duration (d)	113	118	114	114
Height (cm)	75	74	80	79
Lodging score	3	1	1	1
Stem borer deadhearts (%)	25	43	-	-
Panicles/m^2	383	515	356	499
Filled grains/panicle (no.)	66	52	43	20
1000-grain weight (g)	25.6	23.8	23.7	22.0
Yield (t/ha)	6.2	6.1	5.6	4.3
CV		5.9%	24.9%	

Mandya Vijaya, a promising rice variety for summer in Bangalore Rural District

Sharanappa R. Ananthanarayana, H. Eswarappa and V. N. Patel, National Demonstration Project, Bangalore Rural District, BSH College, G.K.V.K., Bangalore 65, Karnataka, India

Mandya Vijaya, from a cross of Sona and Mahsurie, has been released for general cultivation in tank and canal irrigated areas of Karnataka State. It is fine-grained, medium tall, with long duration.

We laid out 0.4-ha field demonstrations at three sites in Devanahally Taluk, Bangabre Rural District. Soils are Udic Paleustalfs, pH around 6.3, low in soluble salts, medium to low in organic C, low to medium in available P, medium to high in available K, and adequate in DTPA-extracted Zn, Mn, Cu, Fe, and B.

Fertilizers to supply recommended NPK based on soil test were applied. Seed was sown in the nursery second week of Jan 1989 and 21-d-old seedlings were transplanted the second week of Feb. The crop took 160-164 d to maturity and yielded 6.3-7.0 t/ha. Other characters are given in the table.

We also studied the economics of cultivating Mandya Vijaya. Cost was $300-$342/ha and net profit $986-$1,043/ha. The cost:benefit ratio was 1:4.1.

The major constraint to farmer adoption of this variety is its long duration: it does not suit farmers who have limited water resources. It gives higher yields in the summer season but delays normal sowing of the wet season rice crop or ragi *Eleusine coracana* Gaertn in a rice - ragi sequence. □

Grain yield, straw yield, duration, growth, yield characters, and economics of cultivation of Mandya Vijaya rice at 3 sites in Bangalore, Karnataka, India.

Location	Grain yield (t/ha)	Straw yield (t/ha)	Duration (d)	Plant ht (cm)	Tillers/hill (no.)	Grains/panicle (no.)	Cost of cultivation ($)	Gross returns[a] ($)	Net returns ($)	Cost: benefit ratio
Hunasamaranahally	7.0	13.5	160	88	10	145	319	1362	1043.0	1:4.2
Sadahally	7.0	13.8	164	85	11	130	342	1366	1024.0	1:3.9
Bhuvanahally	6.3	11.9	161	84	9	150	300	1286	986.0	1:4.3

[a] Price/t rice=$172.41 Price/t straw = $11.49

Integrated germplasm improvement – upland

Two improved upland rice varieties for Bangladesh

M. K. Bashar, R. K. Das, M. A. Islam, M. Nasiruddin, and N. M. Miah, Plant Breeding Division, Bangladesh Rice Research Institute (BRRI), Gazipur 1701, Bangladesh

BRRI recently released improved upland rice varieties BR20 and BR21 for direct seeded aus season in high-rainfall areas of Bangladesh. BR20 (BR201-193-1) was derived from IR272-4-1-2-J*1*/IR5; BR21 (BR1656-22-1) came from C22/IET1444. Both varieties have intermediate plant height, short duration, and high yield potential and are moderately resistant to lodging and drought. Both are moderately resistant to bacterial blight, bacterial leaf streak, rice tungro virus, brown spot, and grain discoloration.

BR20 averages 133 filled grains/panicle, with 1,000-grain weight of 21 g. BR21 has 112 filled grains/panicle with 1,000-grain weight of 23 g.

The new varieties yielded at least two times more than existing local upland varieties (Table 1). Physico-chemical and cooking qualities of BR20 and BR21 are compared with local popular upland variety Hashikalmi in Table 2. □

Table 1. Average grain yield and some agronomic traits of BR20 and BR21 in direct seeded upland conditions in Bangladesh, 1985-88.

Variety	Duration (d)	Plant height (cm)	Average grain yield [a] (t/ha): On station 1985 (10)	On farm 1986 (23)	Demonstration in farmers' field: 1986 (12)	1987 (6)	1988 (70)	Mean	Increase over local check variety (%)
BR20	105-112	110-120	3.8	2.4	3.1	3.2	3.08	3.11	107
BR21	95-105	95-110	3.1	2.5	3.1	3.2	3.06	3.01	101
Local upland variety (check)	90-100	110-115	1.3	1.2	-	1.6	1.85	1.50	–

[a]Numbers in parentheses are number of test sites.

Table 2. Physicochemical and cooking qualities of BR20 and BR21.

Variety	Milling outturn (%)	Grain length (mm)	Grain breadth (mm)	L/B ratio	Protein (%)	Amylose (%)	Gelatinization temp	Imbibition ratio	Elongation ratio	Size and shape	Endosperm	Tenderness
BR20	73	5.1	2.2	2.3	7.8	26	6.0	4.0	1.5	Medium bold	Translucent	Medium hard
BR21	73	5.2	2.0	2.6	8.3	26	4.5	4.0	1.5	Medium bold	Translucent	Medium hard
Hashikalmi (local check)	72	4.8	2.1	2.3	7.0	29	4.0	3.8	1.4	Short bold	White belly	Hard

Integrated germplasm improvement – deepwater

NDGR402, a promising new floating rice

J. L. Dwivedi, R. V. Singh, and O. P. Verma, Crop Research Station, Ghagharaghat, Bahraich 271901, India

NDGR402, a pure line selection from local variety Goanth, can withstand gradual increases in water depth up to 2.0-2.5 m. Its grains are short and bold with red kernels, L/B ratio of 2.1, and 1,000-grain weight of 30.9 g. It takes 215 d from seeding to maturity.

It was selected from 13 entries including local selections and promising lines from cross RP31-49-2/LMN and check variety Jalmagna evaluated for three consecutive seasons 1985-87. Test plots were laid out in a randomized block design with three replications. Seeds were directly sown in Apr in 5- × 2-m plots. Fertilizer was applied 30-30 kg NP/ha as basal and 30 kg N/ha in two equal splits before flooding and at tillering.

NDGR402 (IET10235) gave the highest yield, an average 4.9 t/ha--17% more than check Jalmagna. Plant height ranged from 220 to 311 cm, depending on peak water depth. It showed drought tolerance similar to Jalmagna (and better than Jaladhi 1) at the vegetative stage and good elongation and kneeing ability at later stages.

Its higher yield potential may be ascribed mainly to number of grains/panicle and more productive tillers (Table 1).

NDGR402 looked promising in All India Rice Improvement Trials at Ghagharaghat, Chinsurah, North Lakhimpur, and Pusa during 1987 wet season and in the Uniform Varietal Trial in 1988. It yielded 4.3 t/ha in 1987 and 2.3 t/ha in 1988 wet season at Ghagharaghat and was superior to checks in 1988 at North Lakhimpur

Table 1. Grain yield and agronomic traits of promising deepwater entries. Ghagharaghat, U.P., India, 1985-87.

Variety or line	Parentage	Grain yield (t/ha) 1985	1986	1987	Av of 3 yr: Yield (t/ha)	Days to 50% flowering	Plant ht (cm)	Panicle length (cm)	Grains/ panicle (no.)
NDGR401	Pureline selection	4.5	3.0	4.3	3.9	187	285	23	156
NDGR402	Selection from Goanth	5.0	4.5	5.1	4.9	188	275	24	164
NDGR403	Selection from Kalaungi	4.4	3.4	4.5	4.1	184	267	26	153
NDGR404	Selection from Sainger	4.5	3.7	4.5	4.2	188	280	24	140
FRRS43-3		3.0	0.9	3.3	2.4	181	304	21	160
TCA258		3.7	3.0	4.4	3.7	190	272	24	134
NDGR411	RP31-49-2/LMN920312	3.4	2.4	3.8	3.2	193	273	22	129
NDGR412	RP31-49-2/LMN920312-1	3.1	0.5	4.6	2.7	184	255	27	127
NDGR413	RP31-49-2/LMN920316-1	3.0	2.1	4.1	3.0	188	264	27	149
NDGR414	RP31-49-2/LMN920316-2	3.7	2.8	3.4	3.3	186	255	27	151
NDGR416	RP31-49-2/LMN920351	4.1	3.1	3.7	3.6	189	263	26	136
NDGR419	RP31-49-2/LMN1045-3	2.5	1.6	3.8	2.6	192	256	23	143
Jalmagna	(local check)	4.3	4.2	4.2	4.2	194	323	24	145
LSD (0.05)		0.9	0.4	1.0					
CV (%)		18.3	19.6	30.3					
Max water depth (m)		2.7	1.8	2.4					

Table 2. Performance of NDGR402 at 4 locations in uniform varietal trials. Ghagharaghat, U.P., India, 1985-87.

Variety	Yield (t/ha) Ghagharaghat 1987	Ghagharaghat 1988	Chinsurah, 1987	North Lakhimpur, 1988	Pusa, 1988	Panicles (no./m²)	Drought score
NDGR402 (IET10235)	4.3	2.3	0.4	3.2	1.8	132	5
Jaladhi 1 (national check)	1.2	1.6	0.3	2.6	1.0	89	9
Jalmagna (local check)	2.7	2.4	0.2	2.6	1.2	89	5
LSD (0.05)	0.9	0.5	0.7	0.6	0.4		
CV (%) 20.3	23.5		45.6	10.1	31.4		
Water depth (m)	1.16	2.45	0.95	1.03	1.80		

and Pusa (Table 2). It survived four consecutive flashfloods at North Lakhimpur.

NDGR402 has been recommended for on-farm testing under deepwater conditions in Uttar Pradesh, Bihar, and Assam. □

Seed technology

Application of immunoradiometric assay (IRMA) in rice seed inspection for *Xanthomonas campestris* pv. *oryzicola*

Wang Gongjin, Zhu Xiandai, Chen Yuling, and Wang Faming, Jiangsu Academy of Agricultural Sciences, Nanjing; and Xie Guanlin, Zhejiang Academy of Agricultural Sciences, Hangzhou, China

A rapid IRMA for identifying *X. c.* pv. *oryzicola* in rice seeds was established by nonspecific combination of ^{125}I-protein A with serum immunoglobulin (IgG) obtained from domestic rabbits in Hainan Province.

The rabbits were immunized with isolates of *X. c.* pv. *oryzicola* (Ag) by the intravenous injection method and the specific antiserum against the Ag obtained after 2 mo. The specific antibody (Ab) in the antiserum reacted with the Ag of samples (about 0.2-2.0 g for each sample) in the soaking solution (0.1 M, pH 6.0 phosphate buffer solution containing 0.5% bovine serum albumin and 0.05% Tween 20) to produce the Ag-Ab complex.

The complex reacted on the protein A, which had been labeled by ^{125}I, to form a radioactive complex with the labeled protein A. Finally, the radioactive complex was tested on the gamma counter for its radioactivity (counts per minute, cpm). If the cpm ratio of a tested sample and disease-free check was equal to or more than 1.50, the sample was considered positive, or diseased.

The results showed that IRMA was not only more sensitive but more specific for *X. c.* pv. *oryzicola* in rice seed. At a concentration of 500 bacterial cells/ml, the intrabatch and interbatch coefficients of variation were about 11.2 and 14.2%, respectively. The antiserum showed weak cross-reaction only against *X. c.* pv. *oryzae,* 4.7%; *Pseudomonas syringae* pv. *mori,* 4.3%; *X. c.* pv. *malvacearum,* 2.4%; and the other miscellaneous serums of rice, 0.4%. The cpm ratios of the bacteria ranged from 1.08 to 1.37.

We tested 331 seed samples from seven provinces by IRMA and the concentration inoculation method (CI). The CI method involves inoculating rice seedlings by the needle pricking method during tillering. The

Detection of *X.c.* pv. *oryzicola* of rice seeds from diseased areas by IRMA and CI methods. Hainan Province, China, 1989.

Place of origin	Varieties examined (no.)	Varieties (no.) with positive reaction: IRMA	CI
Hainan	5	5	4
Guangxi	3	2	1
Guangdong	4	3	2
Hunan	7	5	3
Jiangxi	19	11	6
Zhejiang	282[a]	249	168
Jiang	11[b]	9	6
Total	331	284	190

[a] The majority were obtained from artificially inoculated plants. [b] All were from artificially inoculated plants.

inoculum is prepared by soaking 10 g rice seed hulls in 30 ml normal saline solution for 2 h, then concentrating the solution to 10% of its original volume by centrifuging at 4,000 g for 20 min.

The percentage of varieties showing positive reaction by IRMA varied with origin (see table). The lowest was 47.4% and the highest 100% (all seeds were from a diseased area). In general, the majority of the seeds from diseased areas were more or less infected. The CI method was less sensitive than IRMA.

Similar results were obtained for disease-free seed samples by both IRMA and CI methods. For diseased seed samples detected by IRMA, however, only 67% showed a positive reaction to the CI test. IRMA is a more effective and reliable seed inspection method. □

Physiochemical treatments to break dormancy in rice

Zhang Xian-guang, Food Crops Institute, Hubei Academy of Agricultural Sciences, Wuhan, China

We studied the effects of three physiochemical treatments on breaking dormancy in rice, using 200 healthy seeds of IR36, IR34, and H4 per treatment. Two weeks after harvest in 1988, seeds were kept at 50 °C dry heat for 5 d, soaked 20 h in 0.1 N HNO_3 solution, or dehulled. Seeds germinated in petri dishes were counted 5 d after.

Germination varied among varieties and treatments (see table). IR34 could be considered a strongly dormant variety–only 37% of its untreated seeds germinated. With 50 °C dry heat treatment, 75% germinated; with soaking in HNO_3, 52% germinated. Germination in weakly dormant IR36 and H4 also was stimulated by the two methods. The dry heat method was significantly better than the no treatment.

Hull removal did not produce any better results than no treatment, perhaps because the dormancy factor (or germination inhibitor) may be in the seed coat rather than in the hull, or it could be due to mechanical injury to seeds during dehulling. □

Rice seed germination with different dormancy-breaking treatments. China, 1988.

Variety	Germination (%)				
	No treatment	50 °C dry heat	HNO_3 soaking	Dehulled	Mean[a]
IR36	81	92	87	46	76.5 a
IR34	37	75	52	26	47.5 b
H4	84	97	88	86	88.0 a
Mean[a]	67.3 bc	88.0 a	75.7 ab	52.7 c	70.7

[a]Means followed by the same letter are not significantly different at the 5% level by *t*-test

CROP AND RESOURCE MANAGEMENT

Fertilizer management – inorganic sources

Response of rice to pyrite topdressing at different fertilizer levels

H. P. Singh and M. P. Yadav, Crop Research Station, Masodha District, Faizabad, Uttar Pradesh (UP), India

Pyrite contains 22-24% total sulfur, 20-22% Fe, 0.5-0.8% MgO, 0.1% CaO, 0.6-0.8% alumina, 35-40% silica, 2-3% C, 0.02% Zn, 0.05% Cu, and 0.01% Mn. We noticed farmers using pyrite on their rice crops. This led us to test six pyrite rates and one Zn application at three fertilizer levels. The treatments in a split-plot design with three replications are given in the table.

Soil was sandy loam with pH 7.5, EC (1:2) 0.09 dS/m, 0.42% organic C, 17.5 kg available P/ha, 135 kg available K/ha (ammonium acetate extract), CEC 8.8 meq/100 g soil, 180 kg available N/ha (alkaline permanganate method), and 0.86 ppm available Zn (DTPA extractable).

Grain yield of rice with different fertilizer levels and pyrite topdressing at Masodha, Faisabad, India, 1985.

Fertilizer combination (NPK kg/ha)	Grain yield (t/ha)							
	No pyrite	0.2 t/ha	0.4 t/ha	0.6 t/ha	0.8 t/ha	1.0 t/ha	5% $ZnSO_4$ spray	Mean
Low (60:13:25)	4.0	4.2	4.3	4.5	4.3	4.3	4.3	4.3
Medium (80:18:33)	4.1	4.4	4.6	4.6	4.7	4.8	4.6	4.6
High (120:26:50)	4.4	4.8	5.0	5.0	5.1	5.3	5.1	5.0
Mean	4.2	4.4	4.6	4.7	4.7	4.8	4.7	
LSD (P =0.05)		Fertility 0.40		Pyrites 0.20				
CV (%)		4.66						

All the P and K and half the N were applied as basal before transplanting. Rice cultivar Sarjoo 52 was transplanted 18 Jul 1985. Pyrite was topdressed but not incorporated 20 d after transplanting. The remaining N was topdressed at tillering and panicle initiation.

Each fertilizer level increased grain yield significantly. Increasing pyrite levels showed a linear yield response at all fertilizer levels except the low level. There was no interaction between pyrite rate and fertilizer rate.

Several aspects of pyrite application-application time, long-term application on normal soils, and causes of yield increases-are being studied. □

Effect of source and level of phosphorus on rice - grass pea *(Lathyrus sativus)*

N. R. Das and A. Sarkar, Agronomy Department, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Kalyani 741235, West Bengal, India

We evaluated the effect of P level on yield of rainfed lowland rice - grass pea cropping sequence in 1988-89. P sources were single superphosphate, ammonium polyphosphate liquid 16:32% NP, and IFFCO-complex. The 5.0- × 2.5-m plots were laid out in a split-plot design with four replications.

Soil was clayey loam with 0.60% organic C, 0.06% total N, 17 kg available P and 187 kg available K/ha, and pH 6.8. IR36 was transplanted 17 Jul, 22 d after seeding, at 25- × 25-cm spacing, with four seedlings/hill. Fertilizer was broadcast at transplanting. N and K in P sources were calculated and urea and potassium chloride used to total 50-25 NK/ha.

One day before rice harvest on 30 Oct, grass pea cultivar Nirmal seeds (25 kg/ha) were broadcast uniformly over the rice crop. Immediately after rice harvest, half the plot was covered with 1.0 t/ha rice straw mulch. Grass pea was harvested 27 Feb 1989.

Rice grain yield did not differ with P source (see table). Grass pea grain yield was best with residual P from single superphosphate.

Rice straw mulch on grass pea after rainfed lowland rice was superior to no-mulch for both grass pea grain and straw yields. □

Effect of source and level of P on grain and straw yields of rice and grass pea. Kalyani, West Bengal, India, 1988-89.

Treatment	Yield (t/ha)			
	Rice		Grass pea	
	Grain	Straw	Grain	Straw
Source of P				
Single superphosphate	4.5	4.6	2.2	2.5
Ammonium polyphosphate	3.8	3.8	2.0	2.0
IFFCO-complex	4.1	4.3	1.8	2.0
LSD (0.05)	ns	0.7	0.1	0.2
Level of P (kg/ha)				
4.4	3.5	3.7	1.8	1.9
8.8	4.3	4.8	2.1	2.2
13.2	4.6	4.1	2.1	2.3
LSD (0.05)	0.7	0.7	0.1	0.2
Rice straw mulch (t/ha)				
0.0	-	-	1.4	1.3
1.0	-	-	2.6	3.0
LSD (0.05)	-	-	0.1	0.1

Fertilizer management—organic sources

Nitrogen equivalence of green manure for wetland rice on coarse-textured soils

Y. Singh, B. Singh, O. P. Meelu, and M. S. Maskina, Soils Department, Punjab Agricultural University, Ludhiana 141004, India

We studied the relative effect of green manure N and inorganic N on rice grain yield in field experiments in 1986-88. Soil was loamy sand to sandy loam with pH 7.4 to 8.2, 0.30-0.40% organic C, and 0.06-0.08% total N.

Green manure crops *Sesbania aculeata,* sunn hemp *Crotalaria juncea,* and cowpea *Vigna unguiculata* were sown the first week of May and incorporated at 50 to 60 d old 1 d before transplanting rice. Total biomass and N in the green manure crops were determined at incorporation.

In plots without green manure, four levels of urea (0 to 180 kg N/ha) were applied in equal splits at 7, 21, and 42 d after transplanting. Basal 13-25 kg PK/ha was applied at transplanting.

Rice grain yield with urea alone increased significantly up to 180 kg N/ha. The grain yield data were fitted to quadratic response functions and the fertilizer N equivalence of green manure N computed (the amount of inorganic N required to produce yields similar to those obtained with green manure alone).

Green manure added 41-150 kg N/ha depending on the source. In general, green manure N was equal to or better than urea N in increasing grain yield of rice (see table). The N equivalence was 35% higher than urea N and for cowpea, 20% for sunn hemp, and 15% for sesbania. □

Inorganic N equivalence of green manure in wetland rice. Ludhiana, India, 1986-88.

Green manure	Experiments (no.)	Green manure N added (kg/ha)	Rice yield (t/ha)		Inorganic N equivalence (kg/ha)
			No green manure	Green manure	
Sesbania	5	45- 75	3.3	5.0	72
	11	97-150	3.6	6.3	136
Sunn hemp	3	41 - 70	3.1	4.5	72
	2	101-140	3.5	7.1	148
Cowpea	4	55 - 80	3.1	5.5	98

Influence of azolla, sesbania, and urea supergranule (USG) on rice yield and nitrogen uptake

M. Thanagaraju and S. Kannaiyan, Agricultural Microbiology Department, Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India

We evaluated the effect of N-fixing azolla and sesbania on yield and N uptake of IR50 rice in field experiments 1987 dry season and 1987-88 wet season (Co 43).

Azolla microphylla, A. filiculoides, Sesbania rostrata, and *S. aculeata* were incorporated at 2 kg/m^2 with and without N. The N content of the biofertilizers was estimated on dry weight basis as 2.45% in *A. microphylla,* 2.68% in *A. filiculoides,* 3.92% in *S. rostrata,* and 3.25% in *S. aculeata* during the dry season and 3.08, 2.96, 3.68, and 3.07% during the wet season. N as USG was basal, applied at 100 kg/ha. Prilled urea and unfertilized controls were also maintained.

In both seasons, grain yield was significantly higher with *S. rostrata* + USG, *S. aculeata* + USG, and *A. filiculoides* + USG (see table). In the dry season, *S. rostrata* without USG yielded significantly higher than USG (100 kg/ha) alone. Straw yields followed similar trends.

N uptake in grain and straw in the dry season was significantly higher with *S. rostrata* + USG. Trends in the wet seasons were similar.

In general, incorporation of N-fixing green manure in combination with USG increased the yield and N uptake. □

Influence on rice yield and N uptake of azolla and sesbania incorporation with and without USG application. Tamil Nadu, India, 1987-88.

Treatment	1987 dry season (IR50)				1987-88 wet season (CO 43)			
	Yield (t/ha)		N uptake (kg/ha)		Yield (t/ha)		N uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Untreated	3.7	6.6	28.4	26.3	4.4	7.1	34.8	29.5
Prilled urea	4.6	9.0	41.2	40.5	5.7	8.3	48.5	41.7
USG	5.1	11.0	48.8	62.5	6.0	8.8	55.1	45.9
Azolla microphylla	4.5	7.3	39.4	34.0	5.3	9.5	41.4	44.1
Azolla filiculoides	4.5	8.1	40.7	36.0	5.4	10.1	43.6	47.7
Sesbania rostrata	5.6	10.7	51.4	52.6	5.3	10.2	43.6	50.6
Sesbania aculeata	5.2	10.7	47.6	48.5	5.3	9.6	42.9	45.5
USG + *A. microphylla*	6.0	12.4	60.5	70.3	6.3	11.2	58.0	58.9
USG + *A. filiculoides*	6.3	12.6	61.1	70.5	6.7	12.1	60.7	61.8
USG + *S. rostrata*	6.6	14.3	70.2	86.2	7.1	12.3	67.7	69.5
USG + *S. aculeata*	6.3	13.5	61.4	77.9	6.9	11.9	63.4	65.2
SE	0.1	0.3	2.2	5.2	0.2	0.5	3.0	4.9
LSD (P = 0.05)	0.3	0.6	4.7	10.8	0.4	1.0	6.3	10.1

Effect on rice yield of biofertilizers plus inorganic fertilizer

M. R Patel, N. P. Chauhan, J. G. Patel, and I. D. Patel, Gujarat Agricultural University, Main Rice Research Station, Nawagam, Gujarat, India

We evaluated rice yields with sesbania, barnyard manure (BM), and azolla biofertilizer in combination with inorganic fertilizer during 1988 wet season. The experiment was laid out in a randomized block design with four replications. Soil was sandy clay loam with pH 8.0, 0.056% total N, 13 kg available P/ha, and 332 kg K/ha.

Fresh azolla (12.5 t/ha) was incorporated by treading in no standing water 1-5 d after transplanting GR11. *Sesbania aculeata* was grown in situ, coarsely chopped, and incorporated before transplanting. BM was incorporated before transplanting. P was applied at 50 kg/ha before transplanting.

Urea supergranule (USG) alone, prilled urea (PU) + sesbania, and 100 kg N/ha as ammonium sulfate gave significantly higher yields than PU, PU + azolla, and PU + BM (see table).

USG alone also gave significantly higher N uptake (105 kg/ha) than all treatments. □

Influence of N source on rice grain yield and nutrient uptake. Nawagam, India, 1988 wet season.

Nitrogen treatment	Grain yield (t/ha)	Straw yield (t/ha)	Nutrient uptake (kg/ha)		
			N	P	K
No fertilizer N	3.4	3.5	50.60	7.12	64.31
100 kg N/ha					
USG point placed at 10-12 cm soil depth	5.8	7.0	105.05	13.04	136.51
PU 2/3 basal + 1/3 5-7 d before panicle initiation (DBPI)	5.0	4.8	68.32	9.83	85.79
Azolla 3/6 N + PU (1/6 basal + 2/6 5-7 DBPI)	4.9	4.2	70.94	9.43	92.24
Sesbania 3/6 N + PU (1/6 basal + 2/6 5-7 DBPI)	5.3	5.0	83.63	10.22	123.08
BM 3/6 N + PU (1/6 basal + 2/6 5-7 DBPI)	4.5	4.1	67.65	7.77	83.86
PU 1/4 basal + 1/2 at max tillering + 1/4 at booting	4.8	5.9	80.27	9.52	105.68
Ammonium sulfate 1/4 basal + 1/2 at max tillering + 1/4 at booting	5.7	6.0	92.24	10.94	131.48
LSD (0.05)	0.6	0.8	7.86	1.27	14.47

Effects of silica and phosphorus application on yield and phosphorus nutrition of rice

S. K. Sahu, Soils and Agricultural Chemistry Department, College of Agriculture, OUAT, Bhubaneswar 751003, India

We studied the effect of Si, with and without applied P, on yield and P nutrition of rice during 1984-86. Six treatments were laid out in a randomized block design with three replications.

Soil was sandy loam (Haplaquept) with pH 5.4, CEC 6.6 meq/100 g, 0.450% organic C, 3.5 ppm Olsen P, and 9.2 ppm available Si (NH_4OAC extractable at pH 4.0). Rice husk containing 7.0% Si, 0.04% P, 0.33% N, and 1.05% K was applied 25 d before transplanting at 428 kg/ha, to supply 30 kg Si/ha. P at 8.7 and 13 kg/ha and 15 kg N, 24.9 kg K/ha were applied at transplanting of 25-d-old rice variety Jajati. The crop was topdressed with 30 and 15 kg N/ha at 18 and 60 d after transplanting.

Maximum yield and P content of rice were obtained with 30 kg Si + 13 kg P/ha (see table). □

Effect of Si from rice husk and P on yield and P content of rice. [a]

Treatment	Yield (t/ha)			P content (%)		
	1984 WS	1984-85 DS	1985-86 DS	1984 WS	1984-85 DS	1985-86 DS
Control	2.5	3.0	2.9	0.23	0.23	0.21
Rice husk (30 kg Si/ha)	2.6	3.4	3.8	0.28	0.30	0.30
8.7 kg P/ha	2.9	3.4	3.9	0.28	0.30	0.31
Rice husk + 8.7 kg P/ha	2.9	3.8	4.3	0.30	0.31	0.31
13 kg P/ha	3.0	3.9	4.0	0.30	0.31	0.31
Rice husk + 13 kg P/ha	3.2	4.4	4.4	0.31	0.31	0.31
LSD (0.05)	0.2	0.3	0.3	0.01	0.00	0.01

[a] DS = dry season, WS = wet season.

Effect of blue-green algae (BGA) on rice yield in Kashmir

Gh. Hassan Dar, Regional Research Station, S.K. University of Agricultural Sciences and Technology (SKUAST), R.S. Pura, Jammu (J & K) 180012; M. Y. Zargar, N. M. Mir, and M. A. Khan, Plant Pathology Division, SKUAST, Shalimar-Srinagar (Kashmir) 191121, India

We tested the effect on rice yield of BGA inoculation with lime (500 kg/ha) and Mo (sodium molybdate, 0.5 kg/ha) at three levels of urea (30, 45, and 60 kg N/ha).

The experiment was conducted May-Oct 1985 and 1986 in the Kashmir Valley (average rainfall 285 mm, humidity 43-90%, temperature 8-36 °C). Soil was clay loam with pH 5.6, 1.82% organic C, 0.031 ppm available Mo, and CEC 18.2 meq/100 g. The experiment was laid out in a randomized block design with three replications.

Rice variety K39 was transplanted the 3d wk of Jun, 33 d after sowing. Lime and Mo were applied during field preparation. N as urea was applied 10% at transplanting, 25% at panicle initiation, and 25% at flowering. P as single superphosphate at 45 kg P/ha and K as muriate of potash at 20 kg K/ha were applied as basal.

BGA inoculum, a mixture of *Nostoc, Anabaena, Aulosira,* and *Tolypothrix,* was prepared by open air soil culture method. The soil was inoculated with 10 kg BGA culture/ha 1 wk after transplanting.

At low N levels, BGA inoculation alone significantly increased yield (see table). Adding lime and Mo with BGA significantly increased yields at 30 and 45 kg N.

BGA proliferated in the plots where lime and Mo were applied. That contributed to a yield increase equivalent to 15 kg N/ha under the temperate conditions of Kashmir. □

Effect of BGA inoculation on rice yield in Kashmir, 1985-86. [a]

Treatment	Grain yield (t/ha)						Straw yield (t/ha)					
	1985			1986			1985			1986		
	30 N	45 N	60 N	30 N	45 N	60 N	30 N	45 N	60 N	30 N	45 N	60 N
Control	6.2	6.8	7.4	4.6	5.5	6.0	7.4	7.9	8.4	5.3	5.6	6.2
Lime + Mo	6.4	7.0	7.5	4.8	5.6	6.2	7.5	8.1	8.5	5.2	5.8	6.4
BGA	6.9	7.5	7.8	5.4	6.1	6.5	8.0	8.5	8.6	5.7	6.2	6.8
Lime + Mo + BGA	7.3	7.8	7.9	5.8	6.3	6.5	8.4	8.8	8.8	6.0	6.3	6.9
LSD at 0.05												
BGA culture (C)		0.2			0.2			0.2			0.2	
Nitrogen (N)		0.2			0.2			0.2			0.2	
Interaction (C × N)		0.4			0.3			0.3			0.4	

[a] Mean of three replications.

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.

Crop management

Ecological conditions for axillary bud sprouting of ratooning rice

Xiong Hong, Fang Wen, and Yu Jiaqi, Rice and Sorghum Research Institute, Sichuan Academy of Agricultural Sciences, Luzhou, Sichuan, China

We studied the relationship between ratoon tiller number and ecological conditions in southern Sichuan Province, 1987-88, using hybrid rice variety Shanyou 63.

Planting density for the first season was 28 hill/m^2. N was applied basally at 135 kg/ha (N:P:K = 1:0.5:0.5). Urea at 112.5 kg/ha was applied as topdressing 15 d after full heading to encourage axillary bud sprouting. The main crop was harvested at 33 cm height. Ecological conditions during axillary bud sprouting of the ratooning stubble are shown in the table.

Optimum ecological conditions for ratoon tillering were 25-26.0 °C daily average temperature and 84-85% humidity (type VI).

A key factor in obtaining higher yields in ratoon rice is to synchronize the sprouting stage of axillary bud with ecological conditions. □

Ratoon tiller of rice under different ecological conditions in the South of Sichuan, China.

Ecological conditions during axillary bud sprouting stage			Ecological condition type	Ratoon tillers/m^2	Productive panicles/m^2	Grain yield (t/ha)
Daily average temperature (°C)	Humidity (%)	Sunshine (h)				
22.8	92.2	1.1	I	218.4	179.1	0.5
23.1	90.6	1.4	II	257.6	214.6	0.7
23.8	87.8	2.1	III	257.6	242.2	1.3
24.9	86.9	3.2	IV	282.8	271.7	1.6
25.2	82.5	4.8	V	322.0	298.9	2.3
25.6	84.6	4.4	VI	428.4	399.9	3.4
26.2	84.6	5.0	VII	288.4	261.7	1.9
26.8	82.9	6.2	VIII	277.2	252.9	1.6

Plant populations for higher productivity in Basmati-type scented rice

K. S. Rao, B. T. S. Moorthy, and G. B. Manna, Agronomy Division, Central Rice Research Institute, Cuttack, India

IET8579 (CRM8-5078-388-212), a 125-d mutant of Basmati 370, has the qualitative grain characters of Basmati 370, and a 46% higher yield potential. We worked out the population required to improve its productivity under transplanted conditions.

Five plant population levels achieved through different interrow and intrarow spacings were tested during 1988 wet season in a randomized block design with four replications.

Crop yield did not vary significantly among 20- × 10-cm and 15- × 15-cm spacing (see table). At closer spacings (10 × 10 cm and 15 × 10 cm), although number of panicles per unit area was higher, grain yield decreased because of fewer filled spikelets per panicle and lower panicle weight. At wider spacing (20 × 15 cm), panicle production was lower despite higher numbers of filled spikelets and higher panicle weight. □

Effect of spacing on yield components and field of scented rice IET8579.

Spacing (cm)	Hills/m^2	Grain yield (t/ha)	Panicles/m^2	Panicle weight (g)	Spikelets/ panicle	Unfilled spikelets/ panicle	1000-grain wt (g)
10 × 10	100	2.3	288	0.85	34.5	24.5	18.1
15 × 10	66	2.6	286	0.94	46.0	23.0	19.0
20 × 10	50	2.9	283	1.06	48.8	21.0	19.3
15 × 15	44	2.8	282	1.05	46.8	21.5	19.3
20 × 15	33	2.4	270	1.08	48.0	21.4	19.3
LSD (0.05)		0.2	ns	0.12	8.0	ns	ns

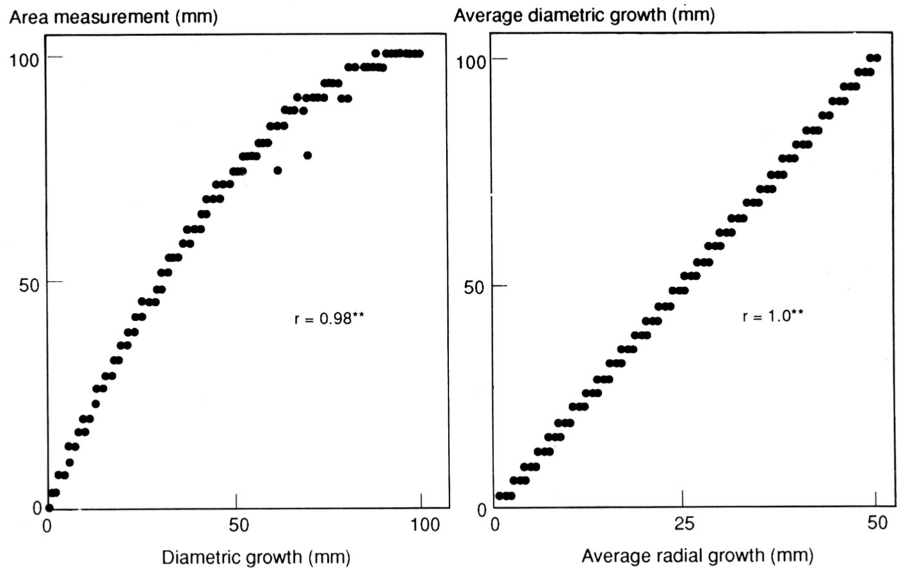
Integrated pest management – diseases

Improved method for bioassay of pesticides

S. N. Tewari and H. S. Shukla, Laboratory of Natural Plant Product, Plant Pathology Department, Central Rice Research Institute, Cuttack 753006, India

The microbial assay of pesticides uses solid media to enable measurement of average diametric growth. But this method only accounts for average diametric growth; it does not account for circular growth of the pathogen. Total radial growth is not measured.

We studied the growth of *Rhizoctonia solani* on standard potato dextrose agar medium mixed with 100 pp *Aegle marmelos* essential oil as an inhibitor. The experiment was re-



Comparison of average diametric growth and radial growth of *R. solani* in *A. marmelos* essential oil.

peated four times with three replications each time.

Treated petri plates were incubated at 28 ± 1°C. The data were computed by the formula 3.14 × r^2 (area measurement technique). The average diametric growth was always less than total radial growth (see figure).

Differences of a given growth ranged between 0.99 and 25%. When inhibition was 50% with the diametric growth measurement method, the same growth was only 25% by the area measurement method. The difference increased from 0 to 50%, then decreased from 51 to 100%—the difference at 51% corresponds to the difference at 49, etc. There is a consistent 0.02% decrease between two adjacent units calculated by the area measurement method.

The method holds good for both sporulating and nonsporulating fungi. When fungal growth was irregular, however, this method was not accurate either. □

Joint infection of rice by *Sclerotium oryzae* Catt., *Sclerotium rolfsii* Sacc., and *Monographella albescens*

N. I. Singh, Botany and Plant Pathology Department, Manipur Agricultural College, Iroisemba, Imphal 795001, India

During disease surveys of several foothill and upland ricefields in four districts of Manipur 1985-86, we noticed cases of sheath rot (ShR) fungus *Monographella albescens* (Thumen) Parkinson, Sivanesan and Booth associated with stem or foot rot disease. We collected 100 ShR-diseased rice plants randomly from Imphal, Thoubal, Bishnupur, and Senapati districts. Those that also showed symptoms of stem- and foot rot-disease were separated and the disease isolated on potato dextrose agar (PDA).

Potted rice plants were inoculated at the late boot stage with 5-d-old cultures of *S. oryzae* or *S. rolfsii;* control plants were treated with PDA medium alone. When disease symptoms appeared, prepared mycelial fragments from a 6-d-old culture of ShR fungus were sprayed on both diseased and control plants. Inoculated plants were maintained at 90% relative humidity.

Only two sclerotium-producing fungi, *S. oryzae* and *S. rolfsii,* were consistently associated with ShR (Table 1). The association of *M. albescens* with *S. oryzae* was higher than with *S. rolfsii.*

Rice plants infected with either *S. oryzae* or *S. rolfsii* were significantly more susceptible to ShR fungus (Table 2). □

Table 1. Association of *M. albescens* with *S. oryzae* or *S. rolfsii.* Manipur Agricultural College, Imphal, India, 1985-86.

District	Plants analyzed (no.)	*M. albescens* association (%) with	
		S. oryzae	*S. rolfsii*
Imphal	100	8	2
Thoubal	100	5	4
Bishnupur	100	10	3
Senapati	100	6	3

Table 2. Severity of *M. albescens* on rice plants infected with either *S. oryzae* or *S. rolfsii.* Manipur Agricultural College, Imphal, India, 1985-86.

Source of infection	*M. albescens*		Disease incidence (%)
	Plants inoculated (no.)	Plants infected (no.)	
S. oryzae	20	19	95
S. rolfsii	20	17	85
Control	20	5	25
LSD (0.05)	-	3	-

Influence of carbendazim concentration on in vitro production of pectinolytic and cellulolytic enzymes by *Rhizoctonia solani*

A. Karthikeyan and R Narayanaswamy, Agricultural Research Station, Bhavanisagar and Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

We studied the effect of different concentrations of carbendazim on in vitro production of pectinolytic and cellulolytic enzymes by *R. solani.*

The culture filtrates of *R. solani*

obtained by growing the fungus in Czapek's pectin broth were treated with different concentrations of the fungicide (0, 0.01,0.05, and 0.1%) and assayed for production of protopectinase, polygalacturonase, polygalacturonate *trans* eliminase, and pectin *trans* eliminase. The activity of the enzymes cellulase (C_1), cellulase (C_x), and ß-glucosidase also were estimated.

Production of protopectinase, polygalacturonase, polygalacturonate *trans* eliminase, and pectin *trans* eliminase by *R. solani* was markedly inhibited in all concentrations of carbendazim (see table). Highest reduction was in 0.1% concentration.

Activity of cellulase (C_1) and cellulase (C_x) also was markedly inhibited. Highest inhibition of cellulase (C_1) and cellulase (C_x) activities was in 0.1% concentration.

Increases in carbendazim concentrations increased ß-glucosidase activity. The increase was highest in 0.1% concentration. □

Influence of carbendazim concentrations on in vitro production of pectinolytic and cellulolytic enzymes by *R. solani*.

Fungicide concentration (%)	Proto pectinase production[a]	Poly galacturonase production[b]	Poly galacturonate trans eliminase production[c]	Pectin trans eliminase production[d]	Cellulase activity units (C_1)	Cellulase activity units (C_x[e])	ß-glucosidase[f] activity
0 (control)	++++	48.50	34.4	22.3	3.500	41.10	3.000
0.01	+++	32.60	24.7	17.1	2.350	30.33	3.532
0.05	++	28.50	18.8	13.4	1.797	25.54	4.246
0.1	+	8.10	8.5	6.4	0.812	13.22	4.925

[a] Maceration of potato disc, + to ++++ = increase in activity. [b] Percent loss in viscosity of 0.75% sodium polypectate after 120 min. [c] Percent loss inviscosity of 1.2% sodium polypectate after 120 min. [d] Percent loss in viscosity of 1% citrus pectin after 120 min. [e] Percent loss in viscosity of 0.5% carboxy methyl cellulose after 120 min. [f] mg of reducing sugars liberated from 1% arbutin/100 ml.

Evaluating fungicides to control rice leaf scald (LSc) in the field

N. C. Swain, B. Behera, A. Narain, and P. K. Chhotray, Orissa Universiy of Agriculture and Technology, Bhubaneswar, India

We tested five fungicides against LSc *Gerlachia oryzae* Has. and Yokogi under field conditions 1987-88.

Rice cultivar Lalat was planted in 4- × 5-m plot at 15- × 20-cm spacing in a randomized block design with three replications. Plants were artificially inoculated during the evening 25 d after transplanting (DT) with a suspension of 30,000 spores/ml, using a plastic atomizer.

Seed treatment involved soaking seeds in carbendazim + thiram suspension for 12 h before sowing. Fungicides were sprayed at 30, 40, and 50 DT. Disease incidence was measured 55 DT.

Seed treatment with carbendazim + thiram was effective. Among spray treatments, thiophanate-methyl was most effective in reducing disease (see table). Carbendazim and maneb also significantly reduced disease. No phytotoxicity occurred in any treatment. □

Control of rice LSc disease by fungicides. Bhubaneswar, India, 1987-88.

Treatment	Application rate (kg/ha)	Disease incidence[a] (%)		Grain yield (t/ha)	
		1987	1988	1987	1988
Carbendazim + thiram (1:1)[b]	0.035 + 0.105	25.00 (28.31)	28.80 (32.45)	2.5	2.4
Carbendazim	0.8	16.80 (24.19)	27.20 (31.43)	2.8	2.5
Thiophanate-methyl	0.8	11.07 (19.43)	19.60 (26.27)	2.9	2.9
Maneb	1.0	23.20 (28.79)	27.90 (31.88)	2.7	2.4
Blitox	1.0	27.40 (31.56)	29.90 (33.14)	2.6	2.3
Control (unsprayed)		41.93 (40.35)	46.10 (42.76)	2.2	1.8
LSD (0.05)		2.4	2.28	0.3	0.3
(0.01)		3.41	3.24	0.4	0.3

[a]Figures in parentheses are the transformed angular values. [b] Chemicals used as seed treatment.

Tungro (RTV) incidence in wetbed seedling nursery

E. R. Tiongco, R. C. Cabunagan, Z. M. Flores, and T. M. Mew, Plant Pathology Department, IRRI

Rice farmers often raise nurseries in areas adjacent to the fields. Unprotected nurseries are suspected to play an important role in the spread of RTV.

We studied RTV incidence on rice seedlings in an unprotected wetbed nursery. Pregerminated TN1 seeds were sown in a 2- × 10-m nursery laid out in the middle of a field planted to TN1 with high RTV incidence.

At 21 d after seeding (DM), green leafhopper (GLH) in the nursery and in the plants surrounding the nursery were sampled by 10 sweeps of an insect net. GLH infectivity was tested by introducing one captured vector into a test tube containing a TN1 seedling for 24-h inoculation. Seedlings were indexed for RTV by ELISA 3 wk later.

At 21 DAS, seedlings in the field nursery were pulled and apportioned to cover four 7.5- × 8-m plots in the insect-proof screenhouse and four 5.5- × 9-m plots in the field. Two to three seedlings were planted per. hill. No insecticide was applied. All plants were scored for symptoms at 20 and 35 DT. Virus infection was indexed by ELISA from leaves taken from each hill in a sample of 5 × 5 hills. Ten samples were taken in W-pattern from each plot.

More *Nephotettix virescens* than *N. nigropictus* were collected within the nursery, but numbers were similar in the surrounding plants. Fewer infective GLH were found in the nursery (Table 1).

At 20 DT, RTV incidence was lower in plants in the screenhouse than in the field. At 35 DT, only a slight increase in incidence was observed in the screenhouse; in the field, incidence was nearly 100% (Table 2). This also indicates the low increase in number of GLH in the screenhouse, although it is suitable for GLH development.

Even under high disease and vector pressures, the unprotected wetbed seedling nursery had low RTV incidence. This may be due to the loss of vector infectivity after feeding on seedlings in succession and to the low probability of the vector recovering its infectivity by feeding on diseased seedlings. ☐

Table 1. GLH and infective vectors collected from a TN1-seeded nursery in the center of a RTV-affected field and from plants surrounding the nursery. IRRI, 1989.

Collection site	GLH/10 sweeps[a] (no.)		Infective GLH[b] (%)		
	Nephotettix virescens	*Nephotettix nigropictus*	RTBV+RTSV	RTBV	RTSV
In the nursery	45	9	0	3	1
Around the nursery	25	22	3	10	0

[a] 21 DAS. [b]No infective *N. nigropictus* was obtained. Infectivity of 80 GLH/site was tested using 1 GLH/TN1 seedling for 24-h inoculation in test tube at 21 DAS. RTBV = rice tungro bacillifom virus, RTSV = rice tungro spherical virus. Plants were assayed by ELISA 21 d after inoculation.

Table 2. RTV incidence based on symptoms and infection by RTBV and RTSV of TN1 plants[a] at 20 and 35 d after transplanting (DT) in the screenhouse and in the field. IRRI, 1989.

	RTV incidence (%)							
	20 DT				35 DT			
	Visual score	RTBV+ RTSV	RTBV	RTSV	Visual score	RTBV+ RTSV	RTBV	RTSV
Screenhouse	1	2	3	1	7	7	5	4
Field	27	24	7	14	99	91	4	3

[a]From a 2- × 10-m nursery at the center of a RTV-infected field. Plants were indexed by ELISA.

Effect of foliar application of various salts on rice sheath rot (ShR) disease

V. Narasimhan, P. Vidhyasekaran, H. D. Lewin, and A. Chandrasekaran, Tamil Nadu Rice Research Institute, Aduthurai 612101, Tamil Nadu, India

We studied the effectiveness of different salts in controlling ShR incidence in rice crop in the greenhouse and in the field.

In the greenhouse experiment, two seeds of susceptible cultivar ADT38 were planted/clay pot, 5 pots/treatment, with five replications. At 90 d after seeding, eight salts at three concentrations were spray applied.

The plants were artificially inoculated with ShR pathogen *Acrocylindrium oryzae* Sawada 24 h after spraying by inserting a diseased grain into the leaf sheath. ShR incidence was recorded 15 d after inoculation.

Sprays of calcium sulfate and magnesium sulfate up to 0.2% concentration reduced ShR incidence (Table 1).

The field experiment Sep-Feb 1989 (when disease incidence was high) was laid out in 4.5- × 2.0-m plots in a complete random block design with four replications. Susceptible cultivar Co 43 was transplanted 11 Sep, 30 d after seeding.

Recommended 150-60-30 kg NPK/ha was applied as urea, superphosphate, and muriate of potash. P and K were basal; N was applied in three equal splits at planting, tillering, and panicle initiation.

Nine salts were mixed in water and sprayed at the boot leaf stage and 15 d later (the check was sprayed with plain water). ShR incidence was measured as percentage tillers affected on randomly selected 25 hills/plot.

Manganese sulfate, calcium sulfate, ferrous sulfate, and copper sulfate gave ShR incidence significantly lower than that of the check (Table 2).☐

Table 1. Effect of various salts on rice ShR incidence in the greenhouse.

Salt	Disease intensity[a] at given concentration		
	0.2%	0.5%	1.0%
Calcium sulfate	1.3	1.5	1.0
Magnesium sulfate	1.3	1.5	2.4
Copper sulfate	5.7	5.6	7.5
Ferrous sulfate	4.0	5.0	2.3
Zinc sulfate	5.0	2.8	1.9
Nickel nitrate	4.7	5.0	1.9
Sodium fluoride	4.0	1.0	1.2
Ammonium molybdate[b]	1.4	2.5	2.0
Untreated check	-	-	6.0

[a] *Stansdard evaluation system for rice* , 0-9 scale. [b]Tested at 10, 50, and 100 ppm.

Table 2. Effect of various salts on rice ShR incidence in the field. Aduthurai, India, Sep-Feb 1989.

Treatment	Concentration	Mean ShR (%)
Zinc sulfate	10^{-2} M	22.3
Manganese sulfate	10^{-2} M	14.0
Copper sulfate	10^{-2} M	19.0
Calcium sulfate	10^{-2} M	16.7
Ferric chloride	10^{-2} M	25.6
Magnesium sulfate	10^{-2} M	22.2
Ferrous sulfate	10^{-2} M	18.2
Sodium borate	10^{-2} M	20.1
Ammonium molybdate	10^{-3} M	24.3
Untreated check		31.2
LSD (P=0.05)		6.6

Tungro (RTV) incidence in direct seeded and transplanted rice

E. R. Tiongco, R. C. Cabunagan, Z. M. Flores, and H. Hibino, Plant Pathology Department, IRRI

We compared RTV incidence and density of RTV vector green leafhopper (GLH) *Nephotettix* spp. in direct seeded and transplanted IR36 and TN1 rice.

In the first experiment Jul-Sep 1986 and Apr-Jun 1987, the nursery for transplanted rice was seeded 3 wk before direct seeded rice was planted. The seedling nursery was prepared near the test field. Data were taken 47 d after transplanting (DT) and seeding (DAS).

In the second experiment Nov-Jan 1986 and Aug-Oct 1987, the nursery for transplanted rice was seeded and direct seeded rice was broadcast at the same time. A small nursery was prepared in each test plot. Data were taken 66 DAS.

Seeding rate of direct seeded rice was 100 kg/ha; spacing of transplanted rice was 20 × 20 cm. Five- × five-m plots were laid out in randomized complete block design with four replications.

RTV symptoms were scored on all plants for transplanted rice and on all plants in ten 20- × 20-cm sampling units for direct seeded rice. Rice tungro bacilliform virus (RTBV) and spherical virus (RTSV) incidence were determined by the latex test in 50-100 plants/replicate samples taken in a W-pattern from transplanted rice and in 10-50 plants/sampling unit in direct seeded rice. All plants showing symptoms were tested. GLH density was determined by 10 sweeps of an insect net in each plot.

In both experiments, there were more plants with RTV symptoms and combined RTBV and RTSV incidence in transplanted rice than in direct seeded rice (see table). GLH density was also higher in transplanted rice. □

GLH density, incidence of RTV, RTBV, and RTSV in direct seeded and transplanted IR36 and TN1 rice plants.[a] IRRI, 1986-87 dry and wet seasons.

Cultural method		GLH density (no./10 sweeps)	RTV incidence (%)	Plants (%) infected with		
				RTBV+RTSV	RTBV	RTSV
Experiment I[b]						
IR36	Direct seeded	13 ± 8	1 ± 1	1	1	2
	Transplanted	33 ± 15	23 ± 15	64	9	12
TN1	Direct seeded	7 ± 3	6 ± 2	4	3	14
	Transplanted	71 ± 26	96 ± 3	81	1	14
Experiment II[c]						
IR36	Direct seeded	6 ± 2	1 ± 1	2	2	1
	Transplanted	12 ± 3	12 ± 6	29	2	18
TN1	Direct seeded	11 ± 4	19 ± 6	9	6	16
	Transplanted	12 ± 1	80 ± 8	66	2	23

[a]± Standard deviation. [b]Data taken 47 d after direct seeding or transplanting. [c]Data taken 66 d after direct seeding or seedbed seeding.

Rice yellow mottle virus (RYMV) on rice in Madagascar

P. M. Reckhaus, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ); and S. Randrianangaly, Service Protection des Végétaux, B.P. 869, Antananarivo, Madagascar

RYMV, reported to cause severe economic damage to rice (*Oryza sativa* L.) in West Africa, has now been identified in Madagascar.

The disease was observed in Apr 1989 in some fields at Lac Alaotra, the largest contiguous rice-growing area, and in May 1989 in some fields on the Marovoay plains in the northwest. Infected varieties were Makalioka 34, Tche kouai, Boina 1329, and Tsipala.

Naturally infected plants exhibit a bright mottle with chlorotic stripes, sterility of panicles, and stunting. Regrowth from diseased plants showed a well defined mosaic. When the virus was mechanically transmitted to Angihika, Chianan 8, and Tsipala, the same symptoms developed.

In agar-gel double-diffusion tests, virus in crude extracts from both inoculated and systemically infected leaves reacted strongly with RYMV antiserum obtained from IITA. These tests showed the isolates from Lac Alaotra and Marovoay to be serologically identical.

RYMV is known to be transmitted by Chrysomelidae beetles. *Trichispa sericea* Guérin and *Hispa gestroi* Chapman are considered the most serious insect problem of rice in Madagascar.

Investigations on the vector beetle and the virus are under way in collaboration with FOFIFA. □

Integrated pest management—insects

Stem borer (SB) incidence at different growth stages of rainfed rice

P. K. Gupta, S. S. Prasad, and R. B. Singh Entomology Section, Crop Research Station, Ghagharaghat, Bahraich 271901, UP, India

We compared SB incidence in farmers' fields in shallow water, deepwater, very deepwater, and flooded rainfed rice environments 1987-88. Rice varieties were Mahsuri, Chakia 59, Jalmagna, and Madhukar, respectively.

Samples of 200 stems were taken in each environment at preflood, early elongation, late elongation, and maturity stages. Correlation coefficients calculated for different rice environments and growth stages are summarized in Table 1.

SB populations increased with level and duration of water in all environments (Table 2). Populations also increased from preflood to maturity crop stages, irrespective of environment. ☐

Table 1. Incidence of SB in relation to different rice environments and different growth stages at Ghagharaghat, India, 1987-88.

Rainfed rice environment	Variety	Year	SB incidence (%) at different growth stages				*r* for different growth stages[a]
			Preflood	Early elongation	Late elongation	Maturity	
Shallow water	Mahsuri	1987	1.5	4.5	4.5	6.5	+0.939
(to 50 cm water)		1988	1.5	3.5	5.5	11.5	+0.956*
Deepwater	Chakia 59	1987	2.0	5.0	8.0	5.5	+0.708
(50-100 cm)		1988	2.5	5.5	9.5	25.5	+0.911
Very deepwater	Jalmagna	1987	3.0	14.0	15.0	31.5	+0.950*
(above 1 m)		1988	4.0	8.0	15.5	44.5	+0.981*
Flood (intermittent)	Madhukar	1987	9.5	14.5	16.5	25.0	+0.969*
(3 times up to 50 cm during 1987, 4 times up to 100 cm during 1988)		1988	-	-	-	-	-
r for different rice environments		1987	+0.937	+0.917	+0.848	+0.802	
		1988	+0.993	+0.862	+0.802	+0.772	

= significant at the 5% level.

Table 2. Stem damage due to SB at different rainfed rice environments and growth stages at Ghagharaghat, India, 1987-88.[a]

Rainfed rice Environment	Variety	Year	Damaged stems (no.)			
			Preflood	Early elongation	Late elongation	Maturity
Shallow water	Mahsuri	1987	3	9	9	13
(to 50 cm water)		1988	3	7	11	23
Deepwater	Chakia 59	1987	4	10	16	11
(50-100 cm)		1988	5	11	19	51
Very deepwater	Jalmagna	1987	6	28	30	63
(>1 m)		1988	8	16	31	89
Flooded 2-3 times (to 50 cm)[b]	Madhukar	1987	19	29	33	50

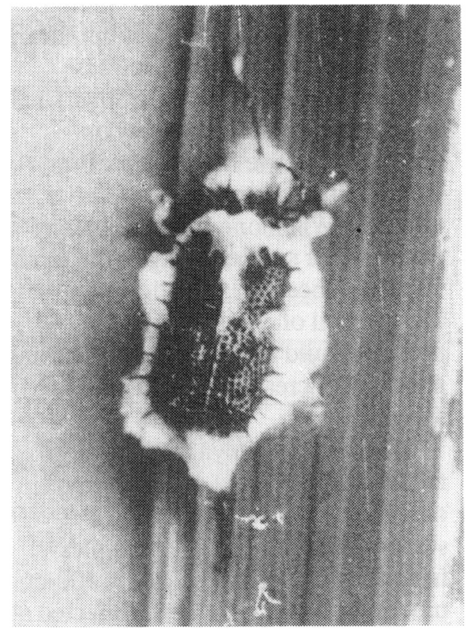
[a]200 stems selected diagonally in the field from each environmentand at each growth stage.[b]The 1988 crop failed because of flash flooding for more than 1 mo at crop initiation.

Beauveria bassiana (Bals.) Vuill. for biological control of rice hispa (RH) in Assam, India

L. K Hazarika and K C. Puzari, Department of Entomology and Plant Pathology, Assam Agricultural University, Jorhat 785013, Assam, India

During a routine search for an alternative to insecticides for control of RH *Dicladispa armigera* Olivier (Coleoptera, Chrysomelidae), we observed the majority of the test beetles reared in cages were dying of a fungal disease. In most cases, the beetles were found stuck to rice leaves and stems.

We cultured the fungus on potato dextrose agar medium incubated at ±24 °C. Fluffy growth of the fungus was noticed 3 d after inoculation on medium; it sporulated at 7 d. The spores were single-celled, hyaline, globose (0.8-), 1-3.5 µm in diameter, with clustering of conidiogenous rachis.



A hispa adult showing infestation with *Beauveria bassiano.* Magnification 11x.

The fungus was identified as *Beauveria bassiana* (Bals.) Vuillemin; its pathogenicity was confirmed through Koch's postulates.

On RH adults, white frosty fungus growth emerged first through intersegmental membranes of the thorax and abdomen (see figure). Ultimately it covered the whole body and appendages. About 90% of the beetle population tested were killed. ☐

Arthropod diversity in tropical rice ecosystems

K. L. Heong and G. B. Aquino, Entomology Department, IRRI

Most organisms that live in ricefields are exogenous species that colonize the rice crop when cultivation begins. The recruitment phase is followed by an interaction phase, and the species present settle into a community.

A large proportion of the individual organisms are more or less trophically interlinked and unified in their dependence on rice.

Pest management actions are often directed at the community of rice arthropods rather than at individual species. That makes understanding how the community behaves important. When a particular pest species is affected by specific interventions, such as planting a resistant variety or applying selective insecticides, the community structure may also be affected. When one component is reduced, other species living in the same niche may become more dominant with the removal of competition. The predator guild may be reduced, causing abnormal increases in other pest species.

We studied the dynamic developments in an irrigated rice arthropod community during the dry and wet seasons. In both trials, 20 samples from an insecticide-free, 25- × 100-m^2 plot at the IRRI farm were collected at 3-d intervals using the CO_2NE sampler in the dry season and using a D-Vac sampling machine in the wet season.

Because populations are indefinitely large, and it is not possible to collect, count, and identify all individuals in a community, the sample was taken to represent members of the community.

Arthropods were sorted into species and counted. Hemipterans predominated in all samples. Species from two guilds—phytophages and predators—were found. The phytophages were composed primarily of pest species, such as leafhoppers and planthoppers. The predators consisted of *Cyrtorhinus lividipennis* and *Microvelia atrolineata* (Fig. 1). Other groups of arthropods, in relatively low numbers, were spiders, coleopterans, hymenopterans, and dipterans.

The Shannon Wiener Index was used to describe species diversity:

$$H(s) = -\sum_{i=1}^{s} p_i \log p_i$$

where s is the number of species and p_i is the proportional abundance of the i^{th} species.

We calculated $H(s)$ and its standard error for each sampling date. Species diversity increased with crop age to about 3 wk after transplanting, then remained relatively unchanged until harvest (Fig. 2).

The plateau value of $H(s)$ varied between 1.75 and 2.25, implying that arthropod diversity was determined by 6 to 9 species. Those species are ranked by abundance:

Feb-May 1988 (dry season)
Micronecta sp. 1
Microvelia atrolineata
Nephotettix virescens
Microvelia vittigera
Cyrtorhinus lividipennis
Tetragnatha sp. 1
Callitrichia formosana
Dystiscus sp. 1
Nephotettix nigropictus
Lycosa pseudoannulata

Jul-Oct 1988 (wet season)
Nephotettix virescens
Microvelia atrolineata
Sogatella furcifera
Cyrtorhinus lividipennis
Lycosa pseudoannulata
Nephotettix nigropictus
Gryliid sp. 1
Callitrichia formosana
Gonatocerus sp. 1
Microvelia vittigera □

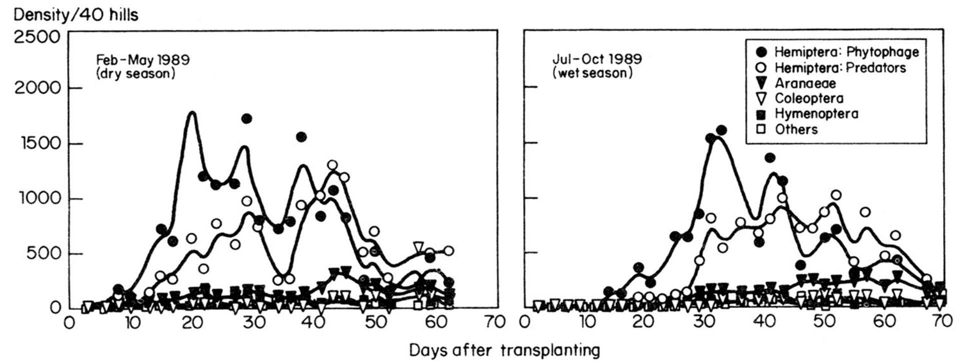


Fig. 1. Arthropods in 2 crops of IR66 grown under submerged conditions. IRRI farm, 1988.

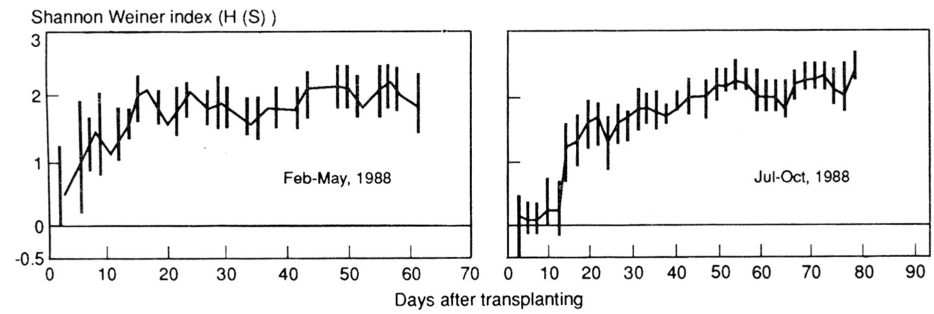


Fig. 2. Shannon-Weiner diversity index in 2 crops of IR66 grown under submerged conditions. IRRI farm, 1988.

A method for collecting leaffolder (LF) eggs on nonplant substrates

R. Ramachandran and Z. R. Khan, International Centre for Insect Physiology and Ecology, P.O. Box 30772, Nairobi, Kenya (currently at IRRI)

Methods for collecting LF eggs to use in experiments and varietal screening involve caging field-collected or laboratory-reared moths on potted 30- to 40-d-old rice plants. Plants with eggs are removed daily and incubated until the larvae hatch.

The process is cumbersome, requires large cages and insectary space, and inefficient. Most eggs are laid on the walls of the cages.

We developed a new oviposition cage in which the moths lay their eggs on black cloth. Wire gauze is rolled into a 5-cm-diameter cylinder 10 cm long. Two 6-cm-diameter petri dishes washed with a layer of moist cotton overlaid with a circular piece of black cotton cloth are fitted onto each end of the wire gauze cylinder with rubber bands (see figure).

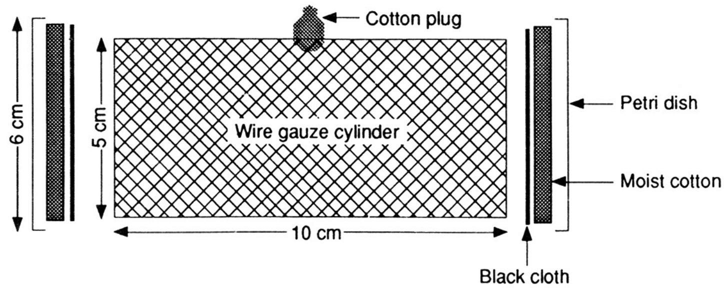
Two pairs of moths can be released inside the cage through a hole made in the wire gauze. The hole is closed with a ball of cotton dipped in 25% honey solution.

We kept cages with moths in darkness. Eggs were laid on the black cloth. They were removed daily and the black cloth reused.

The number of eggs laid on cloth and on potted rice plants did not differ (see table). However, when cellulose paper was substituted for black cloth, no eggs were laid.

Hatchability of eggs laid on cloth was >90%. Also, freshly laid eggs are easily counted against the dark background. (No color preference by the moths is implied.) Eggs collected on a nonplant substrate, such as cloth, are easier to sterilize.

Collecting eggs on cloth would be useful in large-scale rearing of LF and when first-instar larvae are to be infested with minimum handling. This method would be particularly useful where larvae are to be tested in sterile conditions, such as on callus and on artificial diets. The oviposition cage can also be used in assaying various LF attractants and oviposition stimulants. □



Cage for oviposition of rice LF.

Oviposition of the rice LF *Cnaphalocrocis medinalis* (Guenée) on rice leaves and nonplant substrates.

Substrate	Eggs/2 females per d (mean ± SE)
On potted IR36 plants in the insectary	56 ± 15
On black cloth in the oviposition cages	63 ± 9

[a]Av of 9 replications.

A nuclear polyhedrosis virus from rice skipper

X. W. Cheng, Hunan Plant Protection Institute, Changsha, Hunan, China; R. M. Aguda, Entomology Department, IRRI; and B. M. Shepard, Coastal Research and Education Center, Clemson University, 2865 Savannah Highway, Charleston, South Carolina 29407, USA

Rice skipper *Pelopidas mathias* (Fabricius) occurs mostly in rainfed rice. It causes damage similar to that from other rice defoliators (armyworms and rice green semiloopers).

We isolated a nuclear polyhedrosis virus (PmNPV) from a rice skipper colony in the greenhouse at IRRI. Virus-infected rice skippers were sluggish, ceased feeding, and died. Cadavers exhibited typical symptoms of virus-killed larvae: black color and liquefied body contents.

We purified the PmNPV by macerating PmNPV-infected rice skipper larvae with 0.1% sodium dodecyl sulfate (SDS) in a glass homogenizer and filtering through four layers of cheesecloth to remove large particles of insect debris. The filtrate was centrifuged at 100 *g* (1,000 rpm in Beckman rotor JA-20) for 1 min and the precipitate was discarded.

The supernatant was centrifuged at 2,500 g (6,000 rpm in Beckman rotor JA-20) for 10 min to remove lipid, soluble material, and small contaminants. The pellet was resuspended with 0.1% SDS and the centrifuging cycle repeated three times.

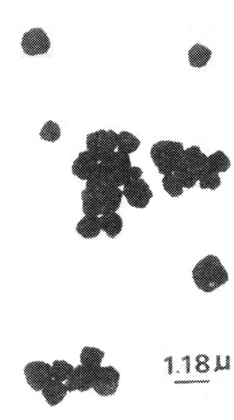
The final pellet was resuspended in a small volume of distilled water and centrifuged on 30-80% (vol/vol) discontinuous glycerol gradients in a Beckman SW-27 swing bucket rotor with a Beckman L8-M ultracentrifuge at 1,500 g or 3,500 rpm for 10 min.

The white virus band was collected, diluted with distilled water, and centrifuged at 2,500 g for 10 min. The supernatant was discarded and the pellet resuspended in distilled water and centrifuged on 25-60% (wt/wt) linear sucrose gradients in a Beckman SW-27 rotor at 1,500 *g* or 10,000 rpm for 30 min.

The virus band formed was collected with a pipette, diluted with distilled water, and centrifuged at 2,500 *g* for 30 min to remove the sucrose. The pellet was suspended in distilled water and stored in a freezer.

The 0.858 ± 0.143 µm polyhedra was somewhat tetragonal (Fig. 1).

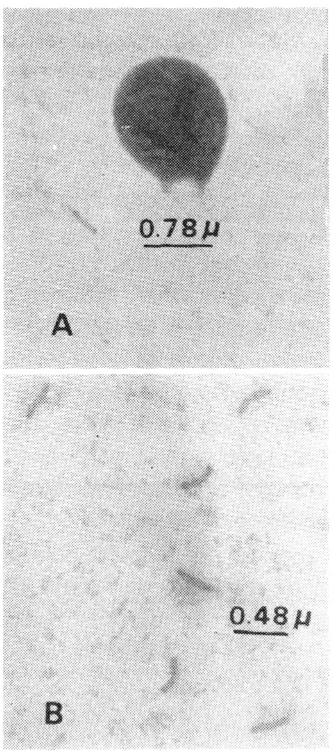
The virions in the polyhedra were released by mixing equal volume of PmNPV suspension with 0.1 M $NaCO_3$ (pH = 10.7) for 60 min at 30 °C. The



1. Electron micrograph of the nuclear polyhedrosis virus from the rice skipper *Pelopidas mathias* stained with 2% PTA.

released virions were stained with 2% phosphotungstic acid (PTA) and examined under electron microscope. The rod-shaped virions (Fig. 2) were 367.84 ± 26.85 nm long and 64.37 ± 5.63 nm wide.

This is the first known evidence of a nuclear polyhedrosis virus from *P. mathias* in the Philippines. □



2. Virions released from the polyhedra after 1-h treatment with 0.05 M $NaCO_3$ at 30°C. A) Virions in the polyhedral membrane; B) virions released from polyhedra.

Simulation of rice yield reduction caused by stem borer (SB)

E. G. Rubia, Entomology Department; and F. W. T. Penning de Vries, Multiple Cropping Department, IRRI

We adapted a rice crop growth model to simulate yield reduction caused by SB on irrigated IR64 at IRRI. Grain yield predicted by the model correlated well with yield obtained by clipping tillers in the field.

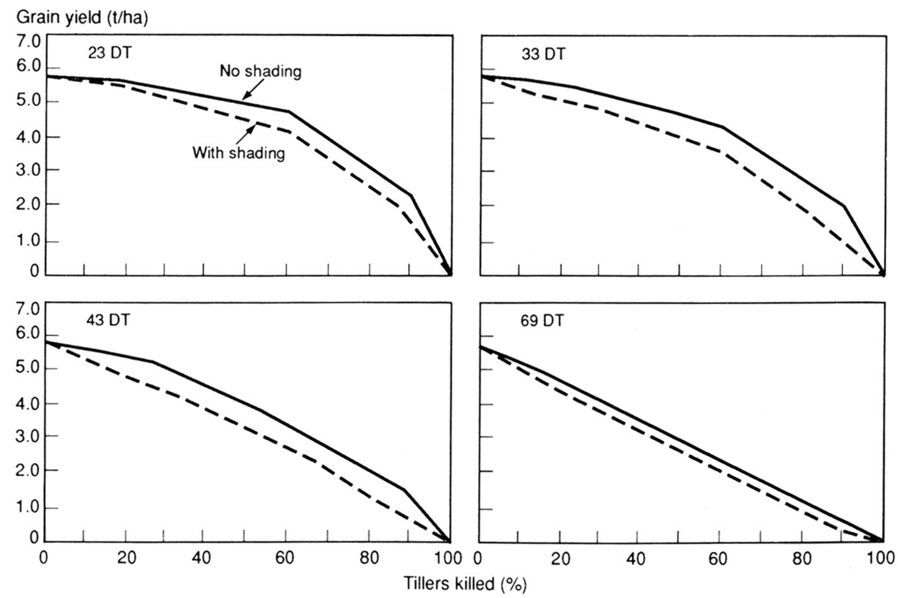
The computer simulations predicted that up to 20% deadhearts at the vegetative stage would cause no significant reduction in grain yield– young plants could compensate for lost tillers. Damage at the grain filling stage (whiteheads) caused an almost proportionate yield reduction (see figure).

This suggests that spraying against SB at the early vegetative stage is often unnecessary, since young rice plants can tolerate considerable damage.

The computer simulations also suggest that yield reduction caused by SB is larger at low N levels since compensation then is less effective. Such physical factors as low radiation also can aggravate SB damage.

Clipping tillers is an artificial method for mimicking deadhearts or whiteheads. It is relatively easy to carry out, but, unlike with natural SB damage, tillers removed by clipping no longer provide shade. We also used the model to compute how much results of experiments using the clipping method need to be adjusted to agree with natural SB damage (see figure).

Using the same model, similar field experiments and simulations were conducted at several research institutes under various weather conditions and using different varieties. Results confirmed that the model is not location specific. □



Simulated grain yield of IR64 in response to damage inflicted at 4 crop stages—active tillering (23 d after transplanting [DT]), maximum tillering (33 DT), panicle initiation (43 DT), and flowering (69 DT)—by clipping a fraction of tillers in each hill. Full lines (—) represent response when tillers are removed, dotted lines (- - -) represent response when killed tillers are kept in place (natural stem borer damage). The difference is due to shading.

Life history of water strider *Limnogonus fossarum* (F.)

E. G. Rubia and K. L. Heong, Entomology Department, IRRI

L. fossarum is a common predator in wetland ricefields in the Philippines. An adult female water strider can consume up to 20 BPH a day.

We collected 100 eggs laid on cut TN1 rice stems. Emerging nymphs were released separately in 9-cm-diam petri dishes filled with distilled water and enclosed in 14-cm-high mylar cages with nylon mesh tops. Each cage contained cut TN1 stems and BPH for food. The cages were kept at 25-30 °C, 70-90% RH, and 12/24 h illumination.

As adults emerged, they were paired and kept inside 0.5-gal containers for oviposition. Survival and female fecundity were recorded daily.

Life cycle of the water strider was

57-66 d (Fig. 1). A female can lay as many as 87 eggs. Mean daily oviposition is shown in Figure 2. Mortality was highest at the 3d nymphal stage.

The species requires constantly flowing water, which is why it has low populations in ricefields. It also exhibits cannibalism. □

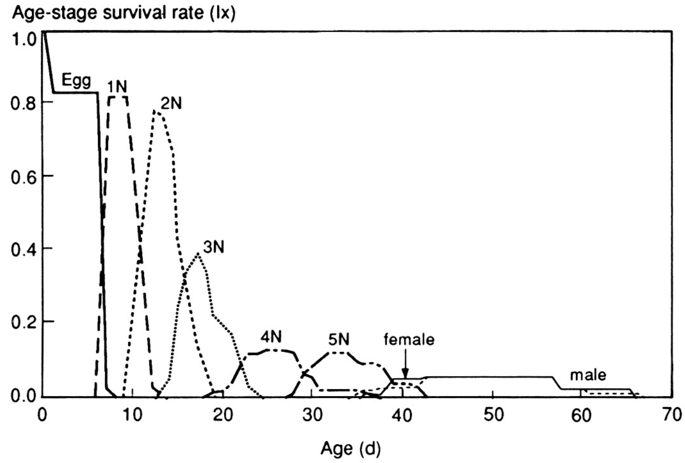


Fig. 1. Age-specific survival rate (1x) of the water strider *L. fossarum,* constructed using a life-table analysis, IRRI, 1989. N = nymphal stage; X = 60.25 ± 1.18.

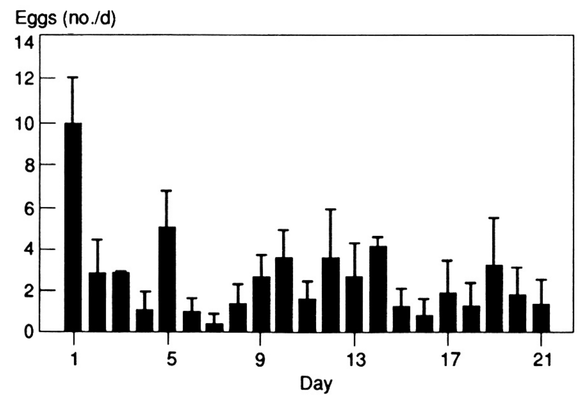


Fig. 2. Average daily oviposition of water strider *L.fossarum.* IRRI, 1989;

Integrated pest management – weeds

Weeds in direct seeded ricefields of Thanjavur District, Tamil Nadu

O. S. Kandasamy, Agricultural College and Research Institute, Madurai 625104, Tamil Nadu; and SP. Palaniappan Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India

Weeds are a more serious problem in dry seeded rice than in wet seeded rice culture. We assessed weed species in direct seeded (dry seeded) rice 60 d after sowing in three cropping seasons: kuruvai (Jun-Jul to Sep-Oct) and thaladi (Sep-Oct to Feb-Mar) in double crop wetlands and samba (Aug-Sep to Jan-Feb) in single crop wetlands.

The major graminaceous weeds were *Echinochloa colona, E. crus-galli,* and *Chloris barbata.* The common Cyperaceae were *Cyperus rotundus, C. iria,* and *Fimbristylis miliacea.* Of nine families of dicots present, Onagraceae, Marsileaceae, and Asteraceae were important.

Weed density was highest during the samba season because of favorable moisture and climatic conditions (see table). Weed flora during kuruvai consisted of nearly equal densities of monocots and dicots. During thaladi and samba, monocots were dominant.

Irrespective of season, among the monocots *E. colona* was the major species (50-81%). *C. rotundus* (50-65%) dominated the sedges and *Ludwigia adscendens* and *Marsilea quadrifolia* (30-50%) dominated the broadleaf weeds. □

Weed density in direct seeded rice, Tamil Nadu, India.

Weed	Kuruvai		Thaladi		Samba	
	Density (no./m^2)	Relative density (%)	Density/m	Relative density (%)	Density/m	Relative density (%)
Echinochloa colona (L.) Link	82	32.1	68	34.3	183	55.0
E. crus-galli (L.) P. Beauv.	8	3.1	28	14.1	18	5.4
Chloris barbata Sw.	12	4.7	22	11.2	14	4.2
Others	3	1.2	21	10.6	12	3.6
Total grasses	105	41.3	139	70.2	227	68.2
Cyperus rotundus L.	16	6.3	8	4.0	20	6.0
C. iria L.	6	2.4	4	2.0	4	1.2
Fimbristylis miliacea (L.) Vahl	4	1.6	2	1.0	4	1.2
Others	5	2.0	3	1.6	5	1.5
Total sedges	31	12.2	17	8.6	33	9.9
Ludwigia adscendens (L.) Hara	42	16.5	12	6.2	38	11.4
Marsilea quadrifolia L.	26	10.2	21	10.6	16	4.8
Eclipta alba (L.) Hassk.	18	7.2	4	2.0	9	2.7
Others	32	12.6	5	2.5	10	3.0
Total broadleaf weeds	118	46.5	42	21.2	73	21.9
Total weeds	254	100.0	198	100.0	333	100.0

Weed species in rice seedling nurseries in eastern Uttar Pradesh (UP), India

H. P. Singh Crop Research Station, P.O. Dabhasemar, District Faizabad, UP, India

We surveyed weed species in farmers' field nurseries in Masodha village 1985-87 wet seasons. Ten nurseries were surveyed a year, for a total of 30 seedling nurseries. Each nursery was sampled twice by quadrat and the weeds found recorded.

Eight species belonging to five genera and three families were found. The most common were *Echinochloa crus-galli* (L.) Beauv., *Cyperus rotundus* L., and *Cynodon dactylon* (L.) pers. (see table).

Weed species found in survey of ricefield nurseries (n = 30 sites) in Eastern Uttar Pradesh.

Weed species	Family	Absolute presence of weed[a]	Consistency[b]	Frequency[c]	Frequency[d] (where present)
Echinochloa crus-galli (L.) Beauv.	Poaceae	30	1.000	0.916	0.916
Cyperus rotundus L.	Cyperaceae	30	1.000	0.833	0.833
Cynodon dactylon (L.) Pers.	Poaceae	29	0.966	0.685	0.706
E. colona (L.) Link	Poaceae	15	0.500	0.216	0.433
Eclipta alba (L.) Hassk.	Asteraceae	12	0.400	0.233	0.583
Cyperus iria L.	Cyperaceae	5	0.167	0.100	0.600
Cyperus difformis L.	Cyperaceae	4	0.133	0.083	0.625
Fimbristylis miliacea (L.) Vahl	Cyperaceae	3	0.100	0.066	0.666

[a] No. of sites where taxon occurred. [b] Proportion of sites where taxon occurred. [c] Proportion of quadrats in which taxon occurred, averaged for all sites. [d] Proportion of quadrats in which taxon occurred, for sites where taxon occurred.

Farmers separate the weeds from the seedlings while uprooting for transplanting. However, *Echinochloa* spp. are morphologically similar to rice and are often transplanted with rice. These species are highly competitive. □

Effect of resource constraints on weed growth in wetland rice

S. George, S. M. Shahul Hameed, and E. Tajuddin, Cropping Systems Research Centre (CSRC), Karamana, Kerala, South India

We studied the effect of resource constraints on growth of weeds. The experiment during 1986-87 wet and dry seasons had four levels of technology: date of planting, fertilizer level, plant population, and weed control method. Treatments were laid out in a strip-plot design with four replications (see table).

The test variety was Jaya. The main field was plowed 3 wk before transplanting for the wet season crop and 1 wk before transplanting for the dry season crop. Final harrowing and leveling were done the day before transplanting.

Weed dry weights from 1-m^2 area were taken 60 d after transplanting (DT). Important weeds found were *Monochoria vaginalis, Marsilia quadrifolia,* and *Cyperus iria.*

Only date of planting significantly affected the growth of weeds (see table). Weight of weeds in plots transplanted on the normal date was lower; rice transplanted 3 wk late showed poorer growth and development. □

Growth of weeds as influenced by resource constraints.

Treatment[a]	Dry weight of weeds (g/m^2)		Yield of grain (t/ha)	
	1986-87 kharif	1986-87 rabi	1986-87 kharif	1986-87 rabi
Normal planting date [15 May (kharif); 28 Sep (rabi)]	16.88	13.60	4.0	2.1
Late planting [5 Jun (kharif); 20 Oct (rabi)]	27.81	29.25	3.1	1.6
LSD (0.05)	7.42	8.69	0.2	0.4
Recommended fertilizer (90:20:31 kg NPK/ha)	22.66	19.69	3.8	1.9
50% recommended fertilizer (45:10:18 kg/ha)	22.03	22.56	3.3	1.8
LSD (0.05)	ns	ns	0.2	ns
Recommended plant population 20 × 15 cm (kharif); 20 × 10 cm (rabi)	19.84	23.13	3.4	2.0
75% recommended plant population 20 × 20 cm (kharif); 20 × 13 cm (rabi)	24.84	23.13	3.7	1.8
LSD (0.05)	ns	ns	ns	ns
Chemical weed control + hand weeding 40 d after transplanting (thiobencarb 2 kg ai/ha 6 DT)	23.13	20.22	3.6	1.9
Hand weeding 20 and 40 DT	21.56	22.03	3.5	1.9
LSD (0.05)	ns	ns	ns	ns

[a] DT = days after transplanting.

Integrated pest management – other pests

Effect of carbofuran on *Hirschmanniella* spp. infestation in irrigated rice and partitioning of rice yield increase

Tin Aung, Agriculture Corporation, Applied Research Division, Gyogon, Rangoon, Myanmar; and Jean-Claude Prot, IRRI

We evaluated different rates of carbofuran on an irrigated field that was naturally infested with *H. mucronata* and *H. oryzae* on the IRRI experimental farm. Enclosed plots 3 × 5 m and irrigated separately were established.

IR36 and IR58 and four rates of carbofuran (Furadan 3G) were used in a randomized complete block design with five replications.

Seedling nurseries were established in the field without nematicide treatment of the seedbeds. Cultivars were transplanted at a 20- × 20-cm spacing. Plots were weeded two times a week to maximum tillering. No fertilizer was used.

Carbofuran was applied in two equal splits 3 d before and 30 d after transplanting. The first application was incorporated, the second was placed at the soil surface in standing water. The field was flooded with 5-10 cm water from transplanting to harvest.

Nematode numbers in roots and soil were estimated at maximum tillering, booting, flowering, and harvest. The central 3-m^2 area in each plot was reserved for evaluating yield.

All the carbofuran treatments significantly reduced *Hirschmanniella* spp. population (see table). Populations at maximum tillering and booting in plots treated with 4 and 8 kg ai carbofuran/ha were significantly lower than those in plots treated with 2 kg ai/ha.

Carbofuran-treated plots also produced significantly higher yields. The yield increase was correlated with number of nematodes and with rate of carbofuran applied (see figure).

Because nematode densities in plots treated with 4 and 8 kg ai/ha did not differ significantly, differences in yield cannot be totally attributed to the reduction in nematodes.

In previous greenhouse experiments conducted in the absence of parasites, carbofuran appeared to stimulate rice growth. It is also an insecticide. Other nematicide (dibromochloropane and ethylene dibromide) also are suspected to be plant growth stimulators.

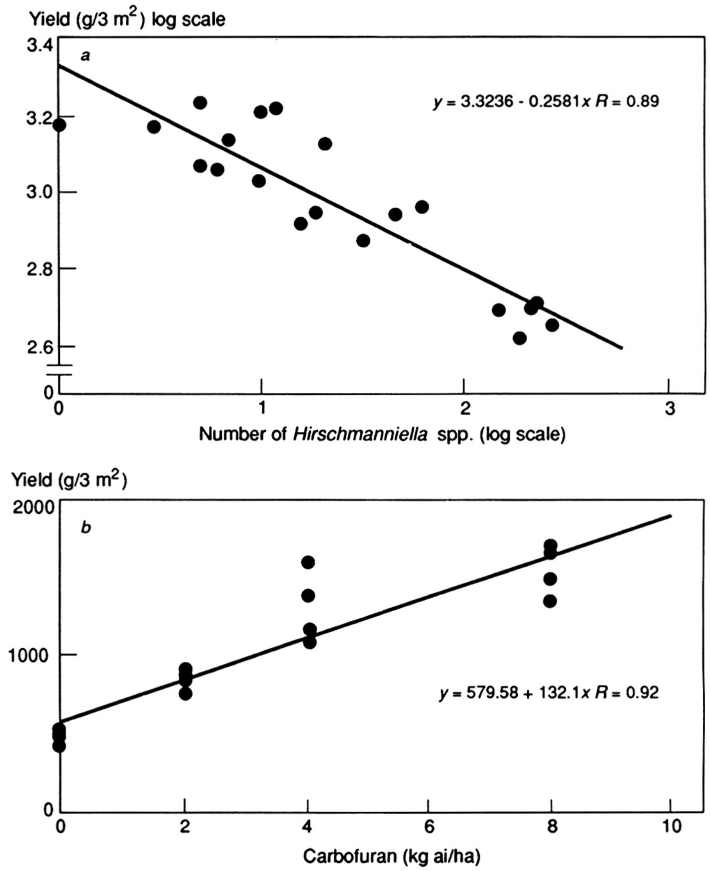
Hirschmanniella spp. may cause yield losses in irrigated rice. However, we are unable to estimate the part of the yield increase attributable to a nematicide treatment.

Despite the tremendous increases in rice yield reported after control of *H. mucronata* and *H. oryzae* by nematicides, the actual reductions in irrigated rice yields caused by rice root nematodes are still controversial. □

Influence of carbofuran treatments on yield of rice cultivars IR36 and IR58 and population densities of *Hirschmanniella* spp. at different growth stages. [a]

Carbofuran (kg ai/ha)	Yield (g/3 m^2) IR36	Yield (g/3 m^2) IR58	Maximum tillering IR36	Maximum tillering IR58	Booting IR36	Booting IR58	Flowering IR36	Flowering IR58	Maturity IR36	Maturity IR58
			Population densities of *Hirschmmniella* spp./liter soil + 3 g roots							
0	539 a	481 a	152 a	210 a	295 a	337 a	438 a	584 a	1160 a	683 a
2	1120 b	861 b	28 b	35 b	57 b	50 b	103 b	100 b	234 b	203 b
4	1461 c	1278 c	9 c	8 c	21 c	21 c	75 b	64 b	111 c	150 b
8	2038 d	1546 d	7 c	8 c	7 c	6 d	54 b	62 b	65 c	102 b

[a] Av of 5 replications. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.



a) Correlation between number of *Hirschmanniella* spp. per liter soil plus 3 g of roots and yield of rice cultivar IR58. b) Correlation between rate of carbofuran and yield of rice cultivar IR58.

Chemical control of crabs in ricefields

M. Sain and M. B. Kalode, Directorate of Rice Research (DRR), Rajendranagar, Hyderabad 30, India

Crabs *(Paratelphusa hydroromus,* Herbst) dig burrows in the bunds of ricefields, allowing water to flow from one field to another. Applied fertilizers or pesticides may get diluted and upper fields dry out while water stagnates in lower fields.

We tested the efficacy of commonly available insecticides (see table) offered as bait or directly applied during 1984 wet season.

All crab burrows on the bunds of a ricefield at DRR experimental farm were closed with mud. The next day, new burrows were counted.

Bait was prepared by diluting 200 g of each insecticide in 50 ml of water, then mixing the solution into 1 kg cooked rice. A 50-g bait was placed inside each burrow. For direct application, about 5 g of the test granular insecticide was placed in each burrow, along with 200-300 ml of water to dissolve the granules (1.5 g of celphos tablet was inserted in a moisturized burrow).

All burrows were plugged with mud and left for 24 h. Counts were taken of open burrows. Burrows not opened were considered "dead."

To verify crab mortality, 50 randomly selected "dead" burrows were dug out: crab mortality was 100%.

Celphos and phorate (81.1 and 80.3% crab mortality) were most effective in direct treatment. Fenthion was most effective (72.4% mortality) as bait. Celphos is already in use to control rats. Phorate granules are also effective in controlling other rice pests, such as stem borer. □

Effect of pesticides on ricefield crabs. DRR, Rajendranagar, Hyderabad, India, 1984 wet season.

Treatment	Burrows treated (no.)	Burrows found opened after 24 h of treatment (no.)	Unopened burrows (%)
With bait			
Carbofuran	52	24	53.8
Quinalphos	92	55	40.3
Phorate	28	13	63.9
Fenthion	58	16	72.4
Control	47	41	12.8
Without bait			
Carbofuran	80	42	47.5
Quinalphos	87	50	37.5
Phorate	61	12	80.3
Fenthion	42	20	52.4
Celphos	90	17	81.1
Control	63	59	6.4

Control of rice rodent *Thryonomys swinderianus* in Sierra Leone

B. D. James, UNDP Project FAO/SIL/85/004, MANR & F Central Crop Protection Laboratory, Magbosi, c/o P.O. Bar 71, Freetown, Sierra Leone

The hystricomorph or cutting-grass rodent *T. swinderianus* Temminek is a notorious pest in rice-based cropping systems of West Africa. Chemical control measures are undesirable because the rodents are a traditional meat source in rural areas. Nonchemical control is necessary.

We monitored rodent drives (see figure) to determine the pest's reproductive cycle in the field and to identify vulnerable stages for crop protection measures.

Drives in three chiefdoms (Kholifa Mabang, Malal, and Yoni) in the Tonkolili District, Northern Province, Sierra Leone, are conducted by a team of 7 trackers, 15 chainmen (netmen), and 5 noisemakers. They use four tracker dogs and up to 18 twine nets of different lengths. Each drive lasts 8-10 h in a succession of selected plots with natural vegetation, mainly wild grasses. The noisemakers and dogs startle and scare the nocturnal rodents toward encircling nets, where they are caught and killed.

In 27 drives Jul 1988 to Jan 1989, 301 *T. swinderianus* were killed; approximately half were females. Adults weighed 3-8 kg and were 0.6-0.85 m long.

The pest appears to breed once a year. All females caught between Jul and Oct 1988 were pregnant, with three to six fetuses each. The gestation period coincided with vegetative growth of upland rice, during which most damage to rice (patches of cut tillers) is reported, primarily at booting. Of 404 fetuses dissected, those within a month's collection were of similar size. That implies a synchronized Jun-Jul estrus cycle.

Parturition was also synchronized, early in the dry season which is from late Oct to early Dec. Catches in those months were lower than in the rainy season.

Although these drives are primarily for catching *T. swinderianus* for human consumption, targeting them at the gestation period would have greater effects on population control. This would also be the best time for well-coordinated drives. However, catch per drive is also determined by rodent abundance and behavior, cover vegetation, and the general motivation and discipline of the hunters. □

Chainmen positioning nets around a grassy plot containing *T. swinderianus* rodents in Sierra Leone.

Farming systems

Raising grass carp with deepwater rice

D. N. Das, B. Roy, and P. K. Mukhopadhyay, Deepwater Rice Pest Management and Fish Culture Project (IRRI/ICAR/Govt. of West Bengal Co-operative Project), Rice Research Station, Chinsurah 712102, West Bengal, India

We experimented with raising grass carp *(Ctenopharyngodon idella* Val) along with deepwater rice NC492 at two sites during 1988 wet season. Rice seedlings were transplanted 4 Jul 1988 at Girirchalk (Midnapore district) and 20 Jul 1988 at Gosaba (South 24-Parganas district). Fish fingerlings were stocked 1 mo later; average length and weight at stocking were 8.0 cm and 12.1 g at Girirchalk and 10 cm and 18.4 g at Gosaba. No fish feed and no fertilizer was applied.

Rice stand count (recorded from a 0.5- × 0.5-m wooden frame) and general field observations were taken periodically. The fish culture period was 120 ± 10 d.

Rice yield data were taken by standard crop-cut method, adjusted to 14% moisture. Fish growth was measured and yield computed.

Stem density did not differ in plots with grass carp and those without fish. Submersed aquatic weed density appeared to be less in plots with fish. Production of rice and grass carp are summarized in the table.

The results indicate that grass carp may be incorporated into a deepwater rice - fish system without jeopardizing rice cultivation. □

Production of rice and fish under integrated deepwater rice + grass carp culture trial. West Bengal, India, 1988 wet season.

Experimental site	Control -only deepwater rice (yield in t/ha)	Rice yield (t/ha)	Fish stocked (1 fish/m^2)	Stocking Length (cm)	Stocking Wt (g)	At harvest Length (cm)	At harvest Wt (g)	Recovery (%)	Fish yield (kg/ha)
Girirchalk (Midnapore)	1.5	1.8	600	8.0	12.1	15.2	80.0	54.0	432.0
Gosaba (24 Parganas S.)	1.8	1.9	320	10.0	18.4	19.2	96.5	60.0	575.8

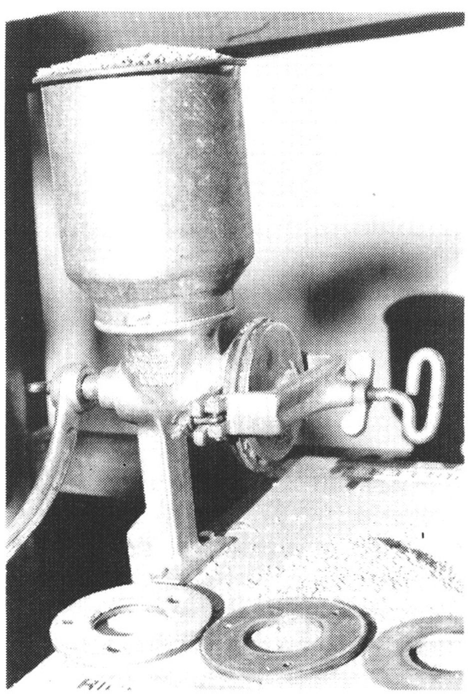
Farm machinery

A hand-operated rice huller

A. Dong and R. J. Edberg, I-Tech, P.O. Box 795, Davis, California 95617, USA

A hand-operated rice huller has been developed that is inexpensive, simple to construct, and easy to maintain. Its two main components are a commercial hand mill and a conversion kit to replace the stationary disk with a gum rubber disk (see figure). When the abrasive rotating disk is turned, rice grains are pressed against the rubber disk and rolled out. The soft rubber disk removes the hulls with minimal damage to the kernels. The huller can also be used for millet and spelt wheat.

The mill will hull 12 kg short grain rice/h. □



Hand-operated rice huller can process 12 kg rice/h.

Surveys of disease or insect incidence/severity in one environment are useful only if the information is related to other variables (e.g., climatic factors, crop intensification, cultivars, management practices, etc.). By itself, information on incidence in one environment does not increase scientific understanding.

Postharvest technology

Aflatoxins in stored rice

S. Vasanthi and R. V. Bhat, National Institute of Nutrition, Hyderabad 500007, India

Mycotoxin contamination of agricultural commodities and the consequent health hazards are problems of considerable relevance in tropical countries. Aflatoxins are the most potent hepatotoxic and carcinogenic agents. In staples such as rice, aflatoxins are of great significance to human health.

Rice can become contaminated with aflatoxin under high moisture conditions that may occur with improper storage, insect infestation, or high humidity.

Studies in India indicate that, under normal circumstances, aflatoxin contamination of rice is low (Table 1). However. rice exposed to stress conditions (such as heavy rains) can become highly susceptible to fungal invasion and increased aflatoxin contamination. In rice damaged by

Table 1. Occurrence of aflatoxin in rough rice and processed rice in India.

Commodity	State	Year	Samples analyzed (no.)	Positive for aflatoxin (no.)	Aflatoxin concentration (μg/kg)
Rough rice	Andhra Pradesh	1975	272	Nil	-
Rough rice[a]	Andhra Pradesh	1976	80	10	Trace-430
Rough rice[a]	Andhra Pradesh	1977	81	19	30-1130
Rice, raw	Karnataka	1974	35	0	-
Rice, raw	Karnataka Uttar Pradesh Andhra Pradesh	1981	76	4	Trace-120
Rice, raw	Andhra Pradesh	1983	63	0	-
Rice, raw	Andhra Pradesh	1987	64	0	-
Parboiled rice	Karnataka	1974	25	8	0-50
Parboiled rice	Tamil Nadu Thanjavur	1976	18	7	30-130
Parboiled rice	Andhra Pradesh	1981	77	7	Trace-120
Parboiled rice	Andhra Pradesh	1988	22	3	Trace- 10

[a]Affected by cyclones.

cyclones along the coastal region of Andhra Pradesh in 1976, 12.5% of 80 samples were positive for aflatoxin; 8.7% had levels from 0.08 to 0.43 ppm. The dominant mycoflora was *Aspergillus flavus.* In 1977, higher aflatoxin levels were found in cyclone-damaged rice: in 81 samples, 23.5% were positive for aflatoxin with 0.03-1.13 ppm levels.

Aflatoxin contamination can be even higher in parboiled rice. Levels reported ranged from traces to 0.13 ppm.

In studies on the effect of processing, dehusking removed 50-70% of the toxin. Polishing further reduced toxin content to 20-35%. Parboiling reduced toxin content in already infected rice by 50%; dehusking and polishing reduced toxins 7 and 17% more (Table 2).

Rice is a dietary staple in many Asian countries, and consumption of mold-damaged or contaminated rice can present serious hazards to public health. Drying to safe moisture levels before storage is an important step. ' In natural disaster situations, the need to monitor stored rice for aflatoxins increases; parboiled rice should be monitored even under normal conditions. □

Table 2. Aflatoxin content of rough and raw rice after processing.

Treatment	Aflatoxin content (ppm)		
	Masuri	Jaya	Sona
Infected rough rice	53.5	16.2	13.3
Infected rough rice after dehusking	24.0	7.6	4.4
Infected rough rice after dehusking and polishing (10%)	18.8	5.7	2.6
Infected rough rice after parboiling	17.9	9.2	8.1
Infected rough rice after parboiling and dehusking	10.4	5.0	3.1
Infected rough rice after parboiling, dehusking, and polishing	3.5	4.5	2.1

SOCIOECONOMIC IMPACT

Production

Constraints to adoption of rice technology in West Bengal, India

N. K. Saha, Joint Director of Agriculture (Rural Sociology), Government of West Bengal; and D. Panda, Research Associate, Farming Systems Research, R.K.M. Ashrama, Narendrapur, South 24-Parganas, West Bengal, India

We studied five villages in Burdwan district under the Operational Research Project on Rice, to identify constraints to adoption of high-yielding wet season rice varieties. The project area has 2,543.76 cultivated ha and is within the irrigation command of Damodar canal system. Of 3,022 farmers, only 1,073 actually have direct control over agricultural activities.

We used stratified random sampling to select 270 working farmers for the study.

Constraints identified were the following:

Holdings in general were small, segmented, and scattered in different locations in more than one village. Much labor is wasted in the movement of inputs, implements, and produce. Farmers have difficulty supervising all their plots efficiently. Consequently, average yield and net return are low (Table 1).

Irrigation water provided by the Damodar canal system cannot be regulated to fit the varying water requirements of transplanted wet season rice at different growth stages. Minimum flow through the existing water canal is 5 ft^3/s, a supply that often is detrimental to the crop.

Puffed rice is an essential component of daily life for the people of this area. Puffed rice prepared from traditional varieties, such as Daharna-

Table 1. Plots owned by rice farmers in Burdwan, West Bengal, India, 1982.

Plots (no.)/ farmer	Yield (t/ha)	Cost ($/ha)	Return ($/ha)
1-3	3.1	271.5	128.0
4-6	3.0	283.3	100.0
7-9	2.9	288.3	93.0
10-12	2.8	291.6	73.3
13-15	2.8	303.3	63.3
>15	2.7	308.2	52.1

era and Kalma, is superior to that prepared from modern high-yielding varieties such as Pankaj and Ratna.

Most of the high-yielding varieties (except Pankaj and Masuri) produce short straw not suitable as cattle feed or roofing material. Marginal and small farmers need straw to thatch their huts.

Nonfarming landowners control 33% of the land. They live outside the project area and either hire labor or rent the land to sharecroppers who take little interest in changing their cropping practices. Moreover, 49.2% of the farm families belong to economically and socially backward scheduled caste and 1.5% to scheduled tribal communities. Most members of these families work as agricultural laborers and sharecroppers and do not have any control over production decisions. All these factors hamper the acceptance of high-yielding varieties (Table 2).

Cultivation costs more for high-yielding varieties than for traditional ones. The marginal and small farmers, 85% of the farming households, cannot afford to grow high-yielding varieties, even though they are aware of the potential of such varieties. Adequate institutional credit is not easily available, particularly from the nationalized banks and cooperatives operating in the area. □

Table 2. Area planted to high-yielding varieties by scheduled caste and by absentee owners compared to others. Burdwan, West Bengal, India, 1982.

Farmer category	% of area planted to modern varieties
Scheduled caste or scheduled tribe	11.6
Absentee owner	15.4
Other farmers	73.0

ANNOUNCEMENTS

First multilingual agricultural research CD-ROM released

Food, agriculture, and science, the first release in a series that will eventually constitute a full, 6,000-title, agricultural library on CD-ROM, is now available from the secretariat of the Consultative Group on International Agricultural Research (CGIAR). The new CD-ROM disk is accompanied by trilingual aids in English, French, and Spanish on floppy disks.

Documents reproduced in *Food agriculture, and science* are drawn from 20 international agricultural research centers—one document per center–and cover 4,000 pages with 850 illustrations, all of which are on the CD-ROM disk.

Among the titles included are *A farmer's primer on growing rice, Field problems of beans in Latin America, Potato research, Agriculture-aquaculture farming systems, Trends and projections of food in the third world, and Sorghum breeding.*

The new CD-ROM is a prototype, which will be tried out internationally. It will be distributed free to interested institutions in developing countries by International agricultural research centers, and will be sold in the U.S. for $99 from Knowledge Access International, Mountain View, CA 94043.

Development of the CD-ROM library is sponsored by the CGIAR, an informal association of over 40 countries, international and regional organizations, and private foundations established in 1971 to support a system of agricultural research around the world. The World Bank, the United Nations Food and Agriculture Organization, and the United Nations Development Programme are co-sponsors of the CGIAR.

The proprietary software technology used in the production of *Food, agriculture, and science*–KAware DISK PUBLISHER and KAware2 RETRIEVAL, SYSTEM–is from Knowledge Access International, a leading producer of CD-ROM, WORM, and floppy disk "desktop databases" for business, research, and the professions.

For more information, contact CGIAR c/o World Bank, 1818 H Street, N.W., Room N5063, Washington, D.C. 20433, USA. (202) 334-8031 or Knowledge Access International, 2685 Marine Way, Suite 1305, Mountain View, California 94043, USA. 800/ 2KAware or 415/969-0606.

IRRC 90 set

The theme of the International Rice Research Conference 1990, to be held in Seoul, Korea, 27-31 August, is IRRIGATED RICE. IRRI and the Rural Development Administration, Korea, are collaborating to organize IRRC 90.

Overview papers and discussion will focus on factors that limit higher yield potential and on the attendant problems of grain quality, distribution, and marketing.

Most of the world's rice supply is grown in the irrigated areas, and irrigated rice shows the highest yield potential. Increasing world populations and limited growth in irrigation mean that grain yield potentials must be increased to 13-15 t/ha.

Low temperature and blast disease are two factors that limit high and stable rice yields. Increasingly, irrigated rice farmers are practicing direct seeding for crop establishment. More related issues will be taken up by conference participants.

Rice scientists from Asia, Africa, Europe, Australia and Latin America will be participating in the conference. □

ERRATA

Effect of seed treatment on early seedling establishment under rainfed conditions, by R. K. Das, R. Ghosh, and B. H. Manjappa. 14 (5) (Oct 1989), 21.

In the table, delete Karnataka, India.

Srivastava R. and Prakash O. Relationship of rainfall distribution patterns to rice productivity. 14 (4) (Aug 89), 12-13.

The equation on page 12 should be replaced by the corrected version given below:

$$Z = 38.105 - 0.07158 \sum_{i=1}^{24} t_i^0 x_i + 0.017056\ t_i x_i$$

$$-0.0008025 \sum_{i=1}^{24} t_i^2 x_i - 0.384T$$

N.E. Alyoshin, E.R. Avakyan, E.B. Lebedev, V.E. Lebedev, and E.P. Alyoshin. External budding in rice aleurone grains. 14 (6) (Dec 1989), 4-5.

In the figure, mm should be changed to μm.

INTERNATIONAL
RICE RESEARCH
INSTITUTE

P.O. BOX 933, 1099 MANILA, PHILIPPINES

Printed Matter

Air Mail

ISSN 0115-0944