Table 2. Correlation coefficients of cold tolerance scores in the field in Korea with traits related to cold tolerance at early seedling and seedling stages in controlled environment at IRRI. 1986.

Characters correlated [a]	Cold tolerance score in field r coefficient
Early seedling stage	
Emergence coefficient	–0.191**
Seedling height, day 8	–0.370**
Seedling height, day 15	–0.640**
Seedling height, day 22	–0.570**
Cold tolerance score, day 8	0.692**
Cold tolerance score, day 15	0.753**
Cold tolerance score, day 22	0.746**
TI based on 15 d survival	–0.758**
TI based on 22 d survival	–0.684**
Seedling stage	
Cold tolerance score after first cold water treatment	0.680**
Cold tolerance score after second cold water treatment	0.823**
TI based on revival 5 d after first treatment	–0.699**
TI based on revival 10 d after first treatment	–0.722**
TI based on final survival after second treatment	–0.771**

[a] TI = tolerance index (integrates both cold tolerance score and percent revival or survival, relative to the resistant check).

indica females, Leng Kwang had the best score of 3.4. All japonica parents, however, had mean cold tolerance scores below 3. Notable cultures were Stejaree 45, SR3044-78-3, SR5204-91-4-1, Shimokita, K84, and Barkat.

Parental performance per se was a good index of their general combining ability (GCA) for leaf discoloration in the field (r = 0.712**). The japonica parents exhibited highly significant GCA effects for low leaf discoloration (high cold tolerance). IR29506 and IR8455-K2 were the only male parents with highly significant GCA effects for low score. The development of cold-tolerant, homozygous lines should be possible through simple selection pressures, and japonicas would be good donors for seedling stage cold tolerance. Of 48 crosses showing specific combining ability (SCA) effects in the desired direction (low score), only 7 were significant. With the exception of China 988/IR8455-K2, SR3044-78-3/IR7167, and Shoa-Nan-Tsan/IR29506, where one of the parents was a good general combiner for cold tolerance, all other good and significant SCA combinations involved at least one parent with significantly poor GCA. High SCA values would not necessarily mean a high performance by the hybrid. Selection of cold-tolerant hybrids on the basis of performance per se appears more realistic.

At IRRI, cultures at the early seedling stage were screened in the phytotron at a constant temperature of 15 °C for 3 wk, and at the seedling stage by the cold-water tank method at a constant temperature of 12 °C for 10 d. All traits scored in the field in Korea and in the controlled environment at IRRI were highly significantly correlated. Except for the association with emergence coefficient and seedling height on day 8, all other associations were of high magnitude (Table 2). Evidently the test cultures behaved consistently in the controlled environment or in the field. Results also indicate that performance in the controlled environment was a good indicator of field performance. Both methods appear equally effective in ranking cultures for cold temperature tolerance at the vegetative stage. For a quick determination of cold temperature tolerance at the seedling stage, however, the cold-water tank method appears highly satisfactory.

Chlorophyll meter (SPAD-501) to quantify relative cold tolerance in rice

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One effect of low temperature on rice is leaf discoloration due to chlorophyll degradation. Quantifying relative cold tolerance by measuring extracted chlorophyll is tedious and time consuming. This study was conducted to evaluate the use of a new chlorophyll meter (Minolta SPAD-501) to quantitatively assess relative cold tolerance in rice. The meter is simple to use and operates on alternating current or batteries. By inserting a leaf into a slit at the head of the instrument and pressing a button, one gets an instant reading.

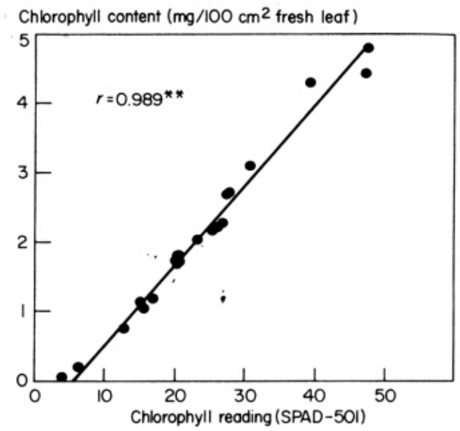
IR8 and Fujisaka 5 seedlings were grown in culture solution for 34 d in the greenhouse and then held in the cold water tank (12°C) for 7 d. Initially, three readings were taken 12 cm from the tip of the first fully developed leaf or second to the youngest leaf (leaf no. 6). Subsequent readings at the same position were taken on the 4th and 7th days. After 4 d of cold water treatment, the SPAD-501 reading of cold-susceptible IR8 decreased from 30 to 27.1, while in cold-tolerant Fujisaka 5, the readings decreased only slightly — from 30.5 to 29.1 although no color change could be detected by the unaided eye at that time (see table). The trend continued in the readings on the 7th day.

SPAD-501 reading of chlorophyll content of IR8 and Fujisaka 5 at 12°C. IRRI, 1986.

Variety	Spad-501 reading Initial	4th day	7th day
IR8	30.0	27.1	22.5
Fujisaka 5	30.5	29.1	28.2

Additional data were collected at 2 temperatures (12 and 30° C) during measurement. The results indicate that temperature during measurement did not affect chlorophyll reading, suggesting that SPAD-501 can be used under high or low temperatures.

Leaf samples were taken from plants having different degrees of yellowing. The chlorophyll content was extracted by dimethyl-sulfoxide (DMSO) method There was a very high correlation (r =



Correlation between chlorophyll content determined by DMSO method and chlorophyll reading from SPAD-501. IRRI, 1986.

0.989**) between SPAD-501 reading and chlorophyll content (see figure). The instrument manufacturer obtained a correlation of 0.815 between chlorophyll reading and actual chlorophyll content using data from several crop species. SPAD-501 is reliable in determining relative chlorophyll content as an index of cold tolerance.

This method has considerable potential in quantifying leaf discoloration due to low temperature as well as yellowing caused by other stresses such as nutrient deficiency, diseases, and drought.

Genetic Evaluation and Utilization

DROUGHT TOLERANCE

Response of rice varieties to protective irrigation

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Extended breaks in monsoon rainfall significantly reduce yield of rice grown on lateritic soils with high infiltration, medium to high total N, high K, and low P in Konkan, India. Yield losses are greatest on newly developed, terraced uplands. Protective irrigation may reduce those losses.

We evaluated 135-d Jaya and RP4-14 for response to protective irrigation in a factorial randomized block design with 5 replications on newly developed terraces of lateritic soil. Rice was sown 9 Jun 1984 and transplanted on 5 Sep at 3 seedlings/hill and 20- × 15-cm spacing. Plots received 50-22-41.5 kg NPK/ha at transplanting and 50 kg N in 2 equal splits at 1-mo intervals. Plots received 251.84 mm of water at each protective irrigation (13 Jul; 19, 21, 24, and 27 Sep; and 1 Oct). Recommended pest control measures were applied. Harvest was 25 Oct.

Yields were relatively low. Protective irrigation increased yield an average 30% over that of the control (see table).

Influence of protective irrigation on grain and straw yield, Maharashtra, India.

Variety	Yield (t/ha)			
	Control		Protective irrigation	
	Grain	Straw	Grain	Straw
Jaya	2.9	3.1	3.9	4.1
RP4-14	3.1	3.1	3.9	4.0
Mean	3.0	3.4	3.9	4.0

		S. Em. ±	CD at 5%
Variety:	Grain	0.1	ns
	Straw	0.1	ns
Irrigation:	Grain	0.1	0.4
	Straw	0.1	0.3
Interaction:	Grain	0.2	ns
	Straw	0.1	0.4

IET7613, a drought-resistant upland rice

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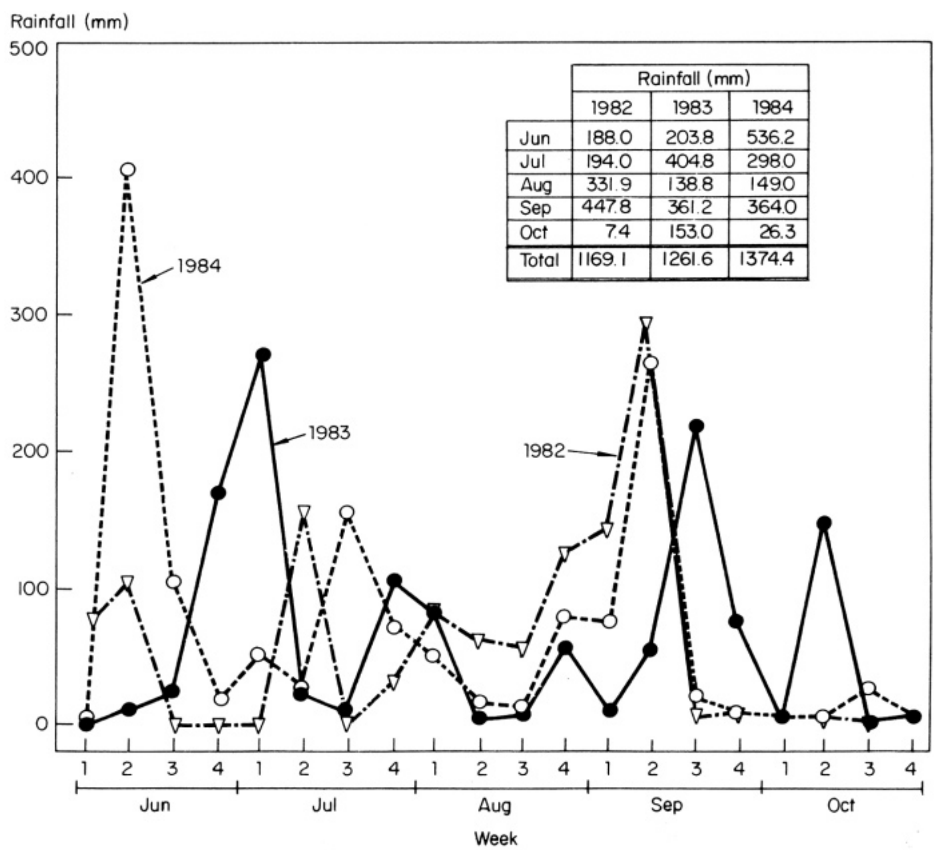
Improved short-duration, drought-resistant, upland varieties are needed for the Uttar Pradesh plains, where rainy season seldom lasts more than 90 d. Newly developed IET7613 (M63-83/Cauvery) yields 15% more at low to moderate soil fertility than locally grown N22. IET7613 is a semidwarf, drought-resistant upland rice that matures in 85 d.



Rainfall distribution in Faizabad, India, during upland trials in 1982-84.