vector- and virus-dependent. In the presence of a resistance-breaking strain, such as Vt6, a shift in GLH virulence (adaptation) results in a breakdown of resistance. On the other hand, the resistance of IR26 did not break down in the presence of RTSV-A. Selection of GLH on this variety for 11 generations did not result in increased RTSV-A infection. TN1 is susceptible to both virus strains regardless of the GLH colony used for inoculation. TKM6 is a differential host for both strains. Although the selected colonies did not transmit RTSV-A, they transmitted RTSV-Vt6 at varying efficiency, depending on the GLH colony used. Variety Adday Sel. (IRGC Acc. No. 180) was highly resistant to both strains regardless of the GLH colony used. Table 2 summarizes the mechanism of resistance of IR26 to RTSV.

This study demonstrated that breakdown of resistance to tungro disease can be both virus- and vector-dependent. This study also showed that some rice cultivars have "true" resistance, that is, race-specific resistance, to the virus strain(s) as exhibited by IR26 and TKM6 against RTSV-A and Adday Sel. against both RTSV strains. This information should be considered when formulating effective control strategies against tungro.

Table 2. Mechanism of resistance of IR26 to RTSV.

Virus strain	GLH colony	Reaction	Mechanism of resistance
RTSV-A	Nonadapted	Resistant	R to both virus and vector
RTSV-A	Adapted	Resistant	R to virus
RTSV-Vt6	Nonadapted	Resistant	R to vector
RTSV-Vt6	Adapted	Susceptible	

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Seed technology

Leaf number: a reliable parameter for determining seeding intervals between parental lines in hybrid rice seed production

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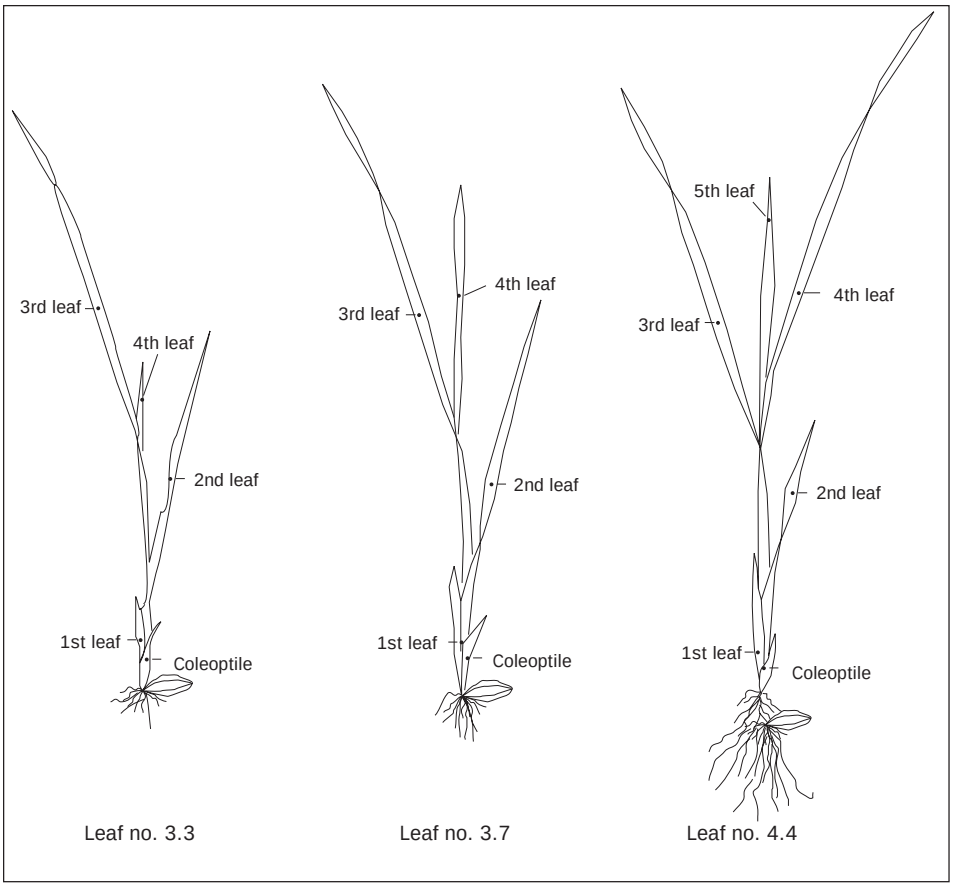
Because parental lines of rice hybrids usually differ in their growth duration, obtaining well-synchronized flowering is a major problem in hybrid rice seed production. The present method of staggered sowing of parental lines based on their growth duration difference, though simple, is not always effective, especially in areas where temperature changes are frequent. Reports from China indicate that because the leaf number of a rice cultivar is fairly stable, leaf number difference can be used to decide the seeding dates of parental lines in hybrid rice seed production. Before using this method, however, the leaf number of the prospective parental lines to be used in hybrid rice seed production should be ascertained. We conducted an experiment to determine the leaf number of two cytoplasmic male sterile (CMS) lines and five promising restorers during the 1994 wet season (WS), 1995 WS, and 1995 dry season (DS) at the DRR research farm. We also compared the extent of variation for leaf number and days to flowering over the seasons.

Seedlings were raised in wet beds, 10 seedlings were marked, and leaf counting started from the tenth day. After 25 d, the same seedlings were transplanted to the main field and leaves were counted at intervals of 5 d until the opening of the flag leaf. Incomplete leaves were numbered by comparing their length with the previous leaf, using a 10-point scale (see figure).

The table presents data for leaf number and days to 50% flowering. Leaf number ranged from 15.3 (IR58025A) to 18.5 (Vajram). The coefficient of variation for leaf number over seasons varied from 0.65 to 1.89 and a wide range of variation was observed for growth duration (CV 6.23-12.53). Variation for leaf number between WS and DS was negligible, whereas growth duration varied widely between the two seasons. In view of the relative stability of leaf number over seasons, this parameter can be used to determine the seeding intervals between parental lines to obtain better synchronization in flowering.

Leaf number difference between two parental lines can be used to determine the seeding interval when the leaf growth rates (leaf growth rate = number of days taken to produce the first 7 leaves divided by 7) of the parental lines are the same. For example, the leaf growth rate of CMS line IR58025A and restorer IR40750-82-2-2-3R is the same (6.4) and the leaf number difference between them is 1.3 during the DS. Therefore, for seed production of hybrid IR58025A / IR40750-82-2-2-3R during the DS, the male parent is sown first and the female parent is sown later, when the earlier sown male parent has produced 1.3 leaves.

In cases where parents differ in their leaf growth rate, the seeding interval is determined by using the following formula: seeding interval (d) = leaf number difference × leaf growth rate of the early sown parent. ■



Rice seedlings showing different leaf numbers.

Leaf number and growth duration of parental lines of promising hybrids at Hyderabad, India[a].

Parental line	Leaf number					Days to 50% flowering				
	1994 WS	1995 WS	1995 DS	Mean	CV	1994 WS	1995 WS	1995 DS	Mean	CV
IR58025A	15.7	15.3	15.0	15.3	1.83	103	98	113	104.6	6.23
IR62829A	16.2	16.0	15.9	16.0	0.81	96	89	106	100.0	7.59
Vajram	18.3	18.6	18.6	18.5	0.75	112	119	144	125.0	10.98
IR10198-66-2R	15.6	15.4	15.0	15.3	1.64	90	87	101	92.6	6.49
IR40750-82-2-2-3R	16.1	16.1	16.3	16.2	0.61	111	102	125	112.6	8.40
IR54742-22-19-3R	18.5	18.0	18.8	18.4	1.89	111	109	142	120.6	12.53
IR29723-143-3-2-1R	17.1	17.8	17.3	17.4	1.69	119	116	143	126.0	9.58

[a]WS = wet season, DS = dry season, CV = coefficient of variation.

Adapting hybrid rice seed production technology

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The success of hybrid rice cultivation in India depends on a successful seed production program. Optimizing row ratio, determining the economic dose of GA_3 and its stage of application, and identifying a suitable substitute for GA_3 are required for hybrid rice seed production.

An experimental study revealed that the row ratio of female to male of 6:1 recorded the highest hybrid seed yield of 1,921 kg ha^{-1}. GA_3 application increased plant height, panicle exsertion, flag leaf angle, seed setting percentage, and seed yield. Comparatively, the proportionate increase in seed set and yield was high when applying GA_3 at 125 g ha^{-1}. For GA_3 application, the 15-20% panicle exsertion stage was found to be ideal for obtaining maximum seed set and seed yield.

Besides GA_3, applying a 2% foliar spray of juvenile leaf extract of *Albizia amara* and 2% urea spray enhanced seed yield by increasing panicle exsertion and seed set in the cytoplasmic male sterile line. ■