0.92(±0.23). The genotype-by-year and the genotype-by-location interaction variance components were near zero. The three-way interaction was one fourth the magnitude of the genetic variance and significant in the analysis of variance. Interactions such as this are the result of either changes in genotype rank or magnitude across environments. In a screening program, changes of magnitude are inconsequential. To further explore the nature of the genotype-by-environment interaction, the number of significant cross-over (rank change) interactions was determined. For the 32 entries and the nine environments, all possible pairs of genotypes in all possible pairs of environments, 17,856 quadruple combinations, were tested for significant cross-over interactions. The test for cross-over interaction for any quadruple depends upon the difference in genotypes means exceeding a critical value (L.S.D. P=0.05) in one environment while the negative of the difference exceeds the critical value in the other environment. Of these possible quadruple combinations, only 798 (4.5%) were significant cross-over interactions. The effect of genotype-by-environment interaction on straighthead was minimal. A single location screening test with four replications, $h^2=0.77(\pm 0.19)$, should be adequate for screening varietal reaction to straighthead.

Cool Weather Induced Blanking and Outcrossing of Rice

Hung, H.H., Barker, L.N., Pope, C.L., and Leonardi-Dron, P.

Outcrossing among different rice genotypes can be very troublesome to plant breeders. Observations indicate surprisingly high frequencies of outcrossing among rice populations planted with seed from a winter nursery. Cool temperatures at critical growth stages appear to be associated with elevated floret sterility and increased outcrossing. Blanking among cultivars and F_1 plants has ranged from 10 to 95% in winter nurseries. This study addresses the cool temperature-blanking-outcrossing relationships.

Eight glabrous (glgl) x pubescent (GlGl) F_2 populations were studied to learn the probable levels of outcrossing in a winter nursery. The segregation ratios of pubescent leaf vs. glabrous leaf were determined for F_2 populations derived from F_1 rows in two planting patterns. In the first, F_1 plants of three glgl x GlGl crosses were in rows between other Glgl F_1 rows and in the second, four Glgl F_1 populations were planted with glgl F_1 plants in adjacent rows. Blanking in F_1's in the first pattern was 80 to 90% and the F_2 segregation of pubescent vs. glabrous barely fit a 3:1 ratio with P = 0.05-0.20 in two crosses and P = 0.01-0.02 in one cross. Two of the four Glgl crosses planted among homozygous glabrous neighbors had less severe blanking (50%) and the subsequent F_2 pubescent vs. glabrous ratios were 3:1 (P = 0.10-0.20 and 0.50-0.70). However, blanking was high in the other two F_1 populations (90%) and Gl__ vs. glgl ratios among their F_2 plants did not fit the 3:1 ratio (P<0.01). A second population of the cross which departed most from the 3:1 ratio was grown. It's seed was derived from F_1 plants in a greenhouse where little outcrossing occurred and the F_2 segregation was 3 Gl__ vs. 1 glgl with P = 0.30-0.50.

Observed data did not provide for precise estimates of outcrossing levels in the rice crosses studied. However, the amount detected was high enough to cause serious problems in a breeding program. Even a small amount of outcrossing, that which may be too low to distort F_2 segregation ratios, may result in progenies that mislead the breeders and hinder the improvement of certain quantitative traits. Some outcrossing may be undetected when crosses do not include marker genes.

Cold Tolerance of Short-Season Rice Cultivars in Uruguay

Blanco, P.H., Pérez, F.B., and Roel, A.

The reproductive phase of rice growth, including panicle development and anthesis, is very susceptible to low temperatures that cause grain sterility. Cold periods during the reproductive phase are common in Uruguay. Warmer months of summer, January and February, have an average of 10 and 9.6 days, respectively, with minimum temperatures below 15° C. The development of short-season cold tolerant cultivars, with good milling and cooking quality, has been a priority for the local breeding program that recently released two short-season high-yielding cultivars, INIA Yerbal and INIA Tacuarí. Their rough rice yields averaged 7.7 and 8.6 t/ha, 9 and 19% higher than that of Bluebelle, during five years of yield trials.

The information from Time of Seeding experiments, from 1989/90 to 1992/93, was used to compare cold tolerance of INIA Yerbal and INIA Tacuarí to that of the check cultivars Bluebelle and El Paso 144. Minimum and mean pre-flowering temperatures for a ten-day period (10DPF), mean temperatures during flowering (10DF), as well as mean temperatures during the whole reproductive phase (10DPF+10DF) were recorded for each plot and related to the observed grain sterility, adjusting regression equations.

INIA Yerbal and INIA Tacuarí maintained moderate sterility even at the lowest 10DPF temperatures, that resulted in high sterility in the check cultivars (Figure). When the 10DF or 10DPF+10DF periods were considered, INIA Yerbal and INIA Tacuarí also showed better cold tolerance than the check cultivars. Bluebelle had better tolerance than El Paso 144 during pre-flowering but was susceptible during flowering. Selection under natural conditions in late-seeded populations has been effective to develop cold tolerant cultivars that may contribute to increase and stabilize grain yield in the country.

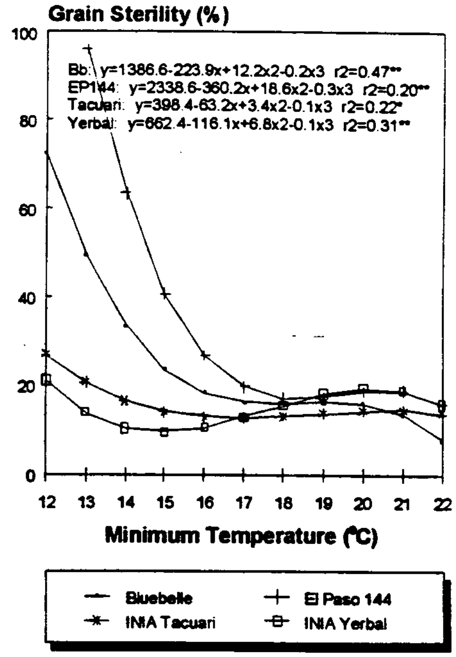

Figure 1. Minimum Temperature 10DPF

Japanese Rice Breeding: Current Situation and Future Plans

Ikeda, R.

Rice is well adapted to Japan and is the staple food for the Japanese people. Paddy fields serve two functions. Firstly, they allow continuous cultivation of rice. Secondary, they are an important component of environmental conservation.

The present aim in Japan is to increase the national yield of brown rice from 5t/ha to 5.5t/ha in 5 years and 5.8t/ha in 10 years. Specific rice cultivars adapted to the various agro-ecological regions of Japan are necessary to obtain stable high yield in each region. In the future, cultivars with characteristics for direct seeding and a higher yield potential will be required. Further improvements in the eating quality of rice and development of rices designed for specific specialized uses are also trends on which rice breeders are focusing attention. In addition, resistance to disease and insect pests and cold tolerance are needed to stabilize rice production in Japan.

To achieve low cost rice production, cultivars adapted to direct seeding with a high yield potential are required. To improve cultivars for direct seeding, high germinability and ability of seedlings to grow at low temperatures and lodging resistance are needed. Cold tolerance at reproductive phase of rice is special important for rice cultivation in the northern part of Japan. Analyzing the mechanism of cold tolerance, the cultivars with high cold tolerance will be developed.

Eating quality of rice cultivars is another important trait in Japan. The standard high quality rice in Japan is "Koshihikari". Ways of improving on the quality and agronomic characters of this cultivar are being sought. Among the traits to be investigated in relation to quality are long or big grain, aroma, or colored grain, high lipid or low protein content, or hypoallergenic rice.