Development of Aromatic Rice Varieties

D.K. Ahrent, K.A.K. Moldenhauer,
J.A Bulloch, V.A. Boyett, V. Booth, and V. Thompson

ABSTRACT

The University of Arkansas System Division of Agriculture has implemented an aromatic rice breeding program at the Rice Research and Extension Center (RREC), Stuttgart, Ark., to develop cultivars for the U.S. to meet the market demand for aromatic rice. Rice imports have doubled in the last ten years and are composed mainly of aromatic rice. The aromatic rice breeding program has made cross-pollinations to incorporate genes for aroma, yield, improved plant type, superior quality, and broad-based disease resistance. Marker-Assisted Selection is used to screen for aroma, cooking quality, and blast resistance. In 2010, an experiment was established to determine the effect of different nitrogen fertilizer rates on the aroma and yield of aromatic rice varieties. Results of the yield trials in 2010 and 2011 showed mixed varietal response to increased nitrogen fertilizer. Some varieties increased in yield while others remained unchanged or decreased with increased nitrogen fertilization. Total rice percentages in the two-year study varied significantly across varieties.

INTRODUCTION

Approximately 13.3 million cwt of milled rice was imported to the U.S. in the fiscal year 2009/2010. This is an increase of 22% in the last eight years (USA Rice Federation, 2008 and 2010). United States consumers are purchasing more aromatic or specialty rices and the overseas markets cannot meet the demand. It has been difficult for U.S. producers to grow the true Jasmine and Basmati varieties due to environmental differences, photoperiod sensitivity, fertilizer sensitivity, and low yields, thus making aromatic rice a valuable commodity. Adapted aromatic rice varieties need to be devel-
oped for Arkansas producers which meet the taste requirements for either Jasmine-type or Basmati-type rice. Research is needed to determine what type of Arkansas soils will produce the best aromatic rice and the optimum fertility to produce the best milling quality which will meet the consumers’ demands.

**PROCEDURES**

The aromatic rice breeding program collected parental material from the U.S. breeding programs and the USDA World Collection. Crosses were made to incorporate genes for aroma, yield, improved plant type, superior quality, and broad-based disease resistance. The winter nursery in Puerto Rico is being employed to accelerate generation advance of potential varieties for testing in Arkansas during the summer of 2012.

DNA analyses were run on the parents and \( F_2 \) populations (Boyett et al., 2011). In 2011, approximately 2,550 \( F_4 \) panicle rows were planted in the RREC nursery from 2010 selections. Approximately 1,575 of the panicle rows were heterozygous lines from two of the \( F_4 \) populations and they were screened through Marker-Assisted Selection for aroma and amylose content. Leaf tissue was collected from five plants in each row for analysis.

An Aromatic Rice by Nitrogen Rate study was conducted in 2010 and 2011 to determine the effect of different rates of nitrogen fertilizer on the aroma and yield of aromatic rice varieties. Eight rice lines: Dellrose, Jasmine 85, Jazzman, Jazzman II, JES, Sierra, Wells, and STG03-085, which is a University of Arkansas experimental line, were treated with six nitrogen rates: 0, 30, 60, 90, 120, and 150 lb/acre. In 2010, another University of Arkansas experimental line, STG06-126, was determined to be non-aromatic and was dropped from the experiment the following year. Agronomic and yield data were collected. Hulled and milled seed samples from each plot were tested for the concentration of the aroma compound 2-acetyl-1-pyrroline (2A-P). This analysis is being conducted at the USDA-ARS Southern Regional Research Center, New Orleans, La.

**RESULTS AND DISCUSSION**

In 2011, 63 cross-pollinations were made to produce aromatic lines for screening. The \( F_1 \) plants from these crosses are growing in the greenhouse this winter to produce \( F_2 \) seed. The \( F_2 \) populations will be planted in 2012 at RREC for observation and selection.

Panicles were selected from 21 \( F_2 \) populations in 2011. All of the parents in these crosses were aromatic. Approximately 625 \( F_3 \) lines were planted in the winter nursery at Puerto Rico to advance a generation. The harvested seed from Puerto Rico will be planted at the RREC for further observation and selections in 2012. Marker analysis will be conducted to detect or determine the characteristics of aroma, cooking quality, and blast resistance.
Results of the Marker-Assisted Selection for the 1,573 heterozygous lines screened in 2011 for aroma and amylose content helped eliminate lines which did not meet quality requirements. Using the microsatellite marker RM190, 16% of the entries were heterozygous for amylose content. “Approximately 45% of the entries were homozygous long-grain class and 37% were homozygous Jasmine-type quality” (Boyett et al., 2012). Only 1% of the lines were discarded due to non-parental alleles.

Results of the 2010 Aromatic Rice by Nitrogen Rate study showed that grain yield responses to increased nitrogen fertilizer differed among varieties. Dellrose, Jazzman, and Sierra appeared to be the least affected by the additional fertilizer with Sierra having the lowest overall yield. STG03-085 had the highest yield with 90 lb N/acre and had the highest overall yield across the varieties. The yields of JES, Jasmine 85, STG06-126, and Wells increased with increasing levels of applied N.

Total rice percentages for 2010 resulted in significant differences across varieties and across nitrogen fertilizer treatments. JES had the lowest and Jazzman had the highest overall percentage of total rice. The lowest percentage of total rice was found in all varieties receiving 0 lb N/acre and the highest percentage was at the 150 lb N/acre rate.

Results of the 2011 Aromatic Rice by Nitrogen Rate study showed that grain yield response to nitrogen rates varied among the varieties. Dellrose, Jasmine 85, and STG03-085 grain yields decreased with increased nitrogen. STG03-085 had the lowest yields across all varieties. Jazzman and Wells responded with increasing yields to the additional nitrogen. Jazzman II, JES, and Sierra had no significant yield changes across the nitrogen rates. The non-aromatic control, Wells, had the highest yield in the 2011 test, followed by JES.

Total rice percentages for 2011 were significantly different across varieties but not across nitrogen fertilizer treatments. STG03-085 had the lowest and Sierra had the highest overall percentage of total rice.

**SIGNIFICANCE OF FINDINGS**

The Aromatic Rice by Nitrogen Rate experiments were planted in two different areas of the RREC and will be continued a third year in a new area. The yields were noticeably higher in 2011. Perhaps the experiment was planted in a high fertility area in 2011. The planting dates for the tests were 12 May 2010 and 18 May 2011. The weather in 2010 was abnormally hot and high nighttime temperatures may have affected kernel fill. The analysis for 2A-P is not complete at this time but will be included in all further reports.

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LITERATURE CITED

