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Effect of Nitrogen Fertilizer on Milling Quality of Rice (Oryza sativa)

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EFFECT OF NITROGEN FERTILIZER ON MILLING QUALITY OF RICE *(ORYZA SATIVA)*

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ABSTRACT

The effect of nitrogen fertilizer on milling quality or milling yield of rice *(Oryza sativa)* was tested for two cultivars, 'Lemont' and 'Newbonnet'. This was an increase in the percentage of broken kernels and a decrease in head rice yield when no nitrogen fertilizer was applied as compared to applying all of the nitrogen at preflood or in split applications. The greater affect was on Lemont, a cultivar that requires a high amount of nitrogen fertilizer for maximum grain yields. Data showed that the percentage of head rice can be reduced by as much as 7 to 22 percent in Lemont and from 2 to 6 percent in Newbonnet when no nitrogen is applied as compared to applying all of the nitrogen at preflood or in split applications. Also, these data show that the percentage of broken kernels can increase from 8 to 19 percent for Lemont and from 4 to 11 percent for Newbonnet when no nitrogen fertilizer is applied as compared to applying all of the nitrogen at preflood or in split applications.

INTRODUCTION

Milling quality of rice *(Oryza sativa)* is determined by the percentage of whole kernels (head rice), broken kernels, and total milled rice. In fact, the United States standards for rough rice and milled rich is based on the quantity of whole kernels and total milled rice (whole and broken kernels combined) that is produced in the milling of rough rice to a well milled degree (Morse *et al.*, 1967). Rice producers received more than twice as much money for whole kernels as they did for broken kernels in 1988 (Anonymous, 1988). Therefore, it is imperative that producers understand the variables that influence milling quality of rice. The effects of moisture content of the grain at harvest on milling yield has been well documented. For example, Smith *et al.* (1938) showed in Arkansas and Texas in the 1930's that rice harvested between 23 to 28% moisture content of the grain, after drying, resulted in maximum grain yield and the highest percentage of head rice yields. In the 1940's and 1950's McNeal (1950) of Arkansas showed that the highest milling quality of dried paddy rice occurred when the grain was threshed between 16 to 24% moisture content. Kester *et al.* (1963) of California showed in the 1960's that the highest head rice yield after drying, was obtained at harvest moisture contents between 25 to 32%. Also, Morse *et al.* (1967) of California showed that the maximum head rice yield was obtained when the grain was harvested between 28-30% moisture content. In the 1970's Calderwood *et al.* (1980) of Texas found that the percentage of total milled rice increased with delays in harvest date but the percentage of head rice reached a maximum at an intermediate harvest date then declined rapidly with delays in harvesting.

Dilday (1987) showed significant differences between cylinder speed, germplasm, and moisture content of the grain at harvest on milling yield. For example, the percentage of broken kernels approximately doubled when the cylinder speed of the thresher was increased from 600 to 1000 RPM. 'Newbonnet' produced the fewest broken kernels (5.7, 11.0) while 'Leah' had the most broken kernels (22.6, 30.6) at 600 and 1000 RPM, respectively. Also, 'Lemont' produced the highest total milling yield (69.5, 70.6); whereas, 'L202' produced the lowest total milling yield (63.4, 66.3) at 600 and 1000 RPM, respectively.

The objective of this study was to determine the affect of nitrogen fertilizer on milling quality of two rice cultivars, Lemont and Newbonnet.

MATERIALS AND METHODS

Nitrogen fertility experiments were conducted during a two-year period, 1986 and 1987. Field trials with two cultivars were conducted at the Rice Research and Extension Center Stuttgart, Arkansas, on a Crowley silt loam soil which is a fine montmorillonitic, thermic Typic Albaqualf. The exprimental design for each of the tests was a randomized block design with four replications. Rice was drill-seeded in plots that were 14 row wide and 4.57 m long with a 0.191 m row spacing on April 23, 1986 and 1987. The seedlings emerged on May 4, 1986 and May 8, 1987, respectively. Plots of the two cultivars were harvested each year at 10 separate harvest dates. Harvesting started at a moisture content of approximately 25% and the harvest continued twice a week for five weeks. The number of days after heading ws noted for each harvest sample.

A single row 3.66 m long was hand-harvested from the center 10 rows of each plot generally between the hours of 1100 and 1400 when the kernels were free of dew and surface moisture. The outer 2 rows on each side of each plot were not harvested. The amount of rice harvested from the 3.66 m row generally ranged from 450 to 750 grams. A vogel thresher [Mention of trade names or proprietary products if for information only and does not necessarily imply their endorsement by the USDA, Riceland Cooperative, or the Arkansas Agric. Exp. Stn.] was used to separate kernels from straw. The samples were passed through a screen to remove the larger leaves and stems. Samples were weighed in the laboratory and the moisture content was determined with a DICKEY-john Model Gac II grain analysis moisture meter. The samples were immediately placed in a zipper-top plastic bag and taken to Riceland Cooperative, Stuttgart, Arkansas the following day for drying to about 12% moisture and analysis. Samples were cleaned over a Carter-Day dockage machine with FGIS approved sieves and determinations of milling yield were carried out in accordance with the standard procedure of rice graders (Anonymous, 1982, 1983), (Smith, 1972), except that the samples processed were smaller (162 g) than the normal 1,000 grams.

The test plots were flushed two times in 1986 and three times in 1987 to obtain uniform seedling emergence and a permanent flood (5-10 cm) was established at about the fifth true leaf stage and maintained until maturity. The four nitrogen treatments were 0, 3-way split, 6-way split and all preflood. A total of 135 and 180 lbs./A of nitrogen were applied as urea to Newbonnet and Lemont, respectively. The 3-way split application of nitrogen was applied at a rate of 75-30-30 and 120-30-30 lbs./A of nitrogen on Newbonnet and Lemont, respectively. The 75 and 120 units were applied prior to the first flood, the first 30 units at ½" to " internode elongation and the second 30 units were applied 10 days later. All of the nitrogen was applied immediately prior to the first flood in the preflood treatment. Head rice, total milled rice, and percentage of broken kernels for each cultivar were analyzed using the General linear models procedure. The LSD procedure was used for mean separation.

RESULTS AND DISCUSSION

The combined analysis (Table 1) for 1986 and 1987 showed that the greatest percentage of broken kernels and the lowest head rice yields occurred when no nitrogen fertilizer was applied. Conversely, the fewest broken kernels and the highest head rice yields were obtained when nitrogen fertilizer was applied. Furthermore, the fewest broken kernels were observed when all of the nitrogen was applied at preflood in both 1986 and 1987. Also, the greatest head rice yield was obtained where all of the nitrogen was applied at preflood in 1987. The greatest numerical head rice yield also occurred where all of the nitrogen was

Table 1. Influence of Nitrogen Fertilizer on Milling Yield (Combined analysis - Lemont and Newbonnet)

	-----------	-%-	-----------	
	Head Rice		Broken	
Treatment	1986	1987	1986	1987
0	59.8 b	43.4 c	10.4 a	24.4 a
3-way split	61.9 a	53.8 b	7.2 b	15.7 c
6-way split	61.7 a	51.4 b	7.2 b	18.0 b
All Preflood	62.2 a	57.1 a	6.8 c	13.0 d

Means within a column followed by the same letter are not significantly different at the P < 0.05.

Table 2. Influence of Nitrogen Fertilizer on Milling Yield of Lemont.

	-----------	-%-	-----------	
	Head Rice		Broken	
Treatment	1986	1987	1986	1987
0	55.9 c	35.0 d	15.2 a	33.3 a
3-way split	60.5 b	52.0 b	8.7 b	18.5 b
6-way split	61.2 ab	49.3 c	8.9 b	21.4 c
All Preflood	62.6 a	56.8 a	7.3 c	14.2 d

Means within a column followed by the same letter are not significantly different at the P < 0.05.

Table 3. Influence of Nitrogen Fertilize on Milling Yield of Newbonnet.

	-----------	-%-	-----------	
	Head Rice		Broken	
Treatment	1986	1987	1986	1987
0	63.7 a	51.7 d	5.6 ns	15.6 a
3-way split	62.9 ab	55.6 b	5.7	13.0 c
6-way split	62.6 ab	53.5 c	5.5	14.6 b
All Preflood	61.8 b	57.3 a	6.2	11.9 d

Means within a column followed by the same letter are not significantly different at the P < 0.05.

applied at preflood in 1986 but the preflood treatment was not significantly different from the 3-way or 6-way split applications.

Data from each cultivar, Lemont and Newbonnet, were analyzed independently and the analysis showed that the highest percentage of broken kernels in Lemont occurred when no nitrogen was applied and the fewest broken kernels occurred where all of the nitrogen was applied at preflood both in 1986 and 1987 (Table 2). Also, the lowest head rice yield occurred where no nitrogen was applied both in 1986 and 1987. The highest head rice yields in 1987 occurred where all of the nitrogen was applied at preflood; furthermore, the largest numerical head rice yield in 1986 was where all of the nitrogen was applied at preflood but the preflood treatment was not significantly different from the 6-way split. There was no significant difference among nitrogen treatments for broken kernels in Newbonnet in 1986 but in 1987 the zero and all preflood treatments caused the milling yield of Newbonnet to react the same as the milling yield for Lemont in 1986 and 1987 (Table 3). Furthermore, the head rice yields of Newbonnet and Lemont reacted the same for all four treatments in 1987. The greatest head rice yield of Newbonnet occurred at the zero level of nitrogen in 1986 and there were no significant differences among the treatments where nitrogen was applied. The 1986 head rice yield data for Newbonnet was not consistent with the head rice yield data for Lemont in 1986 and 1987 or for Newbonnet in 1987. This suggest that further studies are needed to delineate the affects among nitrogen treatments on head rice yields, especially for Newbonnet.

Non uniform applications of nitrogen fertilizer (streaking), which are usually due to improper aerial applications, are common in producer fields of rice. Furthermore, uneven distribution of nitrogen fertilizer can have an adverse affect on milling yield in rice. For example, these data show that the percentage of broken kernels will approximately double when no nitrogen is applied as compared to proper nitrogen application at preflood or in split applications, especially for Lemont. Also, these data suggest that Newbonnet reacts in the same manner as Lemont, although the affect of increasing the percentage of broken kernels in the streaked (no nitrogen) area will not be as pronounced in Newbonnet as it is in Lemont, a variety which requires a higher level of nitrogen for maximum grain yields (Norman and Wells, 1985).

SUMMARY

These data show that nitrogen fertilizer has an influence on milling yield in rice, especially on Lemont. Furthermore, these data show that the percentage of broken kernels can essentially double, especially for Lemont (14 to 33%), in those areas of the field which receives no nitrogen as compared to areas that receive all of the nitrogen at preflood or in split applications. The percentage of broken kernels of Newbonnet (12 to 16%) were affected about like the percentage of broken kernels of Lemont but the affect was not as pronounced. Also, the head rice yield can be reduced by as much as 7-22% percent for Lemont in areas where zero nitrogen is applied as compared to all of the nitrogen being applied at preflood or in split applications.

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