NOTE

Effect of Physical, Physiological, and Chemical Factors on the Expression of Chalkiness in Rice

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Several kinds of chalkiness occur in rice; one is white belly (WB), a chalky spot on the ventral side of the rice grain. Although variously influenced by environmental factors (Ebata and Nagato 1967, Tashiro et al 1980), WB seems to be more stable and predominant than other types of chalkiness and has been considered a varietal factor (Bhashayam and Srinivas 1981). Rice grains have been classified into four types depending on the frequency and distribution of WB in the population (Raju 1989). WB reduces the market quality of rice and predisposes the grain to cracking and thereby accounts for higher breakage in milling.

In the Jaya variety, WB occurs in all the grains. The average breadth and weight of an individual grain are 2.7 mm and 27 mg, respectively. Reduction of the breadth to 2.2 mm and of the weight to 21 mg by applying mechanical constraint during grain maturation (Fig. 1) resulted in the elimination of WB, indicating that breadth is a factor responsible for WB.

Moisture stress in the field during grain maturation reduced the proportion of WB grains from 58.0 to 45.6% in the Pankaj rice variety and from 41.2 to 35.4% in the Mangala variety. This reduction in the frequency of occurrence of WB grains was associated with a corresponding reduction in the grain weight ranging from 2–4 mg per grain. These findings strongly indicate

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Fig. 1. Portion of the rice panicle (Jaya variety), showing aluminum foil rings pressed over the developing grains (arrow).

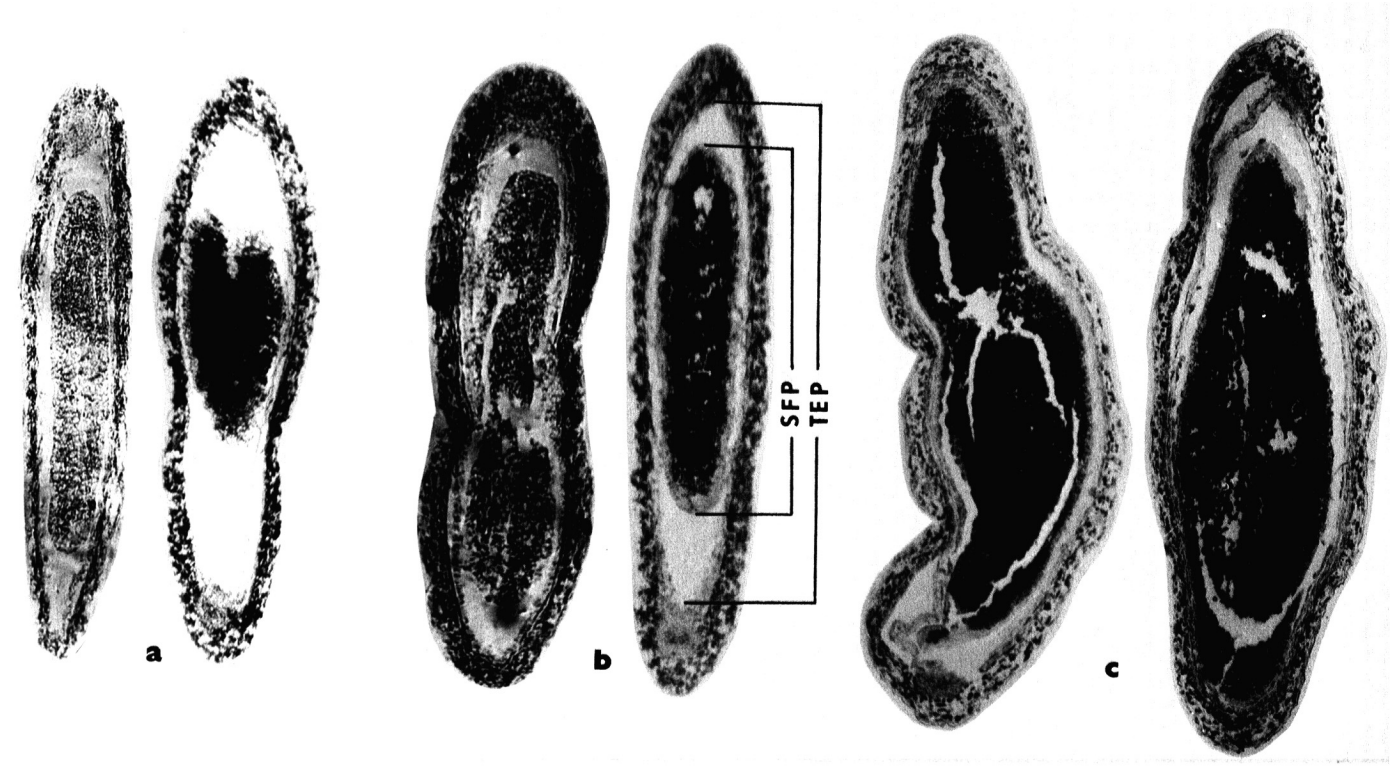

Fig. 2. Transverse sections of three-, five-, and seven-day old grains (**a**), (**b**), and (**c**), respectively, of chalky variety FT199C (left) and translucent variety S199 (right), showing faster starch filling of the former than of the latter (×80). SFP = starch-filled portion, TEP = total endosperm portion.

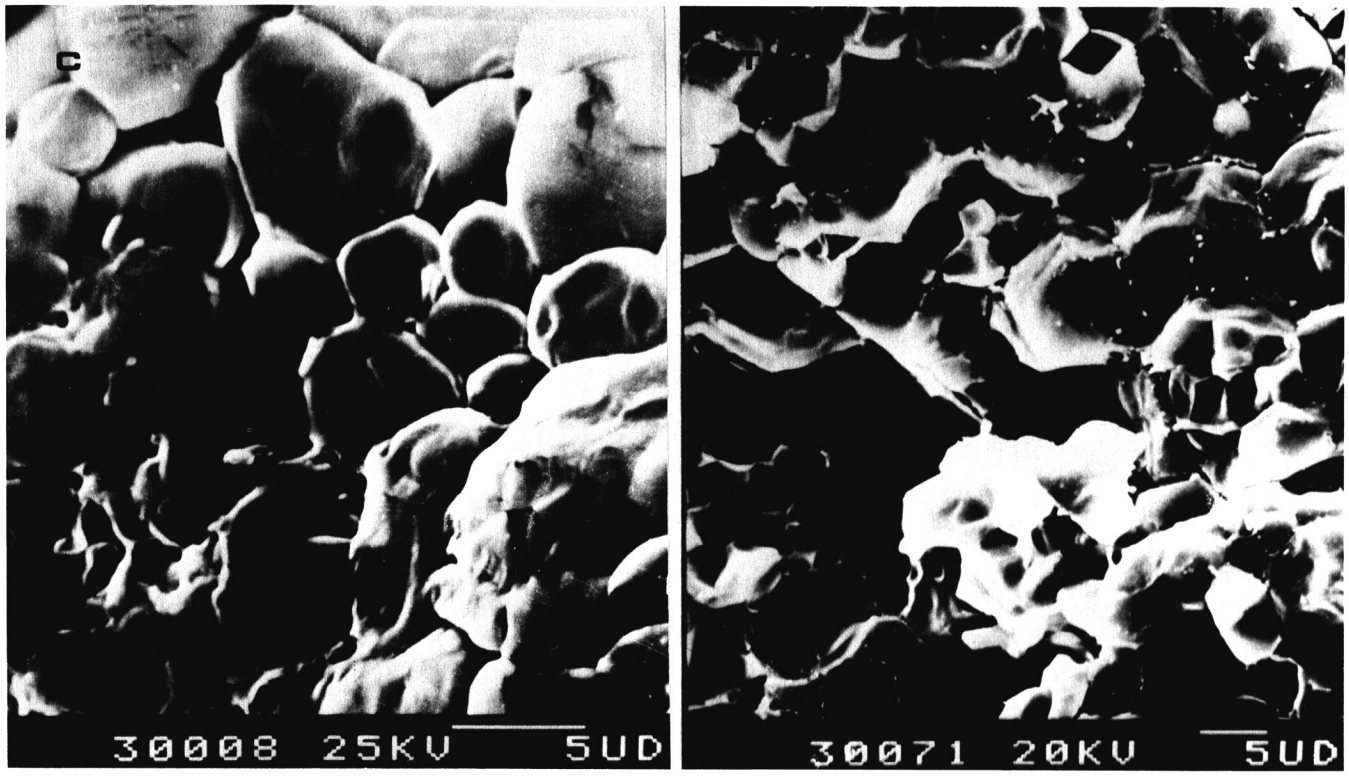

Fig. 3. Scanning electron microscopy of mature grains of chalky variety FT199C (**C**) and translucent variety S199 (**T**), showing endosperm cells containing spherical and polygonal starch granules, respectively.

TABLE I
Measurement of Starch-Filled Portions in the Developing Grains of Chalky and Translucent Rice Varieties

Variety/Days After Pollination	Total Length[a] (μm)	Length of Starch-Filled Portion[a] (μm)
Chalky/3	1,157 a[b]	785 a[b]
Translucent/3	1,284 b	705 b
Chalky/5	1,640 c	1,482 c
Translucent/5	1,625 d	1,423 d
Chalky/7	1,904 e	1,773 e
Translucent/7	1,771 f	1,582 f
Standard deviation (125 degrees of freedom)	± 21.62	± 28.28

[a] Represents measurements in the transverse section of the developing grains as shown in Figure 2b.
[b] Means of the same column followed by different letters differ significantly according to Duncan's new multiple range test.

the influence of grain size on WB and concur with the results of Ebata and Nagato (1967).

Data on the translucent rice variety S199 and its sister variety FT199C (which is completely chalky) showed that in the early stages of grain development the proportion of sugars was greater in the boot leaf (14 versus 9%) and less in the stalk (16 versus 19%) and grain (7 versus 9%) of S199. This indicated a slower translocation of solute from source to sink in the translucent than in the chalky variety.

Examination of sections of the grain revealed that at the early stages of grain development, the grain filled up with starch faster in the chalky variety than in the translucent variety (Fig. 2). Data in Table I show that during the early stages of grain development, the progress of starch filling was significantly greater in the chalky than in the translucent variety, as revealed by Duncan's new multiple range test. The presence of spherical starch granules in the chalky grains and polygonal granules in the translucent grains (Fig. 3), as revealed by scanning electron microscope studies, is in accordance with similar observations recorded for cereals (Wolf et al 1952, Del Rosario et al 1968, Robutti et al 1974, Rooney and Sullins 1977, Sullins and Rooney 1977).

It is possible that the metabolic consequences of the initial vigor in starch filling recorded in the FT199C variety may be responsible for the development of chalkiness in the grains.

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