ing rates. Grain and straw yields depended on yield attributes, which were favorably affected by Fe application. Maximum yields were recorded for the 3 kg Fe ha^{-1} treatment and decreased slightly thereafter. The different Fe placement depths failed to show any significant effect on yield and yield components, but the 10-cm-deep placement recorded the highest grain and straw yields. Interactions were not significant during both years of experimentation.

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Effect of sea water intrusion on yield and grain quality of rice in coastal regions of Korea

Kyu-Seong Lee, Weon-Young Choi, and Jong-Cheol Ko, National Institute of Crop Science, 209 Seodun-dong, Kwonseon-gu, Kyeonggi-do, Republic of Korea Email: klee@rda.go.kr

Soil salinity and intrusion of sea water are major problems in the coastal areas of several rice-growing regions in Korea. An example is the southwestern part of the country, where the inland area is usually inundated by sea water every rice cropping season in August.

In developing rice ecotypes that could withstand sea water, it is important to determine the growth stage of rice at which damage by sea water is critical. In this study, we identified the critical growth stages in terms of yield, yield components, and grain appearance on a reclaimed coastal saline soil in Korea. The experiment was conducted at the Kyehwa Substation of the Honam Agricultural Research Institute in 2002-03.

The experiment involved growing rice at four growth stages (panicle initiation, booting, heading, and milky stage) and a control (no treatment) in a randomized complete block design with three replicates. Sea water without dilution (about 2.7%) was applied once at each stage for 5 d. Seoganbyeo, a newly developed japonica rice variety for the reclaimed area, was used.

The number of spikelets per panicle decreased in all treatments compared with the control, but there were no significant differences among the growth stages (Table 1). In terms of 1,000-grain weight, no significant difference was observed between the control and the salt treatment. However, the percentage of ripened grain decreased sharply when salt stress was applied at booting stage. Sea water did affect yield, especially when salt stress was applied at panicle initiation and booting stages.

Milled rice yield decreased significantly in the treatments in the following order: booting, panicle initiation, heading, and milky stage.

Grain appearance of brown rice was affected by sea water (Choi et al 2003). A lower percentage of head rice was observed in the stress treatments at all growth stages compared with the control. The low percentage of head rice is attributed to the high percentage of immature and damaged rice in the stress treatments (Table 2).

The results demonstrated that the critical growth stage for flooding by sea water was the booting

Table 1. Yield and yield components of rice grown after 5 d of flooding with sea water at critical growth stages on reclaimed medium (0.3%) saline soil, Kyehwa, Korea, 2002-03.[a]

Treatment/growth stage	Spikelets $panicle^{-1}$ (no.)	Ripened grains (%)	1,000-grain weight (g)	Milled rice yield (t ha^{-1})
No treatment (control)	73 a	80 a	21.5 a	3.9 a
Panicle initiation	65 b	69 b	21.3 a	3.4c
Booting	68 b	64 c	21.1 a	3.3 d
Heading	67 b	72 b	21.3 a	3.7 b
Milky	66 b	77 a	20.9 a	3.7 b

[a]Means in a column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

Table 2. Grain appearance of brown rice grown after 5 d of flooding with sea water at critical growth stages on reclaimed medium (0.3%) saline soil, Kyehwa, Korea, 2002-03.[a]

Treatment/ growth stage	Head rice (%)	Incomplete rice (%)			
		Broken	Immature	Damaged	Dead
No treatment (control)	59.7 a	7.2 a	21.1 d	5.7 c	3.7 a
Panicle initiation	55.0 b	7.5 a	23.8 b	9.5 b	3.2 a
Booting	52.8 c	7.1 a	25.0 a	11.7 a	3.7 a
Heading	53.9 bc	7.6 a	23.9 b	10.1 b	3.6 a
Milky	54.7 b	7.2 a	22.4 c	11.1 ab	3.7 a

[a]Means in a column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

stage, which affected both grain yield and grain appearance of brown rice. To avoid severe stress by sea water, early-maturing varieties such as Unkwangbyeo should be cultivated in low-lying areas habitually inundated by the August floods.

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Rice hull ash as a source of silicon and phosphatic fertilizers: effect on growth and yield of rice in coastal Karnataka, India

N.B. Prakash, H. Nagaraj, K.T. Guruswamy, B.N Vishwanatha, C. Narayanaswamy, N.A.J. Gowda, N. Vasuki, and R. Siddaramappa, Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bangalore 65, Karnataka, India

Although silicon (Si) is not considered essential for growth and development, the addition of this element can enhance growth and increase the yield of rice (Savant et al 1997a, Takahashi 1995). Depletion of plant-available Si in the soil where rice is grown may contribute to declining or stagnating yield (Savant et al 1997a). An adequate supply of Si to the rice crop can decrease disease incidence and inhibit iron, aluminum, and manganese toxicities, besides improving the availability and use of P by the plant (Savant et al 1997b). However, many Indian farmers are not aware of these benefits and Si fertilizers are too expensive for them.

An important by-product of rice production is rice hull. A big amount is generated every year in all rice-growing countries. On average, 50% of the rice hull obtained is used as fuel in rice mills, hotels, and brick-making industries in south India. The rice hull ash (RHA) thus obtained has Si as a major constituent. It is already being used in rice nurseries and main fields in different parts of southern India. Application of black to gray RHA at 0.5–1.0 kg m^{-2} to the seedbed resulted in healthy and strong rice seedlings (Sistani et al 1997). Although it is not possible to replenish all the Si used up by the rice crop, a proper way of recycling plant Si will help solve the problem of soil Si depletion. Hence, there is a need to evaluate the effect of continuous application of RHA on growth and yield of paddy.

Though P management is not a problem under submerged conditions, studies on the role of RHA as a source of Si and the effect of RHA application on P availability in rice farming are limited. Our investigation aimed to know the effect of continuous recycling of RHA with and without phosphorus (diammonium phosphate [DAP] and rock phosphate [RP]) on growth and yield of paddy.

Field experiments were conducted at the agricultural research station (coastal zone) in Mangalore, Karnataka. The experimental soil was sandy loam, with a pH of 5.06 and 12.1 kg Si ha^{-1} (ammonium acetate extractable). The experiment was laid out in a randomized complete block design with nine treatments (T1: recommended N and K without P; T_2: T_1 + RHA at 2 Mg ha^{-1}; T_3: T_1 + RHA at 4 Mg ha^{-1}; T_4: recommended NPK (P as DAP); T_5: T_4 + RHA at 2 Mg ha^{-1}; T_6: T_4 + RHA at 4 Mg ha^{-1}; T_7: recommended NPK (P as RP); T_8: T_7 + RHA at 2 Mg ha^{-1}; and T_9: T_7 + RHA at 4 Mg ha^{-1}) with three replications. Three-week-old seedlings were planted at 20 × 10-cm spacing in a 16.25-m^2 treatment plot. The fertilizers recommended for the coastal