Germination Inhibition in *Oryza Sativa* and Control by Preplanting Soaking Treatments

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The seeds of many plant species, including *Oryza sativa*, often fail to germinate promptly after being exposed to favorable conditions. Instead, they may germinate at irregular intervals, with variable vigor. Delayed germination has been associated with a number of factors including impermeability of seeds or seed coats to water and gaseous diffusion, some special stimulus requirement, or the presence of inhibiting substances.

It is commonly known that properly matured rice seed will attain a germination near 100% but that some varieties, especially long maturing *Indica* varieties, may exhibit dormancy. Often the period of dormancy will vary directly with the length of previous growing period. Removal of the hulls, botanically known as the lemma and palea, has been an effective method of breaking the dormancy of some varieties, according to Parija (6). It also generally allows faster germination of all rice seed. Hullled seed, however, is not desirable for field planting because it is extremely susceptible to disease. To date no effort has been made to determine the nature of the delayed germination in rough (unhulled) rice or to study the relation of preplanting soaking in various chemical solutions to reported faster germination, improved seedling growth, and occasional increased yields of rice.

In 1958, Koves and Varga (5) reported that extracts of straw from several rice varieties contained substances capable of inhibiting the germination of *Papaver* seeds. Similar extracts inhibited the elongation of *Avena* coleoptile sections. Svinarev and Boranikov (9) earlier reported that solutions in which rough rice had germinated inhibited the germination of other seed. They also observed that an organic substance excreted from rough rice seed reduced the germination of *Echinochloa crus-galli*. In unpublished work of Mikkelsen and Glazewski, six compounds have been extracted and identified in rice hull extracts and their physiological activities determined. The compounds identified as present in rice hull extracts are vanillic acid, ferulic acid, p-hydroxybenzoic acid, p-coumaric acid, p-hydroxybenzaldehyde, and indole acetic acid. Additional data concerning the nature of the inhibitors present in the hulls of rice and their physiological effects on growth will be published in a separate paper.

Delayed and irregular germination of rice seed and slow developing seedlings have been problems in many rice producing countries. Interest has long been maintained in finding a preplanting treatment of seed to overcome these difficulties. Sampietro (8) in 1926 showed that rice seeds soaked in chlorine-water produced more rapid germination, with subsequent seedling development as much as 27% better than with untreated seed. Ramiah and Rao (7) report that the germination of rice seed was improved by soaking in juice expressed from germinating seeds of mung, *Phaseolus aureus*.

Preplanting soaking of rice in various salt solutions has also given good results in various countries as summarized by De Geus (3) and Ramiah (7). In Indonesia, soaking seed in phosphate solutions produced marked increases in seedling vigor, but had no effect on grain yields. Significant increases in both straw and grain yields were obtained in pot experiments conducted in Ceylon after soaking rice seed in 5 and 20% solutions of Na$_2$HPO$_4$ and K$_2$HPO$_4$. Soaking seed in 10 and 20% solutions of K$_2$PO$_4$ produced yield increases of 21 and 39%, respectively, over controls in experiments conducted at Coimbatore. Seeds soaked in 0.5% solutions of KCl, (NH$_4$)$_2$SO$_4$, NaSCN, and MnSO$_4$ have given variable germination effects which are modified by light effects. Pretreatment of rice seed at the Indian Central Rice Institute, with solutions of K$_2$HPO$_4$, K$_2$PO$_4$, NH$_4$H$_2$PO$_4$, NaH$_2$PO$_4$, (NH$_4$)$_2$SO$_4$, and NH$_4$NO$_3$, gave increases of 14, 12, 9, 13, 12, and 11%, respectively. Varied success has been obtained elsewhere from the use of NaCl and MgSO$_4$ solutions.

The response of rice to preplanting soaking with various chemical solutions has usually been attributed to absorption of inorganic plant nutrients by the seed. It has been presumed that absorption of various essential mineral elements produces a nutritional stimulation during the early stages of plant development. If the percentage of germination is increased, if seedling vigor is improved to aid in stand establishment, or if increased resistance to pest attack results, grain yields might also be expected to improve.

The idea of a nutritional stimulus does not appear completely acceptable, however, since some soaking solutions which do produce observable differences in germination and growth do not contain essential plant nutrients. In any...