Variability Studies for iron and zinc content on segregating population of rice

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Abstract
More than half of the world’s population, especially women and children in the developing countries suffer from micronutrient malnutrition especially deficiency in iron and zinc. Micronutrient malnutrition problems increased the interest of researchers to increase the mineral contents (Fe and Zn) in cereals to ensure adequate attainment of dietary minerals. A lot of variability does exist for micronutrients (Fe, Zn, Vitamin A, etc.) content and bioavailability in many crops including rice. The current study was conducted to assess the variability for iron and zinc content in dehusked rice grains to identify mineral-rich families. This study was conducted with the major objectives of analysis of genetic variability for grain iron and zinc content.

Key words
Rice, Iron, Zinc, variability.

Introduction
Rice, the staple food crop for more than half of the world’s population, supplies adequate energy in the form of calories but it lacks other critical vitamins such as vitamin A, minerals such as iron and zinc, and other micronutrients / amino acids that are essential to human health. Today, micronutrient malnutrition is a large and growing problem in the developing world. Over three billion people currently suffer from micronutrient malnutrition (Welch and Graham, 2004). Iron deficiency may affect three billion people worldwide. It is estimated that 49 per cent of the world’s population is at risk for low zinc intake. These micronutrient deficiencies are concentrated in the semi-arid tropics, particularly in South and Southeast Asia and sub-Saharan Africa (Reddy et al., 2005). Attempts have been made to alleviate these deficiencies through dietary diversification, food fortification, supplementation with limited sustainable success, but these strategies do not reach most of those suffering from iron and zinc deficiency.

Plant breeding to enhance the nutrient quality of staple food crops holds promise for a low cost and sustainable approach to alleviate the problem of micronutrient malnutrition among the poorest segments of the population of developing countries. This approach has been called biofortification. Biofortification reduces malnutrition by breeding essential micronutrients into staple crops. This approach bridges the fields of human nutrition, crop science and public health to develop a set of highly sustainable nutrition interventions in a cost-effective manner. Exploiting the genetic variation in crop plants for micronutrient content is one of the most powerful tools to change the nutrient balance of a given diet on a large scale.

Material and methods
Seeds of F3 generation of four cross combinations generated from Anbil Dharmalingam, Agricultural College &Research Institute, Trichy. viz., ADT 37 x IR68144-3B-2-2-3, ADT 43 x IR68144-3B-2-2-3, TRY (R) 2 x IC 255787, TRY (R) 2 x Mapillaisamba were utilized as the experimental material in the present study. Among the parents viz., TRY (R) 2, ADT 37 and ADT 43 are high yielding commercial varieties and IC 255787 is a high iron content line and IR68144-3B-2-2-3 is a iron donor and Mapillaisamba is a zinc donor which were used in earlier hybridization programme for introgression of high iron and zinc contributing genes. The experiment was conducted at Agricultural College and Research Institute, Madurai. The F4 generation was raised during August to November, 2011 and F5 generation during December 2011 to April 2012 respectively. The F5 progenies were raised along with their parents in randomized block design with two replications. A total of five families were selected from each cross combination based on high iron and zinc content in F3 population. For each family, 75 seedlings per replication were raised with a spacing of 20 cm between the rows and 15 cm between the plants. Each family had five rows of 15 single plants each. The recommended agronomic practices were followed throughout the crop growth period. Five single plants per family per replication were randomly selected for analysis.
selected and forwarded as single plant progeny row in F₃ generation.

The F₃ progenies were raised along with their parents in randomized block design with two replications. For each progeny row, one family with 75 seedlings per replication was raised with row to row spacing of 20 cm and 15 cm between plants. A total of 750 plants were raised with five family of each cross combination. The recommended agronomic practices were followed throughout the crop growth period. Five single plants per family per replication were randomly selected for observations.

The mean data after computing for each character subjected to standard method of analysis of variance following Panse and Sukhatme (1967), phenotypic and genotypic coefficient of variation, heritability (Broad sense) and genetic advance as per cent of mean were estimated by the formula as suggested by Burton (1952) and Johnson et al. (1955). The zinc and iron content were determined by using Atomic absorption spectrophotometer as suggested by Jackson (1973). All the statistical analysis was done by using GENRES statistical software GEN STAT (2004).

Results and Discussion

Grain iron content: Grain iron content showed wide range of variability in ADT 37 x IR68144-3B-2-2-3, and it ranged from 3.420 ppm to 5.420ppm in F₂ generation while in F₃ the concentration was between 4.410 ppm and 8.000 ppm followed by ADT 43 x IR68144-3B-2-2-3. The cross ADT 37 x IR68144-3B-2-2-3 recorded high mean value for grain iron content in F₄ (4.215 ppm) and in F₅ generation (5.427 ppm), whereas low mean value for grain iron content was noticed in cross 3 (3.620 ppm to 3.119 ppm in F₂ and F₃ generation respectively). Genotypic and phenotypic variances were low in both the generations of all the crosses. The magnitude of genotypic and phenotypic coefficient of variation was observed in all the crosses in both the generations except in TRY (R) 2 x Mapillaisamba, which showed low genotypic and phenotypic coefficient of variation (Table 2). Kalaimaghal (2011), in F₂ and F₃ generation reported high GCV and PCV for zinc content in the cross of TRY (R) 2 x Mapillaisamba and also by Shamak et al. (2011) in F₂ and F₃ generation and Purusothaman (2010) in F₄.

High heritability with high genetic advance as percentage of mean was observed for iron content in both the generations of all the crosses. The same trend of results was observed for grain zinc content in all the crosses except TRY (R) 2 x Mapillaisamba, which showed high heritability with moderate genetic advance in both the generations. This suggests that there is high additive gene action. These results were in agreement with Shanmuga sundara pandian (2007), Purusothaman (2010) and Shamak et al. (2011) in F₂ and F₃ generation.

Among the four crosses, ADT 37 x IR68144-3B-2-2-3 showed wide range of variability grain iron content and it ranged from 3.420 ppm to 5.420ppm in F₂ generation and in F₃ the concentration was between 4.410 ppm and 8.000 ppm . For grain zinc content TRY (R) 2 x Mapillaisamba showed wide range of variability and it ranged from 1.620ppm -1.860ppm in F₂ generation, while in F₃ the concentration was between 1.195ppm -2.490ppm. Moderate to high genotypic variability was observed for iron and zinc content that these traits need one or more number of generations of selfing to attain homozygosity. Based on mean, GCV & PCV, heritability and genetic advance, it was understood that the progenies of ADT 37 x IR68144-3B-2-2-3 would be more useful for improving grain iron content. Similarly TRY (R) 2 x Mapillaisamba segregants could be used for improving the grain zinc content.

References


Table 1. Mean value and genetic parameters for iron content in F₄ and F₅ generations of rice crosses

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ADT 37 x IR68144-3B-2-2-3</th>
<th>ADT 43 x IR68144-3B-2-2-3</th>
<th>TRY (R) 2 x Mapillaisamba</th>
<th>TRY (R) 2 x IC 255787</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation</td>
<td>P₁</td>
<td>P₁</td>
<td>P₂</td>
<td>P₁</td>
</tr>
<tr>
<td>Range (ppm)</td>
<td>3.48-3.71</td>
<td>4.39-4.42</td>
<td>3.20-3.44</td>
<td>3.64-3.79</td>
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<tr>
<td>Mean (ppm)</td>
<td>4.215</td>
<td>5.427</td>
<td>4.275</td>
<td>3.020</td>
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<tr>
<td>G.V.</td>
<td>93.39</td>
<td>99.90</td>
<td>97.65</td>
<td>99.58</td>
</tr>
<tr>
<td>Heritability (%)</td>
<td>35.97</td>
<td>55.50</td>
<td>42.32</td>
<td>28.50</td>
</tr>
</tbody>
</table>

Table 2. Mean value and genetic parameters for zinc content in F₄ and F₅ generations of rice crosses

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ADT 37 x IR68144-3B-2-2-3</th>
<th>ADT 43 x IR68144-3B-2-2-3</th>
<th>TRY (R) 2 x Mapillaisamba</th>
<th>TRY (R) 2 x IC 255787</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation</td>
<td>P₁</td>
<td>P₁</td>
<td>P₂</td>
<td>P₁</td>
</tr>
<tr>
<td>Range (ppm)</td>
<td>0.18-1.45</td>
<td>1.05-1.22</td>
<td>1.72-1.84</td>
<td>0.83-0.86</td>
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<tr>
<td>Mean (ppm)</td>
<td>1.022</td>
<td>1.187</td>
<td>0.918</td>
<td>1.62-1.86</td>
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<tr>
<td>G.V.</td>
<td>15.158</td>
<td>19.211</td>
<td>17.899</td>
<td>8.464</td>
</tr>
<tr>
<td>Heritability (%)</td>
<td>95.83</td>
<td>94.23</td>
<td>92.59</td>
<td>89.47</td>
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</tbody>
</table>

http://sites.google.com/site/ejplantbreeding