Characterization of rice flow of cross results (F1) environmental tolerance

D Rahmawati1,2, H Prasetyo1, and P Santika1

1 Department of Agricultural Production, State Polytechnic of Jember
2 rahmawati@polije.ac.id

Abstract
Agricultural Development in Indonesia has begun to be directed to marginal land which is caused by the shrinkage of fertile land area for the sake of transportation and housing interests. However, the productivity of rice on marginal land experiences several obstacles due to low soil fertility, high salt concentration, highly saturated of Al and Fe in moderate concentration. The breeding program for rice aims to assemble superior varieties which possess high yield potential and are adaptive to various environmental stresses. The initial stage of assembling varieties is crossing, in order to combine desirable traits into a breeding population. The purpose of this study was to evaluate the characteristics of crossbred (F1) originated rice strain tolerant to environmental stresses, specifically soil with 0.484% NaCl content. The study was conducted from May to November 2018 in the greenhouse of the Seed Technology Laboratory, State Polytechnic of Jember. Randomized Block Design (RBD) was used for this study, consisting of five treatments, namely parents 1 (V1), parent 2 (V3), parent 3 (V7), crossing 1 (V3xV1) and crossing 2 (V3xV7). Each treatment was repeated three times. The qualitative variables observed included type of grain, grain color, grain shape, plant shape, loss, leaf face, flag leaf position, stem color, leaf color, leaf color, leaf tongue color, and leaf color. Quantitative variables observed were plant height, number of tillers, number of productive tillers, age of flowering, harvesting age, panicle length, number of shelled grains, percentage of pithy grains, weight of 100 seeds, and weight of rice grains per clump. The results of observations of quantitative variables were statistically analyzed using Analysis of Variants (ANOVA). Satisfying genotypes with high potential will be developed to produce genotypes which have superiorities in fast flowering age, very early harvesting age, large number of tillers, large number of productive tillers and ideal plant height.

Keywords: Environmental Stress, Characterization, and Rice

1. Introduction
At present, efforts to increase national rice production are faced with biotic and abiotic stress problems that can disrupt the growth and yield of rice plants. These problems vary between ecosystems where rice plants are cultivated. Rice plants can adapt to a variety of agro-ecosystems, including irrigated rice fields, rain-fed rice fields, dry land (upland), and swampland. Until now superior varieties are still a major technological component in the effort to increase rice production on dry land. Some of the main characters who are the target of improved rice varieties for dry land include high yields, resistance to blast disease, tolerance to drought stress, aluminum poisoning, and the quality of rice and rice (Lubis et al. 2008; Cruz et al. 2009; Suwarno et al. 2009). Improvement of these properties is carried out by combining superior properties from various germplasm and selecting derivatives. The germplasm used can come from rice gene pools such as existing high yielding varieties and wild rice (Silitonga 2004, Suhartini 2010) or can also come from outside the rice pool gene through genetic engineering technology (Amirhusin, 2004, Mulyaningsih et al. 2010).

Increasing the potential yield of a plant can be done by modifying the type of plant (Donald, 1968) and the use of heterosis phenomena (Virman, et al, 1981). Heterosis is an excess of hybrids (first offspring) in terms of vigor against both parents (Poehlman, 1986; Fehr, 1987). While increasing the yield potential by modifying the plant architecture can be done by utilizing genetic resources by
breeding, namely crossing and selection. Modifying the architecture / type of rice plants will be able to increase the production of plant dry matter and the harvest index, so that each or together can increase the yield potential of rice. Rice cultivation in order to provide new varieties needs to test growth and production in the field. There are two types of land that are commonly used in conducting these tests, namely land that has experienced years of fertility maintenance and marginal land or new openings. Rice fields that have been maintained for years are fertile (trendy) land for testing the growth and intended yield. In contrast, it can also be used for new openings in the growth and yield tests. The land in question usually contains nutrients that are relatively poor so that it is less ideal for growth. Even so the land can actually be used to see vigor and the ability to adapt to varieties of environmental conditions. Excellent and superior varieties will show superior growth and yield from other varieties. A number of superior varieties of rice have been released in Indonesia with various advantages (Suprihatno et al. 2010). However, the dynamics of environmental changes both biotic and abiotic require the improvement of sustainable varieties to maintain the stability of rice production in the future. A variety can be classified as tolerant varieties if it is able to grow well, and only has few growth and production constraints (<25%), although these varieties experience stress (Zulman, 2015). The purpose of this study was to evaluate the characteristics of rice lines resulting from crossing (F1) tolerant to environmental stress by using marginal land so that it could directly show which varieties of data showed sufficient varieties to be included in the next selection. The long-term objective of this study is to assemble a new highyielding variety of rice cultivars, which are resistant to environmental stress, namely salinity and high Fe content, with the specific target to be achieved is the release of high yielding high yielding rice varieties and environmental stress resistance.

2. Implementation method
This study uses a non-factorial randomized block design with available treatments namely 2 F1 genotypes and 4 parents, consisting of:

V1: Inpari 13 variety
V2: Sintanur variety
V3: Towuti variety
V7: Ciherang variety
V3xV1
V3xV7

Every treatment that was tried was repeated 3 times. So that 36 units of the experiment were obtained. The linear randomized block design model that will be used in this study is:

\[ Y_{ij} = \mu + \alpha_i + \alpha_j + \epsilon_{ij} \]

Where:
- \( Y_{ij} \): Response or value of observations on the i-block and j-variety
- \( \mu \): General middle value
- \( \alpha_i \): Influence of block i
- \( \alpha_j \): The effect of the J variety
- \( \epsilon_{ij} \): Effect of trial errors from the i-block and j variety

Data were analyzed using F test (ANOVA). If there is a significant difference between treatments, then proceed with a further test with the BNJ (Honest Real Difference) level of 5%.

3. Experimentation
Land preparation (greenhouse cleaning) is done 2 weeks before planting. After land preparation, media preparation was carried out in the form of land taken from the Ambulu area. All land for media is taken in one day. The weight of the soil used as a medium for each polybag is 10 kg of total soil. Before seeding is done soaking for 1 day, then the seeds are sown in a plastic cup containing a mixture of soil and manure in a ratio of 1: 1 to 2 weeks old plants, then planted into polybags. The basic fertilizer used is NPK. Plant maintenance includes irrigation, weed control and disease pests.
Harvesting is done when the plants show signs of harvest, the corn rice ducks, the grain is hard when pressed, the pan is yellow and 95% of the grain has yellowed

Observed Variables

a. Qualitative Variables
   - Grain Type
     Grain is distinguished cere and hairy observed after harvest.
   - Color of grain
     The color of the grain is distinguished by yellow straw, golden yellow, red or purple observed after harvest.
   - Grain shape
     Grain shape is distinguished slim, medium, oval, or round observed after harvest.
   - Plant shape
     The shape of the plant is distinguished upright (<300), medium (+450), open (+600), scattered (> 600), and the stem or the lowest part of the soil surface is observed when the grain is fully cooked.
   - Hair loss
     Loss is determined by grasping the panicle and being pulled and then calculating the percentage of unhulled rice including difficult (<1%), rather difficult (1-5%), moderate (6-25%), rather easy (26-50%) or easy (51 -100%) after harvest.
   - Leaf face
     Leaf face is distinguished by hair, medium or hairless in the flowering phase.
   - Flag position
     The position of the bender leaves is erect, medium (± 450), horizontal, or drooping in the primordia phase.
   - Rod color
     The color of the stem is distinguished by green, golden yellow, purple, purple stripes observed when the grain is fully cooked.
   - The color of the leaves of the leaves
     The color of the leaves of the leaves is distinguished in green, with purple, light purple, or purple stripes observed when the grain is fully cooked.
   - Leaf color
     The color of the leaves is distinguished from light green, green, dark green, purple at the end, purple at the edges, a mixture of purple and green, or purple is observed in the flowering phase.
   - Leaf tongue color
     The color of the leaf tongue is white, purple, or purple, observed in the primordia phase.
   - Color of leaf ears
     The color of the leaf ears is distinguished white (colorless), purple, or purple striped observed in the primordial phase.

b. Quantitative Variables
   - Plant height (cm)
     Plant height is measured from the base of the stem until the first ring at the highest panicle at harvest using a meter.
   - Number of tillers (stems)
     The number of tillers is obtained by counting all the tillers that occur during the primordial phase.
   - Number of productive tillers (stems)
     The number of tillers is counted on each stem that produces panicles and is carried out at harvest time by calculating the number of panicles per clump.
   - Flowering age (days)
Flowering age is calculated by the number of days from planting to rice entering the primordia phase.

- **Harvest age (days)**
  The harvest age is calculated by the number of days from the time of planting to the time when the rice is ducked, the grain is hard when pressed, and 95% of the grain has yellowed.

- **Panicle length (cm)**
  The panicle is measured from the first ring in the panicle to the end of the panicle using a ruler after harvest. Panicle length measurements were carried out on 5 panicles from randomly harvested plants.

- **Amount of grain per panicle (item)**
  The number of grains per panicle is calculated by counting the number of empty and pithy grains from each panicle after harvest. Observations were made on 5 panicles used to measure panicle length.

- **Percentage of pithy rice (%)**
  The percentage of pithy grains was calculated by comparing the number of rice grains with total grains in plants multiplied by 100 at harvest time.

- **Weight of 100 seeds (g)**
  The weight of 100 seeds was obtained from the dry weight of the grains of each seed taken 100 seeds and then weighed to get the weight of 100 seeds. Measurements were made on milled dry grain (± 12% moisture content) after harvest.

- **Results per clump (g)**
  The yield per clump is measured by weighing all the grained rice in 1 year after harvest.

4. Results and discussion

Based on the observation of the character of rice plants in the vegetative phase of the environmental stress that is high Fe and NaCl Content obtained the following results:

**Plant height**

Makarim and Suhartatik (2009) stated that the vegetative phase is the growth phase of vegetative organs, such as: increasing number of tillers, plant height, number of weight and leaf area. In this phase it is very vulnerable to changes in tense environmental conditions.

Stress is all forms of changes in environmental conditions that result in the response of plants to be less effective than the optimum response (Salisbury and Ross 1992). The results of variance in observing plant height at the age of 21 days and 28 days can be seen in Table 4.1 below.

Table 4.1 Results of Sidik Ragam Analysis on Plant Height Due to High Fe Content and High NaCl

<table>
<thead>
<tr>
<th>observation parameter</th>
<th>High Fe Notation</th>
<th>High NaCl Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 hst 28 hst</td>
<td>21 hst 28 hst</td>
</tr>
<tr>
<td>Plant height</td>
<td>** * * *</td>
<td>** * * *</td>
</tr>
</tbody>
</table>

Description: (*): Real Differences; (**) : Very Real Different; (ns): Different Not Real

According to Table 4.1 it appears that each variety has different sensitivity in response to environmental stress due to both high Fe and high salinity. Iron poisoning in rice causes changes in both morphological and physiological character of plants, where the response of each genotype varies depending on the nature of tolerance or sensitivity to iron poisoning.
High stress environment with Fe
Iron poisoning in rice plants is influenced by the environment (ecology) of rice plants growing and also the sensitivity of rice varieties to high Fe content. In addition to high environmental concentration of plant Fe, Fe poisoning is also associated with various factors such as various nutrient stresses (K, P, Ca, and / or Mg) which tend to reduce the ability of root oxidation, environmental conditions such as poor drainage and soil are always inundated, or Fe-sensitive varieties such as IR64 (Makarim and Supriadi 1989; Makarim et al. 1989). Symptoms of iron poisoning in rice only occur in specific conditions, namely in stagnant conditions. Reduction conditions in flooded rice fields show symptoms of iron poisoning by dissolving all forms of Fe into dissolved forms (Fe + 2) involving microbial solvents (Beckers and Ash 2005; Audebert 2006b).

Table 4.2 Advanced Test of Plant Height at the age of 21 days and 28 days due to high Fe

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Age 21 hst</th>
<th>Varieties</th>
<th>Age 28 hst</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2</td>
<td>26.17a</td>
<td>V2</td>
<td>39.00a</td>
</tr>
<tr>
<td>V3</td>
<td>27.00a</td>
<td>V3</td>
<td>39.25a</td>
</tr>
<tr>
<td>V1</td>
<td>29.58ab</td>
<td>V6</td>
<td>40.92ab</td>
</tr>
<tr>
<td>V7</td>
<td>31.17ab</td>
<td>V7</td>
<td>43.42ab</td>
</tr>
</tbody>
</table>

Source: primary data, 2018

Based on table 5.2 above it appears that V7 varieties are more resistant to Fe (iron) poisoning than varieties (V2) with good vegetative phase growth, i.e. the highest plant height at 21 days and 28 days, 31.17 cm and 43.42 cm, respectively. This condition is suspected because tolerant varieties are better able to hold more Fe in the root than sensitive varieties.

Stress the environment with high NaCl
High-dose salt solution can interfere with growth between plants. Excess NaCl or other salts can threaten plants because they cause a potential decrease in soil water solution, salt can cause water shortages in plants even though the soil contains a lot of water. This is because the water potential of the environment is more negative compared to the potential of the water of the root tissue. Second, in salty soils, certain sodium and ionion can be toxic to plants if the concentration is relatively high. Plants that experience salt stress generally do not show a response in the form of direct damage but in the form of depressed plant growth and slow changes (Sipayung, 2003).

Table 4.3 Further Tests of Plant Height at 21 days and 28 days due to high NaCl

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Age 21 hst</th>
<th>Varieties</th>
<th>Age 28 hst</th>
</tr>
</thead>
<tbody>
<tr>
<td>V7</td>
<td>23.25ab</td>
<td>V4</td>
<td>31.83b</td>
</tr>
<tr>
<td>V3</td>
<td>24.67ab</td>
<td>V3</td>
<td>33.07bc</td>
</tr>
<tr>
<td>V2</td>
<td>25.67b</td>
<td>V2</td>
<td>34.01bc</td>
</tr>
<tr>
<td>V1</td>
<td>31.17ab</td>
<td>V1</td>
<td>36.36c</td>
</tr>
</tbody>
</table>

Source: primary data, 2018

Based on table 4.3 above it appears that the Inpari 42 (V1) variety is more resistant to high salinity than the V7 variety which is shown in the good vegetative phase growth which has the highest plant height at the age of 21 days and 28 days, respectively 26.17 cm and 36.36 cm. The low plant growth is thought to be due to high salinity which can damage the growing cells so that plant growth is disrupted and limit the supply of metabolic products essential for cell growth through the formation of tyloses. In addition, the high Na + content in groundwater will cause damage to soil structure, namely the soil will be dispersed and clog water flow so that the soil infiltration process is inhibited and the soil pH becomes higher because the absorption complex is filled with Na + ions.
**Quantitative Observation Results**

Quantitative observations of Inpari 42 (V1) varieties show the characteristics of plants that are resistant to high NaCl stress.

![Figure 1. High Observation Results of Inpari 42 varieties](image1)

**Figure 2. Color of the legs of the Inpari 42 variety stem**

![Figure 2. Color of the legs of the Inpari 42 variety stem](image2)

**Figure 3. Tongue color of Inpari 42 varieties**

![Figure 3. Tongue color of Inpari 42 varieties](image3)

**Variety crosses**

Qualitative and quantitative observations of 10 plant varieties showed that the germplasm used was a group of rice plants that were resistant to the stresses of Fe and NaCl with different influences. However, these varieties can be used as elders in crossing activities to produce stress-resistant new varieties. Single crossing activities carried out resulted in 10 new strain candidates who would become candidates for new rice plasma. However, F1 of the 10 strains did not stand stress when replanted.

Sitompul and Gurino (1995) state that plant height is a vegetative parameter that is often observed, both as a growth parameter and as an indicator used to measure environmental influences or treatments applied. The results showed that the strains resulting from crossing (F1) and parents observed had inhibited growth in the vegetative phase. Plant height vegetative parents phase 1 (V1),
parent 2 (V3), parent 3 (V7), crossing 1 (V3xV1) and crossing 2 (V3xV7) have an average of 22.58 cm as shown in table 1. below.

<table>
<thead>
<tr>
<th>Varieties Plant</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>26.5</td>
</tr>
<tr>
<td>V2</td>
<td>25.7</td>
</tr>
<tr>
<td>V3</td>
<td>27.3</td>
</tr>
<tr>
<td>V7</td>
<td>25.3</td>
</tr>
<tr>
<td>V3xV1</td>
<td>18.2</td>
</tr>
<tr>
<td>V3xV7</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>22.58</strong></td>
</tr>
</tbody>
</table>

Source: primary data, 2018

Figure 4. Line V3xV1 F1 Result of Crossing

Figure 5. Line of V2xV7 F1 Result of Crossing
High NaCl which is 0.484% inhibits plant growth starting at the beginning of growth because these elements inhibit the absorption of water and other nutrients needed by plants.

BIBLIOGRAPHY


