Gorontalo local rice plant response which planted with the lowland system and upland system

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Abstract. The development of upland rice cultivation is a strategic effort to support and increase national rice production. Local superior cultivars have long been cultivated by farmers through generations through various efforts and instincts in their possession by utilizing genetic diversity to obtain superior characters and adapt well to local agro-ecology. The research aims to obtain Gorontalo local rice genotypes that can grow and produce both on upland and lowland fields. The study was conducted in Bulotalangi Village, East Bulango Subdistrict, Bonebolango District, Gorontalo Province. Located at an altitude of 80 m above sea level, an average rainfall of 1,485 mm per year, soil texture of sandy loam and pH of 5.5. The research was conducted from October 2017 to March 2018. This study used a randomized block design with three replications. The treatment consisted of 10 genotype treatments namely Situbagendit, Pulo Putih, Maraya, Bokungo, Monu Genja, Buruna, Yenti, Boleyara, Ponda and Bolotonu. The results show that the adaptive genotype grew and had a high and good production to be developed in the upland and paddy fields, namely the Maraya genotype (4.10 tons.ha\(^{-1}\)), the Situbagendit genotype (3.73 tons.ha\(^{-1}\)), the Yenti genotype (4.10 tons.ha\(^{-1}\) 3.26 tons.ha\(^{-1}\)) and Bolotonu genotype (3.08 tons.ha\(^{-1}\)).

1. Introduction
The development of upland rice cultivation is a strategic effort to support and increase national rice production. At present, the contribution or contribution of upland rice to national rice production is still relatively low compared to lowland rice, therefore the position of upland rice is increasingly important to be developed in the future because its production is still likely to increase by about two to three times. The area of upland rice is relatively not increasing from year to year with an average productivity of 2.3 tons ha\(^{-1}\), while paddy rice is 4.3 tons ha\(^{-1}\) [1].

The agricultural sector in Gorontalo Province is currently a mainstay sector. Gorontalo has a wealth of genetic resources in the form of diverse upland rice cultivars. Conventionally, local superior cultivars have long been cultivated by farmers through generations through various efforts and instincts in their possession by utilizing natural populations (genetic diversity) to obtain superior characters and adapt well to local agro ecology. From interviews with farmers at the research location it was found that the average productivity of upland rice was only around 1.6 tons / ha. In addition, Dariah et al. [2] stated that upland rice cultivation in Indonesia is generally endeavored by farmers on sloping land with technology that is still simple using local rice that averages 5 months old, so that the productivity achieved is still very low, which is approximately 1 ton. ha\(^{-1}\).
The potential of dry lands in Gorontalo Province reaches 729,901 ha and developing potential of upland rice is 220,406 ha. Meanwhile, of large number of area potentials, only about 99,176 ha is utilized remaining 121,230 ha unutilized [3]. Gorontalo Province has a large source of local genetic diversity, especially upland rice. These cultivars are spread specifically in various regions and have been cultivated for generations and adapted to specific environmental conditions. Benny et al. [4] stated that local rice cultivars are a very valuable asset if managed properly.

The low productivity and the unavailability of high yielding varieties at the farmer level cause the interest of farmers to develop upland rice to decline. This greatly affects the rate of development of large areas of land and upland rice production. The availability of local rice genotypes in Gorontalo province are generally planted on dry land in the highlands, but not for lowlands.

In certain environmental conditions, especially land for the development of upland rice plants is very diverse, so we need one or more genotypes that are site specific. One genotype that gives the best results in one location is often inconsistent in another location. For this reason, the aim of this research is to determine whether the genotype can adapt to two land conditions so that genotypes can be grown in both dry land and paddy fields.

2. Methodology
This research was conducted in Bulotalangi Village, East Bulango District, Bonebolango District, Gorontalo Province located at an altitude of 80 m above sea level, rainfall an average of 1,485 mm per year, the texture of sandy loam soil and pH 5.5. The research was conducted from October 2017 to March 2018. The study used a randomized block design at two different locations namely lowland and upland paddy fields, with 10 genotype treatments namely Situbagendit (g1), Pulo Putih (g2), Maraya (g3), Bokungo (g4), Monu Genja (g5), Buruna (g6), Yenti (g7), Boleyara (g8), Ponda (g9) and Bolotonu (g10). Each treatment was replicates three times, so that there were 60 observation plots for 2 land conditions. The plot area of each treatment is 4m x 4m with a spacing of 25cm x 25cm.

Materials used consisted of manure, label paper, pesticides, Urea, NPK and water. The tools used were machetes, hoe scythe, water hose, wood, bamboo, tractor, hedgehog, sprayer, paranet, rope, meter, scale, camera and writing stationery.

The research began with the soil tillage of the lowland paddy fields. Manure was given as much as 2 tons / ha in the two weeks before tillage. Perfect tillage was done by 2 plows and one rake. In the upland land, the field was plowed twice, manure was given at the second plowing of 2 tons / ha. Following to plow, the ground was rakes and flattened. Planting on lowland paddy fields was carried out by planting seeds directly, for upland land using pointed stick, planting with 5 seeds / planting holes. Organic fertilization was given before planting. At the age of 15 days after planting (DAP), and 35 DAP, fertilization was done by using urea 50 kg.ha⁻¹, NPK 100 kg.ha⁻¹. Watering in paddy fields was not inundated, flowing at the age of 20 DAP, on upland land was flushed using water hose at the beginning of planting and at 25 DAP before weeding. Weed control was carried out mechanically and used porcupines at the age of 5 weeks after planting (WAP) and 9 WAP. Pest control was done according to conditions in the field.

The observation component was the yield component, namely the number of productive tillers, number of grains per panicle, panicle density, weight of 1,000 seeds and harvest grain dry weight per hectare. The observational data were analyzed using analysis of variance (ANOVA) and if there was a significant influence on the treatment then it was followed by a test of honest significance difference test (HSD) at a significance level of 0.05.

3. Results and discussion
Growth is a process in plant life that results in changes in size and weight gain over time. There are two important factors that affect plant growth, namely genetic and environmental factors. Based on analysis of variance, it is shown that genotype treatment, location and interaction of two environmental factors did not significantly affect the number of tillers. Genotype treatment significantly affected the number of grains per panicle and panicle density. The treatment of genotypes, location and interaction of the
two environmental factors significantly affected the weight of 1,000 seeds and dried harvest grain weight per hectare.

3.1. Number of productive tillers

The results of analysis of variance show that the treatment of varieties, location and interaction of 2 factors did not significantly affect the number of productive tillers. Figure 1 shows that the Situbagendit genotype in lowland paddy (g112) and Maraya genotypes on upland paddy (g312) produced a higher number of productive tillers (11.00 tillers) than the other genotypes. The number of productive tillers in rice cultivation is strongly influenced by the growing environmental agro-climate such as the availability of water, nutrients and sunlight. These factors influence the photosynthesis process carried out by the plant so there is a sufficient assimilates to be distributed to the plant organs. Plant height growth, number of tillers and number of productive tillers depends on the genotype and phase of plant growth.

3.2. Number of grain per panicle

The results of analysis of variance showed that the treatment of varieties had a very significant effect on the amount of grain per panicle of rice plants. Table 1 shows that the Buruna (g6) variety produced the highest number of panicle grain (151.17 grain) and was not significantly different from the Maraya varieties (g3), Monu Genja (g5) and Bolotonu 9g10). The amount of grain produced in each panicle of rice plants is influenced by their genetic makeup and metabolic activity. The high absorption of sunlight obtained by cropping will produce high assimilation so that the energy requirements for plant panicles are available. The need for water available in the filling phase of seeds of rice plants will streamline the accumulation of assimilates from leaves to seeds [5]. Correspondingly, Surowinoto [8] argues that the amount of grain per panicle is more influenced by genetic factors, namely by the panicle length and number of grains from each panicle.

3.3. Panicle density

Analysis of variance showed that genotype had a very significant influence on the density of rice panicles. Table 2 shows that the Bolotonu genotype produced the densest panicle density (7.17 grain / cm⁻¹) and the Situbagendit genotype produced the lowest panicle density (3.17 grain / cm⁻¹). The
treatment on dry land gives the densest panicle density with an average (5.37 grain / cm$^2$). Land conditions affect, panicle length, panicle number, and panicle density in the growth of crop yields [7].

Table 1. Average number of grains per panicle (grain)

| Varieties     | Location       | Averages |
|---------------|----------------|----------|
|               | l1 (upland fields) | l2 (lowland fields) |
| g1 (Situbagendit) | 47.00          | 75.00     | 61.00$^*$ |
| g2 (Pulo Putih)  | 82.00          | 79.33     | 80.67$^{de}$ |
| g3 (Maraya)     | 129.67         | 119.00    | 124.33$^{ab}$ |
| g4 (Bokungo)    | 90.67          | 92.67     | 91.67$^{ed}$ |
| g5 (Monu Genja) | 131.33         | 121.00    | 126.17$^{ab}$ |
| g6 (Buruna)     | 136.00         | 166.33    | 151.17$^a$  |
| g7 (Yenti)      | 97.33          | 117.33    | 107.33$^{bcd}$ |
| g8 (Boleyara)   | 139.00         | 96.33     | 117.67$^{bc}$ |
| g9 (Ponda Merah)| 103.67         | 84.33     | 94.00$^{cd}$ |
| g10 (Bolotonu)  | 133.67         | 123.00    | 128.33$^{ab}$ |

Averages: 115.93 111.04

Numbers which followed by the same letter (a-e) mean that they are not significantly different in the HSD test at level of 5%.

Table 2. Average number of panicle density (grains/ cm)

| Varieties     | Location       | Averages |
|---------------|----------------|----------|
|               | l1 (upland fields) | l2 (lowland fields) |
| g1 (Situbagendit) | 3.00                  | 3.33       | 3.17$^f$ |
| g2 (Pulo Putih)  | 4.33                  | 4.00       | 4.17$^{ef}$ |
| g3 (Maraya)     | 5.00                  | 3.67       | 4.33$^{de}$ |
| g4 (Bokungo)    | 6.33                  | 5.67       | 6.00$^{bc}$ |
| g5 (Monu Genja) | 5.00                  | 5.00       | 5.00$^{de}$ |
| g6 (Buruna)     | 6.67                  | 6.00       | 6.33$^{ab}$ |
| g7 (Yenti)      | 4.67                  | 4.67       | 4.67$^{de}$ |
| g8 (Boleyara)   | 6.33                  | 4.33       | 5.33$^{bcd}$ |
| g9 (Ponda Merah)| 5.00                  | 4.00       | 4.50$^{de}$ |
| g10 (Bolotonu)  | 6.33                  | 8.00       | 7.17$^a$ |

Averages: 5.37$^a$ 4.46$^b$

Numbers which followed by the same letter (a-e) mean that they are not significantly different in the HSD test at level of 5%.

3.4. Weight of 1,000 grains

Analysis of variance showed that the interaction of genotypes with location had a significant effect on the weight of 1000 rice seeds. Table 3 showed that the Maraya genotype in paddy fields (g312) gave the weight of 1000 heaviest seeds (26.87 g) and was not significantly different from the Situbagendit varieties in lowland paddy fields (g1l2). The size of the seeds formed in rice plants is influenced by gamete fusion, grain size and photosynthetic effectiveness in the generative phase. This is after the opinion of Vergara [9] states that the supporting component of the yield of a variety of lowland rice such
as 1000 grains weighs around 25 grams. Manurung and Ismunadi [10] report that the weight of 1000 grain seeds depend on the size of the lemma and pallea.

Table 3. Average of 1,000 seed weights (g)

| Varieties       | Location                  | Averages |
|-----------------|----------------------------|----------|
|                 | l1 (upland fields)        | l2 (lowland fields) |      |
| g1 (Situbagendit)| 15.17<sup>hi</sup>        | 26.33<sup>a</sup>  | 20.75 |
| g2 (Pulo Putih) | 19.17<sup>def</sup>       | 20.50<sup>cd</sup> | 19.83 |
| g3 (Maraya)     | 23.87<sup>b</sup>         | 26.87<sup>a</sup>  | 25.37 |
| g4 (Bokungo)    | 13.17<sup>i</sup>         | 18.07<sup>ef</sup>| 15.62 |
| g5 (Monu Genja) | 10.23<sup>i</sup>         | 14.27<sup>i</sup>  | 12.25 |
| g6 (Buruna)     | 19.17<sup>def</sup>       | 18.17<sup>ef</sup> | 18.67 |
| g7 (Yenti)      | 21.67<sup>bc</sup>        | 23.57<sup>b</sup>  | 22.62 |
| g8 (Boleyara)   | 14.10<sup>i</sup>         | 18.17<sup>ef</sup> | 16.13 |
| g9 (Ponda Merah)| 20.40<sup>de</sup>        | 23.70<sup>b</sup>  | 22.05 |
| g10 (Bolotonu)  | 16.73<sup>de</sup>        | 22.60<sup>bc</sup> | 19.67 |
| Averages        | 16.39                      | 19.83     |      |

Numbers which followed by the same letter (a-e) mean that they are not significantly different in the HSD test at level of 5%.

3.5. Dried grain weight per hectare at harvest

Table 4 shows that the highest harvested grain weight per hectare was shown by the Maraya genotype (g3) (4.70 ton ha<sup>-1</sup>) and Situbagendit (g1) (4.50 ton ha<sup>-1</sup>) in paddy fields and significantly different from all other interactions. The highest seed yield is produced by Maraya (g3). these results are inseparable from the availability of more water so that the needs of plants in the metabolic process to produce assimilates and energy for filling seeds more optimally. The number of grains per panicle is more influenced by genetic factors, namely by the panicle length and number of grains from each panicle [8]. Land conditions affect the number of panicles, panicle densities, efficient use of light, as well as competition between clumps in water use, nutrients, which will ultimately affect plant growth and yield [7].

Table 4. Average number of dried grain harvest per hectare (ton ha<sup>-1</sup>)

| Varieties       | Location                  | Averages |
|-----------------|----------------------------|----------|
|                 | l1 (upland fields)        | l2 (lowland fields) |      |
| g1 (Situbagendit)| 2.97<sup>c</sup>          | 4.50<sup>a</sup>  | 3.73  |
| g2 (Pulo Putih) | 1.30<sup>hi</sup>         | 1.90<sup>ef</sup> | 1.60  |
| g3 (Maraya)     | 3.50<sup>bc</sup>         | 4.70<sup>a</sup>  | 4.10  |
| g4 (Bokungo)    | 0.99<sup>hi</sup>         | 1.57<sup>efg</sup> | 1.28  |
| g5 (Monu Genja) | 1.93<sup>hi</sup>         | 2.90<sup>ef</sup> | 2.41  |
| g6 (Buruna)     | 1.80<sup>b</sup>          | 1.60<sup>efg</sup> | 1.70  |
| g7 (Yenti)      | 2.80<sup>d</sup>          | 3.73<sup>b</sup>  | 3.26  |
| g8 (Boleyara)   | 1.10<sup>hi</sup>         | 1.90<sup>ef</sup> | 1.50  |
| g9 (Ponda Merah)| 2.73<sup>de</sup>         | 2.90<sup>cd</sup>| 2.81  |
| g10 (Bolotonu)  | 2.87<sup>de</sup>         | 3.30<sup>bc</sup> | 3.08  |
| Averages        | 2.19                      | 2.90      |      |
Numbers which followed by the same letter (a-e) mean that they are not significantly different in the HSD test at level of 5%.

4. Discussion
The genotypes of Maraya, Situbagendit, Yenti and Bolotonu are four genotypes that are adaptive to grow and have high production. Hence, it is very good to be developed on upland and paddy fields because it has an average yield of 4.10 tons ha\(^{-1}\), 3.73 tons ha\(^{-1}\), 3.26 tons ha\(^{-1}\) and 2.81 tons ha\(^{-1}\) respectively.

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