The morphological and physiological studies Gorontalo local upland rice treated with drought and shade stresses

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Abstract. Crop growth and production are strongly affected by abiotic and biotic stresses. Survival rate frequently been used to evaluate rice drought tolerance with a low survival rate of rice plants undergoing drought stress leading to low yields. The aim of this research was to obtain Gorontalo local upland rice variants that are tolerant against drought and shade stresses by considering the morphological and physiological characteristics. The research was conducted in Bulotada Barat Village, Sipatana District, Gorontalo, from January to August 2017. Employing the randomized block design with three replications, the research consisted of two treatment factors. The first factor is the accession, which consists of two tolerant accessions; two moderately tolerant accessions, two drought-sensitive accessions, and two shade-sensitive accessions. The second factor pertains to the drought and shade stresses which consist of drought + 25% shade stress, drought + 50% shade stress, and a control. Irrigation in the drought control specimen was given until inundation reached 1.5 cm. In a drought-stressed situation, irrigation was given when the groundwater reached -30 to -35.9 kPa. The Ponda Merah accessions were the accessions that were tolerant against drought and shade stresses. The morphological characteristics of Gorontalo local upland rice that showed tolerance against drought and shade stresses were longer roots (33.20 cm), heavier dry weight (38.82 gr), a thinner leaf (186,56 cm².g⁻¹), and a higher yield (4,90 gr.cluster⁻¹). The physiological characteristic of the Gorontalo local upland rice that showed tolerance against drought and shade stresses was the sugar content (0,73 g.g⁻¹) which was higher than the other treatment.

1. Introduction
Rice is a staple food and is the source of carbohydrates. The yield of rice farming must be improved to keep up with the growth of the population. However, the uncertain change of climate can disrupt the production of rice. Lack of precipitation is one of the problems that lead to the crops be caught in drought. The repurpose of agricultural land, causing marginal uses of lands, also becomes a threat for the national food sustainability, especially for rice. One of the challenges in rice farming which is cultivated under stands is the lack of sunlight that can cause the plant’s physiological process disrupted and in turn affect productivity. Three common types of drought affect rice production: early water stress that causes a delay in seedling transplantation, mild sporadic stress having cumulative effects, and late stress affecting late-maturing varieties [1]. Drought stress induces various physiological and biochemical changes in rice at different developmental stages [2]. Therefore, efforts to obtain rice variants that are tolerant against abiotic stresses, such as drought or shade stresses or a combination of both, are needed. This is done by selecting from the local accessions. This research aims to find the Gorontalo local upland rice variants that are tolerant against drought and shade stresses by configuring their morphological and physiological features.

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2. Material and Methods

2.1 Study area
The research was conducted in Bulotada Barat village, Sipatana district, Gorontalo, from January to August 2017. Plant physiological analysis was carried out at the Integrated Biotechnology Laboratory, Faculty of Animal Husbandry, Soil Chemistry Laboratory and Biochemistry Laboratory, Faculty of Mathematics and Natural Sciences, Hasanuddin University Makassar.

2.2 Methods and observation contents
The research employed the randomized block design with trice replications. The rice seeds used in the research were from the local Gogo variants which are tolerant against drought and shade stresses. Employing the randomized block design with three replications. The experiment consisted of two treatment factors; first, the accessions which consisted of two drought tolerant accessions, two moderately tolerant accessions, two drought-sensitive accessions, two shade tolerant accessions, and two shade-sensitive accessions [3], and the second factor was drought and shade stresses, which consisted of drought + 25% shade stresses and drought + 50% shade stresses.

The shade was measured 4 x 4 x 2 meters with wooden poles and a shade net roof. The shade net was designed to allow 25% and 50% sunlight exposure. For the specimen with drought stress, the roof was additionally covered with polyethylene plastic (PE) to prevent water absorption. Each accession in each treatment was planted in 10 polybags measuring 30 cm x 40 cm x 0.12 mm, which accumulated into 1,620 poly bags. Irrigation in the drought control specimen was done until inundation reaching 1.5 cm. For the specimen under drought stress, irrigation was given when the groundwater reached -30 to -35.9 kPa [4]. The measuring of the potential groundwater was done with Tensiometer. Samples were selected randomly based on the visual look, which was indicated by the rolling of the leaves and by observing the condition of samples under drought stress. Drought treatment was given four weeks after planting. The preparation was conducted based on the Gogo rice cultivation system. The planting media included soil and organic fertilizer. Before planting, the poly bags which had been filled with soil and organic fertilizer were prepared and categorized based on the experiment designs. Each polybag was given five seeds and was reduced into two seeds after two weeks of planting.

The data acquired were then analyzed using the analysis of variance. If the effects are real, the data are then further analyzed using Tukey’s Honestly Significant Difference Test at a 5% real level using the Minitab v17 software.

3. Result and Discussion
This research experimented with two drought-tolerant accessions (Sonu and Ponda Merah), two moderately tolerant accessions (Yenti and Ponelo), two sensitive accessions (Saniha and Jiema), two shade-tolerant accessions (Ponda Merah and Bulotanu), and two sensitive accessions (Buruna Merah and Luiya).

The observation of the plant growth in this research took place from January to April 2017. The temperature of the location ranged from 26.0 to 27.5°C. The precipitation in January and March was considered moderate with an annual precipitation rate ranging between 100 – 300 mm, while in February the precipitation was considered high at between 301 – 400 mm. In April, the precipitation was only 0-100 mm. In no shade treatment, the light intensity entering the perimeter was between 168.2 Watt/m2 and 654.3 Watt/m2. In 25% shade treatment, the light intensity entering the perimeter was between 60.93% and 70.01%. In 50% shade treatment, the light intensity was between 39.77% and 47.1%.

The result from the analysis of interaction variance of each treatment (drought and shade stresses) and the accessions of the Gorontalo local upland rice showed significantly real effects on the root length, dry weight, leaf width, relative growth rate, total productive seedlings, and yield variables.
3.1 Root length

The accession root experimented in this research showed a difference in length for each treatment applied. The average root length of the Gorontalo local upland rice is presented in Table 1.

Table 1. Average interaction effects between accession and drought and shade treatments on root length variable

| Accession     | Root Lenght (cm) | P1  | P2  | P3  | P4  | P5  | P6  |
|---------------|------------------|-----|-----|-----|-----|-----|-----|
| Sonu          | 30.77 a-d        | 31.47 ab | 32.03 abc | 22.03 f-j | 21.53 e-k | 23.90 b-h |
| Ponda Merah   | 33.27 a          | 33.20 a | 24.70 b-h | 21.33 e-l | 20.67 e-n | 19.63 f-n |
| Yenti         | 14.73 i-r        | 17.73 h-r | 20.40 e-n | 18.80 g-q | 18.83 g-q |           |
| Ponelo        | 19.90 e-m        | 22.90 c-i | 24.70 b-h | 21.33 e-l | 20.67 e-n | 19.63 f-n |
| Saniha        | 10.93 qr         | 12.87 m-r | 11.00 pr | 15.17 i-r | 16.67 h-r | 18.23 g-r |
| Jiema         | 10.43 r          | 13.43 k-r | 11.13 o-q | 18.10 g-r | 17.93 h-r | 19.00 g-q |
| Bulonto       | 28.23 a-e        | 27.60 a-f | 26.20 a-g | 19.53 f-n | 19.20 g-p | 20.30 e-n |
| Buruna Merah  | 12.47 n-r        | 15.20 i-r | 15.03 i-r | 15.33 i-r | 17.43 h-r | 19.90 f-n |
| Lauiya        | 13.13 l-r        | 10.97 qr | 14.17 j-r | 15.20 i-r | 18.53 g-r | 19.30 g-o |

P1 : Drought + 25 % shade stresses
P2 : Drought + 50% shade stresses
P3 : Drought stress
P4 : 25% shade stress
P5 : 50% shade stress
P6 : Control

*Number followed by a similar letter has no significant difference in α = 5%

In drought + 50% shade treatment, the accession with the longest root length was Ponda Merah accessions (33.20 cm), while the shortest root length was Lauiya accessions (10.97 cm). In drought treatment, the longest root length was found in Sonu accessions (32.03 cm). In 50% shade treatment, Ponda Merah accessions had the longest root length, while Saniha accessions had the shortest length. In the control group, the root length ranged from 18.23 cm to 24.83 cm.

The accession’s root length in each treatment is varied. The longer the length of the root, the more tolerant to drought the accession is. A long root length ensures that water absorption is maintained. According to [5] suggested that roots, having an important role in responding to water stress, are the primary organ in plants that detect changes in the soil condition. [6] also pointed out that there is ample evidence that the yield of cereal crops grown under water and nutrient deficiencies can be increased by altering the root structure because this improves their ability to capture soil resources. Out a piece of solid evidence that cereal crops cultivated under drought stress and nutrient deficiency can improve their yield by modifying the root structure as this improves the crop’s ability to obtain minerals and water. [7] said that the access of water to a plant is determined by its root system, properties, structure, and distribution, thus improving root traits to increase the uptake of soil moisture and maintain productivity under water stress is of huge interest.

3.2. Plant’s Dry Weight

The dry weight of the Ponda Merah accessions was higher than the other accessions in all stress treatments, that are single drought stress and shade stress or the combination of drought and shade stresses. The dry weight was valued at around 54.16 gr in drought stress treatment to around 38.82 gr in the combination of drought and 50% shade stresses. The dry weight is one of the indicators of the efficiency of photosynthesis. [8] stated that a higher rate of photosynthesis can trigger healthier organ growth which in turn results in higher dry products. Statistics on the dry weight of the Gorontalo local upland rice are presented in Table 2.
Table 2. Average interaction effects between accession and drought and shade treatments on plant’s dry weight

| Accession  | Plant’s Dry Weight (gr) | P1 | P2 | P3 | P4 | P5 | P6 |
|------------|-------------------------|----|----|----|----|----|----|
| Sonu       | 40.64                   | d-l| 35.71| i-p| 49.29| b-c| 45.38| c-h| 39.14| f-m| 48.60| a  |
| Ponda Merah| 48.28                   | c-f| 38.82| g-m| 54.16| abc| 49.59| bcd| 43.14| d-j| 48.26| ab |
| Yenti      | 35.20                   | i-p| 26.69| p-w| 38.67| g-n| 42.40| d-k| 34.60| j-p| 40.73| i-p|
| Ponelo     | 31.76                   | l-q| 27.45| p-v| 44.36| d-i| 39.73| f-m| 33.77| k-p| 46.92| c-g|
| Saniha     | 20.16                   | s-x| 17.35| x   | 20.89| s-x| 28.96| o-t| 22.56| q-x| 47.12| c-g|
| Jiema      | 19.73                   | t-x| 18.24| vwx | 17.87| wx | 29.37| n-s| 21.80| r-x| 40.08| e-m|
| Bulotonu   | 43.32                   | d-j| 31.11| m-r| 40.14| e-m| 46.17| c-h| 37.46| h-o| 41.19| d-k|
| Buruna Merah| 19.09                  | u-x| 18.31| vwx | 28.90| o-t| 26.71| p-w| 21.89| r-x| 41.04| f-m|
| Lauiya     | 17.72                   | wx | 20.75| s-x| 28.34| o-u| 23.53| q-x| 21.05| s-x| 40.63| j-p|

P1 : Drought + 25% shade stresses  P4 : 25% shade stress  
P2 : Drought + 50% shade stresses  P5 : 50% shade stress  
P3 : Drought stress  P6 : Control  

*Number followed by a similar letter has no significant difference in α = 5% *

[9] showed that dry weight accumulation in the leaves, stems, and roots of all six varieties was significantly reduced under drought conditions. As a drought tolerant variety, DA8 exhibited the greatest dry matter accumulation and root system development under well-watered, drought stress, and recovery conditions.

3.3. Specific leaf area
Leaf thickness can be measured either as specific leaf area (leaf area in cm²produced g⁻¹leaf dry weight plant⁻¹). Leaf properties such as density, thickness, and chemical composition influence whole plant survival and metabolism; SLA can be used as an indirect measure of several basic leaf processes, such as leaf-water relations, photosynthetic capacity and growth potential [10]. Leaf thickness plays an important role in leaf and plant functioning and is related to species’ strategies of resource acquisition and use [11]. Statistics on the specific leaf area of the Gorontalo local upland rice are presented in Table 3.

The specific leaf area of Ponda Merah accession in the drought+50% shade treatment was the highest amongst all accessions in all treatments, while the specific leaf width of the Ponelo accessions with 25% shade and 50% shade treatment was the lowest. This shows that, in drought+50% shade treatment, the Ponda Merah accession’s leaf is thinner than the other accessions, indicating that the accessions are more tolerant to abiotic stresses, specifically the shade stress. This finding is in line with the finding of [12] which stated that the leaf with the abiotic-tolerant genotype is wider and thinner than the leaf with low light intensity-sensitive genotype.
Table 3. Average interaction effects between accession and drought and shade treatments on specific leaf area

| Accession   | Specific Leaf Area (cm² gr⁻¹) | P1 | P2 | P3 | P4 | P5 | P6 |
|-------------|--------------------------------|----|----|----|----|----|----|
| Sonu        | 95.49 i-r                      | 64.11 q-u | 110.78 c-n | 64.32 p-u | 50.53 stu | 141.90 a-d |
| Ponda Merah | 132.67 b-i                     | 186.58 a | 130.37 c-j | 101.19 f-q | 124.48 c-k | 104.96 f-p |
| Yenti       | 96.84 h-q                      | 74.67 n-u | 98.47 g-q | 55.61 r-u | 48.47 tu | 138.87 b-g |
| Ponelo      | 95.40 i-r                      | 69.28 o-u | 91.08 j-s | 41.07 u | 38.88 u | 123.80 c-l |
| Saniha      | 96.34 h-q                      | 48.67 tu | 101.45 f-q | 83.76 l-t | 48.01 tu | 110.65 d-n |
| Jiema       | 104.55 f-q                     | 79.28 m-u | 145.64 b-e | 55.04 r-u | 64.65 p-u | 136.85 b-h |
| Bulotonu    | 139.30 b-f                     | 151.44 abc | 148.27 a-d | 105.63 e-o | 129.91 c-k | 141.97 ab |
| Buruna Merah| 101.47 f-q                     | 147.92 a-d | 101.00 f-q | 89.62 k-s | 111.46 c-n | 112.87 c-n |
| Lauiya      | 103.22 f-q                     | 137.67 b-g | 84.36 l-t | 90.42 j-s | 117.63 c-m | 108.81 d-o |

P1 : Drought + 25 % shade stresses
P2 : Drought + 50% shade stresses
P3 : Drought stress
P4 : 25% shade stress
P5 : 50% shade stress
P6 : Control

*Number followed by a similar letter has no significant difference in α = 5%

3.4 Productive Seedlings

Productive seedlings are seedlings that sprout before the 7 week-period after seed planting. A higher concentration of productive seedlings indicates productivity. The data on the total productive seedlings are presented in Figure 1.

Productive seedlings sprout in the generative phase. Productive seedlings are the seedlings that could generate tassel. Ponda Merah accessions generated the most seedlings in the drought+25% shade treatment and the drought treatment, while Bulotonu accessions generated the most seedlings in drought+25% shade treatment, shade stress treatment, and 50% shade treatment. Lauiya accessions did not survive in the drought+25% shade treatment, the drought+50% shade treatment, and 50% shade treatment, while Saniha accessions could not survive in the drought+25% shade treatment and the drought+50% shade treatment.
Reflecting on the [13], paddy rice seedlings are classified into very high (>25 seedlings/plant), high (20-25 seedlings/plant), moderate (10-19 seedlings/plant), low (5-9 seedlings/plant), and very low (<5 seedlings/plant). Based on this classification, the accessions to experiment with in this research fall into the category of low and very low.

3.5 Rice Grain Yield

The rice grain yield of the Gorontalo local upland rice is in the form of harvested dry rice grain with 14% water content. The information on the rice grain yield is shown in Table 4.

The rice grain yield of the Ponda Merah accession was not significantly different from the yield of the control specimen which was given the drought+25% shade treatment, the drought+50% shade treatment, the 25% shade treatment, and the 50% shade treatment. This indicates that the two accessions were tolerant against abiotic stresses, both the single stress and combination. Sonu accessions also showed tolerance against single stress and combination even though the grain yield was lower than the Ponda Merah accessions. Bulotanu accessions were relatively tolerant against drought and 25% shade stresses. On the other hand, Saniha, Lauiya, and Jiema accessions were unable to survive under stresses, especially the combination of drought+25% shade stresses and drought+50%
shade stress. Saniha, Laiya, and Jiema accessions are accessions that are sensitive against drought and shade stresses because these three variants cannot survive in a condition with water and sunlight deficits. [14] suggested that drought stress not only suppresses growth and yield but also causes the plant’s demise. The findings of [15] confirmed this by stating that shade stress depletes the photosynthesis activity which in turn results in the decrease of photosynthetic output.

### Table 4. Average interaction effect of accession and stress treatment on rice grain yield

| Varietas        | Rice grain yield (gr.cluster-1) | P1 | P2 | P3 | P4 | P5 | P6 |
|-----------------|--------------------------------|----|----|----|----|----|----|
| Sonu            | 3.88 a-h 4.55 a-f 4.68 a-e 4.85 a-d 4.85 a-d 5.65 a | 3.88 a-h 4.55 a-f 4.68 a-e 4.85 a-d 4.85 a-d 5.65 a |
| Ponda Merah     | 5.18 abc 4.90 a-d 4.74 a-d 4.99 a-d 5.10 abc 5.55 ab | 5.18 abc 4.90 a-d 4.74 a-d 4.99 a-d 5.10 abc 5.55 ab |
| Yenti           | 3.85 a-h 4.24 a-f 3.77 a-i 3.52 a-j 3.37 b-k 5.14 abc | 3.85 a-h 4.24 a-f 3.77 a-i 3.52 a-j 3.37 b-k 5.14 abc |
| Ponelo          | 4.00 a-g 3.46 a-k 3.86 a-h 3.67 a-j 3.68 a-j 5.03 abc | 4.00 a-g 3.46 a-k 3.86 a-h 3.67 a-j 3.68 a-j 5.03 abc |
| Saniha          | 0.71 l 0.71 l 2.39 f-l 3.27 c-k 3.26 c-k 4.96 a-d | 0.71 l 0.71 l 2.39 f-l 3.27 c-k 3.26 c-k 4.96 a-d |
| Jiema           | 2.42 e-l 0.71 l 1.54 i-l 3.03 c-k 2.36 f-l 4.62 a-f | 2.42 e-l 0.71 l 1.54 i-l 3.03 c-k 2.36 f-l 4.62 a-f |
| Bulotonu        | 3.21 c-k 3.18 c-k 4.49 a-f 4.31 a-f 3.18 c-k 5.08 abc | 3.21 c-k 3.18 c-k 4.49 a-f 4.31 a-f 3.18 c-k 5.08 abc |
| Buruna Merah    | 1.89 g-l 1.24 kl 4.10 a-g 2.74 d-l 1.44 jkl 4.83 a-d | 1.89 g-l 1.24 kl 4.10 a-g 2.74 d-l 1.44 jkl 4.83 a-d |
| Laiya           | 0.71 l 0.71 l 4.23 a-f 1.73 h-l 0.71 l 4.88 a-d | 0.71 l 0.71 l 4.23 a-f 1.73 h-l 0.71 l 4.88 a-d |

P1 : Drought + 25 % shade stresses  
P2 : Drought + 50% shade stresses  
P3 : Drought stress  
P4 : 25% shade stress  
P5 : 50% shade stress  
P6 : Control

*Number followed by a similar letter has no significant difference in α = 5%

The Ponda Merah accessions are relatively tolerant against drought and shade stresses. The rice grain yield was not significantly different from the control specimen in all stress treatments, both the single stress and the combination. [16] suggested that some rice genotypes show different levels of sensitivity against drought. However, the genotype of Gogo rice is known to be more tolerant against drought stress compared to the garden variant paddy rice. [17] also claimed that drought stress at the tassel initiation stage suppresses the dry weight of the tassel and the grain count per tassel, which means it affects the yield of the grain. This is assumed to be caused by the decrease of the rate of photosynthesis which causes the decrease in the assimilation production for the tassel growth and the rice grain initiation. Therefore, [18] suggested that an effort to anticipate the drought impact involves selecting the rice genotypes that are adaptable and drought tolerant.

### 3.6 Leaf proline content

The reaction against drought stress is connected with the accumulation of proline in the plant. The level of proline content is inversely proportional to the level of drought stress indicated by the decrease of the water potential [19]. Information on the level of proline in the tolerant accessions (Ponda Merah), moderately tolerant accessions (Ponelo), and sensitive accessions (Saniha) against the drought and shade stresses + shade stress in the generative and vegetative stages is presented in Table 5.

In the vegetative stage, the highest proline level was found in the accessions with the combined drought and shade stress treatment, while the lowest proline level was found in Saniha accessions with the combined drought + 25% shade treatment. In the generative stage, the highest proline level was found in Ponda Merah accessions with drought treatment, while the lowest proline level was found in Saniha accessions with drought treatment.
Table 5. Leaf proline content drought tolerant accessions; moderately tolerant accessions and drought-sensitive accessions

| Accession   | Proline content (μg proline/g fresh weight) |
|-------------|--------------------------------------------|
|             | P1          | P2          | P3          |
|--------------|-------------|-------------|-------------|
|--------------|-------------|-------------|-------------|
| Ponda Merah  | 0.31        | 0.33        | 0.49        |
| Ponelo       | 0.16        | 0.11        | 0.15        |
| Saniha       | 0.05        | 0.07        | 0.07        |
|--------------|-------------|-------------|-------------|
|--------------|-------------|-------------|-------------|
| Ponda Merah  | 1.16        | 1.21        | 1.29        |
| Ponelo       | 1.07        | 1.08        | 1.09        |
| Saniha       | 1.03        | 1.04        | 1.01        |

P1: Drought + 25% shade stresses
P2: Drought + 50% shade stresses
P3: Drought stress

The increase of proline level as a response to drought stress is commonly known. The accumulation of proline when plants are underwater deficit shows that accumulated proline acts as a compatible solute which regulates and reduces the loss of water from the plant’s cell during low water conditions [20]. Proline accumulation has a crucial part in the osmosis balance [21]. Furthermore, a higher concentration of proline allows energy to be supplied to maintain the plant’s survival and growth [22].

3.7 Leaf sugar content

The findings of the research show that the sugar content of the control specimen was higher than that of the specimen with stress treatments, both the single stress and combination. The sugar content was also greater than the specimens which were moderately tolerant and sensitive to stresses. Other than the control specimen, the sugar content of the Ponda Merah accessions was higher than those of the other accessions, measuring at 0.78 g.g⁻¹ in the drought treatment. Meanwhile, Lauiya accessions had the lowest sugar content at 0.42 g.g⁻¹ (Table 6).

Table 6. Leaf sugar content tolerant accessions; moderately tolerant accessions and sensitive accessions

| Accession     | Leaf sugar content (g.g⁻¹) |
|---------------|----------------------------|
|               | P1 | P2 | P3 | P4 | P5 | P6 |
|---------------|----|----|----|----|----|----|
| Sonu          | 0.69 | 0.71 | 0.76 | 0.69 | 0.67 | 0.87 |
| Ponda merah   | 0.75 | 0.73 | 0.78 | 0.71 | 0.70 | 0.86 |
| Yenti         | 0.56 | 0.58 | 0.64 | 0.59 | 0.61 | 0.78 |
| Ponelo        | 0.67 | 0.64 | 0.67 | 0.64 | 0.63 | 0.83 |
| Saniha        | 0.53 | 0.49 | 0.49 | 0.64 | 0.68 | 0.88 |
| Jiena         | tt  | tt  | 0.25 | 0.50 | tt  | 0.78 |
| Bulotonu      | 0.61 | 0.53 | 0.70 | 0.61 | 0.61 | 0.86 |
| Buruna merah  | tt  | tt  | tt  | tt  | tt  | tt  |
| Lauiya        | 0.43 | tt  | tt  | 0.55 | 0.42 | 0.61 |

P1: Drought + 25% shade stresses
P2: Drought + 50% shade stresses
P3: Drought stress
P4: 25% shade stress
P5: 50% shade stress
P6: Control

The higher the sugar content in the leaf, the bigger the possibility for the leaf to maintain the photosynthesis rate which in turn maintains the chlorophyll content to remain high. This way sugar
can be produced to its fullest potential. [23] indicated that the carbohydrate which is trans-located from leaves and stem during grain filling and the carbohydrate assimilated during the grain filling is closely correlated with the grain yield.

4. Conclusions

Ponda Merah are accessions that are tolerant against drought and shade stresses indicated by their morphological characteristics such as longer root length (33.20 cm), higher dry weight (38.82 g), thinner leaf (186.56 cm².g⁻¹), higher yield (4.90 gr.cluster⁻¹). Furthermore, the physiological characteristic of the Gorontalo local upland rice which shows tolerance against drought and shade stresses is the sugar content (0.73 g.g⁻¹).

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