Yield ability and grain quality of upland rice in Sukabumi and Lampung

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Abstract. Efforts to increase rice food production in the future are faced with increasing climate uncertainty due to global climate change. One of the impacts is changes in strains or biotypes of pests and diseases, which are increasingly rapid. To minimize the impact of climate change on national rice production, the purpose of this study was to produce upland rice lines that resistant to blast disease and had good rice quality. The research carried at Lampung and Sukabumi of 2018. A total of 17 lines and three comparison varieties tested using a randomized block design with four replications. Observations made on the agronomic character, yield components and quality of rice. The results showed that the average plant height in the two locations ranged from 90 to 136 cm. The number of productive tillers at two locations it’s the average of 11 panicles. The mean flowering age did not differ from the harvest age between the lines tested at the two locations. The length of panicle lines tested at two locations averaged 25.5 cm. The average weight of 1000 grains at both locations is 26.1 grams. Grain yield in Lampung averaged 4.7 t ha⁻¹, higher than in Sukabumi 3.6 t ha⁻¹. Five lines had no significant difference with Limboto both at the Lampung location and in Sukabumi. Among all the lines tested, there are three lines with the medium of chalkiness or LMM size. The results of testing in the greenhouse against blast disease obtained one line resistant to three blast races.

1. Introduction
Increasing rice production can be pursued through enhance cropping intensity and productivity of existing paddy fields, printing of new irrigated lands and developing other potential lands including marginal lands such as dry land. Dry land has a large enough potential to be developed into agricultural land to support national food security [1]. According to [2] demand for food, especially rice, continues to increase from year to year, thus encouraging the government to develop agricultural land into problematic areas including dry land. Dry land in Indonesia is quite extensive, about 16.5 million ha [3]. The use of dry land for agriculture is an alternative that can compensate for the reduction in productive land, especially in Java, which has switched functions for various non-agricultural development needs [4].

Some of the obstacles that are often encountered on dry land include drought, Al toxicity, and major blast disease. Upland rice is a type of rice that is cultivated on dry land where the fulfillment of plant water needs depends on rain. This rice is generally cultivated in hilly areas and is a type of dry land. Climatic factors, especially rainfall, are a very determining factor for the success of upland rice cultivation because the need for water for upland rice only relies on rainfall [5].
The assembly of new upland rice varieties is still being carried out to obtain a variety with superior resistance and tolerance to abiotic biotic stresses and has good grain quality. Indonesian Center for Rice Research (ICRR) has released 13 upland rice varieties with various advantages and yield potential [6]. One of the efforts to obtain these new superior varieties is through conventional plant breeding activities, starting from crossing, selection, and yield testing. This study aimed to determine the appearance of high yielding agronomic characters of the promising upland rice lines.

2. Materials and method
2.1. Time and place
The experiment was conducted in Tamanbogo (Lampung), and Sukabumi (West Java) in wet season in 2018.

2.2. Materials
A total of 17 lines and check varieties i.e. Limboto, Inpago 8 and Batutegi were used at the experimental material (Table 1).

2.3. Experimental design
Design of the experiment was randomized complete block design with four replications. The plot size was 2 m × 5 m, spacing was 30 cm × 15 cm. Planting was done with the number of seeds 2 – 3 grain per hole. Fertilization used were 300 kg/ha NPK + 100 kg/ha Urea. Pets and diseases were controlled optimally.

| Code | Genotype         | Code | Varieties/Lines |
|------|------------------|------|----------------|
| A    | B15053F-PWR-3    | L    | B15175C-TGB-20 |
| B    | B14956-MR-2-2-2-0| M    | B15053F-PWR-8  |
| C    | B12160D-MR-11-3-4| N    | B14957-MR-2-3-2|
| D    | B15119C-TB-5     | P    | B15114C-TB-22  |
| E    | B15119C-TB-13    | Q    | B15231-MR-10-1 |
| F    | B13498D-9        | R    | B15053F-PWR-2  |
| G    | B15119C-TB-42    | S    | B14908C-MR-1-25-1-3 |
| H    | B155340-3B-TB-6  | T    | Limboto        |
| Y    | B15340-1B-TB-45  | U    | Inpago 8       |
| K    | B14981B-TGB-7-1  | V    | Batutegi       |

2.4. Observation
The variables observed the agronomic character, yield component, grain yield, and quality of the rice. The variables for the yielding was yield with 14% moisture content, variable observed in the yield component consisted of the amount of filled grain and empty per panicle, and 1000 grain weight (14% moisture content). The variables observed for the character agronomic were plant height, the number of productive tillers, age of flowering plants (50%), and age harvested (80% yellowing rice). The rice grain was analyzed on its quality at the Laboratory of the Muara Experimental station in Bogor. The variables observed were milling quality, and cooking quality includes observations for physical properties and chemical properties. The physical quality of rice includes the length and width of the rice, measured by a micrometer. The shape of rice is the ratio between the length and breadth of the rice. Standards for evaluation of rice length and shape grouped into very long, long, intermediate, and short for size classification, consist of a slender, medium, and bold for shape classification [7]. The size of the particles of white endosperm grains (chalk grains) was measured based on the
The combined analysis showed significant effect of genotypes on plant height, number of productive tillers, flowering age, panicle length, number of filled grains, weight of 1000 grains, and yield. The effect of genotype interaction with location was significant on grain yield and six characters, except for panicle length (Table 2). Data showed that the tested lines had different effects on plant height, number of productive tillers, flowering and harvesting age, number of filled grains, and yield. Plant height, number of productive tillers, flowering age, harvesting age, panicle length, number of filled grains showed different effects between Tamanbogo and Sukabumi areas.

Table 2. Combined analysis of agronomic characters of upland rice lines, Tamanbogo and Sukabumi, WS 2018

| Source of variance | df | PH   | NPT   | DF   | HT   | PL   | NFG  | W    | Y    |
|--------------------|----|------|-------|------|------|------|------|------|------|
| Location (L)       | 1  | 160* | 146.3*| 5640*| 4368*| 320.9*| 13.2*| 0.2  | 42.4*|
| Repl./location     | 6  | 236.2*| 7.49* | 29.7*| 3.25 | 4.1  | 1920*| 18.1*| 0.5  |
| Genotype (G)       | 19 | 1087.4*| 10.7* | 108.1*| 93.1*| 11.7*| 1220*| 4.5  | 2.9* |
| G x L              | 19 | 21.3* | 4.8*  | 24.1*| 25.3*| 3.4  | 1707*| 7.1* | 0.7* |

*significantly effect at P<5%, PH=plant height, NPT=number of productive tillers, DF=day to flowering, HT=harvest time, PL=panicle length, NFG=number of filled grain, W=weight of 1000 grains, Y=yield.
3.1. Agronomic characters
The average plant height was 109.8 cm in Tamanbogo, 111.8 cm in Sukabumi, and 110.8 cm in both locations (Table 3). Based on the criteria of [11], rice plant height is grouped into three, namely short (<100 cm), medium (101-130 cm) and high (>130 cm), so the average plant height in both locations was in the medium category. The posture of plants in Sukabumi was higher than in Tamanbogo. Tamanbogo was a location with high Al content, suspected that there was an effect of Al stress on plant height in Tamanbogo compared to Sukabumi. It can also be seen from the height plant of the check variety where the check variety was shorter in Tamanbogo than in Sukabumi. According to [12], short plants were one of the criteria for excellence of rice. Rice plants with short stems were admirable because they do not fall due to environmental factors such as rain and wind.

The average number of productive tillers in the two research locations was 10.6. As many as six lines had 11 productive tillers and significantly more than the check varieties in Tamanbogo, namely B15340-1B-TB-45, B15114C-TB-22, B15231-MR-10-1, B15119C-TB-5, and B13498D-9, while in Sukabumi there was only one line with significantly higher tillers than the check variety, namely B15175C-TGB-20 (16 stems). According to [13], the criteria for the number of productive tillers per clump branched into four groups, namely: few (9-11 stems), medium (12-14 stems), many (15-20 stems) and very many (>20 stems). Based on these criteria, it can notice at the average number of lines has a small number of productive tillers. There were several lines with the criteria for medium tillers when planted in Sukabumi.

The average flower age in Sukabumi was longer than in Tamanbogo. The lines with the earliest age in both locations were B14957-MR-2-3-2, B15119C-TB-42, and B15231-MR-10-1. The three lines were significantly faster than all the check varieties. Inpago 8 was the check variety with the deepest age. According to [14], the flowering age of rice plants arranged into four groups, namely: very early age (<110 cm), early age (110-115 days), moderate (115-125 days) and deep (125-150 days). From these criteria, it shows that all genotypes were classified as early flowering in Tamanbogo and moderate in Sukabumi.

The length of panicle lines tested at two locations averaged 25.5 cm. The check variety with the longest panicle was Batutegi with a panicle length of 28.63 cm in Tamanbogo and 27.33 cm in Sukabumi. There were no lines with significantly higher panicle length than the best check variety Batutegi. However, in Tamanbogo there are eight lines and four lines with panicle lengths that are not significantly different from Batutegi, respectively in Tamanbogo and Sukabumi. Two lines with panicle length were not significantly different from Batutegi in the two locations, namely B15053F-PWR-8 and B15053F-PWR-3. [15] classified panicle length into three groups, namely short (30 cm), medium (20-30 cm), and long (>30 cm). Based on these criteria, all tested lines were classified as moderate. Plants that have long panicles will provide more grain so that the weight of grain per hill will increase. Based on these criteria, all tested lines were classified as moderate. Plants with long panicles will provide more grain so that the weight of grain per hill will increase [16].

| No | Genotype     | PH | NPT | DF | HT  |
|----|--------------|----|-----|----|-----|
|    |              | TB | SKB |    |     |
| A  | B15053F-PWR-3| 105| 111 | 8  | 11* |
| B  | B14956-MR-2-2-2-0| 136*| 136*| 11*| 12* |
| C  | B12160D-MR-11-3-4| 90 | 90  | 9* | 12* |
| D  | B15119C-TB-5  | 102| 98  | 11*| 14* |
| E  | B15119C-TB-13 | 100| 103 | 10*| 13* |
| F  | B13498D-9     | 99 | 101 | 11*| 10  |
| G  | B15119C-TB-42 | 100| 98  | 10*| 11* |
The average number of filled grains in the two locations was 128.8 grains per panicle. The Limboto check variety had the best number of filled grains in Tamanbogo, while in the Sukabumi was the Batutegi. In Tamanbogo, one line was obtained with the number of filled grains more than the best check variety, namely the B14957-MR-2-3-2 line, while in Sukabumi there was no line with the number of filled grains exceeding the best comparison. The 1000 grain weights of the lines tested at the Tamanbogo ranged from 24.65 - 27.64, while in Sukabumi was ranged from 22.94 - 30.16. The lines that had 1000 grain weight heavier than the best comparison for the two locations were three lines each. The lines were B15340 -3B-TB-6 and B15175C-TGB-20 for both Tamanbogo and Sukabumi locations, and the other lines were B13498D-9 in Tamanbogo and B14956-MR-2-2-2-0 in Sukabumi.

### Table 4. Panicle length, number of filled grain per panicle, weight of 1000 grains, yield of upland rice lines at Tamanbogo and Sukabumi WS 2017

| No | Genotype          | PL  | NFG | W  | Y  |
|----|-------------------|-----|-----|----|----|
|    |                   | TB  | SKB | TB | SKB | TB  | SKB | TB  | SKB |
| A  | B15053F-PWR-3     | 28.30 | 25.31 | 129 | 154 | 24.65 | 23.09 | 3.64 | 3.50 |
| B  | B14956-MR-2-2-2-0 | 27.73 | 23.73 | 79  | 107 | 26.53 | 30.13* | 4.35 | 4.50* |
| C  | B12160D-MR-11-3-4 | 24.90 | 23.00 | 103 | 130 | 26.22 | 26.65 | 4.73 | 2.79 |
| D  | B15119C-TB-5      | 23.93 | 22.07 | 129 | 128 | 26.14 | 25.35 | 4.66 | 4.08 |
| E  | B15119C-TB-13     | 25.33 | 23.39 | 143 | 131 | 25.67 | 26.41 | 5.09 | 3.79 |
| F  | B13498D-9         | 26.70 | 23.88 | 103 | 135 | 27.64* | 27.10 | 4.60 | 3.72 |
| G  | B15119C-TB-42     | 24.85 | 22.17 | 125 | 129 | 27.01 | 25.98 | 5.14 | 3.56 |
| H  | B15340 -3B-TB-6   | 26.88 | 24.50 | 96  | 117 | 27.36* | 30.11* | 3.94 | 3.65 |
| Y  | B15340 -1B-TB-45  | 27.13 | 23.89 | 128 | 135 | 26.41 | 24.55 | 4.46 | 4.04 |
The lines that had 1000 grain weight was heavier than the best comparison for both locations are three lines each. The lines were B15340 -3B-TB-6 and B15175C-TGB-20 for both Tamanbogo and Sukabumi locations which were higher than the check varieties. The other lines were B13498D-9 (27.64 g) in Tamanbogo and B14956-MR-2-2-2-0 (30.13 g) in Sukabumi. All lines tested were classified as heavy and some very heavy based on the classification by [17] where the weight of 1000 grains was classified into three groups, namely very heavy (> 28 g), heavy (22-28 g), and light (<22 g). According to [18] the weight of 1000 grain was the dry weight accumulated into grain. In addition, the weight of 1000 grain also reflects the size of rice grain which depends on the size of the grain.

Grain yields of the 17 lines in Tamanbogo ranged from 3.64 t/ha (B15053F-PWR-3) to 5.76 t/ha (B15114C-TGB-22). Grain yield in Sukabumi ranged from 2.79 t/ha (B12160D-MR-11-3-4) to 4.5 t/ha (B14956-MR-2-2-2-0). The average grain yield in Tamanbogo was 4.74 t/ha, higher than in Sukabumi 3.62 t/ha. The analysis showed that at Tamanbogo were no lines with significantly higher yields than the best check Limboto. On the other hand, in Sukabumi, three lines were obtained, and the lines were B14956-MR-2-2-2-0, B14981B-TGB-7-1 and B15114C-TB-22. Five lines yield were not significantly different from Limboto both at the Tamanbogo location and in Sukabumi i.e. B15119C-TB-13, B15119C-TB-42, B14981B-TGB-7-1, B14957-MR-2-3-2, and B15114C-TB-22 (Table 4).

### Table 4. Average Grain Yield (t/ha) of All Lines

| Line                      | Tamanbogo | Sukabumi |
|---------------------------|-----------|----------|
| B14981B-TGB-7-1           | 28.63     | 26.1     |
| B15175C-TGB-20            | 25.28     | 26.2     |
| B15053F-PWR-8             | 27.38     | 26.2     |
| B14957-MR-2-3-2           | 25.53     | 26.3     |
| B15114C-TB-22             | 28.58     | 26.2     |
| B15231-MR-10-1            | 26.80     | 26.2     |
| B15053F-PWR-2             | 27.88     | 26.2     |
| B14908C-MR-1-25-1-3       | 27.48     | 26.2     |
| Limboto                   | 28.48     | 26.2     |
| Inpago 8                  | 28.05     | 26.2     |
| Batutegi                  | 28.63     | 26.2     |

The best of varieties for high yield in two locations was Limboto, Limboto had only resistance to one race blast (073). Observation results showed varying resistance from resistant (T) to susceptible (R). The test results showed that six lines had resistance to one blast race that were B12160D-MR-11-3-4, B15119C-TB-5, B15119C-TB-13, B15053F-PWR-8, B14957-MR-2-3-2, and B13498D-9. Four lines had resistance to two blast races that B14956-MR-2-2-2-0, B15340 -1B-TB-45, B14981B-TGB-

### 3.2. Resistance to stress biotic and abiotic

Rice blast disease caused by fungus P. grisea is one of the main biotic problems in the upland rice. In the area of the endemic blast, the productivity of upland rice decreasing to get 11 - 15 % until the farmer fails to harvest [19] [20] [21]. The area of endemic blast disease in Indonesia was Sukabumi and Lampung [22]. Several studies reported to produce promising lines that were resistant to blast disease observed by researchers in rice plant [23] [24] [25]. The ata of for biotic stresses is shown in Table 5.

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7-1, and B15175C-TGB-20. B15053F-PWR-3 had resistance to 3 blast races involving race 033, race 133, and race 173 (Table 6). This line had a low yield in both Sukabumi and Lampung indicated that was difficult to compare yield character and result test of blast disease in the greenhouse because of the race in the field and the greenhouse are different. Monitoring data result showed that the diversity level of blast pathogen populations in Sukabumi was high on then races 001, 123, 133, 173, and 243 [20]. Monitoring population of blast pathogen is available every season in the area upland rice in Lampung obtain seven races (001, 023,033, 073, 101, 133, and 173) [22]. One effort against blast disease was to use resistant rice variety. However, the durability of resistant varieties was easily breakdown so that the blast disease in the rice was difficult to control [26] [27]. Several promising rice lines tested had resistance to blast disease used as a source of resistance. According to [21], the choice of varieties containing resistant gene(s) matches with the pathogen race in the field is highly recommended, also monitoring the composition of races in the area is necessary.

Table 5. The reaction of resistance of upland rice lines of advanced yield trial to four blast races, in the greenhouse at experimental station Muara Bogor on 2018.

| No | Genotype            | Pyricularia grisea reaction |
|----|---------------------|-----------------------------|
|    | Ras 033 | Ras 073 | Ras 133 | Ras 173 |
| A  | B15053F-PWR-3      | 1   | T      | 5   | S      | 1   | T      | 1   | T      |
| B  | B14956-MR-2-2-2-0  | 5   | S      | 1   | T      | 1   | T      | 3   | RT     |
| C  | B12160D-MR-11-3-4  | 3   | RT     | 3   | RT     | 3   | RT     | 1   | T      |
| D  | B15119C-TB-5       | 1   | T      | 5   | S      | 5   | S      | 3   | RT     |
| E  | B15119C-TB-13      | 1   | T      | 5   | S      | 5   | S      | 3   | RT     |
| F  | B13498D-9          | 5   | S      | 1   | T      | 5   | S      | 3   | RT     |
| G  | B15119C-TB-42      | 5   | S      | 5   | S      | 5   | S      | 5   | S      |
| H  | B15340-3B-TB-6     | 5   | S      | 3   | RT     | 3   | RT     | 3   | RT     |
| Y  | B15340-1B-TB-45    | 1   | T      | 5   | S      | 5   | S      | 1   | T      |
| K  | B14981B-TGB-7-1    | 1   | T      | 3   | RT     | 3   | RT     | 1   | T      |
| L  | B15175C-TGB-20     | 1   | T      | 3   | RT     | 3   | RT     | 1   | T      |
| M  | B15053F-PWR-8      | 5   | S      | 3   | RT     | 3   | RT     | 1   | T      |
| N  | B14957-MR-2-3-2    | 5   | S      | 5   | S      | 3   | RT     | 5   | S      |
| P  | B15114C-TB-22      | 1   | T      | 7   | S      | 3   | RT     | 3   | RT     |
| Q  | B15231-MR-10-1     | 5   | S      | 5   | S      | 5   | S      | 5   | S      |
| R  | B15053F-PWR-2      | 7   | S      | 3   | RT     | 5   | S      | 5   | S      |
| S  | B14908C-MR-1-25-1-3| 5   | S      | 3   | RT     | 5   | S      | 5   | S      |
| T  | Limboto            | 5   | S      | 1   | T      | 5   | S      | 3   | S      |
| U  | Inpago 8           | 5   | S      | 3   | RT     | 5   | S      | 5   | S      |
| V  | Batutegi           | 5   | S      | 5   | S      | 3   | RT     | 1   | T      |

S=susceptible, T=tolerant, RT=rather tolerant, VT=very tolerant

Besides being endemic to blast, the two locations differed due to the chemical properties of the soil. Lampung had a high soil acidity, caused aluminum toxicity to the rice plant. Meanwhile, in Sukabumi, the land was fertile, low acidity, so the plant had not aluminum toxicity. Theresults of the rice plant tolerance test to 40 ppm aluminum toxicity is shown in Table 6.

Aluminum toxicity is one of the main abiotic constraints that often occurs in dryland [28]. Al toxicity in rice plants mainly affects root development. On acidic land with Al toxicity, the growth of rice roots was inhibited so that the plant becomes stunted, and orange-yellow leave [29]. Screening Al toxicity in the vegetative phase was carried out using a nutrient solution. In testing tolerance to Al toxicity, the root length relative (RPA) was a tolerance parameter particularly, the comparison
between Al toxicity condition on 40 ppm and condition without Al (0 ppm). The classification of tolerance levels was obtained based on the outcome of research by [30], which stated that lines with an RPA value of more than 0.60 provided high yields on acidic soils, so that can be classified as tolerant to Al toxicity. Tests for Al toxicity identified one very tolerant line, namely the B14957-MR-2-3-2 line, with an RPA value of 0.82. Seven lines were tolerance to Al toxicity with RPA values higher than the Limboto comparison varieties, namely the B15119C-TB-5, B15340-3B-TB-6, B14956-MR-2-2-2-0, B15119C-TB-13, B15340-1B-TB-4, B15053F-PWR-8 and B15114C-TB-22, with RPA values ranging from 0.65 - 0.80. According to [30], not all breeding lines that tolerant to Al had high yields, but those selected for high yielding were tolerant or moderately tolerant to Al. Selection of upland rice lines against Al toxicity using another treat level ppm showed that not all breeding lines that tolerant of Al toxicity had high yields in acid soils [31] [32] [33]. This statement was the same with the experiment obtain showing lines with high RPA values ranging from 0.65 to 0.82, apparently not always giving high results in-field testing because of the test in greenhouses perform on nutrient solution media so that plants only faced the problem of Al toxicity [30]. Selection using nutrient solutions will not guarantee the plants will remain tolerant of acid soils because the expression of genes in rice depends on plant development [33]. The lines produced through nutrient selection can be used as a genetic source in breeding programs to improve tolerance to Al toxicity. The use of improved varieties that are tolerant of Al toxicity is a practical, economical, and stable method.

Table 6. The tolerance level of upland rice lines of advance yield trial to aluminum toxicity at the level of 40 ppm in the greenhouse at experimental station Muara Bogor on 2018

| Code | Line/Variety | Root length on the level 0 ppm | Root length on the level 40 ppm | Root length on the level 40 ppm RPA | Tolerance level Al on 40 ppm |
|------|--------------|--------------------------------|--------------------------------|------------------------------------|-----------------------------|
| A    | B15053F-PWR-3| 8.6                            | 3.4                            | 0.39                               | S                           |
| B    | B14956-MR-2-2-0-0 | 11.3                        | 7.9                            | 0.70                               | T                           |
| C    | B12160D-MR-11-3-4 | 11.8                        | 4.6                            | 0.39                               | S                           |
| D    | B15119C-TB-5  | 12.9                            | 10.3                           | 0.80                               | T                           |
| E    | B15119C-TB-13 | 11.4                            | 7.4                            | 0.65                               | T                           |
| F    | B13498D-9    | 11.3                            | 4.8                            | 0.42                               | RT                          |
| G    | B15119C-TB-42 | 11.8                            | 4.6                            | 0.39                               | S                           |
| H    | B15340-3B-TB-6 | 12.9                           | 10.3                           | 0.80                               | T                           |
| Y    | B15340-1B-TB-45 | 11.4                        | 7.4                            | 0.65                               | T                           |
| K    | B14981B-TGB-7-1 | 10.9                        | 6.2                            | 0.57                               | RT                          |
| L    | B15175C-TGB-20 | 11.7                           | 5.8                            | 0.49                               | RT                          |
| M    | B15053F-PWR-8 | 10.4                            | 7.9                            | 0.76                               | T                           |
| N    | B14957-MR-2-3-2 | 11.1                           | 9.1                            | 0.82                               | VT                          |
| P    | B15114C-TB-22 | 10.4                            | 7.9                            | 0.76                               | T                           |
| Q    | B15231-MR-10-1 | 10.3                           | 5.8                            | 0.57                               | RT                          |
| R    | B15053F-PWR-2  | 11.1                            | 4.3                            | 0.39                               | P                           |
| S    | B14908C-MR-1-25-1-3 | 13.7                        | 5.7                            | 0.41                               | RT                          |
| T    | Limboto       | 9.2                            | 5.6                            | 0.61                               | T                           |
| U    | Inpago 8      | 11.3                            | 6.1                            | 0.54                               | RT                          |
| V    | Batutegi      | 9.7                            | 4.1                            | 0.42                               | RT                          |

S=susceptible, T=tolerant, RT=rather tolerant, VT=very tolerant
3.3. Grain quality of upland rice lines

Grain quality of upland rice lines and variety performed is shown in Table 7. The milling recovery of the milled rice (MRR) from the whole genotype was in the range of 30-67%. Check variety Limboto had the highest MRR percentage compared to other checks. Three lines had a higher MRR percentage than Limboto, namely B15114C-TB-22 (67%), B15119C-TB-5 (63%), and B15175C-TGB-20 (60%). Similarly, on the milling recovery (MR), Check variety Limboto had the highest MR percentage compared to other checks. Eight lines had a higher MR percentage than Limboto, namely B12160D-MR-11-3-4 (66%), B15119C-TB-5 (79%), B15119C-TB-13 (76%), B13498D-9 (74%), B1519C-TB-42 (74%), B15340 -3B-TB-6 (69%), B14957-MR-2-3-2 (67%), and B15114C-TB-22 (79%). Limboto also had the highest percentage of head rice recovery compared to other checks (46%). Three lines with a higher percentage of head rice recovery than Limboto were B15053F-PWR-2 (61%), B15053F-PWR-8 (50%), B15175C-TGB-20 (48%), and B15119C-TB-13 (47%). Previous study [34] reported head rice was healthy or defective rice grains had a size greater than or equal to 75% of the whole grain. It indicates the weight of whole grains obtained after industrial processing. This is one of the most important parameters in rice commercial value determination.

[35] classified amylose content in rice were five group as waxy (0%–2% in brown rice, 0%–2% in milled rice), very low (0%–9% in brown rice, 2%–9% in milled rice), low (10%–19% in brown rice, 9%–20% in milled rice), intermediate (20%–24% in brown rice, 20%–25% in milled rice), and high (> 25% in brown rice, > 25% in milled rice). The percentage of amylose content showed that most of the lines had moderate to high amylose levels ranged from 22.9% - 30.8% except for B14981B-TGB-7-1 with 20.79% amylose. The amylose content was highly correlated with the rice texture, in which it is as the higher the amylose content the harder rice texture. A very low amylose content of 0-5% is included in the glutinous category. Check varieties were classified as moderate to medium amylose levels. [36] have reported that a major factor in determining eating quality was the amylose content, but consumer preferences differed widely in the Indonesian region.

For rice length, shape, and chalkiness of rice, most of the lines were long (L), medium (M) and small (S). This showed that most of the lines had a length, shape and chalkiness that were comparable to the check. Among all the lines tested, there were three lines with LMM shape which were marked with a whitish color that filled about 40% of the middle part of the rice, namely B14981B-TGB-7-1, B15175C-TGB-20, and B15053F-PWR-8. According to [37] rice chalkiness ratio and percentage of unfilled grains significantly increased when water deficits occurred during the panicle emission and grain filling stages. Well-developed grains show higher head rice yield, due to higher resistance to shocks and vibrations caused by harvest processing.

| Code | Genotype       | MRR | MR  | HRR | AC  | Cooking rice | Size |
|------|----------------|-----|-----|-----|-----|--------------|------|
| A    | B15053F-PWR-3  | 30  | 40  | 46  | 25.2| 3.5          | hard | L  | M  | S  |
| B    | B14956-MR-2-2-2-0 | 40  | 53  | 44  | 30.8| 4.0          | hard | L  | M  | S  |
| C    | B12160D-MR-11-3-4 | 46  | 66  | 18  | 26.8| 3.6          | hard | L  | M  | S  |
| D    | B15119C-TB-5    | 63  | 79  | 50  | 28.1| 3.6          | hard | L  | M  | S  |
| E    | B15119C-TB-13   | 58  | 76  | 47  | 26.2| 3.8          | hard | L  | M  | S  |
| F    | B13498D-9       | 58  | 74  | 39  | 26.7| 3.8          | hard | L  | M  | S  |
| G    | B15119C-TB-42   | 58  | 74  | 30  | 27.7| 3.6          | hard | L  | M  | S  |
| H    | B15340 -3B-TB-6 | 57  | 69  | 32  | 27.4| 3.6          | hard | L  | M  | S  |
| Y    | B15340 -1B-TB-45| 51  | 63  | 33  | 27.0| 3.6          | hard | L  | M  | S  |
| K    | B14981B-TGB-7-1 | 52  | 60  | 44  | 20.8| 2.2          | sticky| L  | M  | M  |
| L    | B15175C-TGB-20  | 60  | 64  | 48  | 24.5| 3.4          | medium| L  | M  | M  |
| M    | B15053F-PWR-8   | 48  | 59  | 50  | 24.4| 3.4          | medium| L  | M  | M  |
3.4. Correlated between agronomic characters

The relations pattern between yield components and grain yields at each location is shown in Table 8. In Tamanbogo, it was known that yield characters have a positive correlation with the number of filled grains and vice versa with a negative correlation with flowering and harvesting age, while in Sukabumi positively correlated only with 1000-grain weight characters. However, in general at both locations the grain yield was significantly positively correlated with panicle length.

The character of the number of filled grains, 1000 grain weight and panicle length are the character components of rice yields [39, 40] stated that yield was significantly and positively correlated with plant height, total number of tillers per hill, number of productive tillers per hill, flowering age, harvest age, total number of grains per panicle and weight of 1000 seeds. However, the percentage of filled grain per panicle and panicle length were not significantly correlated with the grain yield.

Table 8. Correlated between agronomic characters in each location WS 2017

| Characters | KP, Tamanbogo, Lampung | PH | NPT | DF | HT | PL | NFG | WG |
|------------|------------------------|----|-----|----|----|----|-----|----|
| NPT        | 0.10ns                 |    |     |    |    |    |     |     |
| DF         | 0.19ns                 | -0.02ns |    |    |    |     |     |
| HT         | 0.18ns                 | -0.03ns | 0.91** |    |    |     |     |
| PL         | 0.55**                 | -0.11ns | 0.32* | 0.23* |    |     |     |
| NFG        | -0.09ns                | -0.20ns | -0.20ns | -0.14ns | 0.11ns |    |     |
| WG         | -0.15ns                | 0.11ns | -0.32* | -0.28* | -0.23* | -0.15ns |     |
| Y          | -0.04ns                | -0.05ns | -0.26* | -0.25* | -0.04ns | 0.42* | 0.20ns |

| Karakter   | Sukabumi, Jawa Barat   | PH | NPT | DF | HT | PL | NFG | WG |
|------------|------------------------|----|-----|----|----|----|-----|----|
| NPT        | -0.19ns                |    |     |    |    |    |     |     |
| DF         | 0.28*                  | -0.20ns |    |    |    |     |     |
| HT         | 0.33*                  | -0.25* | 0.69** |    |    |     |     |
| PL         | 0.18ns                 | -0.14ns | 0.26* | 0.06ns |    |     |     |
| NFG        | 0.09ns                 | 0.001ns | -0.05ns | -0.07ns | 0.11ns |    |     |
| WG         | -0.05ns                | -0.11ns | 0.04ns | 0.21ns | -0.05ns | -0.42** |     |
| Y          | -0.07ns                | -0.04ns | 0.15ns | 0.09ns | 0.107ns | -0.12ns | 0.27* |

PH=plant height, NPT=number of productive tiller, DF=day to flowering, HT=harvest time, PL=panicle length, NFG=number of filled grain, W=weight of 1000 grains, Y=yield, ns = not significant, *=significantly correlated, **=highly correlated
4. Conclusion

The average plant height at the two locations ranged from 90 cm (B12160D-MR-11-3-4) to 136 cm (B14956-MR-2-2-2-0), the number of productive tillers in Tamanbogo and Sukabumi averaged 10.6 stems. The flowering age did not differ from the harvest age between the lines tested at the two locations. The length of panicle lines tested at two locations averaged 25.5 cm. The average weight of 1000 grains at both locations was 26.1 grams. The average grain yield in Tamanbogo was 4.74 t ha\(^{-1}\), higher than in Sukabumi as 3.62 t ha\(^{-1}\). B15119C-TB-13, B15119C-TB-42, B14981B-TGB-7-1, B14957-MR-2-3-2, and B15114C-TB-22 yields were not significantly different from Limboto both at the Tamanbogo and Sukabumi. Among all the lines, there were three lines with medium liming (M) or LMM rice size, namely B14981B-TGB-7-1, B15175C-TGB-20, and B15053F-PWR-8. There was one line resistant to three blastraeces, namely B15053F-PWR-3

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