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## Selection of Character of Yield Component in M2 Aromatic Rice Mutant

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**Abstract.** Toraja has diversity of rice germplasm. Aromatic rice is very popular today because of its good quality and fragrant aroma. However its long harvesting period is not comparable to its low yield (2-3 ton ha<sup>-1</sup>) in 6 month planting season. Efforts to increase production through mutation breeding has been proposed here. The aim of this study is to evaluate the effect of 19 mutant (M2) lines on yield attributes. The study was conducted at Alla District, enrekang regency, South Sulawesi from May to October 2017 using mass selection method consisting of two irradiation treatments, namely: irradiation with Carbon ion dose 150 Gy (PB-C), irradiation with 10 Gy Argon ions (PB-A), and control as a comparison. The result showed that lines that have the best production components is PB-A-14.2.14. Whereas, there are 14 lines that have better production components than controls. Cluster analysis showed that there were 3 main components of lines formed into further 5 sub-groups with similarity level 66.67%.


Keyword: Aromatic Rice, Ion Beam, Irradiation, Mutant, Pare Bau

### 4 Introduction

Rice is one of the major cereal grain consumed more than half of the world's population. It is warm season crop grown extensively in the humid tropical and subtropical region of the world. China, India, Japan, Korea, South-East Asia and the adjacent islands of the Pacific account for about 90 per cent of the world's rice production.

Toraja is an area in South Sulawesi that has germplasm diversity. The diversity of local rice in Toraja is a potential asset to be utilized and preserved [1]. One of the local rice found in Toraja specially North Toraja is Aromatic Rice (Pare Bau). Pare Bau has been cultivated on a small scale for religious purposes, festivals, daily use for a thousand years. Aromatic rice is an important commodity worldwide and command premium prices in local and international market over non-aromatic varieties because of their superior grain quality and pleasant aroma [2, 3].

Otherwise, aromatic rice is not as good as non-aromatic rice, so it is an obstacle for farmers to grow aromatic rice, especially in traditional communities. Aromatic rice generally has a high posture, less

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number of panicles, lower yields and susceptibility to storage. On this, several methods have been tried by scientists to combat this perennial problem. Some researchers have tried nutritional method, physiological method, and breeding as well as control of pests and diseases. Among these methods, it is established that breeding for high yield traits is the most sustainable because the traits are heritable.

Yield and quality of rice depends on the genetic potential of cultivars, its surrounding environment and management practices. Selection of right type of variety is most important factors for maximizing rice production. Yield of rice changes due to growing environment, such as different locations, different dates of planting [4]. In developing varieties that adapt well to specific environments, it is necessary to identify strains that have high interactions with the environment [5]. One of the criteria that DSPAT is used as a selection variable is a component of production. The production component is the main criteria used by plant breeders in producing new varieties with high yield potential [6].

This research is expected to create new aromatic rice. Based on these matters, it is necessary to conduct research on "selection of 2nd generation mutant lines using the character of production component".

## 2. Method

The experiment was conducted at the Alla District, Enrekang Regency, south Sulawesi. The experimental site was a medium high land (650 above the sea level) at the coordinates of S: 3 ° 19'47,44 "; E: 119 ° 50'1,57 "and runs from May to October 2017.

### 2.1. Experimental apparatus

The materials used in this experiment were the local aromatic rice seeds of Toraja (Pare Bau) M1 generation previously irradiated by using 150 Gy carbon ions and 10 Gy of argon ions, manure, and soil for nursery media, rat poison, pesticides, irrigation water, and label. The tools used in this experiment are: Plastic pots for sowing, machetes, hoes, tractors, sprayers, nets, gauges, analytical scales, Contador seed counters, cameras, and stationery.

### 2.2. Problem formulation

The study was conducted by mass selection method consisting of two irradiation treatments, namely: 1) irradiation with Carbon ion dose 150 Gy (PB-C); 2) irradiation with 10 Gy Argon ions (PB-A), and control as a comparison. This research used M2 aromatic rice of local aromatic rice Toraja Pare Bau variety, the result of mutation technique of Ion Beam Carbon and Argon group to M0 seed which was conducted in RIKEN Nishina Center, Wako, Saitama Prefecture, Japan. For raising M2 generation, the seeds of the separate progeny lines of the selected M1 panicle for macromutational and the bulked seeds for macromutational studies of all the treatments varieties.

The final result of the scoring system is to classify the degree of linkage of the output parameters performed by the equation:

$$S_n = (X_n - X_1)/SD + 1 \dots \dots \dots (1)$$

Where :

$S_n$  = data  $n^{\text{th}}$  score                       $X_n$  = Value of the  $n^{\text{th}}$  data  
SD = Standard Deviation                 $X_1$  = Lowest data value

## 3. Results and Discussions

Ion beam exhibited influence on the yield contributing generative characters and yield of aromatic rice (Table 1). Yield components of aromatic rice, such as maximum panicle length (38,78 cm) was recorded from PB-A-12.2.12. Results showed that the Panicle density ranged from 5.20 to 10.92 Maximum density. The maximum number of grain per panicle (386 g) was observed in PB-14.2.14 and the lowest was counted from PB-Cont+ (227 g). Maximum fertile grain weight (10.73 g) was

recorded from PB-A.6.1.9 and the lowest is PB-14.4.3 (4.77 g). Grain weight is one of yielded component that is closely related with production of plant per unit area. Maximum percentage of fertile grain was counted from PB-6.1.5 (94%) and the lowest 72% (PB-A.5.1.13 and PB-A.7.1.41). The fertility decreases linearly with increasing irradiation dose. Fertility was also different in every irradiation treatment even if the same radiation type was applied by the same dose. Maximum production per plant was recorded from 239.23 g and the lowest PB-14.4.3 (85.24 g).

Table 1. Yield contributing attributes of mutant aromatic rice of Local Toraja

| No. | Treatment    | Panicle length (cm) | Number of Grain per panicle | Panicle density (seed/cm) | Number of fertile grain (seed) | Fertile grain weight (g) | Production Per Plant (g/plant) |
|-----|--------------|---------------------|-----------------------------|---------------------------|--------------------------------|--------------------------|--------------------------------|
| 1   | PB-Cont+     | 33,65               | 227                         | 6,75                      | 203                            | 6,09                     | 98,79                          |
| 2   | PB-Cont-     | 29,84               | 229                         | 7,68                      | 193                            | 6,27                     | 121,43                         |
| 3   | PB-A-5.1.13  | 35,08               | 280                         | 7,97                      | 201                            | 6,03                     | 105,59                         |
| 4   | PB-A-5.3.36  | 36,48               | 345                         | 9,46                      | 293                            | 8,34                     | 88,10                          |
| 5   | PB-A-5.3.45  | 32,23               | 352                         | 10,92                     | 279                            | 8,07                     | 99,28                          |
| 6   | PB-A-6.1.9   | 36,05               | 374                         | 10,38                     | 344                            | 10,73                    | 157,01                         |
| 7   | PB-A-6.1.12  | 35,68               | 313                         | 8,78                      | 286                            | 8,32                     | 141,59                         |
| 8   | PB-A-6.1.13  | 34,50               | 284                         | 8,22                      | 264                            | 7,16                     | 79,16                          |
| 9   | PB-A-6.1.15  | 36,90               | 323                         | 8,76                      | 303                            | 9,54                     | 124,07                         |
| 10  | PB-A-8.1.5   | 34,10               | 292                         | 8,55                      | 257                            | 7,59                     | 88,88                          |
| 11  | PB-A-7.1.9   | 36,48               | 346                         | 9,49                      | 308                            | 9,58                     | 137,19                         |
| 12  | PB-A-7.1.30  | 36,42               | 270                         | 7,40                      | 218                            | 6,73                     | 124,12                         |
| 13  | PB-A-7.1.41  | 34,34               | 248                         | 7,23                      | 180                            | 5,26                     | 117,25                         |
| 14  | PB-A-12.2.4  | 37,96               | 343                         | 9,05                      | 291                            | 9,32                     | 98,55                          |
| 15  | PB-A-12.2.11 | 35,64               | 255                         | 7,16                      | 198                            | 6,03                     | 175,40                         |
| 16  | PB-A-12.2.12 | 38,78               | 310                         | 7,99                      | 276                            | 8,83                     | 204,54                         |
| 17  | PB-A-12.2.34 | 37,41               | 327                         | 8,73                      | 275                            | 8,77                     | 239,23                         |
| 18  | PB-A-14.2.14 | 37,67               | 386                         | 10,24                     | 348                            | 10,70                    | 229,43                         |
| 19  | PB-A-14.3.1  | 36,80               | 360                         | 9,78                      | 311                            | 9,72                     | 118,09                         |
| 20  | PB-A-14.4.3  | 32,95               | 171                         | 5,20                      | 149                            | 4,77                     | 85,24                          |
| 21  | PB-C-20.1.49 | 34,55               | 314                         | 9,07                      | 263                            | 8,08                     | 120,26                         |

Table 2. Scoring Data of Yield Components

| No.                       | Treatment    | Panicle length (cm) | Number of Grain per panicle | Panicle density (seed/cm) | Number of fertile grain (seed) | Fertile grain weight (g) | Production per Plant (%) | TOTAL |
|---------------------------|--------------|---------------------|-----------------------------|---------------------------|--------------------------------|--------------------------|--------------------------|-------|
| 1                         | PB-Cont+     | 2,07                | 2,15                        | 2,03                      | 1,76                           | 3,86                     | 1,25                     | 13,12 |
| 2                         | PB-Cont-     | 3,83                | 4,09                        | 3,16                      | 1,86                           | 3,01                     | 1,59                     | 17,54 |
| 3                         | PB-A-5.1.13  | 3,07                | 3,05                        | 1,98                      | 1,72                           | 1,00                     | 1,63                     | 12,46 |
| 4                         | PB-A-5.3.36  | 4,33                | 4,15                        | 3,72                      | 3,05                           | 3,13                     | 1,23                     | 19,61 |
| 5                         | PB-A-5.3.45  | 4,46                | 5,24                        | 3,45                      | 2,90                           | 2,19                     | 1,44                     | 19,67 |
| 6                         | PB-A-6.1.9   | 4,89                | 4,84                        | 4,68                      | 4,42                           | 4,25                     | 2,65                     | 25,73 |
| 7                         | PB-A-6.1.12  | 3,72                | 3,65                        | 3,58                      | 3,04                           | 4,15                     | 2,41                     | 20,55 |
| 8                         | PB-A-6.1.13  | 3,15                | 3,24                        | 3,17                      | 2,37                           | 4,43                     | 1,00                     | 17,37 |
| 9                         | PB-A-6.1.15  | 3,91                | 3,64                        | 3,92                      | 3,74                           | 4,57                     | 1,98                     | 21,77 |
| 10                        | PB-A-8.1.5   | 3,30                | 3,48                        | 3,05                      | 2,62                           | 3,66                     | 1,64                     | 17,75 |
| 11                        | PB-A-7.1.9   | 4,35                | 4,18                        | 4,00                      | 3,77                           | 3,78                     | 2,17                     | 22,24 |
| 12                        | PB-A-7.1.30  | 2,88                | 2,63                        | 2,30                      | 2,12                           | 2,46                     | 1,98                     | 14,38 |
| 13                        | PB-A-7.1.41  | 2,47                | 2,50                        | 1,58                      | 1,28                           | 1,00                     | 1,81                     | 10,65 |
| 14                        | PB-A-12.2.4  | 4,30                | 3,85                        | 3,69                      | 3,62                           | 3,11                     | 1,49                     | 20,05 |
| 15                        | PB-A-12.2.11 | 2,61                | 2,45                        | 1,93                      | 1,73                           | 1,96                     | 2,95                     | 13,63 |
| 16                        | PB-A-12.2.12 | 3,66                | 3,07                        | 3,39                      | 3,33                           | 3,77                     | 3,74                     | 20,96 |
| 17                        | PB-A-12.2.34 | 3,97                | 3,61                        | 3,38                      | 3,30                           | 3,00                     | 4,50                     | 21,76 |
| 18                        | PB-A-14.2.14 | 5,10                | 4,73                        | 4,76                      | 4,41                           | 3,98                     | 4,33                     | 27,32 |
| 19                        | PB-A-14.3.1  | 4,61                | 4,39                        | 4,06                      | 3,85                           | 3,37                     | 1,85                     | 22,12 |
| 20                        | PB-A-14.4.3  | 1,00                | 1,00                        | 1,00                      | 1,00                           | 3,47                     | 1,07                     | 8,54  |
| 21                        | PB-C-20.1.49 | 3,72                | 3,87                        | 3,15                      | 2,90                           | 2,95                     | 1,96                     | 18,55 |
| <b>Standard Deviation</b> |              | 52,23               | 1,35                        | 52,91                     | 1,74                           | 0,06                     | 47,24                    |       |

From the results above, it can be seen that the line with the highest score is PB-A-14.2.14. This can be used as a selection criteria based on phenotypic characters. This is supported by the scoring of yield components such as panicle length (5.10), panicle density (4.76), and Number of fertile grain (4.41). There are 14 lines that have better production components than controls, namely PB-A-5.3.36, PB-A-5.3.45, PB-A-6.1.9, PB-A-6.1.12, PB-A-6.1.13, PB-A-6.1.15, PB-A-8.1.5, PB-A-7.1.9, PB-A-12.2.4, PB-A-12.2.12, PB-A-12.2.34, PB-A-14.2.14, PB-A-14.3.1, PB-C-20.1.49. The line can be used as planting material for further planting. According to Kasno (2013) [7], selection can be done to select a number of individuals, families, or lines in a diverse population to obtain the expected superior individuals.

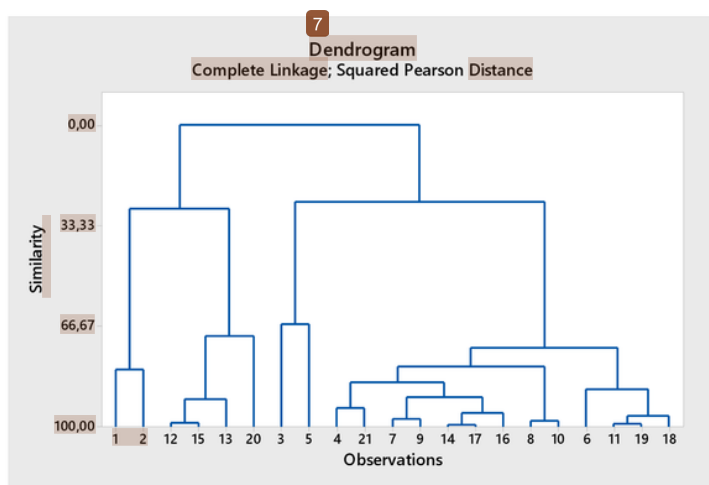


Figure 1. Clustering pattern of the morphological trait at dissimilarity coefficient of 66.67%

Based on the clusters in Figure 1, the presence of lines in one cluster indicates the closer the level of similarity. The most distant cluster differences are the first and fifth clusters. On the other hand, the lines in different clusters have increasingly similar levels of resemblance. The three main components formed into further 5 sub-groups with the similarity level of 66.67%. With a similarity rate of 66.67%, group 1 consisted of subgroups (1) PB-Cont + and PB-CONT-, sub-groups (2) PB-A-7.1.30, PB-A-12.2.11, PB-A -7.1.41, PB-A-14.4.3, sub-group (3) PB-A-5.1.13, sub-group (4) PB-A-5.3.45, sub-group (5) PB-A -5.3.36, PB-C-20.1.49, PB-A-6.1.12, PB-A-6.1.15, PB-A-12.2.4, PB-A-12.2.34, PB-A-12.2 .12, PB-A-6.1.13, PB-A-8.1.5, PB-A-6.1.9, PB-A-7.1.9, PB-A-14.3.1, and PB-A-14.2. 14.

#### 4. Conclusions

Based on the results of the research can be summarized that that lines that have the best production components is PB-A-14.2.14. Whereas, there are 14 lines that have better production components than controls. Cluster analysis showed that there were 3 main components of lines formed into further 5 sub-groups with similarity level 66.67%.

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