Appearance of Agronomic Characters and Genetic Parameters Estimation on M₃ Population of Roselle [*Hibiscus sabdariffa* L.]

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**Abstract.** The morphology of mutant putative plant population can be influenced by genetic factors and environmental factors. M₃ generation population was thought to have wide character variability. The objective of this study was to determine the performance of agronomic characters and to estimate genetic parameters values of M₃ generation in mutant populations of 150 Gy and 450 Gy. Seeds from mutant population 150 Gy and 450 Gy in M₂ generation were harvested, and then their seeds were grown as M₃ generation. Variations that were obtained of each character at generation M₃ influences plants growth and development. The difference in character variability from the two mutant putative populations causes significant differences compared to the mean value character of control plants population. The heritability values of all characters observed range from low to high. Character canopy diameter and number of fruits per plant can be used as a character of selection in the next generation.

**1. Introduction**

*Hibiscus sabdariffa* L. had benefited to health and medicine. The Roselle flower calyx thought to have immune stimulatory effects because the calyx has secondary metabolites such as of phenols and flavonoids [1]. Roselle leaf extract has high polyphenol content and plays a role in inhibiting the development of prostate cancer cells [2].

Roselle was a self-pollinating plant. This population of rosella was homogeneity and the mutation were the one technique in plant breeding to increase genetic variation. Mutation breeding improves the traits of the plant. The variance of agronomic characters in roselle after being irradiated by gamma rays are assumed genetically controlled. The high genetic diversity is very important in the selection process.

Previous researchers have reported hereditary changes in the desirable characters in crop plant by using gamma rays as a physical mutagen, which has been used to develop 64 % of the radiation-induced mutant varieties [3]. Several research [4-8] conducted about gamma irradiation. The objective of this study was to determine the performance of agronomic characters and to estimate genetic parameters values of M₃ generation in mutant populations of 150 Gy and 450 Gy.
2. Materials and Methods
Field research was conducted at Faculty of Agriculture Universitas Sumatera Utara, Medan. Roselle seeds were planted obtained from restricted bulk genotypes obtained from the of M$_2$ generation. A total of 300 seeds (M$_3$) were planted with a spacing 1.5 x 1 m$^2$ from each mutant population of 150 Gy and 450 Gy. The control plant was Rosellindo 2 variety as the control and parent plant. The data was analysed using t test and MINITAB program.

3. Results and Discussion
This study used 2 mutant putative plant populations of 150 Gy and 450 Gy (M$_3$ generation). The results showed that there were significant differences in the mean value of some characters observed from 2 mutant putative populations of M$_3$ generation compared to control plant populations.

**Table 1.** The mean of valued characters in the vegetative stage of the control plant population and mutant putative population of 150 Gy and 450 Gy in M$_3$ generation

| No. | Characters                          | Populations  |
|-----|------------------------------------|--------------|
|     |                                    | 0 Gy | 150 Gy | 450 Gy |
| 1   | Plant height (cm)                  | 168.60 | 186.14** | 181.40** |
| 2   | Number of productive branches per plant | 22.84 | 23.11 | 25.34** |
| 3   | Canopy diameter(cm)                | 137.30 | 146.52** | 128.80** |

Note: Analyze by compared mutant population with control population based on t test

Table 1 showed that the mean value of plant height and canopy diameter in mutant putative populations of 150 Gy were significantly different compared to the mean value of control population characters. The increase in the mean value were found in both characters observed. All mean value of plant height, number of productive branches per plant and canopy diameter of the mutant putative population of 450 Gy also were showed significantly different compared to the mean of control population characters. Gamma ray irradiation dose is different for each species [9].

The data showed that populations of 150 Gy and 450 Gy gave differences in the mean value of the characters observed in the generative stage. The difference mean value from each mutant putative population compared to the control plant population can be seen from Table 2.

**Table 2.** The mean of valued characters in the generative stage of the control plant population and mutant putative population of 150 Gy and 450 Gy in M$_3$ generation

| No. | Characters                          | Populations  |
|-----|------------------------------------|--------------|
|     |                                    | 0 Gy | 150 Gy | 450 Gy |
| 1   | Age of flowering (days)             | 80.82 | 77.54** | 77.79* |
| 2   | Age of harvesting (days)            | 117.55 | 112.52** | 113.30** |
| 3   | Fruit calyx weight per plant (g)    | 83.60 | 76.10 | 96.50* |
| 4   | Capsule weight per plant (g)        | 77.60 | 70.40 | 84.40 |
| 5   | No. of fruits per plant             | 51.19 | 71.7** | 21.20** |

Note: Analyse by compared mutant population with control population based on t test
Table 3. Genetic variability ($\sigma^2_g$), phenotype variability ($\sigma^2_p$), coefficient variation genetic (CVG) and heritability mutant putative population of 150 Gy and 450 Gy in $M_3$ generation

| Characters                          | 150 Gy  | 450 Gy  |
|------------------------------------|---------|---------|
| Plant Height (cm)                  |         |         |
| $\sigma^2_p$                       | 99.79   | 302.50  |
| $\sigma^2_g$                       | 20.45   | 101.06  |
| h2                                 | 0.20(m) | 0.3(m)  |
| CVG (%)                            | 2.43    | 5.54    |
| CVG criteria                       | narrow  | narrow  |
| Number of productive branches per plant |         |         |
| $\sigma^2_p$                       | 10.91   | 24.05   |
| $\sigma^2_g$                       | 2.91    | 0.15    |
| h2                                 | 0.27(m) | 0.01(l) |
| CVG (%)                            | 7.38    | 1.51    |
| CVG criteria                       | narrow  | narrow  |
| Canopy diameter (cm)               |         |         |
| $\sigma^2_p$                       | 439.98  | 413.00  |
| $\sigma^2_g$                       | 273.93  | 199.65  |
| h2                                 | 0.62(h) | 0.48(m) |
| CVG (%)                            | 11.30   | 10.97   |
| CVG criteria                       | moderate| moderate|
| Age of flowering (days)            |         |         |
| $\sigma^2_p$                       | 58.78   | 54.18   |
| $\sigma^2_g$                       | 23.19   | 4.03    |
| h2                                 | 0.39(m) | 0.07(l) |
| CVG (%)                            | 6.21    | 2.58    |
| CVG criteria                       | narrow  | narrow  |
| Age of harvesting (HST)            |         |         |
| $\sigma^2_p$                       | 58.75   | 53.62   |
| $\sigma^2_g$                       | 27.70   | 9.78    |
| h2                                 | 0.47(m) | 0.18(l) |
| CVG (%)                            | 4.68    | 2.76    |
| CVG criteria                       | narrow  | narrow  |
| Number of fruits per plant         |         |         |
| $\sigma^2_p$                       | 104.16  | 113.78  |
| $\sigma^2_g$                       | 48.26   | 59.63   |
| h2                                 | 0.46(m) | 0.52(h) |
| CVG (%)                            | 9.69    | 36.50   |
| CVG criteria                       | moderate| wide    |
| Fruit calyx weight per plant (g)   |         |         |
| $\sigma^2_p$                       | 139.57  | 2511.86 |
| $\sigma^2_g$                       | 37.31   | 1041.29 |
| h2                                 | 0.27(m) | 0.41(m) |
| CVG (%)                            | 8.03    | 33.45   |
| CVG criteria                       | narrow  | wide    |
| Capsule weight per plant (g)       |         |         |
| $\sigma^2_p$                       | 122.19  | 1937.51 |
| $\sigma^2_g$                       | 31.84   | 880.48  |
| h2                                 | 0.26(m) | 0.45(m) |
| CVG (%)                            | 8.01    | 35.14   |
| CVG criteria                       | narrow  | wide    |

Note: (h): high, (m): moderate, (l): low.
The mean value increase in mutant putative population of 150 Gy was found in the number of fruits per plant, while the mean value decrease was found in the age of flowering and harvesting. These mean values were very significantly different from the mean of control population.

The mean value of the age of flowering and harvesting of the 450 Gy population showed significantly different when compared to the mean value of control plant population. The mean value increase of the fruit calyx weight per plant in the population of 450 Gy was significantly different from the mean value of the same character from control population. This supports the selection in obtaining high yield production plants from the mutant plant population of rosella. The character changes cause by gamma irradiation induction that occur in several studies [10-12].

In this M3 generation, genetic variation depends on the agronomic characters observed. The character of canopy diameter and number of fruits per plant have heritability values ranging from moderate to high at mutant putative populations of 150 Gy and 450 Gy. This result showed that the genetic factors were more involved than environmental factors. The coefficient variation genetic also ranges from moderate to wide which showed the variation of the observed characters. Both characters can be used as character selection in the next generation (Table 3).

Almost all production characters observed (number of fruits per plant, fruits calyx weight per plant, capsule weight per plant) in mutant putative populations of 450 Gy had heritability values and coefficient variation genetic ranging from moderate to wide. This shows that the mutant putative population of 450 Gy is a potential population to produce high yield roselle line. Some studies [4-14] resulted that irradiation has been used to increase the genetic variation, quantitative characters and improve the nutrition and quality of roselle plants.

4. Conclusion
There is a variation of morphological characters and genetic variability in mutant putative populations of 150 Gy and 450 Gy. The difference in character variability in the two putative populations of mutants caused significant differences compared to the control plant population [Rosellindo2 variety population]. The heritability values of all characters observed ranged from low to high. Character canopy diameter and number of fruits per plant can be used as a character of selection in the next generation.

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