Evaluation of selected soybean mutant of Kipas Putih M4 at the experimental research station faculty of Agriculture Universitas Syiah Kuala

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Abstract. An evaluation of 4th generation (M4) of Kipas Putih soybean mutants was done to obtain a high potential production line. The research was conducted at Agriculture Faculty of Syiah Kuala University, Darussalam - Banda Aceh. Kipas Putih soybean variety that have not been irradiated was used as a control. Evaluation was done on agronomic character and yield. The results showed that mutants with high potential for production were B4, B15 and B22 mutants. The best mutant is B15 that have increased in the seed size about of 19.19 % from the parent – Kipas Putih variety (B0).

1. Introduction
Soybeans are a variety of edible bean also known as soya beans or Glycine max. Soybean products are used for human consumption, animal feed, and a variety of non-food consumer and industrial products. Soybeans have been a staple food in many parts of the world for thousands of years. The soybean consist of two cotyledons which represent approximately 90% of the weight, a seed coat of hull (8% of weight), and two much smaller and lighter structures, the hypocotyls and the plumuleh [1]. The mature soybeans contain about 38% protein, 30% carbohydrate, 18% oil, and 14% moisture, ash, and hull. Soybeans contain all three of the macro-nutrients required for good nutrition: complete protein, carbohydrate and fat, as well as vitamins and minerals, including calcium, folic acid, and iron [2]. The use of soybean products in feed and food industry has increased steadily over the past decade. Soybean is especially interesting because of its non-gluten proteins [3].

Soybean consumption in Indonesia reached 7.52 kg/capita/year [4]. Processed soy-based food in Indonesia has large variation, for example, tempeh, tofu, soy sauce, milk, tauco etc., and of a wide range of soybean food products in Indonesia, tempeh and tofu are the most popular foods. Based on Susenas data [5], the level of tempeh consumption in Indonesia reached 6.95 kg/capita/year. So far, Indonesia still import soybean about 67.28% or as many as 1.96 million tons to meet the domestic demand.
More than 60 percent of Indonesia's soybean consumption still needs to be imported from abroad. To reduce its dependence on soybean imports, Indonesia's Agriculture Ministry aims to enhance domestic soybean production. For these reasons, soybeans have been included in the government's list of strategic food commodities (other examples are rice, sugar, and corn), meaning these food items get special attention from the government. One of the steps to enhance domestic soybean production according to the Indonesian Ministry of Agriculture (2016) is to add up to nearly 400,000 Ha of soybean plantations to the existing 615,000 hectares. Most additional plantations will have to develop outside the island of Java (characterized by exceptional fertility). The government is looking for the right type of soybean that can grow in regions that have less fertile soil, and potentially increase the production.

Variety plays a very important role in the cultivation of soybean crops, because if it has good genetic potential, it will produce high production. The availability of superior varieties that are able to increase soybean production in Indonesia is small, therefore it is necessary to try to assemble new superior soybean varieties.

We try to assemble new variety that is to repair the unwanted character of the parents, such as soybean variety of Kipas Putih from Aceh Province. Based on the description, the soybean variety of Kipas Putih is one of the native Acehnese varieties with semideterminate growth, the average plant height is 50-60 cm, the average dry seed production reaches 1.69 tons/ha, the weight of 100 seeds is 12 g. The characters that must be improved are production, seed size, weight of 100 seeds, and protein content [6].

Efforts to assemble new varieties can not only be done through crosses, but can also be done by induce mutation. Mutations are sudden and random changes in genetic material such as genomes, chromosomes and genes. One way to induce mutations is to use gamma-ray irradiation that has been widely used for plant breeding purposes. According to Acquaah, (7) gamma rays are electromagnetic radiation produced by isotope and nuclear reactors such as Co60 and Ce137. The ion radiation produced will result in mutations by overhauling or breaking chemical chains in DNA molecules, deletion of nucleotide bonds, or can also lead to substitution of nucleotide bonds.

Using gamma ray irradiation at certain doses can affect changes in quantitative characters and plant chromosomes, thus changing the character of the soybean growth. Generally, radiation with gamma rays is done on the seeds of plants because it has a greater chance of regeneration than other plant parts [8].

This study was done to evaluate the selected mutants line of soybean M4 Kipas Putih at the Experimental Research Station of the Faculty of Agriculture, Syiah Kuala University, Darussalam - Banda Aceh.

2. Method
Soybean of Kipas Putih M4 used as mother plant for producing M5, planted in dry filed at Experimental Research Station of Agriculture Faculty of Syiah Kuala University. Soil processing was plough using a tractor, and then made a trial plot 200 cm x 160 cm as many as 33 experimental plots, with a distance between plots 50 cm (drainage). Planting is done in the afternoon by placing two seeds per planting hole; with a spacing of 40 cm x 30 cm. The mutant plants were grown in accordance with the technical guidance of soybean cultivation [9] and allowed to do their own pollination. This research was conducted using Randomized Block Design with 3 replications. Once physiologically mature, the seeds harvested and dried to obtain M5 mutant seed populations. As a comparison, we also observed the Kipas Putih soybean variety (B0). All the growing plants were observed growth and production. The parameters observed were plant height, number of branches, total number of pods, number of pods contain seeds, seeds weight per plant and weight of 100 seeds.

3. Results and Discussion
3.1 Plant height
As shown in Table 1, the height of the fourth generation mutant plants (M4) were significantly different. Base on statistical analysis the results of plant height at 3 weeks after planting (WAP)
obtained the highest plant was B11 line with a value of 33.73 cm, which was not significantly different with the B10 line. The lowest plant was the B22 line with a value of 13.13 cm, that was not significantly different with B0 (control), B4, B13, B15 and B22 lines. Not only because of genetic factor, the ability to adapt in the environmental and because of other factors such as rain and temperature were support the mutant plants growth. During the growth, process plants always get enough water demand due to high rainfall.

Table 1 shows that in the plant height on 3 WAP were highly significant differences among the tested lines. The average value of plant height for some mutant lines tested was not different from the control plants (B0), meaning that gamma ray radiation does not influence the gene of the plants height character. The Heritability values of mutant’s plants high were low as shown in Table 2. However, some mutant lines had average plant height higher than B0 (controls), namely B7, B11, B12, B14, and B18. It can inferred for the High Plants character suspect strongly influenced by the environment not only caused by genes.

| Mutant Line | Plant High (cm) | Seeds Weight Per Plant (g) | 100 Seeds Weight (g) |
|-------------|----------------|----------------------------|---------------------|
| B4          | 18.73          | 22.24                      | 14.26               |
| B7          | 22.93          | 18.64                      | 14.11               |
| B10         | 33.20          | 6.74                       | 13.62               |
| B11         | 33.73          | 6.73                       | 14.10               |
| B12         | 26.70          | 15.88                      | 13.14               |
| B13         | 18.40          | 9.93                       | 18.12               |
| B14         | 26.83          | 18.22                      | 12.47               |
| B15         | 16.73          | 21.13                      | 18.26               |
| B18         | 24.80          | 5.89                       | 13.14               |
| B22         | 13.13          | 24.51                      | 13.64               |
| B0          | 17.80          | 19.10                      | 15.32               |
| BNT         | 7.52           | 8.98                       | 2.62                |

Note: number with the same alphabet at the same column, not statistically different by LSD test at 5% probability

3.2 Number of branches

Number of branches on M4 Kipas Putih mutants soybean were not statistically significant different. The highest number of branches on 3 WAP measurements was 4.93 on B11 lines followed by B10 at 4.87 and B18 at 3.27. The lowest number of branches was at B22 line at 0.47. The difference in the number of branches between the lines tested as show in Figure 1, probably due to the influence of microenvironments around the plant.
3.3 Number of pods per-plant

There were no significant different on number of pods per plant due to mutant’s line M4 generation. The highest number of pods found in the B4 line as much as 128.20 pods and the lowest number of pods found in B11 line as much as 71.13 pods. The character of each genotype line and the supporting environment influenced the difference in yield of eleven lines tested at the time of pod formation and pod filling. Figure 2 below shows, B4, B7, and B22 line have relatively higher numbers of pods than B0. According to Tah [10], the increase in the number of pods due to gamma ray irradiation with a certain dose can reach 15-23%. In the M4 strain test with the highest number of B4 pods increased 35.33% of the control of Kipas Putih variety (B0), it implied that the mutation by using gamma ray radiation can increase the number of soybean pods. M4 generation soybean mutants did not have a statistically significant effect on the number of pods per plant. The highest number of pods found in the B4 line about 128.20 pods and the lowest number of pods contained in the B1 line as much as 71.13 pods. The character of each line and the supporting environment influenced the difference in yield of eleven lines tested at the time of pod formation and pod filling. It can be assumed that the flowering factor
and the supporting environment determine the number of pods and seeds that are formed at the time of filling the pod.

Figure 2 below shows B4, B7, and B22 line have relatively higher numbers of pods than B0 (control). Tah [10] suggested that increasing in the number of pods due to gamma ray irradiation with a certain dose can reach of 15-23%. On the M4 lines we tested, the highest number of pods found on B4 line which increased about 35.33% from the control Kipas Putih variety (B0). It can be said that the mutation by using gamma ray irradiation can increase the number of soybean pods per plant.

3.4 Number of pods contain seed per plant
Total Number of Pods that contain seed per plant of soybean mutant Kipas Putih M4 were not significantly different. As shown in Figure 3 that the soybean mutant line of B15 had the highest pods contain seed per plant that was about 94.80 pods and the lowest was the B11 line about 39.53 pods. Differences in the results of the number of pods contain seed per plant in the various line tested can be caused by environmental factors at the time of harvesting. It is also can be approved by low the board sense heritability as shown in Table 2.
Line B4, B15 and B22 as shown on Fig 3 have number of pods contain seed per plant higher than B0 (control). However the heritability of B4, B15 and B22 are various, where the lowest on B15 and the highest on B4. From the data we can assumed, that number of pods contain seed per plant is influenced by the environmental of the plant growth.

3.5 Seeds weight per plant
The seeds weight per plant of soybean Mutant Kipas Putih M4 is significantly different. The lowest seeds weight per plant was on B18 line about 5.89 g, and the highest was found on B4 line about 24.51 g that was not significantly different with B0, B4, B7, B12, B14, and B15.

3.6 Weight of 100 seeds
It show from Table 1 that soybean mutants Kipas Putih M4 was significantly different on the weight of 100 seeds. The highest weight of 100 seeds was on B15 line about 18.26 g and was not significantly different with the B13 line about 18.12 g. Whereas the lowest weight of 100 seeds was found on B14 line about 12.47 g. The weight of 100 seeds varies due to the size of the seeds of each line. The B15 line has improved the weight of 100 seeds about 19.19% from the B0 line (control). The larger the seeds size the higher the weight of 100 seeds. It can be assumed that the maximum seed size is determined by genetic factors and the seed conditions during the filling process. Seed size can also be controlled by the size of the fruit or pod. The small pods will produce the small seeds, due to limitations of pod wall where resulting in fewer and smaller cell sizes.

4. Conclusion
The line M4 of soybean mutant plant has significant effect on the height of plant at age 3 week after planting (WAP), weight of seed per plant and weight of 100 seeds. Mutant lines that potentially high yielding are B4, B15 and B22. The best soybean mutants was the B15 line that is assumed base on weight of 100 seeds, in which there is an increase of 19.19% by weight of the parent.

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