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1 Genetic variability and heritability on Kipas Putih soybean mutant lines using gamma rays irradiation (M3 generation) Nilahayati1, Rosmayati□, D S Hanafiah□ and F Harahap□ □Lecturer of Agroecotechnology, Agriculture Faculty, Universitas Malikussaleh, Aceh-Indonesia 24355/Doctoral Student of Agriculture Science at Agriculture Faculty, Universitas Sumatera Utara (USU), Medan 20155. □Lecturer of Agroecotechnology, Agriculture Faculty, USU, Medan 20155. □Lecturer of Biological Science, UNIMED, Medan E-mail : nilahayati@unimal.ac.id Abstrack.

The objective of the research was to determine the selection criteria in Kipas Putih Soybean with gamma rays irradiation in M3 generation. In this study there are four populations namely population 0 Gray (control), 100 Gray, 200 Gray and 300 Gray. The results showed that high genotypic coefficient of variation (GCV) was obtained on the number of pods and seed weight per plant in population 200 Gy, number of branches on 100 Gy and 300 Gy, number of pods and seed weight per plants 100 and 200 Gy, moderate GCV in number of branches on 100 and 300 Gy while other characters such as plant height, numbers of branches on 200 Gy, flowering and harvest age have narrow GCV criteria.

High heritability values are found in 300 Gy on plant height, number of branches 300 Gy, number of pods and seed weight per plant 200 Gy, days to flower 200 Gy and 300 Gy and days to harvest of all doses. Based on the genetic variabiliy and heritability, characters that can be used as selection criteria in this study is number of pods and seeds weight per plant, days to flower and days to harvest. 1.

Introduction The mutation using gamma rays irradiation is the one way to create genetic variation in new varieties with better characteristics. The application of gamma rays in soybean has produced various varieties of early maturity soybeans. [1] used local soybean material (Tidar variety), then it was irradiated with 200 Gy gamma irradiation dose. Furthermore, selection of early maturity mutants were undertaken from M2 generation and selected to M7 generation.

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Their result of the research was 2 mutants showing significant differences in productivity. The Q-298 and 4-Psj mutants had 66 days and 68 days to harvest with high productivity (2.41 and 2.42 tons / ha). Now, these mutants have released as new superior varieties of soybean (better known as Gamasugen 1 and Gamasugen 2). Selection is the important process in plant breeding for character improvement.

Selection activities are largely determined by the availability of wide genetic variability with high heritability. In plant population, only the phenotype values can be observed and measured directly. The observed variance of phenotypes of population shows the degree of phenotypic differences between individual groups arising from the presence of genetic and/or environmental variability [2].

High heritability values indicate a high degree of relationship between phenotype and genotype, and in this case genetic factors have a greater influence than environmental influences on the appearance of the character or phenotype. This suggests that the action of the additive gene is dominant (Malik et al., 2006) 2 The previous research used gamma ray irradiation of local Aceh soybean (Kipas Putih) to obtain the early maturity and high yielding mutants in M1 generation [3]. To find out whether the desired characters are inherited or not, the information about heritability and genetic diversity of the desired characters is required.

This study aims to determine the heritability and genetic variability values of Kipas Putih soybean mutant using gamma ray irradiation in M3 generation. 2. Materials and Methode This research was conducted at Reuleut Timu, North Aceh-Indonesia. In M2 generation, each plant at each dose of gamma ray irradiation treatment was harvested and all of the seeds were grown as M3 generation. M3 seeds at each dose treatment were planted with spacing 40 x 20 cm.

All technical cultivation such as fertilizing, watering, weeding and pest control were carried out during the period of plant growth. The plant was selected based on morphological appearance, early maturity and high yielding mutant. The observation was done on plant height, number of branches, number of pods, number of seeds per plant, seed weight per plant, 100 seed weight, flowering and harvesting age. The data analysis was done by calculating the mean of each character observed, then the mean value of each population was tested by using t test.

The data analysis was followed by various phenotypes and environmental variations and estimates of genotypes, heritability and genetic variability coefficient values of potential mutants selected for each population in accordance with irradiated doses. Differential selection was obtained from the difference between the average of selected population and the avarage of basic population. Genetic variation in M3 generation was calculated with the formula: s 2M3 = s 2p s 2p = s 2 g + s 2e s 2 g = s 2p - s 2 e = s 2M3 - s 2M0 s 2 = variance n = number of population s 2p = phenotipic variance s 2g = genotypic variance s 2e = environmental variance s 2M2 = M3 population variance s 2M0 = M0 poplation variance Heritability values were calculated by using the following formula: h2 = s 2p = s 2g + s 2e h2 = Genetic variation was determined based on the coeffisient of genetic variation (CGV) with the formula: CGV= x 100% = genotypic standard deviation 3 = character means 3.

Result and Discussion Genotype selection is a basis for improving plants in obtaining the new superior varieties. The role of genotypic variation aiming to assembly the superior varieties is important because high

genotypic coefficient of variation provides an opportunity to obtain the source of genes for the improved character [4]. In M3 generation, genotypic coefficient of variation values ranged from 2.43-32.06 with narrow to wide criteria. High CGV values were obtained on number of pods (32.06) and seed weight per plant (31.91) in 200 Gy population, moderate CGV criteria were found at number of branches 100 Gy and 300 Gy, number of pods and seed weight per plant at 100 Gy and 200 Gy, while other characters such as plant height, number of branches 200 Gy, days to flower and days to harvest had narrow CGV criteria. Table 1.

Genetic variation of M3 plants at different gamma irradiation doses in Kipas Putih soybean No. Characters Irradiation doses P 0 Gy P 100 Gy P 200 Gy P300 Gy 1. Plant height 77.70 68.20 66.47 67.44 s 2p (fenotipe variance) 95 . 88 100 . 19 93 . 27 61 . 40 s 2g (genotipe variance) 4 . 31 2 . 61 34 . 47 CGV (coeffisien of genotypic variance) 3 . 04 2 . 43 8 . 70 CGV criteria Narrow N arrow N arrow 2. Number of branches 5 . 46 5 . 05 6 . 14 5 . 44 s 2p 2 . 62 2 . 03 2 . 80 1 . 51 s 2g 0 . 58 0 . 18 1 . 10 CGV 15 . 06 7 . 06 19 . 29 CGV criteria moderate N arrow M oderate 3. Number of pods 241 . 47 186 . 97 253 .

37 218 . 60 s 2p 5126 . 45 4577 . 76 11726 . 55 4372 . 24 s 2g 548 . 75 6600 . 09 754 . 21 CGV 12 . 52 32 . 06 12 . 56 CGV criteria moderate H igh M oderate 4. Seed weight per plant 51 . 88 41 . 32 52 . 71 44 . 47 s 2p 260 . 93 203 . 97 544 . 08 213 . 19 s 2g 56 . 96 283 . 14 47 . 74 CGV 18 . 26 31 . 91 15 . 53 CGV criteria moderate H igh M oderate 5. Days to flower 40 . 20 39 . 13 39 . 28 39 . 67 s 2p 0 . 42 0 . 78 1 . 38 0 . 89 s 2g 0 . 35 0 . 96 0 . 46 CGV 2 . 50 2 . 49 2 . 47 CGV criteria Narrow N arrow N arrow 6. Days to harvest 89 . 97 88 . 99 90 . 00 89 . 01 s 2p 0 . 05 5 . 26 13 . 17 5 . 17 s 2g 5 . 21 13 . 11 5 .

12 CGV 4 . 06 4 . 02 4 . 06 CGV criteria Narrow N arrow N arrow Characters that ha d wide CGV values were number of pods and seed weight per plant in 200 Gy population. [5] found high CGV values on the number of pods per plant (29,59) Mungbean variety 4 K851 in M3 generation. Other characters such as 50% days to flower (2.76), days to harvest (7.42), seed yield per plant (15.73), plant height (12.74) had low to moderate CGV values. Their research also obtained a high value of heritability on all characters of mungbean mutant.

The heritability values observed in this M3 generation population ranged from 0.02 - 0.99 (Table 2). High heritability values were found in plant height 300 Gy (0,56), number of branches 300 Gy (0,72), number of pods (0,56) and seed weight per plant (0,52) 200 Gy, days to flower 200 Gy and 300 Gy (0.69 and 0.52) and days to harvest of all doses (0.98, 0.99 and 0.98). The population of 200 Gy had high heritability values except for the plant height and number of branches.

The population of 100 Gy had low to moderate heritability values in all observed characters except for the days to harvest. The population of 300 Gy had high heritability values for all observed characters except for the number of pods and seed weight per plant. Previous study conducted by [6] observed high heritability in greenbean with ranged from 41,30- 88,96%. This result of the study indicated that the inheritance of characters observed was large enough and the selection activities for the improvement of these properties were easy to perform. The character of days to flower, days to harvest and number of pods had heritability of 68.81, 61.79 and 63.29 respectively.

[7] states that heritability values are needed to predict whether the character is much influenced by the environment or genetics. High heritability values indicate that genetic factors influence is greater than

phenotypic appearance compared to environmental influences. High heritabilility values play an important role in improving the effectiveness of selection. [8] reports that heritability values indicates whether a character is controlled by genetic or environmental factors, which in turn it can be known to what extent characters can be inherited to the next generation.

If the heritability values are high, most phenotypic variations are caused by genetic variation, then the selection will gain genetic progress [9]. Table 2. Heritability values in M3 generation of Kipas Putih soybean using gamma irradiation No Characters Heritability P 100 P 200 P 300 1. Plant height 0.04 0.02 0.56 2. Number of branches 0.28 0.06 0.72 3. Number of pods 0.11 0.56 0.17 4. Seed weight per plant 0.27 0.52 0.22 5. Days to the first flower 0.45 0.69 0.52 6. Days to harvest 0.98 0.99 0.98 The variability in F3 wheat family can be caused by genetic and environmental factors.

In order that selection provides the expected genetic progress, it must be determined in advance the appropriate selection characters. Character selection for a population in a particular environment is chosen based on heritability values. Characters that can be used to select the genotype are characters that have high heritability [10]. The heritability values are one of the genetic parameters considered for selecting the characters in selection [7][11].

Days to flower and days to harvest characters had high heritability values. This indicated that the appearance of the character was influenced a little by environment. Selection might be more effective in characters with high heritability because the environmental impact was very small. Based on the high heritability values, the character that can be considered to select the best family in the next stage of this research were days to flower, days to harvest, number of pods and seed weight per plant.

The results showed that high CGV with high heritability values were number of pods and seed weight per plant characters in 200 Gy population, while days to flower and days to harvest had high heritability values but low CGV values. [12] stated that the high values of genetic coefficients are generally followed by high heritability and genetic variability, so it can be used for selection. The 5 results of this study indicated that days to flower and days to harvest had low CGV but showed high heritability.

[13] reports that the days to harvest character in wheat strain is one of character that has high heritability, so that this character can be used as the character of selection in the early generation in the process of assembling varieties. Selection to obtain early maturity soybean was relatively easy to do because it has a high heritability values in days to flower and days to harvest. Meanwhile, for high yielding improvement, number of pods and seed weight per plant characters can be used as selection criteria.

According to[14], the number of pods per plant has high heritability and directly affected the production. 4. Conclusions In summary, it can be concluded that in 200 Gy population was identified high CGV and heritability in number of pods and seed weight per plant characters. Days to flower and days to harvest characters had high heritability with narrow CGV. Based on the genetic variabiliy and heritability, the characters that can be used as selection criteria in this study were number of pods, seeds weight per plant, days to flower and days to harvest.