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97 Bulgarian Journal of Agricultural Science, 25 (No 1) 2019, 97□102 The genotype selection of M3 generation of Kipas Putih soybean with gamma-rays irradiation on agronomic characters, early maturity and high yielding mutants Nilahayati1*, Rosmayati2, Diana So? a Hana? ah□, Fauziyah Harahap3 1 Doctoral Program of Agricultural Sciences, Faculty of Agriculture, Universitas Sumatera Utara, Padang Bulan, Medan 20155, Indonesia 2Departement of Agroecotechnology, Faculty of Agriculture, Universitas Sumatera Utara, Padang Bulan, Medan 20155, Indonesia 3Departement of Biological Science, Universitas Negeri Medan, Indonesia *Corresponding author: nilahayati@unimal.ac.id

Abstract Nilahayati, Rosmayati, Hana? ah, D. S., & Harahap, F. (2019). The genotype selection of M 3 generation of Kipas Putih soybean with gamma-rays irradiation on agronomic characters, early maturity and high yielding mutants . Bulgarian Journal of Agricultural Science, 25(1), 97□102 Selection is the important process in conventional plant breeding for character improvement. The objective of this study was to select individual plant in Kipas Putih M 3 generation to obtaine early maturity and high yielding mutant lines.

The M 3 generation seeds in each dose treatment were planted with a spacing of 40 x 20 cm. All technical cultivation practices such as fertilizing, watering, weeding and pest control were carried out during the period of plant growth. Plant selection was based on morphological appearance, early maturity and high yielding plant. The research ? ndings show that the gamma-rays irradiation treatment resulted in a population with very different mean values with the control except for number of branches of 300 Gy doses, number of pod at 200 Gy and 300 Gy, number of empty pod at 300 Gy, seed weight per plant at 200 Gy and days to harvest at 200 Gy.

In general, the means values of low agronomic characters were in the population of 100 Gy doses in all of observed characters except for days to ? ower and days to harvest. As a result of genotype selection on M 3 generation, 233 early maturity and high yielding mutants w ere obtained. Keywords: soybean; mutation breeding; gamma-rays irradiation; early maturity Introduction Soybean is one of the most important crops in

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the world. In Indonesia, soybean is the third most important food crop after rice and maize.

This plant is highly pre- ferred because it has various bene? ts in its nutritional content. According to Chauhan et al. (1988) and Khan and Tyagy (2013), soybean contains 40% protein, high essential amino acids, 20% oils rich in unsaturated fatty acids, especially omega-6 and omega-3 fatty acids, 6-7% minerals, 5-6% crude ? ber and 17-19% carbohydrates. In addition, soybean also contains iron, vitamin B complex and iso? avones. The presence of calcium and iron makes it particularly useful for women who are suffering from osteoporosis and anemia.

Pavadai (2015) called soybean as a wonder crop because it has a vast multiplicity of the uses of food and industrial product. He also notes that soybean is the richest, cheapest and easiest source of the best quality protein and fat. The effort to increase soybean production must be done because of the increasing demand along with the growth of population. The superior variety is a farming 98 Nilahayati, Rosmayati, Diana So? a Hana? ah, Fauziyah Harahap technology component that is easy for farmers to adopt.

Assembling of new superior varieties can be done with plant breeding program either by using physical or chemi- cal mutagens. Khan and Tyagy (2010) stated mutation is the ultimate source of variability in organisms. Mutations can be used in many different ways for plant breeding. Mutations can be used as a valuable supplementary ap- proach to plant breeding when 1 or 2 characters are need- ed to increase easily on well adapted variety. Mutation breeding of crop cultivation has been used for self-pollinated crop with limited genetic variability.

Up to now, a lot of researchers have developed plants by mutation breeding techniques for sesame (Sharma, 1993), cowpea (Dhanavel et al., 2008; Horn et al., 2016), horse- gram (Dhumal and Bolbhat, 2012), black gram (Thilaga- vathi and Mullainathan, 2009), mungbean (Tah, 2006) and soybean (Padmavathi et al., 1992; Pavadai et al., 2010; Arefrad et al., 2012). The use of gamma-ray irradiation has resulted in various mutants identi? ed in soybean breeding programs (Rahman et al., 1994; Hana? ah et al., 2010; Mudibu et al.,

2012). In the previous study, the researchers use gamma-ray irradiation with 100, 200 and 300 Gy doses in the Aceh local soybean (Kipas Putih variety) to obtain early matu- rity and high-yielding soybean mutants in M 1 generation (Nilahayati et al., 2015) and M 2 generation (Nilahayati et al., 2016). In this study, the research continues in M 3 gen- eration which aims to select individual plant based on the characters of early maturity and high yielding soybean.

Materials and Methods This research was conducted at Reuleut Timu, North Aceh, Indonesia (8 m altitude). Kipas Putih soybean was treated with gamma-rays irradiation. In M 2 genera- tion, each plant at each dose of gamma-ray irradiation treatment was harvested and all the seeds were grown as M 3 generation. M 3 seeds at each dose treatment were planted with spacing 40 x 20 cm. All technical cultivation practices such as fertilizing, watering, weeding and pest control were carried out during the period of plant growth.

The plants were selected based on morphological appear- ance, early maturity and high yielding mutants. 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, days to ? ower and days to harvest. The data analysis was done by

calculating the means of each character observed, then the mean values of each population were tested by using t-test. Differential selection was obtained from the difference in the average selected population of the selection results with the basic population average.

Results and Discussion In M 3 generation, we found the morphological varia- tions in gamma-ray irradiation population. The visible mutants in M 3 generation were not as large numbers as in M 3 generation. The types of visible morphological mu- tants included chlorophyll mutant (xantha, albino, varie- gated leaf, narrow leaf and sterile mutant (Fig. 1). Other authors have reported some common abnormalities at M 3 generation observed in cowpea genotypes derived through gamma irradiation.

Mutants displayed visual phenotypic diffrences including chlorophyll mutant (yellow and striped leaves, albinos or yellow to pale leaf and stem pig- mentation), spinach-like leaves, short pods, broad-dark leaves and single stem (Horn et al., 2016). The results of t-test showed that the mean characters of gamma irradiation population showed higly signi? cant difference with control except for number of branches 300 Gy, number of pods 200 Gy and 300 Gy, number of null pods 300 Gy, seed weight per plant 200 Gy and days to harves at 200 Gy.

In general, there were low agronomic characters in the population 100 Gy in all observed char- acters except for the days to ? ower and days to harvest (Table 1). The plant height and the number of branches in ir- radiated population differed signi? cantly with control at all irradiated doses except for number of brances 300 Gy. Plant height in irradiated populations was generally lower than control plants. The lowest plants were found a 200 Gy (66.48 cm) while the control was 72.70 cm. The number of branches in irradiated population 200 Gy (6.14 branch) was more than in the control (5.46

branch), while the number of branches in 100 Gy was slightly lower (5.06 branch) than in the control. Sadashiv and Kondi- ram (2012) note that all of the mutagens are effective for inducing variability in plant height in M 3 generation of horsegram. Gamma radiation treatments have caused sig- ni? cant reduction in plant height. In M 3 generation the maximum plant height 49.85 cm was recorded in 300 Gy. The minimum plant height 44.57cm was noted in 200 Gy. The average height of control plants was 50.99 cm.

Reduction plant height in M 3 generation is also noted by Khan et al. (2004), Gaikawad et al. (2005) and Sihombing et al. (2016). The number of pods had very different mean values with control at 100 Gy population, while at 200 Gy and 300 Gy they were not signi? cantly different. The lowest number of pods was found at 100 Gy (187 pod/plant), 99The genotype selection of M3 generation of Kipas Putih soybean with gamma-rays irradiation... while the highest number of pods was found at 200 Gy (253 pod/plant) although it iwas not signi? cantly differ- ent from the number of control pods (241.5 pods).

The character of seed weight per plant of irradiated population had very different mean values with control population except for 200 Gy populaton. The seed weight per plant at irradiated population was lower than the control except for 200 Gy. The highest seed weight per plant was found at 200 Gy (52.7 g) which was not signi? cantly different from the control (51.9 g), while the lowest was found at 100 Gy (41.3 g). The character of days to ? ower and days to harvest of irradiated population had diffrent mean values with con- trol population (Table 2, 3).

The earliest days to ? ower was found at 100 Gy (39.13), whereas the fastest days to harvest was at 300 Gy (88.98 days). In this study, early Fig. 1. Morphological mutants in M3 soybean generation: a) xantha, b) albino; c) varigated leaf, d) narrow leaf, e) sterile mutant A A)) C C)) B B)) D D)) E E)) 100 Nilahayati, Rosmayati, Diana So? a Hana? ah, Fauziyah Harahap maturity mutant showing early ? owering within a short span of 37-41 days in 100 Gy population in comparison with the ? owering duration of 49-43 days in control. The total duration of the crop was 77-90 days in 100 Gy against 88-90 days in control.

Such type of mutants were recorded earlier in horsegram. These mutant are highly desirable to reduce the crop duration. Short duration variety of horse- gram will play a key role in avoiding drought and water stress by rainfed agriculture (Dhumal and Bolbhat, 2012). Khan and Tyagi (2013) also reported early maturity soy- bean mutant with gamma-rays irradiation. Early maturing mutant showed normal growth and rapid productivity. In M 3 generation, individual selection was performed to get early maturity and high yielding genotypes.

The se- lection characters criteria were days to ? ower and seed weight per plant with 10% selection intensity. After the selection of the best crops in this generation, there was obtained an improvement in the mean of days to ? ower and seed weight per plant from gamma-ray irradiation populations. The selection of days to ? ower characters resulted the improvement of the early ? owering genotype mean values in 200 Gy (37.77 days), the baseline popula- tion was 39.29 days and higher than control population with 40.20 days of mean values. The selection of the early Table 1.

The effect of gamma irradiation on agronomic characters in M3 generation No. Characters Irradiation doses P 0 Gy P 100 Gy P 200 Gy P 300 Gy 1. Plant height 72,70□9,79 68,2**□10,0 66,48**□9,66 67,45**□7,84 2. Number of branches 5,46□1,62 5,06**□1,43 6,14**□1,68 5,46tn□1,22 3. Number of pods 236,71□71,6 187,0**□67,7 253tn□108 218,0tn□65,7 4. Seed weight per plant 51,3□16,2 41,3**□14,3 52,7tn□23,3 44,4**□14,5 5. Days to ? rst ? ower 40,20□0,65 39,13 **□0,884 39,29**□1,18 39,67**□0,93 6.

Days to harvest 89,99□0,08 89,00**□2,30 90,01tn□3,63 88,98**□2,27 Note: ** = Signi? cantly different with the control population (0 Gy) at level 1% by t-test Table 2. The range values of agronomic characters of M3 population resulted from gamma-ray irradiation No. Characters Irradiation doses P 0 Gy P 100 Gy P 200 Gy P 300 Gy 1. Plant height 36-105 40-102 34-87 43-88 2. Number of branches 3-10 1-9 2-11 3-9 3. Number of pods 30-343 29-460 30-600 51-598 4. Seed weight per plant 6.24-83.03 5.79-79.5 10.11-135.29 6.6-83.25 5. Days to ? rst ? ower 39-43 37-41 37-42 37-42 6.

Days to harvest 88-90 77-90 82-99 84-99 Table 3. Differential selection in M3 generation No. Characters Irradiation doses P 0 Gy P 100 Gy P 200 Gy P 300 Gy 1. Days to ? ower Kipas Putih population 40,20 Baseline population 39,13 39,29 39,61 Selected genotype 37,90 37,77 38,68 Diffrensial selection 1,23 1,52 0,93 2. Seed weight per plant (g) Populasi Kipas Putih 51,83 Baseline population 41,3 52,7 44,4 Selected genotype 61,94 77,22 61,28 Differential selection 20,64 24,52 16,88 101 The genotype selection of M3 generation of Kipas Putih soybean with gamma-rays irradiation...

days to ? ower characters was also found in the 100 Gy population with 37.90 days of means values. The selection of seed weight plant characters in the M3 population also showed the highest selected genotype

mean values in 200 Gy irradiation population with a mean value 77.22 g, the baseline population was 52.79 g and higher than the control population whose weight was only 51.88 g per plant. Hana? ah et. al. (2015) conducts a se- lection of the total number of pods from the population of Anjasmoro soybean in M 3 generation resulting from gamma-ray irradiation under optimum conditions. The re- sults of the study show the highest selected genotypes in the population of 150 Gy irradiation with 77.6

pods means values, the baseline population 45.2 pods and higher than Argomulyo population with 38.6 number of pods. The re- sult of high pod number selection was also obtained from population 200 Gy with the selected genotype of 76.8. Based on the selection criteria of days to ? ower and seed weight per plant, the genotypes were selected in M 3 generation. The selection results showed that there were 233 mutants putative which would be continued to the next generation.

Conclusions Gamma rays irradiation in M 3 generation affected plant height, days to ? ower, days to harvest, number of pods and seed weight per plant. In general, the low agro- nomic characters were in 100 Gy population for all ob- served characters except for days to ? ower and days to harvest. The result of genotype selection on M 3 generation was obtained 233 mutant putative soybeans with early maturity and high yielding mutant which would be con- tinued in M 4 generation.

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