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IMPROVMENT OFPLANT HEIGHT, HARVEST DATE, AND YIELD OFSIGUPAI ACEH LOCAL RICE BY MUTATION OF GAMMA RAYS IRRADIATION

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Abstract - This research aims to evaluate the M1 mutant rice plants from local Aceh variety that have been improved through Gamma Rays Irradiation 200-400Gy. The implementation of the research was carried out systematically, which is in line with the following methods: (1) evaluation of genotypes and phenotypes on the findings of new mutant lines which include yield potential test, (2) test for drought and high temperature resistance, and (3) test the main resistance to disease, so that better M1 line were obtained. With high productivity and quality, the assembly of this new variety is expected to help improve food security and independence by multiplying the yield and income of farmers that adopt it. This mutant line had the following advantages: high productivity>7 tons/ha; adaptive to extreme climates (drought and high temperatures); saving production facilities/agroinput; early maturing/fast harvest (100-110 days), large tillers/panicles, more resistant to pests and diseases; and high quality. The results will enrich the source of new genetic diversity in order to anticipate the threat of global climate changes, environmental damage, and the threat of future food crises. Therefore, the superior Aromatic Super Rice can be used more effectively and efficiently to encourage the rice seed industry in the future.

Keywords - Mutant, Aromatic, Local Rice, and Gamma Rays Irradiation

I. INTRODUCTION

Global climate change can lead to threats to national food security. El-nino, rising temperatures, greenhouse gas accumulation, droughts, floods and salinity pressures can have a direct effect on decreasing food production, crop failure, and the threat of pest and disease explosions (1, 2, 3). This is a major threat to food security, especially in Asia, including Indonesia. Thus, the task of stabilizing food independence will be a big responsibility for Indonesia. This problem is further complicated by environmental damage, limited water, land degradation, and population growth (4). So, this research is expected to contribute in helping mitigate and adapt the effects of global climate change.

With the threat of climate change and environmental degradation, it is very important to assemble new superior varieties that are able to adapt to global climate change, so that the varieties are able to produce production/quality that remains high in a stressed environment even though plants lack water, fertilizers and pesticides (5). Thus, a very appropriate step is through Aromatic Super Rice (ASR) assembly through the breeding of chromosome mutations from local superior varieties that are very adaptive and potential to be developed in aerobic condition. The results of aerobic rice have been shown to increase rice yields from traditional varieties. Due to low water use, but with higher productivity, super rice aerobics will have wider coverage in areas with limited water availability, such as rainfed rice fields and other dry land areas (6). Increased yield on super rice aerobics can reach up to 69% (7).

This research aims to adapt and stabilize the findings of new advantages in M1 mutant strain rice from local Aceh variety, named Sigupai that have been improved/improved productivity and quality through Gamma 200 to 400 Gy mutation technology, which will become new candidate for superior varieties, called Aromatic Super Rice which will to be a mutant variety that have advantages: high productivity>8 tons/ha and early maturing/fast harvesting (100-110 days).

II. RESEARCH METHODOLOGY

The research was carried out for 5 months, starting in July, 2018 until November, 2018. The research is gradually carried out in three locations: (a). Center for Application of Isotope and Radiation, National Nuclear Energy Agency for irradiation with gamma rays 200 Gy, 250 Gy, 300 Gy, 350 Gy, and 400 Gy, (b). Genetic Laboratory and Plant Breeding for analyzing genetic parameters; c. Greenhouse and Experimental Farm, Faculty of Agriculture, Universitas Syiah Kuala, Aceh, Indonesia for cultivation and mutan selection. The implementation of the research plan was carried out systematically for evaluation of genotypes and phenotypes on the findings of new mutant lines which included yield test, drought and high temperature resistance test, resistance to pests and major diseases, so that M1 lines were obtained.

Planting was done on 15-day-old seedlings. In the early generation population using seeds from pedigree panicles, planting was carried out with a spacing of 20 x 20 cm with one seedling per planting hole with a distance of 40 cm. In the middle and advanced generation populations using panicle seeds, planting is done with one panicle into two row with a spacing of 20 cm x 20 cm and planting is carried out one seedling per planting hole also with Jajar Legowo(Space Row) system 2:1.

Selection was done visually (qualitatively) based on the criteria of the desired character, especially plant height, number of tillers, panicle number, seed grain weight, panicle length, number of grain per panicle, weight of 1000 grains, yield index, harvest date and potential yield. Selection is done to get plants with characters: superior vigor, not too high plants, moderate number of tillers, flag leaves and relatively upright tillers (V shape or around 45° stem angle), thick panicles, filled grain, not small, and bright colors or clean, tolerant of pests in the field, and maturity or maximum age equal to Ciherang cultivar, and resistant to lodging.

III. EXPERIMENTAL RESULTS AND DISCUSSION

3.1 Plant Phenotypic Changes

Mutation of M1 of cultivar rice Sigupai with gamma ray irradiationwith a certain dose raisedvarious good diversity in the form of qualitativeor quantitative (Table 1). Changes that occurin plants can be caused asthe result of the treatment, but it can alsocaused by external factors or the environmentplanting, so the involvement of outside influencesmust be minimized as possible, so thatcharacter changes that appear aretrue changes that occur as a resultfrom the treatment given toplant.

Figure 1. showed thatgamma ray irradiation treatment to Sigupai rice plants can affectphenotypic the rice plants, especially flowering periode and plant architectures. Changephenotypic plants can be seen from the presencedifferences in measurements for each characterobserved observations. The irradiationdone causes it to occurincrease or even decreaseobservational characters measuredquantitative.

3.2 Effects of Gamma Rays on Plant Height

Analysis of variance (ANOVA) showed that the mutation with gamma rays irradiation was significantly affected the plant height of Sigupai (Table 1). Table 2 showed that plant height increases with increasing dose of gamma irradiation, except at a dose of 300 Gy. The highest plant height was in the absence of mutation treatment, namely in the Sigupai (control) variety while the lowest plant was found at the 300 Gy treatment as large as the target of most rice breeders. Pheng et al., 1998 and Khush, 2000; 2002 stated that the ideal rice height was around 90 cm to 100 cm (8, 9). With this height, the potential for breeding will decrease compared to high plants. This study found that plant height decreased by 30.1%.

Figure 1: Some rice plants of the mutant irradiated with gamma rays irradiation showed flowering early and shorter than other plants.

SV	Df	MS	MF	F	P	F crit.
Replications	2	144.3	72,1	1,2	ns	4.1
Treatments	5	4648	929,6	15,4	**	3.3
SE	10	601.7	60,1		-	-
Total	17	17,00				

Table 1. Analysis of variance for rice plant height
Note: **: Highly significant,
ns: non-significant

Dosages of Gamma Rays Irradiation (Gy)	Plant Height (cm)
0 Gy	162.0 c
200 Gy	116.7 a
250 Gy	128.4 b
300 Gy	112.1 a
350 Gy	130,67 b
400 Gy	134,67 b

Table 2. Effects of Gamma Rays Irradiation in Reducing the Plant Height of the Rice Mutant

Values followed by same letters within same column are not significant at $p<0.05$ by Tukey HSD test.

3.3 Reduced Lifespan on Rice Mutant

Table 3 showed analysis of variance that resulted the effect of mutation with gamma rays irradiation was significantly reduced the lifespan of Sigupai local rice from 136 to 107 days after planting. This research discovered that the lifespan of rice mutant was highly reduced (21.3%) at the treatment of 250 Gy of gamma rays irradiation. Warmanet. al. (2015) reported that gamma ray radiation can shorten the harvest date of rice (10). Masruroh et. al. (2016) found that rice mutation with decreased days to 50% heading and plant harvest date (11). Previoues study showed that gamma rays irradiation reduced the age of harvest in Aceh local rice (9).

SV	Df	MS	MF	F	P	F crit 0,05
Replications	2	234,3	117,1	1,8	ns	4,1
Treatments	5	1487	297,4	4,7	*	3,3
SE	10	633,0	63,3		-	-
Total	17	17,00				

Table 3. Analysis of variance of mutation with gamma rays irradiation on the harvest date
Note: *: Significantly,
ns: non-significant

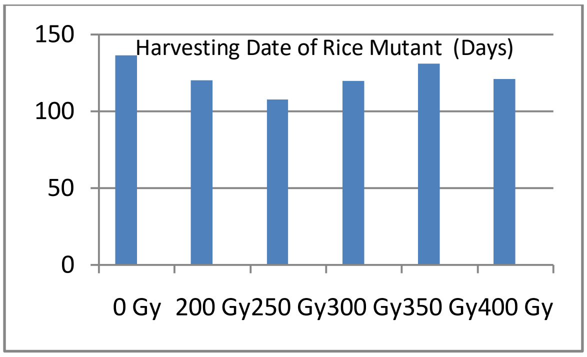


Figure 2. Effect of mutation with gamma rays irradiation on reduced the lifespan of Sigupai

3.4 Improvement of Yield on Rice Mutant

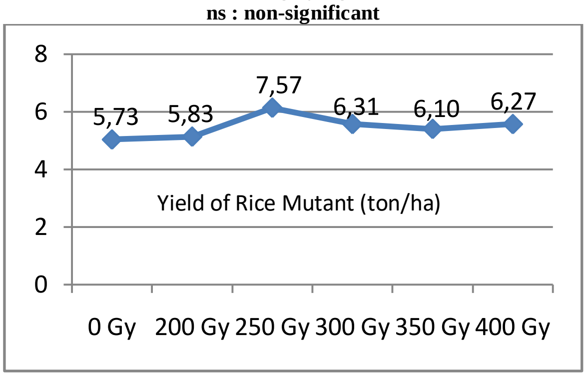
Analysis of variance (Table 4) showed that mutation with gamma rays irradiation was significantly increased the yield of Sigupai local rice from 5.73 to 7.57 ton/hain environmental stress condition on drought and high saline soil (Figure 2). This research discovered that the yield of rice mutant was highly increased (32.1%) at the mutation of 250 Gy by the gamma rays irradiation. Some researches found that improvement of yield in rice mutant was induced by mutation. The mutants were shorter in plant height, and gave higher mean yield than the parent(Syehdaz et al., 2011). A study also discovered that mutation of local rice with gamma rays irradiation improved the tolerance of local rice of Aceh to drought stress and enhanced the yield potential (9).Junita e.t al. (2017) found that the genotypes of rice mutated by gamma-radiation demonstrated a significant effect on the length of root observed at harvest time. Based on observation Sanbei genotype had the longest root, compared to those of the other genotypes (12).

IV. CONCLUSION

Mutation of M1 of cultivar rice Sigupai with gamma ray irradiationwith a certain dose raisesvarious good diversity in the form of qualitativeor quantitative. The mutation was significantly reduced the plant height and lifespan of Sigupai local rice. Mutation with gamma rays irradiation was significantly increased the yield of Sigupai local rice from 5.73 to 7.57 ton/ha. The best treatment of gamma rays irradiation to improve the Sigupai local rice was discovered at the dosage of 250 Gy.

SV	Df	MS	MF	F	P	F crit 0,05
Replications	2	0,6	0,3	1,82	ns	4,10
Treatments	5	11,4	2,3	13,7	**	3,33
SE	10	1,6	0,2		-	-
Total	17	17,0				

Table 4. Analysis of variance about effect of mutation with gamma rays irradiation on yield of rice mutant.
Note: **: Highly significant
ns : non-significant



REFERENCE

[1] Easterling, W.E., Aggarwal, P.K., Batima, P., Brander, K.M., Erda, L., Howden, S.M.,Kirilenko, A., Morton, J., Soussana, J.-F., Schmidhuber, J., Tubiello, F.N. 2007. Food, fibre and forest products. Climate Change 2007: Impacts, adaptation and vulnerability. Cambridge University Press, Cambridge, UK, pp. 273–313.

[2] Meehl, G.A., Stocker, T.F., Collins, W.D., Friedlingsteen, P., Gaye, A.T., Gregory, J.M., Kitoh, A., Knutti, R., Murphy, J.M., Noda, A., Raper,S.C.B., Watterson, I.G., Weaver, A.J., Zhoa, Z.C. 2007. Global climate projections. Cambrige University Press, CambridgeUK/New York, NY, USA.

[3] Maclean, J.L., Dawe, D.C., Hardy, B., Hettel, G.P. 2002. Rice Almanac, 3rd ed. IRRI, LosBa˜nos, Philippines, pp. 253

[4] Yang, J., Q. Zhou, J. Zhang. 2017. Moderate wetting and drying increases rice yield and reduces water use, grain arsenic level, and methane emission. The Crop Journal, 5 (2017) 151–158.

[5] Ali, J., Xu, J.L., Gao, Y.M., Fontanilla, M., Li, Z.K., 2013. Breeding for yield potential and enhanced productivity across different rice ecologies through Green Super Rice (GSR) breeding strategy. In: Muralidharan, K., Siddiq, E.A. (Eds.), International Dialogue on Perception and Prospects of Designer Rice. Society for the Advancement of Rice Research, Directorate of Rice Research, Hyderabad, India, pp. 60–68.

[6] Sandhu, N., S.Jain, K. R. Battan, and R. K. Jain. 2012. Aerobic rice genotypes displayed greater adaptation to water-limited cultivation and tolerance to polyethyleneglycol-6000 induced stress. Physiol Mol Biol Plants. 18(1): 33–43

[7] Amudha, K., K. Thiyagarajan and N. Sakthivel. 2009. Aerobic Rice: A Review. Agric. Rev., 30 (2): 145 – 149

[8] Pheng, S., G.S. Khush, P. Virk, Q. Tang, Y. Zou. 2008. Progress in Ideotype Breeding to Increase Rice Yield Potential. Field Crop Research 108(3) : 32 - 38.

[9] Efendi, Bakhtiar, Zuyasna, W. Alamsyah, Syamsuddin, S. Zakaria, N. Supriatna, and Sobrizal. 2017. The Effect of Gamma Ray Irradiation on Seed Viability and Plant Growth of Aceh's Local Rice (Oryza sativa L.). Advances in Natural and Applied Sciences. 11(3): 91-96

[10] Masruroh, F, Samanhudi, Sulanjari, and A. Yunus. 2016. Improvement of Rice (Oryza sativa L.) var. Ciherang and Cempo Ireng Productivity Using Gamma Irradiation. Journal of Agricultural Science and Technology B 6: 289-294

[11] Warman B., Sobrizal, I. Suliansyah, E. Swasti, and A. Syarif. 2015. Perbaikan Genetik Kultivar Padi Beras Hitam Lokal Sumatera Barat Melalui Mutasi Induksi. Jurnal Ilmiah Aplikasi Isotop Dan Radiasi, 11 (2): 125-136

[12] Shehzad, T, A. Allah, A. E. Naby, M.H.Ammar,and A. F. Abdelkhalik. 2011. Agronomic And Molecular Evaluation Of Induced Mutant Rice (Oryza Sativa L.) Lines In Egypt. Pak. J. Bot., 43(2): 1183-1194

[13] Junita D., Efendi, and Bakhtiar, 2017. Indices of Drought Stress Tolerance And Sensitivity Of M3 Rice Mutant Lines (Oryza Sativa L.) on Organic System. Advances In Natural And Applied Sciences. Advances in Natural and Applied Sciences. 11(9); Pages: 197-204

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