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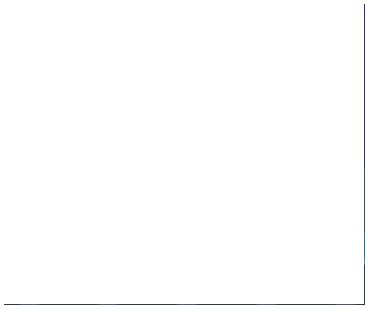
Abstract

Local rice is germplasm which has great potential to be developed in meeting food needs in Indonesia. Black rice is known to have great health benefits but in general has a weakness in low yields. Therefore, research is needed to overcome this weakness. This study aims to determine the effect of heavy ion beam irradiation on production yields per hectare of the black rice mutant lines of the M3 generation. The experiment was carried out for 6 months using 50 strains of black rice mutants obtained from the M2 generation plus 1 negative control and 1 positive control. Based on the results of the coefficient analysis on the observed characters, there are potential and effective characters to be developed in the next M4 generation of black rice, namely the number of grains per panicle, panicle density, panicle length, percentage of filled grains per panicle and 100 grains weight.



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Abstract. Local rice is germplasm which has great potential to be developed in meeting food needs in Indonesia. Black rice is known to have great health benefits but in general has a weakness in low yields. Therefore, research is needed to overcome this weakness. This study aims to determine the effect of heavy ion beam irradiation on production yields per hectare of the black rice mutant lines of the M3 generation. The experiment was carried out for 6 months using 50 strains of black rice mutants obtained from the M2 generation plus 1 negative control and 1 positive control. Based on the results of the coefficient analysis on the observed characters, there are potential and effective characters to be developed in the next M4 generation of black rice, namely the number of grains per panicle, panicle density, panicle length, percentage of filled grains per panicle and 100 grains weight.

1. Introduction

Local rice in Indonesia, especially in South Sulawesi, is a germplasm that has potential as a source of genes that control important traits in rice plants. Prior to the development of technology during the green revolution, farmers in each region planted local rice that adapted to specific agroecosystems. The local rice has been cultivated since centuries ago for generations and is part of the cultural traditions of the people of South Sulawesi.

Tana Toraja is one of the highland areas in South Sulawesi that has a diversity of local rice germplasm. Based on information from the Agriculture Office of Tana Toraja Regency, in this area there are still many local rice varieties planted by farmers. Some local rice varieties used from generation to generation as part of the community's traditions and culture are the black rice (Pare Ambo) and red rice (Pare Lea) from the North Toraja Regency. The use of rice in cultural rituals helps to preserve traditional rice varieties amid the rapid use of introduced varieties.

Black rice has a unique phenotype character. The dark purple color makes this rice look black because of its high anthocyanin content. Anthocyanin is a water-soluble pigment that has antioxidant activity. Black rice is known to have properties to increase the body's resistance to disease, repair damaged liver cells, prevent damage to kidney function, prevent cancer/tumors, slow aging, antioxidants, clean cholesterol in the blood and prevent anemia [1].

Local rice in general has several weaknesses including longevity and low yield [2]. Long harvest life and low productivity are the limiting factors that can cause the interest of farmers to grow local rice, so that it is feared that it will cause a lack of availability of local rice cultivars as germplasm material.

Improvement of local rice plant characteristics can be done in various ways, both conventionally and by mutation induction. Along with the development of the times, breeding techniques are now developed using ion beams known as heavy ion beams. This ion beam is safer, does not damage the endosperm, because the dose is low so the mutation induction rate is higher. Mutations with this technique make it possible to produce local rice mutant genotypes that have good and more stable quantitative and qualitative characters.

Mutation induction in local rice with irradiation is expected to produce mutant rice which has better properties compared to some of its original cultivars [3], especially in terms of improving plant age. From the results of a previous study by Trisnawati [4] on local black rice and red rice using heavy ion beam irradiation in M1 generation, a generation of mutants was obtained, then after planting M2 the black rice and red rice lines of M3 were obtained. Based on the description that has been stated, it is necessary to conduct research on "Black Rice Mutant Strain Selection Results of M3 Generation Mutation Breeding".

2. Materials and methods

This research was conducted at the screen house as a seeding place and paddy field in Kambiolangi Village, Alla District, Enrekang Regency with an altitude of 650 m above sea level (S: 3° 19'47, 44"; E: 119° 50'1, 57", from March to September 2018.

Experiment was carried out using the method of mass selection. At this stage, selected genotypes of the M2 generation mutant strain number in the ion beam irradiation treatment of Carbon and Argon species were planted in 1 line on each line number plus 1 control line as the elders placed on both sides of the treatment plot with spacing 30 cm x 30 cm as many as 50 plants. Land management starts from clearing land from weeds using herbicides and remnants of M2 planting and then proceed with tillage using hand tractors until the land is clean and ready for planting. M3 seedlings that have been planted for three weeks were planted directly in each row plus 1 control line. Each line consisted of 10 plants with a spacing of 30 cm x 30 cm.

Plant maintenance included monitoring water conditions in the field, controlling weeds manually, sowing molluscides to control snail pests and rodenticides to control rodent pests in the field, and spraying insecticides to control pest ladybugs and stink bugs that attack when the plant starts flowering, and installation of nets to avoid sparrow pests when entering the milk maturation phase. Harvesting was done after 2/3 of the panicle has turned yellow. This third generation (M3) harvest has been directed at all possible genotypes arising from mutations. Each mutant genotype is separated into separate groups.

Observations were made on growth and production parameters that included quantitative characters. The quantitative characters observed in this study were the number of productive tillers per hill (panicle), the number of grains per panicle (grain), panicle density (grain/cm), grain weight per hill (g), grain weight per line (g). Observation data obtained were then collected and analyzed by correlation test and heritability test using SPSS software version 24 and Microsoft Excel 2013.

3. Results and discussion

Correlation results between the genotypes of the black rice mutants of the Pare Ambo M3 generation are presented in Table 1. The yield component which is significantly positive with the grain weight per line is the grain weight per hill. Likewise the character of panicle density is positively correlated with the number of grains per panicle.

Table 1. Correlation between characters of Pare Ambo black rice mutant lines

	Number of Productive Tiller per Hill	Number of Grains per Panicle	Panicle Density	Grain Weight per Hill	Grain Weight per Line
Number of Productive Tiller per Hill	1	0.146ns	0.226ns	-0.314ns	-0.329ns
Number of Grains per Panicle	0.146ns	1	0.898**	-0.247ns	0.033ns
Panicle Density	0.226ns	0.898**	1	-0.193ns	0.195ns
Grain Weight per Hill	-0.314ns	-0.247ns	-0.193ns	1	0.598*
Grain Weight per Line	-0.329ns	0.033ns	0.195ns	0.598*	1

ns= not significant; *=Correlation is significant at the 0.05 level (2-tailed); **=Correlation is significant at the 0.01 level (2-tailed).

Based on the heritability of black rice Pare Ambo in Table 2, for carbon ion irradiation treatment ranged from 33.98% to 79.02% and for argon ion irradiation treatment 65.32% to 96.57%. The characters that showed the highest heritability in carbon ion treatment were panicle density (79.02%), number of grains per panicle (59.35%), number of productive tillers (55.38%), grain weight per hill (33.98%) and the characters that showed the highest heritability in the argon ion treatment were grain weight per hill (96.57%), panicle density (72.38%), number of productive tillers (67.43%) and number of grain per panicle (panicle) 65.32%).

Table 2. Genotypic variance (VG), phenotypic variance (VP), genotypic coefficient variation (GCV), phenotypic coefficient variation (PCV) and heritability values (h^2) of the yield components characters from 10 red rice mutant lines third generation (M3)

Character	Treatment	Average	Min	Max	VG	VP	GCV (%)	PCV (%)	h^2
	Cont.	9.10	7	11	49	-	-	-	-
Number of Productive Tiller	Carbon	12.70	6	22	8.57	12.39	23.05	27.72	55.38
	Argon	10.95	7	21	11.73	15.56	31.28	36.02	67.43
	Cont.	186.80	135	257	2227.30	-	-	-	-
Number of Grains per Panicle	Carbon	185.76	100	326	2047.12	2879.22	24.36	28.89	59.35
	Argon	188.10	112	289	2399.04	3231.14	26.04	30.22	65.32
	Cont.	5.12	4.08	6.76	1.97	-	-	-	-
Panicle Density	Carbon	5.55	2.70	9.79	1.66	2.01	23.19	25.51	79.02
	Argon	5.26	3.51	7.63	1.26	1.61	21.33	24.1	72.38
	Cont.	39.93	27.79	55.00	125.51	-	-	-	-
Grain Weight per Hill	Carbon	54.24	10.50	124.64	396.18	657.76	36.69	47.28	33.98
	Argon	68.66	23.24	435.40	7636.95	7898.53	127.27	129.44	96.57

Based on observations of the character of the M3 generation black rice mutant genotype of Pare Ambo, it was found that there was a high significant differences between genotypes. The treatment of heavy ion beam irradiation can cause damage to the main cell components of the chromosomes so as to cause changes in plant phenotypes. Changes in plant phenotypes can be seen from the differences in each character observed. Irradiation carried out causes an increase or even decrease in the measured observational character.

The number of productive tillers of Pare Ambo black rice mutant lines in 10 lines had fewer number of tillers and were significantly different than those of the control. According to IRRI [5], the grouping category consists of number of tillers; few (<10), moderate (10-20) and many (> 20). To observe the total number of tillers, a large classification is taken according to IRRI, because the more total number of tillers it is expected that in these mutants the productivity will also be higher. The average number of productive tillers in Pare Ambo can be categorized as moderate. The effect of the mutated seed, if radioactivity hits the plant tissue will cause ionization of water molecules, then it will oxidize DNA sugars resulting in the breakdown of the nucleotide sequence. In addition, there is also radiation that can directly cause nucleotide bases to become loose, damaged or change the composition of the molecule [6]. The small number of tillers per clump in mutant lines could attributed to plants having relatively high stems. According to Nuruzzaman et al. [7], number of tillers

of rice varieties could also affected by the morphological characters. High-stemmed rice varieties will produce fewer tillers because most of the photosynthetic results will be transferred to plant height growth. Makarim et al. [8] reported that productive tillers is one component of yield that directly affected the grain yields. Increased productivity of rice plants can be associated with the number of productive tillers, because tillers directly produce rice panicles that produce rice seeds or grain.

In Pare Ambo black rice, G12 strain produced the highest grain weight per family (80.21 g) and was significantly different from control and 10 other lines. The weight of grain per line in black rice Pare Ambo has a significantly positive correlation with grain weight per hill (0.598). That is, the more grain weight per hill, the heavier grain weight per line and the character of the grain weight per panicle are positively correlated with panicle density. This is confirmed by research by Ogunbayo et al. [9] which explains that the amount, percentage and weight of filled grains per panicle in rice is one of the factors affecting grain production. This character has a positive correlation with grain yield in rice plants. The increase in grain yield will be followed by the large number of total grain per panicle [10]. This is confirmed by research Winarsi et al. [11] which found that the total grain character per panicle has a very significant correlation with the grain weight per clump.

According to Kumar and Vidyakar [12] each character in rice plants has a different contribution to the level of diversity produced. The heritability value of Pare Ambo black rice mutant lines irradiated with Carbon and Argon for the character of the number of productive tillers, number of grains per panicle, panicle density, grain weight per clump and grain weight per row ranged between 33.98% - 96.57%.

High heritability value means that genetic diversity plays an important role in the appearance of phenotypes of the plants. According to Babu et al. [13], high heritability value means that genetic factors make an important contribution in the subsequent selection process. Heritability values show how the proportion of a gene can be derived in the next generation based on observations of the observed phenotype characteristics. Saleem et al. [14] reported that high heritability and genetic progression results from Basmati rice crossing for traits such as plant height, flag leaf area, grain production per plant and number of productive tillers. Meanwhile, according to the report Vanaja and Babu [15] the heritability value indicated by the ratio of grain length and width, percentage of grain *sosoh*/s*esame* seeds, water absorption and amylose content can be used as a selection parameter in rice plant breeding.

4. Conclusions

The results of this study indicate that the high grain weight per clump in Pare Ambo black rice is supported by the number of grains per panicle, panicle density, grain weight per panicle and grain weight per line. These four characteristics are very important and effective for selection in increasing grain yields in Pare Ambo black rice cultivation in the next fourth generation (M4). The selection of the right characteristics of the crossed product, it is hoped that the selected lines can be developed into new varieties.

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		11	Anggota	Rahmad Laode Asrul Tutik Kuswinanti Yunus Musa	Isolation of fungi producing hormone Indole Acetic Acid (IAA) on sugarcane bagasse and filter cake	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486 (2020)	doi:10.1088/1755-1315/486/1/012131	12131
		12	Anggota	D R Sari Laode Asrul Rinaldi Sjahril K Ozozawa	Path coefficient analysis for growth characters of sago palm related to trunk formation at three years after transplanting	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486 (2020)	doi:10.1088/1755-1315/486/1/012010	12010
		13	Anggota	M M Syarif Rismaneswati Laode Asrul Kaimuddin	Strategy for improving sustainable cocoa (Theobroma cacao L) plant productivity in South Sulawesi based on land suitability	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486 (2020)	doi:10.1088/1755-1315/486/1/012087	12087
		14		Kahar Mustari Laode Asrul Dkk	Modul Climate Change	Surat Pencacatan Ciptaan Menteri Hukum dan Hak Asasi Manusia	internasional	Published	ECO00202003110		000176485
4	Prof. Dr. Ir. Elkawakib Syam'un, MP. 19560318 198503 1 001 elkawakibsyam@gmail.com	1	Anggota	Amir Yassi A. Guricci Elkawakib Syam'un Muh. Riadi Tigin Dariati N. Adyla S	Growth and production of lowland rice (*Oryza sativa* L.) with water management systems on the application of various combination of fertilizers and planting systems	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486	1755-1315	
		2	Anggota	Kasim, N., Syam'un, E., Taufik, N., Widiayani, N., Indhasari, F.	Response of tomato plant on various concentrations and application frequency of gibberellin	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486	1755-1315	
		3	Anggota	Muhidin, Syam'Un, E., Kaimuddin, (...), Yusuf, D.N., Rakian, T.C.	Effect of gamma irradiation on harvest date of local upland red rice cultivar	IOP Conf. Series: Earth and Environmental Science	internasional	Published	454	1755-1315	
		4	Anggota	Muh. Riadi (Ketua), Rinaldi Sjahril, Maryati, E Syam'un, N Kasim, Rafiuddin; dan S Dewi	Growth and production of three rice varieties (Oryza sativa L.) in saline stress condition following halopriming and hydropriming treatment	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-8
		5	Anggota	Feranita Haring (Ketua), S Rantetandung (Anggota),M Riadi, Rafiuddin, dan Rinaldi Sjahril	Selection of purification and formation of double haploid Toraja endemic black rice through anther culture	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012102 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-7
		6	Ketua	Fachirah Ulfa dan Katriani Mantja	**Teknologi Budidaya Bawang Merah Produktivitas Tinggi**	Seminar Nasional Pengabdian pada Masyarakat 2019	akreditasi	Published		192-0291	
5	Prof. Dr. Ir. Yunus Musa, M.Sc. 19541220 198303 1 001 yunusmondi@gmail.com	1	Ketua	Ambo Ala Ifayanti Ridwan Harianto Ponto Muh. Farid BDR Nuniek Widiayani A R Yayank	Application of Arbuscular Mycorrhizal Fungus (AMF) improves the growth of single-bud sugarcane (Saccharum officinarum L.) seedlings from different bud location	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei, Tahun 2020	ISSN: 1755-1315	012122
		2	Anggota	1. Ifayanti Ridwan (Ketua), 2. Y Musa, 3. S Khadijah, 4. M Farid, 5. Rinaldi Sjahril (Anggota), 6. F Ulfa and 7. Ritabulan	Response of Soybean (Glycine max L.) to Arbuscular Mycorrhizal Fungi (AMF) applied with organic liquid fertilizer	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei, Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-7
		3	Anggota	Muh. Farid BDR (Ketua) Nur Azika (Anggota) Yunus Musa Rafiuddin A. Rusdayani Amin Kaimuddin	Evaluation of several tropical wheat genotypes (Triticum aestivum L.) on various water availability in the lowlands	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei, Tahun 2020		
		4	Anggota	1. N Kasim (Ketua), 2. Y Musa, 3. K Mustari, 4. S A Syaiful, 5. M Riadi, 6. Rinaldi Sjahril (Anggota) and 7. N Ahyani	Screening of eight mutants of Sinjai lokal red rice (Oryza sativa) to salinity stress	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei, Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1310	1-6

		5	Anggota	1. R Indriani (Ketua) 2. Rahim Darma 3. A Nixia Tenriawaru 4. S Imran	Product flow pattern at cayyene pepper supply chain	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei, Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1310	012003
		6	Anggota	1. Nirawati 2. M Restu 3. T Kuswinanti 4. S A Paembonan 5. S Millang 6. Syahidah 7. S H Larekeng	Morphological Characteristics of Arenga pinnata Merr. from Maros and Sinjai Provenances in South Sulawesi, Indonesia, and its relationship with Brix Content	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei, Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1310	012080
		7	Anggota	1. Rahmad 2. L Asrul 3. T Kuswinanti	Isolation of fungi producing hormone Indole Acetic Acid (IAA) on sugarcane bagasse and filter cake	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei, Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1310	012131
		8	Anggota	Darwis Lantik (Ketua), Nasaruddin, Yunus Musa, Itji Diana Daud, Ifayanti Ridwan, Kurniawan	The Effect Of Pleurotus Ostreatus And Trichoderma In Oil Palm Empty Fruit Bunches Decomposition	International Journal of Scientific & Technology Research	internasional	Published	Volume 9 - Issue 3, March 2020	e ISSN 2277-8616	1814-1816
		9	Anggota	S Alimuddin Yunus Musa M. Azrai Laode Asrul	Effect of double rows plant system on plant growth, yield components and grain yield in prolific and non-prolific hybrid maize	IOP Conf. Series: Earth and Environmental Science	internasional	Published	473 (2020) 012013	doi:10.1088/1755-1315/473/1/012013	12013
6	Prof. Dr. Ir. H. Nasaruddin, MS. 19550106 198312 1 001 nnasaruddin@gmail.com	1	Ketua	S A Syaiful, M Farid BDR, Ifayanti Ridwan, Katriani Mantja W Utami	Effectiveness of soil tillage and Arbuscular Mycorrhizal (AM) fungi inoculation on fruit development of the cocoa plant (Theobroma cacao L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012118
		2	Anggota	Asmiaty Sahur Muthmainnah	Growth response of pepper (Piper nigrum L.) on application Arbuscular Mycorrhizal Fungi (AMF) and the shallot filtrate	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012130
		3	Anggota	Muh Farid BDR, H Iswoyo, I Ridwan F Arsyad	Analysis of heritability and correlation of agronomic character towards the yield of several m6 generation of wheat mutants (Triticum aestivum L.) in the lowlands	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 484: Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012045
		4	Anggota	Darwis Lantik (Ketua), Nasaruddin, Yunus Musa, Itji Diana Daud, Ifayanti Ridwan, Kurniawan	The Effect Of Pleurotus Ostreatus And Trichoderma In Oil Palm Empty Fruit Bunches Decomposition	International Journal of Scientific & Technology Research	internasional	Published	Volume 9 - Issue 3, March 2020	e ISSN 2277-8616	1814-1816
		5	Ketua	Muh. Farid BDR, Ifayanti Ridwan, Abdul Mollah, Tigin Dariati, Cri Wahyuni Brahmi Yanti, Nandi K. Sukendar	PERBAIKAN TEKNIS BUDIDAYA KELAPA RAKYAT DI KABUPATEN WAJO	Jurnal Dinamika Pengabdian	akreditasi	Published	Volume 5 Nomor 2 Mei 2020	p-ISSN: 2460-8173 e-ISSN: 2528-3219	258-270
		6	Anggota	Muh. Farid BDR Ifayanti Ridwan Hari Iswoyo Nurfaida Hatta Jamil,	Pembinaan Kelompok Tani Menjadi Petani Penangkar Benih Unggul Sebagai Upaya Dalam Mengatasi Kelangkaan Benih Padi Di Kecamatan Bengo Kabupaten Bone	Jurnal Dinamika Pengabdian	akreditasi	Published	Vol. 5 No. 2 Mei 2020	p-ISSN: 2460-8173 e-ISSN: 2528-3219	213-226
7	Dr. Ir. Rafiuddin, MP. 19641229 198903 1 003 rafiuddinsyamsuddin@gmail.com	1	Ketua	A. Rusdayani Amin Amin Nur Muh. Farid, Bdr. A.T.I. Sari	Evaluation on growth and production of convergent breeding wheat (Triticum aestivum L.) genotypes adaptive to lowland	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012098 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-10
		2	Anggota	F. Zul (Ketua) Kaimuddin Rafiuddin	Analysis of climate and population dynamics of Conomoporpha cramerella pest in North Luwu	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012084 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-8
		3	Anggota	Cri Wahyuni (Ketua) Rahmansyah Dermawan N.S. Nafsi Rafiuddin Abdul Haris Bahrun Abdul Mollah A. Arafat	Response of kale (Brassica alboglabra L.) to various planting media and application of liquid inorganic nutrition in DWC (deep water culture) hydroponic systems	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012113 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-7
		4	Anggota	1. Muh. Riadi (Ketua), 2. Rinaldi Sjahril 3. Maryati, 4. E Syam'un, 5. N Kasim, 6. Rafiuddin 7. S Dewi	Growth and production of three rice varieties (Oryza sativa L.) in saline stress condition following halopriming and hydropriming treatment	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-8
		5	Anggota	Amirullah (ketua) Rafiuddin Elkawakib Syam'un Laode Asrul Fachirah Ulfa Susanti	Growth of red dragon fruit seedlings (Hylocereus costaricensis L.) from two sources of cuttings at various concentrations of shallot solutions	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012112 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-8
		6	Anggota	1. Feranita Haring (Ketua), 2. S Rantetandung 3. M Riadi, 4. Rafiuddin 5. Rinaldi Sjahril	Selection of purification and formation of double haploid Toraja endemic black rice through anther culture	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012102 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-7

	7	Anggota	Muh. Farid BDR (Ketua) Nur Azika Yunus Musa Rafiuddin A. Rusdayani Amin Kaimuddin	Evaluation of several tropical wheat genotypes (Triticum aestivum L.) on various water availability in the lowlands	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012093 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-9
	8	Anggota	Lani Pelia (Ketua) Muh. Riadi Rafiuddin	Growth response and yield of several local yam plants with hormax applications	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012128 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-6
	9	Anggota	1.Ir. Rinaldi Sjahril, M.Agr, P.hD. (Ketua) 2. Trisnawaty A. R 3. Muhammad Riadi 4. Rafiuddin 5. Tadashi Sato 6. Kinya Toriyama 7. Yoriko Hayashi 8. Tomoko Abe	Selection of Early Maturing and High Yielding Mutants of Toraja Local Red Rice Grown from M2-M3 Population after Ion Beam Irradiation	Hayati Journal of Bioscience	internasional	Published	Vol. 27 No. 2	ISSN: 1978-3019 EISSN: 2086-4094	166-173
	10	Anggota	1. N.N. Andayani (Ketua) 2. M. Riadi, 3. Rafiuddin, 4. S.H. Kalqutny. 5. R. Efendy, and 6. M. Azrai	Evaluation of yield and agronomic components of three-way cross maize hybrids under low-light environment	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 484: 012016 Tahun 2020	Online ISSN: 1755-1315	1-6
	11	Anggota	Muh. Farid BDR (Ketua), A A Laraswati, Ifayanti Ridwan	Testing of lollo rossa lettuce varieties (Lactuca sativa var. crispa) on different ammonium-nitrate ratio in the hydroponic nutrient solution	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 484: Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012094
8 Dr. Ir. Fachirah Ulfa, MP. 19641024 198903 2 003 fachirah.ulfa@gmail.com	1	Anggota	I.Ridwan, (Ketua) Y Musa Khadijah M.Farid Fachirah Ulfa R. Sjahril Ritabulan	Response of Soybean (Glycine max L.) to Arbuscular Mycorrhizal Fungi (AMF) applied with organic liquid fertilizer	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12114
	2	Ketua	Fachirah Ulfa F Haring M Kanisa A R Amin N Kasim M Farid BDR	Flowering of Chrysanthemum sp. in pot at various concentrations of corn extract and paclobutrazol	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12138
	3	Anggota	Amirullah (ketua) Rafiuddin Elkawakib Syam'un Laode Asrul Fachirah Ulfa Susanti	Growth of red dragon fruit seedlings (Hylocereus costaricensis L.) from two sources of cuttings at various concentrations of shallot solutions	OP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12112
	4	Anggota	Nurlina Kasim Feranita Haring Fachirah Ulfa Nuniek Widiayani N D P Panggula	Growth and production of katokkon (Capsicum chinense Jacq) chili plants in lowland applied with gibberellins and liquid organic fertilizer	OP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12121
	5	Anggota	Katriani Mantja M Farid BDR Fachirah Ulfa Abdul Mollah A. Rusdayani Amin Ifayanti Ridwan Saleh Kasmiati Fitrianti	Effect of Trichoderma and tofu waste based organic fertilizer on the fruit development of chili (Capsicum annuum L.)	OP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12116
	6	Anggota	A. Mollah Kaimuddin E.Hamid, F.Haring Fachirah Ulfa Ridwan M.Syarif	Enrichment of organic complex compounds of coconut water and mungbean extract in chrysanthemum (Chrysanthemum morfolium L.) tissue culture media	OP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12123
	7	Anggota	AE Munawarawanti SBA Omar RA Syamsuddin Syatrianti A.Syaiful Fachirah Ulfa Amirullah Dachlan	The effectiveness of biofilter and density of different stocking in aquaponic resirculation systems in the integration of tilapia (Oreochromis niloticus L.) and pakchoy plants (Brassica rapa L.)	OP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12137
	8	Anggota	Baharuddin (Ketua) Fachirah Ulfa Eryuni	Reactions of Banana Planlets Musa acuminata L. to Exacelluler polysacharides from Ralstonia zyzygii subsp celebenssis causal agent of blood diseases	OP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12154
	9	Anggota	Nurlina Kasim NDP Panggula Feranita Haring Fachirah Ulfa Amirullah Dachlan Nunik Widiayani D Yulsan	Growth and production of Katokkon (Capsicum chinense Jacq) chili plants in lowland applied with gibberellins and liquid organic fertilizer	OP Conf. Series: Earth and Environmental Science	internasional	Published	Volume: 486. Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	12121

9	Dr. Ir. Hj. Syatrianty A. Syaiful, MS. 19620324 198702 2 001 Syatrianty62@gmail.com	1	Anggota	Nurlina Kasim Yunus Musa Syatrianty A. Syaiful Muh. Riadi Rinaldi Sjahril Nini Ahyani	Screening of eight mutants of Sinjai lokal red rice (Oryza sativa) to salinity stress	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486, Mei Tahun 2020	doi:10.1088/1755-1315/486/1/012089 1	12089
		2	Anggota	Ferial Syatrianty A. Syaiful Amirullah Dachlan	Growth of F0 seedlings of oysters mushroom (Pleurotus ostreatus) with different ages of explants	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012092	internasional	Published	486, Mei Tahun 2020	doi:10.1088/1755-1315/486/1/012092 1	12092
		3	Ketua	Muh. Riadi, Faizal A Mustaman, A Rusdayani Amin, Muh Farid BDR, Abdul Mollah, Makmur	Growth and production of South Sulawesi local waxy corn genotypes (Zea mays ceratina L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707 doi:10.1088/1755-1315/486/1/012099 1	012099
		4	Anggota	Nasaruddin Syatrianty A. Syaiful Mh. Farid BDR Ifayanti Ridwan Saleh Katriani Mantja W Utami	Effectiveness of soil tillage and Arbuscular Mycorrhizal (AM) fungi inoculation on fruit development of the cocoa plant (Theobroma cacao L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486, Mei Tahun 2020	doi:10.1088/1755-1315/486/1/012118 1	12118
		5	Anggota	A E Munawarawanti S B A Omar R Syamsuddin Syatrianty A. Syaiful Fachirah Ulfa Amirullah Dachlan	The effectiveness of biofilter and density of different stocking in aquaponic resirculation systems in the integration of tilapia (*Oreochromis niloticus* L.) and pakchoy plants (*Brassica rapa* L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486, Mei Tahun 2020	doi:10.1088/1755-1315/486/1/012137 1	12137
		6	Anggota	Novaty Eny Dungga Syatrianty A. Syaiful A Alfiani Andi Rusdayani Amin Amirullah Dachlan Asmiaty Sahur Rahmansyah Dermawan A Idris	Growth and production of chili (*Capsicum annuum* L.) on the application of Trichoderma sp. and Azolla liquid organic fertilizer	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486, Mei Tahun 2020	doi:10.1088/1755-1315/486/1/012119 1	12119
10	Dr. Ir. Muh. Farid BDR, MP. 19670520 199202 1 001 muhammadfarid235@gmail.com	1	Anggota	Yunus Musa (Ketua) Ifayanti Ridwan Harianto Ponto Ambo Ala Nuniek Widiayani A R Yayank	Application of Arbuscular Mycorrhizal Fungus (AMF) improves the growth of single-bud sugarcane (Saccharum officinarum L.) seedlings from different bud location	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486, Mei, 2020	ISSN: 1755-1315	012122
		2	Ketua	A D Nurazika, Yunus Musa, Rafiuddin, A Rusdayani Amin, Kaimuddin	Evaluation of several tropical wheat genotypes (Triticum aestivum L.) on various water availability in the lowlands	IOP Conf. Series: Earth and Environmental Science	internasional	Published	486, Mei, 2020	ISSN: 1755-1315	012083
		3	Anggota	Nasaruddin (Ketua) Syatrianty A. Syaiful, Ifayanti Ridwan, Katriani Mantja W Utami	Effectiveness of soil tillage and Arbuscular Mycorrhizal (AM) fungi inoculation on fruit development of the cocoa plant (Theobroma cacao L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012118
		4	Anggota	Katriani Mantja (Ketua) Fachirah Ulfa Abdul Mollah A. Rusdayani Amin Ifayanti Ridwan Kasmiati Fitrianti	Effect of Trichoderma and tofu waste based organic fertilizer on the fruit development of chili (Capsicum annuum L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012116
		5	Anggota	Rafiuddin (Ketua) A. Rusdayani Amin Amin Nur Muh. Farid, Bdr. A.T.I. Sari	Evaluation on growth and production of convergent breeding wheat (Triticum aestivum L.) genotypes adaptive to lowland	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012098
		6	Anggota	S A Syaiful (Ketua) M Riadi, F A Mustaman, A R Amin, M Farid BDR, A Mollah, Makmur	Growth and production of South Sulawesi local waxy corn genotypes (Zea mays ceratina L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012099
		7	Anggota	Ifayanti Ridwan (Ketua) Yunus Musa, Sitti Khadijah, Fachirah Ulfa Rinadi Sjahril, Ritabulan	Response of Soybean (Glycine max L.) to Arbuscular Mycorrhizal Fungi (AMF) applied with organic liquid fertilizer	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012114
		8	Ketua	Rafiuddin, A A Laraswati, Ifayanti Ridwan	Testing of lollo rossa lettuce varieties (Lactuca sativa var. crispa) on different ammonium-nitrate ratio in the hydroponic nutrient solution	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 484: Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012094

		9	Ketua	Nasaruddin, Hari Iswoyo, Ifayanti Ridwan Fatimah Arsyad	Analysis of heritability and correlation of agronomic character towards the yield of several m6 generation of wheat mutants (Triticum aestivum L.) in the lowlands	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 484: Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012045
		0	Anggota	Nasaruddin (Ketua) Ifayanti Ridwan, Abdul Mollah, Tigin Dariati, Cri Wahyuni Brahmi Yanti, Nandi K. Sukendar	PERBAIKAN TEKNIS BUDIDAYA KELAPA RAKYAT DI KABUPATEN WAJO	Jurnal Dinamika Pengabdian	akreditasi	Published	Volume 5 Nomor 2 Mei 2020	e-ISSN: 2528-3219	258-270
		10	Ketua	Nasaruddin Ifayanti Ridwan Hari Iswoyo Nurfaida Hatta Jamil,	Pembinaan Kelompok Tani Menjadi Petani Penangkar Benih Unggul Sebagai Upaya Dalam Mengatasi Kelangkaan Benih Padi Di Kecamatan Bengo Kabupaten Bone	Jurnal Dinamika Pengabdian	akreditasi	Published	Vol. 5 No. 2 Mei 2020	p-ISSN: 2460-8173 e-ISSN: 2528-3219	213-226
		11	Anggota	Sri Sudewi (Ketua) Ambo Ala Baharuddin Muh. Farid BDR	The Isolation, Characterization Endhophytic Bacteria from Roots of Local Rice Plant Kamba in, Central Sulawesi, Indonesia	Biodiversitas	internasional	Published	Volume 21, Number 4 April 2020	ISSN : 1412-033X E-ISSn : 2085-4722 DOI : 10.1305/biodiv/vd210442	1614-1624
		12	Anggota	Sri Sudewi (Ketua) Ambo Ala Baharuddin Muh. Farid BDR	Keragaman Organisme Pengganggu Tanaman (OPT) pada Tanaman Padi Varietas Unggul Baru (VUB) dan Varietas Lokal pada Percobaan Semi Lapangan	Jurnal Agrikultura	akreditasi	Published	Volume 31 Nomor 1 2020	ISSN : 0853-2885	15-24
11	Dr. Ir. Amirullah Dachlan, MP. 19560822 198601 1 001 amdachlannn@gmail.com	1	Anggota	Rafiuddin Elkawakib Syam'un Laode Asrul Fachirah Ulfa Susanti	Growth of red dragon fruit seedlings (Hylocereus costaricensis L.) from two sources of cuttings at various concentrations of shallot solutions	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012112	internasional	Published			
		2	Anggota	Novaty Eny Dungga Syatrianty A. Syaiful Rusdayani Amin Asmiaty Sahur R Dermawan A Alfiani	Growth and production of chili (Capsicum annuum L.) on the application of Trichoderma sp. and Azolla liquid organic fertilizer	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012119	internasional	Published			
		3	Anggota	Syatrianty A. Syaiful Ferial	Growth of F0 seedlings of oysters mushroom (Pleurotus ostreatus) with different ages of explants	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012092	internasional	Published			
		4	Anggota	Nurlina Kasim Feranita Haring Fachirah Ulfa Nuniek Widiayani N D P Panggula	Growth and production of Katokkon (Capsicum chinense Jacq) chili plants in lowland applied with gibberellins and liquid organic fertilizer	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012121	internasional	Published			
		5	Anggota	Syatrianty A. Syaiful Fachirah Ulfa F A E Munawarawanti S B A Omar R Syamsuddin	The effectiveness of biofilter and density of different stocking in aquaponic resirculation systems in the integration of tilapia (Oreochromis niloticus L.) and pakchoy plants (Brassica rapa L.)	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012137	internasional	Published			
		6	Anggota	Rinaldi Sjahril A Sakae N Qalby	Colchicine induced polyploidy in Common Ice plant Mesembryanthemum crystallinum L	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012097	internasional	Published			
12	Prof. Dr. Ir. Kaimuddin, M.Si. 19600512 198903 1 003 kaimudin.mole@gmail.com	1	Anggota	Kahar Mustari (Ketua) Laode Asrul, Kaimuddin Lusi Faradilla	Carbon stock analysis of some cocoa planting systems in South Sulawesi	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012085	internasional	Published			
		2	Anggota	Muhidin (Ketua), Syam'Un, E., Kaimuddin, Yusuf, D.N., Rakian, T.C.	Effect of gamma irradiation on harvest date of local upland red rice cultivar	IOP Conf. Series: Earth and Environmental Science	internasional	Published	454	1755-1315	
		3	Anggota	Muh. Farid BDR (Ketua) Nur Azika , Yunus Musa, Kaimuddin, Rafiuddin, A. Rusdayani Amin	Evaluation of several tropical wheat genotypes (Triticum aestivum L.) on various water availability in the lowlands	IOP Conf. Series: Earth and Environmental Science	internasional	Published			
		4	Anggota	F. Zul (Ketua), Kaimuddin, Rafiuddin	Analysis of climate and population dynamics of Conomoporpha cramerella pest in North Luwu	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012084 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	1-8
		5	Ketua	Kaimuddin (Ketua) Rahmansyah Dermawan A R Rahman Elkawakib Syam'un Novaty E. Dungga Cri Wahyuni A Mulawarman	Response of chili (Capsicum annuum L.) to bioslurry fertilization andenrichment of Trichoderma asperellum on planting media	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012115 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	
		6	Anggota	M M Syarif (Ketua), Rismaneswati, Laode Asrul	Strategy for improving sustainable cocoa (Theobroma cacao L) plant productivity in South Sulawesi based on land suitability	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012084 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	
		7	Anggota	A Mollah(Ketua), Kaimuddin, E Hamdi, F Haring, F Ulfa, I Ridwan M Sarif	Enrichment of organic complex compounds of coconut water and mungbean extract in chrysanthemum (Chrysanthemum morfolium L.) tissue culture media	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012084 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	

		8	Anggota	Silke Stöber(Ketua), Amir Yassi, Kaimuddin, Ade Kurniawan, Abdul Mollah, Ifayanti Ridwan, Hari Iswoyo, Rahmansyah Dermawan, Tandu Ramba	Performance of local rice varieties under various organic soil fertility strategies in Toraja, Indonesia	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012084 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	
13	Ir. Nurlina Kasim, M.Si. 19620618 199103 2 001 ninakasimuh@gmail.com	1	Ketua	1. N Kasim (Ketua), 2. Y Musa, 3. K Mustari, 4. S A Syaiful, 5. M Riadi, 6. Rinaldi Sjahril (Anggota) and 7. N Ahyani	Screening of eight mutants of Sinjai lokal red rice (Oryza sativa) to salinity stress	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012089 Tahun 2020	Online ISSN: 1755-1315	1-6
		2	Anggota	1. M. Riadi (Ketua), 2. Rinaldi Sjahril, 3. Maryati, 4. E Syam'un, 5. N Kasim, 6. Rafiuddin, and 7. S Dewi	Growth and production of three rice varieties (Oryza sativa L.) in saline stress condition following halopriming and hydropriming treatment	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315	1-8
		3	Ketua	Kasim, N., Syam'un, E., Taufik, N., Widiayani, N., Indhasari, F.	Response of tomato plant on various concentrations and application frequency of gibberellin	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315	1755-1315
		4	Anggota	F Ulfa, F Haring, M Kanisa, A R Amin, N Kasim and M Farid BDR	Flowering of Chrysanthemum sp. in pot at various concentrations of corn extract and paclobutrazol	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315	1-6
		5	Ketua	Nurlina Kasim Feranita Haring Fachirah Ulfa Nuniek Widiayani N D P Panggula	Growth and production of Katokkon (Capsicum chinense Jacq) chili plants in lowland applied with gibberellins and liquid organic fertilizer	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012121	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315	1-6
14	Dr. Ir. Novaty Eny Dungga, MP. 19591105 198702 2 001 ndungga5@gmail.com	1	Ketua	1. Amirullah Dahlan 2. Syatrianty A. Syaiful 3. Rusdayani Amin 4. Asmiaty Sahur 5. R Dermawan 6. A Alfiani	Growth and production of chili (Capsicum annuum L.) on the application of Trichoderma sp. and Azolla liquid organic fertilizer	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012119	internasional	Published	Volume 486: 012119 Tahun 2020	Online ISSN: 1755-1315	
		2	Anggota	1. N. Buri (Ketua) 2. M. Riadi 3. A Hipi 4. Z Mantau	Gorontalo local rice plant response which planted with the lowland system and upland system	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012155 Tahun 2020	Online ISSN: 1755-1315	1/6/2020
		3	Anggota	1. Tigin Dariati (Ketua) 2. Cri Wahyuni Brahmi Yanti 3. Katriani Mantja 4. Hari Iswoyo 5. D U Zainuddin 6. Firnawati	Planning the upstream agricultural landscape of the Jeneberang watershed using the bioregion approach	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012075 Tahun 2020	Online ISSN: 1755-1315	
		4	Anggota	1. A A Nurnawati (Ketua) 2. F Haring 3. K Osozawa	Leaf growth character of sago palm based on sucker weight at the rosette stage	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012100 Tahun 2020	Online ISSN: 1755-1315	
		5	Anggota	1. Kaimuddin (Ketua) 2. R Dermawan 3. A.R. Rahman 4. E. Syam'un 5. C W B Yanti 6. A Mulawarman	Response of chili (Capsicum annuum L.) to bioslurry fertilization and enrichment of Trichoderma asperellum on planting media	IOP Conf. Series: Earth and Environmental Science	Internasional	Published	Volume 486: 012115 Tahun 2020	Online ISSN: 1755-1315	
15	Dr. Ir. Muh. Riadi, MP. 19640905 198903 1 003 riadimuh64@gmail.com	1	Ketua	1. M. Riadi (Ketua), 2. Rinaldi Sjahril, 3. Maryati, 4. E Syam'un, 5. N Kasim, 6. Rafiuddin, and 7. S Dewi	Growth and production of three rice varieties (Oryza sativa L.) in saline stress condition following halopriming and hydropriming treatment	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315	1-8
		2	Anggota	1. M M Putra (Ketua), 2. M Riadi, and 3. Rinaldi Sjahril	Black rice mutant strain selection results of M3 generation mutation breeding	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012094 Tahun 2020	Online ISSN: 1755-1315	1-5
		3	Anggota	1. S Kannapadang (Ketua), 2. Rinaldi Sjahril, and 3. M Riadi	Characteristic of panicle in M4 red rice mutants	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012090 Tahun 2020	Online ISSN: 1755-1315	1-6
		4	Anggota	1. Lani Pelia (Ketua) 2. M. Riadi, and 3. Rafiuddin	Growth response and yield of several local yam plants with hormax applications	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012128 Tahun 2020	Online ISSN: 1755-1315	1-6
		5	Anggota	1. N. Buri (Ketua) 2. M. Riadi 3. N.E. Dungga 4. A, Hipi, and 5. Z. Mantau	Gorontalo local rice plant response which planted with the lowland system and upland system	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012128 Tahun 2020	Online ISSN: 1755-1315	1-6

		6	Anggota	1. N.N. Andayani (Ketua) 2. M. Riadi, 3. Rafiuddin, 4. S.H. Kalqutny. 5. R. Efendy, and 6. M. Azrai	Evaluation of yield and agronomic components of three-way cross maize hybrids under low-light environment	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 484: 012016 Tahun 2020	Online ISSN: 1755-1315	1-6
		7	Anggota	1. Rinaldi Sjahril (Ketua) 2. Muh. Riadi, 3. Ifayanti Ridwan, 4. Kasmiati, 5. I Suryani, and 6. AR Trisnawaty	Kinship of katokkon chili (Capsicum chinense Jacq.) in Tana Toraja and North Toraja Regencies	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012101 Tahun 2020	Online ISSN: 1755-1315	1-6
		8	Anggota	1. Kasmiati (Ketua), 2, Rinaldi Sjahril, 3. M Riadi, 4. I Ridwan and 5. AR Trisnawaty	The effects of colchicine concentration and soaking time on formation of leaves and roots of katokkon (Capsicum chinense Jacq.) in vitro	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012103 Tahun 2020	Online ISSN: 1755-1315	1-4
		9	Anggota	1. M Darmawan (Ketua), 2. Rinaldi Sjahril, 3. M Riadi, 4. R Asmuliani, 5. A Khairun, and 6. Erse D. Pertiwi	Growth test and production of several local upland rice varieties in Gorontalo Province	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012096 Tahun 2020	Online ISSN: 1755-1315	1-4
		10	Anggota	1. Syatrianty A. Syaiful (Ketua) 2. Muh. Riadi, 3. F A Mustaman, 4. A.R. Amin, 5. M. Farid 6. Abd Mollah, and 7. Makmur	Growth and production of South Sulawesi local waxy corn genotypes (*Zea mays ceratina* L.)	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012099 Tahun 2020	Online ISSN: 1755-1315	1-8
		11	Anggota	1. Nurlina Kasim (Ketua) 2. Y. Musa, 3. K. Mustari, 4. Syatrianty A. Syaiful, 5. M. Riadi, 6. Rinaldi Sjahril, and 7. Nini Ahyani	Screening of eight mutants of Sinjai lokal red rice (Oryza sativa) to salinity stress	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012089 Tahun 2020	Online ISSN: 1755-1315	1-6
		12	Anggota	1. Amir Yassi (Ketua) 2. A. Guricci, 3. Elkawakib Syam'un, 4. M. Riadi, 5.Tigin Dariati, and 6. N. Adyla S.	Growth and production of lowland rice (*Oryza sativa* L.) with water management systems on the application of various combination of fertilizers and planting systems	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012111 Tahun 2020	Online ISSN: 1755-1315	1-9
		13	Anggota	1. A M Okasa (Ketua), 2. M Riadi, 3. K Toriyama, 4. K. Ishii, 5. Y. Hasyashi, 6. T Sato, 7. T Abe, 8. Trisnawaty, 9. N J Panga and 10.Rinaldi Sjahril.	Mutation breeding for improvement of aromatic rice mutant by using ion beam irradiation	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012090 Tahun 2020	Online ISSN: 1755-1315	1-5
16	Dr. Ir. Amir Yassi, M.Si. 19591103 199103 1 002 amiryassi11@gmail.com	1	Ketua	Amir Yassi Kaimuddin Abd Haris B Asmiaty Sahur	Study of Climate Determination Analysis Based On Pallontara / Papananrang and Rainfall Opportunities in Sidrap District	IOP Conference Series: Earth and Environmental Science	internasional	Published	279 (2019) 012052	doi:10.1088/1755-1315/279/1/012052	12052
		2	Ketua	A. Guricci, Elkawakib Syam'un, M. Riadi, Tigin Dariati, and N. Adyla S.	Growth and production of lowland rice (*Oryza sativa* L.) with water management systems on the application of various combination of fertilizers and planting systems	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012111 Tahun 2020	Online ISSN: 1755-1315	1-9
17	Ir. Asmiaty Sahur, MP. 19691010 199303 2 001 asmiatyasmiaty@gmail.com	1		Asmiaty Sahur Muthmainnah	Growth response of pepper (Piper nigrum L.) on application Arbuscular Mycorrhizal Fungi (AMF) and the shallot filtrate	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012130
		2	Anggota	Amir Yassi Kaimuddin Abd Haris B Asmiaty Sahur	Study of Climate Determination Analysis Based On Pallontara / Papananrang and Rainfall Opportunities in Sidrap District	IOP Conference Series: Earth and Environmental Science	internasional	Published	279 (2019) 012052	doi:10.1088/1755-1315/279/1/012052	12052
		3	Anggota	Aminah Marlina S Palad Asmiaty Sahur	Drought Level of Several Soybean's Variety (Glycine Max L Merril)	IOP Conference Series: Earth and Environmental Science	internasional	Published	484 (2020)	doi:10.1088/1755-1315/279/1/012037	12037
18	Ir. Hj. A. Rusdayani Amin, MS. 19561211 198503 2 001	1	Ketua	1. Amirullah Dahlan 2. Syatrianty A. Syaiful 3. Rusdayani Amin 4. Asmiaty Sahur 5. R Dermawan 6. A Alfiani	Growth and production of chili (Capsicum annuum L.) on the application of Trichoderma sp. and Azolla liquid organic fertilizer	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012119	internasional	Published	Volume 486: 012119 Tahun 2020	Online ISSN: 1755-1315	
		2	Anggota	Katriani Mantja (Ketua) Fachirah Ulfa Abdul Mollah A. Rusdayani Amin Ifayanti Ridwan Kasmiati Fitrianti	Effect of Trichoderma and tofu waste based organic fertilizer on the fruit development of chili (Capsicum annuum L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486, Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	012116

		3	Anggota	Syatrianty A Syaiful Muh. Riadi, Faizal A Mustaman, A Rusdayani Amin, Muh Farid BDR, Abdul Mollah, Makmur	Growth and production of South Sulawesi local waxy corn genotypes (Zea mays ceratina L.)	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: Mei Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707 doi:10.1088/1755-1315/486/1/012099 1	012099
		4	Anggota	Novaty E Dungga Amirullah Dahlan Syatrianty A. Syaiful A. Rusdayani Amin Asmiaty Sahur Rahmansyah Dermawan A Alfiani	Growth and production of chili (Capsicum annuum L.) on the application of Trichoderma sp. and Azolla liquid organic fertilizer	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012119	internasional	Published	Volume 486: 012119 Tahun 2020	Online ISSN: 1755-1315	
19	Ir. Rinaldi Sjahril, M.Agr, P.hD. 19660925 199412 1 001 rinaldi.sjahril@gmail.com	1	Ketua	1.Trisnawaty A. R 2. Muhammad Riadi 3. Rafiuddin 4. Tadashi Sato 5. Kinya Toriyama 6. Yoriko Hayashi 7. Tomoko Abe	Selection of Early Maturing and High Yielding Mutants of Toraja Local Red Rice Grown from M2-M3 Population after Ion Beam Irradiation	Hayati Journal of Bioscience	internasional	Published	Vol. 27 No. 2	ISSN: 1978-3019 EISSN: 2086-4094	166-173
		2	Ketua	1. Muh. Riadi, 2. Ifayanti Ridwan, 3. Kasmiati, 4. I Suryani and 5. AR Trisnawaty	Kinship of katokkon chili (Capsicum chinense Jacq.) in Tana Toraja and North Toraja Regencies	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012101 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-6
		3	Anggota	1. A P Hanifa (Ketua), 2. J P Millner, 3. C R M Mc Gill and 4. Rinaldi Sjahril (Anggota)	Total anthocyanin, flavonoid and phenolic content of pigmented rice landraces from South Sulawesi.	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 484: 012036 Tahun 2020	"Online ISSN: 1755-1315 Print ISSN: 1755-1307"	1-8
		4	Anggota	1. Muh. Riadi (Ketua), 2. Rinaldi Sjahril (Anggota), 3. Maryati, 4. E Syam'un, 5. N Kasim, 6. Rafiuddin and 7. S Dewi	Growth and production of three rice varieties (Oryza sativa L.) in saline stress condition following halopriming and hydropriming treatment	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012117 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-8
		5	Anggota	1. Ifayanti Ridwan (Ketua), 2. Y Musa, 3. S Khadijah, 4. M Farid, 5. Rinaldi Sjahril (Anggota), 6. F Ulfa and 7. Ritabulan	Response of Soybean (Glycine max L.) to Arbuscular Mycorrhizal Fungi (AMF) applied with organic liquid fertilizer	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012114 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-7
		6	Anggota	1. Kasmiati (Ketua), 2, Rinaldi Sjahril (Anggota), 3. M Riadi, 4. I Ridwan and 5. AR Trisnawaty	The effects of colchicine concentration and soaking time on formation of leaves and roots of katokkon (Capsicum chinense Jacq.) in vitro	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012103 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-4
		7	Anggota	1. Feranita Haring (Ketua), 2. S Rantetandung, 3. M Riadi, 4. Rafiuddin and 5. Rinaldi Sjahril (Anggota)	Selection of purification and formation of double haploid Toraja endemic black rice through anther culture	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012102 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-6
		8	Anggota	1. N Qalby (Ketua), 2. R Sjahril (Anggota), 3. A Dachlan and 4. A Sakae	Colchicine induced polyploidy in Common Ice plant Mesembryanthemum crystallinum L	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012097 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-8
		9	Anggota	1. M Darmawan (Ketua), 2. Rinaldi Sjahril (Anggota), 3. M Riadi, 4. R Asmuliani, 5. A Khairun and 6. Erse D. Pertiwi	Growth test and production of several local upland rice varieties in Gorontalo Province	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012097 Tahun 2021	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-4
		10	Anggota	1. M M Putra (Ketua), 2. M Riadi and 3. Rinaldi Sjahril (Anggota)	Black rice mutant strain selection results of M3 generation mutation breeding	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012094 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1307	1-5
		11	Anggota	1. A M Okasa (Ketua), 2. M Riadi, 3. K Toriyama, 4. K. Ishii, 5. Y. Hasyashi, 6. T Sato, 7. T Abe, 8. Trisnawaty, 9. N J Panga and 10.Rinaldi Sjahril (Anggota)	Mutation breeding for improvement of aromatic rice mutant by using ion beam irradiation	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012090 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1308	1-5
		12	Anggota	1. S Kannapadang (Ketua), 2. Rinaldi Sjahril (Anggota) and 3. M Riadi	Characteristic of panicle in M4 red rice mutants	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012090 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1309	1-6

		13	Anggota	1. N Kasim (Ketua), 2. Y Musa, 3. K Mustari, 4. S A Syaiful, 5. M Riadi, 6. Rinaldi Sjahril (Anggota) and 7. N Ahyani	Screening of eight mutants of Sinjai lokal red rice (Oryza sativa) to salinity stress	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012089 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1310	1-6
		14	Anggota	1. Suhardi (Ketua), 2. M T Sapsal, 3. Rinaldi Sjahril (Anggota) and 4. Samsuar	Effect of canopy cover level on solar radiation for conservation plant photosynthesis under the stand of cocoa plants	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012062 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1311	1-6
		15	Anggota	1. D R Sari (Ketua), 2. L Asrul, 3. Rinaldi Sjahril (Anggota), and 4. K Osozawa	Path coefficient analysis for growth characters of sago palm related to trunk formation at three years after transplanting	IOP Conference Series: Earth and Environmental Science	internasional	Published	Volume 486: 012010 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1312	1-7
		16	Ketua	1. Irma Jamaluddin 2. Asman 3. Marhamah Nadir	Uji Ketahanan Penyakit Karat Putih Pada Tanaman Krisan Transgenik Putatif Secara In Vitro	Prosiding Seminar Nasional Fakultas Pertanian Universitas Mataram	non akreditasi	Published	Cetakan Pertama, Maret 2020	ISBN: 978-623-7608-50-9	319-325
20	Dr. Ir. Katriani Mantja, MP. 19660421 199103 2 004 katrianimantja@gmail.com	1	Ketua	M Farid BDR Fachirah Ulfa Abdul Mollah A. Rusdayani Amin Ifayanti Ridwan Saleh Kasmiati Fitrianti	Effect of Trichoderma and tofu waste based organic fertilizer on the fruit development of chili (Capsicum annuum L.)	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012116	internasional	Published			
		2	Anggota	Nasaruddin Syatrianty A. Syaiful M Farid BDR Ifayanti Ridwan Saleh W Utami	Effectiveness of soil tillage and Arbuscular Mycorrhizal (AM) fungi inoculation on fruit development of the cocoa plant (Theobroma cacao L.)	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012118	internasional	Published			
		3	Anggota	Tigin Dariati Cri Wahyuni Brahmi Yanti Novaty Eny Dungga Hari Iswoyo D U Zainuddin Firnawati	Planning the upstream agricultural landscape of the Jeneberang watershed using the bioregion approach	IOP Conf. Series: Earth and Environmental Science 486 (2020) 012075	internasional	Published			
		4	Anggota	Rahmansyah Dermawan Ifayanti Ridwan Saleh Hari Iswoyo St Salmiati	Pengendalian Kejadian Gugur Bunga dan Buah dengan Aplikasi Indole Acetic Acid (IAA), Indole Butyric Acid (IBA) dan GA3 pada Tanaman Cabai (Capsicum annuum L.)	Agrosainstek	akreditasi	Published	4 (1) 2020	PISSN : 2615-2207 EISSN : 2579-843X	35-40
		5	Anggota	Muh. Farid BDR Nasaruddin Ifayanti Ridwan Hari Iswoyo Nurfaida Hatta Jamil,	Pembinaan Kelompok Tani Menjadi Petani Penangkar Benih Unggul Sebagai Upaya Dalam Mengatasi Kelangkaan Benih Padi Di Kecamatan Bengo Kabupaten Bone	Jurnal Dinamika Pengabdian	akreditasi	Published	Vol. 5 No. 2 Mei 2020	p-ISSN: 2460-8173 e-ISSN: 2528-3219	
		6	Anggota	Katriani Mantja Slamet Abd. Haris B Andarias	Induction of Lili Hujan polyploid (Zephyranthes rosea Lindl.) with ethanolic extract of Tapak Dara leaf (Catharanthus roseus (L.) G. don.) to increase its economic value	IOP Conference Series: Earth and Environmental Science	internasional				
		7	Anggota	Abd. Haris B Suhesty Pongkendek	Response of determinate and semi-determinate soybean on dolomite liming	IOP Conference Series: Earth and Environmental Science	internasional				
21	Dr. Ir. Abd. Haris B., M.Si. 19670811 199403 1 003 harisbahrun99@gmail.com	1	Ketua	Katriani Mantja Suhesty Pongkendek	Response of determinate and semi-determinate soybean on dolomite liming	IOP Conference Series: Earth and Environmental Science	internasional				
		2	Anggota	Cri Wahyuni N S Nafsi Rafiuddin Rahmansyah Dermawan Abdul Mollah A Arafat	Response of kale (Brassica alboglabra L.) to various planting media and application of liquid inorganic nutrition in DWC (deep water culture) hydroponic systems	IOP Conf. Series: Earth and Environmental Science	internasional				
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22	Cri Wahyuni Brahmi Yanti, SP., M.Si. 19690412 199703 2 001 criwahyuni88@gmail.com	1	Anggota	Tigin Dariati (Ketua) Katriani Mantja Novaty Eny Dungga Hari Iswoyo D U Zainuddin Firnawati	Planning the upstream agricultural landscape of the Jeneberang watershed using the bioregion approach	IOP Conf. Series: Earth and Environmental Science	internasional	Published	Volume 486: 012075 Tahun 2020	Online ISSN: 1755-1315 Print ISSN: 1755-1707	

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24–25 October 2017

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In vitro sterilization technique on embryo of black Toraja rice

In vitro sterilization technique on embryo of black Toraja rice

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Abstract. Toraja black rice has a high anthocyanin content, a water-soluble pigments, with antioxidant activity. Toraja black rice has a variety of seeds colour in one panicles such as full black (the outside and inside the rice), medium black (the outside and slightly inside rice) and a little black (only the outside of rice). Embryo culture in vitro is one way to grow plants in sterile conditions. The presence of contamination and the death of the embryo require *in vitro* embryo culture. The sterilization technique is a very important first step to eliminate contamination and the death of embryos. This research aims to determine the right material composition for sterilization of black rice's embryo. The experiment was done by growing black rice on half strength MS media with the treatment of three method of sterilization, *i.e.*: S1 (70% alcohol for 5 minutes, 3% and 2% Chlorox each for 10 minutes,), S2 (70% alcohol for 3 minutes, 2% Clorox for 10 minutes) and S3 (70% alcohol for 3 minutes and 1% Clorox for 15 minutes). The materials used are rice seedlings that have been cut in two and opened the pericarp of paddy grain, leaving a piece of rice that has a complete embryo. The best sterilization for Toraja black rice embryo culture was using the S3 composition. Best germination was seen on the seeds with full and medium black color.

1. Introduction

Black rice from Toraja District / North Toraja region, has a unique phenotype character. A dark purple color that makes this rice looks black at a glance, caused by high anthocyanin content. Anthocyanins are water-soluble pigments, which have antioxidant activity. Black rice is known to increase the body's resistance to disease, repair damaged liver cells, prevent renal function, prevent cancer / tumor, slow aging, as an antioxidant, clean cholesterol in the blood, and prevent anemia [1, 2].

Black rice in Indonesia is predominantly derived from local rice from various regions. One of the areas in Indonesia that has a variety of local rice is South Sulawesi. Local rice is a major source of genetic diversity in rice breeding efforts, especially black rice. One of the local rice varieties used for generations as part of the tradition, ritual and culture of the community is black rice (Pare Ambo) from Toraja District / North Toraja District.

The productivity of local paddy especially Toraja black rice is still low. BPS data [3] noted that local rice productivity in the country of 3.99 tons ha^{-1} is much lower than that of paddy field productivity of 5.26 tons ha^{-1}. Other shortcomings due to black Toraja rice have a deep age, ranging from 5-6 months [4]. This cause the black rice is less developed in a broad scale.

In addition, Toraja black rice has a very low level of purity, to be used as a source of genetic diversity. Preliminary studies have been done, indicating that at one panicle there were different colors of seeds.

Some black seeds are black in whole (the outside and in the rice), others are medium black (the outside and slightly inside the rice) and are black in color (only the outside of the rice). In vitro culture has been widely used for the development of plant food cultivation. In plant breeding, embryo rescue culture applications are expected to maintain their integrity and grow into new plants [5]. One of the most widely used in vitro culture techniques is embryo culture, because embryo culture is one of the earliest studies to obtain plants that are free from contamination of microorganisms.

Through embryo culture, early embryo development can be studied. In the field of plant breeding, embryo culture can speed up the hybridization cycle [6]. The choice of embryos as explants due to the availability of seeds, has a high physiological uniformity and can be carried over time and at considerable distance [7].

One obstacle in the process of embryo culture in vitro is contamination. The sterilization technique is a very important first step to eliminate contamination and the death of embryos in *in vitro* cultures. In addition it is expected that sterilization does not change the color of black rice rice.

2. Materials and methods

2.1. Place and Time

The research was conducted at the Laboratory of Plant Biosciences and Reproduction Biotechnology, Department of Agronomy, Faculty of Agriculture, Hasanuddin Universit, Makassar. The study took place from April to November 2017.

2.2. Materials

Black rice seed of Pare Ambo variety was obtained from farmers survey in Ao 'Gading Toraja Utara, inorganic and organic material components for the manufacture of Murashige and Skoog (MS) media, clorox and alcohol.

2.3. Implementation of Research

There were two goals in this experiment. First experiment was carried out by testing kinds of sterilization technique for Toraja's black seed and the second experiment was to see germination performance of black seeds of Toraja.

2.3.1. Experiment 1. Preparation of materials. The seeds used were peeled Toraja black rice seeds cut crosswise into two parts to see the color within the endosperm. The part used was the embryo half pieces. Peeling and cutting the seed were conducted to select and classify seeds based on the same color criteria. The pieces are grouped into three sections of the rice color level: the full black (HP) (black on the surface and inside of the rice), the medium black (HM) (black on the surface and slightly inside the rice) and the black one (HS) (black only the surface of the rice) (figure 1). The seeds of embryo half pieces are grown in vitro on ½ MS germination medium after a sterilization process.

Figure 1. Cross-section of black rice seeds of Toraja (a) Black rice seeds with black color (HS), (b) Black rice seeds with medium black color (HM), and (c) Black rice seeds with full black color HM).

Sterilization was performed with three sterilization sequence treatments based on the materials used. Treatment of S1 was done by sterilizing rice explants consecutively using 70% alcohol for 5 minutes, rinsed with sterile distilled water 3 times, then soak in 3% Chlorox solution for 10 minutes, rinsed again with sterile distilled water for 3 times, continued with immersion in 2% Chlorox for 5 minutes and finally rinsed with again with sterile distilled water 3 times. Sterilization S2 treatment with 70% alcohol for 1 minute, rinsed with sterile distilled water 3 times, followed by 2% Chlorox solution for 10 minutes, and finally rinsed with sterile aquades 3 times. S3 sterilization treatment using 70% alcohol for 3 minutes, then rinsed with sterile distilled water 3 times, followed by 1% clorox for 15 minutes, and finally rinsed with sterile distilled water 3 times. Quantitative and qualitative observations were made on the color of cut seeds with embryo part after sterilization process.

2.3.2. Experiment 2. Preparation of materials. The second experiment was based on the first experiment. Seed materials used were black rice seeds of Toraja black rice which have the embryo part and are full black rice (surface and inside of part rice), medium black (surface and slightly inside of part rice) and thin black (only the surface of rice). Half-cut seeds were further planted in vitro on germination medium ½ MS after going through the sterilization process. The sterilization process is based on the best results of the first experiment. Quantitative observations include observing the number of days required to begin germination (day), and the length of the plumula (cm).

2.4. Methods and Analysis

The embryo culture in the laboratory consists of three treatment of sterilization sequence based on the materials used are S1, S2 and S3. Treatment S1 is a sequence of sterilization using alcohol 70% for 5 minutes, Chlorox 3% for 10 minutes and Chlorox 2% for 5 minutes. The treatment of S2 is sterilization with alcohol 70% for 1 minute and Chlorox 2% for 10 minutes. S3 treatment using alcohol 70% for 3 minutes and Chlorox 1% for 15 minutes. To know the difference of treatment, data was analysis by test of two middle value in pairs.

3. Result and discussion

3.1. Result

3.1.1. Sterilization experiment of black rice embryo. Table 1 shows germination of Toraja black rice embryo in combination treatment of sterilization composition. The results of the experiment showed that each sterilization sequence technique can be used for sterilization of black Toraja rice with different germination rates. This can be seen from the absence of contaminants in the culture. The best sterilization composition for black rice embryo culture is S3 sterilization composition with 93% germination.

Table 1. Germination of black rice embryo of Toraja on treatment of combination of chemical sterilization composition.

Sterilization composition	S1 (73)	S2 (80)	S3 (93)
S1 (73)	0.0	7.0 ^{ns}	20.0 ^{ns}
S2 (80)	7.0^{ns}	0.0	13.0 ^{ns}
S3 (93)	20.0 ^{ns}	13.0 ^{ns}	0.0

( ) = Presentation of embryo germination (%)
^{ns} = Not significantly different

3.1.2. Black rice rice seed culture. Rice seeds of black rice Toraja result of embryo culture that has germinated, will grow and develop plantlet. The germination of black rice seeds of Toraja with HM and HP color character is better than HS (figure 2). The time it takes seeds to start germinating gives a difference to the average length of the planlet plumula on the three colors of the seed. The average length of plumula from a small black seed (HS) is 1.1 cm, medium black average length of 1.8 cm and full black average length of 1.7 cm (table 2).

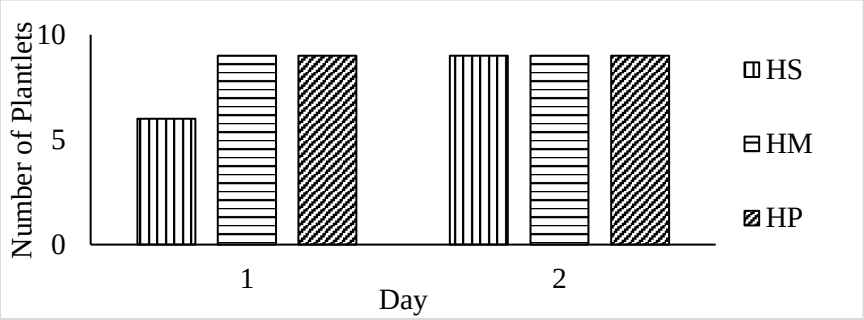

Figure 2. The germination of black rice seeds of Toraja rice is the result of embryo culture.

Table 2. The average length of black rice plumula of Toraja resulting from embryo culture at 7 days after culture.

The color of embyo	HS (1.1)	HM (1.8)	HP (1.7)
HS (1.1)	0.0	0.7 ^{ns}	0.6 ^{ns}
HM (1.8)	0.7^{ns}	0.0	0.1 ^{ns}
HP (1.7)	0.6 ^{ns}	0.1 ^{ns}	0.0

$^{()}$ = The average length of plumula (cm)
^{ns} = Not significantly different

3.2. Discussion

The first experiment was conducted by determining the exact order of sterilization materials for the sterilization of the black rice embryo of Toraja. The composition of the sterilizing agent is one of the main keys in tissue culture. The materials often used for wet sterilization are alcohol and chlorox. Alcohol is a suitable sterilizing agent but also very toxic to plants. Therefore, explant is usually exposed for several seconds or minutes [8].

Chlorox compounds are commonly used as a disinfectant or bleach. This compound is very effective in killing bacteria and viruses, cleaning microorganisms that are embedded in plant material, removing soil particles, dust and others. In plant tissue culture techniques, this compound is commonly used as a sterilizing agent of plant tissue surfaces [9, 10]. The use of Chlorox as a surface sterilizing agent from various sources of plant explants has been widely reported [11, 12, 13, 14, 15, 16].

The concentration and time of using Chlorox solution per explant vary. So with the right concentration and time of exposure, because the less Chlorox concentration the explants are more susceptible to the pathogen, but if the higher concentration of Chlorox the development of tissue explant become obstructed [17]. It is seen that by using S3 composition, the color of black rice seed did not fade Unlike the sterilization using material composition S1 and S2 (figure 3).

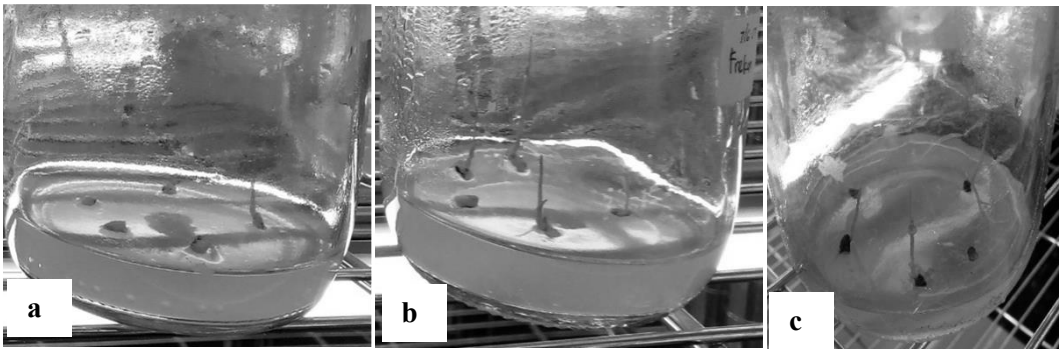

Figure 3. Culture of black rice embryo with different sterilization composition. (a) Composition S1, (b) S2 Composition, and (c) S3 Composition.

The process of seed germination is a complex sequence of physiological, morphological and biochemical changes. In the case of germination of black rice seeds of Toraja, the seeds that have a darker black color (black medium and black full) more quickly experience the germination process. We suspected thickness of the aleouron, cause faster enzyme activity, resulting in the hormone to work faster. This growth hormone activity that triggers the germination of black rice seeds Toraja faster.

The concentration and duration of seed immersion in the Chlorox solution, caused the black color of the rice seed to fade. In addition, the Chlorox solution and the composition of the sterilizing agent can also cause damaged embryos, browning, unable to grow and thrive in a culture bottle and eventually die.

4. Conclusion

The black rice seeds of Toraja have three color characteristics: black full (outside and inside of rice) (HP), medium black (outside and slightly inside rice) (HM), and thin black (only the outside of rice) (HS). The best sterilization for black rice embryo embryo culture Toraja using S3 sterilization sequence (Alcohol 70% for 10 minutes and Chlorox 1% for 5 minutes). Toraja black rice rice embryo culture on MS medium has succeeded in growing a sterile plantlet, with best growth in plantlet from seeds with medium black and black color.

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