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Seed Quality of Paddy Variety (O*ryza sativa* L.) Resistant to Vegetative Phase Drought Stress

Kualitas Benih Varietas Padi (*Oryza sativa L.*) *yang Tahan Cekaman Kekeringan Fase Vegetatif*

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ABSTRAK

Kekeringan termasuk cekaman abiotik yang dapat mempengaruhi hasil padi dengan cara menghambat pertumbuhan sehingga berdampak menurunkan kualitas benih yang dihasilkan. Penelitian ini bertujuan untuk menentukan kualitas benih terbaik dari beberapa varietas padi yang dihasilkan dari tanaman yang mengalami cekaman kekeringan pada fase vegetatif. Varietas yang digunakan dalam penelitian adalah Inpago 12, Unsoed 1, Inpago 4, Inpago 5, Inpago 9, Inpago 8, Inpago 10, Inpara 8, Inpara 9, Rindang 1, Rindang 2, Situ Patenggang, Towuti, dan Batu Tegi. Cekaman kekeringan diberikan pada fase vegetatif tanaman dengan cara pengurangan intensitas pemberian air (kadar air 63,5%), kemudian benih yang dihasilkan diuji dilaboratorium. Hasil penelitian menunjukkan bahwa nilai kualitas benih ter tinggi pada perlakuan cekaman kekeringan fase vegetatif, yaitu pada varietas Inpara 8 kemudian diikuti varietas Towuti dengan masing-masing nilai daya berkecambah 93,33% dan 88%, keserempakan tumbuh 82,67% dan 70%, kecepatan berkecambah 12,11% dan 8,44%, kekuatan berkecambah 64% dan 64%, dan indeks vigor 18,99 dan 16,83, sedangkan, kualitas benih terendah, pada varietas Inpago 8 dengan nilai daya berkecambah 26%, keserempakan tumbuh 21,33%, kecepatan berkecambah 1,33%, kekuatan berkecambah 3,33%, dan indeks vigor 2,71. Di antara semua varietas yang diuji, Inpara 8 dan Towuti merupakan varietas yang memiliki nilai kualitas benih terbaik setelah mengalami cekaman kekeringan pada fase vegetatif.

Kata kunci: cekaman kekeringan, padi, kualitas benih

ABSTRACT

Drought is an abiotic stress that can affect paddy yields by inhibiting growth, thereby reducing the quality of the seeds produced. This study aimed to find out the best seed quality of several paddy varieties produced from the plants experiencing drought stress in the vegetative phase. The varieties used in the study were Inpago 12, Unsoed 1, Inpago 4, Inpago 5, Inpago 9, Inpago 8, Inpago 10, Inpara 8, Inpara 9, Rindang 1, Rindang 2, Situ Patenggang, Towuti, and Batu Tegi. The drought stress was applied to the vegetative phase of the plant by reducing the intensity of water supply (63.5% moisture content), then the resulting seeds were tested in the laboratory. The results of the study showed that the highest seed quality value in the drought stress treatment of the vegetative phase were the Inpara 8 variety, followed by the Towuti variety with 93.33% and 88% germination values, 82.67% and 70% simultaneous growth, 12.11% and 8.44% germination rate, 64% and 64% germination strength, and 18.99 and 16.83 vigor indexes. Meanwhile, the lowest seed quality was the Inpago 8 variety with 26% germination value, 21.33% simultaneous growth, 1.33% germination speed, 3.33% germination strength, and 2.71 vigor index. Among all the varieties tested, the Inpara 8 and Towuti are those with the best seed quality values after experiencing drought stress during the vegetative phase.

Key words: drought stress, paddy, seed quality

INTRODUCTION

South Sumatra is a region that has suboptimal land divided into dry land and alkaline land. There are 5.27 million ha of dry land in South Sumatra and 4.14 million ha can be used for agricultural activities (Mulyani & Hidayat, 2009). However, the main obstacle for agricultural activities on dry land is the limited water that occurs throughout the year which can cause a decrease in crop production in the area (Khalimi & Kusuma, 2018). In paddy, the drought is an abiotic stress that affects yield by inhibiting growth (Nasrudin and Firmansyah, 2020). The main response made by the plants during the drought is physiological changes, followed by morphological changes.

These changes include decreased growth, biomass weight, and yield components (Sujinah & Jamil, 2016). In the vegetative phase, the drought inhibits leaf growth so that the shape of the leaves is narrow and root growth is limited causing the roots to get shrunk (Hariyono, 2014). This results in a small number of tillers and a small number of panicles per clump. Furthermore, the drought in this phase interferes with initiation of seed replenishment causing a high percentage of empty grain because the plant enters the late flowering phase (Afrianingsih, Susanto and Ardiarini, 2018) and the plant's photosynthate yield decreases due to lack of water (Subantoro, 2014). It is suspected that this can reduce the quality of the seeds. The quality seeds are needed for the next growing season so that during the cultivation process, optimum environmental conditions are needed, such as nutrient requirements (Tando, 2018) and sufficient water to support the plant growth and development (Kurniawan and Fajriani, 2014). If all the seed quality is high, the plant will grow strong and the crop production will be high (Oktaviana, Ashari and Purnamaningsih, 2016).

There are two ways to solve the problem of drought stress, namely by changing the environment so that the stress can be minimized and improve plant genotypes so that they are resistant to the drought stress (Sihombing, Damanhuri and Ainurrasjid, 2017). The plant genotype improvement can be done through plant breeding activities (Wirnas et al., 2012). The drought-resistant adaptive paddy genotype selection is one way to anticipate the impact of drought on paddy (Serraj et al., 2015). Through the transgenic selection approach, the genes are identifiable and used to improve drought tolerance (Oladosu et al., 2019). The expression of genes in paddy cultivars was carried out to see whether the plants were resistant to environmental stress (Madabula et al., 2016). A total of 89 WRKY genes in Japonica and 97 WRKY genes in *O. nivara* have been identified as genes that are resistant to environmental stress, especially the drought (Sahebi et al., 2018).

However, the breeding activity through gene insertion is expensive and difficult for farmers who plant in the field. An easier and more economical way is to find out the quality of paddy variety seeds produced from the plants that experience drought stress during the cultivation, so that it can provide an overview of plant varieties that are drought-resistant in the next growing season. Currently, there are no reports on the quality of paddy seeds produced by the plants experiencing drought stress. This study provides information on varieties that have the best seed quality after experiencing drought stress during the vegetative phase during the plant cultivation. The research objective was to determine the best seed quality of several paddy varieties produced from the plants experiencing the drought stress in the vegetative phase.

MATERIALS AND METHODS

The study has been carried out at the Seed Technology Laboratory, Agronomy Study Program, Faculty of Agriculture, Sriwijaya University, Indralaya, South Sumatra, Indonesia from December 2019 to January 2020. The temperature in the Laboratory was 23 ºC room temperature with 62% relative humidity.

Seed Production in the Field

Seed production was already carried out in Indralaya paddy field, Faculty of Agriculture, Sriwijaya University, Ogan Ilir District, South Sumatra Province, Indonesia, from August to December 2019. The varieties used in this study were Inpago 12, Unsoed 1, Inpago 4, Inpago 5 , Inpago 9, Inpago 8, Inpago 10, Inpara 8, Inpara 9, Rindang 1, Rindang 2, Situ Patenggang, Towuti, and Batu Tegi. The seeds were obtained from the Center for Paddy Research, Sukamadi, Subang, West Java.

Land Preparation

The land used was cultivated using a hand tractor in order to clean up previous crop residues. The land used was a paddy field plot measuring 7 m x 11 m. The plot was divided into two subplots, the first subplot was control treatment and the second one was drought stress treatment.

Preparation of Planting Material

The seeds were soaked in water for 24 hours; the floating seeds were removed. Furthermore, the seeds that already appeared radicles were sown in the tray for 14 days.

Planting

After sowing, the plants were transferred to the drought stress and control plots. Seedlings were planted with a spacing of 25 cm x 25 cm (Rahmah & Aswidinnoor, 2014).

Drought Stress Treatment

Before the drought stress treatment was carried out, a plastic housing was made on the two plots to prevent water from entering the plot except for the water provided (Figure 1). In the drought stress plot, a barrier was built using plastic fiber as high as 100 cm, with 30 cm was inside the soil around the plot, while in the control plot, the barrier around it only used waring.

In the first week of transplanting, the water supply of the two plots was the same to adjust the plants after sowing. The drought stress started at the age of 21-56 days (35 days of the drought stress). Meanwhile, in the control plot, the irrigation was still carried out every day (Figure 1).

The implementation of drought stress was carried out by reducing the intensity of irrigation, on the stress plots, the irrigation was carried out every 3 days with the final calculation of soil water content during the drought stress treatment which was 63.5%, while the soil water content in the control was 100% (field capacity). The irrigation was carried out until the plot got wet. On the 57th day, when the plants started to enter the generative phase, the plants in the drought stress plot were watered every day like those in the control plot until the harvest time (Figure 1).

Maintenance

Maintenance included cleaning weeds, replanting the dead plants, NPK fertilizing, and controlling pests using insecticides.

Harvesting

Harvesting was carried out simultaneously on all plots at the age of 108 days, except for Inpara 9 on the 115 days. After harvesting, the seeds were directly sun-dried in a greenhouse for 5 days.

Storage of Seeds

Seed storage was conducted by packing the seeds into ethylene plastic (Sari & Faisal, 2017) and placing them in a brown envelope. The seeds were stored for 15 days beforehand because the paddy seeds have an after ripening period (dormancy after harvest) (Tefa, 2017a).

Testing the Water Content of the Seed

The moisture content of the seeds was tested twice, first after harvesting, and secondly after drying. The moisture content of the seeds was calculated by taking 50 samples of paddy seed grains in each variety.

Seed Testing

The seed testing used 50 grains of paddy seeds (Lesilolo, Riry and Matatula, 2013), which were placed on three layers of paddy straw measuring 30 cm x 20 cm, then the top of the seeds was covered again with two layers of paddy straw (Utomo, Nababan and Pramono, 2012), previously the paddy straw had been given distilled water until it got moist.

Then the straw was rolled according to the sprout test method using the established Rolled Paper Test (UKDd) (Halindra and Linda, 2017). The coils were then placed in an IPB 72-1 germinator. The experiment used was a Completely Randomized Design (CRD) factorial pattern with 3 replications, the first factor was the difference in water content during the plant cultivation (control and drought stress), the second factor was paddy varieties (Inpago 12, Unsoed 1, Inpago 4, Inpago 5, Inpago 9, Inpago 8, Inpago 10, Inpara 8, Inpara 9, Rindang 1, Rindang 2, Situ Patenggang, Towuti, and Batu Tegi).

Vigor Observation and Seed Viability

Observations included germination capacity (%), uniformity of growth (%), germination rate (%), germination strength (%), germination index, normal germination dry weight (g), radicle length (cm), plumule length (cm) and sprouts vigor index. Each observation, the roll of paddy straw was opened and the number of seeds germinating normally was counted according to the observed parameters. Radicles were measured using a ruler from the base of the roots to the tips of the roots and plumules from the base of the plumules to the tips of the plumules, the samples were taken from 10 normal sprouts on a roll of paddy straw. The observations were made at 08.00-10.00 am. During the germination period, the roll of paddy straw was moistened with distilled water using a hand sprayer every day to keep it moist.

Data Analysis

To compare the results of seed quality on control treatment and drought stress, the data analysis was carried out using the t-Test with the IBM SPSS Statistics 23 application.

RESULTS

Seed Moisture Content

The value of seed moisture content at harvest the with control treatment and drought stress showed the different mean percentages for each plant variety (Figure 2), as well as the yield of seed moisture content after drying (Figure 3). The result of the study showed that the moisture content obtained had three patterns, namely the control value being greater than the drought stress, the control value being almost the same as the drought stress, and the control value being smaller than the drought stress. The yield of harvest water content with a control value greater than the drought stress was in the varieties Inpago 5, Inpara 8, Inpara 9, Situ Patenggang and Batu Tegi.

The moisture content value of the control was almost the same as the drought stress in the varieties of Inpago 12, Inpago 4, Inpago 10 and Rindang 1. The moisture content value of the control was smaller than the drought stress, that is Unsoed 1, Inpago 9, Inpago 8, Rindang 2 and Towuti varieties (Figure 2). Meanwhile, the results of water content after drying with the control water content value greater than the drought stress, were Unsoed 1, Inpago 10, Situ Patenggang, Towuti and Batu Tegi varieties. The moisture content value of the control was almost the same as the drought stress in Inpago 5, Inpara 9, Rindang 1 and Rindang 2 varieties. The moisture content value of the control was smaller than the drought stress, namely the Inpago 12, Inpago 4, Inpago 9, Inpago 8 and Inpara 8 varieties (Figure 3).

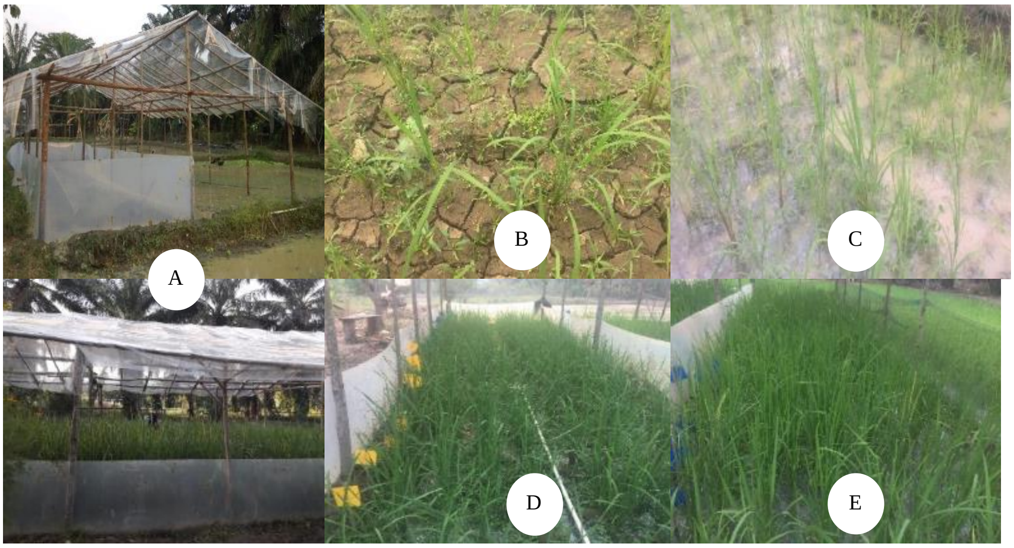

Figure 1. Plastic housing (A), drought stress treatment plot vegetative phase (B), control plot vegetative phase (C), drought stress plot generative phase (D), and generative phase of control plot (E)

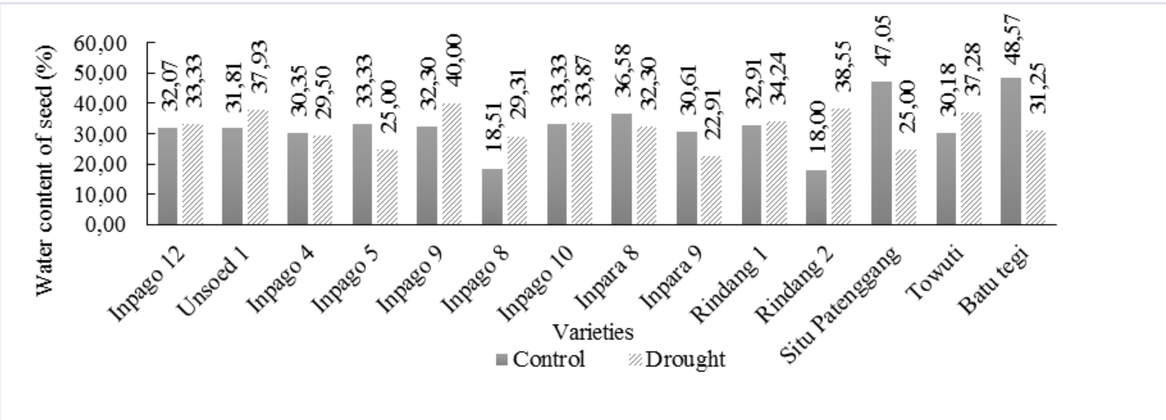

Figure 2. Water content of paddy seed harvest in the control treatment and drought stress in the vegetative phase

Vigor and Seed Viability

There was no significant difference between the percentage value of paddy seeds produced by the plants under the control treatment or drought stress on the variables of seed germination (Table 1), seed growth simultaneity (Table 2), seed germination speed (Table 3), and seed germination strength. (Table 4). In both treatments, the value of seed germination, simultaneous growth of seeds, speed of germination of seeds, and strength of the best seeds of Inpara 8 variety respectively with a higher drought stress value than the control. However, the germination value was higher after experiencing dry storage for 11 weeks and 13 weeks than after dry storage for approximately 2 weeks (Table 1). Figure 4 shows the germination of variety seeds undergoing dry storage for 11 weeks, and Figure 5 shows the germination of variety seeds undergoing dry storage for 13 weeks.

The result of the seed germination index was obtained from comparing the percentage yield of seed germination by the control and drought stress (Table 5). Radicle length and length of paddy seed plumule produced by plants in the control treatment and drought stress showed a percentage that was not significantly different, each treatment had radicle and long plumule values with different varieties (Table 6). The longest radicle and plumule produced by the plants in the drought stress treatment is shown in Figure 6. The sample used for radicle and plumule lengths was the same sample for the normal germination dry weight (Table 7) and the paddy seed vigor index produced by the plants in the control and stress treatments drought in the vegetative phase (Table 8).

Correlation (r) Among Observed Variables

The observed correlation between variables is shown in Table 9 for seeds produced by the plants in the control treatment and Table 10 for seeds produced by the plants in the vegetative phase drought stress treatment. The two tables show that the water content after harvest and the water content after drying were not significantly correlated with the observed variables, whereas, the simultaneity of seed growth had a significant correlation with the germination, and the germination strength had a significant correlation with the rate of germination. This is because the germination and simultaneous growth using the same sample, as well as the power to germinate and germinate speed.

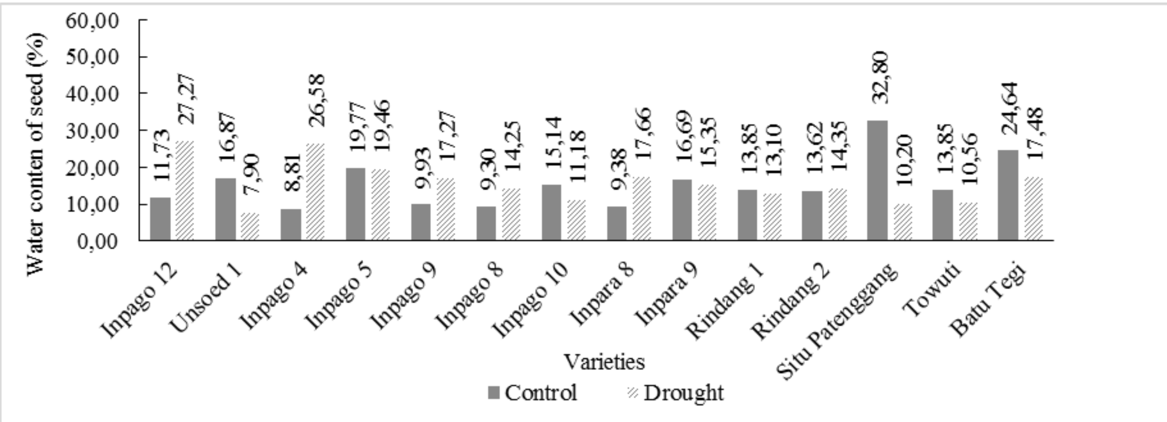

Figure 3. Moisture content of paddy seeds after drying in the control treatment and drought stress in the vegetative phase

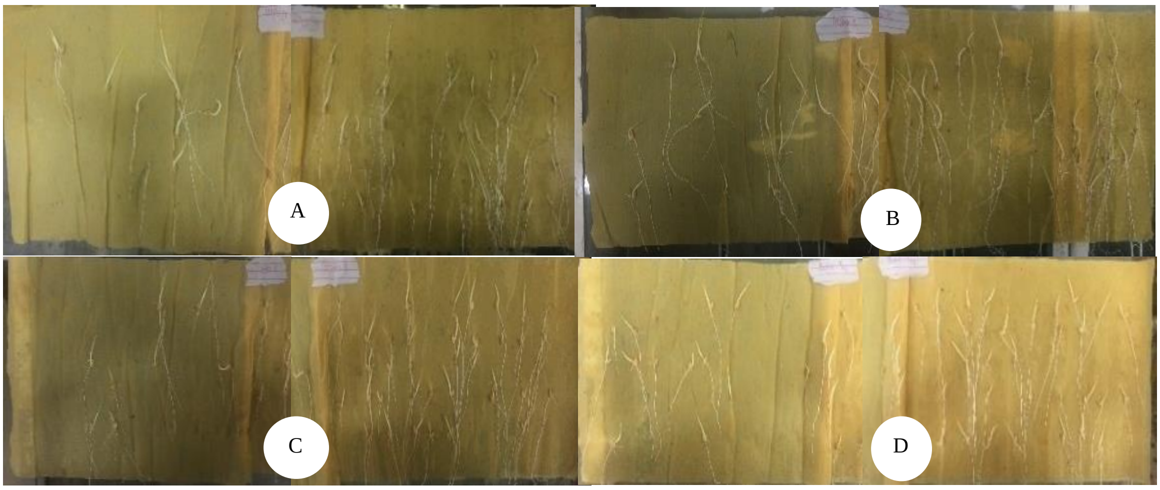

Figure 4. Paddy seed germination of the control treatment of Inpago 4 (A), Inpago 5 (B), Inpara 8 (C), and Batu Tegi (D) varieties under the dry storage for 11 weeks

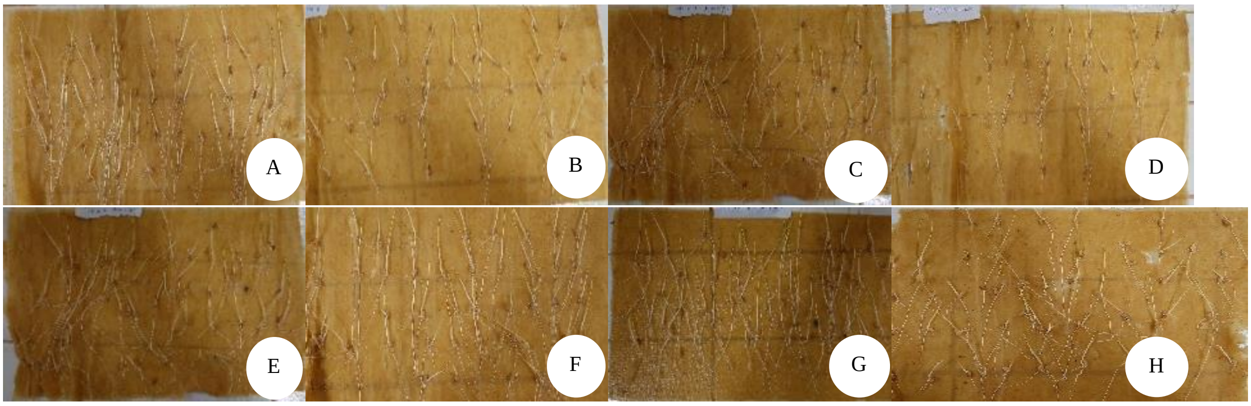

Figure 5. Paddy seed germination of Inpago 12 (A) and Unsoed 1 (B) paddy seeds in the control treatment and Inpago 12 (C), Unsoed 1 (D), Inpago 4 (E), Inpago 5 (F), Inpara 8 (G), and Batu Tegi (H) in the drought stress treatment in the dry storage for 13 weeks

Figure 6. Average of the longest plumule (Inpara 8) (A) and the longest radicle (Towuti) (B) produced by the plants in the drought stress treatment of the vegetative phase

Table 1. Germination power of paddy seeds produced in the control treatment and drought stress in the vegetative phase (%)

Varieties	Germination power (%)			
	Control		Drought	
Inpago 12	74.00	90**	70.00	98**
Unsoed 1	52.67	100**	48.00	92**
Inpago 4	37.33	100*	38.00	90**
Inpago 5	38.00	100*	43.33	92**
Inpago 9	42.00		66.00	
Inpago 8	38.00		26.00	
Inpago 10	60.00		84.67	
Inpara 8	86.67	100*	93.33	94**
Inpara 9	26.67		38.67	
Rindang 1	46.00		42.00	
Rindang 2	62.00		41.33	
Situ Patenggang	49.33		74.67	
Towuti	86.00		88.00	
Batu Tegi	80.67	100*	80.67	94**
Student t-value	-0.569			
P significance <0.05	0.238ns			

Notes: ns = not significantly different, * = germination capacity in the seed test after 11 weeks of dry storage, ** = germination in the seed test after 13 weeks of dry storage

Table 2. Simultaneous growth of paddy seeds produced in the control treatment and drought stress in the vegetative phase (%)

Varieties	Simultaneous Growth (%)	
	Control	Drought
Inpago 12	56.67	56.00
Unsoed 1	34.67	30.00
Inpago 4	26.00	30.00
Inpago 5	24.00	24.00
Inpago 9	30.00	45.33
Inpago 8	32.00	21.33
Inpago 10	52.67	76.67
Inpara 8	75.33	82.67
Inpara 9	23.33	28.67
Rindang 1	30.00	28.67
Rindang 2	31.33	22.00
Situ Patenggang	47.33	64.67
Towuti	58.00	70.00
Batu Tegi	64.67	77.33
Student t-value	-0.662	
P significance <0.05	0.057ns	

Notes: ns = not significantly different

Table 3. Germinating speed of paddy seeds produced in the control treatment and drought stress in the vegetative phase (%)

Varieties	Germinating Speed (%) / hari	
	Control	Drought
Inpago 12	6.99	6.09
Unsoed 1	5.62	4.60
Inpago 4	3.00	2.69
Inpago 5	3.91	3.77
Inpago 9	4.10	6.76
Inpago 8	4.03	1.99
Inpago 10	7.16	11.23
Inpara 8	11.12	12.11
Inpara 9	2.66	4.53
Rindang 1	3.22	3.63
Rindang 2	4.65	3.53
Situ Patenggang	8.70	10.36
Towuti	8.70	8.44
Batu Tegi	5.53	7.02
Student t-value	-0.476	
P significance <0.05	0.293^{ns}	

Notes: ns = not significantly different

Table 4. Germination strength of paddy seeds produced in the control treatment and drought stress in the vegetative phase (%)

Varieties	Germination Strength (%)	
	Control	Drought
Inpago 12	30.00	10.00
Unsoed 1	18.00	9.33
Inpago 4	6.00	4.67
Inpago 5	10.67	4.00
Inpago 9	12.67	22.00
Inpago 8	9.33	3.33
Inpago 10	34.67	55.33
Inpara 8	47.33	64.00
Inpara 9	8.00	17.33
Rindang 1	2.00	7.33
Rindang 2	2.67	8.00
Situ Patenggang	22.00	26.67
Towuti	22.67	64.00
Batu Tegi	30.67	23.33
Student t-value	-0.645	
P significance <0.05	0.149^{ns}	

Notes: ns = not significantly different

Table 5. Germination index of paddy seeds produced in the control treatment and drought stress in the vegetative phase

Varieties	Germination Index
Inpago 12	0.95
Unsoed 1	0.91
Inpago 4	1.02
Inpago 5	1.14
Inpago 9	1.57
Inpago 8	0.68
Inpago 10	1.41
Inpara 8	1.08
Inpara 9	1.45
Rindang 1	0.91
Rindang 2	0.67
Situ Patenggang	1.51
Towuti	1.02
Batu Tegi	1.12

Table 6. Radicle length and plumule length of paddy seeds produced in the control treatment and drought stress in the vegetative phase (cm)

Varieties	Radicle Length (cm)		Plumule Length (cm)	
	Control	Drought	Control	Drought
Inpago 12	9.65	10.81	6.76	5.65
Unsoed 1	9.70	9.37	5.86	5.55
Inpago 4	9.58	12.09	4.46	5.68
Inpago 5	11.15	10.67	5.57	5.20
Inpago 9	9.21	11.62	4.89	6.26
Inpago 8	9.77	7.53	4.87	2.93
Inpago 10	11.33	12.23	7.38	7.87
Inpara 8	12.10	12.15	7.22	8.20
Inpara 9	8.10	9.97	4.54	5.35
Rindang 1	9.04	10.88	5.18	6.13
Rindang 2	8.15	7.65	2.96	4.55
Situ Patenggang	3.14	10.09	8.37	6.22
Towuti	4.40	12.65	9.96	6.48
Batu Tegi	3.98	10.89	9.93	4.48
Student t-value	-2.443		0.795	
P significance <0.05	0.095^{ns}		0.059^{ns}	

Notes: ns = not significantly different.

Table 7. Normal sprouts dry weight of paddy seeds produced in the control treatment and drought stress in the vegetative phase (mg)

Varieties	Normal Sprouts Dry Weight (mg)	
	Control	Drought
Inpago 12	7.67	10.33
Unsoed 1	7.00	7.00
Inpago 4	6.67	7.67
Inpago 5	7.00	8.00
Inpago 9	7.00	7.33
Inpago 8	6.33	4.33
Inpago 10	9.67	9.00
Inpara 8	9.00	11.00
Inpara 9	4.67	6.67
Rindang 1	7.00	7.67
Rindang 2	5.67	5.67
Situ Patenggang	5.33	7.67
Towuti	6.00	9.00
Batu Tegi	6.00	7.67
Student t-value	-1.716	
P significance <0.05	0.098 ns	

Notes: ns = not significantly different

Table 8. Vigor index of paddy seeds produced in the control treatment and drought stress in the vegetative phase

Varieties	Vigor Index	
	Control	Drought
Inpago 12	12.14	11.52
Unsoed 1	8.19	7.16
Inpago 4	5.24	6.75
Inpago 5	6.35	6.87
Inpago 9	5.92	11.80
Inpago 8	5.56	2.71
Inpago 10	11.22	17.01
Inpara 8	16.74	18.99
Inpara 9	3.37	5.92
Rindang 1	6.54	7.14
Rindang 2	6.88	5.04
Situ Patenggang	5.67	12.17
Towuti	12.34	16.83
Batu Tegi	11.22	13.83
Student t-value	-1.121	
P significance <0.05	0.140 ns	

Notes: ns = not significantly different.

Table 9. Correlation coefficient (r) between paddy seed variables produced in the control treatment

	1	2	3	4	5	6	7
1	-	0.700**	0.279 ns	0.487 ns	0.398 ns	0.520 ns	0.041 ns
2	-	-	0.004 ns	0.120 ns	0.059 ns	0.104 ns	-0.396 ns
3	-	-	-	0.908**	0.931**	0.743**	0.344 ns
4	-	-	-	-	0.968**	0.923**	0.428 ns
5	-	-	-	-	-	0.911**	0.458 ns
6	-	-	-	-	-	-	0.607*
7	-	-	-	-	-	-	-

Notes: ns = not significantly different, * = significantly different at P 0.05 (r 0.05 = 0.532), ** = very significantly different at P 0.01 (r 0.01 = 0.661), 1: moisture content at harvest, 2: moisture content after drying, 3 : germination, 4: simultaneous growth of seeds, 5: germination speed, 6: germination strength, and 7: normal sprouts dry weight

Table 10. Correlation coefficient (r) between variables in paddy seeds produced in the drought stress treatment of the vegetative phase

	1	2	3	4	5	6	7
1	-	-0.195ns	0.225 ns	0.107ns	0.218ns	0.102ns	0.081ns
2	-	-	-0.101ns	-0.080ns	-0.212ns	-0.344ns	0.298ns
3	-	-	-	0.976**	0.949**	0.840**	0.736**
4	-	-	-	-	0.942**	0.866**	0.714**
5	-	-	-	-	-	0.941**	0.724**
6	-	-	-	-	-	-	0.606*
7	-	-	-	-	-	-	-

Notes: ns = not significantly different, * = significantly different at P 0.05 (r 0.05 = 0.532), ** = very significantly different at P 0.01 (r 0.01 = 0.661), 1: moisture content at harvest, 2: moisture content after drying, 3 : germination, 4: simultaneous growth of seeds, 5: germination speed, 6: germination strength, and 7: normal sprouts dry weight

DISCUSSION

The best paddy seed varieties produced in the control treatment and drought stress were different for each parameter. The paddy seeds with drought stress treatment had the best quality values in the Inpara 8 variety with values of uniformity of growth, germination speed, germination strength, normal germination dry weight, vigor index, and plumule length were higher than the other varieties, while for the longest radicle parameter was in that of the Towuti variety. In the control treatment, the variety that had the best seed quality value was in that of Inpara 8 with higher germination value, simultaneous growth, germinating speed, germinating strength, radicle length and vigor index than the other varieties, while for the longest plumule parameter was the that of Towuti variety. The results showed that in the vegetative phase of the drought stress treatment, the variety with the best seed quality value was that of Inpara 8 followed by that of Towuti. Meanwhile, the Inpago 8 variety had the lowest seed quality value.

The Inpara 8 is a swamp paddy commodity released in 2014 (Pusat Penelitian dan Pengembangan Tanaman Pangan, 2016), and in this study this variety has the best viability and vigor qualities of other varieties. This is supported by the results of research (Suparwoto, 2019), that the Inpara 8 has good plant genetics because it has productive tillers, the number of grains per panicle, and the highest grain production of other varieties. The productive tillers determine the number of panicles, and grain per panicle determines the grain yield.

The next best seed quality is that of the Towuti variety, which is an upland paddy inbred which is developed and suitable for planting in dry land. In accordance with the results of the study by (Sitohang, Siregar and Putri, 2014), stating that the Towuti variety is a quality seed because it has a high yield of productive grain, grain weight, and production. This yield is higher than those of Situ Patenggang and Batu Tegi varieties. (Ferayanti, Idawanni and Azis, 2020) also states that the number of filled grains per panicle is higher in that of Towuti variety than that of the Inpago 8 variety. The high grain yield indicated that the grain was fully filled and the food reserve in the seed was high. The seeds with high food reserves have better germination ability (Wiguna and Sumpena, 2012). This is because the food reserves are used by the seeds as an energy source for germination (Wulandari, Bintoro and Duryat, 2015). However, according to (Ichsan et al., 2015) besides the Towuti, the Situ Patenggang is also a national superior variety which has good physiological resistance because it has drought-resistant gene assembly; therefore, it can be an alternative for the seeds planted in the locations with limited water.

The seeds of Inpago 12, the Unsoed 1 variety had parameters of higher germination, growth uniformity, growth speed and germination speed higher than those produced in the control treatment compared to those with the drought stress treatment. The varieties of Inpago 9, Inpago 10, Inpara 9, and Situ Patenggang had parameters of germination power, simultaneous growth, germination speed and germinating strength higher than those in the seeds produced in the drought stress treatment compared to those in the control treatment. Meanwhile, the Inpago 4 variety had the best parameter values for the speed of germination and germinating strength in the control treatment; the best parameter values for germination and simultaneous growth were in the seeds produced in the drought stress treatment.

The Inpago 5 variety has the same growth simultaneity value between the seeds produced in the control treatment and those produced in the drought stress, the best germination parameter values in the seeds produced by the drought stress treatment, while the best value of the parameters of the germination speed and the germinating strength in the seeds produced in the control treatment. The variety of Rindang 1 had the best parameter values for germination capacity and uniformity of growth in the seeds produced in the control treatment, while the best parameter values for growth speed and germinating strength were for seeds produced with the drought stress treatment. Then, the Batu Tegi variety had the best parameter values for germination and growth simultaneity in the seeds produced in the drought stress treatment, and the parameter values for the best germination speed and germinating strength in the seeds produced in the control treatment. Meanwhile, the Rindang 2 variety of paddy seeds had better germination value, simultaneous growth and germinating speed in the control treatment, and the best germinating strength parameter was in the drought stress treatment.

This study shows that each variety has a different response and seed quality to the drought stress treatment and control. The difference in the quality of paddy seeds was influenced by the differences in genetic traits of plant varieties and crop cultivation methods (Pandiangan and Rasyad, 2017). (Mulsanti, Wahyuni and Sembiring, 2014) states that the germination is influenced by the process of seed production, from planting to harvesting and storing seeds before replanting. There are several varieties that are tolerant of drought stress, but some varieties are not tolerant. Paddy that is not tolerant of drought stress planted in drought conditions will experience disturbed physiological and morphological processes, thus affecting growth and seed production (Sujinah and Jamil, 2016). Water availability supports plant physiological processes so that chlorophyll formation is optimal (Banyo et al., 2013). Supported by the study (Song and Banyo, 2011), When having water deficiency plants generally respond with a decrease in leaf chlorophyll concentration. The higher the level of drought stress is received by the plant, the more it will suppress the growth rate and yield of paddy plants. The size of the seeds plays an important role in producing energy during the germination process, (Wahyudi, 2019) states that a large seed size means having sufficient food reserves. The food reserves in the endosperm are used by the seeds as energy to germinate, morphologically, the seeds which have immature endosperm will show slow germination (Lesilolo and Moriolkossu, 2014). The main food reserves of seeds are carbohydrates, proteins and fats which are generally accumulated in the form of cotyledons and endosperm. As long as the plants are not able to carry out the photosynthesis process perfectly, the seeds rely on the food reserves in the seeds (Sahroni et al., 2018).

Several paddy varieties showed low germination values in both the control treatment and drought stress. If the seeds we germinate have been given all the factors needed to germinate, but the seeds do not germinate, it could be because the seeds are dormant or have lost their viability. There are several factors that cause stunted germination, they include internal and external factors. The internal factors are genetic factors, seed maturity level, and seed age. While the external factors are the environment during seed germination, such as water, temperature, light, gas, and the germination medium (Hedty, Mukarlina and Turnip, 2014). The plant genetic factors include seed dormancy and inhibition. Paddy seeds have different dormancy periods after harvest, or it is called the after-ripening phenomenon, namely the need for dry storage (Tefa, 2017b).

The seed dormancy is a condition where the seeds are alive but do not germinate until the end of the observation of germination, despite the optimum environmental factors for germination. In his study, (Astari, Rosmayati and Bayu, 2014) states that physical and chemical dormancy affect germination significantly. The seed inhibitor is a condition when the seed germination becomes inhibited (Iriani, Kendarini and Purnamaningsih, 2017), the seed inhibitor is divided into two, namely physical inhibitor and chemical inhibitor. The physical inhibitor occurs because the hard shell of the seeds prevents the entry of water into the embryo, while the chemical inhibitor occurs because the seed coat contains a high osmotic solution, which hinders the germination process. This is consistent with the study of (Bramasto et al., 2015), stating that the high content of abscisic acid inhibitor and the thickness of the skin on the mindi seeds resulted in seed dormancy. The breaking of seed dormancy can be done by dry storage, and various methods of seed extraction such as washing the seeds with water until all inhibitors are removed, fermentation for several days, using mechanical methods with machines, and chemical methods by giving certain solutions so as to clean the seeds from inhibitors which inhibits germination (Prasetya, Yulianah and Purnamaningsih, 2017).

Figure 4 shows that the paddy seeds of Inpago 4, Inpago 5, Inpara 8, and Batu Tegi varieties with the control treatment had high germination by calculating the germination capacity of 100% after experiencing dry storage for 11 weeks. Whereas the dry storage for 2 weeks showed a low germination value. Then Figure 5 shows that in 13 weeks of dry storage, paddy seeds of Inpago 12 and Unsoed 1 varieties in the control treatment had germination values of 90% and 100% and in the drought stress treatment with values of 98% and 92%. In the drought stress treatment, the Inpago 4 variety had a value of 90%, Inpago 5 with a value of 92%, Inpara 8 with a value of 94% and Batu Tegi with a value of 94%. Meanwhile, the dry storage for 2 weeks showed a lower germination value, both in the control treatment and in the drought stress.

This proves that the control treatment and drought stress varieties of Inpago 12, Unsoed 1, Inpago 4 and Inpago 5 initially experienced dormancy and were the plants with high germination values after experiencing the dry storage for a certain period. This does not rule out other varieties used in this study. The newly harvested seeds generally experience dormancy even though the embryos are fully formed and environmental conditions allow. According to the study conducted by (Tefa, 2017b), the storage period for seeds that can increase the vigor and viability of paddy seeds is a storage period of 3 months or approximately 12 weeks. Meanwhile, according to (Dewi and Subang, 2015), the storage period of 1 month, 2 months, and 3 months did not experience a significant difference in the seed germination, that is both had the germination percentages above 90%, this is because these seeds had high physiological maturity.

The differences in the level of panicle maturity at harvest both at the storage period of 1 month, 2 months, and 3 months affected the vigor index of paddy seeds (Fitrianingsih and Yudono, 2019). The seeds that have high vigor will perform well in the germination under the uniform environmental conditions (Tefa, 2018).

As a recommendation, the paddy replanting should be carried out after the seeds have passed the dormancy (after-ripening) phase to produce high growth power. It should be noted that each variety has a different dormancy phase.

CONCLUSSION

The varieties having the best seed quality value after experiencing drought stress in the vegetative phase were Inpara 8 and Towuti. Meanwhile, the lowest seed quality was in the Inpago 8 variety.

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