10th Asian Crop Science Association Conference

Agriculture, Environment and Health for Future Society in Asia

CERTIFICATE

Certificate of Presentation

Awarded to

Ahmad Rifqi Fauzi

as a Lecturer

P1-01

Title: Seed Size Evaluation of Rice Genotypes for Direct Seeding Development Cultivar

ACSAC10 ONLINE FROM NAGOYA, JAPAN Sep.8[WED]-Sep.10[FRI],2021

M. Kobulun

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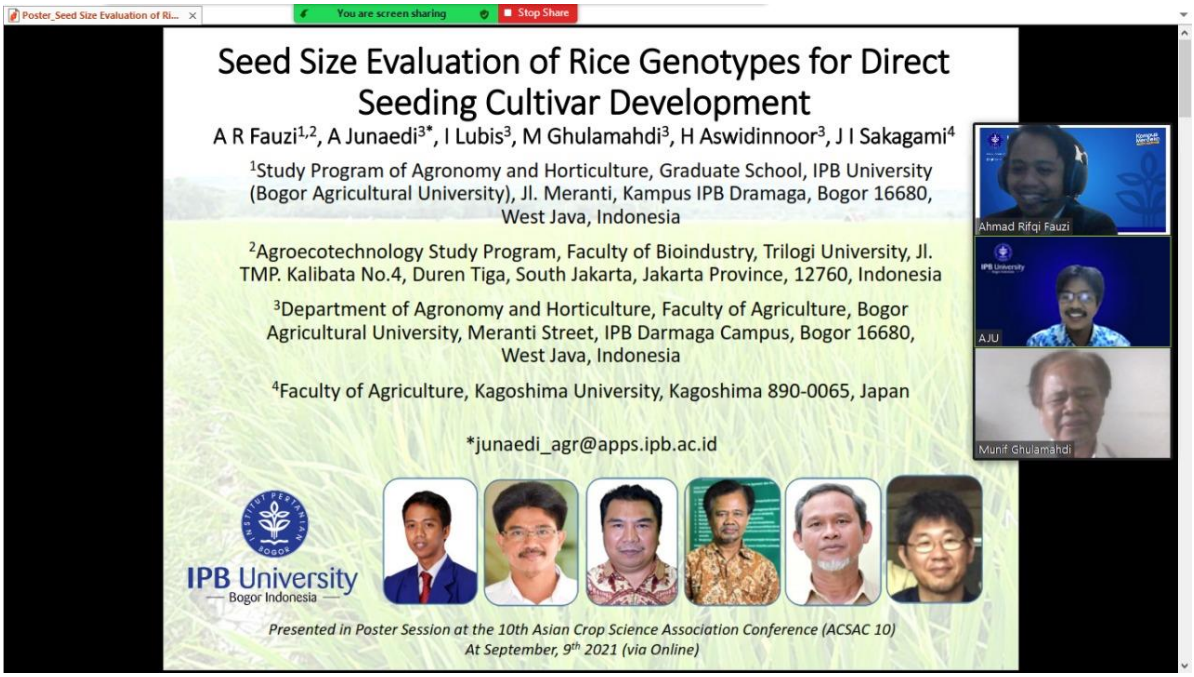
10th Asian Crop Scince Association (ACSA) Conference

Nagoya, 8-10 September 2021 (online)



12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-01] Seed Size Evaluation of Rice Genotypes for Direct Seeding Development Cultivar

*Nominated for Presentation Awards

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Direct seeding of rice (DSR) system would be potentially giving more efficient rice production which less labor and saving water. An appropriate DSR cultivar will improve DSR systems through early vigor trait that may relate to seed size. This research has objective to evaluate the relationship among seed observed variables, i,e.: seed (whole grain), endosperm and embryo size (area, length, width, perimeter, and length-to-width ratio (LWR)) and its early vigor test. The rice germplasm consists of 55 rice genotypes (50 genotypes originating from the IPB University breeding program and 5 national varieties). Description of rice germplasm indicated that the size of seeds, endosperms, and embryos among tested genotypes are significantly different, and the seed and endosperm size (length, perimeter, and LWR) are positively correlated with 1000-grain weight and length of endosperm and seed have given direct effect by path analysis (R^2 = 42.6%). The rice genotypes are continuously observed for early vigor characters by seed germination test and will be evaluated its relationship with seed size traits. Further evaluation on the growth and development performance in the greenhouse and field experiment of selected potentially rice germplasm will be performed to confirm the early vigor character with agronomical goal of this DSR cultivated system.

Seed Size Evaluation of Rice Genotypes for Direct Seeding Cultivar Development

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ABSTRACT

Direct seeding of rice (DSR) system may reduce labor and saving water. The development of DSR suitable cultivar such as early vigor (EV) trait has become a focus to improve DSR systems. EV characters are related to the ability of germination, seedling growth, and development after emergence. The EV ability is reported has a correlation with the size of seed, endosperm, and embryo (area, length, width, perimeter, and length-to-width ratio (LWR)). In this research, we clarify these characters. We did analysis on size characters of 55 rice genotypes (50 genotypes originating from the IPB University breeding lines and five released varieties). Our findings indicated that the size of seeds, endosperms, and embryos among genotypes was significantly different (P-value <0.01) and some of these variables have a positively correlation (P-value <0.05) with each other. We also found that seed and endosperm size (length, perimeter, and LWR) have positively correlation with 1000-grain weight (P-value <0.01), and length of rice seed and endosperm have given direct effect by path analysis (R2 = 42.6%). This initial identification provides information that seed and endosperm size could be considered for plant breeding programs in the development of DSR cultivars. Selected genotypes are continuously observed for early vigor characters by seed germination test and under progress on evaluation for growth performance in the greenhouse and field experiment.

Keywords : *early vigor, embryo size, endosperm size, germination test*

BACKGROUND

Challenge:
Unavailability of proper varieties developed for DSR → Early vigor was identified as one of important traits to develop DSR varieties (Ohno *et al*., 2018; Mahender *et al*., 2015)

Consumed by >60% world population (Deng et al, 2020); > 50 % produced with Transplanted or TPR system (Rao et al., 2007) that need much water and labor → influencing sustainable development of rice production

- High importance to sustain profitable rice production under the current agricultural scenario (Quilloy *et al*., 2021)
- Low labour input and reduce total production cost (Mishra *et al*., 2017)
- Less water (Pathak *et al*, 2011)
- Lower methane emission than TPR (Susilawati *et al*., 2019)

Rapid seedling establishment

- Related to seed physical characters (Chen *et al*., 2015) like size of seed (Kesavan *et al*., 2013; Ambika *et al*., 2014)
- Key success in further plant growth and development (Huang *et al*., 2017)
- Reduced losses of rice yield due to competition with weeds and drought (Namuco *et al*., 2009)

Need for clarification and evaluation of specific various genotypes of breeding lines

Objective: clarify and evaluate seed size characters using genotypes of IPB rice breeding program to develop EV varieties

METHODS

1st experiment: Measurement of seed, endosperm and embryo physical characters (September-November 2019)

Collected seeds material of 50 genotypes of IPB University rice breeding program + 5 released varieties

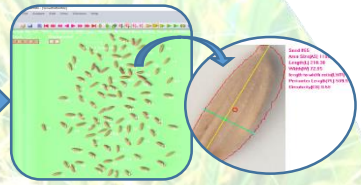
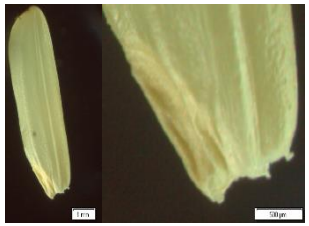


Image analysis of seed and endosperm characters using SmartGrain apps (Tanabata *et al*., 2012). 400 seeds and 40 endosperms each genotype with moisture 11-13%



Measure characters of 8 embryo/genotype with image analysis approach using DP2-BSW Apps (by Olympus). Image taken using fluorescence microscope at 1.25x magnification at scale 500 µm.

Statistic analysis: ANOVA and Pearson correlation. Means comparison by tukey test ($p \leq 0.05$) using Minitab 17th version

2nd experiment: Gemination test (February-March 2020)

Germination test of 55 genotypes to measure early vigor characters conducted by RCD using controlled germinator (24 h illumination, 25±2^{0}C, and RH 95%) with top of paper method (ISTA, 2017). 200 seeds each genotype germinated in a transparent box (145 mm x 90 mm)

Statistic analysis: ANOVA and Pearson correlation. Means comparison by tukey test ($p \leq 0.05$) using Minitab 17th version

3rd experiment: Plastic House experiment: Seeding emergence (February 2021)

Seeding emergence test of 10 selected genotypes to evaluate early vigor characters. Conducted by RCBD in GH (T 29.9^{0}C; RH 71.9%; 12h light) with 3 replication each genotype, using 75 seeds/genotype/replication in a pot experiment (d 30 cm; H 40 cm).

RESULT

Table 1. ANOVA of seed, endosperm, and embryo phisycal characters of 55 rice genotypes

Physical characters	Seed			Endosperm			Embryo		
	Means	Sig.	Coeff. Varians	Means	Sig.	Coeff. Varians	Means	Sig.	Coeff. Varians
Area (mm2)	13.73 ± 0.38	***	1.61	10.23 ± 0.26	***	1.54	0.68 ± 0.14	***	14.65
Length (mm)	7.24 ± 0.11	***	3.32	5.59 ± 0.07	***	3.05	1.65 ± 0.05	***	4.48
Width (mm)	2.44 ± 0.05	***	1.59	2.26 ± 0.06	***	1.77	0.55 ± 0.06	***	13.76
Perimeter (mm)	17.57 ± 0.26	***	2.64	14.28 ± 0.17	***	3.12	3.96 ± 0.65	***	4.86
Length-to-width ratio	3.02 ± 0.23	***	3.11	2.52 ± 0.15	***	4.54	3.07 ± 0.37	***	13.65

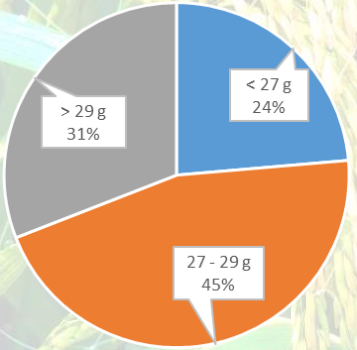


Figure 1. Percentage of 1000 seed weight group

The differences in seed size are influenced by differences in genotypes (Table 1), which of the 55 genotypes observed, more than 75% of them had 1000 grain weight above 27 grams (Figure 1). This size difference becomes the basis for testing the early vigor characters.

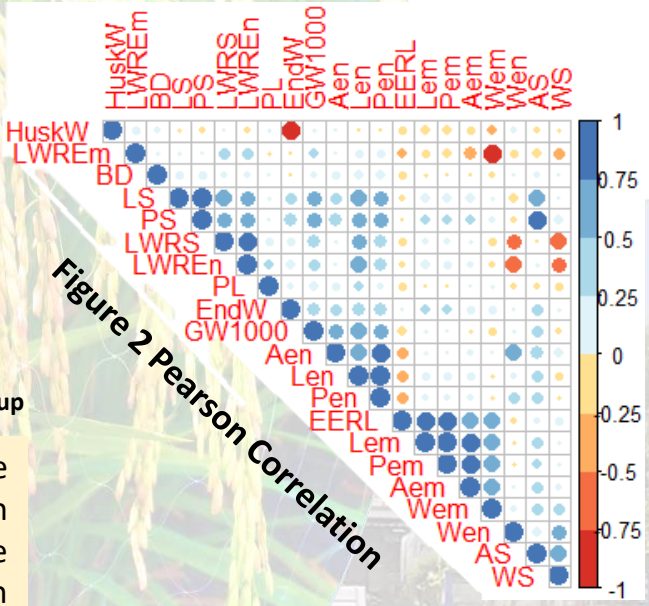


Figure 2 Pearson Correlation

Note: L=length; W=width; P=perimeter; LWR=length to width ratio; S=seed; En=endosperm; EndW=endosperm weight; em=embryo; PM=panicle length; GW1000=weigth of 1000 grain; BD=seed density; HuskW=husk weight; EERL=embrio/endosperm ratio

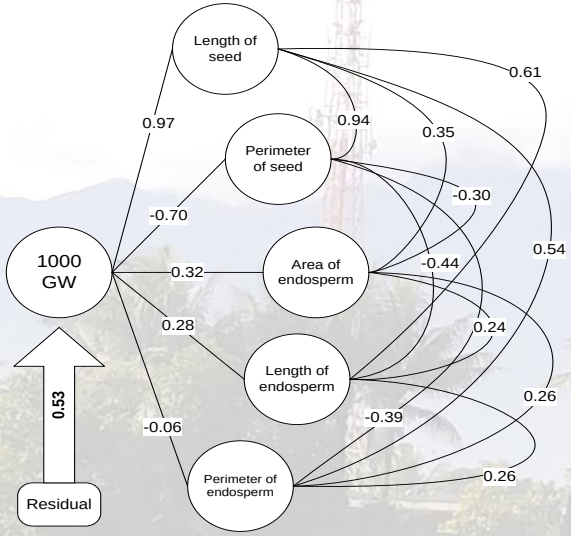


Figure 3 Path Analysis

The weight of 1000 grain (GW1000) as one of the popular variables for assessing seed quality has a positive correlation with the length and perimeter of the seed and endosperm and also area of endosperm with a coefficient of correlation > 0.50 and has direct effects on the variable (Figure 2&3)

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RESULT (*Cont…*)

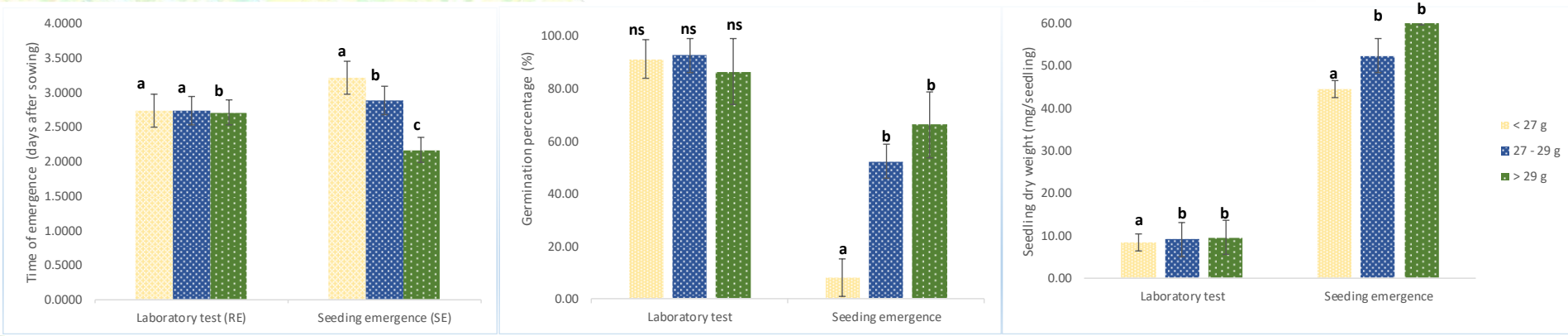

Figure 4 Means EV traits (time of emergence, germination percentage, and seedling dry weight) between genotypes with different 1000 seed weight in germination test (laboratory exp.) and seeding emergence (pot experiment in a plastic house)

Physical characters such as the 1000 grain weight of the seed affect the ability of the seeds to germinate earlier. The results of this study confirmed that seed weight affect several EV variables such as time of emergence, germination percentage, dry seedling weight, and the number of tillers (Figure 4 and Table 2). Genotypes with hevier seeds emerged 1% faster in laboratory testing and more than 10% faster in a pot seeding emergence than other genotypes. The genotypes also had higher seedling dry weight (> 7%) in both experiments. Moreover, in the seedling emergence in a plastic house, the heavier seed genotypes are 17.3% and 11% higher dry weight of seedling and tiller number, respectively, than the medium seeds. It indicates that the heavier seeds genotypes can accumulate biomass more quickly. The seedling performance of different seed length in both experiments is in figures 5&6.

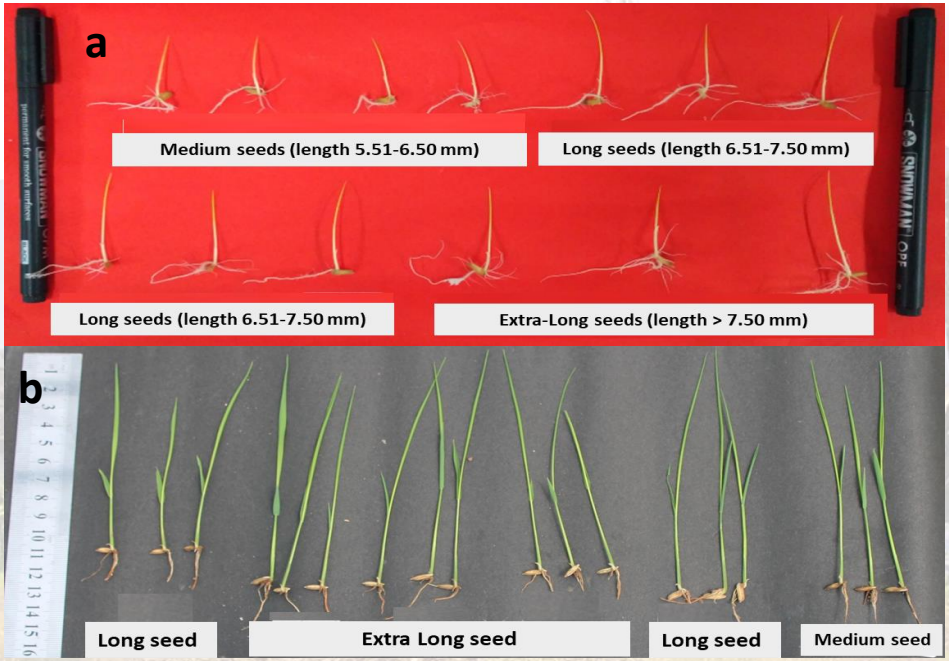

Figure 5 Seedling performance in germination test (a) and seedling emergence (b) at 7th days after sowing

RESULT (*Cont…*)

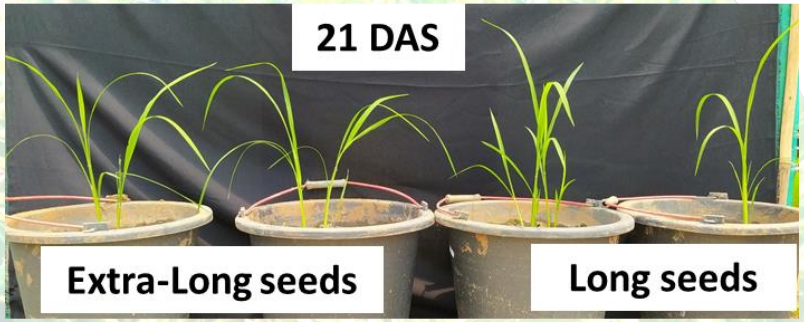

Figure 6 Seedling performance between two genotypes with different seed size at 21st days after sowing in a pot experiment

Table 2 Means height and number of tiller between genotypes with different 1000 grain weight at 25th days after sowing in Pot experiment

Group of 1000 seed weight	Traits		
	Height (cm)	Number of tiller	Number of leaves
< 27 gram	43.63 a	2.33 a	10.10 a
27 - 29 gram	43.52 a	2.59 b	11.73 b
> 29 gram	42.69 a	2.42 b	12.34 b

**the same letters in same column are not significantly different of Tukey test at α < 0.05*

Discussion

- Early vigor is the character of initial plant growth indicating the ability to emerge seedling quickly (seed vigor) and the development of fast and robust seedlings to the next growing phase (seedling vigor). According to Ohno *et al*. (2018), the character was important to be considered in developing cultivar for direct seeding systems.
- Our results showed that 1000 grain weight have correlation positively significantly with seed and endosperm size characters and embryo shape but no correlate with width characters (see figure 2 & 3). We also found that the heavier seeds tend to be showed by longer size, larger endosperm, and higher LWR of embryo. This seed variables has affected the ability of seeds to germinate and encourage stronger seedling development. Rice seeds which emerged earlier indicates ability to accumulate faster and higher biomass (Figure 4) which encourage rapid seedling growth as indicated by the higher number of tillers and the higher number of leaves (Table 2). Total amylase and α-amylase activity play a key role in biomass accumulation (Huang *et al*., 2017).
- Our finding agree with Shi *et al*. (2020) that reported early vigor characters were contributed by 1000 grain weight whereas the superior early vigor variety had 1000 grain weight higher than that of other variety. The early vigor variety was expected to provide advantages to the DSR system by reducing the negative effects of competition with weeds and showing tolerance with sub-optimum environmental conditions (Mahender *et al*., 2015).
- By knowing the traits of rice seed suitable for the DSR system, we could use it for planting by machines development program (Fıratlıgil-Durmuş *et al*., 2010) for DSR, in addition to be considered for crop improvement programs.

Conclusion

1. The weight of 1000 grain has strong correlation (*r > 0.50*) with seed length, seed perimeter, ensosperm area, endosperm length, and endosperm perimeter. Length to width ratio of embryo also correlate with 1000-GW (*r = 0.28*). The seed characters affect to the early vigor traits of the tested genotypes.
2. Rice genotypes with heavy seeds (> 27 grams) had early vigor traits such as the time of seedling emergence, germination percentage, seedling dry weight, and the number of tillers was superior.
3. Several genotypes among the IPB University's rice breeding lines tested in this study showed the potential to be developed as DSR cultivars. The selected genotypes from plastic house experiment will be further observed and evaluated in the field experiment.

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