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Yield Stability and Adaptability of Aromatic New Plant Type (NPT) Rice Lines

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ABSTRACT

Aromatic new plant type (NPT) rice lines were selected to obtain high yielding and aromatic lines. The objectives of the research were to study the yield stability and adaptability of 35 NPT rice lines across different environment, with Ciherang and Sintanur as check varieties. The lines planted at two locations, Bogor and Pusakanagara in two seasons (2009 dry and wet seasons, DS-WS). The experiment used randomized complete block design (RCBD), with three replications. The 21-day-old seedlings were planted with spacing of 20 cm x 20 cm, with a plot size of 2 m x 5 m. Yield stability and adaptability were estimated by using coefficient regression (bi) and general mean of yield by Finlay-Wilkinson method. Combined analysis of variance showed that lines (G), environment (E), and the G x E interaction were significantly different. Lines showed different stability and adaptability. Several lines yielded higher than Ciherang variety. Nine lines were classified as stable and widely adapted at the marginal environment, i.e IPB 116-F-3-1, IPB 117-F-4-1, IPB-117-F-14-2, IPB-117-F-15-2, IPB-117-F-17-5, IPB 140-F-1-1, 140-F-IPB, 2-1, IPB 140-F-3, and IPB 149-F-2. Lines IPB 113-F-2, IPB 140-F-4, IPB 140-F-6, IPB 140-F-7, and B11738-MR-Si-1-2-1-2 were not stable and adapted only in optimum environmental condition (bi > 1) while IPB 116-F-46-1, IPB-117-F 17-4, IPB-117-F 18-3 and B11955-MR-84-1-4 has the value of bi < 1 or adaptable to marginal environments.

Keywords: aromatic rice, NPT rice, yield stability

INTRODUCTION

Rice (*Oryza sativa* L.) is still one of the most important food crops in world's population. Most of the rice-producing countries are in Asia where average consumption is higher than 80 kg per person per year, such as China, 90 kg; Indonesia, 150 kg; and Myanmar, the highest, more than 200 kg. Most rice was consumed in the same country that it was produced not only as a major food source but also as an economic activity or resources that provide employment opportunities for rural income (Adnyana*et al*., 2008; UNCTAD, 2010).

High yielding varieties as one of component technologies remains a priority to support food security programs. Two major programs in rice improvement, namely increasing yield potential and yield stability. High yield potential programs could be promoted through the establishment of a new plant type (NPT) of rice. NPTs are designed to have more efficient assimilate distribution to the grain (Khush, 2000). New rice varieties, that have better benefits than existing rice varieties, will be more acceptable if their characteristics follow the consumer's preferences (Zen, 2007). Therefore, rice breeders should consider better quality and aroma of new rice varieties as well as higher yield potential.

The development of NPT rice lines having aromatic character continues. Bogor Agricultural University (IPB) has been using upland rice originated from of South Sulawesi as the aroma gene source. These local rice varieties were Pulu Mandoti, Pinjan, Pare Bau, and Sintanur. Currently, Indonesian Center of Rice Research (ICRR) also developed NPT lines expectations aromatic fragrant with the gene source from Gilirang and local variety. Lines with aromatic potential were obtained from different aroma genes. However, the stability of the rice aroma parents from different sources in different environments is unknown. Yield stability and adaptability of these lines are necessary to be evaluated across different location and season.

Appearance of a plant (phenotype) is influenced by genotype, environment, and the interaction between genotype and environment (G x E) (Allard, 1960). Environment is one component that can affect the quality of grain and rice production. G x E interaction must be considered by plant breeders to develop high yielding varieties because the response of genotype is not the same in every environment. Macro-environment that affects the physical plant adaptation including soil type, altitude, temperature, latitude, climate, and seasons. G x E interactions greatly affect the phenotype of a variety, so the stability analysis is required to characterize the performance of varieties in different environments, to help plant breeders in selecting varieties. Instability is the result of cultivars response in different environments which usually indicates a high interaction between genetic

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and environmental factors (Jusuf *et al.,* 2008; Lone *et al.,* 2009).

Phenotypic stability is dependent upon plant's ability to determine its response to different environments. Stability analysis is an important and efficient tool for the plant breeders and agronomists to identify and select the most stable, high performing genotypes that are best suitable under a given set of environmental conditions. Haryanto *et al.* (2008) showed that the yield stability of aromatic upland rice lines varied across different environments. Four lines, i.e. G10, G19, G39, and G136 have high yield stability, wide adaptability, and were potential to be released as a new aromatic upland rice variety. In the study of Dakheel *et al.* (2009) in pearl millet, six lines were suitable for cultivation under medium to high saline and marginal growing environments. These genotypes can be exploited in future breeding programs to develop high yielding, stable genotypes for saline growing conditions. Nur *et al.* (2007) reported that there was significant G x E interaction for yield and yield components of hybrid maize in seven different environments.

Simple method to analyze the stability of the various experiments is the method proposed by Finlay-Wilkinson (1963) and Eberhart-Russell (1966). Adaptability and stability parameters used are regression coefficients (bi), deviation of regression (S^2di), and the mean of genotypes yield. Regression coefficient (bi) is used to categorised the stability of being low (bi > 1), medium (bi = 1), and high (bi < 1).

This research determined the stability of grain yield of rice NPT aromatic lines across four different environments and to select lines having wide adapttation and/or specific adaptation to environment.

MATERIALS AND METHODS

Thirty-seven promising NPT lines and two improved varieties, Ciherang and Sintanur were planted at two locations, Bogor (elevation 200 m above sea level-asl) and Pusakanagara region (8 m asl) in two seasons (2009 dry and wet seasons, DS-WS). Bogor 2009 DS was considered as the first environment; Pusakanagara 2009 DS, the second; Bogor 2009 WS, as the third; and Pusakanagara 2009 WS as the fourth. The design used was randomized complete block design (RCBD), with three replications. A seedling of 21-day-old was planted per hole with spacing 20 cm x 20 cm, with a plot size of 2 m x 5 m, so that there were 250 plants per plot.

Homogeneity of error range was performed by the method outlined by Gomez and Gomez (1995). Each growing environment was tested using Bartlett test that compares calculated *chi-square* value by *chi-square* table. If variances of all environments were found to be homogenous, then combined analysis of variance was proceeded to look at G x E and stability of the genotypes across all environments.

Eberhart and Russell (1966) method was used to analyze the stability of the yield, as follows:

$$Yij = \mu + b_i I_j + d_{ij}$$

Where:
Y_{ij} = yield rate genotype ith at location jth
μ = average of the ith genotype in all locations
b_i = regression coefficient of the ith genotype
I_j = environmental index on the location of jth
d_{ij} = deviation of regression genotype ith at location jth

Adaptability and stability of genotypes were calculated by the regression coefficient (bi) between the yield averages of a genotype with a general average of all genotypes in a particular environment. Thus the stability classified into three possibilities:

1. If the regression coefficient (bi) of a genotype is close or equal to one then the stability is the average (average stability). If the stability is categorized as average stability and the average yield is higher than the average yield of all genotypes in all environments, then the genotype has a good general adaptation (general adaptability). Conversely, if the average yield is lower than the average yield of all genotypes in all environments, then the genotypes has poor adaptability.
2. If the regression coefficient (bi) of a genotype is greater than one, then the stability is under the average (below average stability). This kind of genotype is sensitive to environmental changes and adapted only to specific environments which is favorable to the genotype.
3. If the regression coefficient (bi) of a genotype is smaller than one, then the stability is above average (above average stability). This kind of genotype is less sensitive to environmental changes and adapted to marginal environments. Statistical analysis was done using SAS version 9.0.

RESULTS AND DISCUSSION

As uniformity test of error variances was non-significant, therefore its homogeneity is confirmed ($\chi2 = 2.07 < 7.81$) and then combined analysis of data was conformed. Combined analysis of variance in yield showed that lines, environment, and the interaction between line and environment (G x E) was significantly different (Table 1).

Table 1. Combined analysis of variance in yield of NPT lines

Source of variation	Degree of freedom (df)	Mean square (MS)
Environment (E)	3	717.68**
Replication within environment	8	8.45**
Genotype (G)	36	2.67**
G x E	108	2.15**
Error	279	1.03
CV (%)	17.5	

Note: ** = significant at P < 0.01; CV = Coefficient of Variance

The significant G x E interaction shows that the relative performances of the genotypes were significantly affected by the varying environmental conditions. There were differences between yield and appearance of the lines in each environment. Means of lines varied considerably at different environment. This was also reported by Asad *et al*. (2009) in seven rice genotypes at eight different sites in Sindh, Pakistan. However, Soroush (2005) reported that the effects of location, year, interaction between genotype x location, and interaction between genotype x year were not significant, in eight rice promising genotypes that were carried out in three locations in Gilan province, Iran. It means that the genotypes had similar response over different locations and years.

Grain Yield

Grain yield of the lines varied when planted in different environmental conditions. The average grain yield ranged from 0.53 ton ha^{-1} to 11.00 ton ha^{-1} (Table 2). In the 2009 DS, the average yield reached more than 8 ton ha^{-1} in Bogor and Pusakanagara. There were four lines yielded more than 10 ton ha^{-1}, i.e. IPB-117-F 17-5, IPB 140-F-6, IPB 140-F-7, and B11738-MR-1-2-Si-1-2, at Bogor in 2009 DS. Line B11742-RS*2-3-MR-34-1-2-1 had the lowest yield. The average yield of lines was not significantly different from that of Ciherang and Sintanur as check varieties. In Pusakanagara, the yield ranged from 8.07 ton ha^{-1} (IPB 149-F-3) to 10.00 ton ha^{-1} (B11742-RS*2-3-MR-34-1-2-1), with an average of 8.97 ton ha^{-1}.

In 2009 WS, at Bogor, the average yield declined from 8.41 to 3.98 ton ha^{-1} in the DS; in Pusakanagara as well, the average yield in the WS turned to 4.61 ton ha^{-1}. In Bogor, there were several lines yielded higher than 5 ton ha^{-1}, i.e. IPB 117-F-17-4 (5.33 ton ha^{-1}), IPB 117-F-17-5 (5.51 ton ha^{-1}), and IPB 117-F-18-3 (5.09 ton ha^{-1}). These lines yielded higher than Ciherang (3.36 ton ha^{-1}) and Sintanur (4.00 ton ha^{-1}) variety. In Pusakanagara, Ciherang and Sintanur had highest yield at 5.70 ton ha^{-1} and 6.00 ton ha^{-1}, respectively. There were 12 lines, i.e. IPB 116-F-3-1 (5.83 ton ha^{-1}), IPB 116-F-46-1 (6.36 ton ha^{-1}), IPB 117-F-17-4 (5.40 ton ha^{-1}), IPB 117-F-17-5 (5.73 ton ha^{-1}), IPB 117-F-18-3 (5.11 ton ha^{-1}), IPB 140-F-1-1 (5.62 ton ha^{-1}), IPB 140-F-2-1 (5.91 ton ha^{-1}), IPB 140-F-5 (5.19 ton ha^{-1}), IPB 149-F-2 (5.14 ton ha^{-1}), B11738-MR-1-2-Si-1-2 (5.14 ton ha^{-1}), B11742-RS*2-3-MR-34-1-2-1 (5.96 ton ha^{-1}), and B11955-MR-84-1-4 (5.40 ton ha^{-1}), yielded more than 5 ton ha^{-1} and were not significantly different from the check varieties. Average yield at Pusakanagara with lower elevation than Bogor was higher, in DS and WS. Imran (2003) reported similar result, in which Gilirang had higher yield at elevation 10 m asl at Takalar (7.2-7.5 ton ha^{-1}) than 800 m asl at Soppeng (4.8 ton ha^{-1}), in South Sulawesi.

B11742-RS*2-3-MR-34-1-2-1 was the line that had the lowest yield in the WS and reached 0.53 ton ha^{-1} only. Yield reduction until 50% in the WS, both in Bogor and Pusakanagara could not be regarded as the worst performance of the line. This line was severely damage caused by rats attack and infested by leaf blight (BLB) as a result of unfavorable weather with high rainfall. Sintanur was also sensitive to BLB. Some lines were destroyed by rat attack and also by BLB. Some of the sensitive lines, showed a symptom of drying leaf tips at primordial growth stage. Islam *et al.* (2010) reported that NPT lines IR2967-12-2-3 produced significantly lower yield in WS 2004 than in the DS 2005 at the research farm of the IRRI. Previous research by Yoshida (1981) reported that maximal grain yield of rice was 10 ton ha^{-1} in the DS and 6 ton ha^{-1} in the WS in tropical irrigated rice system under normal conditions.

Yield Stability

Stability analysis is an important and efficient tool for the plant breeders and agronomists to identify and select the most stable, high performing genotypes that are best suitable under a given set of environmental conditions.

Assessment of lines stability and adaptability were tested following the test method of Finlay-Wilkinson (1963), based on regression coefficient (bi) and the general mean. Regression coefficient (bi) of nine lines was significantly different from one, they were IPB 113-F-2, IPB-116-F 46-1, IPB-117-F 17-4, IPB 117-F-18-3, IPB 140-F-4, IPB 140-F-6, IPB 140-F-7, B11738-MR-Si 1-2, 1-2, and B11955-MR-84-1-4 (Table 3). Five lines, i.e. IPB 113-F-2, IPB 140-F-4, IPB 140-F-6, IPB 140-F-7, and B11738-MR-Si-1-2-1-2, was only adapted to optimum environmental conditions (Azar *et al*., 2008). Those lines were sensitive to environmental changes. While the four others, namely IPB 116-F-46-1, IPB-117-F 17-4, IPB-117-F 18-3 and B11955-MR-84-1-4 were classified as adaptable to marginal environments.

From the value of bi and yield averages of 37 lines, there were nine lines having wide adaptability to the environment because they had a bi values equal to one and the average score higher than general mean. The lines were IPB 116-F-3-1, IPB 117-F-4-1, IPB 117-F-14-2, IPB 117-F-15-2, IPB 117-F-17-5, IPB 140-F-1-1, IPB 140-F-2-1, IPB 140-F-3, and IPB 149-F-2, including Ciherang and Sintanur. With the change of environment, those lines had only a few changes in yield. It could be seen from the average value of line yield, which have a high yield (> 6.5 ton ha^{-1}) in all environments. These lines were stable and have wide stability. Samaullah and Ismail (2009) reported that upland rice line S3382-2D-1-6-3 gave highest yield and was considered the most stable genotype among 11 others in nine locations.

There were 17 lines which had a value close to bi or not significantly different from one (bi = 1) but the average yield was below the general average. Those lines were poorly adapted in all environments and sensitive to environmental changes so it should be used only in specific locations. The research of Haryanto *et al.* (2008) on the aromatic upland rice lines showed that the yield stability in different environments varied between lines. A total of four lines had a high yield stability and wide adaptability and hence potentially be released as a new aromatic upland rice variety.

Table 2. Yield of NPT lines in four environmental conditions

Line	Yield (ton ha^{-1})				
	Bogor 2009 DS	Bogor 2009 WS	Pusakanagara 2009 DS	Pusakanagara 2009 WS	Average
IPB 113-F-1	7.03	3.25	9.16	3.86	5.83
IPB 113-F-2	8.97	2.53	9.29	3.80	6.15
IPB 115-F-3-2	7.25	3.14	9.15	3.52	5.77
IPB 115-F-11	6.66	3.36	8.95	3.24	5.55
IPB 116-F-3-1	8.63	4.13	8.94	5.83	6.88
IPB 116-F-44-1	8.94	4.09	8.75	3.44	6.30
IPB 116-F-46-1	7.84	4.15	9.10	6.36	6.86
IPB 117-F-1-3	6.81	3.89	9.48	4.45	6.16
IPB 117-F-4-1	9.15	4.93	8.85	3.39	6.58
IPB 117-F-6-1	6.30	4.05	9.42	4.74	6.13
IPB 117-F-14-2	9.16	4.73	9.33	4.57	6.95
IPB 117-F-15-2	8.96	4.72	9.08	3.48	6.56
IPB 117-F-17-4	8.78	5.33	8.80	5.40	7.08
IPB 117-F-17-5	10.17	5.51	9.35	5.73	7.69
IPB 117-F-18-3	8.01	5.09	8.18	5.11	6.60
IPB 117-F-45-2	8.12	4.13	8.41	4.40	6.26
IPB 140-F-1-1	8.68	3.95	9.14	5.62	6.85
IPB 140-F-2-1	8.91	4.21	8.94	5.91	6.99
IPB 140-F-3	8.42	4.88	9.15	3.70	6.54
IPB 140-F-4	9.22	3.07	9.45	4.35	6.52
IPB 140-F-5	8.34	2.51	8.81	5.19	6.21
IPB 140-F-6	11.00	4.63	9.09	3.99	7.18
IPB 140-F-7	10.09	3.82	9.06	4.64	6.90
IPB 149-F-1	7.80	4.38	9.11	3.87	6.29
IPB 149-F-2	9.02	3.95	8.31	5.14	6.60
IPB 149-F-3	9.04	4.53	8.07	4.13	6.44
IPB 149-F-4	7.75	3.63	8.60	4.23	6.05
IPB 149-F-5	7.65	4.41	8.83	4.26	6.29
IPB 149-F-7	8.04	4.05	8.93	4.27	6.33
IPB 149-F-8	7.40	4.32	8.88	3.64	6.06
B11249-9C-PN-3-3-2-2-MR-1	8.00	4.39	9.09	3.88	6.34
B11738-MR-1-2-Si-1-2	10.38	3.26	8.90	5.14	6.92
B11742-RS*2-3-MR-34-1-2-1	5.72	0.53b	10.00	5.96	5.55
B11823-MR-3-15-1	7.65	3.71	9.21	3.74	6.08
B11955-MR-84-1-4	8.40	4.49	8.14	5.40	6.61
CIHERANG	9.22	3.36	8.50	5.70	6.69
SINTANUR	9.55	4.00	9.48	6.00	7.26
Average	8.41	3.98	8.97	4.61	6.50

Note: Number in the column followed by letter b is significantly different from Sintanur by Tukey test at $P < 0.05$

Table 3. Stability analysis of NPT lines in four environmental conditions

Line	Yield (ton ha^{-1})	Regression coefficient (bi)
IPB 113-F-1	5.83	1.05 ns
IPB 113-F-2	6.15	1.35*
IPB 115-F-3-2	5.76	1.12 ns
IPB 115-F-11	5.55	1.04 ns
IPB 116-F-3-1	6.88	0.88 ns
IPB 116-F-44-1	6.31	1.12 ns
IPB 116-F-46-1	6.86	0.77*
IPB 117-F-1-3	6.16	0.93 ns
IPB 117-F-4-1	6.57	1.05 ns
IPB 117-F-6-1	6.13	0.83 ns
IPB 117-F-14-2	6.95	1.02 ns
IPB 117-F-15-2	6.56	1.08 ns
IPB 117-F-17-4	7.08	0.77 ns
IPB 117-F-17-5	7.69	0.92 ns
IPB 117-F-18-3	6.60	0.67*
IPB 117-F-45-2	6.25	0.90 ns
IPB 140-F-1-1	6.85	0.95 ns
IPB 140-F-2-1	6.99	0.89 ns
IPB 140-F-3	6.54	1.00 ns
IPB 140-F-4	6.52	1.28*
IPB 140-F-5	6.21	1.10 ns
IPB 140-F-6	7.18	1.24*
IPB 140-F-7	6.90	1.19*
IPB 149-F-1	6.29	0.98 ns
IPB 149-F-2	6.61	0.93 ns
IPB 149-F-3	6.43	0.92 ns
IPB 149-F-4	6.05	0.97 ns
IPB 149-F-5	6.27	0.88 ns
IPB 149-F-7	6.33	0.98 ns
IPB 149-F-8	6.06	0.94 ns
B11249-9C-PN-3-3-2-2-MR-1	6.34	0.99 ns
B11738-MR-1-2-Si-1-2	6.92	1.22*
B11742-RS*2-3-MR-34-1-2-1	5.55	1.17 ns
B11823-MR-3-15-1	6.08	1.07 ns
B11955-MR-84-1-4	6.61	0.75*
CIHERANG	6.69	0.99 ns
SINTANUR	7.26	1.04 ns
Average	6.50	1.00

Note: ns = not significantly different from bi = 1; * = significantly different from bi = 1

CONCLUSION

NPT lines yielded higher than Ciherang (6.69 ton ha^{-1}), were 116-F-IPB 3-1 (6.88 ton ha^{-1}), IPB-116-F 46-1 (6.88 ton ha^{-1}), IPB-117-F 14-2 (6.95 ton ha^{-1}), IPB-117.F 17-4 (7.08 ton ha^{-1}), and B11738-MR-1-2-Si-1- 2 (6.92 ton ha^{-1}). Nine lines were stable and widely adapted at the marginal environment, i.e IPB 116-F-3-1, IPB 117-F-4-1, IPB-117-F-14-2, IPB-117-F-15-2, IPB-117-F-17-5, IPB 140-F-1-1, 140-F-IPB, 2-1, IPB 140-F-3, and IPB 149-F-2. Lines

IPB 113-F-2, IPB 140-F-4, IPB 140-F-6, IPB 140-F-7, and B11738-MR-Si-1-2-1-2 were not stable and adapted only in optimum environmental condition (bi > 1), while IPB 116-F-46-1, IPB-117-F 17-4, IPB-117-F 18-3 and B11955-MR-84-1-4 has the value of bi < 1 or adaptable to marginal environments.

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REFERENCES

Adnyana, M.O., J.S. Munarso, D.S Damardjati. 2008. Ekonomi kualitas beras dan selera konsumen. p. 483-499. *In* F. Kasryno, E. Pasandaran, A.M. Fagi (*Eds*.) Ekonomi Padi dan Beras Indonesia. Badan Litbang Pertanian. Jakarta.

Allard, RW. 1960. Principle of Plant Breeding. John Wiley & Sons. Inc. New York

Asad, M.A., H.R. Bughio, I.A. Odhano, M.A. Arain, M.S. Bughio. 2009. Interactive effect of genotype and environment on the paddy yield in Sindh province. Pak. J. Bot. 41:1775-1779.

Azar, M.S., G.A. Ranjbar, H. Rahimian, H. Arefi. 2008. Grain yield stability and adaptability study on rice (*Oryza sativa*) promising lines. J. Agric. Soc. Sci. 4:27-30.

Dakheel, A.J., G. Shabbir, A.Q. Al-Gailani. 2009. Yield stability of pearl millet genotypes under irrigation with different salinity levels. Europ. J. Sci. Res. 37:288-301.

Eberhart, S.A., W.A. Russel. 1966. Stability parameters for comparing varieties. Crop. Sci. 6:36-40.

Finlay, K.W., G.N. Wilkinson. 1963. The analysis of adaptation in a plant breeding programme. Aust. J. Ag. Res. 14:742-754.

Gomez, K.A., A.A. Gomez. 1995. Statistical Procedures for Agricultural Research. John Wiley and Sons, Inc., Canada.

Haryanto, T.A.D., Suwarto, T. Yoshida. 2008. Yield stability of aromatic upland rice with high yielding ability in Indonesia. Plant Prod. Sci. 11:96-103.

Imran, A. 2003. Penampilan padi aromatik Varietas Gilirang di Sulawesi Selatan. Bul. Plasma Nutfah 9:7-9.

Islam, M.S., S. Peng, R.M. Visperas, M. Sultan, U. Bhuiya, S.M.A. Hossain, A.W. Julfiquar. 2010. Comparative study on yield and yield attributes of hybrids, inbred, and NPT rice genotypes in a tropical irrigated ecosystem. Bangladesh J. Agric. Res. 35:343-353.

Jusuf, M., S.A. Rahayuningsih, T.S. Wahyuni, J. Restuono. 2008. Adaptasi dan stabilitas hasil klon harapan ubi jalar. J. Penel. Pert. Tan. Pangan 27:37-41.

Khush, G.S. 2000. New plant type of rice for increasing the genetic yield potential. p. 99-108. *In* J.S. Nanda (*Ed*.) Rice Breeding and Genetics: Research Priorities and Challenges. Science Publishers, Inc., Enfield USA.

Lone, A.A., P.A. Sofi, M.Z. Warsi, S.H. Wani. 2009. Stability analysis in maize (*Zea mays* L.) for anthesis-silking interval and grain yield. Maize Genet. Coop. Newslett. 83:1-9.

Nur, A., M. Isnaeni, R.N. Iriany, A. Takdir. 2007. Stabilitas komponen hasil sebagai indikator stabilitas hasil genotipe jagung hibrida. J. Penel. Pert. Tan. Pangan 26:106-113.

Samaullah, M.Y., B.P. Ismail. 2009. Stabilitas dan adaptabilitas genotipe padi pada beberapa lingkungan gogo rancah. J. Penel. Pert. Tan. Pangan 28:39-42.

Soroush, R. 2005. Study of grain yield stability in rice (*Oryza sativa* L.) promising genotypes. Iranian J. Crop Sci. 7:112-122.

[UNCTAD] United Nations Conference on Trade and Development. 2010. Rice Market. http://www.unctad.org/infocomm/anglais/rice/market.htm. [9 July 2010].

Yoshida, S. 1981. Fundamentals of Rice Crop Science. IRRI, Los Banos, Philippines.

Zen, S. 2007. Stabilitas hasil galur baru padi sawah preferensi konsumen Sumatera Barat. Agritrop 26:1-5.