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IDENTIFICATION OF RICE (*Oryza sativa* L.) VARIETIES SUITABLE FOR DRY SEASON AND WET SEASON PLANTING

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ABSTRACT

Rice planting on dry and wet seasons faces a specific climatological characteristic, which affects directly on rice growth and yield. Fifteen rice genotypes were evaluated for their seasonal planting adaptation at Sukamandi Experimental Station, Subang, West Java, during the dry and wet seasons of 2009-2010. Randomized complete block design with three replications was applied on the experiment. Plot size was 4 m x 6 m and plant spacing was 20 cm x 20 cm. Standard agronomic practices were applied on both planting season experiments. Data were collected for major morphological traits, days to grain maturity and grain yield, measured on wet and dry basis (11% moisture content). Data were analysed for analyses of variance for each season and for combined seasons, and mean values separation of the variable used the 5% Duncan Multiple Range Test. Correlation between grain yields and morphological variable data were computed for each season and for combined seasons. The correlation coefficients of variables and grain yield were partitioned into direct and indirect causes using path analyses. Combined analyses of variances indicated significant effects of genotypes, seasons and genotypes x seasons interaction for almost all variables, including grain yields, suggesting there were seasonal adaptation specificity among genotypes. Five genotypes were identified as suitable for dry season planting, and nine genotypes as suitable for wet season planting. Among those genotypes, three genotypes, namely Mekongga, Inpari-10 and OM 5240 were suitable for both dry and wet season planting. Ciherang and Cigeulis varieties were more suitable for dry season, while Cibogo, Inpari-1, Inpari-3, Inpari-5, and Inpari-8 were more suitable for wet season planting. Adopting the most productive rice varieties for planting on dry or wet season as was suggested on this research should increase rice production substantially. To facilitate the availability of varieties adapted for a specific planting season, rice breeding should purposedly apply a directional selection of lines suitable for specific planting season, starting on the early generation of selection.

[***Keywords:*** *Oryza sativa*, genotypes, seasonal adaptation, dry season; wet season; grain yield]

INTRODUCTION

Rice (*Oryza sativa*) as a tropical crop is generally considered suitable for commercial planting during the year round, on the onset of wet season or in the dry season. Rice crop, therefore, can be found in particular locations at any months of the year. In the lower altitude of tropical irrigated lands, the climatological factors seemingly to affect the rice growth and grain yield are temperature, irradiation intensity, cloudiness, rainfall patterns and rain intensities, humidity, and to a lesser degree wind velocity. Most of the tropical rice varieties had been bred for photoperiod-insensitive, and therefore different planting times do not usually affect on the crop development ontogeny.

Farmers in rice production areas, where water irrigation is available year round, grow rice at any months of the year, such as those in Klaten District, Central Java. However, the major planting seasons in general can be grouped into three periods of growing seasons, namely: (1) wet season planting, from October to February; (2) early dry season planting, from March to June; and (3) late dry season planting, from July to September. The peak planting season of rice occurs during the wet season, from October to January, to be harvested in February to March, which accounted for 60% of the total yearly harvest (Suryana and Hermanto 2003). The remaining planting times are spread in February to September. For practical reporting purposes, the Directorate General of Food Crops divided the planting season into two periods, namely October-March and April-September cropping seasons.

Most people assumed that the wet season crop produces higher rice yield compared to those of the dry season crop, for reasons of water availability and lower pest and disease incidences (Irawan 2003). However in specific locations, dry season rice crop yielded higher than those in the wet season (Sumarno *et al*. 2009). Research in the Philippines using six rice varieties for two years indicated that rice yield from dry season was always better than that from wet season, with an advantage of 65% (Yang *et al*. 2008). The better rice yield during the dry season according to their study was due to the higher solar radiation during the grain filling period.

The climatological factors constituting dry and wet seasons in Indonesia are quite distinct. The dry season is characterized with a clear sky, high irradiation, no rainfall, and high temperature. Conversely, the wet season is almost always cloudy, with frequent and high rainfalls, as indicated by Karsono (1984) and Laza *et al*. (2003). Yoshida (1981) and Peng *et al*. (2000) reported that rice productivity during dry season could reach up to 10 t ha^{-1} dry grain, where as in wet season the maximum yield was only 6 t ha^{-1}. Peng *et al*. (2004) had indicated that rice grain yield was positively correlated with the daily solar radiation during the rice growing period. Doberman *et al*. (2000) also reported that high solar radiation during the dry season had contributed to the higher rice yield. The solar radiation in Indonesia during the dry season in the lower elevation is quite high, as was recorded by Karsono (1984) which ranged from 434 to 502 cal cm^{-2} day^{-1}. Despite these environmental differences, rice varieties recommended for dry season are the same with those for wet season planting (Suprihatno and Daradjat 2008). Rice breeders in Indonesia have not purposedly bred varieties specifically designated for dry or wet season planting. Varietal releases were not generally recommended for specific planting season, meaning that rice varieties could be planted for either dry or wet season (Suprihatno *et al.* 2007; Suprihatno and Darajat 2008).

The present technology formulation for rice production on the irrigated lands follows the integrated crop management principle, where the most adapted and suitable varieties should be planted in a specific agro-ecological area (Suyamto *et al*. 2007). The right choice of the most adapted variety for dry or wet season, if available, should optimize the rice crop productivity, which leads to the increases of the national rice production. An effort to identify rice varieties suitable for a specific planting season, therefore, is justified.

The release of rice varieties at present is based on the types of agroecology, such as irrigated lands, swamp lands, dry lands, high elevation lands, but none had been designated specifically for dry or wet season planting (Suprihatno *et al.* 2007; Badan Penelitian dan Pengembangan Pertanian 2008). Peng *et al*. (2000) had suggested characteristics of rice variety for the tropical dry season planting, which could be expected to produce 10 t ha^{-1} dry grain, including average of 270-330 panicles m^{-2}, 12 productive tillers per hill, 150 grains per panicle, biomass total of 22 t ha^{-1}, and harvest index of 0.55. Horton (2000) and Hubbart *et al*. (2007) suggested that rice varieties which were suitable for dry season planting to optimally use the abundance of solar radiation for photosynthesis, were those which had stem height minimum of 100 cm and the leaves stayed green or delayed senescence during grain maturing. Different responses of varieties to solar radiation might be manifested on radiation interception, crop growth rate, and assimilate accumulation prior to panicle formation, which determined the grain yield (Miah *et al*. 1996).

Among the released rice varieties, there are variations in their morphological traits, which may be possible to identify their suitability for dry or for wet season planting. The hypothesis of the present research was that among the tested rice genotypes (varieties and lines) there are genotypes which are most suitable for a season specific planting. The objective of the research was to identify rice genotypes most suitable for dry and/or for wet season planting. If such variety is available, rice productivity can be maximized, and thus the national rice production could be increased.

MATERIALS AND METHODS

Research was conducted at Sukamandi Research Station, Subang, West Java, during the dry season of 2009 and wet season of 2009-2010. A total of fifteen genotypes, consisted of twelve released high yielding varieties and three promising lines, were used in the experiments. Name and origin of the genotypes was listed on Table 1. For dry season experiment, the seeds were sown in the seedling nursery on 26 June 2009, and transplanted on the experimental plots on 16 July 2009. For the wet season experiment, the seeds were sown on 22 October 2009 and planted on 12 November 2009. During the dry season cropping, there was no rainfall; the wet season experiment was planted right on the onset of wet season, where the rainfall at the experiment site started on 10 November 2009.

The fifteen entries in each season were arranged in a randomized complete block design in three replicates. Plot size was 4 m x 6 m; plant spacing was 20 cm x 20 cm, two seedlings per hill. Fertilizer rate was 115 kg N + 50 kg P_2O_5 + 50 kg K_2O ha^{-1}. A third of N and whole P and K were applied at transplanting, and the remaining N was given evenly at 35 and 45 days after transplanting. Crop maintenance was done following the standard agronomic practices. Pests were controlled as needed. Irrigation water was supplied sufficiently during the dry season, and

Table 1. Name and origin of rice genotypes used in the experiment, Sukamandi Experimental Station, 2009-2010.

Name of genotype[1]	Pedigree	Origin	Year of released
Ciherang	S3383-id-PN-41-3-1	MVC	2000
Mekongga	S4663-SD-KN-5-3-3	Cross of A 2790/2*IR64	2004
Cigeulis	S3429-40-PN-1-1-2	Cross of Ciliwung/Cikapundung//IR64	2002
Cibogo	S3382-20-PN-16-3-KP-1	MVC	2003
Inpari-1	BP23F-PN-11	IR64/IRBB-7/IR64	2008
Inpari-3	BP3448E-4-2	Digul/BPT164C-68-7-2	2008
Inpari-5	IR65600-21-2-2	Shen Nung 89-366/Ketan Lumbu	2008
Inpari-8	IR73012-15-2-2-1	IR6804/IR61979	2008
Dodokan	IR28128-45-3-3-2	MVC	1987
Silugonggo	IR39357-71-1-1-2-2	MVC	2001
Inpari-10	S3382-2d-PN-4-1	MVC	2009
OM 1490	Unknown	Vietnam	-
OM 4495	Unknown	Vietnam	-
OM 5240	Unknown	Vietnam	-

[1]Genotype denoted name of variety and line, and was used when variety and line were involved. When variety alone was considered, then the term variety or varieties was used.

MVC = multiple variety crosses.

Source: Hermanto *et al*. (2009).

rainfall water was rather excessive for the rice crop during the wet season experiment. The experiment was purposedly protected from the rat attack, by putting plastic fences of 75 cm high around the experiment plots, but some damages were observed. Birds were sent away during the office working hours, but during the off-office hours bird's damages could not be prevented.

Data were collected for plant height at maximum tillering, plant height at harvest, number of tillers, panicles per hill, days to grain maturity, plant weight at tillering (5 hills), dry straw weight at harvest, wet grain yield weighted at harvest, and dry grain yield at 10-11% moisture content. Data were analyzed using analyses of variances by season and combined of two seasons for all observed data. Simple-correlation analyses were computed among variables for each season and combined seasons.

The correlation coefficients between variables to grain yield each were partitioned into direct and indirect causes, using path analyses (Li 1977). Dry grain yields among genotypes in each season were grouped into three classes, namely high, medium and low yields, to identify the most productive (high yielder) genotypes during a particular planting season. The value of 5% DMRT was applied on this rank order. Farmers usually record their rice yield based on the wet grain on the time of harvest. In this experiment, the grains were dried to reach the moisture content of 10-11%, slightly lower than the dry weight based on moisture content at milling.

RESULTS AND DISCUSSION

Analyses of variances for each season data indicated significant differences for treatment effects of almost all variables, except for dry plant weight at tillering and number of panicles per hill in dry season experiment (Table 2). These analyses suggested that the genotypes used in the experiment posses inherent variations on the observed morphological traits. The agronomic indicator variables for seasonal planting adaptation, such as straw weight at harvest, plant height, tiller number, days to maturity, and grain yield, all were significantly different among entries in each planting season, suggesting there was a possibility of selecting the best genotypes among varieties and lines for planting on a specific season.

The combined analyses of variances also indicated significant effect of entries for almost all variables, except for number of panicles per hill. The effects of seasons on agronomic variables were also significant, indicating some degree of consistency of variations over seasons. Season's effect was significant for all variables suggesting that indeed there were some changes of variable values affected by planting seasons. The entry x season interaction effect was significant for six agronomic variables, but was not for days to maturity. The differences in number of tillers, number of panicles, and days to maturity among genotypes due to seasons seemed to be consistent, and were not affected by the entry x season interaction.

Table 2. Analysis of variance of variable data, rice varietal identification for dry and wet season planting experiment, Sukamandi, 2009-2010.

Variable	Mean square		Mean square of combined seasons		
	Dry season	Wet season	Entry (E)	Season (S)	E x S
Dry plant weight at max tillering	0.0013(ns)	0.0007**	0.0005**	0.008**	0.0003**
Plant height at max tillering	106.60**	99.09**	153.90**	1279.00**	52.00**
Plant height at harvest	151.10**	69.78**	180.80**	666.90**	40.10**
Number of tillers per hill	7.23**	2.88*	7.67**	1180.80**	2.40(ns)
Number of panicles per hill	3.50(ns)	2.09*	2.56(ns)	683.00**	3.02(ns)
Days to maturity	62.45**	93.94**	150.90**	190.70**	5.49(ns)
Straw weight	8.50**	11.43*	15.12**	248.20**	4.80*
Grain yield (wet)	3.20**	1.34**	3.85**	7.55**	0.69*
Grain yield (dry)	1.51**	0.93*	1.89**	9.68**	0.55*

* and ** = significantly different at $P < 0.05$ and < 0.01, respectively.
ns = not significant.

Plant growth till tillering stage, as indicated by plant height of each entry, was slower for the dry season crop as compared to that for wet season crop (Table 3). Each of the fifteen entries, its plant height in dry season was significantly shorter than that in wet season, where the differences ranged from 13 to 37 cm. Shorter plant stature for dry season crop was possibly due to higher daily temperatures which were up to 32°C during July to September 2009. At harvest, plant heights of four entries, namely Ciherang, Inpari-5, Dodokan and Inpari-10, were each similar between those in dry and wet seasons. The plant heights of remaining eleven genotypes, in the wet season were significantly taller than those in the dry season. Plant heights in dry season experiment for all fifteen genotypes were shorter than were expected based on the varietal description (Suprihatno and Daradjat 2008). Tiller and panicle numbers per hill for the dry season experiment, however, were significantly higher than those of wet season experiment, for all fifteen genotypes. In dry season experiment each genotype produced normal amount of tillers, ranging from 15 to 21 tillers per hill, and also produced normal number of panicles, ranged from 12 to 16 panicles per hill. The figures for the wet season experiment were lower, 9-13 tillers and 7-10 panicles per hill.

Straw yields in the wet season of all genotypes were heavier that those in the dry season, except for Dodokan variety. However, heavier straw weight harvested during the wet season might have been attributed to higher moisture content, due to problem of drying the bulky straw during the wet season. An adjustment of straw weight based on the 14% moisture content from their original 20% moisture content revealed somewhat similar dry weight, and only for two genotypes, Cigeulis and Silugonggo, the wet season straw weight was each higher than that of the dry season.

Grain yields of genotypes obtained from dry season planting were medium high, ranging from 4.13 to 6.60 t ha^{-1} dry grain. To follow farmers' measurement based on wet-grain weight, grain yield based on wet grain weight were 5.07-8.22 t ha^{-1} comparable to those of farmers' (Table 4).

For further discussion on this paper only dry grain yields were considered. The average ratio of dry grain weight to wet grain weight was 80% for the dry season harvest. Grain yield separation among genotypes in dry season based on 5% DMRT value resulted in three groups, namely low yielding genotypes (4.13-5.44 t ha^{-1} dry grain), medium high yielding genotypes (5.60-6.02 t ha^{-1} dry grain), and high yielding genotypes (6.04-6.60 t ha^{-1} dry grain). Genotypes fell into low yielding group in the dry season were Dodokan, Silugonggo, OM 4495, Inpari-8, and OM 1490; medium high yielding genotypes were Inpari-1, Inpari-5, Conde, Inpari-3, and Cibogo; high yielding genotypes in dry season planting were OM 5240, Inpari-10, Cigeulis, Mekongga, and Ciherang. If grain yield alone was considered, those five high yielding genotypes could be considered as varieties suitable for dry season planting.

In the wet season, grain yields of all genotypes were lower compared to those in the dry season experiment. Dry grain yields among genotypes ranged from 4.41 to 5.67 t ha^{-1}. Yields of genotypes based on wet grain weight were 4.78-7.16 t ha^{-1}, comparable to those of farmers' in the surrounding area. The average ratio of dry grain to wet grain weight for the wet season experiment was 70%.

Days to maturity of seven genotypes planted on the wet season were significantly later than those on

Table 3. Agronomic traits of rice genotypes planted on dry and wet seasons, Sukamandi Experimental Station, 2009-2010.

Entry	Dry season 2009					Wet season 2009/2010				
	Plant height at tillering[1] (cm)	Plant height at harvest (cm)	Tiller number per hill	Panicles per hill	Straw yield (t ha^{-1})	Plant height at tillering[1] (cm)	Plant height at harvest (cm)	Tiller number per hill	Panicles per hill	Straw yield (t ha^{-1})
Ciherang	74d	112fg	17a-c	13a	8.5abc	94ab	113c	11ab	8ab	11.6cd
Mekongga	68abc	105d-f	19b-d	13a	9.4bc	92ab	115e	10ab	9bc	12.4c-e
Cigeulis	70a-d	106ef	16ab	14ab	7.6ab	96bc	111de	10ab	7a	14.2ef
Cibogo	70a-d	106ef	18a-c	15ab	9.0bc	93ab	113e	11ab	9bc	12.7d-f
Inpari-1	65a	90a	19b-d	14ab	7.2ab	89a	105bc	11ab	9bc	10.2bc
Inpari-3	73cd	107ef	19b-d	15ab	9.8bc	92ab	113e	12bc	8ab	12.0c-e
Inpari-5	74d	110e-g	19bd	14ab	9.6bc	92ab	111de	11ab	8ab	11.9cd
Inpari-8	82e	117g	20cd	13ab	11.8c	95bc	112de	13c	11c	14.8f
Dodokan	72cd	95ab	21d	16b	6.5ab	98cd	97a	11ab	10bc	6.5a
Silugonggo	73d	97a-d	18a-c	15ab	5.3a	101de	102b	10ab	9bc	11.3b-d
Conde	68abc	105c-f	19b-d	14ab	8.8bc	94bc	113e	11ab	9bc	11.6cd
Inpari-10	70a-d	109ef	20cd	16b	8.8bc	93ab	111de	11ab	9bc	11.1b-d
OM 1490	74d	103b-f	18a-c	14ab	6.3ab	106f	114e	10ab	8ab	11.9c-e
OM 4495	89f	102b-e	15a	13a	7.8ab	108f	108cd	9a	9bc	9.3b
OM 5240	67ab	97a-c	17a-c	15ab	7.1ab	104ef	108cd	11ab	8ab	11.5b-d
CV (%)	3.5	4.2	2.7	10.9	3.5	2.5	2.4	10.7	10.8	10.6

[1] maximum tillering stage.

Figures on the same column followed by similar letters were not significantly different ($P < 0.05$) based on the DMRT.

Table 4. Grain yield of rice genotypes planted on dry and wet seasons, Sukamandi Experimental Station, 2009-2010.

Entry	Grain yield (t ha^{-1})					
	Dry season		Wet season		Days to maturity (days)	
	Wet grain	Dry grain	Wet grain	Dry grain	Dry season	Wet season
Ciherang	8.22g	6.60g	6.29bc	4.41a	113	115*
Mekongga	7.75fg	6.11fg	6.81ed	5.39b	116	115
Cigeulis	7.93fg	6.33fg	6.49cd	4.90ab	114	115
Cibogo	7.73ef	6.02ef	6.76cd	5.32b	116	117
Inpari-1	7.60de	5.60ef	6.66cd	5.50b	120	118*
Inpari-3	7.56de	5.78ef	7.67d	5.15b	116	115
Inpari-5	7.20cd	5.67de	6.62cd	5.00b	115	118*
Inpari-8	7.00bc	5.27bc	6.90cd	5.49b	119	122*
Dodokan	5.07a	4.13a	4.78a	3.50a	87	92**
Silugonggo	5.07a	4.43a	5.65ab	4.43ab	88	93**
Conde	7.44e	5.69de	6.53cd	4.81ab	120	116**
Inpari-10	7.91fg	6.33fg	7.16d	5.24b	114	115
OM 1490	6.78b	5.44cd	6.22bc	5.30b	88	99**
OM 4495	5.5ab	4.87b	6.01bc	4.79ab	89	101
OM 5240	7.13bc	6.04fg	6.67cd	5.67b	87	92**
Mean	7.06	5.62	6.48	4.99	107	110
CV (%)	5.30	7.10	11.05	12.57	1.05	2.59

Figures within the same column followed by similar letters were not significantly different ($P < 0.05$) based on DMRT.

* and ** = significantly and highly significantly different for the corresponding dry and wet season data.

the dry season, but two genotypes, namely Inpari-1 and Conde were earlier (Table 4). The delay of maturity during the wet season ranged from 2 to 5 days, except for OM 1490 which matured 11days later.

Genotypes in the wet season experiment could be divided into three groups, namely low yielders (3.5-4.41 t ha^{-1} dry grain), medium yielders (4.43-4.90 t ha^{-1} dry grain), and high yielders (5.00-5.67 t ha^{-1} dry grain). In the wet season, the low yielding genotypes were Dodokan and Ciherang; the medium yielding genotypes were Silugonggo, Conde, OM 4495, and Cigeulis; and the high yielding genotypes for the wet season were Inpari-5, Inpari-3, Inpari-10, OM 1490, Inpari-8, Inpari-1, Cibogo, Mekongga, and OM 5240. The nine genotypes which yielded the highest on the wet season were different from those on the dry season experiment, except for Mekongga, Cibogo, and Inpari-10. If grain yield alone was used as criterion for the identification of variety suitable for wet season planting, the above nine high yielding genotypes could be considered. Among nine genotypes suitable for the wet season planting, two genotypes were also suitable for dry season planting, namely Mekongga and Inpari-10. Therefore, Mekongga and Inpari-10 were considered to be suitable for planting on dry and wet season.

Genotypes identified as suitable for specific planting season were presented on Table 5. The genotypes identified as suitable for a specific planting season were each yielded higher than the average yield of all genotypes planted on the respective season.

Selected varieties suitable for the wet season planting indicated longer maturity, between 2 and 11 days later than that of similar variety when planted on dry season, except for Inpari-10, Inpari-3, and Cibogo which had practically constant days to maturity between planting seasons. Inpari-1 infact was 2 days earlier when planted on wet season. Few genotypes evaluated on this study might not to be considered as suitable for either dry or wet season planting, due to their lower grain yield compared to other varieties. Those genotypes were Dodokan, Silugonggo, Conde, and OM 4495. The early maturing genotypes, less than 90 days on dry season, or less than 100 days on the wet season, were prone to birds' damages when planted among the later maturing varieties in the same field. Therefore, their harvested yields were lower than were expected. Earlier maturing varieties were also prone to rats' damages, when planted at the same time with the later maturing varieties.

Correlation analyses among variables on dry season planting revealed significant correlation between grain yield and plant height at harvest and grain yield with days to maturity, but the coefficients were each rather small, namely r = 0.40* and r = 0.44*, respectively. The wet season data indicated a slightly different correlation pattern, namely grain yields were correlated with straw weight and grain yield with plant height at harvest, with the coefficients of correlation were r = 0.43** and r = 0.46**, respectively. Other variables did not significantly correlate with grain yield. When dry and wet season data were combined, the correlation between grain yield and other variables was significant only for tiller number (r = 0.38**) and for panicles per hill (r = 0.31**). There was a significant negative correlation between grain yield and height at maximum tillering (r = -0.43**), signifying that earlier maturing genotypes grew faster to reach the tillering stage but were producing lower grain yields. Some significant correlations among variables were observed, including plant dry weight at maximum tillering and straw yield (r = 0.48**) and plant height at harvest and straw yield (r = 0.63**), but those were not considered agronomically relevant pertinent to this research.

Partitioning the coefficient of correlation of each variable into its direct effect onto the grain yield using path analyses, showed that only plant height at harvest had a sizeable direct effect on yield (p = 0.43); plant height at maximum tillering stage had a negative direct effect on grain yield as did its correlation coefficient to grain yield (Fig. 1). All other variables

Table 5. Rice genotypes identified as suitable for dry and wet season planting, Sukamandi Experimental Station, 2009-2010.

Selected genotype	Suitable for planting		Grain yield (t ha^{-1})		Days to maturity (days)	
	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season
Ciherang	+	-	6.60	4.41	113	115*
Mekongga	+	+	6.11	5.39	116	115
Cigeulis	+	-	6.33	4.90	114	115
Inpari-10	+	+	6.33	5.24	114	115
OM 5240	+	+	6.04	5.67	87	92**
Inpari-5	-	+	5.67	5.00	115	118*
Inpari-3	-	+	5.78	5.15	116	115
OM 1490	-	+	5.44	5.30	88	99**
Inpari-8	-	+	5.27	5.49	119	122*
Inpari-1	-	+	5.60	5.50	120	118*
Cibogo	-	+	6.02	5.32	116	117

\+ = identified suitable for planting at particular season, based on yield separation using 5% DMRT (see Table 3).

\- = not considered suitable for planting at particular season, based on yield separation using 5% DMRT (see Table 3).

*and ** = significantly different at $P < 0.05$ and $P < 0.01$ respectively, between data on dry and wet seasons.

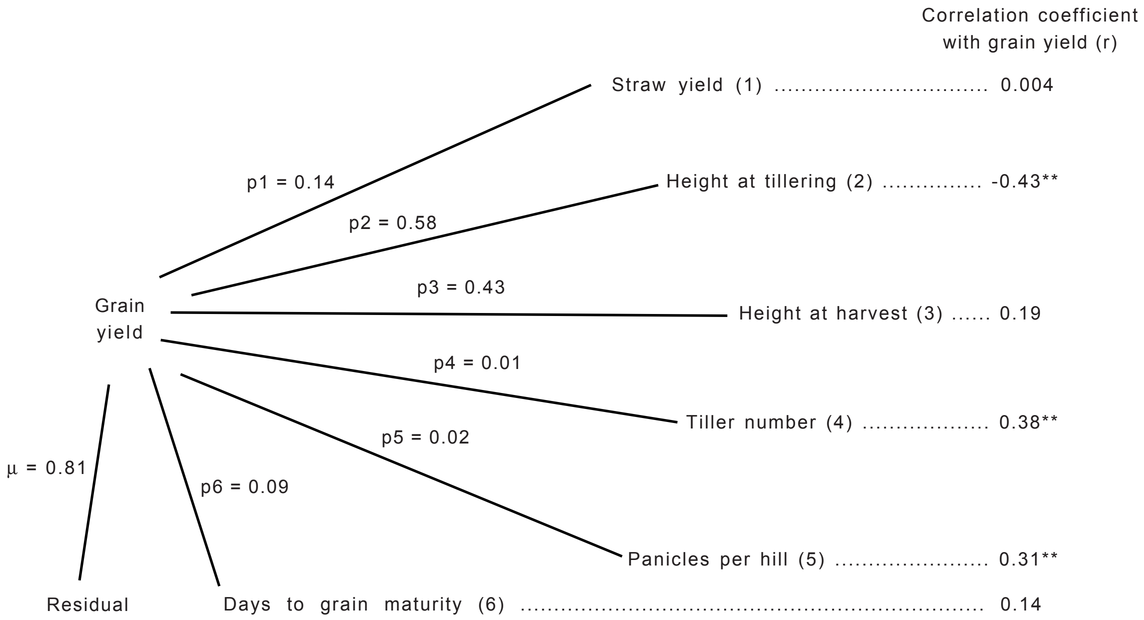

Fig.1. Diagram of coefficients of path analyses of causal variables (1-6) to grain yield, obtained from fifteen genotypes of rice, combined data of dry and wet seasons; Sukamandi Experimental Station, 2009-2010.

showed small path coefficient suggesting that their direct effects on grain yield were small. The residual effect was $\mu = 0.81$, and the R^2 value was 44%. Thus the six variables used in the analyses were only partly, to be accounted for the variations of grain yields. Other variables, which were not observed on this experiment, might have contributed to the yield variation among the tested genotypes.

On rice breeding program, selection and yield evaluation of lines are conducted intermittently during the dry and the wet seasons. Selected lines proposed for varietal releases subsequently utilize the averaged data across locations and planting seasons, and the most outstanding lines based on the averaged yields in both seasons would be proposed for varietal releases. Released varieties therefore, are expected to be suitable for dry and wet season planting.

The present research data indicated that some varieties yielded best on dry season only, while others did best on wet season. Certain varieties produced high grain yield in both dry and wet seasons. If the data obtained from this experiment are consistent over locations and over planting seasons, hence varietal recommendation for specific planting season could be established. The advantages of such recommendation are that rice productivity in each season could be optimized and higher rice production could be expected.

The present research could not be able to indicate a certain association pattern between morphological traits and high productivity for either planting seasons, presumably because the present rice breeding program did not use the morphological traits as a basis for selection criteria, but selection rather based on the empirical yield data, for superior line identification. The high yielding varieties, therefore, could not be described based on their specific agronomic traits, but on the summed up of the overall traits. Genotype x season interactions were frequently observed on the multilocational data analyses as well as on this experiment. These interactions would suggest the occurrence of seasonal specificity on yield performance of genotypes. Breeding program therefore, is suggested to apply directional selection for season adaptations, starting on the early generation from F2 onwards. Lines selected on the wet seasons would be yield tested on the wet season planting, and lines selected on the dry seasons would only be evaluated on the dry season. This way, a part from the other breeding objectives, genotypes are purposedly developed for specific planting season adaptation.

CONCLUSION

To obtain an optimum rice grain yield in a dry and a wet season planting, a most suitable rice variety for a specific season is required. Rice genotypes suitable for dry and for wet season planting were identified. Ciherang, Mekongga, Cigeulis, Inpari-10, and OM

5240 genotypes are more suitable for dry season planting. Inpari-5, Inpari-3, Inpari-8, Inpari-1, OM 1490, and Cibogo are more suitable for the wet season planting, while Mekongga, Inpari-10, and OM 5240 are suitable for both dry and wet season planting.

The implication of the present research results to future breeding program is that rice breeding should apply season directional selection, namely certain breeding populations should be selected for a specific season, and selected lines are to be evaluated on the corresponding season of selection. This way, varieties suitable for specific planting season are expected to be identified more precisely.

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