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VARIETAL DIFFERENCES OF ROOT SYSTEMS IN RELATION TO GROWTH AND PRODUCTION OF RICE

Perbedaan Varietas Tentang Sistem Perakaran yang Berhubungan dengan Pertumbuhan dan Produksi Tanaman Padi

Kukuh Setiawan dan Agus Karyanto[1]

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi pertumbuhan dan produksi dari berbagai varietas tanaman padi, menjelaskan sistem perakaran yang berhubungan dengan pertumbuhan dan produksi, dan menentukan sistem perakaran sebagai salah satu faktor seleksi varietas tanaman padi yang berdaya hasil tinggi. Penelitian ini dilaksanakan pada November 1998 sampai dengan Mei 1999 dan ditanam di lahan sawah Lampung Tengah dengan menggunakan 12 varietas padi. Dua belas varietas padi ini terdiri atas dua ekotipe yaitu *Javanica* dan *Indica*. Total panjang akar dievaluasi dengan cara mencuci hati-hati lalu mengukur panjang akar secara individu setiap varietas padi. Hasil penelitian menunjukkan bahwa berbagai varietas padi mempunyai variasi; panjang akar, jumlah akar, dan bobot kering akar. Ekotipe *Indica*, khususnya Dular mempunyai perakaran yang lebih panjang dan bobot kering akar yang lebih besar daripada yang ekotipe *Javanica*. Keadaan ini mengakibatkan peningkatan hasil dan jumlah malai tanaman padi varietas Dular. Walaupun *Indica* mempunyai kanopi yang lebih luas yang mungkin dapat menyebabkan rebah, namun tetap berdaya hasil tinggi karena mempunyai sistem perakaran yang lebih dalam.

Keywords: Varietas, perakaran, pertumbuhan, produksi

INTRODUCTION

In the near future, Lampung is one of central production areas for rice in Indonesia, however the rice production is still low as compared to that of in Java. It seems very difficult to increase rice production in Lampung due likely to limited amount of rice cultivars. Recently, farmers generally grow rice cultivars, as IR-64 and Talangpadang which produce not more than 4 ton per ha, although the potential rice production is around 8 Mg ha^{-1}. The other problem is due mainly to soil type and microclimate which might limit the growth and production of rice plant. It means that farmers in Lampung need new rice cultivars for adapted rice variety.

Suga *et al.* (1988) and Morita, Suga & Nemoto (1988) proposed a model that root length density could be used as a root system morphology. It means that total

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root length corresponds to the root system. Previous result in peanut plant also showed that the longer total root length the higher root activity and this resulted to the enhancement of peanut yield (Setiawan, 1998).

It is hoped that new introduced rice cultivars would give some information for developing new adapted rice cultivar resulting in improved rice production in Lampung. Additionally, it was reported that improved root system of rice plant could enhance the production due likely to high translocation in both mineral and photo-assimilate (Jiang, Hirasawa & Ishihara 1994). It seems that improved root system of rice (high root activity) is one of promising techniques and strategies for increasing rice production. Such condition could be achieved from evaluation and selection of new introduced rice cultivars.

Consequently, the objectives of this study were to evaluate the growth an the production of different rice cultivars, to elucidate the root system in relation to growth and production, and to determine root system as a selection factor for new adapted high yielding rice cultivars.

METHODS

This study was conducted in low-land rice field, Lampung Tengah by using 12 rice varieties which consisted of two ecotypes of rice plants, as Javanica and Indica (Table 1). This study was scheduled by planting rice in rainy season from November 1998 to May 1999. The variety of IR-64 is used as a check for comparison. Before planting in the field, seeds are planted in the seedbed to get good seedlings. Then each variety with two rice seedlings was planted in the field (low-land) in a plot with 5 x 5 m^2 in size.

The variables used in this study were the number of plant, root length, root number, root dry weight, leaf number, leaf chlorophyll, shoot dry weight, grain number, grain weight, and yield. The leaf chlorophyll was measured with chlorophyll meter SPAD 502. Moreover, the qualitative observations, as leaf color, damage of disease, time for flowering, maturity, and grain color are also observed.

Table 1. The name of rice varieties, ecotypes, and origin.

No	Variety	Ecotype	Origin
1	Surjamkhi	Indica	India
2	Milayang 23	Indica	Korea
3	Dular	Indica	India
4	T 246	Indica	India
5	Nepal No. 18	Indica	Nepal
6	Ciliwung	Javanica	Indonesia
7	Cirata	Javanica	Indonesia
8	IR-64	Javanica	Indonesia
9	TB-205	Javanica	Indonesia
10	S-969	Javanica	Indonesia
11	S-3429	Javanica	Indonesia
12	S-3382	Javanica	Indonesia

Two plants from each plot were carefully pulled in each replication at one week after planting and another two plants were pulled at seed milk stage for total root length. The roots were carefully and gently washed then waited for air-dried condition. After air-dried condition, the individual roots from each plant were cut and then measured the length.

There were three replications in each observation, and each replication consisted of ten samples that were randomly taken. Data were analyzed by variance analysis methods (Steel & Torrie, 1980) and calculated by SAS method. The means of treatments were separated by using LSD with 5% level of difference.

RESULT AND DISCUSSION

There was a varietal difference of root system, as total root length, root number, and root dry weight in 12 rice varieties

(Table 2). TB-205 had the longest total root length and total root number. This mainly TB-205 had high root dry weight and root length, approximately 5.6 g and 36.5 cm, respectively. On the other hand, Dular variety showed the longest total root per plant that was approximately 465 cm and 2.80 g, respectively. However, IR-64 was the lowest total root length/plant and root dry weight, which was around 118 cm. Although the highest root number was S-3429 (807), this variety had total root per plant only 198 cm. It means that the root length of this variety was not as long as that of Dular. Moreover, Dular also showed the longest individual root, that was approximately 12.73 cm, and followed by TB-205, that was around 12 cm. The shortest individual root was shown by IR-64, that was around 8 cm.

Although Dular showed the good performance of root system, but Dular had the lowest total leaf area, that was 977.94 cm^2. Besides, Dular also showed the lowest dry weight of stem and leaf, that was 10.4 g and 8.4 g, respectively (Table 3). The lowest leaf area of Dular was due mainly to the low number of plant and leaf. It means that Dular'leaf was relatively had bigger leaf than the other rice plants.

In general, Indica ecotype as Surjamkhi, Milayang 23, Dular, T 246, and Nepal 18 showed the small seed size, but they had high yield and average of inflorescence number, approximately between 600-627 g $4m^{-2}$ and 81 no $4m^{-2}$, respectively (Table 4). This could make Indica ecotype of rice plants to be potential for high yielding rice variety. To support this, we could refer to the root length and yield of Indica (Figure 1). This figure showed that the longer total root length of Indica had high yield. Furthermore, high chlorophyll of Indica ecotype might cause high number of inflorescence.

Although Indica ecotypes could be a potential high yielding rice variety, they showed little bit bigger canopy (data not shown). This means that Indica ecotypes also had potential for lodging due probably

Table 2. Total root length, root number, root dry weight, and individual root length (longest root length) of different rice varieties.

Varieties	Total root length	Total root length per plant	Root number	Root dry weight	Longest root
	..... cm	..... cm		..... g	..... cm .....
Surjamkhi	4798.70 b	293.40 e	448 de	4.50 d	23.00 c
Milayang 23	3805.70 a	129.70 ab	337 b	2.80 a	21.00 b
Dular	6350.00 d	465.10 f	499 f	4.70 de	25.00 d
T 246	3554.50 a	144.00 b	369 c	4.80 e	25.70 d
Nepal No. 18	7011.00 e	238.80 d	605 i	4.70 d	23.60 c
Ciliwung	3436.80 a	130.50 a	327 a	4.00 c	22.60 c
Cimta	5217.10 c	237.70 d	513 g	4.00 c	27.00 e
IR-64	3409.00 a	117.80 a	442 c	2.80 a	20.70 b
TB-205	9112.10 g	290.60 e	734 j	5.60 f	36.50 g
S-969	5731.40 c	281.90 e	561 h	3.60 b	29.90 f
S-3429	8456.50 f	198.50 c	807 k	3.50 b	21.00 b
S-3382	4394.30 b	134.10 a	456 e	3.70 b	19.20 a

The same letters in the same column indicated no significant different by LSD at the significant level of $P > 0.05$

Table 3. Plant number, leaf number, leaf area, stem dry weight, and leaf dry weight of different rice varieties

Varieties	Plant number	Leaf number	Leaf area	Dry Weight	
				Stem	Leaf
Surjamkhi	17 b	79 a	1066.50 b	13.20 b	8.10 a
Milayang 23	30 g	135 e	2269.20 d	16.90 d	11.90 cd
Dular	14 a	75 a	977.90 a	10.40 a	8.40 d
T 246	25 e	107 b	1335.50 c	24.00 g	11.10 c
Nepal No. 18	30 g	124c d	2454.00 f	26.80 h	11.20 c
Ciliwung	27 f	129 d	2365.00 e	14.20 bc	10.00 b
Cirata	23 d	104 b	1103.50 b	21.10 f	9.30 b
IR-64	30 g	110 b	2267.30 d	15.30 c	9.60 b
TB-205	32 h	148 f	2215.30 d	16.20 d	12.20 d
S-969	21 c	104 b	1267.60 c	18.10 e	8.90 a
S-3429	40 j	158 g	2457.50 f	29.00 i	11.90 cd
S-3382	34 i	118 c	2286.60 d	14.70 bc	9.30 b

The same letters in the same column indicated no significant different by LSD at the significant level of $P > 0.05$

Table 4. Yield and yield components of 12 rice varieties

Varieties	Seed size (1000 seed weight)	Yield	Infloresence number
	..... g	..... g $4m^{-2}$	
Surjamkhi	18.90 a	612.10 c	72 ab
Milayang 23	23.10 c	600.40 c	83 bc
Dular	23.70 c	625.70 c	86 bc
T 246	24.30 de	603.90 c	87 c
Nepal No. 18	22.20 bcd	627.30 c	76 abc
Ciliwung	20.90 ab	571.40 bc	76 abc
Cirata	23.40 c	520.10 a	66 a
IR-64	26.50 f	430.80 a	82 c
TB-205	26.30 e	426.30 a	78 abc
S-969	24.10 d	449.00 a	75 abc
S-3429	26.30 e	465.50 ab	88 c
S-3382	21.60 bc	613.80 c	78 abc

The same letters in the same column indicated no significant different by LSD at the significant level of $P > 0.05$

to plant high and not uprightness. On the other hand, *Javanica* ecotypes, as IR-64 showed uprightness but still had small number of inflorescence and yield compared to the Indica ecotypes as Dular. It seems that yield and yield components of Indica ecotype have not been affected by canopy shape and uprightness during grain filling period since this ecotype has good performance of root system, as longer total root length, root dry weight, and high root number. It was previously reported by

Settawan (1998) in peanut that good root system as longer root length and high root activity of peanut could be an indicator for high peanut yield under dry condition due mainly to high root penetration in the soil. Conversely, Zubaidi (1998) reported that the higher root growth (root length, dry root weight, and fresh root weight) of Rau (local variety) did not show higher yield and yield components of Rau compared to national varieties of Memberamo and Si Ampat. Interestingly, from the visual observation, compared to Javanica, Indica showed earlier flowering time (2 weeks earlier) and this resulted in the earlier harvest time.

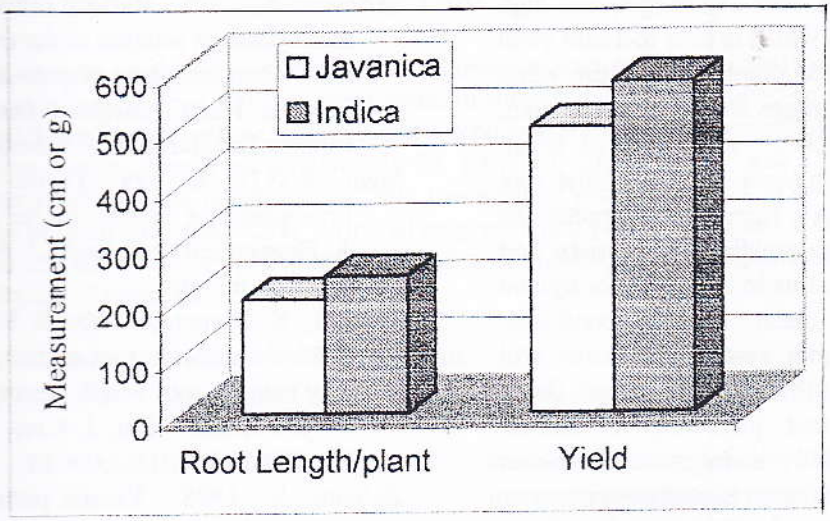

Fig 1. Root length per plant and yield of two ecotypes of rice plant

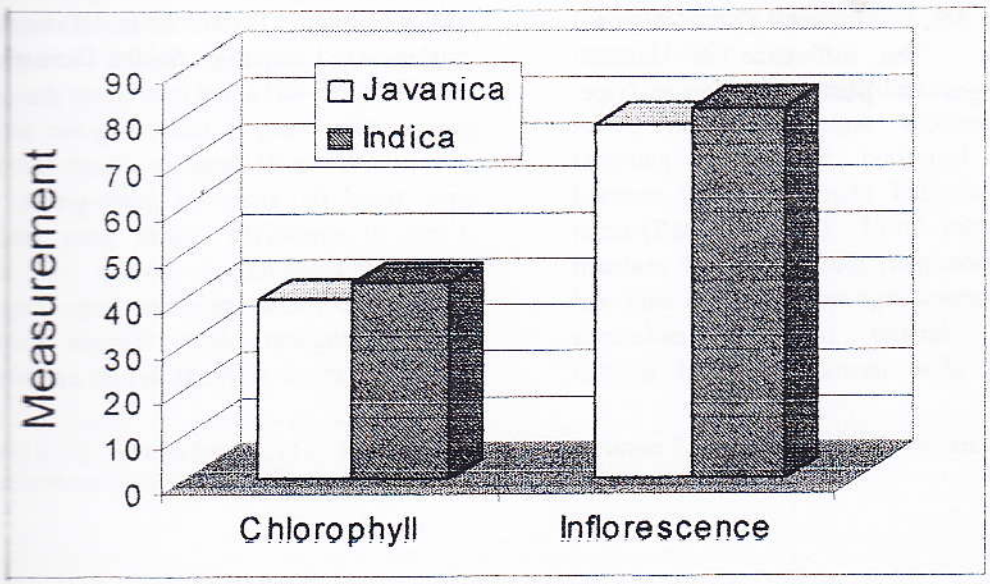

Fig 2. Chlorophyll and inflorescence of two ecotypes of rice plant

CONCLUSION

Indica and Javanica ecotypes showed a varietal difference of root system, as total root length and root number. Among 12 rice varieties, Dular (Indica) had highly potential for high yielding rice varieties due mainly to good performance of root system (root dry weight and total root length per plant). Moreover, Indica showed longer total root length, root dry weight, and high leaf chlorophyll which in turn increase yield and inflorescence number. On the other hand, although Indica showed tallness stem, early flowering time, and scattered grain, but still had high yield. It seems that root system could be a promising character for selection of high yielding rice variety and this character seems to be useful for upland rice selection under drought condition. However, the root system evaluation still needs to be further studied to get detail information about physiological characteristics, especially endogenous hormones of cytokinin in relation to root system.

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