TIME OF FLOODING FOR GOGO RANCAH RICE AND REPRODUCTIVE STAGE MOISTURE STRESS FOR WALIK JERAMI RICE

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ABSTRACT

Time of flooding gogo rancah rice and reproductive stage moisture stress for walik jerami rice. Effect of time of flooding and reproductive stage moisture stress crop productivity was studied in the Jakenan experimental station during the 1988-1989 wet season, the 1991 (second dry season) and the 1992 first dry season. The was clasified as planosol type with the texture of sandy loam. Three separate field experiments were conducted and each was arranged in split plot design with four replications. Time of flooding treatments consist of six levels i.: a) 4 wk; b) 5 wk; c) 6 wk; d) 7 wk; e) 8 wk and 9 wk after seeding. The reproductive stage moisture stress treatment for the experiment in 1991 and 1992 consists of three level, namely; a) continually field saturation b) no irrigation from panicles initiation to heading and c) no irrigation heading-harvest. The rice genotypes used n these experiment are ; Dodokan and Cikapundung, (for the gogo rancah experiment) and IR 36, IR 64, Ciliwung, IR 39357-71-1-1-2-2, 5969b-265-1-4-1, S400b-552, IR39422-18-1-2-2, IR45912-9-1-2-2 and IR 48563-11-2-2-3. The result showed that flooding at 7 week after seeding was very important for gogo rancah to achieve higher yield. Without the supply of the rainfall during walik jerami growing period, the moisture stress imposed from panicles initiation to heading reduced grain yield up to around 70% when the moisture stress was imposed from heading to maturity. The result of the 1992 experiment failed to detect any of the effect of reproductive stage moisture stress on grain yield because the rainfall distributed well during the treatment. Green house experiment (supporting research) with the - 50 cub moisture stress during panicles initiation to heading reduced 50% grain yield of IR 64, however, Ciliwung variety was relatively stable under various stages of moisture stress tested. IR39357-71-1-1-2-2 had the intermediate tolerance to the reproductive moisture stress and also suitable for gogo rancah rice particularly when the rainfall was uneven during the early par of the growing season.

Key Word : *Oryza sativa*, gogo rancah, time flooding, moisture stress, walik jerami rice

INTRODUCTION

In Pati district, rainfed rice area occupies about two-third of the total wetland rice areas (irrigated rice 20.598 ha; rainfed rice 39.383 ha), and comprise 11% of the total rainfed rice areas concentrates at Jaken, Jakenan and Pucakwangi subdistrict.

The traditional cropping pattern at Jaken subdistrict in gogo rancah (dry seeded bunded) during wet season followed by walik jerami rice (minimum till age, transplanted) in dry season I and dryland crops in dry season II.

Variability of the onset and lack of rainfall before and after sowing were serious production constraint for gogo rancah rice. Drought often occurs in the beginning west season, therefore the farmers delayed till age and sowing. The average yield of gogo rancah was around 6.0 t/ha under normal conditions. Drought stress during reproductive stage was a mayor problem for the walik jerami rice and so the yield was very low only about 2.0 t/ha.

The proportion of the length of dryland and wetland during gogo rancah growing season determine growth and yield performance.

Little information was available on the time of flooding for gogo rancah and also many the systematic studies on the effect of moisture stress at different growth stages on rice have been conducted, however, the result varied with location, season and variety. These variations were attributed to the effect of climatic., soil and hydrological factors on yield components and root growth and development.

The objectives of experiment were : (1) to study the effect of time of flooding on the yield of gogo rancah rice and to determine optimum time of flooding for gogo ancah rice; (2) to study the reaction of varieties or breeding lines to water stress at reproductive stage in walik jerami system.

MATERIALS AND METHODS

Experiment 1. Effect of time of flooding on the yield gogo rancah rice. Field experiment was conducted during the 1988 - 1989 wet season at Jakenan experimental station on the planosol soil with sandy loam texture ; pH 5.6, organic matter 0.62%, total N 0.07% CEC 5.3 meg per 100 g soil, extractable P 18.0 mg kg^{-1} and exchangeable K 0.04 meq per 100 g soil.

A split plot design with four replications was used. A time of flooding treatment was studied on the sub-plot and variety on the main-plot. A very early maturing rice variety Dodokan and an early variety Cikapundung were used. Time of flooding was consisted of 6 levels namely; a) 4 wk; b) 5 wk; c) 6 wk; d) 7 wk; e) 8 wk; f) 9 wk after seeding, respectively. Watering was from the rainfall and from water collector which located near the experimental site.

The seeds were dibbled with three seeds per hole with 20 x 20 cm spacing. The plot size was 4.0 x 5. 0 m. All plots were fertilized with the rates of 112 kg N ha^{-1}, 45 P_2O_5 ha^{-1} and 40 kg K2O ha^{-1} at seedling time, 4 kg N ha^{-1} 3 weeks after seeding and 32.5 kg N ha^{-1} at panicle initiation. All dosages of Potassium (KCl) and triple superphosphate (TSP) were given at seeding time together with the first nitrogen application. Weeds and pest disease were controlled intensively.

Observation of crop variables were made for root dry mass, yield components and grain yield. Root mass density were sampled by core methods. Yield components and yield were recorded at harvest. Yield was obtained from 5 m^2 harvest area and then adjusted to ton per hectare at 14% moisture content. Five plants per plot were used to characterize yield components. Soil matrics potential was measured by tensiometer (manometer type) which installed at 10 cm depth whereas piezometric water level was measured with piezometer inserted at the 75 cm depth. Daily rainfall data were taken from a weather station located 50 m from the experimental site.

Experiment 2. Study on the effect of soil water stress at reproductive stage on grain yield in walik jerami rice. Field experiment was conducted at the Jakenan experiment station during the 1991 and 1992 dry season.

A split plot design with three replications was used for both experiments. Experiment in 1991, five rice genotypes were used as sub-plot and three levels of soil water stress were used as main-plot and three levels of soil water stress were used as main-plot factor i.e : a) continuously field saturation; b) from panicle initiation to heading; c) from heading to maturity. Experiment in 1992 , there was some modification for number and type rice genotypes used as sub-plot factor. These rice genotypes were : IR39357-71-1-1-2-2, S969b-265-1-4-1 and S400b-55-2.

The 21-d-old seedlings were transplanted at 2 seedling/hill with the 20 x 20 cm spacing. Land was plowed twice by hoeing and one harrowed by buffalo power. The plots size were 4 x 5 m and each of plot received Urea, TSP and KCl with the rates 135 kg N ha^{-1}, 45 kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1} respectively. Urea was applied at transplanting with 45 kg N ha^{-1}, at 3 weeks after transplanting with 45 kg N ha^{-1} and the rest of rate was given at panicle initiation. All rates of KCl and TSP were applied as basal. Weeds were kept free and pest diseases controlled intensively.

Observations were made for crop variables consisted of the yield components and yield. Four plants per plot were used to characterize yield components and grain yield was obtained from 8 m^2 harvest area and then adjusted to ton per hectare at 14% seed moisture content.

Soil moisture status at the 0-15 cm depth was determined by gravimetric method and expressed the unit with percent oven dry weight (% ODW).

Experiment 3. Greenhouse study on the effect soil water stress at different growth stages on the yield of lowland rice. Experiment was conducted at the Sukamandi experimental station during the 1989 dry season on Ultisol soil with silty clay texture.

A split plot design with four replications was used. Four levels of soil water stress as used as sub-plot factor i.e; a) continuously flooding; b) imposed from 10 DAT to panicle initiation; c) imposed from panicle initiation to heading and d) imposed from heading to maturity. Two varieties were used as main plot factor i.e; a) IR 64 and b) Ciliwung. The soil moisture stress was allowed to - 50 cb and measured by tensiometer at 10 cm depth and then reirrigate until soil reached at field saturation. The 21-d old seedlings were transplanted to each pot with 4 hill per pot.

Grain yield data were obtained from each pot and expressed in gram per hill at 14% seed moisture content.

Crop data analyzed using analysis of the split plot design and Duncan's Multiple Range Test was employed if F-tes shows significance.

RESULT AND DISCUSSION

The effect of time of flooding on the yield components and grain yield for gogo rancah rice are presented in Table 1.

Table 1. Effect of time of flooding and cultivar on the yield components and grain yield for gogo rancah, Jakenan, 1988-1989 WS

Treatment	Yield components				
	Spikelet/ panicle (no)	Filled spikelet	1.000 grain wt	Panicle length	Grain yield (t/ha)
Cultivars (C)					
c1: Dodokan	84.3 b	75.0 a	24.7 a	22.3 b	4.17 a
c2: Cikapundung	119.4 a	69.5 b	23.5 b	23.1 a	3.95 a
Time of flooding (F) (WAS)					
f1: 4	105.4 a	74.4 a	25.1 a	23.4 a	4.54 a
f2: 5	98.3 a	73.5 a	24.5 ab	22.9 ab	4.24 ab
f3: 6	103.0 a	70.7 a	24.2 abc	22.9 ab	4.10 ab
f4: 7	105.1 a	71.9 a	23.8 bc	22.4 b	4.05 bc
f5: 8	101.5 a	71.1 a	23.3 c	22.3 b	3.81 bc
f6: 9	97.6 a	72.0 a	23.6 bc	22.3 b	3.63 c
cv (c) :	5.3%	4.7%	3.3%	3.9%	18.9%
cv (F) :	7.8%	4.5%	3.8%	3.3%	10.0%

In a column, menas followed by a commòn letter are not significantly different at the 5% level by DMRT

WAS : week after seeding

cv : coeffecient variation

There were significant difference in spikelet number per panicle, filled spikelet percentage and 1.000 grain weight between Dodokan and Cikapundung, but it was not observed in grain yield.

Panicle length, the 1.000 grain weight and grain yield were offered by time of flooding. Flooding from four to six weeks after seeding were important period to achieve higher yields. There were a tendency of declining in grain yield when the flooding was applied more than six weeks after seeding.

Spikelet number per panicle and filled spikelet percentage were not affected by time of flooding treatments.

The declining of yield at or above seven weeks after seeding might be due to lower in supply of water and nutrient particularly nitrogen to the crop. Ismunadji (1985) stated that the form and availability of nutrients are directly related to moisture supply in the soil.

The effect of time of flooding on the root mass density for the gogo rancah rice are illustrated in Figure 1 and Figure 2.

There were a gradual increase in root mass density from 37 to 88 days after seeding. The length period of dryland relative to wet land was tended to increase in root mass density at the 0-5 cm depth.

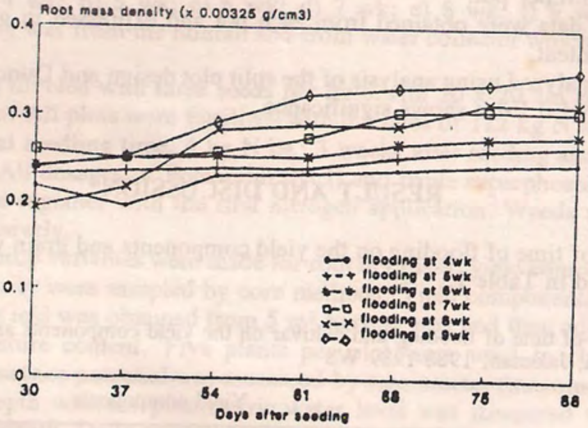

Figure 1. Root growth of Dodokan variety at the 0-5 cm soil depth as effected by time of flooding, Jakenan. 1988-1989 WS

Apparently, Cikapundung had root mass density at 0-5 cm depth higher than Dodokan particularly under flooding at nine weeks after seeding. The rooting characteristics influenced by water regime and type of cultivars. The rooting depth of a variety was deepest when it is grown under dryland condition.

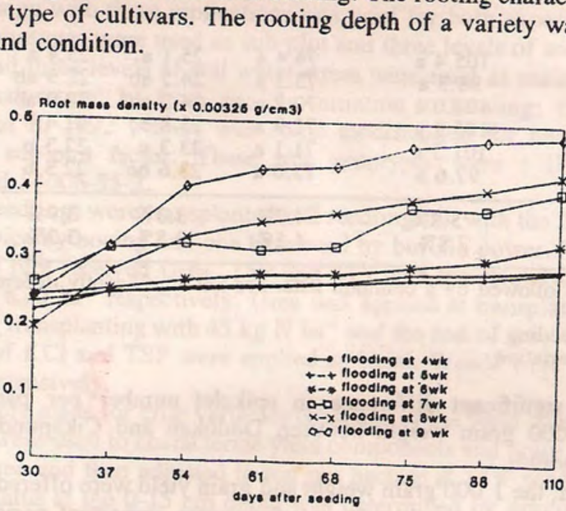

Figure 2. Root growth of Cikapundung variety at the 0-5 cm soil depth as effected by time of flooding, Jakenan, 1988-1989 WS

An aerobic soil favors deep root growth and rice varieties differs markedly in their rooting habits, both laterally and vertically (Yoshida and Hasegawa, 1982).

The fluctuation of soil matric potential and piezometric water level during gogo rancah growing season are illustrated in Figure 3 and Figure 4.

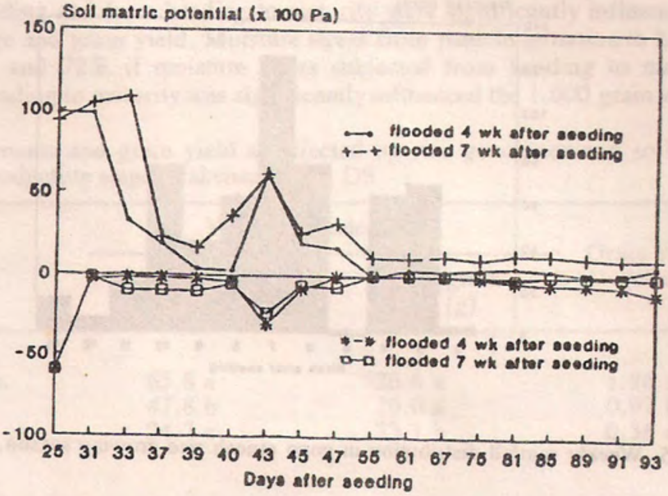

Figure 3. Fluctuation of the soil matric potential at the 10 cm soil depth and piezometric water level for the two time of flooding of Dodokan, Jakenan, 1988-1989 WS

High fluctuation of soil matric potential have been occurred from 25 to 40 days after seedling and subsequently relatively stable. The piezometric water level closed to the soil surface from 45 days after seeding to harvest.

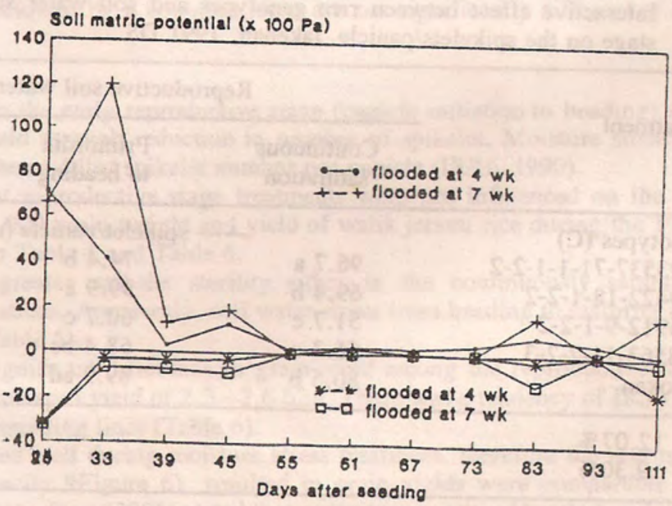

Figure 4. Fluctuation of the soil matric potential at the 10 cm soil depth and piezometric water level for the two time of flooding of Ciliwung, Jakenan, 1988-1989 WS

The dynamics of soil matric potential and the depth of piezometric water level were partly controlled by rainfall. Weekly rainfall distributed well from 45 days after seeding until harvest (Fig. 5), therefore the soil matric potential and perched water table were stable.

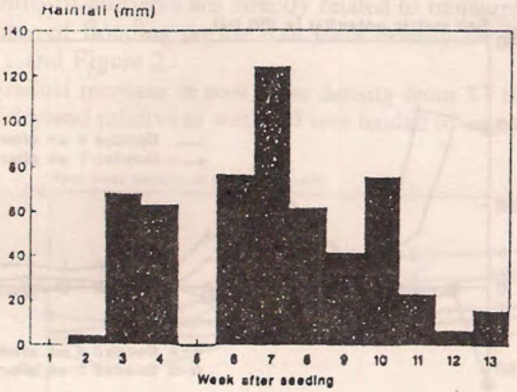

Figure 5. Weekly rainfall distribution in gogo rancah rice growing season, Jakenan, 1988-1989

The effect of rice genotypes and soil water stress at the reproductive stage on the yield components and yield are presented in Table 2 to Table 7.

There was rice genotypes and soil water stress interaction on the spikelet per panicle (Table 2).

Dodokan and IR394322-18-1-2-2 had the stability in production of spikelet per panicle under reproduction moisture stress.

Table 2. Interactive effect between rice genotypes and soil water stress at reproductive stage on the spikelets/panicle, Jakenan, 1991 DS

Treatment	Reproductive soil water stress (S)		
	Continuous saturation	Primordia to heading	Heading to maturity
Rice genotypes (C)		------ spikelet/panicle (no) ------	
c1: IR393537-71-1-1-2-2	96.7 a	74.4 b	78.1 a
c2: IR39422-18-1-2-2	69.4 b	99.9 a	82.7 a
c3: IR45912-9-1-2-2	51.7 c	60.7 c	62.0 b
c4: IR48563-11-2-2-3	56.3 c	68.4 bc	64.0 b
c5: Dodokan	80.5 b	89.9 ad	75.9 a
cv (C) : 12.07%			
cv (S) : 9.30%			

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT

Number of spikelet per panicle reduced by reproductive phase drought (De Datta, 1981).

The effect of moisture stress at the reproductive stage on the yield component and yield are presented in Table 3.

Without rainfall during growing season of walik jerami rice, moisture stress from panicle initiation to heading and from heading to maturity were significantly influenced the filled spikelet percentage and grain yield. Moisture stress from panicle initiation to heading reduced yield of 50% and 72% if moisture stress subjected from heading to maturity. Moisture stress from heading to maturity was significantly influenced the 1,000 grain weight.

Table 3. Yield components and grain yield as affected by rice genotypes and soil water stress at reproductive stage , Jakenan, 1991 DS.

Treatment	Yield components		Grain yield (t/ha)
	Filled spikelets (%)	1,000 grain wt (g)	
Soil water stress (S)			
s1:continuous saturation	65.8 a	26.6 a	1.96 a
s2:PI too heading	47.8 b	26.0 a	0.97 b
s3:heading to maturity	24.7 c	23.1 b	0.36 c
Rice genotypes (C)			
c1:IR393537-71-1-1-2-2	51.3 a	25.9 a	1.20 a
c2:IR39422-18-1-2-2-	52.0 a	22.8 b	1.19 b
c3:IR45912-9-1-2-2	40.8 b	25.6 a	0.99 b
c4:IR48563-11-2-2-3	44.4 b	25.6 a	0.97 ab
c5:Dodokan	42.1 b	26.3 a	1.13 ab
cv (S)	16.0%	5.3%	
cv (C)	13.4%	5.0%	

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT

Moisture stress in the early reproductive stage (panicle initiation to heading) resulted in a decrease grain yield through reduction in number of spikelet. Moisture stress during reproductive phase reduced filled spikelet number per panicle (IRRI, 1990).

Moisture stress at reproductive stage treatments were not influenced on the panicle number per hill, the 1,000 grain weight and yield of walik jerami rice during the 1992 dry season are presented in Table 4 and Table 6.

The IR36 had greater spikelet sterility either in the continuously saturation of reproductive moisture stress. Apparently, soil water stress from heading to maturity induced the spikelet sterility (Table 5).

There was not significant difference in grain yield among the reproductive moisture stress treatment. The averaged yield of 2.2 - 2.6 t/ha. There was a tendency of IR36 yielded higher than did other breeding lines (Table 6).

Rainfall distributed well during moisture stress treatment, therefore the soil moisture status above field capacity 9Figure 6), resulted in grain yields were comparable among moisture stress treatments. Fagi (1986) stated that capacity was critical level of soil moisture for rainfed lowland rice.

Table 4. Yield components of walik jerami as affected by rice genotype and soi water stress at reproductive stage, Jakenan, 1992 DS

Treatment	Yield components		
	Panicle per hill (no)	spikelet per panicle (no)	1,000 grain wt (g)
Rice genotypes (C)			
c1:IR36	13.8 a	84.0 a	19.2 d
c2:IR393537-17-1-1-2-2	14.0 a	58.1 b	21.2 b
c3:S969B-265-1-4-4	13.4 a	62.9 b	24.4 a
c4:S400B-55-2	10.8 a	82.1 a	20.2 c
Soil water stress (S)			
s1:Continuous saturation	12.6 a	79.7 a	21.5 a
s2:PI to heading	12.7 a	64.5 b	20.9 a
s3:Heading to maturity	13.7 a	71.2 b	21.3 a
cv (C)	19.6%	9.5%	1.9%
cv (S)	30.1%	12.0%	2.3%

In a column, means followed by by a common letter are not significantly different at 5% level by DMRT.

Table 5. Interactive effect of rice genotypes and soil water stress at reproductive stage on the spikelet sterility, Jakenan, 1992 DS

Rice genotypes (C)	Soil water stress (S)		
	Continuous saturation	Panicle initiation to heading	Heading to maturity
	--- spikelet sterility (%) ---		
c1:IR36	15.8 a	34.3 a	41.0 a
c2:IR393537-71-1-1-2-2	13.3 a	23.9 ab	28.8 b
c3:S969b-265-1-4-1	10.2 a	16.2 c	17.2 b
c4:S400b-55-2	18.7 a	23.0 ab	19.5 b
cv (V)	29.6%		
cv (S)	31.0%		

In a column , means followed by a common letter are not significantly different at the 5% level by DMRT

Table 6. The grain yield of walik jerami as affectted by rice genotypes and soil water stress at reproductive stage Jakenan, 1992 DS

Treatment	Grain yield (t/ha)
Rice genotypes 9C)	
c1:IR36	3.02 a
c2:IR393537-71-1-1-2-2	1.99 a
c3;S969B-265-1-4-1	2.19 a
c4:S400B-55-2	2.16 a
Soil water stress (S)	
s1:Continuous saturation	2.62 a
s2:PI to heading	2.21 a
s3:heading to maturity	2.20 a
cv (C): 29.6%	
cv (S): 26.1%	

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT

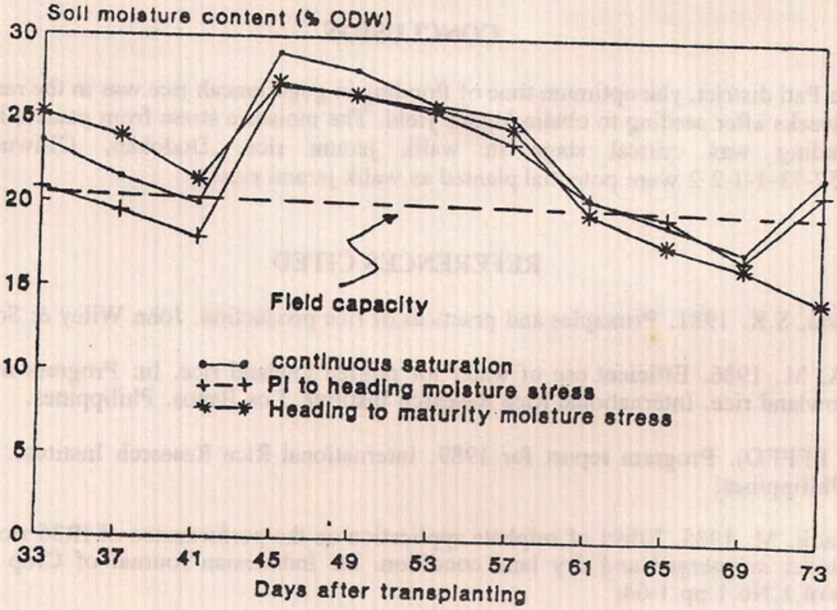

Figure 6. Soil moisture status at the 0-15 cm depth under different moisture stress conditions for walik jerami, Jakenan, 1992 DS

Although the level of yield of Ciliwung lower than IR64, however, it had more tolerant to moisture stress at various growth stages. iR64 was more sensitive to moisture stress from panicle initiation to heading than other phases of moisture stress (Table 7).

Table 7. Interactive effect of cultivar and soil water stress at different growth stages on the grain yield (g/hill), Sukamandi Greenhouse, 1989 DS

Soil water stress (S)	Cultivar (C)	
	c1:IR64	c2:Ciliwung
	--- grain yield (g/hill) ---	
s1:continuous flooding	20.82 a	17.23 a
s2:10DT to panicle initiation	18.82 a	15.71 a
s3:PI to heading	10.31 b	15.04 a
s4:Heading to maturity	19.90 a	17.25 a
cv (V) : 3.0%		
cv (S) : 10.7%		

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT
PI : panicle initiation
DT : days after transplanting

CONCLUSION

In Pati district, yhe optimum time of flooding in gogo rancah rice was in the range four to six weeks after seeding to obtain higher yield. The moisture stress from panicle initiation to heading was critical stage in walik jerami rice. Dodokan, CIliwung and IR39357-71-1-1-2-2 were potential planted as walik jerami rice.

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