

Ecophysiology of Growth and Yield of Several Local Rice Varieties (*Oryza Sativa* L.) with Various Kinds of Irrigation

Bambang Heri Isnawan^{1*}, Hariyono¹, dan Iffa Nur Faridatul Adillah¹

¹Agrotechnology Department, Universitas Muhammadiyah Yogyakarta

*Email: bambanghi@umy.ac.id

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ABSTRACT

A research aims to examine the physiology, growth and yield of rice in several varieties of rice plants with System of Rice Intensification and conventional irrigation methods. The study was conducted using 3x4 factorial strip plot design arranged in a Completely Randomized Block Design with 3 blocks as replications. The first factor was the type of irrigation that had 3 treatments, i.e., irrigation, intermittent irrigation: 10 days inundated, 5 days drained and intermittent irrigation: 7 days flooding, 3 days drying. The second factor was the rice varieties consisting of 4 varieties, i.e., Rojolele Genjah, Mentik Wangi, Mentik Susu and Cempo Hitam. The results showed that the plant height of the Rojolele Genjah variety was higher than other varieties. The grain yield per hectare of Mentik Wangi, Mentik Susu and Cempo Hitam varieties were higher than the Rojolele Genjah Variety. The treatment of irrigation for 7 days of flooding and 3 days of drying was greater than other irrigation for panicle length, and harvest index. CGR of conventional irrigation treatment was greater than intermittent irrigation. There was interaction between varieties and irrigation on the leaf area of rice plants, which in Cempon Hitam Variety with irrigation intermittently 10 days of flooding 5 days drying had the broadest leave area.

Keywords: aromatic rice; plants physiology, System of Rice Intensification;

INTRODUCTION

Rice (*Oryza sativa* L.) is a major component in the national food security system. Under highland agriculture circumstances, the main stress variables that affect rice development and yield are soil re-watering patterns brought on by intermittent rainfall patterns and drought cycling [1]. The four pillars of food security include availability, access, usage, and stability of the food supply through time. These pillars promote nutrition outcomes [2].

The increasing demand for rice is currently not comparable to rice production per hectare and

the conversion of agricultural land to non-agricultural is the main cause of low national rice production. Rice is the main source of carbohydrates for half of the world's population, especially for Asians, and rice demand is rising for non-Asians as well [3]. The findings demonstrated that land acreage, urea fertilizer, and NPK fertilizer all had an impact on corporate farming's ability to produce rice [4]. Urea fertilizer has been used excessively, especially on marginal land, to improve rice output [5].

Rice is the primary food commodity in Indonesia [5]. To The average increase in national

rice production in recent years is still low at 2.2 – 2.3% per year. Yield testing at various agro-climates for some promising lines bred is required in order to generate such excellent rice [6]. Utilizing urea (N-fertilizer) in conjunction with crop residue and animal manures as organic carbon sources could support an exhausted agricultural system based on rice [7]. In comparison to rice output in 2020, which was 54.65 million tons of milled dry grain, rice production in 2021 was 54.42 million tons GKG, down 233.91 thousand tons or 0.43 percent [8]. The rice harvest area in 2021 reached around 10.41 million hectares, a decrease of 245.47 thousand hectares or 2.30 percent compared to the rice harvest area in 2020 which was 10.66 million hectares [8].

Indonesia must at least increase the availability of rice to 7 million tons in 2025-2030 to anticipate the increase in population. The increasing population coupled with climate change amplifies issues of food insecurity and negatively impacts the livelihoods of smallholder farmer households [9]. Beras untuk pangan penduduk mencakup pangan rumah tangga dan non rumah tangga, seperti hotel, restoran, dan katering [10]. Indonesian rice consumption reaches 139 kg per capita per year or is the highest in the world. Recent increases in rice consumption in Sub-Saharan Africa are noteworthy. Most of the rice production in these countries depends on an enormous number of small-scale rice farmers [11].

The National Rice Production Improvement Movement is an activity to increase rice production accompanied by the provision of inputs to facilities and infrastructure through optimizing the utilization of agricultural, technological, and institutional resources. To catch up with the lack of production targets, the Ministry of Agriculture has made efforts to accelerate by increasing rice productivity, assistance with superior seeds, direct assistance for fertilizers, irrigation, assistance with

agricultural machinery and agricultural extension workers.

One of the innovations developed to increase agricultural production is the System of Rice Intensification (SRI) method of rice cultivation. When SRI farming is done in tidal areas, there are two significant issues, including the presence of Fe, which may be hazardous to plants, and a lack of nutrients [12]. Rice is a major source of daily calories for both people and animals [3]. By reducing inter-plant competition, transplanting young, single seedlings at a wide spacing, enhancing favorable soil conditions with organic amendments, increasing soil aeration through weeding, and using controlled water management, the system of rice intensification (SRI) aims to create the best conditions for healthy plant growth [13].

The first SRI rice cultivation method was discovered in Madagascar between 1983-1984 in which the SRI method applied different ways of managing crops, soil, water and nutrients. The SRI method develops rice management practices that pay attention to better plant growing conditions, especially in root zones. The emphasis on saving water is also an effort to anticipate the increase in water needs, among others, for agriculture, drinking water, industry and sanitation. One method for increasing rice yield is the usage of native varietals. There are various types of rice, and each type has unique physical and chemical features [14].

Local varieties have many advantages including tolerance to marginal land conditions, resistance to several types of pests and diseases, requiring low inputs (fertilizers and pesticides), and easy and simple maintenance. The purpose of this study is to compare the growth and yield of various varieties of local rice plants, analyze the growth and yield of rice plants on various irrigation methods and determine the interaction between local rice plant varieties and types of irrigation on growth and yield.

MATERIALS AND METHODS

The research was carried out for 4 months, in the experimental field of the Faculty of Agriculture, University of Muhammadiyah Yogyakarta. The materials used include Rojolele Genjah variety rice seeds, Mentik Wangi, Mentik Susu, Cempo Hitam as well as manure and NPK fertilizer. The tools used include: hoes, rulers, electric scales, Leaf Area Meters, measuring cups, ovens, optical microscopes and binocular microscopes.

The study used a 3x4 factorial experiment method with a strip plot design (path plot design) arranged in a Complete Group Random Design (RAKL) The factors and treatments are as follows: Factor 1 is the type of irrigation system consisting of: Conventional irrigation, 10 days

intermittent irrigation is flooded, 5 days is dried, and 7 days intermittent irrigation is flooded 3 days is dried. Factor 2 is the variety of varieties consisting of four varietal levels: Rojolele Genjah, Mentik Wangi, Mentik Susu, and Cempo Hitam.

The implementation of research includes seeding, tillage, planting, maintenance, and harvesting. The parameters observed consist of: Plant Height, Number of Saplings, Leaf area, , number of panicles per clump, panicle length, harvest index, CGR, NAR, SLW, , weight of 1000 grains and grain yield/hectare. The research data were analyzed with Sidik Ragam at alpha 5%, and if there was a real difference continued with Duncan's Double Fingerprint Test at alpha 5%

RESULTS AND DISCUSSION

Plant growth.

The fingerprint results showed no real interaction between irrigation and variety on crop height and number of rice saplings. Variety has a significant effect on rice plant height, while irrigation has no real effect on plant height (table 1).

The variety exerts a noticeable influence on

the height of rice plants. The Rojolele Genjah variety is markedly taller than the Black Cempo Variety at 108.59 cm (Table 1). The height of the Cempo Hitam rice plant is significantly higher than Mentik Wangi. This is because each variety has a different plant height growth, depending on plant genetics.

Table1 1. Average Plant Height and Number of Rice Saplings Age 10 Weeks (cm)

Treatment	Plant Height (cm)	Number of rice saplings (buah)
Conventional irrigation	100.64 a	16.67 a
10 days flooded, 5 days dry	100.67 a	15.00 a
7 days flooded, 3 days dry	99.28 a	15.17 a
Rojolele Genjah	108.59 p	14.19 p
Mentik Wangi	95.41 r	14.93 p
Mentik Susu	94.89 r	17.11 p
Cempo Hitam	101.89 q	16.22 p
Interaksi	(-)	(-)

Description: Numbers followed by the same letter in one column show no real difference based on fingerprints at the level of α 5%. (-): No interaction

Conventional and intermittent treatments showed no real effect on rice plant height. This shows that intermittent irrigation is sufficient to support the high growth of rice plants. Varietal

treatment had no significant effect on the number of rice saplings nor did irrigation treatment have a significant effect on the number of rice saplings (table 1). Table 1 shows that varietal treatment

had no significant effect on the number of rice saplings. The ability to form saplings is influenced by genetic traits and environmental circumstances corresponding to plant growth.

Macam irrigation has no real effect on the number of rice saplings. This is because irrigation treatment, both conventional and intermittent irrigation, has provided a sufficient amount of water for the growth of the number of rice saplings. The results of fingerprinting the variety of rice leaf area show that there is a real interaction between varieties and irrigation, meaning that the two factors influence each other on rice leaf area (table 2).

Table 2 shows that the treatment of Black Cempo Varieties with intermittent irrigation (10

days of inundation, 5 days of dryness) had a significantly higher effect than the treatment of Fragrant Picking Varieties with conventional irrigation, Rojolele Genjah Varieties and Fragrant Picking with intermittent irrigation (10 days of inundation, 5 days of dry) and Black Cempo Varieties with intermittent irrigation (7 days of inundation, 3 days of dryness).

Based on the results of fingerprints, it shows that there is no interaction between irrigation treatment and variety on the number of panicles and panicle length. This means that there is no mutual influence between variety treatment and irrigation of panicle length and number of rice panicles

Table 2. Average Leaf Area of Rice Plants unnt 10 weeks (cm²)

Treatment	Rojolele Genjah	Mentik Wangi	Mentik Susu	Cempo Hitam	Average
Conventional irrigation	1.498,00abc	893,33c	1.548,00abc	1.206,33abc	1.286,42
10 days flooded, 5 days dry	1.063,00bc	1.148,67bc	1.420,33abc	1.846,00a	1.369,50
7 days flooded, 3 days dry	1.630,33ab	1.221,00abc	1.238,67abc	956,00bc	1.261,50
Average	1.397,11	1.087,67	1.402,33	1.336,11	(+)

Description: Numbers followed by the same letter in a row or column showed no real difference based on the results of various fingerprints at the level of α 5%. (+) : There is an interaction between variety and irrigation

The treatment of varieties exerts no noticeable difference on the number of panicles. The irrigation treatment showed no

real difference between conventional and SRI irrigation methods (table 3).

Table 3. Average Number of panicles and length of Rice panicles

Treatment	Panicle length (cm)
Conventional irrigation	21,23b
10 days flooded, 5 days dry	21,52b
7 days flooded, 3 days dry	22,97a
Rojolele Genjah	21,86p
Mentik Wangi	20,75p
Mentik Susu	22,01p
Cempo Hitam	23,01p
Interaksi	(-) (-)

Description: Numbers followed by the same letter in one column showed no real difference based on fingerprints and DMRT at the level of α 5%.

This shows that the number of rice panicles by irrigation by SRI method is able to

compensate for the number of rice panicles with conventional methods. The number of

panicles is related to the grain weight per clump, and the grain yield per hectare. The greater the number of panicles produced, the higher the grain weight per clump and the grain yield per hectare.

Varietal treatment showed no real effect,

while irrigation treatment showed a real effect on rice panicle length (table 3). The irrigation treatment after 7 days flooded, 3 days dried showed longer panicle growth than the irrigation treatment after 10 days flooded, 5 days dried and conventional irrigation.

Physiology of Rice Plant

The harvest index is the ability of plants to channel assimilate for the growth of rice grains. The results of fingerprinting the variety of crop growth index and crop growth rate (CGR) of rice show that there is no real interaction between variety and irrigation,

meaning that there is no mutual influence between variety treatment and irrigation on the harvest index and CGR of rice. Varietal treatment had a significant effect, while irrigation treatment had no real effect on the rice harvest index (table 4).

Table 4. Average Harvest Index and CGR

Treatment	Harvest index	CGR (g/m ² /minggu)
Conventional irrigation	0,74b	2,48a
10 days flooded, 5 days dry	0,74b	1,78b
7 days flooded, 3 days dry	0,85a	1,97b
Rojolele Genjah	0,70p	2,22p
Mentik Wangi	0,78p	2,26p
Mentik Susu	0,81p	2,02p
Cempo Hitam	0,81p	1,80p
Interaksi	(-)	(-)

Description: Numbers followed by the same letter in one column show no real difference based on fingerprints and DMRT at the level of α 5%. (-): No interaction

Table 4 shows that variety has no real effect on rice harvest index, meaning that variety treatment has the same effect on rice harvest index. Irrigation treatment has a significant effect on the rice harvest index. The 7-day flooded 3-day dry treatment with a grain weight of 0.85 grams showed a real harvest index higher than the 10-day flooded 5-day dry irrigation treatment and the conventional treatment with a ganbah weight of 0.74 grams. This shows that irrigation 7 days flooded 3 days dry has the ability to channel assimilate for better grain growth than other irrigation methods.

CGR is an increase in weight per unit area of land in a certain time. The results of CGR fingerprints showed that the varietal treatment showed no real effect, while the irrigation treatment had a real effect on CGR

(table 4). Table 4 shows that varietal treatment has no real effect on rice CGR, that is, varieties have the same effect on rice CGR. Irrigation treatment has a real effect on CGR. CGR with conventional irrigation of 2.48 g/m²/week, markedly higher than the treatment of irrigation 10 days flooded 5 days dry and irrigation 7 days flooded 3 days dry.

Net Assimilation Rate (NAR) is the rate of dry weight accumulation per unit leaf area per unit time. The results of NAR fingerprints and Specific Leaf Weight (SLW) showed no real interaction between varieties and irrigation, meaning that there was no mutual influence between variety treatment and irrigation on NAR and SLW rice. The average results of rice NAR and SLW analysis are presented in Table 5.

Table 5. Average NAR and SLW of rice

Treatment	NAR (g/dm ² /weeks)	SLW (g/dm ²)
Conventional irrigation	0,015a	0,035a
10 days flooded, 5 days dry	0,010a	0,026a
7 days flooded, 3 days dry	0,010a	0,029a
Rojolele Genjah	0,011p	0,028p
Mentik Wangi	0,016p	0,038p
Mentik Susu	0,010p	0,027p
Cempo Hitam	0,008p	0,026p
Interaksi	(-)	(-)

Description: Numbers followed by the same letter in one column showed no real difference based on fingerprints and DMRT at the level of α 5%. (-): No interaction

The varietal treatment showed results that did not differ markedly, as well as the irrigation treatment showed results that did not differ markedly from the net assimilation rate of rice. Table 5 shows that varietal treatment has no significant effect on rice NAR. NAR is related to the leaf area of rice plants, although varietal treatment and irrigation interact markedly with leaf area. Varietal treatment has the ability to produce dry matter from amylate at relatively equal units of leaf area and time. The irrigation treatment showed no real difference or the same effect on the net assimilation rate of rice plants.

SLW is an indicator of plant physiology that describes leaf thickness. The higher the BDK value indicates thicker leaves []. Varietal treatment showed no real difference, nor did irrigation treatment show no significant effect on typical rice leaf weight (table 5). This shows that the irrigation treatment has no real

effect on the typical leaf weight in both conventional and intermittent irrigation.

Components of Plant Yield and Yield

The average weight of 1000 seeds and grain yield per hectare of rice are presented in Table 6. The results of fingerprinting the weight of 1000 seeds and yield per hectare of rice showed that there was no real interaction between variety and irrigation, meaning that there was no mutual influence between variety treatment and irrigation on the weight of 1000 seeds and yield per hectare of rice. Varietal treatment had no significant effect on the weight of 1000 grains, nor did irrigation treatment show no real effect (Table 6). Varietal treatment showed no significant effect on the weight of 1000 grains, as well as irrigation treatment showed no real effect on the weight of 1000 grains (Table 6).

Tabel 6. Average Weight of 1000 Grains and Grain Yield per hectare

Treatment	Weights of 1000 Grain (grams)	Grain yield per hectare (ton/ha)
Conventional irrigation	26,65a	3,52a
10 days flooded, 5 days dry	23,40a	4,83a
7 days flooded, 3 days dry	22,89a	4,47a
Rojolele Genjah	22,21p	3,19q
Mentik Wangi	27,61p	4,86p
Mentik Susu	22,89p	4,36p
Cempo Hitam	24,54p	4,69p
Interaksi	(-)	(-)

Interaksi (-) (-)

Description: Numbers followed by the same letter in one column showed no real difference based on fingerprints and DMRT at the level of α 5%. (-): No interaction

The weight of 1000 grains is influenced by the water content and nutrients contained in the soil so that it can be used for the growth of rice grains. The potential weight of 1000 grains of grain in the Rojolele genjah variety is 32 grams, the Mentik Wangi variety is 21.11-22.51 grams, the Mentik Susu variety is 22.3 grams and the Cempo Hitam variety is 25 grams.

The irrigation treatment of SRI and conventional methods shows that the weight of 1000 grains of rice is not significantly different. Thus, it can be interpreted that intermittent irrigation is the best choice because it saves water. Irrigation in rice plants is closely related to the availability of water during the grain filling period, if there is a lack of water at this time then the grain is not fully drained so that it affects the weight of 1000 grains [15].

Grain yield per hectare is influenced by several plant yield component factors, namely panicle length, number of panicles, grain weight per clump and grain weight of 1000 grains. Based on the results of fingerprints, it shows that there is no real interaction between varieties and irrigation on yield per hectare of rice, meaning that there is no mutual influence between variety treatment and irrigation on grain yield per hectare. Varietal treatment had a significant effect on grain yield per hectare,

while irrigation treatment showed no real effect (table 6).

Varietal treatment showed a significantly different effect on grain yield per hectare, namely the Fragrant Mentik Variety, Milk Picking and Black Cempo had a higher yield than the Rojolele Genjah Variety which was only 3.19 tons / ha (Table 6). This shows that the treatment of different local rice varieties has a significant effect on grain yield per hectare. Each variety has different properties and characteristics and different morphologies. The generative phase of each rice variety differs in grain filling. Intermittent and conventional irrigation treatment has no real effect on grain yield per hectare.

Grain yield per hectare in some varieties is still lower than the expected yield potential. Based on the description of rice, the Rojolele Genjah variety has a potential yield of 4.2 tons / ha. The Mentik Wangi Variety has a potential yield of 4.18 tons/ha and the Mentik Susu Variety has a potential yield of 5 tons/ha. Black Cempo rice variety has a potential yield of 5 tons / ha. The yield of grain per hectare of research results is lower due to several factors of pest attacks of rats, snails, rats, birds and walang sangit.

CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that the height of the Rojolele Genjah Variety is 108.59 cm, higher than the Black Cempo variety, and the Black Cempo Variety is higher than the Fragrant Mentk and Milk Picking Varieties. The grain yield per hectare of Mentik Wangi, Mentik Susu and Cempo Hitam varieties is higher than that of Rojolele Genjah Varieties. Irrigation treatment intermittently 7 days of

inundation and 3 days of dry results in panicle length, harvest index greater than irrigation treatment. Crop Growth Rate rice plants conventional irrigation treatment is greater than intermittent irrigation. There is an interaction between the variety and irrigation of the leaf area of the rice plant. The Black Cempo variety with irrigation 10 days apart flooded 5 days dry has the most extensive leaves.

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