ADVANCES IN AGRICULTURAL AND FOOD RESEARCH JOURNAL

HH PUBLISHER

Original Research Article

River Water Quality Monitoring at Paddy Field in Merlimau, Melaka

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Abstract: Water is the main resource of rice cultivar input for growth development and yield production. The water quality can affect the rice yield. The study aims to analyse the water quality in rivers that are directly supplied to the paddy fields. The water quality of the river at Merlimau paddy field was tested using Cyberscan 600 series. The variables taken were pH, conductivity level, sodium chloride (NaCl) and resistivity level. The monitoring was conducted at three stages of the paddy cultivation process which are during land preparation, vegetative stage and maturing stage to see the variables supplied to the paddy fields. This study can help farmers to know the state of water quality that has been used to irrigate the paddy field.

Keywords: river water quality; paddy field; paddy water pH; paddy water conductivity; sodium chloride

Received: 13th March 2021

Received in revised form: 21st January 2022

Accepted: 21st January 2022

Available Online: 4th February 2022

Citation: Sabran, M.S., & Mustaffha, S. River Water Quality Monitoring at Paddy Field in Merlimau, Melaka *Adv Agri Food Res J* 2022; In-Press: a0000286. https://doi.org/10.36877/aafrj.a0000286

1. Introduction

About half of the world's population consumes rice as staple food in which Asia has produced 90% of total world production (Radin Firdaus *et al.*, 2020). In Malaysia, agriculture accounted for 22% of the water consumption in 2005 (Worldometer, n.d.). The paddy field covered about 677.000 hectares in 2014 (Rahmat *et al.*, 2019).

Water can easily dilute anything surrounding them, whether it is contaminants or nutrients in the surrounding water environment which will result in water quality in paddy systems (Liu *et al.*, 2018). Salinity is one of the main variables of abiotic stress that can reduce the efficiency of rice production. Water salinity is also known as salt soluble concentrations in the water. Water salinity relates to different physiological and metabolic processes changes in the plant (Gupta & Huang, 2014). Plant growth and yield loss are the problems that emerged and arose from water salinity to paddy crops (Munack, 2003). Other effects of high-water salinity observed are photosynthesis, respiration, nitrogen fixation and carbohydrate metabolism (Gupta & Huang, 2014). The high salt concentration of water produces adverse effects on paddy growth because this plant is very sensitive to it (Amirjani, 2012).

Rice is a particularly susceptible plant to salinity, which can be present in both water and soil in paddy fields. This salinity sensitive plant would have detrimental effects on its growth during the reproductive period where it is very tolerant of salinity during germination at the vegetative level (Scardaci *et al.*, 2001). Salinity affected the number of panicles and the weight of each panicle, resulting in slower rice development.

The electrical conductivity of irrigated water has a relationship between rice yield and also soil. The electrical conductivity of soil is affected by a mix of physiochemical properties including dissolvable salts in irrigation water, clay content and mineralogy, soil water content, bulk density, and soil temperature (Ezrin *et al.*, 2010).

The chlorophyll content of salt-stressed paddy can be defined as a function of the leaf's sodium content (Soomro, 2004). The sodium chloride (NaCl) that accumulates in the leaf laminae can reduce photosynthesis and rice growth. Besides, sodium uptake from the soil and water to the rice plant is larger at lower air humidity. The response of transpiration to salt stress under various air humidity rates varies among rice cultivars as per their general protection from salinity and their opposition procedure and furthermore, relies upon the external salt fixation. The standard rate of NaCl of paddy cultivars is 0–440 ppm and this range shows the salinity status is low.

Water resistivity is the one measurement of the capacity and ability of the water to oppose an electrical current and directly related to the amount of dissolved salts in the water. There resistivity is low in the water with a high concentration of dissolved salts, and vice versa (Bischetti, 2014). When the salts are bonded in the water, the free ions are created. Free ions can conduct an electrical current in the water drainage at paddy fields.

The total dissolved oxygen (DO) is very important as it influences rice root growth and nitrogen availability in the soil. The rate of DO in the water increases when enough sunlight reaches the surface of rice leaves and bare fields (Usui & Kasubuchi, 2011). This term measures water quality for rice where water's capability to pass electrical flow. This conductive ion occurs from dissolved salts and inorganic materials such as alkalis, chlorides, sulphates, and carbonate compounds. The recommended rate of dissolved oxygen for good paddy growth requirement is 500 mg/L.

Hence, this study aims to analyse the quality of water which is used to irrigate the paddy field using Cyberscan 600 series. However, this study was only focusing on the variables of the water itself without involving the effect of the water on the rice as a whole.

2. Materials and Methods

The focus area of the study was Kampung Merlimau of the Melaka region which was involved in the production of paddy rice. The study was conducted at the river in Kampung Sempang and Kampung Pengkalan Samak. For each area, the water samples were taken at three points at a distance of 1 m each. Most of the farmers in these areas irrigate their paddy fields using water sources from the river around that place.

Data was taken during land preparation, vegetative and maturing stages throughout the paddy growth to see the differences of each variable of the water supplied at different stages. However, the data were taken without considering the growth of paddy itself in that area since the focus was on the water quality in the river supplied to the paddy fields. The variables studied were pH, conductivity level, NaCl, DO and resistivity level. The tool used to measure the variables is the Cyberscan 600 Series. The water samples were put in a container and the Cyberscan 600 Series was probe dipped in the water to get the readings. Table 1 shows the recommendation level of the water salinity standard rate.

Table 1. Recommendation standard rate of water salinity

Water Content	Value / Rate	Unit	Author
Water pH	6.0–7.5	pH	Dung *et al.* (2019)
Conductivity Level	High < 70, Intermediate 70–110, Low > 110	µs	Fipps (2003)
Sodium Chloride (NaCl)	0.0–440.0	ppm	Amirjani (2012)
Resistivity	30.0	kΩ	Fipps (2003)
Dissolved Oxygen (DO)	3.0	mg/L	Zainuddin (2010)

3. Results and Discussions

Water quality supplied to agricultural fields is very important for a healthy growth of the crops. The quality and quantity of water will help to transport nutrients through the plant. The quality of water supplied also will determine the stability of soil structure and exchangeable sodium which can lead to water movement reduction and aeration in the paddy soil (Hassan *et al.*, 2016).

Table 2 shows the average value of each variable taken from Kampung Sempang and Kampung Pengkalan Samak during the three stages of paddy cultivation. The results showed that the average pH values of the river water were in between 6.62 to 7.31 for both areas. The pH level was higher at the maturing stage compared to two other stages which were the preparation stage and vegetative stage at Kampung Sempang, while the water pH of

Kampung Pengakalan Samak was highest during the vegetative stage. However, the pH values for the water sources still meet the recommended standard for water salinity.

Results of NaCl of water sources for both areas showed that all the NaCl value were within the recommended level. There was no significant difference between NaCl levels in Kampung Pengkalan Samak but showed differently in Kampung Sempang. The standard rate of NaCl of paddy cultivars was 0–440 ppm and this range showed that the salinity status is low and acceptable. The paddy growth can be affected by the low rate of NaCl content in the irrigation water at the paddy field. Among the effects on rice growth are reduced germination rate, reduced plant height and tillering, poor root growth, and increased spikelet sterility (Zhang *et al.*, 2015). However, for this study, no data was taken to show any effect of NaCl towards paddy growth.

Table 2. Average value of variables at (a) Kampung Sempang, Merlimau and (b) Kampung Pengkalan Samak

Stage	**Average pH**		**Conductivity (µS)**		**Sodium Chloride (NaCl) (ppm)**		**Resistivity (kω)**		**Dissolved Oxygen (mg/L)**	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Land preparation	6.72	6.90	119.63	279.90	108.70	137.23	4.63	3.65	1.28	6.15
Vegetative	6.62	7.31	153.94	161.70	142.21	148.27	3.79	3.29	11.80	10.69
Maturing	7.00	6.47	357.17	161.27	174.87	146.47	2.81	3.33	5.93	1.25

Overall, the resistivity level of the river water was low, which means that the dissolved salt in the water was high. On the other hand, low resistivity can also mean that the conductivity level was high. The main reason that led to the readings obtained was due to the river location which is close to the sea. The streams are often exposed to salt water spray or flooding near the sea. The highest level of resistivity was recorded at the preparation stage for both areas. According to the standard rate of resistivity for paddy plants, all stages of paddy cultivars were below the optimum resistivity level. This can lead to unhealthy paddy plants and limit growth at all levels.

The results showed that the DO in the river was very low during land preparation stage for Kampung Sempang and at the maturing stage for Kampung Pengkalan Samak area. Among the reasons for the result was the presence of oil palm plantations along the river. Organic matter from the plantations can cause a decrease in DO. The reduction in the paddy growth and yields was expected to happen based on previous research (Matsuo *et al.*, 1995) if the value of DO was low during the vegetative stage. The paddy uses the oxygen available from water and soil especially during germination until the plant can create an air space cell that allows the roots to use ambient oxygen (Mowjood & Kasubuchi, 1998). Typically, the oxygen is exchanged between the atmosphere and the water surface in paddy fields under saturation disorder.

Poor salinity level in irrigation water around these two areas is normally due to the mixing of seawater with fresh water, the excessive usage of fertiliser in the plantation and animal waste from poultry factory. Since, there is nothing much that can be dependent on the water quality from the river, water quality management in paddy fields needs to be taken into consideration to apply "4R" nutrients stewardship proposed by Liu *et al.* (2018) where the source, the rate, the timing and placement of fertiliser must be right.

4. Conclusions

This study assesses the water quality of river water that was used to irrigate paddy fields in Kampung Sempang and Kampung Pengkalan Samak of Merlimau district. The results showed that the properties of the water source in Merlimau met the standard requirement to irrigate paddy fields except for resistivity level which can lead to growth limitation of paddy plants. In general, water salinity gives a bad impact to crops, especially paddy. Therefore, this water quality monitoring should be continued from time to time to ensure that the water used is in good condition to irrigate the paddy fields. Further research is needed to see the effect of water quality supplied to the paddy fields towards plant growth.

Conflicts of Interest: The authors declare no conflict of interest.

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