PRELIMINARY EVALUATION OF WATER QUALITY IN FELCRA SEBERANG PERAK

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ABSTRACT

In recent decades, agriculture intensification is highlighted as the major source of water pollution in rivers via surface runoff. Excessive use of agriculture inputs such as fertilizer and pesticides can cause eutrophication harmful to aquatic ecosystem and human health. Precision farming is a sustainable agriculture method to optimize input while protecting the environment. Different elements of precision farming such as soil fertility, seed application, fertilizer application, field levelness, and pest and disease have received significant research attention. However, impact of precision farming variable rate fertilizer application on water quality have not been well researched and needs to be explored. Water is crucial for paddy production and maintaining the desired water quality for crop growth without polluting the environment should be a priority. The objective of this preliminary study were : 1) to evaluate water quality trend in FELCRA Seberang Perak; 2) to determine the effect of different fertilizer management practices on water quality and 3) to determine the level of water pollution using Malaysian water quality standard. Water quality changes in the field were examined by measuring several physical and chemical water quality parameter at twelve sampling points within the 60 ha of paddy field. Sampling was done from September to December 2018. Water quality parameter measured were temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Ammoniacal Nitrogen, Phosphate and Nitrate. Results have shown that all water quality parameters were within Class II-IV National Water Quality Standards (INWQS) and Water Quality Index (WQI) were between 70.16 to 88.73 (slightly polluted - clean). The results obtained from this study offer a better insight into improving the application of variable rate fertilizer to control agriculture water pollution and manage sustainable agroecosystem.

Key words: Nutrient management, water management, non-point pollution, surface water monitoring

INTRODUCTION

Water used for agriculture accounts for 70% of all freshwater withdrawals compared to 20% usage for industry and 10% for domestic use (UN Water, 2009). Water is a key driver of agricultural production and irrigation water has enabled farmers to increase crop yield and reduce dependence on rainfall for plant cultivation. Rice is the main food source for almost half of the world's population and almost 90% of rice is produced in Asian countries. As water is needed throughout the rice-growing season, paddy fields altogether consume up to 90% of the total water used for irrigation in Asia (GRISP, 2013). Rice is commonly grown in regions close to inland streams and lakes, where water resource is abundant for irrigation but it generates risk of nutrient runoff in the extensive hydrological networks between paddy fields and their adjacent water bodies.

Nutrient losses from paddy production systems contribute to contamination and eutrophication in freshwater bodies (FAO, 2011). Eutrophication, a result of high nutrient loads, is considered to be the prevailing water quality problem for surface water (UN-Water, 2009). Other pollutants originating from agricultural activities include pesticides, oxygen-demanding substances and sediments. Poor water quality has constrained the use of water for irrigation to paddy systems in many areas of the world.

In Malaysia, rice farming is the highest water user in agriculture. As the demands for rice consumption is higher, concerns over intensive use of nutrients and poor water quality resulting from agriculture intensification have arisen in recent decades (DOE 2015). Excessive use of fertilizer by farmers was a major concern by scientist, community and water industry. The transport of nitrogen (N) fertilizer from agricultural soils to groundwater through leaching is an environmental concern and a potential risk to human health. Issues in the country's water resources resulting from increasing national water demand and water pollution is a shared responsibility need to be addressed by all water user including agriculture sector. Sustainable and effective management of water resources is one of the key contributor in achieving water security and sustainability as a national priority (NRE, 2012). Agricultural sector has to be transformed into a modern, profitable and sustainable sector to meet the growing consumption demand and conserve the environment (MOA, 2012; NRE 2012). Therefore, sustainable agriculture practices is highly recommended to reduce pollution and maintain desirable yield for consumption

Precision farming is highlighted in third national agriculture policy (2001-2010), national agro food policy (2011-2020) and Eleventh Malaysia Plan (2016-2020) as a government's vision of modernizing agriculture to improve agro food productivity (MOA, 2012; EPU 2015). Variable rate fertilizer application is one of nutrient management method to reduce non-point pollution from rice fields to the water environment. Variable rate fertilization is a precision farming technology made possible by using high-speed computers, accurate Global Positioning System (GPS) receivers, Geographic Information Systems (GIS), remote sensing, yield or soil maps, actuators, and electronic sensors capable of measuring crop properties in real time (Schumann, 2012). In the variable rate application technology (VRT), crop production input rate is changed within fields in response to spatially variable factors (Sawyer, 1994). Previous research by Abu Hassan, D. (2001), Abu Hassan et. al (2007), Teoh et.al. (2010), Chan C.W.(2013) and Mohd. Syaifudin et. al. (2016) have considered different research elements of precision farming such as soil fertility, seed and fertilizer application technology, field levelness, pest and disease; however water quality research in paddy precision farming have not been well documented and needs to be explored.

The objective of this preliminary study were : 1) to evaluate water quality trend in FELCRA Seberang Perak; 2) to determine the effect of different fertilizer management practices on water quality and 3) to determine the level of water pollution using Malaysian water quality standard. Water quality changes in the paddy field was monitored by measuring several physical and chemical water quality parameter at twelve sampling points throughout the planting season. Water quality sampling was done from September to December 2018. The collected data were statistically analysed and results were compared with National Water Quality Standards (INWQS) and Water Quality Index (DOE-WQI). The results obtained from this study will offer a better insight into variable rate fertilizer management systems and help enhance the management of agroecosystems for water quality pollution control and water resource conservation.

METHODOLOGY

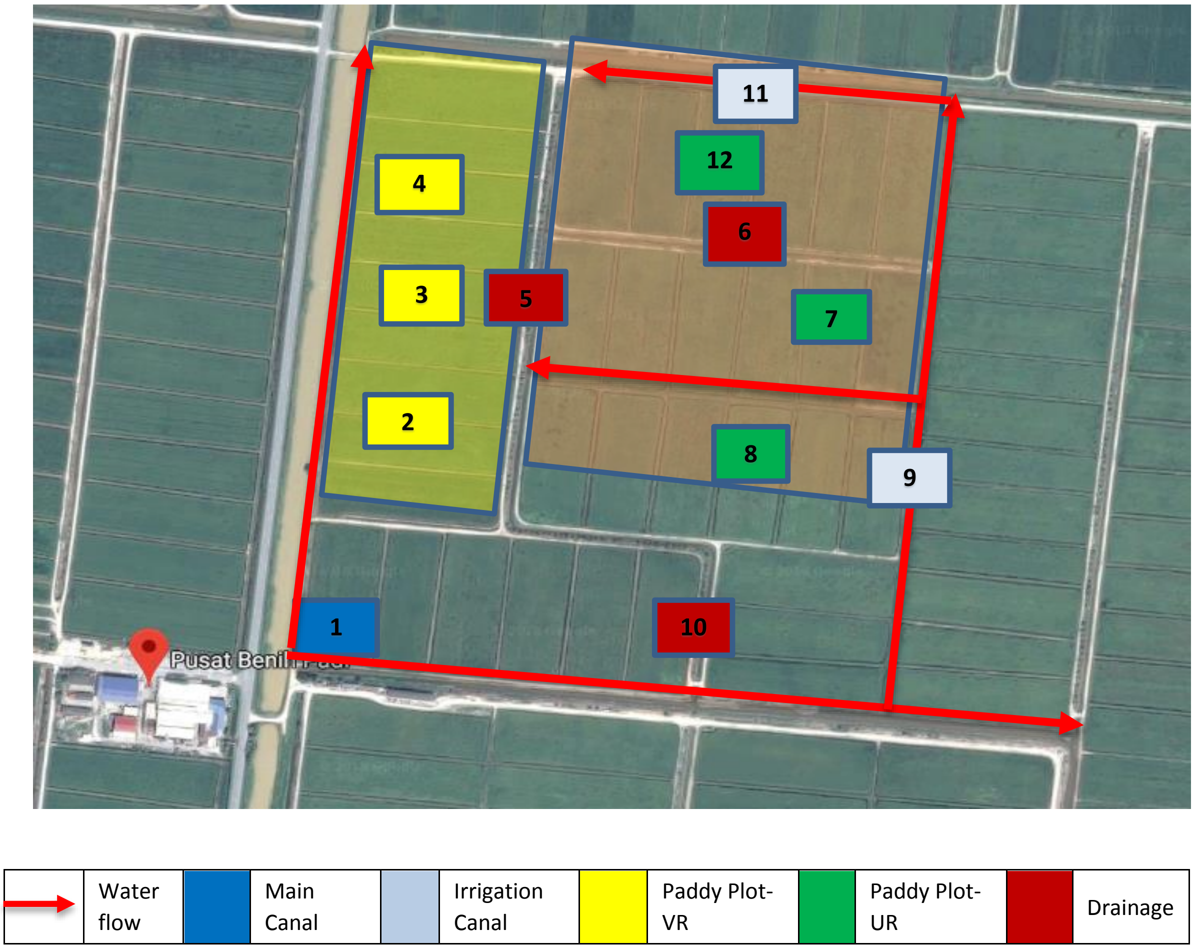
Description of study site

The Federal Land Consolidation and Rehabilitation Authority (FELCRA) Seberang Perak paddy estate is located at $4^0$7'N and 101^0 4'E. The average yield of paddy was 3.7MT/ha and was considered below national average yield (MOA, 2016). Water source for irrigation is from Perak River and drainage water from the estate flows into the downstream section of Sungai Dedap. The cultivated area is around 4000 ha and for easy management purposes, the paddy plantation was divided into several block. Block L3 was chosen for the case study due to its close proximity to the main irrigation canal. Block L3 comprises total area of 60 ha, partitioned into plots of approximately one hectare each. Rice planting season in Block L3 started from September to December 2018. The management of fertilizer was divided into two approach namely precision farming variable rate fertilizer (VR) and normal practice uniformed rate fertilizer (UR). Several plots were selected for both nutrient management. The UR plots were managed by using single rate fertilizer and the VR plots were managed by using several rate of fertilizer based on measured crop canopy throughout rice planting season. Throughout the season, the UR plots received 104kgN/ha and VR plots received 101 kgN/ha of fertilizer.

Water sampling points

Water sampling were conducted six times during the planting season (25 September 2018, 2 October 2018, 17 October 2018, 30 October 2018, 22 November 2018, and 6 December 2018) at 3-7 days after fertilization except for first and last sampling. First water sampling was taken during fertilization and the last sampling was taken before water was drained for harvesting. In this study, there were 12 sampling points located in main canal, irrigation canal, paddy plot and drainage. Sampling points were as followed : one sampling point in main canal (point 1); two sampling points in irrigation canal (points 9 &11); six sampling points in the paddy plot (points 2,3,4,7,8,12) and three sampling points in drainage canal (5,6,13). Sampling locations were shown in Figure 1. Water quality was monitored for each sampling points and collected samples were analyzed for chemical water quality parameter. Variable Rate (VR) field was represented by sampling points 2, 3 and 4. Uniformed Rate (UR) field was represented by sampling points 7, 8, 12.

Figure 1: Sampling points



In situ water quality measurement

In situ physical water quality parameter (temperature, dissolved oxygen (DO), pH) were measured using YSI Multimeter 6820. The measurements were taken three times in each sampling points. Sampling was done from 9-11 in the morning.

Water sampling for laboratory analysis

Water samples for laboratory analysis were collected in HDPE bottles that were pre-soaked in HCL for 24 hours and rinsed with deionized water. Samples for BOD analysis were collected using glass amber bottle. Samples were taken in three replicates for every sampling points. Samples have to be kept in cooler box filled with ice during transportation and immediately stored in 4°C chiller in the laboratory before it was analysed.

Chemical water quality analysis

Water samples had to be removed from the refrigerator and placed for two hours at room temperature for conditioning prior to the analysis. Chemical water quality parameter involving nutrient Nitrate (NO_3 –N), Phosphate (PO_4^{3-}), Ammoniacal Nitrogen (NH_3-N) and Total Suspended Solids (TSS) were analyzed using Spectrofotometer HACH DR 3900. Nutrient analysis was done by 48 hour after sampling. The method for determination of BOD and COD was based on Standard Methods for Examination of Water and Wastewater (APHA, 2005).

Data and statistical analysis

Statistical analysis of one way ANOVA (sampling time and parameter water quality; sampling points and parameter water quality), T-Test (VR and UR) and correlation were performed using SPSS version 17.

Water Quality Classification

In Malaysia, water quality classification using Water Quality Index (WQI) and Interim National Water Quality Standards (INWQS) are the most common accepted standards. Water Quality Index (WQI) describes quality value to an aggregate set of measured parameters. Six parameters were chosen for the WQI; Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Suspended Solids (SS), Ammoniacal Nitrogen (AN) and pH. The developed WQI can be applied to measure water quality that are categorized into three categories namely, clean (81-100), slightly polluted (60-80) and polluted (0-59) (DOE 2017). The INWQS comprises of over 120 physico-chemical and biological parameters and is defined by six classes (I, IIA, IIB, III, IV and V) for classification of water bodies based on the descending order of water quality from Class I to class V (DOE 2017). Water quality data in this study will be classified using both classification to determine level of water pollution.

RESULTS AND DISCUSSION

Water quality data from all sampling location was summarized in Table 1 to evaluate overall water pollution level in Blok L3. Correlation between water quality parameters was shown in Table 2. Water quality comparison between UR and VR was shown in Figure 2. The concentrations of water quality parameters were used to determine the respective sub-index to calculate the water quality index (WQI) and classify level of water pollution using INWQS.

Table 1: Water Quality Result

Samp Point	Mean/ Std Dev.	Temp °C	pH	DO (mg/l)	TSS (mg/l)	NO_3-N (mg/l)	PO_4^{3-} (mg/l)	NH_3-N (mg/l)	COD (mg/l)	BOD (mg/l)
1	Mean	29.50	7.86	5.29	25.78	1.21	0.29	0.04	5.14	1.51
	Std. Dev	1.80	0.78	1.34	8.50	1.46	0.27	0.02	3.13	1.18
2	Mean	28.70	6.72	5.17	22.28	0.73	0.39	0.30	20.71	2.06
	Std. Dev	2.02	0.54	4.24	17.00	0.94	0.32	0.34	13.45	1.45
3	Mean	28.47	6.60	6.26	45.56	0.50	0.55	1.01	16.69	3.31
	Std. Dev	2.44	0.33	6.24	37.45	0.35	0.65	1.76	14.09	3.30
4	Mean	28.96	6.74	4.18	32.44	0.66	0.54	0.06	19.63	1.65
	Std. Dev	2.79	0.43	3.66	23.65	0.51	0.59	0.03	20.08	1.53
5	Mean	29.13	6.65	3.78	39.84	0.47	0.38	1.17	10.08	2.51
	Std. Dev	2.79	0.44	1.93	27.67	0.43	0.23	1.63	14.14	1.98
6	Mean	28.98	6.68	4.89	29.39	0.87	0.55	1.44	14.09	2.78
	Std. Dev	2.88	0.32	2.56	18.44	0.84	0.24	1.67	10.85	1.14
7	Mean	28.46	7.12	5.10	24.67	0.63	0.33	0.80	11.97	2.77
	Std. Dev	1.80	0.74	5.24	12.65	0.72	0.13	1.67	13.80	1.82
8	Mean	28.72	6.91	3.08	35.28	1.08	0.43	0.66	8.36	3.06
	Std. Dev	2.32	0.54	2.48	25.21	1.78	0.22	0.76	9.65	1.51
9	Mean	29.83	6.74	6.01	11.89	0.54	0.41	0.16	9.03	3.09
	Std. Dev	2.71	0.29	3.29	17.53	0.64	0.46	0.17	15.22	0.96
10	Mean	29.88	6.88	4.96	28.94	2.72	0.44	0.30	13.78	2.58
	Std. Dev	3.77	0.47	3.22	20.45	5.21	0.21	0.18	17.50	1.87
11	Mean	29.56	6.96	6.76	21.56	1.26	0.28	0.92	9.66	2.87
	Std. Dev	2.59	0.58	3.61	10.44	1.64	0.28	1.76	13.68	1.83
12	Mean	28.04	6.63	5.60	21.50	2.00	0.37	0.22	9.16	2.14
	Std. Dev	1.43	0.21	4.43	15.04	2.66	0.24	0.21	12.03	2.05
Avg.	Mean	29.02	6.87	5.09	28.26	1.06	0.41	0.59	12.36	2.53
	Std. Dev	2.38	0.57	3.60	21.20	1.90	0.34	1.13	13.43	1.76

Samp. Point : Sampling point, Std. Dev.: Standard Deviation, Avg.: Average, Temp. : Temperature, NO_3-N: Nitrate, PO_4^{3-}; Phosphate, NH_3-N; Ammoniacal Nitrogen

Figure 2: Average water quality between two fertilizer management

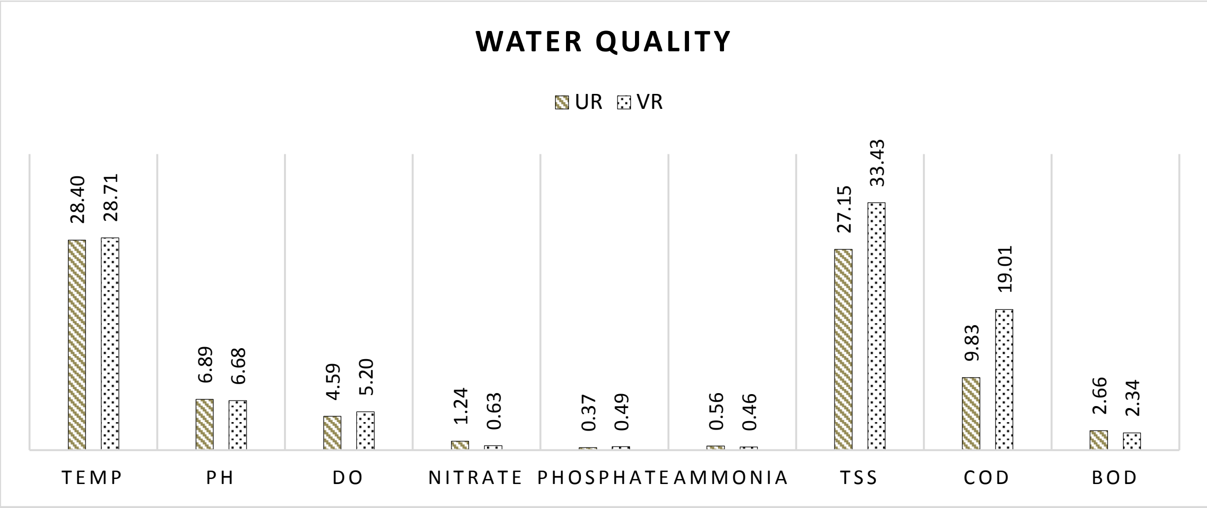


Table 2: Correlation coefficient between water quality parameter

	Temp.	**pH**	**DO**	**TSS**	**NO_3-N**	**PO_4^{3-}**	**NH_3-N**	**COD**	**BOD**
Temp.	-	ns	**0.51****	**0.24****	ns	ns	ns	ns	**0.26***
pH	**0.41****	-	ns	ns	ns	ns	ns	ns	ns
DO	**0.51****	ns	-	ns	ns	ns	ns	ns	ns
TSS	**-0.24***	ns	ns	-	ns	**0.46****	ns	**0.56****	**-0.25***
NO_3-N	ns	ns	ns	ns	-	ns	ns	ns	ns
PO_4^{3-}	ns	ns	ns	**0.46****	ns	-	**0.30****	**0.50****	ns
NH_3-N	ns	ns	ns	ns	ns	**0.30****	-	ns	ns
COD	ns	ns	ns	**0.56****	ns	**0.50****	ns	-	**-0.34****
BOD	**0.26***	ns	ns	**-0.25***	ns	ns	ns	**-0.34****	-

Temp. : (Temperature),), NO_3-N: Nitrate, PO_4-$^{3-}$; Phosphate, NH_3-N; Ammoniacal Nitrogen
***** Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
ns-non significant

Temperature

Temperature in all sampling station ranged from 26.30 to 36.20 ^{o}C. The highest temperature was recorded in sampling point 10 during the fourth sampling (30 October) and the lowest was recorded in sampling point 12 during the last sampling at 6 December. This value is within favourable temperature range for rice planting in Malaysia. Temperature was slightly higher in sampling points exposed directly to sunlight compared to sampling points that has vegetation cover (paddy plots). Temperature has significant positive correlation with pH *(r=0.41, p<0.01,)* and DO *(r=0.51, p<0.01)* and shows significant difference within sampling time (F=45.34, p<0.01). There was no significant difference between temperature in both VR and UR.

pH

pH is a measurement of acidity and alkalinity based on pH scale and is an important factor that determines the suitability of water for different usage. The normal pH range for irrigation water is from 6.5 to 8.4. (Ayers &Wescott, 1985). The pH reading of all sampling stations were between 6.24 to 8.54 indicating that water samples were almost neutral to alkaline in nature. The highest pH value of 8.54 was recorded at inlet in November, and the lowest pH value of 6.24 was recorded at paddy plot in September. As shown in Table 1, pH value at inlet source were higher compared to other stations. The mean pH value in the study is 6.87, which falls within Class III INWQS. pH is strongly correlated with temperature *(r=0.41, p<0.01,)* and shows significant difference within sampling points. There was a no significant difference between pH in VR and UR. Generally, the pH values in paddy fields differ following rice phases during the cultivation period (Fores, 1992). The increase of pH in ponded water during daytime was due to the absorption of dissolved CO_2 by photosynthetic bacteria and micro-algae within the ponded water (Yasuhiro et. al., 2003).

Dissolved Oxygen (DO)
The average DO value in all sampling station was 5.09 mg/l. The maximum concentration of DO was found during fourth sampling (30 October) in sampling point 3 (paddy plot) and the highest average concentration of DO was also found during the same sampling time. This phenomenon was due to the heavy rain occurring a day before the samples were taken. Heavy rain increases the flow rate of surface water hence promotes aeration via formation of air bubbles. Warm temperature was also responsible for the increasing dissolved oxygen. The concentration of dissolved oxygen in the flowing water also increased when enough sunlight reached the surface of paddy field (Akira I., 1987).The lowest DO was found during 22 November in sampling point 4 (paddy plot). The decrease of DO level at this station was due to a few factors such as dry period during sampling and the sampling points was covered with aquatic plant. Oxygen reaction in the water is influenced by equilibrium reaction between physical, chemical and biochemical of the water. The DO dynamics is also correlated with biological processes in the ponded paddy soil (Mowjood and Kasubuchi, 1998). This reaction causes changes in water temperature and dissolved oxygen. Average DO in all sampling points ranged between 3.08 to 6.76 mg/l and classified as Class II-III INWQS. DO has positive correlation with temperature. DO shows significant difference between sampling time *(F=26.12, p<0.01*) but no significant different between sampling points. There was no significant difference between DO in VR and UR.

Total Suspended Solids (TSS)
The TSS determination is extremely valuable in the analysis of polluted waters. It is one of the major parameter used to evaluate water quality (APHA 2005). The value of TSS at each sampling point varies between 0.33 to 100 mg/l. The highest value was recorded at the paddy plot in 6 December, two days before water was drained in preparation for harvesting process. Average TSS was the highest in the first and last sampling due to disturbances from farming activity in paddy soil and resulting to an increase in the suspended solids of water sample. The mean value of TSS was 28.26 mg/l, which was within Class II INWQS. TSS is highly correlated with temperature *(r= -0.24, p<0.05).* Phosphate *(r=0.46, p<0.01),* COD *(r=0.56, p<0.01)* and BOD (r=-0.22 p<0.01). TSS result was significantly different in sampling date (*F=7.19, p<0.01*). There was no significant difference between TSS in VR and UR.

Nitrate
The Nitrate readings of all sampling stations were between 0.1 to 13.3 mg/l. The highest Nitrate value was recorded at sampling point 10 (drainage) in 22 November. The lowest nitrate value was recorded in multiple sampling points throughout the season. As shown in Table 1, Nitrate values at drainage canal was higher compared to other stations. This was because Nitrate is susceptible to losses in rice ecosystem and it disappeared from rice root zone within a week or two of a soil being flooded (Lindquist et. al 2006). The mean Nitrate value in the study was 1.06 mg/l. Nitrate value was significant with sampling date *(F=2.64, p<0.05).* Nitrate was significantly different between VR and UR (*t=1.32, p<0.01)*. Nitrate value in sampling points with VR was lower compared with normal practice uniformed rate. This was due to slightly lower amount of fertilizer application in VR compared to UR.

Ammoniacal Nitrogen
The concentration of Ammoniacal Nitrogen in the study was between 0.01 -4.57 mg/l. The highest concentration was found at sampling point 3 (paddy plot), 5 (drainage) and 11 (irrigation canal) in 2 October. The concentration of Ammonia was high in this sampling point due to dry weather and accumulation of excess nutrients in the location. The mean concentration of NH_3-N at study areas was 0.59 mg/l. Ammonia has positive correlation with Phosphate (*p<0.01)*. There was a significant difference of Ammonia within sampling time *(F=4.60, p<0.01*) Average Ammonia in all sampling field was classified in Class III INWQS. There was no significant difference between Ammonia in VR and UR sampling points.

Phosphate
The Phosphate reading of all sampling points were between 0.01 to 1.71 mg/l. The highest Phosphate value was recorded at sampling points 3 (paddy plot) in 2 October. The mean Phosphate value in the study is 0.41 mg/l. Phosphate shows significant difference within sampling time *(F=3.33, p<0.01*) and was positively correlated with TSS *(r=0.46, p<0.01),* Ammonia *(r=0.30, p<0.01*) and COD (*r=0.5, p<0.01*). There was a significant difference between Phosphate in VR and UR *(t=-0.91, p<0.01*). Phosphate in VR was higher compared with UR. Phosphate in this study were generally higher during early growing season due to the fertilization process and low concentrations appear at the end of the season when most of the phosphate has been utilised by rice plants.

Chemical Oxygen Demand (COD)
In general, COD is a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (APHA, 2005). The COD measured for all sampling points were in the range of 0.33 to 51.67 mg/l. The highest value of COD was recorded at sampling point 4 (paddy plot) in 2 October. The high value of COD can be attributed due to the level of organic matters that came from the fertilizer during fertilization process. The mean value of COD concentration is 12.36 mg/l. The value of COD falls within Class III INWQS. COD shows positive correlation with phosphate and TSS (p<0.01). There was a significant difference between COD*)* and sampling time (*F=6.21, p<0.01*). There was a significant difference between COD in VR and UR (*t=-2.05, p<0.01).* Mean COD in sampling points with VRT were higher compared with UR.

Biochemical Oxygen Demand (BOD)

BOD measurement for all sampling stations were in the range of 0.06 to 8.83 mg/l. In general, BOD is used to measure DO concentration caused by microorganisms as they degrade organic matter. It can be used to conclude the general quality of the water and its degree of pollution by biodegradable organic matter (APHA, 2005). The highest value of BOD was recorded in sampling point 3 (paddy plot) in 30 October where fertilization activity was occurring and heavy rainfall in the field a day before sampling. During this period, bacteria used more oxygen to activate in the oxidation process of organic material. This situation increased the value of BOD in the water body. The lower value of BOD was recorded at the paddy field (point 2) during 25 September. The decrease of BOD level at this station was due to hot and dry period when sampling was done and lower organic material in the water. The decrease of organic material gave impact to BOD value, because oxygen demand in the water by aerobic bacteria decreased in the process of oxidation organic material. BOD concentration in the study has a mean of 2.53 mg/l and classified in Class II INWQS. There was significant difference between sampling time *($F=11.22$, $p<0.01$)* and no significant difference between sampling points. There were significant positive correlation between BOD with DO, temperature and negative correlation with COD. There was no significant difference between BOD in VRT and UR sampling points.

Water Quality Index and Classes

Water Quality Index in all sampling points were shown in Table 3. Water Quality Index is derived from sub-index calculation in six main parameter and the equation of calculation is as follows:

WQI = (0.22* SlDO) + (0.19*SIBOD) + (0.16*SICOD) + (0.15*SIAN) + (0.16 * SISS) + (0.12 * SipH)

where;

SIDO = Sublndex DO (% saturation)
SIBOD = Sublndex BOD
SICOD = Sublndex COD
SIAN = Sublndex NH3-N
SISS = Sublndex SS
SipH = Sublndex pH
$0 \leq WQI \leq 100$
Source: DOE (2017)

Table 3: SubIndex Value and Water Quality Index in all sampling time

Sampling Time	Day After Sowing (DAS)	SIDO	SIBOD	SICOD	SIAN	SISS	WQI
25 September 2018	14	81.02	96.34	70.11	70.65	75.11	81.82
2 October 2018	21	80.14	91.05	73.87	32.23	78.29	75.94
17 October 2018	36	48.17	94.06	93.26	57.38	89.04	78.02
30 October 2018	49	100	83.27	91.04	67.51	89.58	88.73
22 November 2018	72	40.31	83.65	90.87	80.55	86.1	77.02
6 December 2018	86	17.94	89.36	80.81	82.65	75.8	70.16

Water Quality Index for the study area vary from 70.16 to 88.73 and was similar with results found by Mohd Rozali et al (2006).There were two categories of water pollution status in study area: clean (WQI 81-100) and slightly polluted (WQI 60-80). Inlet and irrigation canal were categorized as clean throughout the planting season while other sampling points were categorized as slightly polluted. SIDO value was higher in the early stage of planting and decrease towards the end of planting season except during sampling four (30 October 2018). SIBOD showed higher value in the early planting season and the value gradually degrade towards the end of the season. SICOD showed increasing value throughout the planting season except during the last sampling. SIAN value was high in the first sampling, decrease during the second sampling and gradually increase throughout the planting season. SIAN and SICOD were highly affected by fertilization activity in paddy field and a slight decrease in either value will reduce WQI (Mohd Rozali et. al. 2006). SISS value was lower during the first sampling, gradually increase throughout the planting season and decrease during last sampling due to irrigation activity in the paddy field. SubIndex and WQI in all sampling points vary between sampling time due to different activity occurring in the paddy field. WQI was clean in the early stage of planting and become slightly polluted towards the end of planting season except for sampling four (30 October 2018) due to heavy rain a day before sampling. WQI in paddy plot with VR (78.53) was slightly higher compared with UR (77.94). This was due to slightly lower amount of fertilizer used in VR resulting to better Ammonia SubIndex value compared with UR. The higher SIAN resulted in better WQI for VR compared with UR.

CONCLUSION

This study evaluate water quality trend in FELCRA Seberang Perak, determine the effect of different fertilizer management practices on water quality and determine the level of water pollution using Malaysian water quality standard. Preliminary results found that clean irrigation water used in paddy field decrease in water quality due to planting activities including land preparation, agriculture input application and irrigation throughout the planting season. Water quality trend in Block L3, FELCRA Seberang Perak changes from clean in the early planting season to slightly polluted towards the end of planting season.

Water quality in Block L3 FELCRA Seberang Perak was within class II-IV INWQS and Water Quality Index was between 70.16 to 88.73 which was classified as slightly polluted to clean. Several parameter such as Ammoniacal Nitrogen and Nitrate need some attention as a slight increase can alter the WQI indicator to slightly polluted and INWQS to Class V. Preliminary results from this study also found that several water quality parameter (COD, Nitrate & Phosphate) showed significant difference between VR and UR in paddy field. This showed that variable rate fertilizer application in precision farming has potential to reduce water quality degradation in paddy plantation. However, this study was limited to evaluate surface water quality based on manual sampling during one season of paddy plantation in the study area. Further research to evaluate water quality at spatial and temporal scale, quantify water and nutrient balance in both nutrient management practices, identify suitable cost effective water quality monitoring strategy and implement practical mitigation action to reduce water pollution into surface water are strongly recommended. Lastly, beyond research, governance, legislation and policy enforcement by respective authorities are needed to reduce water pollution from agriculture to achieve National Water Resources Policy goal and Malaysian Government 11th Development Plan for sustainable agriculture.

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