Name	Counterpart	Title
Herdatha Augusta	**A02**	Role of surface covers on ground water quality of oil palm plantation area

Background and objectives

The surface cover of oil palm plantation consist of frond piles, where its covering rate represents about 10-20% of the total planted area, and understory vegetation, where its covering rate varies depending on the vegetation types, soil texture and properties, water availability in the wet or dry season, and management practices. After infiltration and percolating in the soil, the flowing water is distributed with different quality depending on the filtration capacity of the surface vegetation and root system to filter the accompanying dissolved minerals and other probable contaminants. In this study, the groundwater quality of oil palm plantation up to a soil depth of 4.0 m is related to the frond piles covers, understory vegetation and its rooting system. The water quality parameters observed are pH, Total Dissolved Substances (TDS), electrical conductivity, the concentration of ammonium, nitrate, potassium, calcium, sodium, and herbicides in the water. At the same time, the water quality of the water body at the site in question is evaluated.

Water quality in the soil and water bodies of an oil palm plantation is driven by management practices that intensively used fertilizer and pesticides. Oil palm plantations in Jambi are intensively managed by the application of fertilizer ranging from 48–88 kg N, 21–38 kg P, and 40–157 kg K ha^{-1} yr^{-1} (Ballauf *et al.* 2021) to 260 kg N, 50 kg P, and 220 kg K ha^{-1} yr^{-1} (Formaglio *et al.* 2020). The lower uptake efficiency of the applied fertilizer supports the residual nitrogen content in the soil (Edy *et al.* 2020). It has the potency to contribute an additional nitrogen footprint in water bodies and groundwater. The leaching rate reaches 74±20 kg N ha^{-1} yr^{-1} (Formaglio *et al.* 2020). Due to the lack of technical equipment and manpower, especially in Sumatra and Kalimantan, the use of synthetic pesticides is unavoidable and tends to increase year by year. In Jambi, the application rate reaches 2.25 l glyphosate ha^{-1} yr^{-1} (Formaglio *et al.* 2020). The control of environmental impact, especially nitrate flux and pesticide input to groundwater and water bodies, must be observed. The relationship between vegetation surface cover as filtration agent of potential contamination in water bodies by conventional agriculture system in oil palm was analyzed.

The study's objective was to identify the role of understory vegetation and frond piles covers on water quality of oil palm groundwater quality and contamination in water bodies. The water quality was also related to the distance from the water bodies.

Methodology

The observation was conducted at the riparian zone PTPN6 installed plots area. A synergy with other interested researchers in this plot area was coordinated priorly. The destructive area outside of the core plots was selected as observation point. Data collection took place from August-December 2021.

Distance points in 4 replications from the water body of the riparian zone at the available area of the contracted research plot area were: water body of the riparian zone, 5 ± 5 m, 10 ± 5 m, 20 ± 5 m, 40 ± 5 m and 60 ± 5 m.

Conducted on the measurement of the parameters were:

- Groundwater quality with pH (Horiba Ion Meter), Total Dissolved Substances (TDS) (Horiba Ion Meter), Electro Conductivity (EC) (Horiba Ion Meter), K^+ (Horiba Ion Meter), Na+ (Horiba Ion Meter), Ca^{2+} (Horiba Ion Meter), NO_3^- (Horiba Ion Meter/Nitrate Stick test pack), NH_4^+ (Ammonium test pack), herbicide (glyphosate) (Gas Chromatography-Mass Spectrometry)
- Monitoring of soil water level, 0-400 cm (manual method, with cylinder pipe)
- Identification of understory vegetation existence and its domination status

Results and Conclusion

The vegetation cover and the results of the analyses show that grass vegetation tend to grow in the closer vicinity of the water body, while broadleaves plants were more likely to be found in wider vicinity of the water body (Tables 1 and 3).

Table 1. Vegetation covers and analyses at oil palm in PTPN6

Species	Vegetation Type	Distance to the water body				
		3 m	10 m	20 m	40 m	60 m
Elaeis guineensis	Broadleaves	5	3	5	12	6
Axonopus compressus	Grass	11	32	0	15	3
Digitaria adscendens	Grass	5	5	0	3	0
Borreria alata	Broadleaves	6	1	0	19	14
Clidemia hirta	Broadleaves	4	3	2	6	7
Phyllantus niruri	Broadleaves	0	1	0	7	1
Cyperus kyllingia	Sedge	1	5	0	3	1
Nephrolepis exaltata	Fern	3	0	10	1	2
Melastoma malabatrichum	Broadleaves	0	0	0	0	1
Saoropus androgynus	Broadleaves	0	0	1	0	0
Dryopteris filix-mas	Fern	0	0	0	0	1
Ottochloa nodosa	Grass	4	1	0	0	0
Richardia scabra	Broadleaves	0	0	0	0	0
Pilea depressa	Broadleaves	0	0	0	0	0
Althernanthera sessilis	Broadleaves	0	0	5	4	0
Cyrtomium fortunei	Fern	0	0	0	0	0
Veronica officinalis	Broadleaves	0	0	0	0	0
Peperomia pellucida	Broadleaves	1	1	0	0	0
Asystasia gangetica	Broadleaves	0	1	0	0	0
Asplenium adiantum nigrum	Fern	2	0	0	0	3
Adiantum capillus veneris	Fern	0	0	0	0	0
Eclipta prostata	Broadleaves	0	0	0	0	0
Echinochloa crus galli	Grass	0	0	0	0	0
Viola odorata	Broadleaves	0	0	0	0	0

Nitrate concentration in the water body showed higher value due to intensive fertilizer application in this area. Glyphosate in groundwater closed to water body showed an average lower value of 1 mg/l both in the water body and in the groundwater of the oil palm plantation (Table 2).

Table 2. Ground water quality at 0-60 m to water body*

		Distance to the water body					
		0m**	3 m	10 m	20 m	40 m***	60 m***
pH	-	5.5±0.5	5.2±0.2	5.1±0.3	4.9±0.1	--	--
NO_3^-	ppm	122.5±0.8	113.5±85.1	77.1±9.0	80.0±42.7	--	--
NH_4^+	ppm	1.0±0.2	1.6±0.2	3.5±0.0	2.4±0.8	--	--
Conductivity	µS/cm	23.5±2.2	52.5±13.6	53.8±9.5	32.3±4.9	--	--
K^+	ppm	111.3±22.3	268.7±369.5	284.9±237.0	112.0±90.5	--	--
Na^+	ppm	31.3±2.3	47.7±19.3	42.9±18.5	31.6±6.0	--	--
Ca^{2+}	ppm	98.8±4.5	347.5±167.8	275.8±20.0	253.3±117.8	--	--
Glyphosate	ppm	0.45±0.05	0.39±0.03	0.37±0.03	0.44±0.06	--	--

* ± (standard deviation) **Waterbody *** Not observed, no ground water found until 4.0 m soil depth

Table 3. Oil palm growth and flower fertility at 0-60 m from water body*

		Distance to the water body				
		3m	10 m	20 m	40 m	60 m
Plant Height	cm	9.24 ±0.99	9.04 ±0.92	8.95 ±0.56	8.06 ±1.37	8.80 ±1.23
Frond number	per tree	39.43 ±8.28	35.33 ±11.55	40.80 ±5.40	40.56 ±4.47	41.33 ±4.57
Male flower number	per tree	7.86 ±3.80	5.67 ±3.39	6.50 ±3.08	6.64 ±1.51	7.00 ±2.31
Female flower number	per tree	4.14 ±1.86	2.33 ±1.37	1.33 ±1.51	2.89 ±1.07	3.17 ±1.21
Aborted flower number	per tree	14.29 ±7.21	15.56 ±10.68	19.00 ±5.87	17.32 ±3.80	17.39 ±3.66
Flower fertility	%	13.35	10.75	10.67	10.97	11.35

References:

Ballauff J, Schneider D, Edy N, Irawand B, Daniel R, Polle A. 2021. Shifts in root and soil chemistry drive the assembly of belowground fungal communities in tropical land-use systems. Soil Biology and Biochemistry 154:108140

Edy N, Yelianti U, Irawan B, Polle A, Pena R. 2020. Differences in Root Nitrogen Uptake Between Tropical Lowland Rainforests and Oil Palm Plantations. Front. Plant Sci. 11:92

Formaglio G, Veldkamp E, Duan X, Tjoa A, Corre MD. 2020. Herbicide weed control increases nutrient leaching compared to mechanical weeding in a large-scale oil palm plantation. Biogeosciences 17: 5243-5262