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Effect of Agricultural Chemicals on Aquatic Ecosystem in Guyana

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Abstract: This research work was carried out during the year 2005-2006 in Region-2 Pomeroon Supenaam down the back lands of Essequibo Coast Guyana. It focused on the effects of agricultural chemicals and fertilizers on the aquatic ecosystem. Moreover it targeted the most prevalent and dangerous agricultural pollutants causes of the pollution and the extent of the damages cause by these pollutants on the ecosystem as a whole. Laboratory and field testing of water soil plants and animal samples using various and standard methods of analysis proved that the level of the important heavy metals like lead nitrates phosphates arsenic iron were above toxic limit which contributed to toxicity. The results proved that toxicity varied linearly with the crop activities. With an increase in the toxicity the aquatic ecosystem was found to be unstable and in deteriorated state. An overgrowth of algae hyperplasia of gills migration of fishes change in the natural soil structure increase in salinity of the water and decrease oxygen were also recorded. The study conclusively proves that the aquatic water bodies were contaminated by agricultural pollutants (nutrient fertilizers and chemical fertilizers). Overflow of water careless handling of chemicals by laborers spillage runoff and erosion lead to the toxicity of the heavy metals hence affected the quality of the water soil and aquatic life.

Key words: Aquatic ecosystem · Agricultural pollutants · Aquatic life · Nutrients · Pesticides

INTRODUCTION

Agricultural areas have the potential to pollute the Aquatic Ecosystem via the popular use of pesticides (chemicals) and fertilizers (nutrients) salts and sediments. Guyana has vast potentials in the agricultural sector. This sector now contributes approximately 25-30% to the Gross Domestic Product (GDP). With a growing agricultural sector and poor application of safe environmental products and techniques to eliminate or control pests and for the quick growth of Crop there will be a more likely response towards increased use of pesticides and fertilizers. Excessive or improper use of these alternative pest control methods will indirectly or directly lead to contamination of the water bodies that are in proximity or even distal to the sites where these agricultural chemicals and fertilizers are being applied.

The most popular synthetic fertilizer used in the rice fields in Guyana is Urea. This contains nitrates. Following this is TSP which has a phosphorus content of 43-48% [1] and 15-15 which contains 15% sulphate 15%nitrates 15% phosphates. Popular chemicals include Monocrotophos Pestac and Fastac (Insecticides) Gramoxone 2-4D and Glyfosan (Herbicides) and Kocide (Fungicides).

Louis *et al*. [2] states t hat a pesticide's capacity or a fertilizer's capacity (nutrients) to harm fishes and aquatic animals is largely a function of it's toxicity exposure time dosage rate and persistence in the environment. Importantly not all pesticide poisonings result in the immediate death of an animal. Small "sublethal" doses of some pesticides can lead to changes in behavior weight loss impaired reproduction inability to avoid predators and reduced tolerance level to extreme temperatures [2, 3]. As such fishes and other aquatic organisms in trenches flowing through croplands are likely to receive repeated low doses of chemicals [2].

In Guyana the rice crops have a season of approximately 6 months of which about 2 to 21/2 months are spent using pesticides or fertilizers. Hence with in a year the aquatic ecosystem is affected constantly a total of approximately 5 months. This repeated exposure of certain chemicals and fertilizers can result in reduced fish and other aquatic organism's egg production and hatching nest and brood abandonment lower resistance to diseases decreased body weight hormonal changes and reduced avoidance of predators [2] as well as disruption to the water quality and the natural soil structure of the stream/trench bed.

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Pollutants can reduce the availability of plants and insects that serve as habitat and food for fishes and other aquatic animals. Insect-eating fishes can lose a portion of their food supply when pesticides are applied. A sudden inadequate supply of insects can force fish to range farther in search of food where they may risk greater exposure to predation [2]. Spraying herbicides can also reduce reproductive success of fish and aquatic animals. The shallow weedy nursery areas for many fish species provide abundant food and shelter for young fish [2].

Aquatic plants provide as much as 80% of the dissolved oxygen necessary for aquatic life in ponds and lakes. Algae are one of the most primitive group of organisms and the first oxygen producer of the world the major carbon dioxide consumers major primary consumers and a key component of the aquatic ecosystem [4]. Spraying herbicides to kill all aquatic plants [2] or it entering the waterways via runoff can result in severely low oxygen levels and the suffocation of aquatic organisms as well as significantly reducing fish habitat food supply dissolved oxygen and fish productivity [2].

Since Guyana is a country of which one of its largest export is rice a large amount of agricultural chemicals and fertilizers (synthetic) are used to promote the growth of the crop to give a high yield. Little emphasizes are placed on the effects of these pollutants on the animals plants and the ecosystem as a whole

Key

Probability Level	Significance
5%	+
1%	++
Not Significant	

MATERIAL AND METHODS

The Area located for this research is found in Region # 2-Pomeroon Supenaam. It is found down the back lands of the Essequibo Coast-Aurora/Dryshore District. Two areas are selected-One area is contaminated by agricultural pollutants and the other is not. These areas are allocated as Site A and B respectively.

Two water bodies were sampled-contaminated and non-contaminated. Each water body is divided in three quadrants. Each quadrant (I II III) one sample of water fishes (2 species hence 6 samples for this) o ne algae and bamboo grass. These are taken with in a fifteen days period from mid March to Ending of June 2006.

The parameters tested in this research are mostly the component of the natural ecosystem and that of Fertilizers and Agrochemicals. Both fields and lab testing were performed using standard methodology of testing temperature Potassium Sodium Calcium Iron manganese Copper in Ammonium Acetate Extract Lead Cadmium Arsenic Boron Zinc Iron Bromine in Ammonium Acetate Extract NPK test Electrical Conductivity DO and other standard tests.

RESULTS AND DISCUSSION

Generally there was a drastic increase in the metal concentration in the water, then a decrease, then an increase, then a decrease for most of the parameters tested. This is due to the field activities. With a rise in the elements concentration (Tables 1-6) either from the use of the pollutants or from the natural activities of the ecosystem or both the plants animals the natural structure of the soil and water quality decreases resulting in a disruption of Aquatic life. From the results some elements especially those found in the pesticides (Tables 4-6) are in such concentration that they can pose significant effect to the ecosystem making it unstable and improper for its inhabitants resulting in major changes and adaptation migration or even death.

Table 1: Showing the Physiochemical Characteristics of Water Samples

Physiochemical Characteristics	Site A	Site B	Significance
Temp. of Air	26.523±0.796	26.263±1.164	
Temp. of Water	31.96±1.315	32.738±1.384	
pH	4.746±0.387	4.893±0.339	
Electrical Conductivity (us/cm)	54.946±29.408	57.709±35.739	
Dissolve Oxygen (mg/L)	7.124±0.487	5.750±0.733	
Ammonia (ppm/L)	1.038±0.032	4.733±0.540	
Nitrates (ppm/L)	1.158±0.015	5.943±1.13	++
Phosphates (ppm/L)	0.077±0.118	0.155±0.098	
Sulphates (ppm/L)	1.213±0.0043	0.349±0.294	++
Chlorides (ppm/L)	72.5±1.513	89.634±4.559	++
Sodium (ppm/L)	2.605±0.066	3.789±1.078	
Potassium (ppm/L)	0.299±0.0081	0.540±0.394	
Iron (ppm/L)	0.724±0.001	1.558±0.138	+
Magnesium (ppm/L)	0.056±0.015	2.169±1.187	
Manganese (ppm/L)	1.213±0.043	0.349±0.294	++
Lead (ppm/L)	0.005±0.004	0.002±0.002	
Cadmium (ppm/L)	0.0029±0.0108	0.0053±0.0121	
Copper (ppm/L)	1.16±0.052	3.779±1.173	

Table 2: Showing the Physiochemical Characteristics of Soil Samples

Physical and Chemical Characteristics of Soil	Site A	Site B	Significance
pH	6.164±0.349	5.155±0.624	
Electrical Conductivity (us/cm)	23.375±2.199	103.75±52.491	
Nitrates (ppm/L)	1.38±0.086	6.205±1.651	++
Phosphates (ppm/L)	0.0222±0.010	47.45±0.19	++
Sulphates (ppm/L)	0±0	00.081±0.0128	
Chloride (ppm/L)	78.424±1.899	95.473±2.849	++
Sodium (ppm/L)	25.025±1.874	51.125±4.247	
Potassium (ppm/L)	17.65±1.744	47.45±3.624	++
Iron (ppm/L)	222.79±19.017	306.709±115.578	
Magnesium (ppm/L)	13.848±0.812	624.246±282.756	
Manganese (ppm/L)	3.55±0.411	52.715±6.475	++
Calcium (ppm/L)	94.005±2.986	1028.97±519.459	
Sodium (ppm/L)	25.025±1.874	51.125±4.247	
Lead (ppm/L)	12.276±0.361	23.453±6.029	
Cadmium (ppm/L)	0±0	0.0023±0.0128	++
Copper (ppm/L)	2.125±0.191	3.465±0.335	++
Arsenic (ppm/L)	0±0	0±0	
Boron (ppm/L)	0±0	0.0025±0.0004	

Table 3: Showing the Physiochemical Characteristics of Algal Samples

Parameters tested (ppm/L)	Site B	Significance
Nitrates	2080.301±136.988	++
Phosphates	2199.71±299.211	++
Sulphates	0.214±0.081	++
Sodium	11.385±3.014	++
Calcium	12.41±1.035	+
Manganese	2071.43±99.28	++
Manganese	82.578±10.365	++
Lead	0.214±0.081	++
Cadmium	0.079±0.0115	
Arsenic	0.067±0.135	
Boron	0.054±0.075	

NB: Site A was the non-contaminated site hence no algal sample was found there

Table 4: Showing Pesticide Residue in Water

Pesticides Residue (ppm/L)	Site A	Site B	Significance
Nitrates (Organic and Inorganic)	0.085±0.00071	4.378±1.569	+++
Sulphates	1.213±0.0043	0.349±0.294	++
Phosphates	0.077±0.118	0.155±0.098	
Glyphosate	0±0	0.567±0.436	
Zinc	0±0	0.006±0.001	+++
Iron	0.724±0.001	1.558±0.138	+
Lead	0.005±0.004	0.002±0.002	
Bromine	0±0	0.002±0.006	+++
Arsenic	0±0	0±0	
Cadmium	0.0029± 0.0108	0.0053 ±0.0121	
Boron	0±0	0±0	

Table 5: Showing Pesticide residue in Soil

Pesticides Residue (ppm/L)	Site A	Site B	Significance
Nitrates (Organic and Inorganic)	0.0007±0.0006	6.07±0.26	+
Sulphates	0±0	00.081±0.0128	
Phosphates	0.0222±0.010	47.45±0.19	+++
Glyphosate	0±0	0.036±0.0036	+++
Zinc	0±0	0.004±0.003	
Iron	222.79±19.017	306.709±115.578	
Lead	12.276±0.361	23.453±6.029	
Bromine	0±0	0.0026±0.0005	
Arsenic	0±0	0±0	
Cadmium	0±0	0.0023±0.0128	+++
Boron	0±0	0.0025±0.0004	

Table 6: Showing Pesticide Residue in Algal Samples

Pesticides Residue (ppm/L)	Site B	Significance
Nitrates (Organic and Inorganic)	2080.301±136.988	+++
Sulphates	0.214±0.081	+++
Phosphates	2199.71±299.211	+++
Glyphosate	6.04±0.23	+
Zinc	0.001±0.23	
Iron	0.001±0.021	
Lead	0.214±0.081	+++
Bromine	0±0	
Arsenic	0.067±0.135	
Cadmium	0.079±0.0115	
Boron	0.054±0.075	

NB: Site A was the non-contaminated site hence no algal sample was found there

CONCLUSION

The most prevalent Agricultural pollutant is Nutrient Fertilizers. Aquatic ecosystem is polluted via drainage and irrigation of the field's water overflow of water careless handling of chemicals by laborers Spillage Runoff erosion. Agricultural pollutants are present in the aquatic ecosystem. However they are affected since fish species migrate, hyperplasia of the gills, and over growth of algae.

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