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Effect of Herbicidal Control of Water Hyacinth on Fish Health at the Ere Channel, Ogun State, Nigeria.

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ABSTRACT: A herbicidal control of water hyacinth,WH (*Eichhornia crassipes, Martius Solms – Laubach*) was carried out by applying glyphosate (N – phosphyonomethyl glycerine) containing 360g/*l* glyphosate in the form of 480g/*l* isopropylamine salt at the rate of 2.16kg active ingredient (a.i/ha) by a fixed wing, AG-CAT Schweizer plane at the Ere fishing channel.Pathological studies revealed that of the total number of fishes examined prior to the chemical application, 334 (5%) had fin-rot, 2541 (38%) abrasion, 802 (12%) lesions, 334 (5%) ulcerations, 1805 (27%) sloughing of their body slime. None had tumours or nodules. The post application examination of fishes revealed that 5806 (7%) had fin-rot, 8294 (10%) abrasion, 4147 (5%) lesions, 1244 (1.5%) ulcerations and 4145 (5%) sloughing of body slime. None had tumours or nodules. The total number of fish that showed signs of infection prior to herbicidal application was 516 (86.9%) while it was 23,636 (28.49%) for post application of herbicide. The total number of fish caught prior to herbicidal treatment was 6,686 (7.46%) while a total number of 82,943 fish (92.54%) were caught after treatment. No fish mortality was observed throughout the post treatment monitoring. In this multi-disciplinary work, it was established that glyphosate at 2.16 a. i / ha controlled WH and associated weeds within four weeks of application without any intrinsic deleterious effect on fish and aquatic fauna. @ *JASEM*

Water hyacinth (*Eichhornia crassipes*) was first reported in Nigeria in 1984. It has been known to constitute a nuisance in Rivers Congo and Nile.
The project by African Development Bank-Economic Community of West Africa (ECOWAS) which began in 1992 revealed the spread, current weed status and control methods of *Eichhornia crassipes* which arrived Benin Republic in 1977 (ANPP, 1996). The weed, which was carried by water current into Nigerian waters, drifted from the neighbouring Republic of Benin. The Weed precisely came from Port-Novo creek, which has an entry in the sea around the Lagos Lagoon.

Water hyacinth (WH) in addition to being detrimental to the aquatic environment biologically, it physically blocks the waterways thereby impeding transportation and human activities. Their masses when adrift dislodge fishing nets in water resulting in huge financial losses to artisanal fisher-folk. WH also provides a hiding for snakes and other dangerous aquatic organisms.

Ere is a fishing village on the outlets of Yewa River to the Lagoon waters of Badagry Creek (OGADEP, 1991; Akinyemiju, *et al*, 1993). The World Bank in a recent survey estimated the loss due to WH in Nigeria to be a minimum of $500 million annually and therefore advised direct intervention as a measure to abate the menace of the weed (World Bank, 1990).

MATERIALS AND METHODS

This research exercise lasted a total of twelve months, from July, 1991 to June, 1992.A period of six months was used for pre-sample base-line data collection while another six months after treatment, was used to collect post-treatment data. The study was carried out at Ere village that is situated on the edge of Yewa Lagoon. It is located between 3^0 00'N and 6^0 30'W and is found in the Ado-Odo, Ota Local Government Area of Ogun State about 25km from Port-Novo Creek, the original source of the water hyacinth to Nigeria (Fig. 1).

Data collection was carried out in two phases. Phase I consisted of pre-treatment baseline data collection and lasted for six months, from July 1991 to December 1991. Phase II consisted of post-application/impact assessment and covered a period of six months after treatment, from January, 1992 to June, 1992. A total of twelve fishermen were used for the pre and post-treatment sampling. The mode of sampling included the use of cane traps (funnel/bag types), before treatment as well as daily visual observation of the channel, since weed obstructs t use of other gears. After herbicidal treatme 3 cast nets/set gill nets were also used in addition to cane traps and visual observation of the Ere channel. Parameters considered, included species identification/diversity, length-weight relationships, as well as necropsy for clinical symptoms which included, abrasions, lesions, ulcerations, fin-rots, sloughing of body slime as well as tumours and nodules.

The effect of the water hyacinth and the herbicidal control on physico-chemical properties of the Ere channel was also monitored. Three stations namely Ere channel (Station I) which was completely covered with WH and treated with glyphosate, Yewa lagoon (Station 2) which was free of WH and untreated with glyphosate and Soki channel (Station 3) which was covered with WH but untreated with glyphosate, were monitored. Two depths of sampling namely surface 0.5m below water surface and bottom

1.5-2.0m below water surface were used. The following physico-chemical parameters were monitored using: Knick Portamess 402, portable thermometer (temperature), WTW 54 meter (conductivity), titration with HCL (alkalinity), titration with $AgNO_3$ (chloride), Winkler method (dissolved oxygen), and AAS spectroscopy (dissolved Ca, Mg, Na, K).

Prior to aerial application of the herbicide, a preliminary sensitivity index mapping exercise was carried out on the Ere main fishing channel for the determination of foliage/ambience exposure indices which was used for herbicide calibration prior to application. Hydrographic parameters were taken to assess the possibilities for post-application absorbance, assault levels, seclusion of area, herbicide screening tests and the drift characteristics of the aquatic weeds. Erected screening of outlet to the lagoon was done with bamboos tied to erected stakes.

Aerial application of the herbicide, Round-up (360/litre glyphosate in the form of 480/litres isopropylamine salt) was carried out with a fixed wing Schweizer Ag-Cat aircraft at a rate of 2.16 litres active ingredient per hectare on 17th December, 1991. This was followed by a mopping up operation with an adapted knapsack sprayer (with extensive nozzle) at 2.88/ a.i /ha at a spray volume of 100 litres of water per hectare.

RESULTS

A total of three major floating plants namely *Eichhornia crassipes, Pistia stratiotes, Aeschynomene indica* and some submersed plant like *Ceratophyllum demersum* were identified (Table 1). Average percentage totals of the various plants prior to treatment (August – December 1991) was *E. crassipes* (89.5%), *P. stratiotes* (6.2%), *A. indica* (2.7%) and others (1.6%). After treatment, the average percentage totals were 0.0% for *E crassipes, P. stratiotes, A. indica* and others respectively (Table 1) for the first two months. By March *Pistia stratiotes* flourished with other smaller floating plants. Table 2, revealed a total of eighteen (18) species of fish caught and identified prior to herbicidal treatment while a total of twenty-six (26) species were caught and identified after application of the herbicides.

The total number of fish caught prior to chemical treatment was 6,686 (7.46%) while a total of 82,943 fish (92.54%) were caught after treatment. (Table 2).

Pathological studies (Table 3) revealed that of the total number of fishes examined prior to the chemical application, 334 (5%) had ulcerations, 2,541 (36%) abrasion, 4,147 (5%) lesions, fin-rots 1,805 (27%) sloughing of their body slime. None had tumours or nodules. The post application examination revealed that 5806 (7%) had fin-rots, 8294 (10%) abrasions, 4147 (5%) lesions, 1244 (1.5%) ulcerations, 4145 (5%) sloughing of body slime. None had tumours or nodules. The total number of fish showing signs of infection before herbicidal application was 5816 (86.9%) but in the post-application period it was 23,636 (28.49%). The observation for fish mortality revealed no mortalities in the Ere channel both before and after herbicidal application. The physico-chemical parameters in Ere channel before and after herbicidal treatment is presented as Table 4.

Table 1: Species abundance of floating aquatic plants in Ere channel*

Pre-treatment period					Pre-treatment period				
Month	*E.crassipes*	*P.stratiotes*	*A.indica*	Others**	Month	*E.crassipes*	*P.stratiotes*	*A.indca*	Others**
Sept.'91	89.5	6.9	2.5	1.4	Jan.'92	0.0	0.0	0.0	0.0
Oct.'91	89.5	6.5	2.7	1.5	Feb.'92	0.0	0.0	0.0	0.0
Nov.'91	89.5	6.0	2.8	1.7	Mar.'92	0.0	0.0	0.0	2.7
Dec.'91	90.0	5.0	2.8	1.8	Apr.'92	0.0	2.8	0.0	3.2
Average Total (%)	89.5	6.2	2.7	1.6		0.0	2.65	0.0	2.95

* Floating plants was based on a 5m x 5m grid established all over the Ere channel.
**Others include submersed plants like *Ceratophylum demersum* (Horn-wort), small floating plants like *Lemnne sp* (Duckweed) which do not hinder mobility in Ere Channel.

Table 2. Abundance, species diversity and length weight relationships of fish in Ere channel pre- and post application of herbicide (round-up)

		Pre-application samples				Post-application samples			
No	Fish Species	Total Fish caught	Av. weight (kg)	Av. weight (mm)	Catch per unit effort	Total Fish caught	Av. Weight (kg)	Av. Length (mm)	Catch per unit Effort.
1.	*Oreochromis niloticus*	166	0.40	202	5.53	1875	0.48	2.34	75.0%
2.	*Tilapia guineensis*	183	0.43	228	6.56	1735	0.52	336	75.2%
3.	*Tilapia melanopleura*	-	-	-	-	3605	0.25	200	75.1%
4.	*Hemichromis fasciatus*	297	0.21	176	5.20	3592	0.25	189	74.8

5.	*Hemichromis bimaculatus*	-	-	-	-	4500	0.20	101	75.0
6.	*Auchenoglanis occidentalis*	-	-	-	-	3197	0.28	224	74.60
7.	*Chrysichthys nigrodigitatus*	212	0.35	244	6.18	2343	0.38	258	74.2
8.	*Clarias gariepinus*	220	0.32	258	5.87	2186	0.41	281	74.7
9.	*Clarias angullaris*	-	-	-	-	4090	0.22	206	75.0
10.	*Hepsetus odoe*	-	-	-	-	2308	0.39	264	75.0
11.	*Heterotis niloticus*	170	0.52	234	7.37	1599	0.56	240	74.6
12.	*Gymmarchus niloticus*	176	0.45	272	6.60	576	1.52	508	73.0
13.	*Momyrus rume*	193	0.36	214	5.80	2029	0.42	262	71.0
14.	*Parachana obscura*	153	0.44	257	5.61	1698	0.48	269	67.9
15.	*Guathonemus tomandua*	186	0.38	238	5.90	2070	0.43	241	74.2
16.	*Schilbe mystus*	-	-	-	-	2875	0.28	203	67.1
17.	*Bagrus bayad*	-	-	-	-	2349	0.35	196	69.0
18.	*Notopterus afer*	-	-	-	-	2358	0.38	205	74.7
19.	*Polypterus senegalensis*	109	0.61	252	5.54	1261	0.67	259	70.4
20.	*Mugil cephalus*	188	0.35	206	5.48	1970	0.44	211	72.2
21.	*Synodontis clarias*	155	0.43	203	5.60	1724	0.51	209	73.3
22.	*Alestes nurse*	407	0.17	128	5.76	3739	0.23	136	71.7
23.	*Petrocephalus bane*	145	0.48	206	5.80	1686	0.50	212	70.3
24.	*Barbus nigeriensis*	2162	0.03	166	5.41	20,500	0.04	169	66.8
25.	*Calamoichthys calabaricus*	725	0.10	281	5.44	5367	0.15	288	67.1
26.	*Dictichodus rostatus*	239	0.26	194	5.18	2161	0.38	204	68.4
	Total	6,686 (7,46 %)			104.8	82,943 (92.54 %)	10.72		1.880.3
Total no of species (pre-treatment) = 18 *Total no. of species (post-treatment) = 26*									

Table 3: External clinical symptoms of examined fish from Ere channel (pre – and post herbicidal application)*.

Pre-treatment			Post-treatment			
Parameters examined	Total .no of Fish examined	No of observed diseased fish	% observed of diseased fish	Total. no. of fish examined	No. of diseased fish	% observed of diseased fish
Fin rot (FR)	6686	334	5%	82,943	5,806	7
Abrasion	"	2,541	38	"	8,294	10
Lesions (LS)	"	802	12	"	4,147	5
Ulcerations (UL)	"	334	5	"	1,244	1.5
Sloughing slime (SS)	"	1,805	27	"	4,145	5
Tumour/Nodules (TM/N)	"	0	0	"	0	0
Total		5,816	87	23,636		28.5

*Two or more clinical symptoms can occur on the same fish

Table: 4 Physico-chemical parameters of Ere channel (before and after herbicidal treatment)-all values are in mg/l unless otherwise stated

	Station 1*		Station 2**		Station 3***	
Parameters	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Conductivity (S/cm)	85.9 – 114.5	107.2 – 38.4	90.3 – 103.0	91.0 –56.0	103.7 – 106.0	903.0 – 164.5
pH	6.2 – 7.8	7.3 – 7.9	6.5 – 7.5	6.6 – 7.0	6.5 – 7.7	6.6 – 7.2
Sodium	4.2 – 9.7	9.1 – 11.7	8.7 – 76.8	8.0 – 47.8	8.8 – 9.0	12. 0 – 76.8
Potassium	3.4 – 9.0	8.5 – 10.9	8.1 – 71.3	7.5 – 44.4	8.2 – 8.4	11.1 – 71.3
Calcium	7.2	6.8 – 24.2	6.5 – 56.9	6.2 – 35.4	6.5 – 6.7	8.9 – 56.9
Magnesium	3.2 – 5.8	5.5 – 19.6	5.3 – 46.1	5.4 – 28.7	5.3 – 5.4	7.2 – 46.1
Bicarbonate	24.4 – 36.6	24.4 – 32.6	24.5 – 45.7	24.4 – 25.0	42.7 – 48.0	18.3 – 24.4
Chloride	8.4 – 18.8	17.7 – 63.6	16.7 – 150.0	16.3 – 92.7	17.1 – 17.5	23.3 – 149.0
Sulfate	3.5 – 4.7	4.4 – 15.7	4.2 –37.0	4.5 – 23.0	4.2 – 4.3	5.8 – 37.0
Nitrate	1.0 – 2.7	2.6 – 9.2	2.4 – 21.7	2.0 – 13.5	2.5 – 2.5	3.4 – 21.7
Dissolved. Silica	15.0 – 17.0	25.7 – 96.0	25.5 – 220.0	26.2 – 140.5	25.9 – 26.5	35.3 – 225.7
Biochemical Oxygen Demand	2.50 – 3.65	1.10 – 3.90	2.0 – 4.62	2.30 – 4.45	1.10 – 3.50	2.30 – 3.40
Dissolved Oxygen	4.8 – 5.5	2.2 – 4.2	3.0 – 4.0	3.2 – 3.8	0.7 – 2.8	1.5 – 3.8

Table 4 cont.

Chemical Oxygen Demand	1.4 – 3.2	0.8 – 4.8	2.0 – 3.2	2.4 – 4.6	2.0 – 3.5	2.3 – 3.3
Temperature ^{0}C	28.5 – 29.9	28.5 – 32.0	29.5 – 32.0	29.0 – 31.0	27.9 – 30.5	28.7 – 30.8

*Station 1- Ere Channel treated with glyphosate on 17th December 1999. **Station 2 –Untreated open Yewa lagoon free of water hyacinth. ***Station 3 - Untreated Soki Channel infested with water hyacinth; adjacent to Ere Channel.

DISCUSSION

The result of the pilot demonstration of herbicidal control of water hyacinth in Ere Channel revealed a total elimination of the water hyacinth which constituted limiting factor to fisheries activities. Other plants like *Pistia stratiotes,. Aeschynomene indica,* and other smaller floating aquatic plants were also cleared. This result revealed the effectiveness of the herbicide (glyphosate) to control the menace of water hyacinth. The increase in the number of fish species from eighteen species (18) prior to treatment, to twenty-six (26) post-application of herbicide, the total number of fish caught, as well as the catch per unit effort, is a clear indication of an enhanced fisheries production after the application of the herbicide .

Pathological studies, revealed that the number of the fishes infected after treatment, increased although, the total percentage infection reduced. This increase in the number of infected fish may be as a result of the increase in bacteria number due to decaying dead water hyacinth as well as impairment of water parameters like the pH, oxygen concentration, and temperature which could induce stress to fish. The reduced total percentage infection after treatment (28.49%), as against (87.0%) prior to the treatment period, was due to the increase in the number of fish caught after herbicidal control i.e 82, 943 fish (92.54%). The visual observation on the Ere Channel both before and after treatment, revealed no fish mortalities. This may be due to the presence of the water hyacinth which did not allow for a clear observation of the water surface in the channel prior to treatment. It may be that the herbicide used was not toxic to fish or that the fish emigrated after treatment in order to avoid the effect of the herbicide. But, the increase in catch by fishermen around the channel and the species diversity confirmed the presence of fishes while the absence of dead fish in treated area revealed that the application of the herbicide (Round-up) at the rate of 2.11 litre a.i/ha aerial application by aircraft, and 2.88 litre a.i/ha with knapsack sprayer for mopping-up operations was not toxic to fishes in Ere Channel. Annon (1979) stated that glyphosate is a foliar acting herbicide that breaks into non-toxic residues and is not expected to bio-accumulate at the normal rate of application and is thus considered as a safe herbicide.

The state of the water medium after the herbicidal treatment favored fish production and migration and this was reflected by the recorded higher catches after treatment with the herbicides. Observations from this study showed that glyphosate application at reasonable rate could restore the integrity of a river channel that is clogged by aquatic weed especially *E. crassipes.*

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