EFFECTS OF THIOBENCARB HERBICIDE ON SOME CHEMICAL PARAMETERS AND PLANKTON COMMUNITIES OF RICE FIELDS

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Abstract

The adverse effects of the rice herbicide thiobencarb (Saturn) on rice field chlorophyll "a" concentrations, zooplankton communities and water quality were studied throughout the period investigation. Treatments simulated direct spraying of rice field by this herbicide was followed. Two rates of 1 and 1.5 kg faddan^{-1} of thiobencarb were tested, representing approximate high and low level. Water quality measurements were done prior to herbicide application (0 time) and then after 1, 2, 3, 4 days from application.

The obtained results indicated that Thiobencarb was reduced greatly oxygen production in water. These stressful oxygen levels, however, occurred only with the simulated direct spraying by this herbicide in rice field. Also, stimulation of chlorophyll "a" was recorded. Herbicide concentration froued influenced in this respect. In addition, significantly higher rotifers and copepods counts were observed after 4 days from herbicide treatment.

INTRODUCTION

Aquaculture often shares physical requirements with agricultural endeavors. The widespread use of herbicides in modern agriculture might adversely affect algal flora. Thiobencarb [S-4-Chlorobenzyl diethylthiocarbamate], which has Saturn as principle trade name, is a thiocarbamate herbicide with moderate water solubility (30 mg/lat 20 °C). It is widely used for weed control in paddy fields due to its low persistence and high effectiveness. (Tomlin, 1994 and Eladel et al., 1999). The recommended field application dose in terms of active ingredients is approximately 4 kg ha^{-1}, or 40 mg/l for a 10-cm deep paddy (Beste et al., 1983).

Herbicides may cause adverse effects on the phytoplankton communities in fish ponds through direct spraying or drift during crop dusting, but should not be present at levels toxic to fish (Spradley, 1991). Death or reduction in the metabolic rate of phytoplankters would reduce the supply of dissolved oxygen in pond water, inhibit removal of toxic nitrogenous wastes, and reduce production of zooplankton by reducing the food supply (Waiser and Robarts, 1997). These conditions could results in death, disease, or lower growth rates of cultured fish. (Perschbacher et al., 2002).

This study aimed to throw light on the adverse effect of the high and low application of thiobencarb herbicides on phytoplankton productivity, zooplankton and water quality in rice field.

MATERIALS AND METHODS

The study was conducted at Ibrahimia, Sharkia Governorate during 2003 in rice field. Thiobencarb was thouroshly and homogeneously sprayed on the surface at two rates equivalent to that of direct application of 1 kg $faddan^{-1}$ and 1.5 kg $faddan^{-1}$ thiobencarb. The concentrations are recommended for weed control in rice field (Baldwin et al ., 2000). Commercial formulation used in water without any adjuvant or wetting agents then mixed with sand and distributed uniformly over the water surface. Each treatment was replicated three times in randomly assigned design in each trial. Pools were flushed and air dried for 4 days between trials. A set of measurements was taken before application (0 time as a control) and then after 1, 2, 3 and 4 days from application. In case of high level of herbicide, the measurements were taken 1, 2, 3 days, respectively.

Water column sampler was used to collect samples of water then poured at one liter polyethylene wide-mouth jars and kept cool in the dark. Some chemical measurements of water i.e. temperature, dissolved oxygen, pH, total ammonia nitrogen concentration were measured in rice fields within one hour after collection. Also, salinity (ppt), electric conductivity (µmhos/cm), total alkalinity mg/l, chlorophyll "a" (µg l^{-1}), orthophosphate (mg l^{-1}), and nitrite (mg l^{-1}) were measured in the laboratory (APHA, 1995). Zooplankton samples for quantitative analysis were taken every day before and after application. Ten liters of the rice field water were filtered through zooplankton net of 55 µm mesh diameter. Samples were preserved immediately after collection in 4% neutral formaline. In addation, a fresh samples were collected for taxonomic work. Major zooplankton group were also determined in each replicate following Ludwig (1993). All data were subjected to analysis of variance by using general linear model (GLM) procedure of SAS (1996) for personal computer. Analysis of variance were used to test the significant differences ($P < 0.05$) among treatments in each trial.

RESULTS AND DISCUSSION

The effect of two rates of thiobencarb herbicide and time on some water chemical parameters, phytoplankton productivity and zooplankton population was studied in the rice fields. Data in Tables (1 and 2) and (Fig 1) showed that the oxygen production was affected by the time and its interactions with thiobencarb rates but not with the thiobencarb rates in the rice field. This is in contrary with Perschbacher et al. (1997 & 2002) who found that propanil herbicide was significantly reduced oxygen production by 75% after 1h and reduced dissolved oxygen levels by 48% after 24h. such stressful oxygen levels, however, occurred only at the simulated direct spraying of rice field. However, at high rates (HL) of propanil the oxygen levels were not affected.

Although any unnecessary chemical addition to aquaculture rice field should be avoided to eliminate the potential for accumulation in cultured fish, this study indicates that drift from common applied rice herbicides should not effect phytoplankton productivity, zooplankton populations, and water quality. The mode of action of thiocarbamate herbicides are not well understood, but they seem to inhibit the growth of plankton (Sabater and Carrasco, 1996). The effect in fields may be less severe than in the mesocosms as fields contain mud substrates that could adsorb herbicides. However, the highest herbicide concentrations and thus greatest impact would be expected in surface layers and associated plankton. This study also confirms that potential problems exist with direct spraying by the rice herbicides, thiobencarb. Specifically, this photosynthesis inhibitor (Ashton and Crafts, 1981) will depress primary production of phytoplankton on contact for 2 days, resulting in stressful and potentially lethal dissolved oxygen levels from 2 to 3 days after application.

Stimulation of chlorophyll "a" was again observed. The primary productivity in the HL trail was significantly higher than in the LL trial. In addition, significantly higher rotifer and copepod counts were observed at 4 days. These are judged to reflect the stimulatory effect of thiobencarb on chlorophyll "a".

The significant increase in chlorophyll "a" following addition of thiobencarb, especially at higher rates, that was observed in this study and the previous studies of Perschbacher et al., (1997& 2002) continues to be unexplained. It is assumed to be related to compensatory action by the algae for phytosynthesis inhibition, Ashton et al. (1977) found that phytosynthetic inhibitors stimulated rapid synthesis and suggested that it may be related to a membrane repair mechanism. The increase in chlorophyll "a" concentration suggests an increase in food availability for zooplankton and is ultimately believed to have been responsible for the observed increase in numbers of rotifers and copepods at high rate, although the exact mechanisms are also unknown (Perschbacher et al., 2002). Generally the percentages of the change for chemical measurements were low when compared with the biological measurements chlorophyll "a" concentrations (µg l^{-1}) and total zooplankton count (org l^{-1}) after application of the herbicide.

As shown in Table (3) and Figures (1 and 2), the population of zooplankton was significantly high with the high rate of thiobencarb (mean = 1630 org. l^{-1}) compared with the low rate (335 org. L^{-1}) at first day. The standing crop of total zooplankton revealed a gradually increase from 1st day to 4th day after application. Rotifers were the most abundant group in the two rates comprising 92.47, 71.9, 76.11, 91.37, 91.4 % of total zooplankton numbers at the 1st , 2nd, 3rd ,4th days from application, respectively with the low rate, while comprising 83.49, 90.02, 88.72, 73.35 % of standing crop at 1st , 2nd, 3rd ,4th days after application respectively in the high rate of thiobencarb. In this study, copepoda were less abundant than and common group of total zooplankton density with the two herbicide rates.

Data in Table (2) were showed that temperature (^{o}C), salinity (ppt), Electric conductivity (µmhos/cm), total alkalinity mg/l, chlorophyll "a" concentrations (µg/l) and total zooplankton count (org/l) were affected significantly ($P<0.05$) by all studied factors, i.e. herbicide rate, time and their interactions. The pH, NH_3 concentrations and total hardness mg/lwere affected significantly ($P<0.05$) by the rate of application. On the other hand the time factor affected significantly ($P<0.05$) the dissolved oxygen (mg l^{-1}). Orthophosphate (mg l^{-1}) and primary productivity did not affect significantly ($P>0.05$) neither the herbicide rate nor the time and their interactions. Total hardness concentration was affected by both thiobencarb rates and its interaction with the time. NO_2 concentration was affected by the interaction between the time and the thiobencarb rates only.

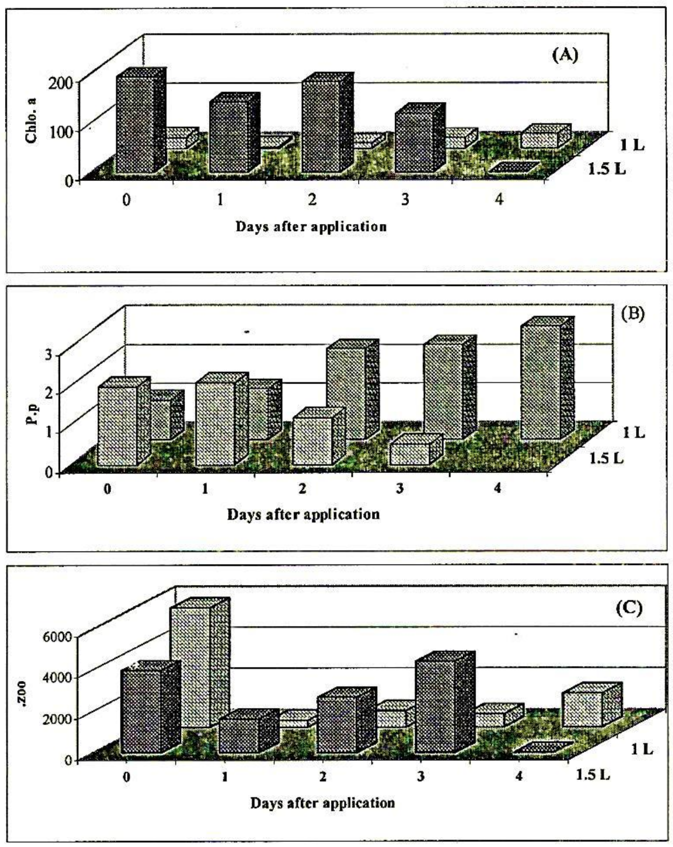

Fig. (1A, B and C) : The effects of different rates (1 and 1.5 l /faddan) of thiobencarb on the chlorophyll "a" concentration (µg l^{-1}), primary productivity and total zooplankton count (org l^{-1}) after different days.

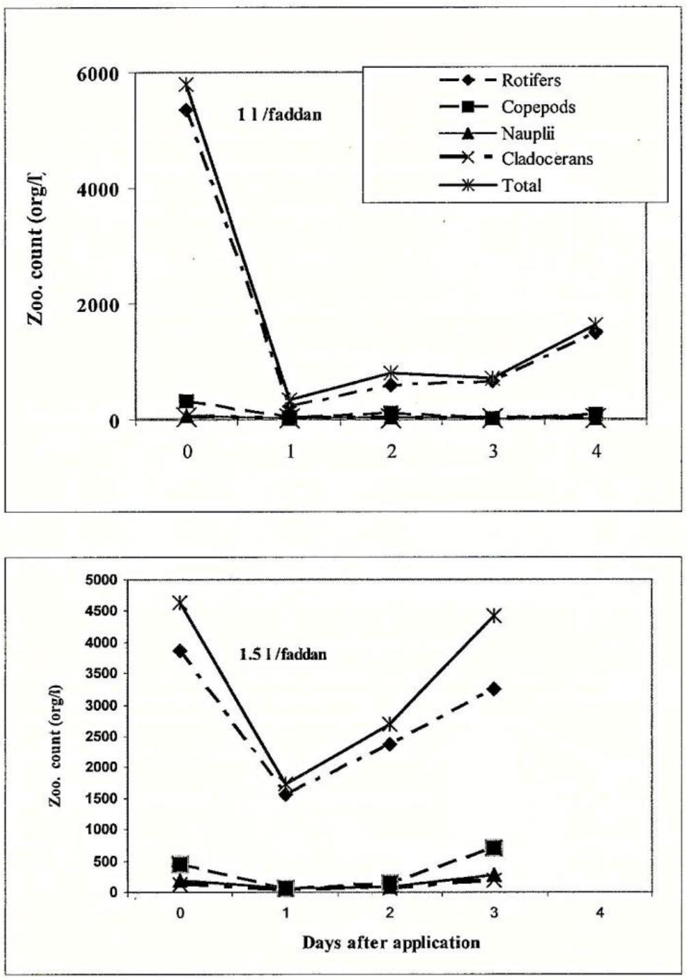

Fig. (2A and B): The effects of different dose (1 and 1.5 l faddan^{-1}) of thiobencarb on the zooplankton 2 l^{-1}) after different days.

Table (1A): Some water quality parameters (mean ±SE) for rice field treated with 1L of thiobencarb/faddan.

VARIABLE	DAYS AFTER APPLICATION				
	0	1	2	3	4
Temp. (°C)	23.7 Bb ± 0.42	30.00 Aa ± 1.73	24.30 Bb ± 0.85	24.27 Ab ± 0.64	27.90 a ± 1.15
DO (mg l^{-1})	6.17 Bc± 0.52	8.80 Aa ±0.12	7.10 Bbc ± 0.31	8.93 Aa ± 0.22	8.00 ab ± 0.61
PH	8.08 Ba ± 0.22	8.50 Aa ± 0.06	8.08 Ba± 0.36	8.42 Ba ± 0.22	8.58 a ± 0.08
Salinity (ppt)	0.10 Ba ± 0	0.10 Ba ± 0	0.10 Ba ± 0	0.10 Ba± 0	0.10 a ± 0. 0
E.C.(µmohs/cm)	396.67 Aa ± 26.67	343.3 Ba ± 28.48	346.67 Ba ± 33.83	446.67 Ba ± 37.12	446.67 a ± 24.04
NO_2 (mg l^{-1})	0.057Aa ± 0.01	0.04 Aab ± 0.01	0.05 Aab ± 0.01	0.03 Ab ± 0.01	0.03 b ± 0.003
NH_3 (mg l^{-1})	0.06 Ba ± 0.03	0.24 Aa ± 0.11	0.09 Ba ± 0.05	0.19 Ba ± 0.05	0.23 a ± 0.04
T.Alk.(mg l^{-1})	96.67 Ba ± 4.41	95.00 Ba ± 10.41	103.33 Ba ± 21.62	111.67 Ba ± 1.67	110.00 a ± 15.00
T. H (mg l^{-1})	134.5 Aab ± 0.34	129.5Ab± 10.18	123.13 Ab ± 14.02	167.83 Aa ± 10.18	165.17a ± 13.24
Orth. (mg l^{-1})	0.04 Aa ± 0.02	0.08 Aa± 0.05	0.34 Aa± 0.25	0.30 Aa ± 0.06	0.39 a ± 0.20
P. p. ((mg O_2 l^{-1} h^{-1})	1.00 Aa ± 0.60	1.30 Aa ± 0.57	2.33 Aa ± 0.62	2.43 Aa ± 0.67	2.90 a ± 0.60
Chlo a (µg l^{-1})	23.15 Ba ± 3.69	4.35 Bc± 2.18	11.69 Bbc ± 3.27	21.63 Bab ± 3.52	31.09 a ± 4.09
T. zoop. (org l^{-1})	5802Aa± 582	335 Bc ± 36	799B bc ± 81	635 Bc ± 102	1640 b ± 203

Table (1B): Some water quality parameters (mean ±SE) for rice field treated with 1.5 L of thiobencarb/faddan.

VARIABLE	DAYS AFTER APPLICATION			
	0	1	2	3
Temperature (°C)	29.00 Ab ± 0.58	28.03 Ab± 0.09	34.167 Aa ± 0.167	23.57 Ac ± 0.47
D. oxygen (mg l^{-1})	9.10 Aa ± 0.21	9.067 Aa ± 0.58	9.03 Aa ± 0.58	4.63 Bb ± 0.3
PH	9.10 Aa ± 0.06	9.08 Aa ± 0.22	9.75 Aa ± 0.14	9.50 Aa ± 0.29
salinity (ppt)	0.3 Ab ± 0.0	0.23 Ab ± 0.03	0.3 Ab± 0.0	0.5 Aa ± 0.0
E.C.(μmohs/cm)	109.00 Bd ± 3.79	923.33 Ac±82.12	1146.67Ab±26.03	1430.00Aa ± 55.06
NO_2 (mg l^{-1})	0.04 Aa ± 0.01	0.11 Aa ± 0.04	0.047 Aa ± 0.003	0.04 Aa± 0.003
NH_3 (mg l^{-1})	0.83 Aa ± 0.21	0.74 Aa ± 0.15	1.13 Aa± 0.09	0.76 Aa ± 0.2
T.alkalinity (mg l^{-1})	535.00 Aab±36.86	420.00 Bb±39.05	553.33 Aa± 20.28	567.50 Aa ± 37.50
T. hardness (mg l^{-1})	102.13 Aa ± 14.17	114.78 Aa± 8.69	84.08 Ba± 4.62	85.42 Ba ± 5.8
Orth. (mg l^{-1})	0.05 Ab ± 0.04		0.047 Ab ± 0.04	0.29 Aa ± 0.003
P. p. ((mg O_2 l^{-1} h^{-1})	2.00 Aa ± 0.76	2.10 Aa ± 0.52	1.20 Aa ± 0.65	0.53 Aa ± 0.28
Chlo. "a" (μg l^{-1})	197.84 Aa ± 5.54	146.15 Aab± 27.45	185.96 Aab± 17.97	121.78 Ab ± 3.88
T. zoop. (org l^{-1})	3974 Aa ± 318	1630 Ac ± 116	2678 Ab ± 280	4414 Aa ± 460

Different capital littres indicate that there are significant difference between means at the same day after application of two rates, but the other indicate that there are significant difference among means of the different days under the same rate.

Table 2. Least square means (LSM) analyses of variance of some water quality parameters for rice field treated by different rates of thiobencarb.

	Temp. (°C)		D.O. (mg l^{-1})		pH		Salinity (ppt)	
Factor effect	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Rate (L/fadd)	***		NS		***		***	
1	6.03	0.37	7.80	0.19	8.33	0.90	0.10	0.02
1.5	28.69	0.39	7.95	0.20	9.36	0.11	0.33	0.02
DAY	***		**		NS	.	**	
0	26.35	0.59	7.63	0.30	8.59	0.15	0.20	0.02
1	29.02	0.59	8.93	0.30	8.79	0.15	0.17	0.02
2	29.23	0.59	8.07	0.30	8.92	0.15	0.20	0.02
3	23.92	0.59	6.78	0.30	8.96	0.15	0.30	0.02
4	.	.	.	.	.	.	.	.
Rate*Day	***		***		NS		**	
Rate 1*0	23.70	0.83	6.17	0.42	8.08	0.21	0.1	0.04
Rate 1*1	30.00	0.80	8.80	0.42	8.50	0.21	0.1	0.04
Rate 1*2	24.30	0.80	7.10	0.42	8.08	0.21	0.1	0.04
Rate 1*3	24.27	0.80	8.93	0.42	8.42	0.21	0.10	0.04
Rate 1*4	27.90	0.80	8.00	0.42	8.58	0.21	0.10	0.04
Rate 2*0	29.00	0.80	9.10	0.42	9.10	0.21	0.30	0.04
Rate 2*1	28.03	0.80	9.07	0.42	9.08	0.21	0.23	0.04
Rate 2*2	34.17	0.80	9.03	0.42	8.75	0.21	0.30	0.04
Rate 2*3	23.57	0.80	4.63	0.42	9.50	0.21	0.50	0.04
Rate 2*4	.	.	.	.	.	.	.	.

Table 2. Cont.

Factor effect	EC (µmhos/cm)		NO_2 (mg l^{-1})		NH_3 (mg l^{-1})		Ortho. (mgl^{-1})	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Rate (l/fad)	***		NS		***		NS	
1	396.00	18.31	0.040	0.007	0.160	0.050	0.230	0.050
1.5	902.25	21.30	0.060	0.008	0.860	0.060	0.240	0.060
DAY	***		NS		NS		NS	
0	252.83	28.95	0.048	0.010	0.440	0.090	0.040	0.080
1	633.33	28.95	0.075	0.010	0.490	0.090	0.040	0.080
2	745.67	28.95	0.048	0.010	0.610	0.090	0.200	0.080
3	938.33	28.95	0.037	0.010	0.470	0.090	0.290	0.080
4	.	.	.		.	.	.	
Rate*Day	***		*		NS		NS	
Rate 1*0	396.67	40.95	0.060	0.010	0.060	0.120	0.040	0.110
Rate 1*1	343.33	40.95	0.040	0.010	0.240	0.120	0.080	0.110
Rate 1*2	346.67	40.95	0.050	0.010	0.090	0.120	0.340	0.110
Rate 1*3	446.67	40.95	0.030	0.010	0.190	0.120	0.300	0.110
Rate 1*4	446.67	40.95	0.030	0.010	0.230	0.120	0.390	0.110
Rate 2*0	109.00	40.95	0.040	0.010	0.830	0.120	0.050	0.110
Rate 2*1	923.33	40.95	0.110	0.010	0.740	0.120	0.000	0.110
Rate 2*2	1146.67	40.95	0.040	0.010	0.130	0.120	0.050	0.110
Rate 2*3	1430.00	40.95	0.040	0.010	0.750	0.120	0.290	0.110
Rate 2*4	.	.	.	.	.	.	.	.

Note: ns = not significant (P>0.05), * = significant (0.05>P<0.01) , ** =high significant (0.01>P<0.001) and ***=highly significant (P<0.001). E.C. =electric conductivity.

Table 2. Cont.

Factor effect	T. alkalinity (mg/l)		T. hardness mg/l)		Primary productivity		Chlor. a (µg/l)		T. Z. (org/l)	
	LSM	SE	LSM	SE	LSM	LSM	SE	LSM	SE	LSM
Rate (l/fadd)	***		***		NS		***		***	
1	103.33	10.39	144.01	4.49	1.99	0.27	18.38	5.12	1869	160
1.5	518.96	12.79	96.61	4.48	1.46	0.30	162.93	6.03	3340	190
DAY	*		NS		NS		*		***	
0	315.83	16.43	118.30	6.77	1.50	0.40	110.49	8.10	5221.00	254.00
1	257.50	16.43	122.12	6.70	1.70	0.40	75.25	8.10	982.00	254.00
2	328.33	16.43	103.60	7.57	1.77	0.40	98.83	8.10	1638.00	254.00
3	339.58	18.37	126.63	7.57	1.48	0.40	71.71	8.10	3194.00	254.00
4	.		.				.		.	
Rate*Day	*		*		NS		*		***	
Rate 1*0	69.67	23.23	134.47	9.58	1.00	0.60	23.15	11.45	5802.00	360.00
Rate 1*1	95.00	23.23	129.46	9.58	1.30	0.60	4.35	11.45	335.00	360.00
Rate 1*2	103.33	23.23	123.13	11.72	2.33	0.60	11.69	11.45	599.00	360.00
Rate 1*3	111.67	23.23	167.83	9.58	2.43	0.60	21.63	11.45	1974.00	360.00
Rate 1*4	110.00	23.23	165.17	9.58	2.90	0.60	31.09	11.45	4641.00	360.00
Rate 2*0	535.00	23.23	102.13	9.58	2.00	0.60	197.84	11.45	4641.00	360.00
Rate 2*1	420.00	23.23	114.78	9.58	2.10	0.60	146.15	11.45	1630.00	360.00
Rate 2*2	553.33	23.23	84.08	9.58	1.20	0.60	185.96	11.45	2678.00	360.00
Rate 2*3	567.50	23.23	85.42	9.58	0.53	0.60	121.78	11.45	4414.00	360.00
Rate 2*4	.	.	.	.	.	.	.	.	.	.

NS = not significant (P>0.05), * = significant (0.05>P<0.01) , ** =high significant (0.01>P<0.001) and ***=highly significant (P<0.001).

Table 3. Development of zooplankton groups (means and percentages of the group to the total count) before and after application of thiobencarb for rice field.

Day	1 L/faddan				
	Rotifers	Copepods	Nauplii	Cladocerans	Total
0	5365.67	313.33	72.67	51.00	5802.67
%	92.47	5.40	1.25	0.88	100.00
1	241.33	48.00	30.67	15.67	335.67
%	71.90	14.30	9.14	4.67	100.00
2	608.67	125.33	39.67	26.00	799.67
%	76.12	15.67	4.96	3.25	100.00
3	660.00	27.33	19.67	15.33	722.33
%	91.37	3.78	2.72	2.12	100.00
4	1495.33	91.00	30.33	24.00	1640.67
%	91.14	. 5.55	1.85	1.46	100.00

Table3. Cont.

Day	1.5 L/faddan				
	Rotifers	Copepods	Nauplii	Cladocerans	Total
0	3875.00	441.00	196.00	129.00	4641.00
%	83.49	9.50	4.22	2.78	100.00
1	1557.33	72.33	55.67	44.67	1730.00
%	90.02	4.18	3.22	2.58	100.00
2	2381.33	158.67	85.33	58.67	2684.00
%	88.72	5.91	3.18	2.19	100.00
3	3238.00	704.33	274.00	198.00	4414.33
%	73.35	15.96	6.21	4.49	100.00

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تأثيرات مبيد الأعشـــاب ثيـــو بنكـــارب على بعض القياسات الكيميائية وعشائر الهائمات لحقول الأرز

عايدة محمد ضوة ، صفوت عبد الغنى عبد المجيد ، محمد فرج

المعمل المركزي لبحوث الثروة السمكية ، مركز البحوث الزراعية – مصر.

إستهدفت الدراسه إلقاء الضوء على التأثيرات الفعالة لمبيد الأعشاب ثيوبنكارب (ساترن) في حقول الأرز على الهائمات الحيوانية والنباتية وانعكاسات ذلك على جودة المياه في الحقول المعاملة. تم رش المبيد مباشرة بمعدلين هما ١،٥ كجم /فدان (معدل عال)، ١ كجم / فدان (معدل منخفض) من الثيوبنكارب كمستويين وتم قياس خالة المياه قبل وبعد رش المبيد عند ٠ ، ١ ،٢ ،٣ ، ٤ يوم. وأتضح من الدراسة إن الثيوبنكارب يختزل الأوكسجين حيثما حفز هذا الإجهاد لمستوى الأوكسجين عند الرش المباشر للمبيد في الحقول ولوحظ أيضا وجود تحفز لمستوى كلوروفيل. إن الإنتاج الأولى في المعدل العالي أعلى من المعدل المنخفض. بالإضافة إلي أنه يوجد فرق معنوي عال في عدد الروتيفرا والكوبيبودا عند اليوم الرابع بعد رش المبيد. ويتضح من النتائج ان معظم القياسات الكيميائية و الهائمات تبدأ في التعافي والزيادة بعد اليوم الرابع من المعاملة مما يعنى إمكانية إستزراع الأسماك بعد هذه الفترة .