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Research Article

IMPACT OF PESTICIDES ON AQUATIC INSECTS IN IRRIGATED RICE FIELDS

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Abstract: Aquatic insect population in irrigated rice fields of Coimbatore was studied during early *Samba* and late *Thaladi* on 2018-2019. The collected aquatic insects represented six insect orders, Hemiptera, Coleoptera, Diptera, Odonata, Collembola and Ephemeraptera. Application of butachlor @ 1.25 kg/ha on 35 DAT reduced the aquatic faunal abundance especially the Hemiptera and Collembola. Application of cartap hydrochloride @ 50 SP 400g/acre on 65 days after transplanting resulted in increased population abundance of Hemipter while the remaining faunal population abundance was drastically reduced especially Collembola which failed to survive after the application of the insecticide.

Keywords: *Irrigated rice field, Aquatic insects, Population, Growth stage and Pesticide residue*

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Introduction

Rice is staple food for half of the world population. Irrigated rice fields are man-made wetlands and it is suitable environment for several aquatic insects and are important in the preservation of biodiversity [1-3]. In the recent, under modern agricultural ecosystems irrigated rice fields are mostly pesticide driven [4]. Pesticide applications and rice associated agronomic practices may affect the aquatic insects and also may prevent the establishment in rice fields [5-8]. Elsewhere, it has been studied that the densities of predators, aquatic beetles and dragonflies decreased due to pesticide application, while population of chironomids and ostracods increased. Molozzi, *et al*., (2007) [9] reported that the pesticides in irrigated rice fields altered water quality. Pesticide usage in rice fields may impact non-target insects and thereby modifies food webs and the development of communities [10]. For example, Odonata was adversely affected due to pesticide application in turn reduced the larval biomass [11] thereby disrupting the food chain [12]. However, Schoenly *et al*. (1998) [13] has stated that the aquatic invertebrate in rice ecosystems recover from the pesticide effect and later colonize the rice fields. The impact of agrochemicals on aquatic insects in irrigated rice is wanting in India. Hence, this study was taken up.

Materials and Methods

Study site

The impact of pre emergence herbicide butachlor and insecticide cartap hydrochloride on aquatic insect population in irrigated rice was assessed during 2018-2019 in rice fields of wetlands at Tamil Nadu Agricultural University (TNAU), Coimbatore.

Details of irrigated rice field

The rice crop cultivated during early *Samba* (July 2018 to December 2018) comprised variety CO 51 (short duration variety) in an area of 0.35 acres, while late *Thaladi* (October 2018 to January 2019) cultivation was undertaken with CO 51 (short duration variety) in area of 0.75 acres.

The agrochemicals applied included 36 kg of urea and 10 kg of MOP applied in four split doses on 15, 50, 75, 125 DAT. Pre emergence herbicide Butachlor @ 1.25kg/ha on 35 DAT and insecticide Cartap hydrochloride @ 50SP 400g/acre 65 DAT were applied.

Sampling methods

Aquatic insects were collected with the help of D-frame aquatic hand net (12" frame, D shaped loop of 30 cm thickness, handle 60 cm length and 1200 µm mesh) from 6.30 h to 9.30 h on one day before application and one, three, five, seven and nine days after application during different crop growth stages *viz*., seedling stage, vegetative stage, reproductive stage and grain maturity stage. Totally 64 samples were taken during this study period. Samples were collected randomly at 10 places within a single field and then these samples were pooled to make a single sample. The collected insects were transferred to a container of one litre capacity. The soft bodied insects were preserved in 70% ethanol in cryo tubes. Each specimen was labelled with information on geographical coordinates, date of collection, method of collection, name of collector and host plant. Sorting and taxonomic characterization were done with the help of stereozoom microscope (Leica M205C) at the TNAU Insect Museum. Identification was based on the key Barrion and Litsinger (2004) [14].

Data analysis

The insect population abundance data before and after spay were subjected to paired t-test to know significance of the impact of agrochemicals applied. The analysis was done with Microsoft Office Excel 2017.

Impact of agrochemicals on aquatic insects = Total abundance (after chemical input application) - Pre count application (before chemical input application)

Result and Discussion

The insects collected during the study, represented six orders *viz*., Hemiptera

Table-1 *Composition of aquatic insect fauna in irrigated rice*

Insect Orders	Family
Hemiptera	Notonectidae, Corixidae, Micronectidae, Gerridae, Nepidae, Hydrometridae, Pleidae and Veliidae
Coleoptera	Dytiscidae, Hydrophilidae and Gyrinidae
Diptera	Culicidae, Chironmidae and Empididae
Odonata	Coenagrionidae, Libellulidae and Gomphidae
Collembola	Undetermined family
Ephemeroptera	Baetidae

Table-2 *Abundance of aquatic insect populations against butachlor application in irrigated rice field*

Insect orders	Aquatic insect abundance (Numbers)													
	Early *Samba* (July 2018 to December 2018)							Late *Thaladi* (October 2018 to January 2019)						
	Pre application count	DAA	3DAA	5DAA	7DAA	9DAA	Mean*	Pre application count	1DAA	3DAA	5DAA	7DAA	9DAA	Mean*
Hemiptera	129.00	65.00	81.00	77.00	87.00	85.00	79.00	42.00	11.00	17.00	20.00	26.00	46.00	24.00
Coleoptera	7.00	6.00	13.00	6.00	8.00	7.00	8.00	5.00	5.00	8.00	4.00	3.00	6.00	5.20
Diptera	3.00	3.00	3.00	3.00	3.00	2.00	2.80	6.00	2.00	4.00	3.00	7.00	6.00	4.40
Odonata	2.00	0.00	0.00	6.00	7.00	5.00	6.00	5.00	2.00	5.00	3.00	0.00	6.00	4.00
Collembola	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Ephemeroptera	0.00	0.00	1.00	2.00	1.00	1.00	1.25	1.00	0.00	1.00	2.00	2.00	1.00	1.50
Mean	28.60	24.67	24.50	18.8	21.20	20.00	21.83	10.00	5.00	7.00	6.40	9.50	13.00	8.18
SD	56.16	34.96	38.03	32.58	36.89	36.41	35.77	15.82	4.24	6.12	7.64	11.21	18.57	9.55
t_{cal}	0.90							1.19						
t_{tab}	2.02							2.02						

***DAA-Days after application, * Mean of five observation*

Table-2a *Impact of butachlor on aquatic insects in irrigated rice field*

Insect orders	Early *Samba* (July 2018 to December 2018)						Late *Thaladi* (October 2018 to January 2019)					
	1 DAA	3 DAA	5 DAA	7 DAA	9 DAA	Mean	1 DAA	3 DAA	5 DAA	7 DAA	9 DAA	Mean
Hemiptera	-64.00	-48.00	-52.00	-42.00	-44.00	-50.00	31.00	-25.00	-22.00	-16.00	4.00	-5.60
Coleoptera	-1.00	6.00	-1.00	1.00	0.00	1.00	0.00	3.00	-1.00	-2.00	1.00	0.20
Diptera	0.00	0.00	0.00	0.00	-1.00	-0.20	-4.00	-2.00	-3.00	1.00	0.00	-1.60
Odonata	-2.00	-2.00	4.00	5.00	3.00	1.60	-3.00	0.00	-2.00	-5.00	1.00	-1.80
Collembola	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Ephemeroptera	0.00	1.00	2.00	1.00	1.00	1.00	-1.00	0.00	-1.00	1.00	0.00	-0.20
Mean	-11.50	-7.50	-8.17	-6.17	-7.17	-8.10	3.67	-4.17	-5.00	-3.67	0.83	-1.67
SD	25.74	20.06	21.58	17.70	18.13	20.57	13.47	10.34	8.37	6.44	1.72	2.08

***DAA-Days after application*

Table-3 *Abundance of aquatic insect populations against cartap hydrochloride application in irrigated rice field*

Insect orders	Aquatic insect abundance (Numbers)													
	Early *Samba* (July 2018 to December 2018)							Late *Thaladi* (October 2018 to January 2019)						
	Pre application count	1DAA	3DAA	5DAA	7DAA	9DAA	Mean*	Pre application count	1DAA	3DAA	5DAA	7DAA	9DAA	Mean*
Hemiptera	30.00	38.00	37.00	82.00	85.00	78.00	64.00	31.00	10.00	36.00	33.00	64.00	51.00	38.80
Coleoptera	5.00	3.00	2.00	3.00	3.00	2.00	2.60	7.00	2.00	3.00	3.00	3.00	11.00	4.40
Diptera	3.00	3.00	1.00	1.00	2.00	2.00	1.80	2.00	2.00	5.00	0.00	6.00	1.00	2.80
Odonata	2.00	4.00	1.00	1.00	1.00	3.00	2.00	2.00	2.00	1.00	2.00	0.00	5.00	2.00
Collembola	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.60
Ephemeroptera	1.00	0.00	0.00	0.00	1.00	1.00	0.40	3.00	4.00	1.00	3.00	0.00	1.00	1.80
Mean	7.00	12.00	10.25	21.75	18.40	17.20	11.80	9.00	4.00	9.20	10.25	18.50	11.83	8.40
SD	11.37	17.34	17.84	40.18	37.24	34	25.59	12.47	3.46	15.07	15.17	30.4	19.56	14.94
t_{cal}	-0.82							-0.61						
t_{tab}	2.02							2.02						

***DAA-Days after application, * Mean of five observation*

Table-3a *Impact of cartap hydrochloride on aquatic insects in irrigated rice field*

Insect orders	Early *Samba* (July 2018 to December 2018)						Late *Thaladi* (October 2018 to January 2019)					
	1 DAA	3 DAA	5 DAA	7 DAA	9 DAA	Mean	1 DAA	3 DAA	5 DAA	7 DAA	9 DAA	Mean
Hemiptera	8.00	7.00	52.00	55.00	48.00	34.00	-21.00	5.00	2.00	33.00	20.00	7.80
Coleoptera	-2.00	-3.00	-2.00	-2.00	-3.00	-2.40	-5.00	-4.00	-4.00	-4.00	4.00	-2.60
Diptera	0.00	-2.00	-2.00	-1.00	-1.00	-1.20	0.00	3.00	-2.00	4.00	-1.00	0.80
Odonata	-2.00	-1.00	-1.00	-1.00	1.00	-0.80	0.00	-1.00	0.00	-2.00	3.00	0.00
Collembola	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	0.00	0.00	0.00	1.00	2.00	0.60
Ephemeroptera	-1.00	-1.00	-1.00	-1.00	0.00	-0.80	1.00	-2.00	0.00	-3.00	-2.00	-1.20
Mean	0.33	-0.17	7.50	8.17	7.33	4.63	-4.17	0.17	-0.67	4.83	4.33	0.90
SD	3.83	3.60	21.81	22.95	19.97	14.40	8.52	3.31	2.07	14.11	8.02	3.61

***DAA-Days after application*

(Notonectidae, Corixidae, Micronectidae, Gerridae, Nepidae, Hydrometridae, Pleidae and Veliidae), Coleoptera (Dytiscidae, Hydrophilidae and Gyrinidae), Diptera (Culicidae, Chironmidae and Empididae), Collembola (Undetermined family) and Ephemeroptera (Baetidae) [Table-1]. During early *Samba* season, the aquatic insect population was comparatively significantly higher before the application of butachlor (28.60 numbers) than in post application count (21.83 numbers) with t_{cal} (0.90) lesser than t_{tab} (2.02) [Table-2]. Similarly, during late *Thaladi* season, the aquatic insect population was comparatively significantly higher in pre application count (10.00) than in post application count (8.18 numbers) with t_{cal} (1.19) lesser than t_{tab} (2.02) [Table-2].

Among, the different insect orders under study, the impact of butachlor was conspicuously observed with drastic reduction in population of Hemiptera and Collembola. Butachlor application reduced the aquatic insect population on period of observation, during early *Samba* season 1 DAS (-11.50 numbers) with respectively 3 DAS (-7.50 numbers), 5 DAS (-8.17 numbers), 7 DAS (-6.17 numbers) and 9 DAS (-7.17 numbers). During late *Thaladi*, the aquatic insect population were counted on 1 DAS (3.67 numbers), 3 DAS (-4.17 numbers), 5 DAS (-5.00 numbers), 7 DAS (-3.67 numbers) and 9 DAS (0.83 numbers) [Table-2a]. The possible reason may be that as, Hemiptera and Collembola were mostly surface dwellers they would have had more exposure to butachlor application. The remaining fauna were observed to be unaffected by or least affected by the application of butachlor. Aquatic Coleoptera (Dytiscidae, Gyrinidae and Hydrophilidae) occupied water columns and intermittently visited the water surface. Hence, the chance of exposure to butachlor may be less comparatively. Similarly, the immature Diptera, Odonata and Ephemeroptera are all floor dwellers. The reach of butachlor to these faunae likely to be remote when compared to Hemiptera and Collembola. Herbicide contamination rice fields resulted in bioaccumulation in ecosystem thereby affecting primary producers, the environment and subsequently affect the trophic chain. However, studies indicated that Dipterans were not affected by the herbicide concentration in water and surface soil [15,16]. Application of butachlor may affect the pH of water and it was influencing the aquatic insect population [27]. Thus, this study indicated that impact of herbicide on aquatic insect fauna differ with the fauna and functional habit of the fauna. However, in the long run accumulation of agro chemicals in irrigated rice fields would definitely hamper the complex food webs in rice ecosystems. In the present study, when cartap hydrochloride was applied on 65 DAT, it was observed that the abundance of Hemiptera escalated (64.00 numbers during early *Samba* and 38.80 during late *Thaladi*) after application of the insecticide in comparison to the pre-treatment abundance of (30.00 numbers during early *Samba* and 31.00 numbers during late *Thaladi*). For the remaining fauna, the study revealed that the insecticide application [Table-3]. The impacted population ranged from -0.17 to 8.17 numbers. During late *Thaladi*, the impacted ranged from -0.67 to 4.83 numbers [Table-3a]. It is inferred that either cartap hydrochloride promoted or increased the Hemipteran population or that there was brood emergence coinciding on 65 DAT which needs further study. Cartap hydrochloride, a thiocarbamate insecticide acts as a synaptic blocking agent and it is easily absorbed into the plant tissue. It has been characterized as highly effective with low toxicity and low residue [17]. Though many studies have demonstrated the ill effects of agrochemical usage on invertebrate diversity in different agro ecosystems, rice field invertebrates are unique in their recovery rates after the initial kill by these pesticides. In irrigated rice fields the cartap hydrochloride reduced populations of dragonflies and damselflies by 20-50 percent [18]. In addition, non-target survivors have been continuously threatened by these chemical inputs. Aquatic insects are sensitive to the chemical inputs and these rice fields are periodically disrupted by various agricultural practices [19]. The negative effect of pesticides on aquatic insects in rice fields have been previously documented [20]. Application of pesticides indirectly influencing the species diversity, changes in community structure and proliferation of selected species [21]. Repeated application of pesticides in rice fields destroys the most of the Odonata and Chironomid larva [22-26].

Conclusion

The impact of herbicide butachlor and insecticide cartap hydrochloride resulted in the reduction in aquatic insect population in irrigated rice fields but the Hemiptera increased after the application of the insecticide. This indicates the scope for future research on the actual reason for the increase in Hemiptera.

Application of research: The aquatic insect population an irrigated rice field declined at the time of pesticide and herbicide application after one week the population were reconstructed the same result was observed on the Philippines rice fields

Research Category: Agricultural Entomology

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Study area / Sample Collection: Rice fields of wetlands at Tamil Nadu Agricultural University (TNAU), Coimbatore.

Cultivar / Variety / Breed name: Rice

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