Impact of agrochemicals on odonata in rice (*Oryza sativa* L.) ecosystem

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ABSTRACT

Two supervised field experiments were conducted during *kharif*, 2012 and *rabi*, 2012-13 to study the impact of agrochemicals on the population of odonata in rice at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI), Karaikal, U.T. of Puducherry, India. The experiment was laid out in a randomized block design with eight treatments and three replications. It includes sole application of herbicide (Butachlor @ 2.5 litres/ha), fertilizers (NPK applied @ 50% N + 100% P + 100% K), insecticide (Chlorpyriphos @ 0.02 per cent seedling dip and foliar spray @ 1250 ml/ha), herbicide + fertilizer, herbicide + insecticide, fertilizer + insecticide, herbicide + fertilizer + insecticide and untreated check. In this experiment eight species of odonata *viz*., *Agriocnemis pygmaea* Rambur, *Ceriagrion coromandelianum* F., *Ischnura aurora* Brauer, *Lestes elatus* Hagen in Selys, *Diplacodes trivialis* Rambur, *Orthetrum sabina* Drury, *Pantala flavescens* F. and *Rhyothemis variegata* Linn. were identified during the crop growth period. The population of odonata was recorded from 1st week to 12th week after transplanting. During *kharif*, the overall mean population of odonata ranged from 0.19 to 0.65/sweeping. It was found that the per cent reduction was higher in the treatment with herbicide + insecticide (70.77%) compared to the untreated check. During *rabi*, the overall mean population of odonata ranged from 0.19 to 0.56/sweeping. A higher per cent reduction was observed in the treatment with herbicide + insecticide (66.07%) as in the *kharif*. It was concluded from both field experiments a higher population of odonata was observed in the untreated check followed by the treatment with fertilizer alone while a low population was observed in the herbicide + insecticide treatment followed by insecticide alone.

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INTRODUCTION

Rice, *Oryza sativa* L. is a staple food for over 55 per cent population of India and is grown in almost all the states (Jadhao and Khurad, 2011). Paddy field is one of the biggest agroecosystems in the world, and rice holds a responsible position in the world food problem. It is more excessive in Asia where paddy field is the largest and probably one of the oldest agroecosystem. More than 30 per cent of rice arthropod complex was found to be beneficial. But due to the application of pesticides adopted by farmers for higher yield, the rice agro-ecosystem is totally disturbed and misbalanced. Beneficial insects are more vulnerable and quickly go down than herbivores. It is very important to manage the herbivores by judicious use of novel and safer insecticides for proper maintenance of ecological balance. Many studies have shown that the impact of pests in rice paddy fields is often reduced to negligible levels when predator communities are conserved through reducing the use of pesticides (Way and Heong 1994; Settle *et al.*, 1996; Schoenly *et al.* 1998).

Odonata is the only large insectan order which is entirely predaceous. Both the nymphs and adults are voracious predators on other insects. All odonata are found close to fresh, though adult dragonflies often venture out for some distance overland, foraging for food (Gunathilagaraj *et al*., 1999). Rice ecosystem provides a good habitat for Odonata because of its aquatic nature and availability of prey species throughout the cropping season (Bambaradeniya *et al*., 2004). Thirty per cent species of Odonata inhabiting mainland utilize rice fields for oviposition (Ueda, 1998). They are the important predators in rice ecosystem and predate on adult stemborer, leaf folder and nymphs of leaf and planthoppers (Israel and Padmanabhan, 1976; Krishnasamy *et al*., 1984; Gunathilagaraj *et al*., 1999; Khaliq, 2002). To maximize production and

minimise insect pest infestation, agrochemicals *viz*., fertilizer, pesticides *etc* are excessively applied into the rice fields and more than 75 per cent of farmers in rice growing regions of Tamil Nadu are using moderately or highly hazardous pesticides (Chitra *et al*., 2006). Over usage of agrochemicals causes not only environmental contamination but also is detrimental to other organisms particularly natural enemies *viz*., dragonflies, damselflies, coccinellids, groundbeetles, spiders etc., in the rice ecosystem (Takamura *et al*., 1991). Hence, this study was undertaken to assess the impact of agrochemicals on Odonata in rice ecosystem.

MATERIALS AND METHODS

Two supervised field experiments were conducted in an irrigated condition during *kharif*, 2012 and *rabi*, 2012-13 at eastern farm of PAJANCOA and RI, Karaikal. The experiment was laid out in a Randomized Block Design (RBD) with three replications and eight treatments in a 5.5 x 4.5 square meter plot with a spacing of 15 x 10 cm and the variety used was ADT 45. The treatments of the experiments were : Control (No chemical inputs) – T1, Herbicide only (Butachlor @ 2.5 litres/ha applied as sand mix and broadcast three days after planting with a thin film of water maintained in the plots) – T2, Fertilizers only (NPK applied @ 50% N + 100% P + 100% K as basal and the remaining N applied in three splits at 15, 30 and 45 days after planting) –T3, Insecticide only (Chlorpyriphos @ 0.02 per cent seedling dip and foliar spray @ 1250 ml/ha at 45 and 60 days after planting)-T4, Herbicide + Fertilizer (Butachlor @ 2.5 l/ha + NPK applied @ 50% N + 100% P + 100% K as basal and the remaining N applied in three splits at 15, 30 and 45 days after planting)-T5, Herbicide + Insecticide (Butachlor @ 2.5 l/ha + chlorpyriphos seedling dip (0.02%) and foliar spray @ 1250 ml/ha at 45 and 60 days after planting)-T6, Fertilizer + Insecticide (NPK applied @ 50% N + 100% P + 100% K as basal and the remaining N applied in three splits at 15, 30 and 45 days after planting + chlorpyriphos seedling dip (0.02%) and foliar spray @ 1250 ml/ha at 45 and 60 days after planting)-T7 and Herbicide + Fertilizer + Insecticide (Butachlor @ 2.5 litres/ha + 100N: 50P: 50K + chlorpyriphos seedling dip (0.02%) and foliar spray @ 1250 ml/ha at 45 and 60 days after planting)-T8.

The impact of agrochemicals on odonata population was assessed based on the net sweeping method at weekly intervals in each of the treatment (Arulprakash and Gunathilagaraj, 2011). The data obtained from the field were analyzed in a simple Randomized Block Design by 'F' test for significance as described by Panse and Sukhatme (1958). Critical difference values were calculated at 5 per cent probability level and the treatment mean values of the experiments were compared using Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Table 1. Odonata observed in the rice ecosystem

Name of the Order/Family/Scientific name	Occurrence	
	Kharif	***Rabi***
Odonata		
a. Coenagrionidae		
Agriocnemis pygmaea Rambur	√	-
Ceriagrion coromandelianum Fabricius	√	√
Ischnura aurora Brauer	√	√
b. Lestidae		
Lestes elatus Hagen in Selys	√	√
c. Libellulidae		
Diplacodes trivialis Rambur	√	√
Orthetrum sabina Drury	√	√
Pantala flavescens Fabricius	√	√
Rhyothemis variegata Linnaeus	√	-

RESULTS AND DISCUSSION

During the survey, eight species of odonata were recorded (Table 1). During *kharif*, the population of odonata was recorded from 1st week to 12th week after transplanting. At 1st week, the odonata population ranged from 0.05 to 0.32/sweeping. A low population was recorded in all the treatments compared to the untreated check which recorded a higher population of odonata. Similar trend was observed upto 2nd week after transplanting. At 3rd week, the population of odonata was in an increasing trend and ranged from 0.23 to 0.64/sweeping. It was found that the population of odonata was low in all the treatments which ranged from 0.23 to 0.56/sweeping compared to the untreated check. The population of odonata from 4th week to 8th week after transplanting ranged from 0.13 to 0.94/sweeping. It was found that the population of odonata was low in all the treatments which ranged from 0.13 to 0.94/sweeping compared to the untreated check which ranged from 0.40 to 1.07/sweeping.

Table 2. Impact of agrochemicals on the population of odonata in rice ecosystem during *kharif*, 2012 (Field experiment I).

Treatments	Population of odonata in numbers (week after transplanting)												Overall mean	Per cent reduction over untreated check
	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week	10th week	11th week	12th week		
Untreated check	0.32^{c}	0.49^{d}	0.64^{c}	0.40^{c}	0.47^{c}	0.82^{e}	1.01^{c}	1.07	0.78^{c}	0.72^{e}	0.64^{d}	0.4^{c}	0.65^{e}	-
Herbicide	0.15^{ab}	0.23^{bc}	0.44^{b}	0.23^{ab}	0.17 ^{ab}	0.54^{bcd}	0.59^{a}	0.61^{bc}	0.47^{b}	0.39^{cd}	0.36^{bc}	0.16^{ab}	0.36^{c}	44.62
Fertilizer	0.19^{b}	0.29^{c}	0.56^{bc}	0.33^{bc}	0.33^{bc}	0.68^{de}	0.87^{bc}	0.94^{d}	0.65^{c}	0.58^{de}	0.52^{cd}	0.29^{bc}	0.52^{d}	20.00
Insecticide	0.07^{a}	0.13^{ab}	0.27^{a}	0.14^{a}	0.17^{ab}	0.35^{ab}	0.47^{a}	0.45^{ab}	0.19^{a}	0.11^{ab}	0.13^{a}	0.05^{a}	0.21^{ab}	67.69
Herbicide + Fertilizer	0.11^{ab}	0.22^{bc}	0.44^{b}	0.31	0.29^{abc}	0.56^{cd}	0.83^{b}	0.67^{c}	0.44^{b}	0.41^{cd}	0.33^{bc}	0.18^{ab}	0.40^{c}	38.46
Herbicide + Insecticide	0.05^{a}	0.09^{a}	0.25^{a}	0.13^{a}	0.14^{a}	0.31^{a}	0.46^{a}	0.39^{a}	0.17^{a}	0.09^{a}	0.11^{a}	0.07^{a}	0.19^{a}	70.77
Fertilizer + Insecticide	0.09^{ab}	0.15^{abc}	0.25^{a}	0.19^{ab}	0.20 ^{ab}	0.37^{abc}	0.59^{a}	0.57^{abc}	0.33^{b}	0.30^{bc}	0.24^{ab}	0.11^{a}	0.28^{b}	56.92
Herbicide + Insecticide + Fertilizer	0.11^{ab}	0.17^{abc}	0.23^{a}	0.17^{ab}	0.23^{abc}	0.34^{a}	0.47^{a}	0.45^{ab}	0.31^{b}	0.23^{abc}	0.18^{ab}	0.11^{a}	0.25^{b}	61.54
CD(P=0.05)	0.115**	0.136**	0.099**	0.158*	0.144*	0.126**	0.091**	0.132**	0.112**	0.180**	0.170**	0.164**	0.038**	-

** - Significant at P=0.01, * - Significant at P=0.05, In a column mean followed by a common letter are not significantly different by DMRT (P=0.05); Mean of 5 sweepings, Mean of 3 replications.

Table 3. Impact of agrochemicals on the population of odonata in rice ecosystem during *rabi*, 2012-13 (Field experiment II).

Treatments	Population of odonata in numbers (week after transplanting)												Overall mean	Per cent reduction over untreated check
	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week	10th week	11th week	12th week		
Untreated check	0.25^{d}	0.41^{c}	0.57^{c}	0.73^{e}	0.74^{c}	0.88^{e}	0.68^{d}	0.61^{c}	0.58^{d}	0.52^{c}	0.44^{c}	0.27^{c}	0.56^{g}	-
Herbicide	0.13^{bc}	0.19^{ab}	0.31^{ab}	0.49^{bc}	0.50^{ab}	0.60^{bcd}	0.45^{bc}	0.44^{bc}	0.30^{abc}	0.19^{ab}	0.14^{ab}	0.12^{ab}	0.32^{d}	42.86
Fertilizer	0.21^{cd}	0.27^{b}	0.37^{b}	0.65^{de}	0.59^{bc}	0.74^{de}	0.67^{d}	0.54^{c}	0.45^{cd}	0.41^{bc}	0.32^{bc}	0.23^{bc}	0.45^{f}	19.64
Insecticide	0.05^{ab}	0.15^{a}	0.22^{ab}	0.36^{a}	0.41^{ab}	0.41^{ab}	0.30^{ab}	0.18^{a}	0.15^{a}	0.12^{a}	0.10^{a}	0.06^{a}	0.21^{ab}	62.50
Herbicide + Fertilizer	0.17^{cd}	0.24^{ab}	0.31^{ab}	0.53^{cd}	0.58^{abc}	0.62^{cd}	0.63^{cd}	0.47^{bc}	0.37^{bcd}	0.25^{ab}	0.19^{ab}	0.15^{abc}	0.38^{e}	32.14
Herbicide + Insecticide	0.03^{a}	0.14^{a}	0.18^{a}	0.33^{a}	0.40^{a}	0.38^{a}	0.26^{a}	0.12^{a}	0.18^{ab}	0.14^{a}	0.08^{a}	0.04^{a}	0.19^{a}	66.07
Fertilizer + Insecticide	0.07^{ab}	0.17^{ab}	0.26^{ab}	0.39^{ab}	0.46^{ab}	0.44^{abc}	0.43^{b}	0.36^{abc}	0.22^{ab}	0.15^{a}	0.11^{a}	0.08^{a}	0.26^{c}	53.57
Herbicide + Insecticide + Fertilizer	0.06^{ab}	0.20^{ab}	0.23^{ab}	0.37^{a}	0.43^{ab}	0.43^{abc}	0.32^{ab}	0.25^{ab}	0.18^{ab}	0.14^{a}	0.09^{a}	0.05^{a}	0.23^{b}	58.93
CD(P=0.05)	0.112**	0.094**	0.120**	0.086**	0.117*	0.119**	0.119**	0.206**	0.169**	0.191*	0.185*	0.141**	0.058**	-

** - Significant at P=0.01, * - Significant at P=0.05, In a column mean followed by a common letter are not significantly different by DMRT (P=0.05), mean of 5 sweepings, mean 3 replications.

The population of odonata was in a decreasing trend from 9th week to 12th week after transplanting and ranged from 0.05 to 0.78/sweeping. It was found that the population of odonata was low in all the treatments which ranged from 0.05 to 0.65/sweeping compared to the untreated check which ranged from 0.41 to 0.78/sweeping. The overall mean population of odonata ranged from 0.19 to 0.65/sweeping. The odonata population was low in the treatment with herbicide + insecticide followed by insecticide treatment alone compared to the untreated check.

It was found that the treatment with herbicide + insecticide recorded a higher per cent reduction while a low per cent reduction of odonata population was observed in the treatment with fertilizer alone compared to the untreated check (Table 2). During *rabi*, the population of odonata was observed from 1st week and continued upto 12th week after transplanting. At 1st week, the population of odonata ranged from 0.03 to 0.25/sweeping. A low population was recorded in all the treatments compared to the untreated check which recorded a higher population of spiders. At 2nd week, the population of odonata was in an increasing trend and ranged from 0.14 to 0.41/sweeping. It was found that the population of odonata was low in all the treatments which ranged from 0.14 to 0.27/sweeping compared to the untreated check. The population of odonata from 3rd week to 6th week after transplanting ranged from 0.18 to 0.88/sweeping and found that the population of odonata was low in all the treatments which ranged from 0.18 to 0.74/sweeping compared to the untreated check which ranged from 0.57 to 0.88/sweeping.

The population of odonata was in a decreasing trend from 7th week to 12th week after transplanting and ranged from 0.04 to 0.68/sweeping. It was found that the population of odonata was low in all the treatments which ranged from 0.04 to 0.67/sweeping compared to the untreated check which ranged from 0.27 to 0.68/sweeping. The overall mean population of odonata ranged from 0.19 to 0.56/sweeping. It was found that, the odonata population was low in the treatment with herbicide + insecticide than insecticide treatment alone compared to the untreated check. A higher per cent reduction was observed in the treatment with herbicide + insecticide while a low per cent reduction of odonata population was observed in the treatment with fertilizer alone compared to the untreated check (Table 3).

It was found that there was a higher reduction of odonata in the treatment with the herbicide + insecticide followed by insecticide alone and other treatments. The results also showed that a lower per cent reduction was observed in the treatment with fertilizer alone. Hence, it was concluded that the agrochemicals namely herbicide + insecticide found to have an impact on the population of odonata, while fertilizer alone found to have a lesser impact on the population. Takamura and Yasuno (1986), Tang and Siegfried (1995), Arulprakash and Gunathilagaraj (2011) reported that odonata are highly susceptible to pesticides and its repeated application in rice fields may result in the destruction of most species of Odonata.

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