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Rice insect pests and their natural enemies complex in different rice ecosystem of Cauvery command areas of Karnataka

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Abstract
Fixed plot survey carried out during Kharif season (August to December) 2013 for insect pests and natural enemies complex of paddy ecosystem in different location of Cauvery command areas of Mandya district (nearby Vishveshvaraiah canal farm, Mandya). Among the pests, yellow stem borer, plant hoppers, gall midge and leaf folder were very severe and in case of predators, mirids and spiders were most important natural enemies. The average yield loss in rice has been estimated 21-51 %. The population of yellow stem borer was significantly positively correlated to Hymenopterans, Odonata and Staphylinids, whereas BPH is positively correlated with mirids (r=+0.770**), spider spider (r=+440*), odonatan (r=+0.700**), coccinellids (r=+0.476*), carabids (r=+0.779**) and cicindelids (r=+0.417*). In the same way white backed plant hopper, skipper, caseworm, hispa, blue beetle & grass hopper recorded positive significant and positive non-significant with the predators and parasitoids.

Keywords: Rice insect pests, natural enemies, incidence, correlation

1. Introduction
Rice (*Oryza sativa* L.) is one of the important cereal crops of the world and forms the staple food for more than 65 per cent of the world population and known as king of cereals, nearly 90 per cent of the area, production and consumption of rice are confined to South East Asian countries [7]. Insect pests constitute the major yield limiting biotic stresses throughout the rice growing countries. About 300 species of insects have been reported to attack rice crop in India, out of which 20 have been found to be the major pests [1]. Among the insect pests, yellow stem borer (*Scirpophaga incertulas* WIk.), brown planthopper (*Nilaparvata lugens* Stal.), green leafhopper (*Nephotettix spp*.), ear head bug (*Leptocorisa oratorius* Fabricius), leaf folder (*Cnaphalocrocis medinalis* Gn.) and case worm (*Nymphula depunctalis* Guenee) are predominant in Karnataka. These pests infest the crop at all stages of plant growth and cause a variety of damage such as tissue boring, sap sucking, defoliation and leaf scrapping [11].
The rice ecosystem is bestowed with a lot of pests and natural enemies complex, The average yield loss in rice have been accounted for 30% loss in stem borers, while plant hoppers 20%, gall midge 15%, leaf folder 10% and other pests 25% respectively [6]. Naturally occurring biological control has a potential role to play in the management of rice fields of tropical south and south East Asia and there is a need to emphasize the impact of indigenous natural enemies as an essential part of IPM programme [8, 15]. Conservation of the natural enemy fauna in situ for supressing the pest population seems to be a very good alternative.Information available on natural enemies of paddy insect pests from this area is meagre. An attempt has been made to study the pest and natural enemy fauna and its association with rice crop during the year 2013-2014.

2. Materials and Methods
A fixed plot survey was conducted during kharif season (August to December) 2013 in different rice fields in Cauvery command area of mandya district of Karnataka. Looking to the specific conditions of mandya district (V.C. farm Mandya), eight villages were selected and from each village two rice fields were selected for the study. From among the 16 rice fields, four rice fields each were selected with manual transplanting, mechanical transplanting, aerobic and drill sowed rice. These rice fields were visited fortnightly and observations made on the incidence of different insect pests.

The observation on insect pests occurrence was recorded on 20 hills in each field randomly and averaged to per hill basis for expression. Standard procedure was followed to record the observations on the incidence of insect pests of paddy as per Bentur *et al*. [2]. The damaged leaves and total leaves from 20 randomly selected hills were observed in each plot. The percentage of leaf damage was calculated as follows.

The sample of predators and parasitoids were collected by sweep net and the population of mirids and spiders were counted on 20 hills and averaged to per hill basis for expression. Numbers of adult populations per unit area were counted for predators like Odonatans, Carabids, Cicindelids, Coccinellids, Staphylinids and Hymenopterans.

The correlation coefficients were worked out by adopting multiple correlation analysis to find out the relationship between insect pest of rice and their natural enemies in different rice ecosystems of cauvery command areas of Mandya district.

3. Results and Discussion

The insect pest and natural enemy complex in different paddy ecosystem of cauvery command areas of Karnataka are represented in the Table 1 and 2. The complex of rice insect pests revealed that a total of 30 pests were found feeding on paddy crop (Table 1). Out of these, brown plant hopper, white backed plant hopper followed by leaf folder in isolated patches were recorded as major pests of this crop. Whereas, paddy horned caterpillar, Skipper, Stem borer, thrips, green leafhopper, hispa, grasshopper and caseworm were recorded as minor pests. Survey indicated that leaf damage by paddy thrips was confined to nursery stage of the crop. The yellow stem borer cause dead hearts during vegetative stage and white ears at harvest. Among the sucking pests the population of green leafhoppers was found throughout the crop growth. Among the defoliators, rice skipper, Paddy horned caterpillar was active at the tillering stage of the crop and declined with the advancement in the crop stage. These findings on the occurrence of the pest are in conformity with the findings of Subhash Chander [9] reported BPH appeared in rice crop during first week of August and its activity gained momentum during the third week of August and reached highest level during 2nd week of October, similarly earhead bug was observed during 2nd week of September and reached highest level during last week of October. The pest was observed on the crop from tillering stage to harvest of crop

Among the predators the spiders and mirids were the most important natural enemies. Spiders and odonata recorded as general predators of rice pests. Among the odonata, damselflies population was more compared to the dragonflies. Mirids *Cyrtorhinus lividipennis* (Reuter) was considered as important, potential and efficient predator of BPH and WBPH. Staphylinids were indentified as *Paederus fuscipes* (Curtis) which is a predator on leafhoppers. Coccinellids and Cicindellids were also found on the bunds of flowering plants. The collected specimens were identified as predatory. Other important natural enemies on the insect pests of rice recorded as parasitoid which belongs to the hymenopterans orders. The recorded hymenopterans were identified parasitoids such as, *Ischnojoppaluteator* (Fabricius), *Xanthopimpla punctate* (Fabricius), *Xanthopimpla* sp. (larval and pupal parasitoid of leaf folder) *Charops bicolor* (Szepligeti) (Ichneumonidae) (larval parasitoid of skipper) and *Stenobracon nicevillei* (Bingham) (pupal parasitoid of yellow stem borer) and *Apanteles* sp. (Braconidae) (larval and pupal parasitoid of leaf folder) (Table 2).

Apart from the major predators and parasitods, a small group of predators were *Pseudagrion* sp. (Mantodea: Empusidae), *Gongylus gongylodes* (Linnaeus), *Mentis religiosa* (Mantodea: Mantodae), *Sepedon* sp. (Diptera: Sciomyzidae), *Melanostoma* sp. (Diptera: Syrphidae), *Revelia*sp. (Diptera: Platystomatidae) and other unidentified species of predators were belonging to order Neuroptera and Dermaptera. Invertebrate species diversity and population density are related to the type of farmland or other surrounding vegetation. Studies conducted by several authors has indicated that weeds and other non crop plants also provide diversified habitats, which offer a wide variety of resources, including alternative prey, plant food sources, optimal microclimates, and refugia for natural enemies that can reduce pest abundance [4,16]. Therefore, the manipulation of weed communities has potential to promote conservation of natural enemies in crops to key pests. In the present study, predators such as spiders, dragon and damselflies, mirid bugs, coccinellids, carabids and cicindellids were found throughout the crop growing period with little fluctuation in the three methods. However, spidres, dragonfly, damselfly and coccinellids were more during the vegetative stage of the crop, where as mirids, Staphylinids and cicndellids were more during reproductive stage of the crop. All the recorded predators and their population are known to be directly related to their prey population. These observations are in agreement with studies by Venkateshalu [12], who reported peak population of spiders during tillering stage, Vinothkumar [14] on mirid bugs.

The correlation study of yellow stem borer indicated a positive significant correlation with odonata (r=+0.410*), styphilinids (r=+0.471*) and hymenopterans (r=+0.452*). Similarly, positive but non- significant correlation with spiders (r=+0.150), mirids (r=+0.245), coccinellids (r=+0.191), carabids (r=+0.25) and cicindelids (r=+0.280), while in case of gall midge was showed the significant positive correlation with the occurrence of spider (r=+0.403*) and odonata (r=+0.388*). Similarly it had positive but non-significant correlation with carabids (r=+0.178), staphylinids (r=+0.047), cicindelids (r=+0.265) and hymenopterans (r=+0.336). Similarly the correlation study of BPH found a positive and significant with spider (r=+440*), odonata (r=+0.700**), mirids (r=+0.770**), coccinellids (r=+0.476*), carabids (r=+0.779**), styphilinids (r=+0.771**) and cicindelids (r=+0.417*). Further it had a positive but non-significant correlation with hymenopterans (r=+0.189). The interaction study of leaf folder indicated a positive significant correlation with spider (r=+455*), odonata (r=+0.651**), coccinellids (r=+0.662**), carabids (r=+0.404*) and positive but non-significant correlation with mirids (r=+0.328), styphilinids (r=+0.302), cicindelids (r=+0.263) and hymenopterans (r=+0.264). In the same way white backed plant hopper, skipper, caseworm, hispa, blue beetle & grass hopper recorded positive significant and positive non-significant with the predators and parasitoids as showed in the table 3. The present investigation on the occurrence of parasitoids was in close agreement with the report of Vijaykumar and Patil [13] who reported natural enemy complex of ricer insect pests respectively. Occurrence of these predators might help to curtail the pest population and the cost of insecticide required to control the pests. Similarly Rajendra Prasad [10] reported similar findings except carabids and spiders which showed positively and significant with yellow stem borer and leaf folder showed negative correlation with spiders, cicindelids and positively non-significant correlation with odonata, staphylinids, and carabids.

Table 1: List of insect pest of rice in different rice ecosystems during kharif, 2013.

Sl. No.	Common name	Scientific name	Family	Order
1	Thrips	*Stenchaetothrips biformos* (Bangall)	Thripidae	Thysanoptera
2	Yellow stem borer	*Scirpophaga incertulus* (Wlk.)	Pyralidae	Lepidoptera
3	Gall midge	*Orseolia oryza* (Wood-Mason)	Cecidomyiidae	Diptera
4	BPH	*Nilaparvata lugens* (Stal.)	Delphacidae	Hemiptera
5	WBPH	*Sogatella furcifera* (Horvath)	Delphacidae	Hemiptera
6	Leaf folder	*Cnaphalocrocis medinalis* (Guen.)	Pyralidae	Lepidoptera
7	Skipper	*Pelopidas methias methias* (Fab.)	Hesperiidae	Lepidoptera
8	Horned caterpillar	*Melantis ledaleda* (Drury)	Nymphalidae	Lepidoptera
9	Leaf hopper	*Nephotettix virescens* (Distant) *Nephotettix nigropictus* (Stat.)	Deplhacidae	Hemiptera
10	Case worm	*Nymphula depunctalis* (Guen)	Pyralidae	Lepidoptera
11	Hispa	*Dicladispa armigera* (Oliv)	Chrysomelidae	Coleoptera
15	Blue beetle	*Leptispa pygmaea* Baly	Chrysomelidae	
16	Grass hopper	*Hieroglymphus banian* (F.)	Acrididae	Orthoptera
		Oxy sp.	Acrididae	
		Unidentified	Tetrigidae	
		Unidentified	Tettigoniidae	
17	Ear head bug	*Leptocorisa oratorius* (Fabricius)	Alydidae	Hemiptera
18	Whorl maggot	*Hydrellia sasakii* (Ferina)	Ephydridae	Diptera
19	White leaf hopper	*Cofana spectra* (Dist.)	Cicadellidae	Hemiptera
20	Red pumpkin beetle	*Aulacohopora foveicolis* (Lucas)	Chrysomelidae	Coleoptera
21	Leaf beetle	*Lema* sp	Chrysomelidae	Coleoptera
23	White-spotted leaf beetle	*Monolepta signata* (Oliver)	Chrysomelidae	Coleoptera
24.	Rice weevil	*Sitophilus oryzae* (Linnaeus	Dryophthoridae	Coleoptera
25	Japanese beetles	*Popillia* sp	Scarabaeidae	Coleoptera
26	Seed bug	*Nysius* sp	Lygaeidae	Hemiptera
27	Stink bug	*Eysarcoris ventralis* (Westwood)	Pentatomidae	Hemiptera
28	Seed bug	*Menida versicolor* (Gmelin)	Pentatomidae	Hemiptera
29	Blue Shield bug.	*Zicrona caerulea* (Linnaeus).	Pentatomidae	Hemiptera
30	Smooth-eyed bush brown butterfly	*Orsotriaena* sp	Nymphalidae	Lepidoptera

Table 2: Fauna of natural enemies in different rice ecosystems during kharif, 2013.

Insect order	Family	Scientific name	Host
Coleoptera	Carabidae	*Pheropsophus* sp.	General predator
		Ophio neaindica (Thunberg)	
	Coccinellidae	*Micraspis discolor* (Fabricius)	General predator
		Coelophora bissellata Mulstant	
		Cheilomenes sexmaculata (Fabricus)	
		Coccinella transversalis (Fabricus)	
	Cicindelidae	*Cicindela duponti* (Dejean)	Nymphs of *Leptocoris*a *oratorius*
		Cicindelas exguttata (Fabricius)	
	Staphylinidae	*Paederus fuscipes*(Curtis)	Leafhopper
Hemiptera	Geocoridae	*Geocoris* sp	General predator
	Miridae	*Tythus* sp	Nymphs and adults of *Nilaparvata lugens*
		Cyrtorhinus lividipennis(Reuter)	
Odonata	Libellulidae	*Neuro themistullia* (Drury)	General predator
		Orthetrium sabina (Drury)	
		Pantala flavescens(Fabricius)	
	Coenagrionidae	*Cerigrion* sp	General predator
		Ischnura aurora (Brauer)	
Mantodea	Empusidae	*Pseudagrion*sp	General predator
		Gongylus gongylodes (Linnaeus)	
	Mantodae	*Mentis religiosa*(Carrion)	General predator
Diptera	Sciomyzidae	*Sepedon*sp	General predator
	Syrphidae	*Melanostoma* sp	
	Platystomatidae	*Revelia* sp	
	Ephydridae	Unidentified	General predator
Neuroptera	Ascalaphidae	Unidentified	
Dermaptera	Dermistidae	Unidentified	
Hymenoptera	Ichneumonidae	*Ischnojoppaluteator* (Fabricius)	Larval and pupal parasitoid of *Cnaphalocrocis medinalis*
		Xanthopimpla punctata(Fabricius)	pupal parasitoid of *Cnaphalocrocis medinalis*
		Xanthopimpla sp	
		Unidentified	
		Charops bicolor (Szepligeti)	Larval parasitiod of *Pelopidas methias methias*
	Braconidae	*Stenobracon nicevillei* (Bingham)	Pupal parasitoid of *Scirpophaga incertulus*
		Apanteles sp.	Larval and pupal parasitoid of *Cnaphalocrocis medinalis*
	Mutillidae	Unidentified	Parasitoid
Arachnida	Lycosidae	*Lycosa pseudoannulata* (Boesenberg & Strand)	General predator
	Oxyopidae	*Oxyopes birmanicus* (Thorell)	
	Oxyopidae	*Oxyopes salticus* (Hentz)	
	Tetragnathidae	*Tetragnatha maxillosa* (Thorell)	
	Tetragnathidae	*Tetragnatha amandibulata* (Walckenaer)	

Table 3: Correlation coefficient between rice insect pests and their natural enemies in different rice ecosystems (Kharif, 2013).

	Spiders	Odonata	Mirids	Coccinellids	Carabids	Staphylinids	Cicindellids	Hymenopterans
Yellow stem borer	0.150	0.410*	0.245	0.191	0.285	0.471*	0.280	0.452*
Gall midge	0.403*	0.388*	-0.101	0.178	-0.205	0.047	0.265	0.336
BPH	0.440*	0.700**	0.770**	0.476*	0.779**	0.771**	0.417*	0.189
WBPH	0.614**	0.654**	0.598*	0.454*	0.084	0.362	0.443*	0.416*
Leaf folder	0.455*	0.651**	0.328	0.662**	0.404*	0.302	0.263	0.264
Skipper	0.331	0.540**	0.275	0.229	0.284	0.458*	0.508**	0.299
Horned caterpillar	0.484**	0.373	0.346	0.410*	0.267	0.265	0.573**	0.294
Caseworm	0.614**	0.621**	0.041	0.581**	-0.073	0.075	0.389*	0.376*
Hispa	0.551**	0.315	-0.193	0.388*	-0.245	-0.028	0.139	0.371
Blue beetle	0.187	0.386*	-0.139	0.198	-0.071	-0.012	0.050	0.361
Grass hopper	0.438*	0.325	-0.101	0.463*	-0.145	-0.014	0.272	0.079
Earhead bug	0-.348	-0.094	0.512**	-0.171	0.536**	0.347	0.173	-0.167

4. Conclusion

This study has revealed a large number of insect species associated with rice production, portends to be a potential danger to rice production, as many of the species found have been identified as important pests elsewhere. However, the large number of natural enemies species (parasitoids and predators) found in this study, some natural enemies were found throughout the crop growing period, some were more during the vegetative stage of the crop and reproductive stage of the crop. All the recorded predator and parasitoids are known to be directly related to their prey population. It suggests that important biological control agents can be exploited in the management of the major insect pests of rice.

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