

Original Research Article

Potential and Prospects of Natural Enemies in Rice Ecosystem in Jharkhand

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ABSTRACT

Over half of the world's population depend upon paddy as a staple food. Rice *Oryza sativa* is distributed all over the world with a high concentration in Asia. Most of this population increase will occur in developing countries of Asia and Africa, where rice is the staple food. Out of nearly 800 insect pest species recorded on paddy, only 18–20 species are major pests in tropical Asia. There is a rich complex of natural enemies in tropical Asia. These arthropod natural enemies have existed in this environment for thousands of years and have contributed to keep the pest species below damaging levels. We had collected 9 order, 26 families and 39 genus species in Jharkhand rice ecosystem. We represent in the Table 1, Out of 38 types organisms enumerated during survey in the state hymenopterans, coleopterans, dipterans, odonata, archnida, Hemiptera, Mantodea, Neuroptera and Dermaptera were by far the most abundant about 23 types of natural enemies are balance ratio of natural enemies between pests. Those NE were occurrence in almost all district of Jharkhand and potential to control major pest in the state rice grown area. Depending upon topography, land is broadly classified into six groups by state. In *Don I* & *Don II*, major NE are found WS, LS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF, MB & RB and *Don III* & *Tanr III* is medium land in this region major occurrences of NE are WS, LS, DS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF, CoB, W, CaB, MB, RB, CF & B *Tanr I* & *Tanr II* pure upland condition in this area major NE are WS, LS, DS, LJS, OS, DnF, DmF, C, PM, TJ, TC, B, W & CoB. They are highly host specific natural enemies such as parasitoid and the general feeders like predators collected from the rice field. Egg parasitoid *Trichogramma japonicum* and *T. Chilonis* have been found from the egg mass of yellow stem borer and *T. Chilonis* also found from leaf folder eggs, more common in rice growing area in Jharkhand. Egg-larval parasitoids *Platygaster oryzae* (cameron) have been found from the most important pest of rice gall midge. Among the predacious orders, coleopteran and family coccinelidae (*Micraspis hirtashimai* & *Harmonia octamaculata*) is exclusively predacious on rice pests. Dragon flies and damsel flies are amongst the most conspicuous predators associated with irrigated rice fields. Damsel flies were more prevalent than the dragonflies. The adult dragon flies and damsel flies have been observed to predate on adults of yellow stem borer and leaf folders. Spider are an integral part of rice ecosystem and we have found different types of spider such as wolf spider belong to Lycosidae families *Lycosa pseudoannulata*, Lynx spider belong to Oxyopidae families *Oxyopes javanus*, Long-jawed spider belong to Tetragnathidae families *Tetragn maxillosa atha*, *T. mandibulata*, & *T. javesis*, Orb-spider belong to Araneidae families *Araneus sp.* *Neoscona theisi*, *N. mukerjei* and other families (Salticidae & Thomisidae) are also found in rice growing area. Other predators, Mirid bug (*Cyrtorhinus lividipennis*), Preying mantids, crickets, carabid beetle, reduviid bug, rove beetle, long-horn grasshopper, ear wig, *Amyotea malabarica*, *Andrallus spinidens* and wasp, those are found during survey and surveillance in rice growing area in Jharkhand. They are potential predator, effective control at below the economic threshold level of rice insect pest in rice growing area in the Jharkhand.

Keywords

Potential and prospects, natural enemies, rice ecosystem

Introduction

Rice (*Oryza sativa* L.) is the important cereal crops of the world and forms the staple food for more than 65 per cent of the world population. Rice production decrease, among various reasons of low production of rice, insect pest complex are one of the major factors for lowering down the yield. Out of nearly 800 insect pest species recorded on paddy, only 18–20 species are major pests in tropical Asia. Of the several management options available, by and large, only pesticides still dominate and serve as the primary component. The largest proportion of the world paddy market is affected by insecticides. There is a rich complex of natural enemies in tropical Asia. These arthropod natural enemies have existed in this environment for thousands of years and have contributed to keep the pest species below damaging levels. Most paddy farmers apply their first insecticide spray 40 days after crop establishment which is aimed to control early season foliage feeding insect pests. Biological control is an important component of integrated pest management programme. It exists as a naturally occurring phenomenon. A large number of biocontrol agents have been recorded on rice pests. Many minor or sporadic pests today probably are kept in check by the action of natural enemies. Biological control is primarily ecology based and therefore, eco-friendly. They are highly host specific natural enemies such as parasitoid and the general feeders like predators, Egg parasitoid *Trichogramma japonicum* and *T. Chilonis*, Egg-larval parasitoids *Platygaster oryzae* (cameron), Among the predacious orders, coleopteran and family coccinellidae (*Micraspis hirticornis* & *Harmonia octamaculata*) is exclusively predacious on rice pests. Dragon flies and damsel flies are amongst the most conspicuous predators associated with irrigated rice fields. Damsel

flies were more prevalent than the dragonflies. The adult dragon flies and damsel flies have been observed to predate on adults of yellow stem borer and leaf folders. Spider are an integral part of rice ecosystem and we have found different types of spider such as wolf spider belong to Lycosidae families *Lycosa pseudoannulata*, Lynx spider belong to Oxyopidae families *Oxyopes javanus*, Long-jawed spider belong to Tetragnathidae families *Tetragn maxillosa* aha, *T. mandibulata*, & *T. javesis*, Orb-spider belong to Araneidae families *Araneus sp.* *Neoscona theisi*, *N. mukerjei* and other families (Salticidae & Thomisidae) are also found in rice growing area. Other predators, Mirid bug (*Cyrtorhinus lividipennis*), Preying mantids, crickets, carabid beetle, reduviid bug, rove beetle, long-horn grasshopper, ear wig, *Amyotea malabarica*, *Andrallus spinidens* and wasp. Keeping in view the importance of potential natural enemy's need of the today's rice growers and changing scenario of cropping patterns, it is necessary to study the prevalence and abundance pattern of natural enemy's fauna in paddy. They are potential predator, effective control at below the economic threshold level of rice insect pest in rice growing area in the Jharkhand.

Materials and Methods

We were conducting rice ecology survey & surveillance to explore information on the potential natural enemies (NE) scenario associated with rice in different district and different rice ecology of Jharkhand, roving survey and surveillance was periodically conducted for two consecutive years, 2016 to 2017 during Kharif season. For the purpose of conducting survey regarding gather the information of NE status, farmers field of different rice ecology in different districts. A pocket lens (10X) and insect collecting net, glass vials, and polythene

bags were used for collecting appropriate technical literature. Some NE were identified on the spot / farm and some of them for their, proper identification in the laboratory some of them were brought to laboratory for detailed study. Periodically, intensity of the respective NE was measured in terms of population per unit area. In case of parasitoids, we had collected parasitized egg mass, larva, pupa & adult and wait for emergence of NE from those stage of insect. Intensity of NE by recorded at different observations was worked during the respective years. Overall mean of two years of observation were calculated NE wise and correlate with NE status in different district (Table 1) and rice ecology (Table 2). Based on their abundance, density and mode of parasitized pest status they were properly categorized into different groups (Table-3). On the basis of extent of habit and mode of prey stage selection by the particular NE, they were grouped in to predator, egg parasitoid, egg larval parasitoid, larval parasitoid, larval pupal parasitoid, pupal parasitoid and adult parasitoid. Keeping in view their mode of occurrence & frequency and overall information explored from the field investigation was Compiled and presented in Table 1, Table 2 & Table 3.

Results and Discussion

The natural enemy complexes in different paddy ecosystem of cover 24 district of Jharkhand are represented in the Table 1, 2 & 3. We represent in the Table 1, Out of 38 types organisms enumerated during survey in the state hymenopterans, coleopterans, dipterans, odonata, archnida, Hemiptera, Mantodea, Neuroptera and Dermaptera were by far the most abundant about 23 types of natural enemies are balance ratio of natural enemies between pests. Those NE were occurrence in almost all district of Jharkhand and potential to control major

pest in the state rice grown area. A large number of biocontrol agents have been recorded on rice pests. It exists as a naturally occurring phenomenon. Some major NE (WS, LS, DS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF, CoB, W, CaB, MB, RB, CF and B) are present here, taking advantage of their natural existence the scope of exploiting the potential of natural enemies in the management of rice pests is encouraging. Many minor or sporadic pests today probably are kept in check by the action of natural enemies. Behera *et al.*, 203a & 203b obtained more or less similar observations and also similar found by Behera 2008 & Parasappa *et al.*, 2017.

In the Jharkhand state water holding capacity of soil is very low due to porous nature of the soil and undulating topography. Depending upon topography, soils are broadly classified into six groups, in which groups upland farther divided in to three groups *Tanr* I to *Tanr* III and low land also divided in to three groups *Don* I to *Don* III, *Don* I- low land, *Don* II- Shallow land and *Don* III Drought prone shallow land and *Don* III & *Tanr* III are together called medium land (Table 2).

Don I (low land) is one of the major rice growing areas of about 6.3 lakh ha. *Don* I (low land), that area having most dominant pest is yellow stem borer, asian rice gall midge, case worm, rice grass hopper presence in this region rice crop. Rice pest and natural enemies of rice pest require same ecology for existence, so some NE (WS, LS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF) are related to pests are dominate hi same ecology and high potential to manage this region pest.

Don II (Shallow land) is the major rice growing areas about 6.7 lakh ha in Jharkhand.

Table.1 District-wise distribution of natural enemies of the major insect pests of rice in Jharkhand

S.N.	District	W S	L S	D S	L J S	O S	R B	M B	D n F	D m F	C o B	C a B	C	L H G	P M	W	E W	R B	T J	T C	T E	T S	T R	G	A	O	C N	P O	A A	S N	C F	E	B	H	P	X F	B L	B E	O S
1.	Dumka	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
2.	Ranchi	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
3.	Chatra	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
4.	Garhwa	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
5.	East Singhbhum	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
6.	West Singhbhum	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
7.	Ramgarh	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
8.	Saraikela Kharsawa	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
9.	Khunti	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
10.	Palamu	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
11.	Bokaro	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
12.	Lohardaga	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
13.	Gumla	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
14.	Latehar	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
15.	Simdega	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
16.	Jamtara	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
17.	Giridih	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
18.	Godda	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
19.	Hazaribagh	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
20.	Pakur	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
21.	Sahibganj	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
22.	Deoghar	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
23.	Dhanbad	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×
24.	Koderma	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	√	×	×	√	×	√	×	×	√	×	×	×

Predator WS = Wolf Spiders, LS= Lynx Spiders, DS = Dwarf Spiders, LJS= Long-Jawed Spiders, OS= Orb-Spider, RB= Reduviid Bug, MB= Mirid Bug, DnF= Dragon Fly, DmF= Damsel Fly, CoB= Coccinellid Beetle, CaB= Carabid Beetle, C= Crickets, LHG= Long-Horn Grasshopper, PM= Preying Mantid, W= Wasps, EW= Ear Wig, RB= Rove Beetle, Egg Parasitoids, TJ= *T. japonicum*, TC= *T. chilonis*, TE= *T. exigua*, TS= *Tetrastichus schoenobii*, TR= *Telenomus rowani*, G= *Gonatocerus spp.*, A= *Anagrus spp.*, O= *Oligosita spp.*, CN= *Copidosomopsis ncoliae*, Egg Larval Parasitoid, PO= *Platygaster oryzae*, Larval Parasitoids AA= *Amauromorpha accepta*, SN= *Stenobracon necevillei*, CF= *Cotesia favipes*, E= *Elasmus spp.* B= *Bracon spp*, H= *Haplogonatopus spp.*, P= *Pseudogonatopus spp.* Larval Pupal Parasitoids XF= *Xanthopimpla favolineata*, BL= *Brachymeria lasus*, BE= *B. escarinata*, OS= *Opius spp.*

Table.2 Ecology-wise key rice pest and natural enemies of rice pest in Jharkhand

Group	Sub group	Type	Description of land	Rice pest	Natural enemies of rice pest
Don land	Don- I	Low land	Clay-loam soil, lowest in toposequence, suitable for long duration rice crop	YSB, RH, CW, GM, RGH,	WS, LS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF
Don land	Don –II	Shallow land	Clay loam soil and Best for rice production, Rarely faces drought, Suitable for medium duration rice	YSB, RH, CW, RLF, GLH, RGB,, BPH, RGH,, GM	WS, LS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF, MB, RB
Don land	Don- III	Drought prone shallow land	Clay loam soil, transitional lands between don & tanr, upper toposequence and suitable for short duration rice	YSB, RH, RLF, GLH, RGB, RMB, BPH, RGH, SwC, BhC, Thrips, GM	WS, LS, DS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF, CoB, W, CaB, MB, RB, CF
Tanr land	Tanr- III	Upland	Sandy loam soil, sloppy, poor soil fertility, shallow soil depth, low WHC, Near foothills and acidic in nature	Termite, GM, CW, YSB, RH, RLF, GLH, RGB, RMB, BPH, RGH, SwC, BhC, Thrips	WS, LS, DS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF, CoB, W, CaB, MB, RB, CF, B
Tanr land	Tanr – II	Upland	Sandy loam soil, gentle sloppy, good soil depth, low WHC, poor in organic matter, erosion prone, acidic in nature. Land used for vegetables, maize and rice seedlings	Termite, YSB, RH, WG	WS, LS, DS, LJS, OS, DnF, DmF, C, PM, TJ, TC, B, W, CoB,
Tanr land	Tanr – I	Upland	Loam soil and land immediately adjacent to the houses. Land used for vegetables, maize and rice seedlings	Termite, YSB, RH, WG	WS, LS, DS, LJS, OS, DnF, DmF, C, PM, TJ, TC, B, W, CoB

YSB = Yellow stem borer, GM = gall midge, CW = case worm, RH = rice hispa, RLF = rice leaf folder, GLH = green leaf hopper, RGB = rice gundhi bug, RMB = rice mealy bug, WG = white grub, BPH = brown plant hopper, RGH = rice grass hopper, SwC = swarming caterpillar, BhC = brown hairy caterpillar, CtW = Cut worm, WM = whorl maggot, * = low, ** = moderate, *** = severe, # = Negligible.

Predator WS = Wolf Spiders, LS = Lynx Spiders, DS = Dwarf Spiders, LJS = Long-Jawed Spiders, OS = Orb-Spider, RB = Reduviid Bug, MB = Mirid Bug, DnF = Dragon Fly, DmF = Damselfly, CoB = Coccinellid Beetle, CaB = Carabid Beetle, C = Crickets, LHG = Long-Horn Grasshopper, PM = Preying Mantid, W = Wasps, EW = Earwig, RB = Rove Beetle, Egg Parasitoids, TJ = *T. japonicum*, TC = *T. chilonis*, TE = *T. exigua*, TS = *Tetrastichus schoenobii*, TR = *Telenomus rowani*, G = *Gonatocerus spp.*, A = *Anagrus spp.*, O = *Oligosita spp.*, CN = *Copidosomopsis ncoliae*, Egg Larval Parasitoid, PO = *Platygaster oryzae*, Larval Parasitoids AA = *Amauromorpha accepta*, SN = *Stenobracon necevillei*, CF = *Cotesia favipes*, E = *Elasmus spp.*, B = *Bracon spp.*, H = *Haplogonatopus spp.*, P = *Pseudogonatopus spp.* Larval Pupal Parasitoids XF = *Xanthopimpla favolineata*, BL = *Brachymeria lasus*, BE = *B. escarinata*, OS = *Opius spp.*

Table.3 Fauna of natural enemies in different rice ecosystems during kharif, 2016 & 2017

NE order	Family	Scientific name	Host/Prey/Types
Arachnida	Lycosidae	<i>Lycosa pseudoannulata</i> (Boesenberg & Strand)	General predator
	Oxyopidae	<i>Oxyopes birmanicus</i> (Thorell)	
		<i>Oxyopessalticus</i> (Hentz)	
	Tetragnathidae	<i>Tetragnatha maxillosa</i> (Thorell)	
<i>Tetragnatha amandibulata</i> (Walckenaer)			
Coleoptera	Carabidae	<i>Pheropsophus</i> sp.	General predator
	Carabidae	<i>Ophio neaindica</i> (Thunberg)	
	Coccinellidae	<i>Micraspis discolor</i> (Fabricius)	
	Coccinellidae	<i>Coelophora bissellata</i> Mulstant	
	Coccinellidae	<i>Cheilomenes sexmaculata</i> (Fabricius)	
		<i>Coccinella transversalis</i> (Fabricius)	
	Cicindelidae	<i>Cicindela duponti</i> (Dejean)	Nymphs of <i>Leptocoris oratorius</i>
	Cicindelidae	<i>Cicindelas exguttata</i> (Fabricius)	
Staphylinidae	<i>Paederus fuscipes</i> (Curtis)	Leafhopper	
Odonata	Libellulidae	<i>Neuro themistullia</i> (Drury)	General predator
		<i>Orthetrium sabina</i> (Drury)	
		<i>Pantala flavescens</i> (Fabricius)	
	Coenagrionidae	<i>Cerigrion</i> sp	
		<i>Ischnura aurora</i> (Brauer)	
Hemiptera	Geocoridae	<i>Geocoris</i> sp	General predator
Mantodea	Empusidae	<i>Pseudagrion</i> sp	General predator
		<i>Gongylus gongylodes</i> (Linnaeus)	
	Mantodae	<i>Mentis religiosa</i> (Carrion)	
Diptera	Sciomyzidae	<i>Sepedon</i> sp	General predator
	Syrphidae	<i>Melanostoma</i> sp	
	Platystomatidae	<i>Revelia</i> sp	
	Ephydriidae	Unidentified	
Neuroptera	Ascalaphidae	Unidentified	General predator
Dermaptera	Dermistidae	Unidentified	General predator
Hymenoptera	Ichneumonidae	<i>Ischnojoppaluateator</i> (Fabricius)	Larval and pupal parasitoid of <i>Cnaphalocrocis medinalis</i>
		<i>Xanthopimpla punctata</i> (Fabricius)	Pupal parasitoid of <i>Cnaphalocrocis medinalis</i>
		<i>Xanthopimpla</i> sp	
		Unidentified	
		<i>Charops bicolor</i> (Szepligeti)	Larval parasitoid of <i>Pelopidas methias methias</i>
	Braconidae	<i>Stenobracon nicevillei</i> (Bingham)	Pupal parasitoid of <i>Scirpophaga incertulus</i>
		<i>Apanteles</i> sp.	Larval and pupal parasitoid of <i>Cnaphalocrocis medinalis</i>
	Mutillidae	Unidentified	Parasitoid
	Braconidae	<i>Platygaster oryzae</i>	Egg Larval Parasitoid
<i>Cotesia favipes</i>		Larval Parasitoids	

In this region major pest of rice infest on shallow land rice growing area. Insect pests are major biotic stress of this fragile ecology. The major insect pests of shallow rainfed lowland rice include rice yellow stem borer, *Scirpophaga incertulas*; rice leaf folder, *Cnaphalocrocis medinalis*; caseworm; *Nymphula depunctalis*. Asian rice gall midge and Rice hispa *Dicladispa armigera* are infests rice crop during early stage rice crop. BPH are the regular pests during early crop stage when fields water for longer period. Rice hybrids grown in this ecology are prone to rice leaf folders. Rice earhead bug infest at milking stage. *Don II* are almost similar to *Don I* ecology so natural enemies also same but few some are different in this area.

Don III land and *Tanr III* land together called medium land about 3.7 lakh ha land in this are used for rice growing in Shallow lowland & upland drought prone ecology, yellow stem borer, gall midge, swarming caterpillar, mealy bugs, leaf folder, gundhi bug, green leaf hopper, BPH, rice grass hopper, rice hispa, black hairy caterpillar, thrips and termite are major problems.

On the rule fallow of ecology tritrophic interaction of host (rice) plant, pest and natural enemies more number of vegetation, more number of pest and similar more number of natural enemies (WS, LS, DS, LJS, OS, DnF, DmF, C, LHG, PM, TJ, TC, PO, XF, CoB, W, CaB, MB, RB, CF, B) are exist in medium land.

Tanr I & *Tanr II* land are Loam soil and land immediately adjacent to the houses. Land used for rice seedlings and very few area direct seeded rice grown. In this region there is major problem of termite, rice gundhi bug at milking stage and yellow stem borer. According to pest in this region very few organism of natural enemies (WS, LS, DS, LJS, OS, DnF, DmF, C, PM, TJ, TC, B, W, CoB) in this area, But some predacious spider population are high.

In the Table 3, we had collected 9 order, 26 families and 39 genus species in Jharkhand rice ecosystem. 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, *Ischnojoppalutator* (Fabricius), *Xanthopimpla punctuate* (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) Apart from the major predators and parasitods, a small group of predators were *Pseudagrion* sp. (Mantodea: Empusidae), *Gongylus gongyloides* (Linnaeus), *Mentis religiosa* (Mantodea: Mantodae), *Sepedon* sp. (Diptera: Sciomyzidae), *Melanostoma* sp. (Diptera: Syrphidae), *Reveliasp.* (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 (Henrik 1998).

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, spiders, dragonfly, damselfly and coccinellids were more during the vegetative stage of the crop, whereas mirids, Staphylinids and cicindellids 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 *et al.*, 1996, who reported peak population of spiders during tillering stage, Vinothkumar *et al.*, 2013 on mirid bugs. Vijaykumar *et al.*, 2006 was similar reported on natural enemies complex of paddy ecosystem.

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