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Biodiversity of insect pests, natural enemies and diseases in SRI and traditional system of rice cultivation in North Eastern region of India

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ABSTRACT

On farm trials were conducted during wet season 2011and 2012 at Ngorlung village under Ruksin block of East Siang district of Arunachal Pradesh. Two rice varieties viz. CAU R-1 (improved variety) and Itanagar (local variety) were transplanted under system of rice intensification (SRI) and traditional system of cultivation. The results reveled that incidence of stem borer was significantly lower in SRI, mean damage of 5.67 and 6.43 per cent (dead heart) and 13.46 and 14.35 per cent (white ear head) was recorded in CAU R-1 and Itanagar, respectively, as against a higher incidence of dead heart (7.89%) and white ear head (15.67%) in CAU R-1 and 10.72 (dead heart) and white ear head (18.12%) in Itanagar under traditional system. The incidence of leaf folder case worm, blue beetle and Gundhi bug m^{-2} were lower in SRI as compared to traditional system. The occurrence of natural enemies like wolf spiders, lynx spiders, damsel flies, dragon flies and lady bird beetles population was higher in traditional system as compared to SRI. Among all the diseases, blast was lower in SRI with a mean damage of 7.28 and 9.87 per cent in var. CAU R-1 and Itanagar, respectively as against a higher incidence of 9.65 in CAU R-1 and 12.63 per cent in Itanagar. Among Bacterial diseases, bacterial leaf blight incidence was found to be lower in CAU R-1 and Itanagar with the mean 4.94 and 5.88 per cent, respectively under SRI as compared to a higher level of incidence 5.81 in CAU R-1 and 9.88 per cent in Itanagar under traditional system. In both the system of rice cultivation, var. CAU R-1 recorded higher grain yield than the Itanagar. The economic analysis indicated that benefit cost ratio was higher in traditional system as compared to SRI.

Key words: *bio-diversity, system of rice intensification, traditional cultivation, insect pests, natural enemies, diseases*

The current rice production in India has to be increased to 135 million tones by 2020 to meet the promising population demands (Prakash *et al*., 2007). Annually rice is grown under 4 major ecosystems: irrigated (21 million ha), rainfed lowland (14 million ha), rainfed upland (6 million ha) and flood-prone (3 million ha) which contributes, respectively, 67.3, 22.6, 6.6 and 3.3 per cent of the total rice production (ICAR, 2011). Rice is the staple food crop of the North Eastern hilly ecosystem followed by maize, occupying 3.51 million hectares which accounts for more than 80% of the total cultivated area of the region and 7.8 per cent of the total rice area in India while its share in national rice production is only 5.9 per cent. The total rice production of NE region is estimated to be around 5.50 million tones with average productivity of 1.57 t ha^{-1}, which is much below the national average of 2.08 t/ha (Datta *et al.,* 2006). The crop is prone to stress throughout the growth period due to attack from different pests such as insects, nematodes, diseases, weeds and rats. In recent year, due to increasing water scarcity as well as climate change scenario throughout the country, the system of rice intensification (SRI) is fast coming up. The SRI, a technical innovation from Madagascar (Uphoff, 2003), is a rice farming practice which requires less water but provides better growing conditions in comparison to the traditional practices of flooded rice (Ramaswamy, 2004). This alternative method has shown promise in addressing problems of water scarcity, high energy usage (40 per cent saving) and environmental degradation (Vibhu Nayar and Ravichandran, 2008). Rice crop is damaged by

multitude of insect pests and diseases, causing an overall estimated yield loss ranging from 21 to 51% (Pasalu *et al*., 2004; Prakash *et al*., 2007). Very few scattered reports are available on the insect pests, natural enemies and disease scenario in SRI system (Karthikeyan *et al.,* 2007; Ratnasudhakar and Narasimha Reddy, 2007; Padmavathi *et al*., 20007). The bio-diversity of insect-pests, natural enemies and diseases are expected to be different in SRI and traditional system of rice cultivation. Therefore, an attempt was made in the present study to investigate and compare the biodiversity of insect-pests, natural enemies and diseases in SRI and traditional system of rice cultivation under north eastern region conditions.

MATERIALS AND METHODS

Farmer's participatory on farm trials were conducted in factorial randomized block design during wet season 2011 and 2012 at Ngorlung village under Ruksin block of East Siang district, Arunachal Pradesh. Two rice varieties *viz*. CAU R-1 (improved variety) and Itanagar (local variety) were transplanted under SRI and traditional system with three replication of each treatment. The on farm trials were undertaken in a plot area of 5 x 3 m under both systems. Under SRI, 15 days old seedlings were transplanted @ one seedling hill^{-1} with a spacing of 25 x 25 cm. While in case traditional system of cultivation, 25 days old seedlings were transplanted @ 3 seedlings hill^{-1} with a spacing of 20 x 10 cm. Observations were recorded on the incidence of insect pests, natural enemies and disease at 30, 45, 60, 75 and 90 days after transplanting (DAT) on selected 20 hills plot^{-1} by walking diagonally across the plot. Tiller count was taken for assessing dead heart at vegetative stage and white ear head at reproductive stage for recording damage by stem borer (*Scirpophaga incertulas*). Incidence of leaf feeding insects such as leaf folder (*Cnaphalocrocis medinalis* Guenee), caseworm (*Nymphula depunctalis*) and blue beetle (*Leptipsa pygamea* Baly) were assessed by counting the number of damaged leaves and total leaves hill^{-1}. Gundhi bug (*Leptocorisa* spp.) population was recorded by counting no. of nymphs and adults per m^2. Natural enemies population was estimated by making sweep net counts diagonally across each plot and counting the major species of predator's present *viz*., dragon fly (*Crocothemis servilia*), damselflies (*Agriocnemis pygmaea*), wolf spider (*Lycosa pseudoannulata*), lynx spider (*Oxyopes javanus*) and lady bird beetle (*Harmonia octomaculata*) per five sweeps plot^{-1}. Tiller count was also taken for assessing different fungal and bacterial diseases i.e. blast (*Pyricularia grisea* perfect stage, *Magnaporthe grisea*), sheath blight *(Rhizoctonia solani* perfect stage *Thanatephorus cucumeris*), brown spot (*Drechslera oryzae* perfect stage, *Bipolaris oryzae)*, false smut *(Ustilaginoidea virens)*, bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*) and bacterial leaf streak (*Xanthomonas oryzae*) on the basis of their symptoms.

RESULTS AND DISCUSSIONS

The results of wet season 2011 and 2012 (pooled analysis) on the bio-diversity of different insect-pests (Table 1), natural enemies (Table 2), diseases (Table 3)

Table 1. Bio-diversity of Insect pests in SRI and Traditional system of rice wet season 2011 and 2012.

System of cultivation	Variety	Stem borer		Leaf folder	Case worm	Blue Beetle	Gundhi bug m^{-2}
		% DH	% WE	% DL	% DL	% DL	
SRI	CAU R-1	5.67 (13.81)	13.46 (21.47)	6.34 (14.54)	4.76 (12.66)	2.86 (9.81)	1.0
	Itanagar	6.43 (14.65)	14.35 (22.22)	7.12 (15.56)	5.87 (14.06)	4.65 (12.52)	2.0
Traditional	CAU R-1	7.89 (16.32)	15.67 (23.34)	8.45 (16.85)	6.87 (15.23)	5.76 (13.94)	3.0
	Itanagar	10.72 (19.09)	18.12 (25.18)	11.23 (19.55)	11.18 (19.55)	8.36 (16.85)	4.0
CD (P<0.05)		0.77	0.36	0.57	0.67	0.62	0.28

Figures in parenthesis are arc sine transformed value

Table 2. Natural enemies' diversity in SRI and traditional system of rice wet season 2011 and 2012

System of cultivation	Variety	Dragon flies *Crocothemis servilia*	Damselflies *Agriocnemis pygmaea*	Wolf spiders *Lycosa pseudoannulata*	Lynx spiders *Oxyopes javanus*	Lady bird beetles *Harmonia octomaculata*	Grain yield (t ha^{-1})
SRI	CAU R-1	3.56 (10.94)	3.91 (11.39)	4.78 (12.66)	4.62 (12.39)	3.42 (10.63)	6.56
	Itanagar	2.63 (9.67)	3.57 (10.94)	4.39 (13.12)	4.19 (11.83)	3.30 (10.47)	5.25
Traditional	CAU R-1	3.81 (11.24)	4.18 (11.83)	5.21 (13.18)	4.87 (12.79)	3.95 (11.39)	5.94
	Itanagar	2.97 (9.81)	3.79 (11.24)	4.92 (12.79)	4.46 (12.25)	3.78 (11.09)	4.78
CD (P<0.05)		0.57	0.58	0.36	0.41	0.26	0.14

Figures in parenthesis are arc sine transformed value

and yield and economics (Table 4) revealed that under SRI and traditional system of cultivation the incidence of stem borer was lower in SRI system of cultivation with a mean damage of 5.67 and 6.43 per cent (dead heart) and 13.46 and 14.35 per cent (white ear head) in var. CAU R-1 and Itanagar, respectively as against a higher incidence of 7.89 and 10.72 per cent (dead heart) and 15.67 and 18.12 per cent (white ear head) in var. CAU R-1 and Itanagar. There was no significant difference in the incidence of stem borer at the reproductive stage under both the varieties and system of cultivation. The incidence of leaf folder was found to be lower in CAU R-1 and Itanagar with mean leaf damage 6.34 and 7.12 per cent, respectively under SRI as compared to a higher level of damage 8.45 and 11.23 per cent in CAU R-1 and Itanagar under traditional system of cultivation. The incidence of case worm was found to be lower in CAU R-1 and Itanagar with mean leaf damage 4.76 and 5.87 per cent, respectively under SRI as compared to a higher level of damage 6.87 and 11.18 in CAU R-1 and Itanagar under traditional system of cultivation. Similarly, lower incidence of blue beetle was observed in SRI (2.86 per cent) in CAU R-1 and 4.65 per cent in Itanagar as compared to 5.76 per cent (CAU R-1) and 8.36 per cent (Itanagar) in traditional system of cultivation. The reduced incidence of blue beetle under SRI might have been due to alternate drying and wetting of rice fields making it unfavorable for blue beetle reproduction. The incidence of Gundhi bug was found to be lower in CAU R-1 and Itanagar with mean population of 1 and 2 bugs m^{-2}, respectively under SRI as compared to a higher level of population

Table 3. Incidence of diseases in SRI and traditional system of rice wet season 2011 and 2012.

System of cultivation	Variety	Fungal diseases				Bacterial diseases	
		BL	SB	BS	FS	BLB	BLS
SRI	CAU R-1	7.28 (15.56)	6.89 (15.23)	7.56 (16.00)	5.77 (13.94)	4.94 (12.79)	5.27 (13.31)
	Itanagar	9.87 (18.34)	7.96 (16.32)	8.78 (17.26)	6.69 (15.00)	5.88 (14.06)	6.69 (15.00)
Traditional	CAU R-1	9.65 (18.15)	9.87 (18.34)	9.68 (18.15)	6.55 (14.89)	5.81 (13.94)	8.17 (16.64)
	Itanagar	12.63 (20.79)	11.78 (20.09)	12.47 (20.70)	8.24 (16.64)	9.88 (18.34)	8.65 (17.16)
CD (P<0.05)		0.60	0.26	0.38	0.29	0.31	0.30

Figures in parenthesis are arc sine transformed value.
BL - Blast, SB - Sheath blight, BS - Brown spot, FS - False smut, BLB - Bacterial leaf blight, BLS - Bacterial leaf stripes

Table 4. Economics in SRI and traditional system of rice wet season 2011 and 2012

Parameters	SRI Mean	Traditional Mean
Variety: CAU R-1		
Total Cost of all Inputs (₹)	37800.00	32000.00
Mean Yield (t ha^{-1})	6.56	5.94
Total Returns (₹)	131200.00	118800.00
Net returns(₹)	93400.00	86800.00
Benefit/Cost ratio	3.47	3.71
Variety: Itanagar		
Total Cost of all Inputs (₹)	35000	31600
Mean Yield (t ha^{-1})	5.25	4.78
Total Returns (₹)	94500	86040
Net returns(₹)	59500	54440
Benefit/Cost ratio	2.7	2.72

The CAU R-1 was sold @ ₹2000 q^{-1} in I & II yr respectively. Itanagar was sold @ ₹ 1800 q^{-1} in I & II yr respectively.

Total cost included labour cost for land preparation, nursery sowing, puddling, transplanting, fertilizer application, hand weeding, pesticide application etc. and material cost like seed, fertilizer, biocontrol agents, pesticides etc.

3 in CAU R-1 and 4 bugs m^{-2} in Itanagar under traditional system of cultivation. The present findings corroborates with the earlier work of Padmavathi *et al*. (2007); Ravi *et al*. (2007); Ratnasudhakar and Narasimha Reddy (2007) and Katti *et al*. (2008) who recorded higher incidence of insect pests in traditional system as compared to SRI.

The studies on the occurrence of natural enemies in both the systems of cultivation indicated a higher population of wolf spiders (*Lycosa pseudoannualata*), lynx spiders (*Oxyopes javanus*), damselflies (*Agriocnimis pygmaea*) and lady bird beetles (*Harmonia octomaculata*) and a lower population of dragon flies (*Crocothemis servilia*) under traditional system than SRI system of cultivation. The mean number of wolf spider in traditional system was 5.21 and 4.92 per cent in CAU R-1 and Itanagar respectively, while under SRI it was 4.78 and 4.39 per cent in CAU R-1 and Itanagar respectively. But in case of dragon flies, the mean number was 3.81 and 2.97 per cent in CAU R-1 and Itanagar under traditional system while it was less 3.56 (CAU R-1) and 2.63 per cent (Itanagar) under SRI system indicating reduction of dragon fly population under SRI over the traditional system. The reason for the reduction of dragon fly population could be due to low stem borer, leaf folder and case worm population in SRI system. Moreover during the cropping year 2012, East Siang experienced an unexpected total annual rainfall of about 6500 mm. These findings are in consonance with the earlier work done by Karthikeyan *et al*. (2007), Padmavathi *et al*. (2007) and Riba *et al*. 2011, who reported lower population of natural enemies in SRI system.

In both the system of rice cultivation variety CAU R-1 recorded higher grain yield (6.56 t ha^{-1}) than variety Itanagar (5.25 t ha^{-1}). The economic analysis indicated that benefit cost ratio was higher in traditional system as compared to SRI mainly due to less involvement of labour in traditional system.

Data recorded on disease incidence revealed that in SRI and traditional system of rice cultivation the bio-diversity of fungal diseases such as blast was lower in SRI system of cultivation with a mean damage of 7.28 and 9.87 per cent in CAU R-1 and Itanagar, respectively as against a higher incidence of 9.65 per cent in CAU R-1 and 12.63 per cent in Itanagar. The incidence of sheath blight was found to be lower in CAU R-1 and Itanagar with the mean 6.89 and 7.96 per cent, respectively under SRI as compared to a higher level of incidence 9.87 and 11.78 per cent in CAU R-1 and Itanagar under traditional system. The incidence of brown spot was found to be lower in CAU R-1 and Itanagar with the mean 7.56 and 8.78 per cent, respectively under SRI as compared to a higher level of incidence 9.68 in CAU R-1 and 12.47 per cent in Itanagar under traditional system of cultivation. The incidence of false smut was found to be lower in CAU R-1 and Itanagar with the mean 5.77 and 6.69 per cent, respectively under SRI as compared to a higher level of incidence 6.55 in CAU R-1 and in 8.24 per cent in Itanagar under traditional system. Similar pattern was also observed in bacterial diseases *i.e.* incidence of bacterial leaf blight was found to be lower in CAU R-1 and Itanagar with the mean 4.94 and 5.88 per cent, respectively under SRI as compared to a higher level of incidence 5.81 in CAU R-1 and 9.88 per cent in Itanagar under traditional system. The incidence of bacterial leaf streak was found to be lower in CAU R-1 and Itanagar with the mean 5.27 and 6.69 per cent, respectively under SRI as compared to a higher level of incidence 8.17 in CAU R-1 and 8.65 per cent in Itanagar under traditional system. The present findings corroborate with the earlier studies of Riba *et al*. (2011) who reported higher incidence of fungal and bacterial

diseases in traditional system of rice cultivation in North Eastern Region.

The present study revealed that in SRI there was less bio-diversity of insect pests, diseases and also natural enemies which could possibly be due to restricted flooding of field and wider spacing between hills. The system also gave higher grain yield of rice, however higher natural enemies population and maximum benefit cost ratio was recorded in traditional system of rice cultivation.

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