International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 1115-1120

Received: 21-09-2020
Accepted: 29-10-2020

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Field screening of popular rice cultivars against rice leaf folder (*Cnaphalocrosis medinalis* Gunee.) incidence in north eastern coastal plains of Odisha

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DOI: https://doi.org/10.22271/chemi.2021.v9.i1p.11372

Abstract
Studies on the reaction of popular rice cultivars against rice leaf folder *Cnaphalocrocis medinalis* (Guenee) and various aspects of morphological characters of popular rice cultivars of coastal plains of Odisha together was conducted for kharif 2015-16 and 2016-17 at farmers field and Krishi Vigyan Kendra Research unit. It is one of the most serious pest in rice production. It is expensive and environmentally unsafe to manage this serious pest by using chemicals. Best approach to manage this pest is to develop host-plant resistance. Ten popular rice genotypes were screened for resistance to rice leaf folder. Varietal preference of rice leaf folder among ten popular rice varieties was analysed during kharif 2015 and 2016 at 30, 45, 60 and 75 DAT and the percent of leaf folder damage, the varieties were given ratings according to Standard Evaluation System (IRRI)'s for rice (scale of 0-9). All the ten varieties come under two different ratings i.e., nine varieties under a rating of 3 (Moderately resistance) and one varieties under a rating of 5 (moderately susceptible). The lowest damage was recorded in PRATIKSHYA(ORS-201-5) (14.9%) followed by Pooja (15.7%), Anjana(15.9%),which was on par with Surendra (16.1),CR-1018(16.7%),CR-1009(16.7%) and MTU-1001(16.9%).The highest damage was observed in MTU-7029 (31.00%) followed by SWARNA SUB -1 (29.03%).The correlation coefficient (r) values between Morphological characters and percent leaf damage by the rice leaf folder during 2015-2016 kharif and 2016-17 indicated that the length of the leaf did not affect the infestation of rice leaf folder significantly, but all the other factors showed significant correlation with leaf folder infestation, whereas positive significant correlation was observed with leaf width.

Keywords: Rice leaf folder, rice cultivars, Resistance, susceptible, infestation

1. Introduction
Rice farming is a common source of livelihood among Indian farmers. Increasing cost of production and unsustainable crop management practices being employed in the farm are matters of serious concern. Rice (*Oryza sativa* L.) is one of the most significant cereal grains which serve as staple food for a major part of world's population (FAO, 2017) [1]. During 2017 and 2018, India is the second largest producer after China with a production of 166.5 million metric tons (Statista, 2019) [2]. Rice is grown in different agro-ecosystems such as irrigated, rainfed upland, rainfed lowland and flood prone areas. Odisha had rice grown area of 39,63,000 hectare with production of 97.94 lakh metric tons during the year 2016-17 (Odisha Economic Survey, 2017-18) [3]. In India there are more than 50,000 rice varieties, but unfortunately most of these varieties are fast vanishing because of faulty agricultural practices (Mishra and Sinha 2012) [4]. Now a day's farmers are mostly growing high yielding varieties which have developed through few races of rice and have stopped cultivating local varieties. Generally the high yielding varieties have lower adaptability and susceptible to different biotic and abiotic stresses. But local varieties are of enormous value in agriculture as they are the store house of infinite important genes as they have evolved in particular environment since millions of years. (Mishra and Sinha 2012) [4]. Rice crop is affected by various biotic and abiotic stresses. Among the biotic stresses insect pests are creating hindrance in production of rice. An approximate 52 percent of the global rice produce is lost annually owing to the damage caused by biotic factors. Out of which 21 percent is attributed to the attack of insect pest fauna (Yarasi *et al*, 2008.) [5].

The rice leaf folder, *C. medinalis*, so far was considered as a minor pest, but now has assumed major pest status in the entire rice growing area of the country (Nanda *et al*., 2000) [6]. particularly in areas of high fertilizer usage, multiple cropping patterns, reduced genetic variability of high yielding varieties and prophylactic use of pesticides. This pest may cause severe damage at maximum tillering and flowering stages of the crop, The larvae fold the leaves and scrape the green tissues of the leaves from within and cause scorching and leaf drying, which may leads 60 to 70 percent leaf damage with 50 percent of reduction in yield (Kushwaha and Singh, 1984) [7]. and from 30 to 80 percent reduction in yield under epidemic condition (Raveeshkumar, 2015) [8].

Natural resistance in plants against insect pests is one of the important components of eco friendly management of pest. Knowledge of resistance level of a certain variety is also very important for planning of good management practices. Khan *et al.* (2003) [23] reported the development and use of resistant varieties can be a better option to reduce the dependence on insecticides and also to obtain a sustainable rice production. The use of varietal resistance to control insect pests provides no additional cost and is also free from the problems connected with the environmental pollution. As all the existing commercial rice varieties are susceptible to rice leaffolder attack, it has become imperative to find out the resistance sources in rice germplasm in order to evolve new rice varieties resistant to rice leaffolder (Rehman *et al*., 2005) [10]. Investigation of resistance in rice germplasm against rice leaf folder and its subsequent incorporation in agronomically suitable variety through suitable breeding program is an important approach to combat the problem. Attempts are required to identify least preferred rice varieties. Keeping in the above view a study was undertaken with the following objectives:

1. To evaluate the performance of different rice cultivars against rice leaf folder.
2. To studied the relationship between morphological characters of different screened cultivars with leaf folder incidence.

2. Materials and Methods

In order to study the reaction of rice varieties against rice leaf folder, a set of 10 locally popular germplasm were planted in Randomized Block Design in three replications in paired rows of 20 hills each with the spacing of 20 x 15 cm. in 15th August during *Kharif*, 2015 & 2016. A sound nursery was sown in Krishi Vigyan Kendra Jajpur. Transplantation was done with 30 days old seedlings with Line planting. Two to three seedlings were planted per hill. All the recommended agronomic practices were adopted during the experimentation without any plant protection measure and screened the cultivars against rice leaf folder. Susceptible check Swarna (MTU-7029) and resistant check Pratikshya were planted after every 10 entries. Single line of variety Swarna (MTU-7029) was planted as infester row in between the path and around the field. The leaf folder infestation was recorded at 30 DAT, 45 DAT, 60 DAT and 75 DAT on ten plants per entry by counting total number of leaf as well as leaf folder infested leaf, which was statistically converted into percent leaf folder infestation. Germplasm were collected from the NRRI, Cuttack and Locally for the study are given in Table 1. On the basis of average leaf folder infestation, entire germplasm were scored into six groups as suggested by DRR technical bulletin 51 (2011) given as below.

$$\text{Leaf folder per cent damage} = \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves on the hill}} \text{ X } 100$$

The total and damaged leaves were counted on each test cultivars and percent leaf damage was work out by using with the following formula.

On the basis of damage rating and scale, the status of rice variety was worked out by following International Rice Research Institute, Philippines (IRRI)'s Standard Evaluation System (SES), (1980) for rice, as given below(0-9 scale).

Table 1: Rice leaf folder damage scoring scale used in the experiment for Varietal Resistant

Leaf folder damage (%)	Scale	Status
0	0	Highly Resistant
1 – 10	1	Resistant
11 – 20	3	Moderately Resistant
21 – 35	5	Moderately susceptible
36 – 50	7	Susceptible
51-100	9	Highly Susceptible

2.1. Correlation of rice leaf folder incidence with morphological characters of leaves of the rice varieties.

For development of sustainable management strategies study on the basis of resistance and susceptibility status of the varieties, the morphological and biochemical characters of the varieties were also documented. The maximum length and width of the leaf, just below the flag leaf of 10 plants (excluding border row) in each entry was measured and expressed in cm. (SES for rice) and were determined when leaf folder incidence was found high and mean values were obtained (Lascar *et al*., 2008) [11].

The pubescence on leaves of different rice varieties screened was rated by finger feel method using DUS (Distinctness, Uniformity and Stability) system of rice (Table 2) (Shobharani *et al*., 2006) [12] as mentioned hereunder.

Table 2: Pubescence scoring scale used in the experiment

Pubescence on rice leaves	Scale
Absent	1
Weak	3
Medium	5
Strong	7
Very strong	9

Table 3: Particulars of different rice Cultivars used in the Screening Trial

Sl. No	Variety	Duration	Special characters
1	Pratikshya (ORS-201-5)	145	Medium slender, Suitable for medium to medium low land, resistant to sheath rot, substitute of MTU-7029
2	PADMNI-CR-1014	140	Medium slender, super fine, moderately tolerant to lodging, Resistant to blast

	Mutant		
3	Swarna SUB -1	145	Medium bold, Suitable for mediun low to low land, moderate tillering habit, resistant to sheath rot, substitute of MTU-7029
4	Bejeta (MTU-1001)	145	Medium long slender, Suitable for medium to low land, good tillering habit, resistant to several pest and diseases.
5	Pooja (R-629-256)	145	Medium slender Rain fed Shallow Low Lands, resistant to blast.
6	SURENDRA	135	Medium bold, Straw, White, Semi-dwarf, Blast, Sh.R, Resistant to Tungro Virus.
7	Gayatri (OR-210-1018)	155	Short bold Suitable for Low land, very good tillering habit, moderately resistant to several pests and diseases. Semi dwarf (100 cm), grains:, resistant to BLB, moderately resistant to blast & GM.
8	ANJANA	145	Medium slender, suitable for medium land, good tillering, disease resistant, substitute for MTU-7029
9	Sabitri (CR-210-1009)	155	Small bold, Suitable for Low land, very good tillering habit, moderately resistant to several pests and diseases.
10	MTU-7029(SWARNA)	145	Medium bold, Suitable for Medium land, good tillering habit, plants remain green even after maturity. Susceptible to sheath rot.

Table 4: Mean percent of leaf folder damage in different popular rice cultivars of North Eastern coastal plains of Odisha during kharif 2015 and 2016 (pooled)

Cultivars with IET no/Culture No.	The Percent leaf folder damage at					Damage Rating
	30DAT	45DAT	60DAT	75DAT	Mean	
PRATIKSHYA (ORS-201-5)	7.9	12.3	18.5	23.4	15.5	MR
PADMNI-CR-1014 MUTANT	10.4	16.4	21.1	24.8	18.2	MR
SWARNA SUB -1	18.9	27.85	30.2	38.9	28.96	MR
BEJETA (MTU-1001)	9.7	13.8	20.9	23.3	16.9	MR
POOJA (R-629-256)	7.5	12.1	19.1	24	15.7	MR
SURENDRA	8.5	14	18.7	23	16.1	MR
GAYATRI (OR-210-1018)	8.4	15.4	18.3	24.7	16.7	MR
ANJANA	8.5	13.5	19	22.5	15.9	MR
SABITRI (CR-210-1009)	8.4	15.4	18.3	24.7	16.7	MR
MTU-7029 (SWARNA)	22.9	28.9	34.7	40.7	31.8	MS
Mean	11.12	16.98	21.86	27	19.24	
'F test'	*	*	*	*		
S.Em	0.2	0.18	0.29	0.2	0.55	
CD (5%)	0.61	0.55	0.88	0.58	1.59	
CV %	3.19	1.82	2.33	1.25	5.7	

*Significant at 5% level

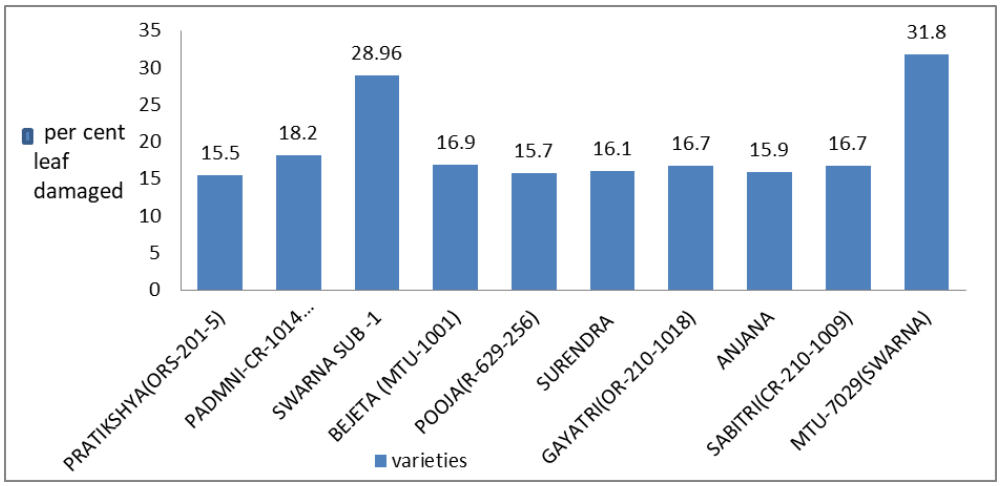

Fig 1: Mean Percent damage of leaf folder, Cnaphalocrosis medinalis in different rice varieties, kharif 2015-&16

Table 5: Morphological characters of different tested varieties exhibited reaction to Leaf folder

Sl. No	Rice Genotypes	Leaf Length(cm)	Leaf Width(cm)	Scale for Pubescence
1	PRATIKSHYA(ORS-201-5)	43.00^{b}	1.13^{e}	(3) Weak
2	PADMNI-CR-1014 MUTANT	49.5^{a}	1.00^{f}	(3) Weak
3	SWARNA SUB -1	42.00^{b}	1.35^{cd}	(5) Medium
4	BEJETA (MTU-1001)	37.00^{c}	1.40^{c}	(5) Medium
5	POOJA(CR-629-256)	42.5^{b}	1.5^{b}	(5) Medium
6	SURENDRA	36.0^{c}	1.10^{ef}	(3) Weak
7	GAYATRI(OR-210-1018)	37.5^{c}	1.65^{a}	(5) Medium
8	ANJANA	42.5^{b}	1.05^{ef}	(3) Weak
9	SABITRI(CR-210-1009)	41.5^{b}	1.1^{ef}	(3) Weak
10	MTU-7029(SWARNA)	32.50^{d}	1.3^{d}	(3) Weak
	Mean	40.40	1.263	

	'F' test	Sig.	Sig.	
	S.Em	0.54	1.85	
	CD(P=0.05%)	1.385	0.094	
	CV%	2.12	3.85	

Values with similar alphabets in each column do not vary significantly at 5% level as per Duncan's Multiple Range test (**DMRT**).

Table 6: Correlation and simple regression studies of morphological characters of rice varieties against the damage of rice leaf folder, *Cnaphalocrosis medinalis*, kharif 2015 & 16

Sl. No	Variable	Correlation coefficient	Regression equations	
I. Morphological characters				
a.	Leaf Damage (Y) Vs Leaf Length (X)	-0.127**	Y = -0.4461x + 37.269	
b.	Leaf Damage (Y) Vs Leaf Width (X)	0.358*	Y = 5.1834x + 12.699	
S. No.	**Variable**	**Regression model**	**R^2**	**$100R^2$**
1. Morphological characters				
a.	Leaf Damage (Y) Vs Leaf Length (X)	Y = -0.4461x + 37.269	0.0358	3.5
b.	Leaf Damage (Y) Vs Leaf Width (X)	$y = 5.1834X_2 + 12.699$	0.62	62

***Significant at 5% level, **NS-Non significant

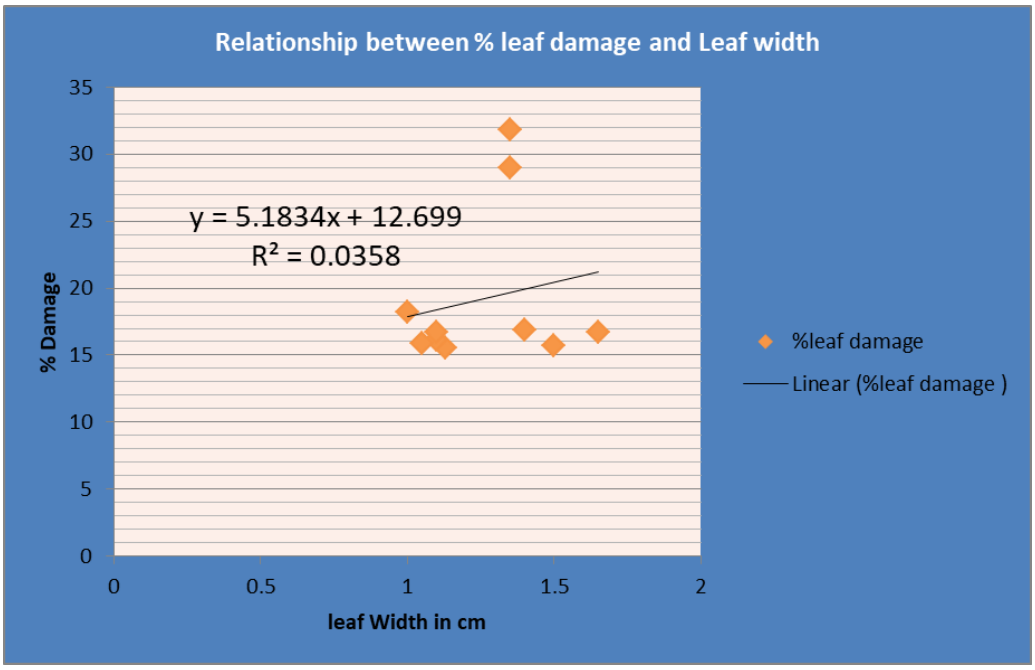

Fig 2: Relationship between different morphological characters of rice leaf and leaf damage due to rice leaf folder

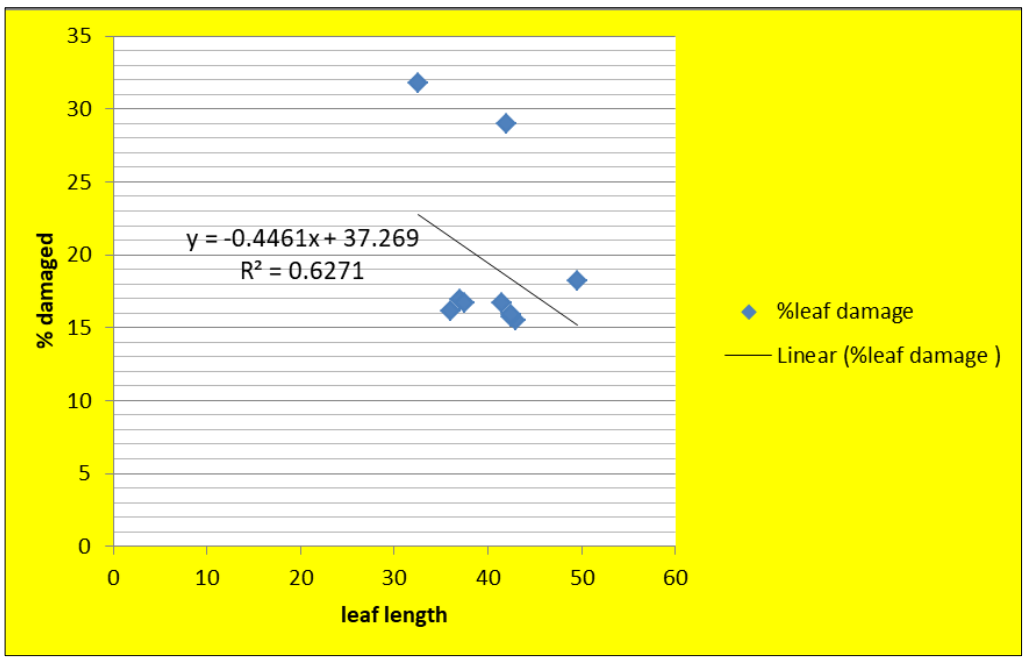

Fig 3: Relationship between Leaf length and leaf folder damage

3. Result and Discussion

Data on Cumulative mean percent of leaf folder damage and Morphological characters *viz*., Leaf length, leaf width and leaf pubescence in leaf of rice varieties selected were presented here under (Table 2). It was evident from the results that there were significant differences among selected varieties regarding the leaf folder damage potential, leaf length, leaf width and pubescence presence in their leaves.

3.1. Cumulative mean percent of leaf folder damage

The data on leaf damage in the year 2015-16 and 2016-17 in ten cultivars during different growth stages (30, 45.60 and 75 DAT) were pooled (Table 4).The cumulative mean percent damage was 22.06 and the damage ranged from 14.9 to 31.00%. The lowest damage was recorded in Pratikshya (ORS-201-5) (14.9%) followed by Pooja (15.7%), Anjana (15.9%), which was on par with Surendra (16.1),CR-1018(16.7%),CR-1009(16.7%) and MTU-1001(16.9%).The highest damage was observed in MTU-7029 (31.00%) followed by SWARNA SUB -1 (29.03%).Based on overall reaction of leaf folder in two years in different (10) cultivars, the cultivars were categorized in to various groups according to Standard Evaluation System for Rice given by IRRI, Phillippines. Out of 10 cultivars of rice, eight moderately resistant (11-20%) two moderately susceptible (35%) were found (Fig. 1).

3.2. Studies on morphological character of selected cultivars against leaf folder incidence with correlation and Regression model

Various morphological characters like maximum leaf length, maximum leaf width, pubescence on leaf in leaves of varieties were investigated to determine their role in mechanism of resistance against rice leaf folder. Effect of these morphological characters on the leaf folder incidence was also determined by working out simple correlations, and presented (Table 4 & Fig. 2).With regard to the length of the leaves, results indicated that there was significant difference among different varieties. The average length of the leaf was 40.35 cm and it ranged between 32.00cm to 49.50 cm in different varieties. The highest leaf length was observed in CR-1014 (49.50 cm) followed by ORS-201-5 (43.00 cm), OR-629-256 (42.5cm), Anjana (42.50 cm) and CR-210-1009. The lowest leaf length was observed in MTU-7029 (32.50 cm) followed by Surendra (36.00), MTU-1001(37.00) and CR-210-1018 (37.50 cm). Similarly results on width of the leaves indicated that there was significant difference among different varieties. The average width of the leaf was 1.26 cm and leaf width ranged between 1.00 to 1.65 cm in different varieties. The highest leaf width was observed in both of the varieties CR—210-1018(1.65) and CR-629-256 (1.5 cm) followed by MTU-1001(1.40 cm) and Swarna Sub--1 (1.35 cm). The leaf width was minimum in CR-1014 (1.00 cm) followed by, Anjana (1.05CM), CR-1009,Surendra(1.10 cm) and Pratikshya – ORS-201-5 (1.13 cm). Regarding the scale of pubescence on leaves, PRATIKSHYA(ORS-201-5), Padmni-CR-1014 mutant, Surendra, Anjana, SabitriI(CR-210-1009), and MTU-7029(Swarna) recorded a rating of 3 (weak pubescence), whereas SWARNA SUB -1, Bejeta (MTU-1001), Pooja(CR-629-256) and Gayatri(OR-210-1018) recorded a rating of 5 (medium pubescence). It could as well be noted from the results (Table 5) all rice cultures with maximum leaf width in the range of 1.40 cm to 1.65 cm have recorded medium pubescence (scale 5) compared to the remaining cultures (1.00cm to 1.35 cm) that recorded weak pubescence (scale 3).

The correlation coefficient (r) values between Morphological characters and percent leaf infestation by the rice leaffolder during 2015-2016 kharif and 2016-17 indicated that the length of the leaf did not affect the infestation of rice leaffolder significantly, but all the other factors showed significant correlation with leaf folder infestation. Leaf width at 45 DAT (Fig. 2 and 3) has positive correlation with leaf damage (r values were 0.358),

Simple regression analysis revealed that the leaf damage with various biophysical characters (Leaf length and leaf width) were significant. The results presented in Table 6 showed that the leaf length contributed only 3.5 percent towards the leaf-infestation caused by the rice leaffolder but with the addition of effect of width of leaf and this value increased up to 62.0 percent.

These findings was in accordance with Elanchezhyan *et al*., (2015) [13] tested 20 rice genotypes found that none of the genotypes were free from leaf damage to be categorized as highly resistant (0% leaf damage). Xu *et al*. (2010) [14], who reported that among different lines screened for rice leaffolder, most of the varieties were fell under a damage leaf scale (DLS) of 3, 5 and 7. TN- 1 was most susceptible line among all with DLS of 9. No highly resistant variety was found. Thamrin and Rasmini (1993) [15] also reported that out of 20 cultivars screened, except IR-36, all were fell under moderately resistant group for leaffolder. It was also in accordance with Rathika (2008) [16] where TN-1 was the most susceptible cultivar among 0 cultivars screened.Nigam *et al*. (2008) [17] reported that, out of 25 rice germplasms tested at different cropping stages (tillering, booting and dough) for resistance to leaf folder, six germplasms such as IET 13310, NDR 6023, IET 10649-1, Mahsuri, NDR 6232 and NDR 6175, showed a consistent damage rating of one.

Rice varieties *viz*. Parijat, Rudra, Sankar, Khandagiri, Sarathi, Samanta, Meher and Rambha showed moderate resistance as per the report of Mishra *et al.* (2002) [18]. Upadhyaya *et al*. [19] and Veerma *et al*.(1979) [20] also reported the attack of rice leaf foldein rice var Jaya in Odisha and W.B condition. Venkateswarlu *et al*.2002 [21] reported the extent of leaf damaged by leaf folder was 17.4 to 22.38%.

The results are supported by Kamakshi *et al*., (2012) [22] who reported that among morphological characters, leaf length did not influence the leaf folder incidence whereas positive significant correlation was observed with leaf width.

4. Conclusion

It is concluded that the varietal preference of rice leaf folder *C. medinalis* among ten popular rice varieties was analyzed during kharif 2015 and 2016 at 30, 45, 60 and 75 DAT. The percent of leaf folder damage, the varieties were given ratings according to Standard Evaluation System (IRRI)'s for rice. All the ten varieties come under two different ratings i.e., nine varieties under a rating of 3 (Moderately resistance) and one varieties under a rating of 5 (moderately susceptible). Highly resistant and highly susceptible varieties were not recorded. The correlation coefficient (r) and simple regression (R2) analysis of various morphological characters with the percent leaf folder damage indicated that leaf width is positively correlated with leaf folder damage whereas the leaf length contributed only 0.5 percent (R2) towards leaf folder infestation but with the addition of leaf width, R2 value enhanced up to 62.0 percent.

5. Acknowledgement
Special thanks are due to Dr. Swarnali Bhattacharya (Asst. Professor), Department of Plant Protection, Palli Sikshya Bhawan, Visva Bharati (W.B), Dr S.K. Mishra (Principal Scientist) ICAR-NRRI Cuttack and Dr. D. Panigrahi (Associate Director of Research), RRTTS, OUAT. Bhubaneswar (Odisha) for their valuable advice and guidance, for providing rice varieties for screening trial.

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