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Correlation studies and multiple linear regression analysis of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) incidence with morphological characters of leaves of the rice varieties

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Abstract

Studies on “Correlation of rice leaf folder *Cnaphalocrocis medinalis* (Guenee) incidence with morphological characters of leaves of the rice varieties” were conducted during *kharif* 2015 at Agricultural college farm, Bapatla, A.N.G.R.A.U. Andhra Pradesh. The effect of different morphological characters like leaf length, leaf width and pubescence on leaf on per cent leaf folder damage were correlated and multiple regression models were worked out. The correlation coefficient (r) values between morphological characters and per cent leaf folder infestation during *kharif* 2015 indicated that the length of the leaf did not affect the infestation of rice leaf folder significantly, but the maximum leaf width showed significant positive correlation (r = 0.785) with the pest infestation. The results showed that the leaf length contributed 0.5 per cent (R^2) towards the leaf folder infestation but with the addition of leaf width effect the value increased up to 62.5 per cent, clearly indicating that the significant role of leaf width in colonizing leaf folder larvae. Among morphological characters, leaf length did not influence the leaf folder incidence whereas positive significant correlation was observed with leaf width.

Keywords: rice leaf folder, correlation, regression, leaf length, leaf width

1. Introduction

Rice (*Oryza sativa* L.) belongs to the family of grasses (Poaceae), which is one of the most important cereal crops worldwide. It is the staple food for more than two billion people in developing countries [1]. In India, farmers grow many kinds of cereals in an area of 53.87 M ha with an annual production of 110.74 Mt. Among them, the rice is grown in an area of 44.6 M ha with an annual production of 90 M t, which constitutes 52 per cent of total food grain production. In Andhra Pradesh, rice is grown in an area of 3.5 M ha with the production of 11.17 Mt [2]. Insect pests are the major biotic constraints in enhancing rice productivity that cause 20-30 per cent losses every year, besides diseases and weeds. The warm and humid climate of the tropics is quite congenial for the outbreak of insect pests. Nearly 300 species of insect pests are attacking the paddy crop at various stages. Among the insect pests, only 23 species are causing notable damage [3].

Generally lepidopteran insect pests cause significant yield loss to crop plant. The rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) (Lepidoptera: Pyralidae), is a predominant foliage feeder and one of the most destructive pests affecting in all the rice ecosystems in Asia**.** The yield loss is from 30 to 80 per cent under epidemic condition [4]. The rice leaf folder, *C. medinalis*, earlier was considered as a minor pest, but now has assumed the major pest status in the entire country particularly in areas of high fertilizer usage. In conducive environment, this pest may cause severe damage at maximum tillering and flowering stages of the crop which may lead to 60 to 70 per cent leaf damage with 50 per cent of reduction in yield [5].

Second instar leaf folder larvae glue to the growing paddy leaves longitudinally for shelter and feed voraciously on green foliage which results in papery dry leaves. Feeding on paddy leaves often results in stunting, curling or yellowing of plant green foliage. Severe infestations may annihilate the plant totally. Losses that incurred to the growing paddy crop are irrevocable [6].

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 incurs no additional cost and is also free from the problems connected with the environmental pollution. As all the existing rice varieties are susceptible to rice leaf folder attack, it has become imperative to find out the resistance sources in rice germplasm in order to evolve new rice varieties resistant to rice leaf folder [7]. Further, identification of morphological characters associated with host plant resistance would help in increasing the precision and efficiency of resistance in different cultivars and also will help in confirming the physiological factors of antibiosis in the new germplasm of rice against leaf folder.

2. Material and Methods

2.1 Raising the rice nursery and main field preparation

The nursery of all the test rice genotypes were raised in wet land block in Agricultural College farm, Bapatla in *Kharif* 2015 by adopting all the ANGRAU recommended package of practices like land preparation, manures, fertilizers and irrigation but without any plant protection measures to the nursery of rice genotypes. The main field was ploughed initially twice with tractor drawn cultivator after onset of the monsoon. Weeds and stubbles were removed. Puddling was done twice with the tractor drawn disc harrow after letting the water into the field. Then thorough levelling was done with the levelling plank

Twenty one (21) varieties/advanced cultures including susceptible check (BPT-5204, Samba Mahsuri) (Table. 1) of paddy collected from different agricultural research stations were raised under natural field conditions at Agricultural college farm, Bapatla during *kharif* 2015. The nurseries were sown on well prepared raised beds. All the recommended agronomic practices were adopted during the experimentation.

Table 1: The particulars of different varieties/advanced cultures used in the experiment

S. No.	Designation of variety/Advanced culture	Duration (days)	Grain type
1	BPT-2270 (Bhavapurisannalu)	165	Medium slender
2	BPT-2570(Advanced culture)	125	Medium slender
3	BPT-2605(Advanced culture)	125	Medium slender
4	BPT-2295(Advanced culture)	150	Medium slender
5.	BPT-2411(Advanced culture)	145	Medium slender
6	BPT-2571(Advanced culture)	135	Medium slender
7	BPT-2741(Advanced culture)	125	Medium slender
8	BPT-2615(Advanced culture)	120	Medium slender
9	BPT-2644(Advanced culture)	140	Medium slender
10	BPT-2231(Akshaya)	145-150	Medium slender
11	BPT-2590(Advanced culture)	145	Medium slender
12	BPT-2595(Advanced culture)	145-150	Medium slender
13	BPT-2660(Advanced culture)	145	Medium slender
14	BPT-2593(Advanced culture)	145	Medium slender
15	JGL-11727 (Pranahita)	135	Large slender
16	JGL-3844 (Jagityal Samba)	135	Medium slender
17	MTU-1061 (Indra)	150-155	Medium slender
18	NLR-3041(Nellore Sona)	140	Medium slender
19	NLR-3042	145	Medium slender
20	RNR-15048 (Telangana Sona)	125	Medium slender
21	BPT-5204 (Samba Mahsuri)	150	Medium slender

2.2 Experiment lay out and transplantation

The experiment was laid out in randomized block design (RBD). A row length of 5 m was followed and each variety transplanted in 6 rows per each plot. A total of three replications and 63 plots were formulated. A total of 400 m² area was used for the screening. Transplantation was done with 30 days old seedlings. Line planting was adopted with a spacing of 25 × 15 cm (25 cm between the rows and 15 cm within the row) with the help of a marked rope (Plate 2). Two to three seedlings were planted per hill. Around the experimental field, one meter width of BPT-5204 was transplanted as bulk. Gap filling was done after one week to obtain uniform population in all the plots.

2.3 Agronomic practices

Weeding was done with manual labour at 15 and 30 days after transplantation and thereafter whenever necessary. The experimental field was maintained with 2 cm depth of water up to tillering stage. Then the water level was increased to 5 cm from post tillering stage to grain filling/maturity stage. Finally the field was completely drained ten days before harvesting. A recommended fertilizer dose of120:60:60 kg of NPK/ha was applied to the experimental field in the form of urea, single super phosphate and muriate of potash, respectively. Nitrogen was applied in three split doses, *i.e.* at puddling as basal dose and remaining two doses each at tillering and panicle initiation stages as top dressing. Total amount of the phosphorus was applied at once as basal dose at the time of puddling. Potash was applied in two splits, once at puddling and then at panicle initiation stage.

2.4 Data collection

2.4.1 Leaf folder per cent damage

Observations were recorded from 30 DAT (Days After Transplanting) at every 15 days interval, from 10 randomly selected hills. To calculate the per cent leaf damage by the leaf folder, total number of leaves and the number of damaged leaves were counted from each hill. Incidence of leaf folder was recorded on randomly selected 10 hills per test variety in each plot. The total and damaged leaves were counted on each test variety and per cent leaf damage was calculated by using with the following formula.

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

2.4.2 Maximum leaf length and maximum leaf width

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.

2.4.3 Pubescence
The pubescence on leaves of different rice varieties screened was rated by finger feel method using DUS (Distinctness, Uniformity and Stability) system of rice [8] (Table. 2) as mentioned hereunder.

Table 2: Rice leaves pubescence scoring scale used in the experiment

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

3. Results and Discussion
Data on leaf folder per cent damage and various morphological parameters like leaf length, leaf width and pubescence on leaf were recorded and presented (Table.3)

3.1 Cumulative mean per cent of leaf folder damage
The per cent leaf folder damage due to leaf folder on twenty one varieties of rice at different intervals (30, 45, 60 and 75 DAT) was summarized here. The differences in leaf folder damage among twenty one varieties were significant at different intervals. Data indicated that the leaf damage ranged between 7.10 to 18.20 per cent. The highest leaf damage was observed in the varieties BPT-5204(18.20%) followed by BPT-2570(16.90%), which was on par with BPT-2593(16.70%) followed by BPT-2270(16.20%), NLR-3042 (16.10%), BPT-2571 (15.90%) and JGL-3844 (15.90%). The lowest incidence was noticed in BPT-2231(7.10%), which was on par with BPT-2615(7.40%), JGL-11727(7.60%), BPT-2660(7.60%), BPT-2741(7.90%), BPT-2644 (8.10%), RNR-15048 (8.30%), BPT-2411(8.40%) and BPT-2595(8.60%).

3.2 Leaf length
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 43.38 cm and it ranged between 36.07 to 49.50 cm in different varieties. The highest leaf length was observed in JGL-3844 (49.50 cm) followed by BPT-2741(48.98 cm), BPT-2411 (48 cm) and MTU (47.63 cm). The lowest leaf length was observed in BPT-2593 (36.07 cm) followed by BPT-2595 (38.30 cm) and JGL-11727 (38.50 cm).

3.3 Leaf width
Similarly results on width of the leaves indicated that there was significant difference among different varieties. The average width of the leaf was 1.35 cm and leaf width ranged between 0.98 to 1.75 cm in different varieties. The highest leaf width was observed in both of the varieties BPT-2295and BPT-2605 (1.75 cm) followed by BPT-2590 (1.65 cm) and BPT-2571 (1.60 cm).The leaf width was minimum in BPT-2231 (0.98 cm) followed by BPT-2595 (1 cm) and RNR-15048 (1 cm).

3.4 Pubescence
Regarding the scale of pubescence on leaves, BPT-2660, BPT-2570, BPT-2270, BPT-2593, BPT-2605, JGL-3844, MTU-1061, BPT-2571, NLR-3042, NLR-3041 and BPT-5204recorded a rating of 3 (weak pubescence), whereas BPT-2295, BPT-2644, BPT-2615, BPT-2231, BPT-2595, RNR-15048, BPT-2411, JGL-11727 and BPT-2741 recorded a rating of 5 (medium pubescence).
It could as well be noted from the results but for BPT 2660 (1.17 cm), all rice cultures with maximum leaf width in the range of 0.98 cm to 1.23 cm have recorded medium pubescence (scale 5) compared to the remaining cultures (1.33cm to 1.75 cm) that recorded weak pubescence.

3.5 Correlation and multiple regression models
The effect of different morphological characters like leaf length, leaf width and pubescence on leaf on per cent leaf folder damage were correlated and multiple regression models were worked (Table. 4 & Fig. 1).
The correlation coefficient (r) values between morphological characters and per cent leaf folder infestation during *kharif* 2015 indicated that the length of the leaf did not affect the infestation of rice leaf folder significantly, but the maximum leaf width showed significant positive correlation (r=0.785) with the pest infestation.
The results showed that the leaf length contributed 0.5per cent (R^2) towards the leaf folder infestation but with the addition of leaf width effect the value increased up to 62.5 per cent, clearly indicating that the significant role of leaf width in colonizing leaf folder larvae.
The present finding are in accordance with [9] who reported that there was no significant correlation between leaf length and leaf folder incidence but leaf width showed significant positive correlation with leaf folder incidence. [10] also confirmed that the leaf length has no significant effect on leaf folder incidence, but a significant positive correlation existed between leaf width and leaf damage [11, 12] showed negative correlation between leaf length and leaf damage, but conformed the positive correlation of leaf width to the leaf folder incidence. It was apparent from the present investigation that germplasm which had narrow leaves showed maximum resistance against leaf folder. [13, 14] reported that plants with broader leaf width facilitate easy folding and provide more area for feeding of leaf folder. Further, they also stated that the larvae of leaf folder in narrower leaves probably less protected from weather and natural enemy complex.

Table 3: Susceptibility-resistance status vs Leaf morphological characters in rice varieties against rice leaffolder, *Cnaphalocrocis medinalis*, *kharif* 2015

S. No.	Rice variety	Mean per cent leaf folder damage	Maximum Leaf length (cm)	Maximum Leaf width (cm)	Scale for Pubescence
1	BPT-2660	7.60^{c}	46.67^{cd}	1.17^{fg}	Weak (3)
2	BPT-2570	16.90^{a}	43.00^{e}	1.50^{d}	Weak (3)
3	BPT-2270	16.20^{ab}	45.33^{d}	1.38^{e}	Weak (3)
4	BPT-2593	16.70^{a}	36.07^{i}	1.53^{cd}	Weak (3)
5	BPT-2605	15.70^{ab}	42.87^{e}	1.75^{a}	Weak(3)
6	BPT-2590	15.50^{ab}	46.03^{d}	1.65^{b}	Weak (3)
7	BPT-2295	12.70^{b}	42.00^{efg}	1.75^{a}	Medium (5)

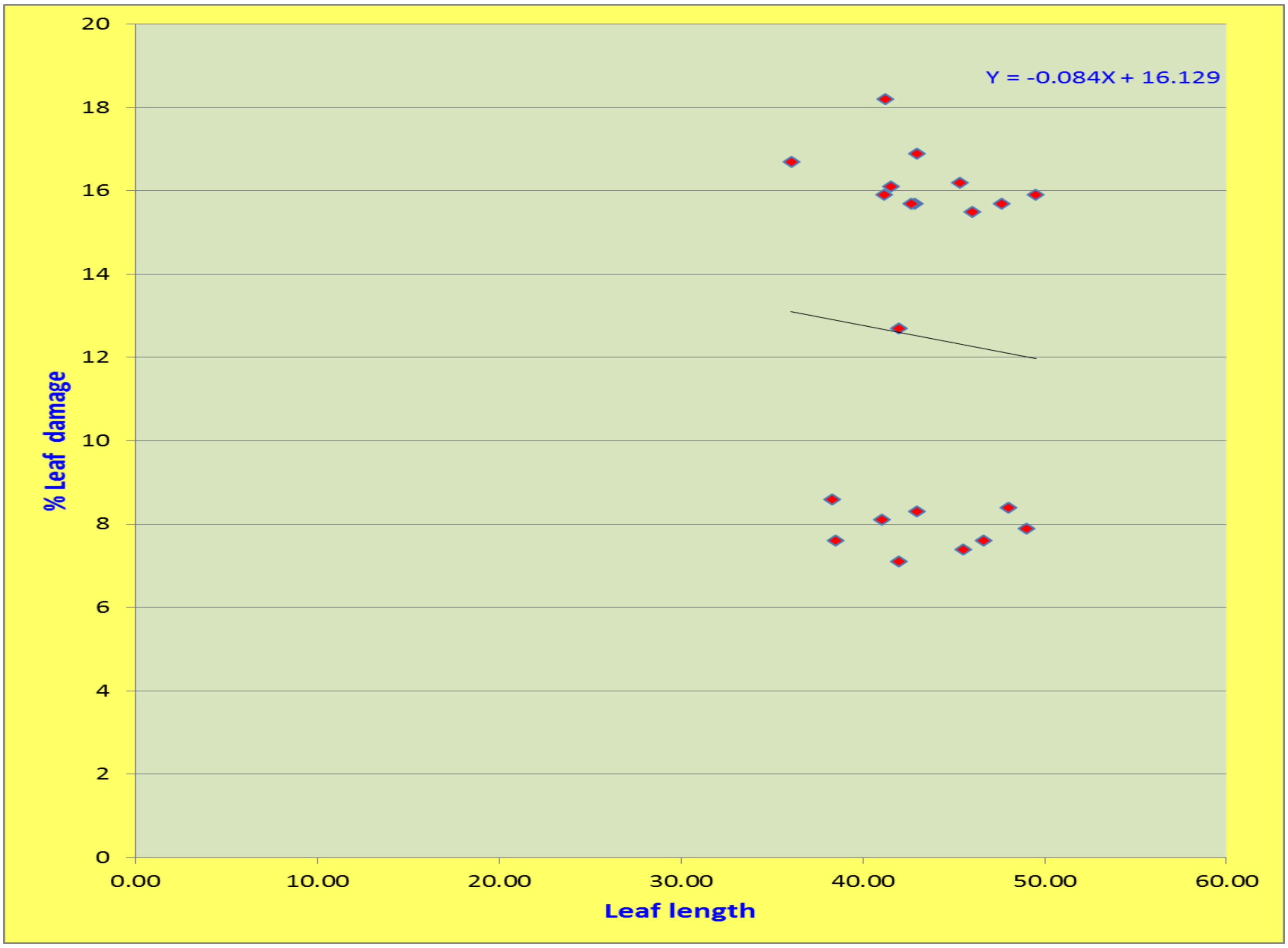
8	BPT-2644	8.10^{c}	41.07^{g}	1.15^{fg}	Medium (5)
9	BPT-2615	7.40^{c}	45.50^{d}	1.13^{g}	Medium (5)
10	BPT-2231	7.10^{c}	42.00^{efg}	0.98^{h}	Medium (5)
11	BPT-2595	8.60^{c}	38.30^{h}	1.00^{h}	Medium (5)
12	RNR-15048	8.30^{c}	42.98^{e}	1.00^{h}	Medium (5)
13	BPT-2571	15.90^{ab}	41.17^{fg}	1.60^{bc}	Weak (3)
14	JGL-3844	15.90^{ab}	49.50^{a}	1.53^{cd}	Weak (3)
15	MTU-1061	15.70^{ab}	47.63^{bc}	1.33^{e}	Weak (3)
16	NLR-3042	16.10^{ab}	41.57^{efg}	1.37^{e}	Weak (3)
17	NLR-3041	15.70^{ab}	42.6^{ef}	1.53^{cd}	Weak (3)
18	BPT-2411	8.40^{c}	48.00^{bc}	1.20^{fg}	Medium (5)
19	JGL-11727	7.60^{c}	38.50^{h}	1.15^{fg}	Medium (5)
20	BPT-2741	7.90^{c}	48.98^{ab}	1.23^{f}	Medium (5)
21	BPT-5204	18.20^{a}	41.25^{fg}	1.40^{e}	Weak (3)
	'F' test	*	Sig.	Sig.	_
	Mean	6.85	43.38	1.35	_
	SEm	0.95	0.52	0.04	_
	CD (P=0.05%)	3.00	1.479	0.095	_
	CV (%)	10.53	2.10	4.50	_

Values with similar alphabets in each column do not vary significantly at 5% level as per DMRT

Table 4: Correlation and multiple linear regression studies of morphological characters of rice varieties against the damage of rice leaffolder, *Cnaphalocrocis medinalis, kharif* 2015

Morphological characters			
S. No.	**Variable**	**Correlation coefficient**	**Regression equations**
a.	Leaf Damage (Y) Vs Leaf Length (X)	-0.072^{NS}	Y= -0.0839X +16.12862
b.	Leaf Damage (Y) Vs Leaf Width (X)	0.785*	Y=13.6X - 5.8742
S. No.	**Variable**	**Regression model**	**R^2**
a.	Leaf length (X_1)	$Y=-0.0839X_1+16.12862$	0.05
b.	Leaf width (X_2)	$Y= -1.402-0.1041X_1+13.634X_2$	0.62

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



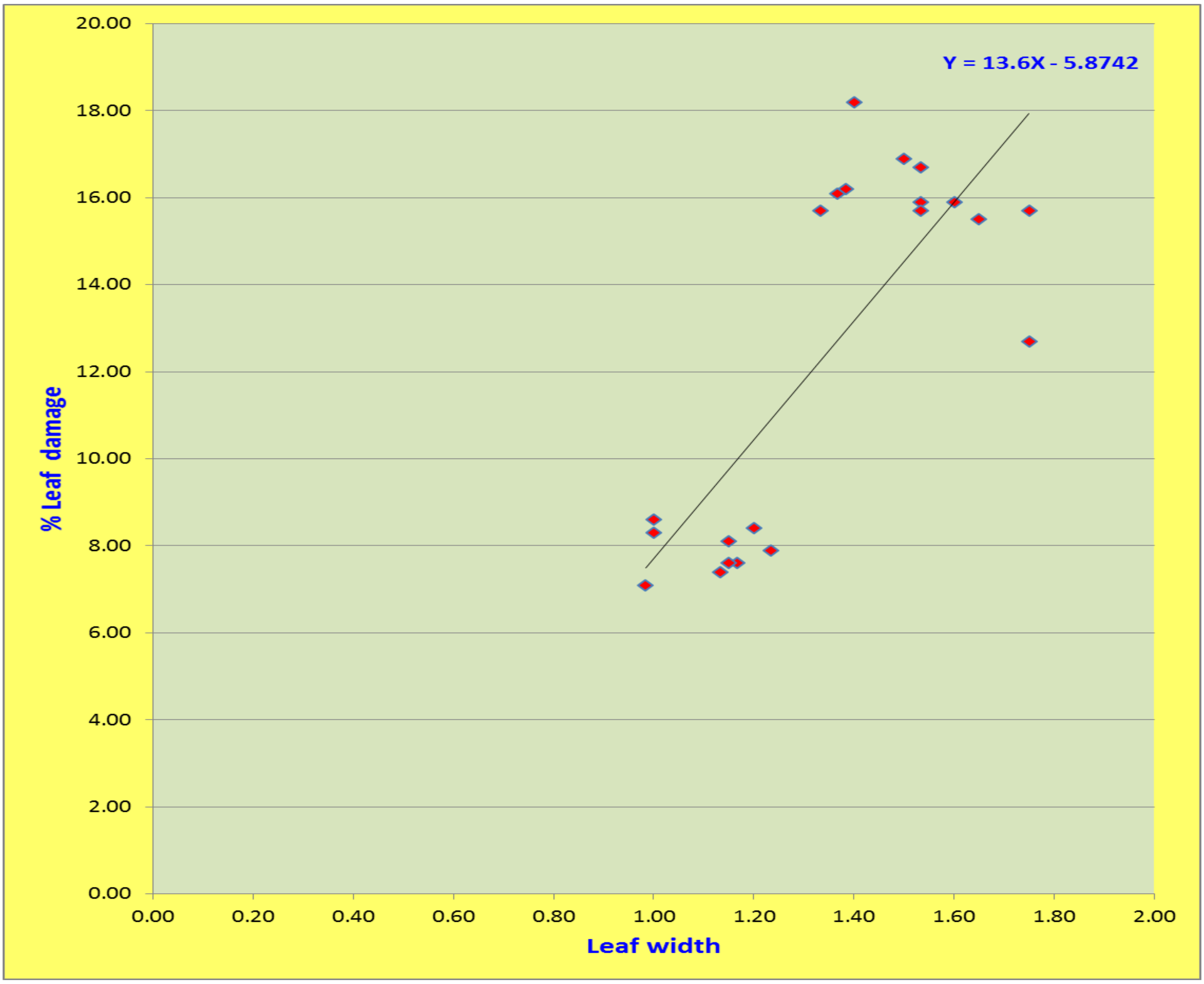


Fig 1: Relationship between different morphological characters of rice leaf and leaf damage due to rice leaf folder

4. Conclusion

The average leaf length among different varieties was 43.38 cm. Long leaves were observed (49.50 cm) in JGL-3844 and the smaller leaves were observed in BPT-2593 (36.07 cm). The average maximum leaf width was 1.35 cm and the broad leaves were observed in BPT-2571 (1.60 cm) while narrow leaves (0.98 cm) were found in BPT-2231. The correlation coefficient (r) and multiple linear regression (R^2) analysis of various morphological characters with the per cent leaf folder damage indicated that leaf width is positively correlated with leaf folder damage whereas the leaf length contributed only 0.5 per cent (R^2) towards leaf folder infestation but with the addition of leaf width, R^2 value enhanced up to 62.5 per cent.

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