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Screening of indigenous rice genotypes of Manipur for their resistance reaction against rice yellow stem borer

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Abstract
Different local Manipuri rice genotypes were screened out to find their resistance reaction against rice yellow stem borer. The per cent of the incidence of stem borer ranges from 1.07 to 4.97 per cent of stem borer damage. Among the 41 local Manipuri rice genotypes screened against stem borer, Moirangphou Khokngambi (1.47 per cent stem borer damage), Chingphou (1.70 per cent stem borer damage), Tei (1.71 stem borer damage), Bungpat (1.79 per cent stem borer damage), Phouren Khoknembi (1.83 per cent stem borer damage) and Langphou (1.98 per cent stem borer damage) were recorded minimum incidence against stem borer. Whereas, Mieling Manthowean (4.53 per cent stem borer damage), Kiebiphou (4.28 per cent stem borer damage), Mashi (3.89 per cent stem borer damage), Mashi Manui (3.81 per cent stem borer damage), Tathai (3.78 per cent stem borer damage), Aso (3.72 per cent stem borer damage) and Shangao (3.72 per cent stem borer damage) recorded highest incidence of stem borer.

Keywords: Indigenous rice genotypes, resistance reaction, rice yellow stem borer

Introduction
Rice (*Oryza sativa* L.) belongs to the family poaceae and it is one of the major staple food of about 60 per cent world population. Rice dominates Indian agriculture and accounts for 40 per cent production under food grains (Sri Chandana Bhogadhi. and J. S. Bentur. 2015) [11]. Rice is known as a wonderful cereal cultivated in a variety of ecological zones with wide range of variations in the productivity. India ranks first in area under rice (42.56 million hectares) and second in production (95.33 million tonnes) (Anon., 2011) [3] with an average productivity of rice in world about 4,004 kg/Ha (FAO, 2008) [5]. Around 90% of the world rice is produced and consumed in Asian countries. The rice production requires more attention due to the rapid population growth in this part of the world. Human population is increasing up to 7 billion and more than one half depend on rice as their major diet (IRRI 2010) [7]. Paddy crop is planted on about 154 mha or about 11% of the world cultivated land with annual production of 700.7 million tons. India has got world largest growing area with 43.93 million ha with production of 91.61 million tons (Anon., 2010) [2]. Agriculture is a dominant occupation of the people in Manipur. Paddy is the most dominant and staple food crop grown in Manipur. It is grown in hilly and plain areas of the state and is mainly grown during *kharif* season. The crop is cultivated in an area of 1, 76,310ha, with production of 435.9 thousand tonnes. The productivity of Rice in Manipur is 2413.52kg/ha (Anon., 2005).
Rice crop is prone severe yield loses due to biotic and abiotic stress to an extent of 46.2 per cent, out of which 23.2 per cent is due to insect pests (Justin C. and G. Preetha. 2014.). There are over seventy insect pests infesting rice in India out of which 20 are in regular occurrence (Punithavalli, 2014) [10]. Among all insect pest, the rice stem borers are the chief devastators and responsible for economic yield losses under natural condition. These are common and impotent pests in Asian countries, responsible for annual yield losses of 5-10 per cent of rice crop. Eight species of stem borer of rice are known to be significantly importance in Asia. This insect attacks the crop specifically during seedling stage and causes yield reduction. Symptoms produced by this insect are drying of central shoot known as dead heart at vegetative stage and white ear and chaffy panicle at harvesting stage, which lead to no grain formation. *S. incertulus* causes yield loss of 27- 34 per cent every year. Screening the rice accessions and identifying the resistant accessions against a particular pest and consequently understanding the biochemical mechanism will aid in breeding genotypes for resistance against specific pest

(Pandey Sujoy and Choubey M.N. 2011,) [9]. Plants belonging to various families have most abundant classes of anti-metabolic proteins as an important defence mechanism against plant feeding insect pests (Lawrence and Koundal, 2002). In view of above background, an attempt has been made to screen different rice accessions against yellow stem borer and identify the biochemical parameter

Materials and Methods

To screen the rice entries against yellow stem borer, *S. incertulas*, a supervised field experiment was conducted during *Kharif* 2018 at College of agriculture CAU, Imphal, Department of Entomology with 42 entries along with susceptible check variety Liemaphou were used for the experiment (Table 1). The experiment was laid out in a Randomized Block Design with three replications. The entries were raised in nursery and at 25 days after sowing (DAS) the seedlings were transplanted in the main field with the spacing of 20 × 10 cm. The recommended dose of fertilizers of 120: 40: 40 kg/ha NPK were applied as per the crop production guide (Anon., 2005).

A) Assessment of dead heart and white ears infestation in per cent age: Observations on Yellow stem borer infestation were recorded in randomly selected ten hills per replication for each entries at 30,45,60,75,90 and 105 days after transplanting. At vegetative stage of the crop, total number of tillers per hill and total number dead heart symptoms were counted from 10 randomly selected hills. However, in reproductive stage of the crop, the total number of tillers and total number of white ear heads in the 10 randomly selected hills were counted. The stem borer infestations were confirmed by slightly pulling the dead heart and white ear head. The percentage infestation by stem borer was determined by using the formula:

$$\text{Per cent dead hearts} = \frac{\text{Number of dead heart per hill}}{\text{Total number of tillers per hill}} \times 100$$

$$\text{Per cent white ears} = \frac{\text{Number of white ears per hill}}{\text{Total number of tillers per hill}} \times 100$$

B) Biochemical analysis: The biochemical factors responsible for imparting resistance in the promising genotypes, estimation of total soluble sugars by Anthrone method, reducing sugars by DNS method, total phenol by Malik and Singh method and ortho-dihydroxy phenol by Arnow method. The top five resistant and five susceptible genotypes were selected for biochemical analysis and compared with the check Liemaphou. Observations were recorded from the spectrophotometer (Microprocessor spectrophotometer, Model 130, Electronics, India)

Results

A) Incidence of yellow stem borer: Out of 42 local rice accessions (including susceptible check) the incidence of stem borer at 30 DAT varied from 1 .10 to 10.07 per cent. Among them Mashi manui (70.07 per cent dead heart) noted as the highest infestation percentage followed by Ago manui (8.81 per cent dead heart). The minimum infestation percentage was recorded in Kaenoh (1.1 per cent dead heart) followed by Thangjing phou (1.72 per cent dead heart) which was shown in Table 1. However, in the advance stage of the crop, the infestation of the pest was very low. At 90 DAT, the highest infestation of 2.33 per cent white ears was recorded in Langzam in comparison with 3.07 per cent in standard check.

The incidence of stem borer was nil in the local genotypes viz. Mashi Manui, Moirangphou, Langmanbi, kakchengphou, bungpat, Mathi boro Mono, Chaugoi, Phourel Amubi, Kikhu, Tareshang, Shangao, Chingphou, Phouren Noining and Napiphou at 90 DAT.

Considering the average of 6 observations i.e. at 30,45,60,75,and 90 DAT, the lowest incidence was observed in Kaenoh with 1.07 per cent which was followed by Moirangphou Khokngambi (1.47 per cent)< Chingphou (1.70 per cent) < Tei (1.71) <Bungpat (1.79 per cent)< Phouren Khongnembi (1.83 per cent) < Langphou (1.98 per cent) in the ascending order. The highest average infestation was recorded in the standard check (Leimaphou) with 4.97 Per cent. Among the local entries, Mileing Manthowean suffer highest incidence with 4.53 per cent infestation followed by Kiebiphou (4.28 per cent), Mashi (3.89 per cent), Mashi Manui (3.81 per cent), Tathai (3.78 per cent), Aso (3.72 per cent) and Shangao (3.72 per cent) in descending order.

B) Biochemical constituents in certain rice stem borer resistant and susceptible rice genotypes of manipur: The total soluble sugars present in the six selected susceptible varieties (including standard check) five resistant varieties are presented in Table 2. Among the susceptible entries the total soluble sugars content ranges from 5.11 to 6.34 per cent whereas in the resistant entries ranged from 3.07 to 3.78 per cent. The highest total soluble sugar content was recorded in Keibiphou, (6.134 per cent) and lowest in chingphou (3.07 per cent).

The reducing sugars content in the susceptible entries ranged from 2.30 to 3.29 per cent. The lowest contents were recorded from Tei (1.72 per cent) and Phuren Khongnembi (per cent). Whereas the highest content was recorded on liemaphou (3.29 per cent). Out of the five resistant entries Tei (per cent) recorded lowest content and it was followed by Phuren Khongnembi (1.93 per cent) Khaenoh (2.01 per cent), Moirangphou Kheknagambi (2.20 per cent) and chingphou (2.20 per cent) in the ascending order.

The total phenol contents are relatively high in resistant entries. The highest phenol contents was recorded in khaenoh (4.67 per cent) and it was followed by Phuren Khongnembi (4.19 per cent), Chingphou (4.16 per cent), Moirangphou Kheknagambi (4.04 per cent) and Tei (3.96 per cent) descending order. The phenol content was lowest in standard check, liemaphou (1.93 per cent).

In the susceptible entries, the ortho dihydroxy phenol cntent were relatively lower when compare with resistant entries. The susceptible entries viz liemaphou (1.11 per cent), Mieling Manthowean (1.23 per cent), Mashi Manui, Naga Buh (1.2 per cent), Kikhu (1.2 per cent) and tathai (1.41 per cent) recorded lower ortho dihydroxy phenol content in ascending order. Whereas the resistant entries viz langphou (2.68 mg g^{-1}), Khaenoh (2.4 per cent), Ching phou (2.10 mg g^{-1}), Tei (2.11 per cent), Phouren Khongnembi (2.11 per cent and Moirangphou Kheknagambi (2.03 per cent) were observed with higher ortho dihydroxy phenol.

Correlation between pest incidence and biochemical contains

The correlations analysis between the stem borer and biochemical contains in eleven selected entries i.e. five resistant and six susceptible entries were carried out.

In case of stem borer, total soluble sugar and reducing sugar s showed a positive relationship with 0.9174 and 0.6813 respectively. Whereas, the total phenol and ortho di hydroxyphenol and stem borer infestation was found negative with -0.9383 and -0.9591 respectively.

Table 1: Per cent infestation of yellow stem borer of rice in certain rice cultivars of Manipur during *kharif*, 2018.

Local rice accessions	Per cent of dead heart			Per cent of white ear		Per cent mean of both dead heart and white ear
	30DAT	45DAT	60DAT	75DAT	90DAT	
Naga Buh	4.9I (2.3)	3.60 (2.02)	2.05(1.59)	2.21(1.64)	1.12(1.27)	2.77(1.7).1.77)
Tathai	2.10 (1.61)	8.68 (3.02)	2.78(1.81)	4.22(2.17)	1.16(1.2)	3.78 (1.98)
Mashi Manui	10.07 (3.25)	7.50 (2.82)	1.52(1.42)	0(0.70)	0(0.70)	3.81 (1.78)
Aso	3.10 (1.89)	7.3 1(2.79)	4.80(2.3)	1.16(1.28)	2.26(1.66)	3.72 (1.98)
Napduina	7.07 (2.75)	5.81 (2.51)	1.91(1.5)	1.54(1.42)	1.20(1.30)	3.50 (1.90)
Ago Manui (chakhao)	8.81 (3.05)	2.94(1.85)	1.02(1.23)	0(0.70)	1.25(1.32)	2.80 (1.63)
Mileing manthoweam	7.98(2.91)	6.58(2.66)	4.79(2.3)	1.13(1.27)	2.19(1.64)	4.53 (2.15)
Moirangphou	6.2(2.5)	5.23(2.39)	1.12(1.27)	3.20(1.92)	0(0.70)	3.15 (1.70)
Heimang Phou	8.42(2.98)	2.72(1.79)	3.2(1.92)	0(0.70)	1.12(1.27)	3.09 (1.73)
Mashi	6.30(2.60)	5.60(2.46)	4.8(2.30)	1.60(1.44)	1.16(1.2)	3.89 (2.02)
Chaku	2.96(1.86)	4.90(2.33)	5.46(2.4)	0(0.70)	1.20(1.3)	2.91 (1.73)
Langmanbi	5.17(2.38)	4.00(2.12)	1.21(1.30)	0(0.70)	0(0.7)	2.076(1.44)
Kakcheng Phou	3.36(1.96)	2.359(1.69)	5.77(2.46)	2.24(1.65)	0(0.70)	2.705(1.69)
Langzam	5.13(2.37)	2.98(1.86)	4.98(2.34)	3.02(1.87)	2.33(1.68)	3.68 (2.02)
Bungpat	4.758(2.29)	2.58(1.75)	1.65(1.46)	0(0.707)	0(0.70)	1.79 (1.38)
Mathi Boro Mono	8.66(3.02)	4.40(2.21)	3.42(1.97)	1.10(1.26)	0(0.70)	3.51 (1.83)
Khaenoh	1.10(1.26)	2.06(1.6)	0(0.70)	0(0.70)	2.2(1.64)	1.07 (1.18)
Chaugoi	5.79(2.50)	3.64(2.03)	3.36(1.96)	4.41(2.21)	0(0.70)	3.44 (1.88)
Thoibi	5.8(2.58)	2.66(1.77)	1.26(1.32)	0(0.70)	0.98(1.21)	2.14 (1.50)
Tatha(chiru)	4.41(2.21)	3.50(2.01)	3.57(2.01)	0(0.70)	1.12(1.27)	2.52 (1.64)
Stao amniemte	3.71(2.05)	4.09(2.14)	4.72(2.28)	0(0.70)	1.13(1.27)	2.73 (1.69)
Phourel Amubi	2.06(1.6)	4.18(2.16)	3.72(2.05)	1.24(1.31)	0(0.70)	2.24 (1.56)
Heitup Phou	4.49(2.21)	1.17(1.29)	3.77(2.18)	1.23(1.31)	1.06(1.2)	2.72(1.71)
kikhu	6.74(2.69)	5.98(2.54)	4.64(2.26)	1.15(1.28)	0(0.70)	3.70(1.89)
Lang Phou	3.31(1.95)	2.27(1.66)	4.25(2.17)	0(0.70)	0.091(0.76)	1.98(1.4)
Kiebi Phou	8.66(3.02)	1.67(1.473)	5.73(2.49)	3.54(2.0)	1.82(1.52)	4.28(2.10)
Tareshang	6.4(2.62)	4.83(2.30)	5.18(2.38)	0(0.70)	0(0.707)	3.28(1.74)
Shangao	5.86(2.52)	5.15(2.37)	4.17(2.16)	3.45(1.98)	0(0.707)	3.72(2.01)
Ching Phou	3.42(1.97)	1.21(1.30)	2.77(1.80)	1.12(1.22)	0(0.70)	1.70(1.41)
Mingoli	5.83(2.51)	3.9(2.09)	1.81(1.51)	1.09(1.26)	1.12(1.27)	2.75(1.73)
Phouren Noining	8.24(2.95)	3.74(2.05)	3.51(2.00)	1.01(1.22)	0(0.70)	3.3(1.79)
Tei	4.08(2.14)	1.31(1.34)	2.1(1.61)	0(0.70)	1.1(1.21)	1.71(1.41)
Napi Phou	5.69(2.48)	1.84(1.52)	3.22(1.92)	1.1(1.26)	0(0.70)	2.37(1.58)
Chedo	8.47(2.99)	1.91(1.55)	4.26(2.18)	0(0.70)	1.12(1.27)	3.15(1.74)
Moirangphou Khoknaganbi	2.98(1.86)	0(0.70)	3.21(1.92)	0(0.70)	1.16(1.28)	1.47(1.29)
Bupui	2.60(1.76)	3.83(2.08)	1.9(1.54)	1.5(1.41)	1.02(1.23)	2.17(1.60)
Manui Kacharva	7.37(2.80)	1.81(1.51)	3.24(1.93)	1.02(1.23)	0.42(0.95)	2.77(1.69)
Phouren Phoujao	6.6(2.66)	3.87(2.09)	2.82(1.82)	0(0.7)	0.83(1.15)	2.82(1.68)
Phouren Khongnembi	3.7(2.04)	1.72(1.48)	1.82(1.52)	1.01(1.2)	0.91(1.18)	1.83(1.49)
Niirui	2.37(1.69)	3.76(2.06)	4.07(2.1)	1.12(1.2)	0.58(1.03)	2.38(1.641)
Thanjing Phou	1.72(1.48)	4.41(2.21)	3.83(2.08)	1.00(1.2)	0.54(1.01)	2.30(1.60)
KD-2-6-3 (Leimaphou)	6.20(2.58)	5.49(2.44)	5.89(2.52)	4.2(2.16)	3.07(1.8)	4.97(2.32)
S.Ed(±)	0.39	0.24	0.12	0.16	0.21	0.26
CD	0.78	0.49	0.25	0.31	0.43	0.43

Table 2: Biochemical constituents in certain rice stem borer resistant and susceptible rice genotypes of manipur

Treatments	Rice varieties	Per cent infestation stem borer	Biochemical constituents (per cent)			
			Total soluble sugars	Reducing sugars	Total phenols	Ortho-dihydroxy phenols
t_{17}	Khaenoh	1.07(1.18)	3.29(1.94)	2.01(1.58)	4.67(2.25)	2.4(1.87)
t_{35}	Moirangphou Khoknaganbi	1.71(1.41)	3.23(1.94)	2.2(1.53)	4.04(2.14)	2.03(1.56)
t_{32}	Tei	1.71(1.41)	3.13(1.89)	1.72(1.64)	3.96(2.16)	2.11(1.78)
t_{29}	Chingphou	1.47(1.29)	3.07(1.82)	2.2(1.59)	4.16(2.25)	2.10(1.61)
t_{39}	Phouren Khoknembi	1.83(1.49)	3.78(2.07)	1.93(1.59)	4.19(2.06)	2.13(1.64)
t_{7}	Mileing Manthowean	4.53(2.15)	5.70(2.41)	2.68(1.66)	2.90(1.63)	1.23(1.33)
t_{26}	Keibiphou	3.89(2.02)	6.34(2.75)	2.55(1.68)	2.19(1.65)	1.24(1.38)
t_{28}	Shangao	3.69(2.02)	5.11(2.37)	2.37(1.70)	2.10(1.60)	1.21(1.31)
t_{10}	Mashi	4.28(2.1)	4.75(2.49)	2.30(1.78)	2.09(1.84)	1.20(1.31)
t_{14}	Langzam	3.72(2.01)	5.25(2.39)	2.75(1.66)	2.93(1.6)	1.20(1.31)
t_{42}	KD-2-6-3	4.97(2.55)	5.71(2.50)	3.29(2.18)	1.93(1.55)	1.11(1.20)

S.Ed(±)	S.Ed(±)	0.26	0.051	0.065	0.02	0.04
CD	CD	0.43	0.10	0.13	0.05	0.02

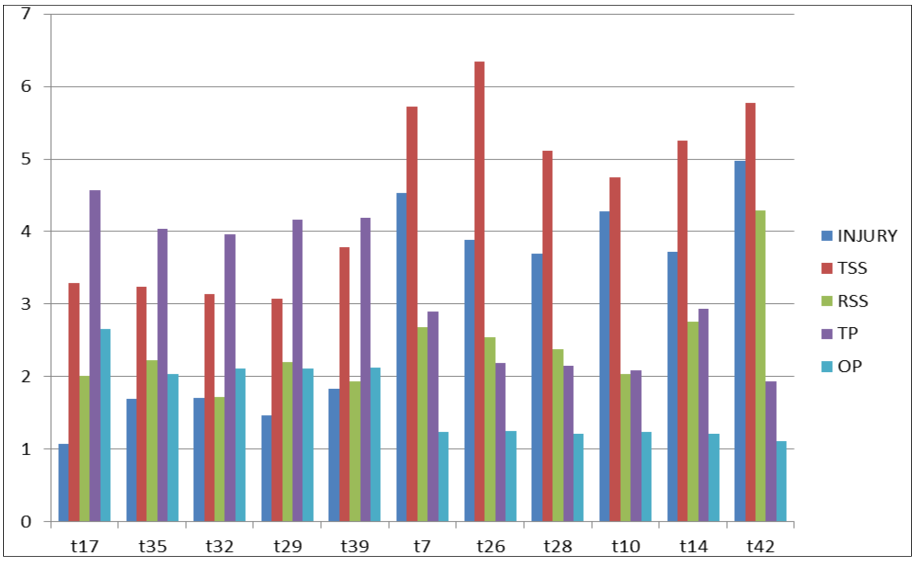

Fig 1: Graphical Representation between Per-cent Stem Borer Infestation Genotypes and Biochemical Constituents

Discussion

Incidence of stem borer low during the study period. Since, the incidence was low, it is difficult to give damage score using standard evaluation system of rice. Hence comparisons are made using the C.D at 5% among the different entries. Among the 42 entries, least incidence of stem borer in terms average of both per cent dead hearts and white ears was recorded in khaenoh (1.07) and it as followed by Moirangphou (1.47), chingphou (1.70), Tei (1.71), bungpat (1.79), Phouren Khoknembi (1.83) and Langphou (1.98). khaenoh and Moirangphou chingphou were comparable and the entries *viz*. chingphou, Tei, bungpat, Phouren Khoknembi, and Langphou were inferior to khaenoh in terms of resistance against stem borer. The highest incidence of stem borer was recorded in the standard check. Among the test cultivars, Mieling Mantowean and Keibiphou recorded maximum stem borer infestation but they were significantly lower than the standard check. The cultivars, viz. Mashi, Mashi Manui, Tathai, Aso and Shangao also recorded highest incidence of stem borer however they were comparatively lower than Mieling Manthowean. The early stage of the crop suffers more stem borer damage than the advance stage of the crop. This may be due to ability of the stem borer larvae to damage more number of tillers in the early crop stage however when the crop was grown up, stem borer larvae mainly confine in a single tiller. An almost similar finding was also reported by Bandong and Litsinger (2005). They also reported that resistance at midgrowth and after panicle exertion could be from: (1) Lignin and cellulose deposits on the cell walls, (2) tight wrapping of the leaf sheath and (3) deposition of silica.

Total soluble sugars contain in selected susceptible genotypes were significantly higher than the selected resistant genotypes. Similarly, the reducing sugar contained in susceptible genotypes were higher in compare to the resistant genotype. Similar observations were also reported by Gothandaraman and Kumar (2017) [6]. They reported that low amount sugars and soluble proteins contain were the factors for imparting resistance against yellow stem borer (*Scirpophaga incertulas*). In contrary to the sugars, total phenol and ortho-dihydroxy phenol content in the selected susceptible genotypes were significantly lower than the selected resistant cultivars. Elanchezleyan *et al*. (2017) [4] also reported that higher concentration of total phenols found in the resistance group could be one.

Conclusion

From the results of infestation per cent of stem borer genotypes and biochemical constituents of selected genotypes of stem borer. We have concluded that the total sugars and reducing sugars in resistant varieties is low in comparison to susceptible varieties. Whereas, the total phenol content and ortho-dihydroxy phenol content was highest in resistant genotypes, which was comparatively lower in susceptible varieties. The final conclusion was the relationship between total soluble sugars and reducing sugars with infestation is positively correlated with infestation per cent of stem borer. Whereas, the relationship between stem borer infestation percentage and total phenol and ortho-dihydroxy phenol content was negatively correlated.

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