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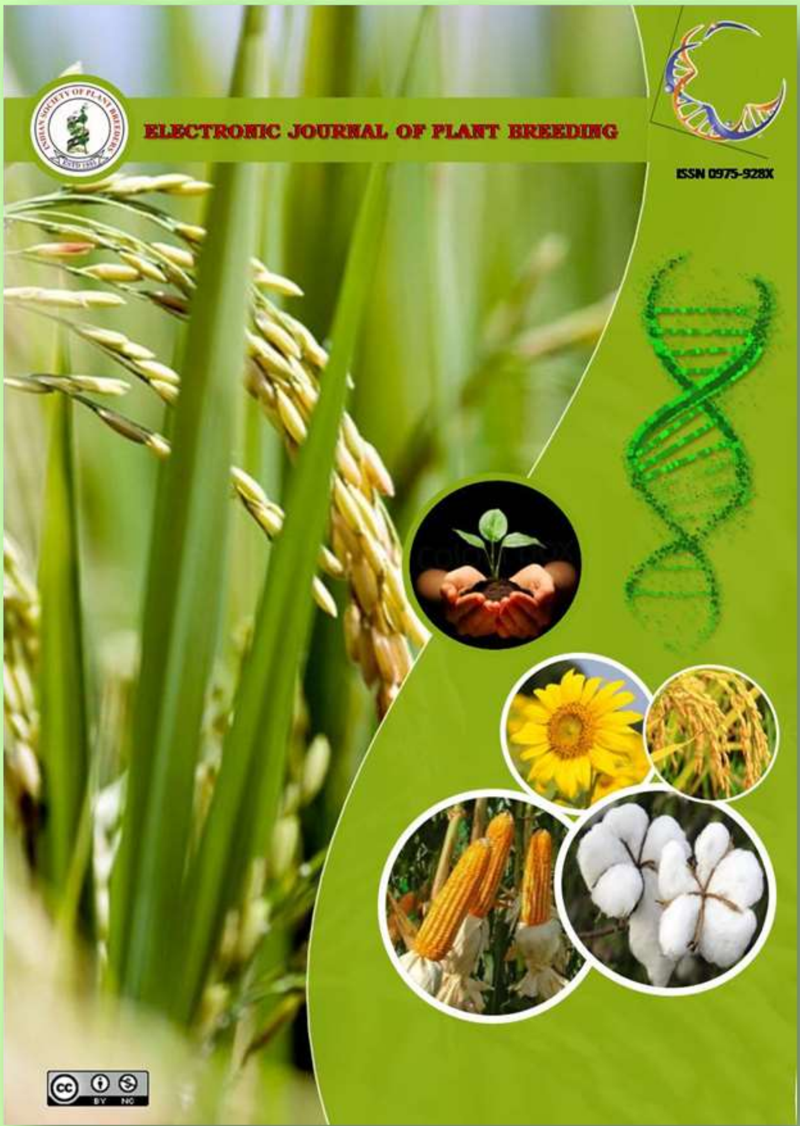

ISSN: 0975-928X

Volume: 10

Number:2

EJPB (2019) 10(2):570-575

DOI: 10.5958/0975-928X.2019.00072.3

Electronic Journal of Plant Breeding, 10 (2): 570-575 (Jun 2019) DOI: 10.5958/0975-928X.2019.00072.3
ISSN 0975-928X

Research Article

Field screening of wild introgressed rice lines for resistance to yellow stem borer, *Scirpophaga incertulas* W.

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(Received: 10 May 2019; Revised: 14 Jun 2019; Accepted: 15 Jun 2019)

Abstract
Rice yellow stem borer (*Scirpophaga incertulas* W), a monophagous pest, is the most destructive pest causing 3 to 95% yield losses in India. Though it accounts for 50 per cent of insecticides used in rice fields, their typical internal feeding behaviour necessitates other management options. In the present study, evaluation of various wild rice lines- wild rice magic population (WRM), derivative of crosses from six species *viz., Oryza rufipogon, O.nivara, O.meridionalis, O.glumaepatula, O.barthi, O.gaberrima, O.longistaminata* and *O.sativa* has been carried out. The results of field screening carried out in 38 wild rice introgressed lines, the entries WRM 2, WRM 6, WRM 10, WRM 12, WRM 14, WRM 43, WRM 44, WRM 45 and WRM 76 were moderately resistant to yellow stem borer. The morphological characters of the entries were recorded and correlated with stem borer damage. It revealed a significant negative correlation for plant height and top internode length for their resistant to yellow stem borer.

Keywords
Rice, yellow stem borer, field screening, mechanism of resistance

Introduction

Rice is an important food crop in the world and India is one of the world's largest producers of rice. Approximately 43 million ha of rice planted area in India accounting for 22 per cent of the world's rice production. Improving the productivity and quality are the key challenges that the farmers are facing as the crops production is being hampered by many abiotic and biotic stresses. Among the biotic stress role of insect pest mainly rice yellow stem borer *Scirpophaga incertulas* Walker is inevitable. Yellow stem borer attacks the crop from seedling to harvest stage and thus causes complete loss of yield (Salim and Masir, 1987). It is observed that the rice yield loss may increase upto 87.66 per cent when the crop is left unsprayed (Pallavi *et al.,* 2017). Management of rice yellow stem borer with insecticides seems challenging and economical due to its internal feeding behavior, monophagous nature of the pest and development of resistance to insecticide. Hence, host plant resistance becomes an important component in the management strategies for yellow stem borer. Evaluation of resistance in various rice cultivars is the prime step towards development of insect resistant varieties. Very few resistance sources are available for evolving stem borer resistant varieties. The complex genetic traits and the inherent problems in screening have made breeding for yellow stem borer resistance a difficult task (Selvi *et al.,* 2002). Moreover, it is observed that the crop wild relatives provide the opportunity to improve the productivity and resilience of agriculture as they contain genes for multitude of useful traits. Keeping these criteria in consideration, present study has been undertaken to identify the resistant source for rice yellow stem borer in the wild introgressed lines. To understand the mechanism of resistance, influence of morphological traits in resistance against rice yellow stem borer was also studied.

Materials and Methods

Field screening of 38 wild introgressed rice lines were carried out at the Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore, India during rabi season of 2016-17. The introgressed lines are known as Wild Rice Magic (WRM) population, is derivatives of crosses from six species *viz., Oryza rufipogon, O.nivara, O.meridionalis, O.glumaepatula, O.barthi, O.gaberrima, O.longistaminata* and *O.sativa* were screened under field condition. The entries were raised in nursery and transplanted in the main field at two rows /entry. Each row comprises of 20 -25 plants and raised in two replications. Along with the test entries resistant check W-1263 and susceptible checks Pusa basmati, TN-1 were included. The recommended agronomic practices were carried out in the field without applying any insecticides. Dead heart and white ear counts were taken at 45 DAP, 80DAP and before harvest and per cent dead heart / white ear were calculated. In each replication five plants were randomly selected and observed for stem borer damage. Per cent dead heart and white ear per cent was assessed by the standard formulae.

$$\text{Dead heart \%} = \frac{\text{No. of dead hearts}}{\text{Total no. of tillers in the particular hill}} \times 100$$

$$\text{White ear \%} = \frac{\text{No. of white ears}}{\text{Total no. of productive tillers in the hill}} \times 100$$

The plant morphological characters *viz*., plant height, stem diameter, top internode length, number of internodes, number of productive tillers, number of filled grains per panicle, number of ill filled grains per panicle and grain yield per plant were recorded in 38 wild introgressed lines raised in the field. In each line, randomly five plants were selected for observation. Three replications were maintained and the plants were selected only after panicle emergence to record morphological characters.

Results and Discussion

The results of field screening experiment revealed that there was significant difference in the stem borer damage for dead heart as well as white ear symptoms (Table.1). Out of 38 introgressed lines screened 21 lines showed nil dead heart damage at 45 DAP and WRM 49 showed maximum damage of 18.46 per cent. Whereas white ear damage observed at 80 DAP revealed that the wild rice introgression lines *viz*., WRM 2, WRM 5, WRM 15, WRM,17 WRM 20 and WRM 76 showed no white ear damage. Observations recorded before harvest reveals that the entries WRM 5, WRM 18 and WRM 44 were found with no white ear damage. WRM 2, WRM 6, WRM 10, WRM 12, WRM 14, WRM 43, WRM 44, WRM 45 and WRM 76 were moderately resistant to yellow stem borer under field screening. In overall stem borer damage observations, WRM 5, WRM 6 and WRM 12 were the entries found with minimum or nil dead heart and white ear damage. In the susceptible check TN-1 and Pusa basmati, 12.5 and 21.72 per cent dead heart damage was recorded respectively. White ear damage was more in Pusa basmati (12.33%). Similarly in resistant check W 1263, minimum dead heart (2.78%) and white ear damage (0 & 1.96 %) were observed. Devasena *et al.* (2017) evaluated the rice genotypes resistance for yellow stem borer under artificial screening method and recorded dead heart damage of 28.00 and 92.00 per cent in TKM-6 and TN-1 respectively. Heinrichs (1988) revealed from field screening that yellow stem borer damage was nil in the wild germplam line IRGC 104068 (*O.barthii*); IRGC 80762A and CR 100438A (*O.rufipogon*); CR 100316, 100318 and 100328 (*O.nivara*); IRGC 105291A (*O. meridionalis*); IRGC 101171 (*O. punctata*); IRGC 103787 (*O. latifolia*), IRGC 104387 (*O. glumaepatula)* and IRGC 105440 (*O.rhizomatis*). Brar *et al.* (2005) reported that *O. longistaminata* accessions were tolerant to yellow stem borer. Padmakumari and Ram (2012) identified donors for rice yellow stem borer tolerance in *O. rufipogon* and *O. glaberrima* accessions. Sarao *et al.* (2013) evaluated 62 wild rice germplasm accessions and observed CR100316 (*O.nivara*) as the one that show low stem borer damage. In the present study also the wild rice introgression lines evaluated were derived from *O.rufipogon*, *O.nivara*, *O. meridionalis, O.barthii, O. glumaepatula, O. longistaminata* and *O. glaberrima.*

Morphological parameters were recorded in 38 wild introgressed lines for their influence on yellow stem borer (Table 3). Plant height was highest in WRM 20 (139.74 cm) as shown in Table 2 and it was lowest in WRM 10 (67.10 cm). The stem diameter was more **(**2.32 cm) in WRM 34 and less in WRM 79 (1.17 cm). Maximum number of internodes was noticed in WRM 54 and WRM 45 (4.00). It was less in WRM 29 (2.20). The top internode length in WRM 72 was maximum (35.6 cm) and minimum in WRM 34 (16.40 cm). More productive tillers of 57.4/plant was recorded in WRM 72 and lowest of 13 productive tillers in WRM 2. Filled grains per panicle were higher in WRM 34 (123.8) and 14.4 in WRM 8. Ill filled grains were highest in WRM 27 (30.2) and WRM 19 (21.6). Grain yield was maximum (30.2 g) per plant in WRM 27. Based on the results, WRM 20 which had maximum height was observed to show their resistance to yellow stem borer in field and artificial screening. Short internode length influences the resistance to yellow stem borer. The internode length was maximum WRM 20 (33 cm) and had minimum field damage in the screening experiment, whereas minimum internode length (16.40 cm) was recorded in WRM 34 showed its susceptibility. Patanakamjorn and Pathak (1967) revealed that tall varieties would be attractive to ovipositing moths. Top internode length also shows a significant negative correlation whereas the stem diameter shows a significant positive correlation in the present study. This shows that larva does not prefer thin stems for feeding and needs stem with more diameter as they have more space and better case for feeding.

Morphological characters of wild rice introgressed lines like plant height, stem diameter, number of internodes and top internode length was correlated with the damage caused by yellow stem borer (Table 3). Plant height (r = -0.501) and top internode length (-0.473) showed a significant negative correlation with the incidence and the remaining parameters had negative non significant correlation (Table 4). This was in agreement with the reports of Saxena (1986) which states that rice genotypes with characters like short plant height, high tiller and thin stem diameter will be resistance against striped stem borer. In contrast to this some reports suggested that plants with wider and longer leaves, a large number of tillers per hill and tall stature appeared more susceptible to stem-borers (Israel, 1967). Patanakamjorn and Pathak (1967) reported that plant height, stem diameter, length and width of the flag leaf were positively correlated with number of eggs laid. The present results suggested that yellow stem borer larva does not prefer thin stems for feeding and needs stem with more diameter as they have more space for feeding.

Acknowledgement
The authors are highly grateful to Late Dr. S.Robin, Professor and Professor & Head, Paddy Breeding Station, Department of Rice, Tamil Nadu Agricultural University, Coimbatore for providing rice lines and their encouragement to conduct the screening trials.

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Table 1. Field screening of wild introgression lines for yellow stem borer resistance

S.No.	Entries	Yellow stem borer damage (%)		
		DH at 45 DAP	WE at 80 DAP	WE before harvest
1	WRM 2	0 (1.28)	0 (1.28)	3.08 (10.1)
2	WRM 5	2.56 (9.21)	0 (1.28)	0 (1.28)
3	WRM 6	0 (1.28)	0.65 (4.62)	1.85 (7.82)
4	WRM 8	5.95 (14.11)	13.16 (21.27)	1.22 (3.64)
5	WRM 10	0 (1.28)	5.61 (13.7)	2.7 (9.46)
6	WRM 12	0 (1.28)	0.67 (4.7)	1.14 (6.13)
7	WRM 14	0 (1.28)	4.88 (12.76)	1.75 (7.6)
8	WRM 15	2.90 (9.81)	0 (1.28)	2.29 (8.7)
9	WRM 16	0 (1.28)	6.82 (15.14)	2.46 (9.02)
10	WRM 17	0 (1.28)	0 (1.28)	3.35 (10.55)
11	WRM 18	3.70 (11.09)	0.83 (5.23)	0 (1.28)
12	WRM 19	0 (1.28)	4.17 (11.78)	3.17 (10.26)
13	WRM 20	0.54 (4.21)	0 (1.28)	5.51 (13.58)
14	WRM 21	5.68 (13.79)	7.14 (15.5)	1.16 (6.18)
15	WRM 22	8.89 (17.35)	4.00 (11.54)	2.65 (9.37)
16	WRM 23	0 (1.28)	4.83 (12.7)	3.27 (10.42)
17	WRM 25	0 (1.28)	5.56 (13.64)	7.06 (15.41)
18	WRM 27	0 (1.28)	3.03 (10.03)	5.26 (13.26)
19	WRM 29	0 (1.28)	13.04 (21.17)	5.05 (12.98)
20	WRM 30	1.45 (6.92)	5.38 (13.41)	3.49 (10.76)
21	WRM 32	0 (1.28)	9.26 (17.72)	3.70 (11.09)
22	WRM 34	0 (1.28)	5.49 (13.55)	6.14 (14.35)
23	WRM 40	0 (1.28)	3.57 (10.89)	2.05 (8.23)
24	WRM 41	3.33 (10.51)	7.27 (15.64)	3.61 (10.95)
25	WRM 43	0 (1.28)	5.00 (12.92)	1.96 (8.05)
26	WRM 44	0 (1.28)	6.25 (14.48)	0 (1.28)
27	WRM 45	4.60 (12.39)	0.96 (5.62)	1.69 (7.47)
28	WRM 47	0 (1.28)	1.62 (7.31)	2.47 (9.04)
29	WRM 49	18.46 (25.45)	1.06 (5.91)	2.56 (9.21)
30	WRM 50	3.03 (10.02)	10.53 (18.94)	6.06 (14.25)
31	WRM 51	6.25 (14.48)	1.32 (6.6)	2.19 (8.51)
32	WRM 52	1.64 (7.36)	2.33 (8.78)	3.64 (10.99)
33	WRM 54	5.26 (13.26)	1.20 (6.29)	3.52 (10.81)
34	WRM 72	0 (1.28)	2.58 (9.24)	2.44 (8.99)
35	WRM 73	2.00 (8.13)	6.98 (15.32)	1.86 (7.84)
36	WRM 75	14.29 (22.21)	3.49 (10.77)	5.56 (13.64)
37	WRM 76	0 (1.28)	0 (1.28)	2.92 (9.84)
38	WRM 79	0 (1.28)	0.97 (5.65)	3.97 (11.49)
	W 1263	2.78 (9.59)	0 (1.28)	1.96 (8.05)
	TN 1	12.50 (20.71)	2.63 (9.33)	2.70 (9.46)
	Pusa basmati	21.72 (4.57)	11.77 (3.40)	12.33 (3.53)
	CD	11.513	8.7378	7.3293
	S.Ed	5.6826	4.3123	3.6172

* The figures in the parenthesis are arc sine transformed values. DH – Dead heart, WE – White ear

Table 2. Morphological parameters of wild introgressed lines

Lines	Plant height (cm)	Stem diameter (cm)	No. of internodes	Top internode length (cm)	No. of productive tillers	No. of filled grains/ panicle	No. of ill filled grains/ panicle	Grain yield/ panicle (g)
WRM 2	88.70 (9.42)	1.60 (1.28)	3.00 (1.75)	23.40 (4.84)	13.00 (3.61)	59.80 (7.73)	12.40 (3.53)	1.27 (1.15)
WRM 5	104.10 (10.20)	1.96 (1.42)	3.20 (1.80)	29.90 (5.47)	15.80 (3.98)	29.00 (5.39)	8.00 (2.84)	1.15 (1.10)
WRM 6	112.10 (10.59)	1.88 (1.39)	3.00 (1.75)	28.40 (5.33)	43.20 (6.54)	39.80 (6.31)	7.40 (2.73)	1.11 (1.08)
WRM 8	80.60 (8.98)	1.78 (1.35)	2.80 (1.69)	28.20 (5.31)	16.40 (4.05)	14.40 (3.80)	5.40 (2.33)	0.27 (0.57)
WRM 10	67.10 ((8.19)	1.32 (1.17)	2.40 (1.57)	21.10 (4.60)	22.20 (4.72)	28.40 (5.33)	6.80 (2.62)	0.87 (0.96)
WRM 12	89.00 (9.43)	2.12 (1.47)	3.40 (1.86)	29.90 (5.47)	35.00 (5.92)	37.80 (6.15)	8.73 (2.96)	0.97 (1.01)
WRM 14	107.30 (10.36)	1.44 (1.22)	3.40 (1.86)	31.78 (5.64)	45.60 (6.76)	38.40 (6.20)	10.20 (3.20)	0.92 (0.99)
WRM 15	88.68 (9.42)	2.12 (1.47)	3.00 (1.75)	28.58 (5.35)	43.60 (6.60)	43.50 (6.60)	9.83 (3.14)	1.43 (1.22)
WRM 16	84.94 (9.31)	1.60 (1.28)	3.00 (1.76)	22.38 (4.74)	24.40 (4.94)	35.50 (5.96)	15.75 (7.13)	0.82 (0.93)
WRM 17	97.40 (9.87)	1.98 (1.42)	3.20 (1.80)	29.90 (5.47)	37.80 (6.15)	71.80 (8.47)	13.40 (3.67)	1.73 (1.33)
WRM 18	107.80 (10.38)	1.86 (1.40)	3.80 (1.96)	28.36 (5.33)	18.80 (4.34)	56.80 (7.56)	7.20 (2.69)	1.43 (1.22)
WRM 19	91.70 (9.58)	1.62 (1.29)	2.80 (1.69)	31.24 (5.59)	25.20 (5.62)	21.60 (4.65)	7.80 (2.80)	0.64 (0.83)
WRM 20	139.74 (11.82)	2.20 (1.50)	3.60 (1.91)	33.00 (5.75)	51.80 (7.20)	73.00 (8.56)	17.60 (4.20)	1.76 (1.35)
WRM 21	84.40 (9.19)	2.18 (1.49)	2.80 (1.69)	24.30 (4.93)	60.40 (7.77)	32.80 (5.73)	33.80 (5.82)	0.92 (0.99)
WRM 22	97.00 (9.85)	1.62 (1.29)	2.80 (1.69)	29.30 (5.42)	25.40 (5.05)	42.20 (6.50)	7.20 (2.69)	1.04 (1.04)
WRM 23	114.60 (10.71)	1.84 (1.37)	3.40 (1.86)	31.90 (5.71)	42.80 (6.54)	74.20 (8.61)	13.80 (3.72)	1.81 (1.36)
WRM 25	84.00 (9.17)	1.64 (1.30)	2.80 (1.69)	28.20 (5.31)	17.00 (4.13)	41.20 (6.42)	6.00 (2.46)	0.97 (1.01)
WRM 27	100.40 (10.02)	1.50 (1.21)	3.20 (1.80)	25.60 (5.66)	15.20 (3.90)	31.80 (5.64)	30.20 (5.50)	0.98 (1.02)
WRM 29	76.70 (8.76)	1.58 (1.25)	2.20 (1.49)	25.30 (5.03)	19.80 (4.45)	28.60 (5.35)	12.00 (3.47)	0.46 (0.71)
WRM 30	96.40 (8.92)	1.88 (1.28)	3.00 (1.76)	24.80 (4.98)	34.40 (5.87)	59.00 (7.68)	5.60 (2.38)	1.18 (1.11)
WRM 32	86.00 (9.23)	2.18 (1.39)	3.20 (1.80)	25.00 (5.00)	16.20 (4.03)	35.00 (5.92)	18.80 (4.34)	0.89 (0.97)
WRM 34	104.80 (10.24)	2.32 (1.49)	3.80 (1.96)	16.40 (4.05)	22.80 (4.78)	123.80 (11.13)	22.8 (4.78)	2.25 (1.52)
WRM 40	95.20 (9.76)	1.90 (1.55)	3.20 (1.80)	25.40 (5.04)	29.20 (5.41)	64.60 (8.04)	16.60 (4.08)	1.15 (1.09)
WRM 41	81.10 (9.01)	1.74 (1.40)	2.80 (1.69)	23.00 (4.80)	16.60 (4.08)	30.00 (5.48)	16.00 (4.00)	0.75 (0.89)
WRM 43	76.50 (8.75)	1.76 (1.34)	2.40 (1.57)	26.30 (5.13)	30.60 (5.53)	29.87 (5.47)	11.23 (3.36)	1.09 (1.07)
WRM 44	99.80 (9.99)	1.98 (1.35)	3.00 (1.75)	29.40 (5.42)	16.40 (4.06)	27.60 (5.26)	9.83 (3.14)	1.33 (1.17)
WRM 45	99.20 (9.96)	1.90 (1.42)	4.00 (2.01)	27.14 (5.21)	35.40 (5.95)	61.00 (7.81)	17.00 (4.13)	1.39 (1.20)
WRM 47	94.60 (9.73)	1.70 (1.40)	3.20 (1.80)	28.40 (5.33)	16.20 (4.03)	42.80 (6.54)	10.37 (3.23)	1.17 (1.10)
WRM 49	82.80 (9.11)	1.76 (1.32)	2.80 (1.69)	24.10 (4.91)	39.00 (6.25)	51.80 (7.20)	3.40 (1.86)	1.21 (1.12)
WRM 50	82.20 (9.07)	1.66 (1.31)	3.00 (1.75)	22.80 (4.78)	13.20 (3.64)	26.20 (5.12)	34.00 (5.83)	0.54 (0.77)
WRM 51	102.60 (10.23)	1.66 (1.31)	3.20 (1.82)	29.20 (5.41)	18.20 (4.27)	41.00 (6.41)	9.80 (3.14)	1.19 (1.11)
WRM 52	99.40 (9.97)	1.92 (1.40)	3.40 (1.86)	28.90 (5.28)	33.00 (5.75)	65.00 (8.06)	15.20 (3.90)	1.62 (1.29)
WRM 54	112.00 (10.59)	1.72 (1.34)	4.00 (2.01)	30.80 (5.55)	26.80 (5.18)	34.40 (5.87)	9.80 (3.14)	0.80 (0.92)
WRM 72	132.6 (11.51)	2.08 (1.46)	3.60 (1.91)	35.60 (5.97)	57.40 (7.58)	57.40 (7.58)	1.40 (1.20)	0.87 (0.96)
WRM 73	92.60 (9.62)	1.06 (1.05)	3.00 (1.75)	22.10 (4.71)	32.20 (5.68)	82.80 (9.10)	6.60 (2.58)	2.03 (1.59)
WRM 75	83.80 (9.15)	1.29 (1.16)	3.60 (1.91)	22.40 (4.74)	25.20 (5.02)	38.00 (6.16)	10.40 (3.23)	0.94 (0.99)
WRM 76	128.00 (11.31)	1.24 (1.14)	3.60 (1.91)	29.00 (5.39)	27.40 (5.24)	54.80 (7.40)	27.80 (5.28)	1.50 (1.24)
WRM 79	105.30 (16.26)	1.17 (1.10)	3.00 (1.75)	26.50 (5.15)	30.20 (5.50)	78.00 (8.83)	15.60 (3.96)	1.80 (1.36)
CD (0.05)	5.211	0.261	0.421	2.421	3.216	5.154	2.154	0.142
SEd	2.801	0.114	0.232	1.143	1.715	2.141	1.715	0.074

***** The figures in the parenthesis are √ x+0.05 transformed values

 DOI: 10.5958/0975-928X.2019.00072.3

Table 3. Correlation of morphological parameters of wild lines with stem borer damage

Morphological parameters	Correlation coefficient (r value)
Plant height (cm)	-0.501*
Stem diameter (cm)	-0.201
No. of internodes	-0.323
Top internode length	-0.473*

*Significant @ p=<0.05