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Evaluation of gall midge interaction and yield attributes of promising genotypes of rice

Lokesh Kumar Singh, KL Painkra, GP Painkra, PK Bhagat and Neelam Chouksey

Abstract
A set of 10 promising genotypes of rice i.e. CUL M9, CR 3006-8-2, CR DHAN 317, Akshayadhan PYL, RP 5587-273-1-B-B-B, KMR3, Suraksha, W1263, RP2068 and TN 1 were assessed against rice gall midge in the field at RMD College of Agriculture and Research Station Ambikapur during Kharif 2022. The result revealed that the rice gall midge infestation as silver shoot was recorded between 0.50 to 21.39% at 30 DAT and 50 DAT. Among 10 genotypes of rice, only two genotypes *viz*., CUL M9 and W1263 were reacted as resistance with <1% SS. Whereas, five genotypes *viz*., CR 3006-8-2, CR Dhan 317, RP5587-273-1-B-B-B, KMR 3 and TN1 were exhibited susceptible with 11-25% SS infestation, and rest of the three genotypes *viz*., Akshayadhan PYL, Suraksha and RP2068 were reacted as moderately resistant with 1-5% SS. The various qualitative characters *viz*., plant height, leaf length, leaf width, No. of trichomes, trichomes position, trichomes length, penical length and No. of grain were showed with wide range of variation in different promising genotypes of rice. The correlation analysis showed that the infestation of rice gall midge at 30 DAT revealed highly significant and positive correlation with incidence of gall midge at 50 DAT (r=0.950**). The infestation of gall midge at 50 DAT showed significant and negative correlation with plant height (r=-0.717*), however trichomes length exhibited significant and negative correlation (r=-0673*) to gall midge infestation. The correlation between plant height and leaf length showed positive correlation (r=0.731*) with each other, however highly significant and negative correlation (r=-0.767**) with leaf width. The correlation between leaf length and number of grain/plant showed positive correlation (r=0.734*) with each other.

Keywords: Gall midge, promising rice genotypes, qualitative parameters

Introduction
The princess of cereals, rice is a life and staple food for 65 per cent of total population in India. It constitutes about 55 per cent of total cereal production. Rice is grown under diverse condition such as irrigated, rainfed lowland, rainfed upland and flood-prone ecosystem. India is the largest rice growing country, while China is the largest producer of rice (Kakde and Patel, 2014) [5].

Rice gall midge (*Orseolia oryzae* Wood-Mason) belongs to order Diptera and family Cecidomyiidae is one of other important major insect pest of rice in Chhattisgarh, and widely distributed in South-East and West Asian countries. The gall midge attacks rice from nursery to the end of tillering stage. The larvae of the gall midge cause heavy damage to the rice crop. Early infestation results in gall formation from the tillers which consequently do not bear panicles. The gall midge remains inactive as a pre pupa in wild rice or weeds during the dry season. At the onset the monsoon, it becomes active and completes one or two generation in grasses before it moves to the rice crop. Seasonal incidence of gall midge commenced in late August, reaching to a peak in September-October and declined in November in the northern hill of Chhattisgarh.

The formation of gall, also known as "Silver shoots" or "Onion shoots," which is a modified leaf sheath, is the typical indication of this pest's attack on rice plants (Hidaka 1974; Hill 1987) [3, 4]. It also results in the production of secondary tillers, which may also become infected. Galls form as a cellular reaction to an irritating salivary gland secretion called "Cecidogen," which leads to abnormal cell proliferation at the site of feeding (Chiu Shin-foon, 1980) [2], grouping of leaf blades during flowering (Rajamani *et al.* 1979) [8], infestation of terminal shoot apix, and tender grains in panicles during flowering stage. The abnormal twisting and curling of the leaf sheaths, the abundance of leaf primordial from the beginning of the panicle until its ripening, etc., make the tiller infertile and prevent it from producing panicles.

The farmers highly rely on synthetic insecticides against destructive insect due to their broad-spectrum activity and rapid killing attributes. However, the excessive use of synthetic chemicals in the field results in severe adverse effects on the agro-ecosystem, human health and wildlife. Many conventional insecticides though have been evaluated against the major pests, yet, most of the chemicals have failed to provide adequate control. Hence, new promising genotypes are being tested for their evaluation with an aim to cause least disruption to environmental quality. For effective management as resistant sources, present study was carried out to have a fair knowledge on interaction of gall midge in different promising genotypes of rice. Keeping in mind the above facts, present investigation entitled "Evaluation of gall midge interaction and yield attributes of the most promising genotypes of rice" was carried out

Material and Methods

The present experiment was conducted to evaluate the gall midge interaction and yield attributes of promising genotypes on rice during Kharif 2022. As per above, 10 rice genotypes were received from the Department of Entomology, ICAR – Indian Institute of Rice Research, Rajendranagar, Hyderabad and were planted with all agronomic package of practices. The experimental details are as follows:-

Experimental detail

Crop: Rice
Variety: 10 genotypes
Date of sowing: 05/07/2022
Date of transplanting: 20/08/2022
Plot size: 5 x 4 m2
Spacing (RxP): 20 x 15 cm
Treatments: 10 cultures
Replication: 3
Design: Randomized Block Design

Table 1: Details of rice cultures

S. No.	Rice Cultures	Designation
1	V1	CULM9
2	V2	CR 3006-8-2
3	V3	CR Dhan 317
4	V4	Akshayadhan PYL
5	V5	RP5587-273-1-B-B-B
6	V6	KMR 3
7	V7	SURAKSHA
8	V8	W1263
9	V9	RP2068
10	V10	TN1

Observations recorded

Observation of pest damages were recorded in 10 plants based on stratified random sampling. Silver shoot was counted at 30 and 50 DAT along with total tillers and infested tillers. For the per cent infestation as silver shoot caused by pest was calculated with the following formula:-

$$\text{Silver shoot or SS (\%)} = \frac{\text{No. of silver shoot}}{\text{Total number of tiller}} \times 100$$

The plant stature at maturity was recorded as plant height, leaf length, leaf width, No. of trichomes, trichomes position, trichomes length, penical length and No. of grain. Correlation coefficient analysis were performed to evaluate relations,

Statistical analysis

The data obtained from the individual plant observations from Randomized Block Design experiment and analyzed statistically as per the standard procedure.

Result and Discussion

Rice gall midge (*Orseolia oryzae* Wood-Mason) is the most significant pests of the rice crop in Chhattisgarh particularly in the Surguja districts. The outcome showed that the gall midge was a significant pest during the crop growth periods.

Incidence percentage of rice gall midge as silver shoot at 30 DAT

The result revealed that the damage percentage of gall midge as silver shoot ranged between 0.00 to 21.69% and scoring was both highly resistant and vulnerable at 30 DAT. Among 10 genotypes, one genotype of rice i.e. W 1263 found to be nil damage of silver shoot and scored as highly resistant to gall midge damage (0% SS), two genotypes of rice i.e. CUL M9 and Akshayadhan PYL reacted as resistant, (<1% SS), and two other genotypes i.e. Suraksha and RP2068 were discovered to have a moderate level of resistance to gall midge occurrence (1-5% SS).Gall midge damage was shown to be genotypes CR 3006-8-2, CR Dhan 317, KMR 3 and TN1 were found to be maximum damage (11-25% SS) and categorized as susceptible and remaining one genotype i.e., RP 5587-273-1-B-B-B was found to be moderately susceptible with (6-10% SS) damage.

Incidence percentage of rice gall midge as a silver shoot at 50 DAT

At 50 DAT, the incidence per cent of silver shoot was varied between 0.69 (Resistant) to 22.85 (Susceptible), which are presented in Table 2. Out of 10 rice genotypes, one rice genotype reacted as resistant (<1% SS) *viz.*, CUL M9; three rice genotypes reacted as moderately resistant (1-5% SS) *viz.*, Akshayadhan PYL, Suraksha, W1263; one rice genotypes reacted as moderately susceptible (11-25% SS) *viz.*, RP2068, while four rice genotype *viz*., CR 3006-8-2, CR Dhan 317, RP 5587-273-1-B-B-B, KMR 3 and TN1 were reacted as susceptible (11-25% SS).

Overall mean incidence percentage of rice gall midge as a silver shoot (at 30 DAT and 50 DAT)

The average damage of per cent silver shoot caused by gall midge varied between 0.50 to 21.39 at 30 DAT and 50 DAT. Among 10 genotypes of rice, only two genotypes *viz.*, CUL M9 and W1263 were reacted resistance (<1% SS). Whereas, five genotypes reacted as susceptible (11-25% SS) *viz.*, CR 3006-8-2, CR Dhan 317, RP5587-273-1-B-B-B, KMR 3 and TN1, while three genotypes *viz.*, Akshayadhan PYL, Suraksha, and RP2068 were reacted moderately resistant (1-5% SS) to gall midge. The current findings more or less supported with the work of Sumathi and Manickam (2013) [9] who reported that among the 17 genotypes, two genotypes *viz*., ARC 6605 and INRC 3021 were nil gall midge damage, and showed resistant, whereas five genotypes *viz*., Phalguna, Madhuri L9, Abhaya, RP 2068-18-3-5 and Aganni were found highly susceptible. The check variety TN 1 noticed 14.7% damage and found to be susceptible. Similar findings are also reported by Kumar (2021) [6] who assessed that out of 21 rice genotypes, two genotypes *viz*., Kavya and W 1263 were found nil damage to gall midge and scored as highly resistant. Three genotypes *viz*., Aganni, INRC 15888 and RP 5923 were recorded in the resistant category with up to 1% damage score. But the current findings revealed that sum of

10 rice genotypes, the two genotypes *viz*., CUL M9 and W 1263 were recorded (<1%) damage to gall midge and exhibited resistant. Similarly, the check genotypes *viz*., TN 1 was also found susceptible with maximum silver shoot damage. The genotypes recorded with less percent of silver shoot caused by gall midge of present study can be used as donors, and further selection can be made for resistant or susceptible varieties for rice gall midge based on the experimental studies.

Study of the qualitative parameters in term of yield in different genotypes of rice

The various qualitative characters showed with wide range of variation in different genotypes of rice under studied, which are furnished in Table 3. Among different qualitative characteristics, the plant height for the rice genotypes was recorded with very smallest to tallest. The two genotypes *viz*., CR Dhan 317 (76.60 cm) and CR 3006-8-2 (79.20 cm) were showed very smallest plant height, while seven genotypes *viz*., TN1, RP2068, RP5587-273-1-B-B-B, W1263, Akshaydhan PYL, KMR 3 and Suraksha were recorded medium plant height (with 101.20, 102.60, 102.80, 109.20, 111.00, 112.00 and 112.80 cm, respectively). However, CUL M9 genotype exhibited tallest plant height (131.60 cm). Leaf length highest in genotype CUL M9 (50.40 cm) followed by KMR 3 (47.80 cm) and Akshaydhan PYL (47.80 cm) but lowest leaf length recorded from CR 3006-8-2 (28.80 cm). Rests of the genotypes were moderately length. Leaf width revealed that no significant difference observed but the maximum leaf width noticed from genotypes Akshayadhan PYL (1.48 cm) followed by CR Dhan 317 (1.46 cm) while, lowest leaf width recorded from genotype W 1263 (0.98 cm). No. of trichomes were significant variable from genotype to genotype, the highest number of trichomes were recorded in genotype RP2068 (131 cm) and lowest number of trichomes CR3006-8-2 (19 cm). Trichomes positions were found straight in CUL M9, CR 3006-8-2, CR Dhan 317, W 1263, RP2068 and TN1 while, sleeped in Akshayadhan PYL, RP5587-273-1-B-B-B, KMR 3 and Suraksha. Similarly, trichomes length was noticed small in CR 3006-8-2, CR Dhan 317, RP5587-273-1-B-B-B, KMR 3, Suraksha, RP2068 and TN1 and medium trichomes length was observed in CUL M9, W 1263 while longest trichomes length was in Akshayadhan PYL genotype. Qualitative character of panical length was recorded with the ranges of 18.40 to 23.80 cm. Among all, the four genotypes *viz*., TN1, CR Dhan 317, RP2068 and W1263 were recorded as small panical length (with 18.40,18.60, 19.40 and 19.60 cm respectively) and five genotypes *viz*., RP5587-273-1-B-B-B, CR 3006-8-2, Suraksha, KMR 3 and CUL M9 were medium panical length with 21.00, 22.00, 22.00, 22.20 and 22.80 cm, respectively. However, Akshaydhan PYL genotype was recorded longest panical length (23.80 cm). The maximum number of grains observed in RP2068 genotype (149.20/plant) followed by CUL M9 (142.80/plant) and Akshaydhan PYL genotype (142.20/plant) while, four genotypes *viz*., KMR 3, TN1, RP5587-273-1-B-B-B and CR Dhan 317 were recorded as moderate number of grains with 136.80, 135.00, 132.20 and 129.40/plant, respectively. While three genotypes *viz*., CR 3006-8-2, Suraksha and W1263 were recorded as least nnumber of grain/plant (119.00, 108.20 and 101.20, respectively).

Correlation coefficient between insect-pests infestations and qualitative characters in different promising genotypes of rice

Determination of correlation co-efficient (r) was provided the information how insect-pests infestation depends on qualitative parameters in different genotypes of rice (Table 4). The result of correlation analysis showed that the infestation of rice gall midge at 30 DAT revealed highly significant and positive correlation with incidence of gall midge at 50 DAT (r = 0.950**). The infestation of gall midge at 50 DAT showed significant and negative correlation with plant height (r = -0.717*), however trichomes length exhibited significant and negative correlation (r = -0673*) to gall midge infestation at 50 DAT. The infestation of stem borer at 30 DAT, 50 DAT and white earhead had showed non-significant correlation with each other. The correlation between plant height and leaf length showed positive correlation (r=0.731*) with each other, however highly significant and negative correlation (r=-0.767**) with leaf width. The correlation between leaf length and number of grain/plant showed positive correlation (r=0.734*) with each other. The present result partially agrees with the previous finding of Bashir *et al.* (2013) [1] who reported that a significant positive correlation (P=0.05) between percentage gall midge infestation at 42 and 63 DAT, But negative correlation (P=0.05) between percentage gall midge infestations at 63 DAT with number of panicle squared meter. Grain yield did not correlate significantly (P=0.05) with percentage gall midge infestation at 42 and 63 DAT. This result is dissimilar to the findings of Ogunbayo *et al.* (2010) [7] who indicated that the AfRGM is highly significantly associated with panicle/m^2.

Table 2: Reaction of rice gall midge (as per cent silver shoot) on different promising genotypes of rice during Kharif – 2022

S. No.	Treatment details	Gall midge infestation (% SS)			Damage Score	Reaction
		30 DAT	50 DAT	Overall mean		
1	CUL M9	0.32 (1.13)	0.69 (1.25)	0.50 (1.19)	1	R
2	CR 3006-8-2	15.88 (4.05)	20.28 (4.56)	18.06 (4.30)	7	S
3	CR Dhan 317	14.43 (3.92)	22.85 (4.88)	18.64 (4.40)	7	S
4	Akshayadhan PYL	0.62 (1.23)	1.73 (1.64)	1.17 (1.43)	3	MR
5	RP 5587-273-1-B-B-B	10.14 (3.31)	14.62 (3.95)	12.38 (3.63)	7	S
6	KMR 3	21.69 (4.72)	19.97 (4.57)	20.83 (4.64)	7	S
7	Suraksha	1.25 (1.45)	3.37 (2.06)	2.31 (1.76)	3	MR
8	W1263	0.00 (1.00)	1.69 (1.57)	0.84 (1.28)	1	R
9	RP2068	2.22 (1.58)	6.69 (2.69)	4.46 (2.14)	3	MR
10	TN1	21.33 (4.66)	21.46 (4.73)	21.39 (4.69)	7	S
CD		7.98 (1.10)	5.55 (0.82)	6.77 (0.96)	-	-
SE(m)		2.66 (0.36)	1.85 (0.27)	2.26 (0.32)	-	-

The data are parenthesis in square root transformed value √x+0.5

(DAT = Day after transplanting, HR - Highly Resistant, R - Resistant, MR - Moderately Resistant, MS - Moderately Susceptible, S - Susceptible, HS - Highly Susceptible)

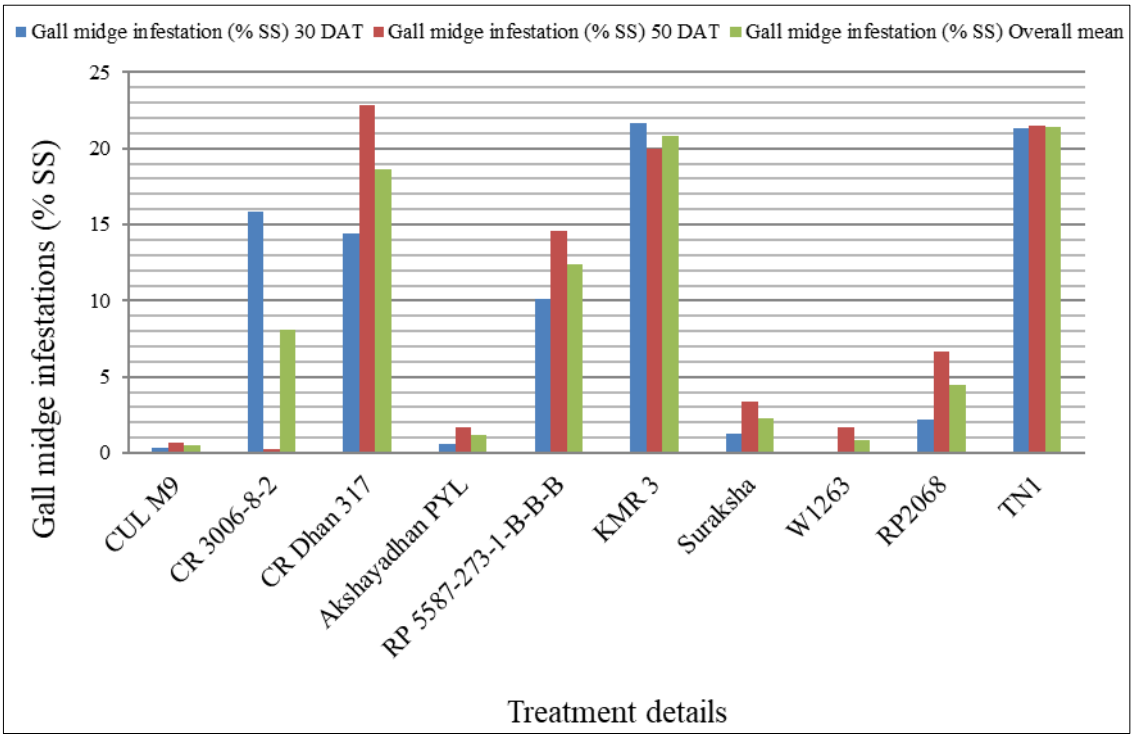

Fig 1: Reaction of rice gall midge (as per cent silver shoot) on different promising genotypes of rice during Kharif – 2022

Table 3: Reaction of insect-pests infestations and qualitative characteristics of promising rice genotypes during Kharif 2022

Tr. No.	Treatment details	Gall midge (% SS) at 30 DAT	Gall midge (% SS) at 50 DAT	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	No. of trichomes /cm	Trichomes position	Trichomes length (mm)	Panical length (cm)	No. of grain/ plant
V_1	CUL M9	0.32	0.69	131.60	50.40	1.00	38	1	3	22.80	142.80
V_2	CR 3006-8-2	15.88	20.24	79.20	28.80	1.74	19	1	1	22.00	119.00
V_3	CR Dhan 317	14.43	22.85	76.60	35.68	1.46	49	1	1	18.60	129.40
V_4	Akshayadhan PYL	0.62	1.73	111.00	47.30	1.48	59	3	5	23.80	142.20
V_5	RP5587-273-1-B-B-B	10.14	14.62	102.80	39.32	1.38	25	3	1	21.00	132.20
V_6	KMR 3	21.70	19.97	112.00	47.80	1.22	21	3	1	22.20	136.80
V_7	Suraksha	1.25	3.37	112.80	39.52	1.24	46	3	1	22.00	108.20
V_8	W 1263	0.00	1.69	109.20	32.26	0.98	32	1	3	19.60	101.20
V_9	RP2068	2.22	6.69	102.60	44.20	1.38	131	1	1	19.40	149.20
V_{10}	TN1	21.33	21.46	101.20	40.90	1.30	60	1	1	18.40	135.00

Trichomes position as Straight = 1 and Sleeped = 3, Trichomes length as Small length = 1, Medium length = 3 and Longest length = 5

Table 4: Correlation coefficient between the insect-pests infestations and qualitative characteristics of promising rice genotypes during Kharif 2022

S. No.	Correlation	1	2	3	4	5	6	7	8	9	10
1	Gall midge (% SS) at 30 DAT	1									
2	Gall midge (% SS) at 50 DAT	0.950^{**}	1								
3	Plant height (cm)	-0.504^{NS}	-0.717^{*}	1							
4	Leaf length (cm)	-0.170^{NS}	-0.335^{NS}	0.731^{*}	1						
5	Leaf width (cm)	0.377^{NS}	0.524^{NS}	-0.767^{**}	-0.376^{NS}	1					
6	No. of trichomes /cm	-0.312^{NS}	-0.236^{NS}	0.011^{NS}	0.284^{NS}	0.069^{NS}	1				
7	Trichomes position	-0.035^{NS}	-0.130^{NS}	0.306^{NS}	0.352^{NS}	0.046^{NS}	-0.270^{NS}	1			
8	Trichomes length (mm)	-0.595^{NS}	-0.673^{*}	0.464^{NS}	0.335^{NS}	-0.232^{NS}	-0.019^{NS}	0.123^{NS}	1		
9	Panical length (cm)	-0.307^{NS}	-0.431^{NS}	0.480^{NS}	0.416^{NS}	0.049^{NS}	-0.353^{NS}	0.584^{NS}	0.516^{NS}	1	
10	No. of grain/plant	0.124^{NS}	0.092^{NS}	0.175^{NS}	0.734^{*}	0.163^{NS}	0.491^{NS}	0.014^{NS}	0.102^{NS}	0.116^{NS}	1

** = Significant at 1% probability level,
*= significant at 5% probability level.

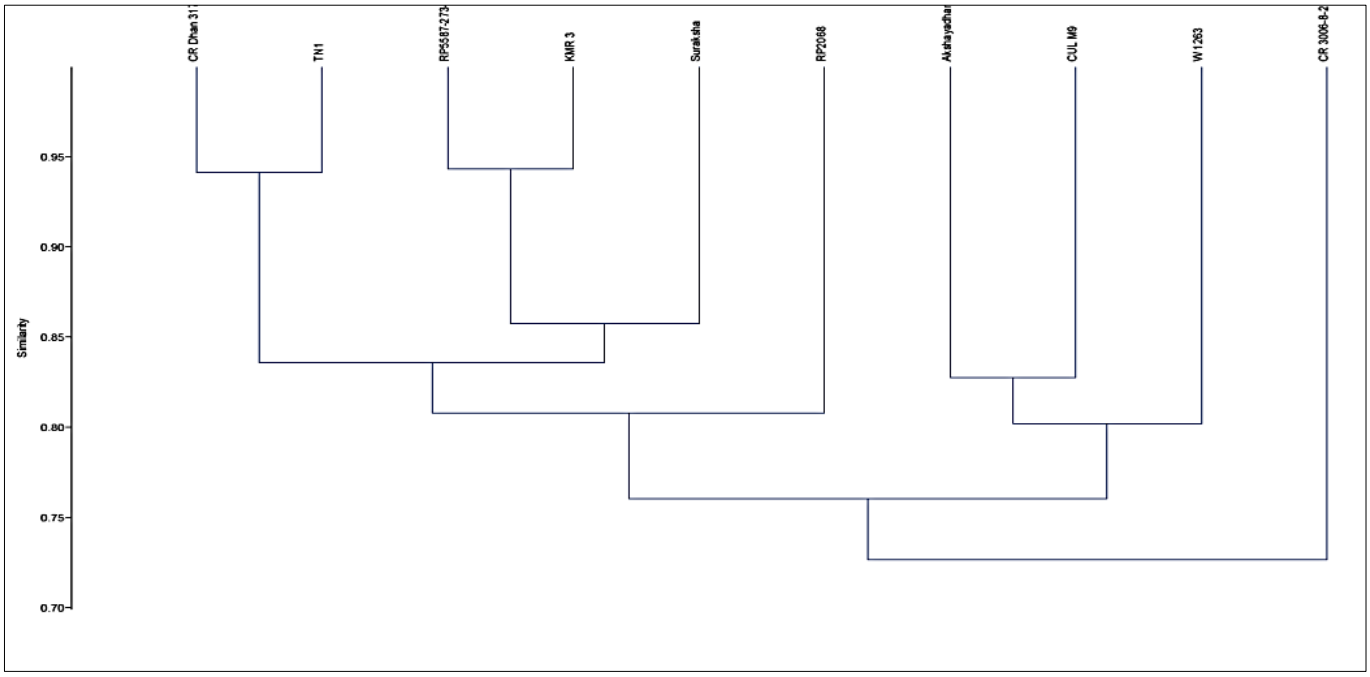

Fig 2: Dandrogram of 10 rice genotypes constructed by qualitative characterization

Conclusions

On the basis of obtained results following conclusions can be drawn

- The gall midge and stem borer were observed as the most significant pests in the 10 promising genotypes of rice during Kharif 2022. The two genotypes *viz*., CUL M9 and W1263 were recorded minimum gall midge infestation with <1% SS, whereas five genotypes *viz*., CR 3006-8-2, CR Dhan 317, RP5587-273-1-B-B-B, KMR 3 and TN1 were observed maximum infestation with 11-25% SS at 30 DAT and 50 DAT.
- The various qualitative characters *viz*., plant height, leaf length, leaf width, No. of trichomes, trichomes position, trichomes length, panical length and No. of grain were showed with wide range of variation in different promising genotypes of rice.

The correlation analysis showed that the infestation of rice gall midge at 30 DAT revealed highly significant and positive correlation with incidence of gall midge at 50 DAT (r=0.950**). The infestation of gall midge at 50 DAT showed significant and negative correlation with plant height (r=-0.717*), however trichomes length exhibited significant and negative correlation (r=-0673*) to gall midge infestation.

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