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To study the inheritance pattern and allelic interactions of the two resistant verieties Abhaya and Jhitpiti for the gall midge

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Abstract
The present study was carried out at the Research and Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *kharif* 2007, *rabi* 2007-08 and *kharif* 2008. The experimental material consisted of parents, F_1, and F_2 of the each crosses (i.e. Abhaya x Swarna and Jhitpiti x Swarna, respectively), the crosses between F_1's (Abhaya x Swarna // Jhitpiti x Swarna) and F_2 recombinant population of this cross. The experimental material consisted of Abhaya and Jhitpiti gall midge resistant varieties along with one ergonomically superior but gall midge susceptible variety i.e., Swarna. The screening test revealed that Abhaya and Jhitpiti varieties were resistant against gall midge, whereas Swarna was susceptible. Inheritance study reported the presence of single dominant gene for gall midge resistance in Abhaya and Jhitpiti. Allelic studies revealed the ratio 15 R: 1 S indicated that the gene governing resistance in Abhaya and Jhitpiti were independent resistant genes.

Keywords: Rice, Gall midge, *Gm2*, *Gm4*, Resistant gene

Introduction
Rice is grown in the varied climatic conditions at the high rainfall area to the driest area of the world. India, the second largest producer after China nearly occupies a a total harvested area of about 156 million hectare, producing more than 680 million tonnes grain annually(Anonymous 2010). The increase in the rice production in the country is due to the development of high yielding semi dwarf verities of rice and increase in their acreage over the country. In the present scenario due to the cultivation of only few popular verities all over the world had reduced the genetic variability of the rice genotypes resulted in the vulnerability of the crop to diseases and insect-pests. In India, annual yield losses due to insects have been calculated to vary from 28% (Kalode, 1987) to 35% (Way, 1976). Among these major insects, the gall midge alone causes a damage of more than US $ 700 million annually (Herdt, 1991). Although many resistant genes for rice gall midge have been identified in rice germplasm, it has been difficult to develop varieties with long lasting or stable resistance due to high degree of variability in the insect. Moreover resistance varieties, particularly those carrying single gene for resistance, often break down (become susceptible) due to inadequate screening and / or due to emergence of new biotype. Keeping in view for confirmation the screening of the two important resistant varieties was carried along with allelic interaction between them.

Materials and Method
The present study was carried out at the Research and Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *kharif* 2007, *rabi* 2007-08 and *kharif* 2008. The experimental material consisted of parents, F_1, and F_2 of the each crosses (i.e. Abhaya x Swarna and Jhitpiti x Swarna, respectively), the crosses between F_1's (Abhaya x Swarna // Jhitpiti x Swarna) and F_2 recombinant population of this cross. The inheritance of entries Abhaya and Jhitpiti were studied to confirm the gene carrying by them and to know the allelic relationship between them. F_1's of the crosses (Abhaya x Swarna, Jhitpiti x Swarna and their reciprocals) were available in the gall midge screening project. The sowing of parents, F_1's and all the testing materials were delayed up to last week of July (27th-30th July) and the transplanting was completed in the last week of August so as to ensure the population build up of the gall midge which occur after September month in the region. Each screening materials were space planted in separate blocks. Each plot were surrounded by two rows of gall midge susceptible purple leaf variety 'Shyamla' as 'spreader row' to ensure the uniform gall midge infestation throughout field, since gall midge incidence is quite high on this variety. Besides

these fertilizers doses were also alliterated for maximum build up of the insect population.

Results and Discussion

The inheritance studies were carried out in varieties, Abhaya and Jhitpiti. These varieties were crossed with a gall midge susceptible variety Swarna which is otherwise ergonomically very well established. Since, Swarna did not possess any resistant gene, the crosses involving it as one of the parents, gave an idea of the number and nature of resistant gene(s) present in test variety. The crosses between both of the resistant varieties Abhaya and Jhitpiti gave information on allelic nature of the resistant genes present in them.

The present study was under taken to confirm the gene(s) for resistance present in varieties viz., Swarna, Abhaya and Jhitpiti. The hundred per cent hill damage was observed in susceptible variety (Shyamla) on plant basis indicating that the gall midge population was adequate to undertake genetic studies. Varieties Abhaya and Jhitpiti were observed to be resistant against gall midge biotype-1 existing in Raipur whereas, variety Swarna and Shyamla showed highly susceptible against this biotype. Varieties Abhaya (*Gm 4*), Jhitpiti (*Gm 8*) and Swarna were screened in the field during *kharif* 2007 and *kharif* 2008 (Table 1) for there reaction against gall midge. Varieties Abhaya and Jhitpiti showed 100 percent resistant reaction during all years (Table 1). The susceptible variety, Swarna consistently showed susceptible reaction during the screening.

Although the genes *Gm 4* and *Gm 8* are known for their resistant gene they carry but to understand their inheritance, allelic relation, and to find their reaction with molecular markers new crosses were made.

The F_1 and F_2 generations of the crosses between the varieties Abhaya, Jhitpiti and the susceptible variety, Swarna were screened for gall midge reaction. The results are presented in Table 2. All the crosses i.e., Abhaya x Swarna and Jhitpiti x Swarna showed resistant reaction in F_1 and individual F_2 populations segregated in 3 resistant: 1 susceptible ratio. This indicated and confirms that resistance in each test variety was controlled by a single dominant gene. The presence of single dominant gene for resistance in Abhaya had also been reported by Shrivastava *et al.* (1995), Bose (1996), Shrivastava (1998) and Mishra *et al.* (1999). Similarly, the monogenic dominant inheritance in Jhitpiti confirms the findings of Kumar *et al.* (2000), Gauraha *et al.* (2004) and Jadhav *et al.* (2006).

Allelic test is an important tool to identify the diverse sources of resistance. This test determines whether the gene(s) present in different varieties are the same or different. Screening results for allelic test are presented in Table 2. Allelic relationship of gene present in Abhaya with Jhitpiti was studied in the F_2 progeny of cross Abhaya x Swarna // Jhitpiti x Swarna. The F_2 progenies of these crosses segregated in 15 Resistant: 1 Susceptible ratio, indicating the segregation of two independent dominant genes. This confirms the findings of previous works reported by Chaudhary *et al.* (1985), Mishra (1990), Sahu (1991), Kumar, A. (1992), Shrivastava *et al.* (1993), Shrivastava *et al.* (1995), Bose (1996) and Shrivastava (1998).

The present finding reveled that the available varieties Abhaya and Jhitpiti are the resistant varieties carrying the two dominant genes, identified by various workers as *Gm 2* resistant genes for Abhaya and *Gm4* for Jhitpiti. The allelic interaction result showed that the two genes are different in the varieties and segregate independently.

Table 1: Reaction of parental varieties to gall midge during *kharif* 2007 and 2008

S.No.		Number of Plants evaluated									
		Total		Resistant		Susceptible		% Susceptibility		Remark	
		2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
1	Swarna	100	100	0	0	100	100	100	100	S	S
2	Abhaya	100	100	100	100	0	0	0	0	R	R
3	Jhitpiti	100	100	100	100	0	0	0	0	R	R

Table 2: Gall midge reaction to F_1 and F_2 progenies between resistant and susceptible test varieties

		F_1		F_2					
		No. of Plants	Reaction against gall midge	No. of Resistant Plants	No. of Susceptible Plants	Total	Ratio	X^2 value	P value
1.	Abhaya x Swarna	15	R	3760	1340	5100	3:1	0.441	0.60-0.50
2.	Jhitpiti X Swarna	15	R	3580	1250	4830	3:1	0.199	0.70-0.50
3.	Abhaya x Swarna // Jhitpiti X Swarna	12	R	4650	360	5010	15:1	0.748	0.50-0.30

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