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Short communication

Inheritance of downy mildew resistance in cauliflower (Group I)

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Cauliflower is an important vegetable grown for its nutritive value as well as for its value added foods in the processing sector. Among the various diseases infecting cauliflower, downy mildew caused by *Peronospora parasitica* (Pers. Fr.) is a serious disease which not only affects young seedlings, transplanted crop but also produces damaging abnormalities in the inflorescences of seed crops. Though, there is considerable work done in mid and late cauliflowers, work has been scanty in the direction of developing early cauliflower varieties resistant to downy mildew. Resistant sources against downy mildew in early group of cauliflower have been identified at the Indian Institute of Horticultural Research, Bangalore but genetics of inheritance of downy mildew resistance has not been worked out. However, information on this line will be useful in planning a systematic breeding procedure to incorporate the downy mildew resistance into the susceptible cultivars.

To study the inheritance of downy mildew resistance, six susceptible x resistant crosses namely, IIHR-382 x IIHR-260-1, IIHR-379 x IIHR-260-1, IIHR-368 x IIHR-260-1, IIHR-382 x IIHR-305, IIHR-389 x IIHR-305 and IIHR-311-3 x IIHR-305 were made during Rabi 2005-06 and the F_2 and back cross populations of each of the six crosses were produced during Rabi 2006-07. Six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of each of the six crosses were evaluated for inheritance studies in RBD with two replications during Rabi 2007-08 under natural epiphytotic conditions. The crop was densely planted, compared to the normal one and frequently irrigated to maintain the micro-climate, favouring the disease development. The susceptible line 'IIHR- 73-24' has been planted all around the experimental plot and at regular intervals in the plot to act as infector rows. To increase the inoculum load, the diseased leaves collected from other fields were also lined up in between rows. All the cultural practices except fungicidal sprays were employed to raise the crop. During January, 2008, when the natural conditions favored the disease incidence and development, the data was recorded as percentage incidence on 10 plants from P_1, P_2, 20 plants from BC_1 and BC_2 and 100 plants from F_2 generation of each cross in each replication. For biometrical analysis, the data on downy mildew incidence (%) were subjected to angular transformation (Fisher and Yates, 1956). To determine the presence or absence of non-allelic interactions, scaling test suggested by Mather (1949) has been used. In the presence of non-allelic interaction the data has been analyzed statistically as per the six generation mean model suggested by Hayman (1958) to find out the inheritance of downy mildew resistance. Three-parameter model suggested by Jinks and Jones (1958) was used in the absence of non-allelic interaction.

The data on scaling test for the three crosses namely, IIHR-382 x IIHR-260-1, IIHR-379 x IIHR-260-1 and IIHR-368 x IIHR-260-1 (wherein IIHR-260-1 is the resistant male parent) revealed that none of the scales were significant in the crosses IIHR-382 x IIHR-260-1 and IIHR-368 x IIHR-260-1 indicating the absence of epistatic interaction gene effects (Table 1). Among the main gene effects, in IIHR-382 x IIHR-260-1 additive gene effects were significant indicating that selection may be employed for the improvement of this trait where as in IIHR-368 x IIHR-260-1, none of the additive or

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Table 1: Scaling tests in six crosses for downy mildew incidence in early cauliflower

Cross	A	B	C	D
IIHR-382 x IIHR-260-1	1.57 ± 10.15	-10.74 ± 9.63	-4.50 ±21.43	2.34±5.13
IIHR-379 x IIHR-260-1	10.73 ± 8.83	26.85**± 3.46	30.15**±8.28	-3.71±4.94
IIHR-368 x IIHR-260-1	-1.40 ± 12.38	2.89 ± 11.06	- 26.74 ±21.50	-14.11±9.80
IIHR-382 x IIHR-305	-11.74 ± 7.46	-6.27* ± 2.09	7.48** ±3.35	12.74**±3.72
IIHR-389 x IIHR-305	-15.97 ± 9.07	-6.05 ± 3.85	-27.46**±7.31	-2.72±6.01
IIHR-311-3 x IIHR-305	-42.20** ±1.60	-2.92 ± 1.50	-18.21**±4.88	13.46**±2.44

A-additive, B-Dominance, C-dominance x dominance, D -additive x additive gene interaction, * P=0.05 ** P=0.01

Table 2: Estimates of genetic components of six crosses in early cauliflower for resistance against downy mildew

Crosses	m	d	h	i	j	l	Epistasis
IIHR-382 x IIHR-260-1	31.08**±10.29	12.51**±0.76	7.64±24.00	-	-	-	
IIHR-379 x IIHR-260-1	30.39**±1.36	-0.64±4.12	-1.08±10.36	-122.86**±9.84	-8.06±4.27	88.84**±18.45	Duplicate
IIHR-368 x IIHR-260-1	23.94±20.29	8.17±5.28	29.46±49.10	-	-	-	
IIHR-382 x IIHR-305	26.24**±0.24	3.62±3.69	-28.86**±7.61	-97.72**±7.33	-2.73±3.72	111.94**±15.13	Duplicate
IIHR-389 x IIHR-305	19.05**±1.77	4.53±4.85	-1.10±12.05	-67.13**±11.54	-4.96±4.93	121.76**±20.73	Duplicate
IIHR-311-3 x IIHR-305	14.99**±1.15	-14.22**±0.82	-36.84**±4.95	-88.39**±4.73	-19.64**±1.02	21.27**±5.88	Duplicate

* P=0.05 ** P=0.01

dominance gene effects were significant (Table 2.). However, in case of the cross, IIHR-379 x IIHR-260-1, additive x additive and dominance x dominance interaction effects were significant indicating the importance of both additive and dominance gene action in controlling the resistance against downy mildew. Further the opposite sign of 'h' and 'l' indicates the duplicate nature of epistasis. However, Mahajan *et al.* (1995) in late group of cauliflower and Paula *et al.* (2003) in broccoli have reported that the inheritance of downy mildew resistance is governed by single dominant gene.

In another set of three crosses namely, IIHR-382 x IIHR-305-1, IIHR-389 x IIHR-305-1, and IIHR-311-3 x IIHR-305-1 involving IIHR-305-1 as male parent, at least one of the ABCD scales were significant (Table 1). This indicates the presence of epistatic interaction effects in controlling the inheritance of downy mildew resistance in these crosses. Among the main gene effects, dominance gene effects were significant in the cross IIHR-382 x IIHR-305-1 and both additive and dominance gene effects were significant in the cross IIHR-311-3 x IIHR-305-1. Further the additive x additive and dominance x dominance epistatic components were highly significant in all these crosses indicating the importance of both additive and dominance gene action in controlling the resistance against downy mildew (Table 2). All these crosses expressed duplicate type of epistasis which may hinder the process of selection.

To conclude, in majority of the crosses, both the additive and non-additive gene effects were found to be equally important in the inheritance of downy mildew resistance. For this reason, a breeding procedure which could exploit both kinds of gene action would be appropriate for improvement. Further such procedure should also cater for the duplicate epistasis found in these crosses which generally hinders improvement through selection. Hence, in the present situation reciprocal recurrent selection appears to be the appropriate breeding plan for the development of the downy mildew resistant varieties in early group of cauliflower.

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