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Genetics of resistance to Karnal bunt of wheat [*Neovossia indica* (Mitra) Mundkur]

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Abstract

Embryos excised from seeds of six generations (P_1, P_2, F_1, BC_1, BC_2 and F_2) of a wheat cross HD29 x HD2329 were cultured on modified MS medium in petriplates already inoculated with secondary sporidia of Karnal bunt of wheat [*Neovossia indica* (Mitra) Mundkur]. Significant variation for callusing response (CR) (45.55-76.66%) was observed among generations. Presence or absence of *N. indica* did not affect callusing response. A clear inhibition zone (IZ) was formed around each of the embryo showing callusing, the diameter of IZ varied significantly among generations. It was maximum (3.70 cm) in HD29, the resistant genotype. *N. indica* was also cocultured with just initiated calli (from embryos). Fresh weight and dry weight of calli (observed after 30 days), also varied significantly among generations. Generation mean analysis indicated that three-parameter model was inadequate for CR, fresh weight and dry weight. Six-parameter model showed that in presence of *N. indica* additive, and additive x dominance effects were significant for CR, however, in absence of *N. indica* only additive effects were significant. Duplicate type of epistasis for fresh weight of calli and dominance and dominance x dominance effects for dry weight of calli were observed in presence of *N. indica*. Only additive gene effects were significant for diameter of IZ in both three and six parameter model, therefore, selecteion might be helpful for improving resistance to *N. indica*.

Key words: Wheat, Karnal bunt, *Neovossia indica*, callusing, coculturing, fresh and dry weights of calli

Introduction

Karnal bunt of wheat [*Neovossia indica* (Mitra) Mundkur] infects the developing grain and replaces its infected portion with masses of fishy smelling fungal spores thus deteriorating the grain quality. Screening against it, is carried out by creating artificial epiphytotic conditions at boot leaf stage, but it is time and labour consuming. Efforts have been made to see the possibility of *in vitro* screening. Arya [1] and Tandon *et al.* [2] cultured wheat embryos in presence of *N. indica*. A circular inhibition zone was formed around the embryos in which no growth of the pathogen could be observed. Diameter of inhibition zone was different in different genotypes. The present investigations were planned to study the nature and magnitude of gene effects for inhibition zone formed by wheat embryos and callusing response both in presence and absence of *N. Indica* and also to see the effect of *N. indica* on callus growth.

Material and methods

Embryos excised from seeds of six generations (P_1, P_2, F_1, BC_1, BC_2 and F_2) of a cross involving a resistant and a susceptible parent *viz.*, HD29 x HD2329 were cultured on MS medium supplemented with 200 mg/l casein hydrolysate, 2 mg/l 2, 4-Dichloro-phenoxyacetic acid and 0.5 mg/l of (α-Naphthalene aceteic acid, in petriplates already inoculated with 0.1 ml of spore suspension (10^3 secondary sporidia) of *N. indica*. At least 20 embryos of each of the parents, F_1s and backcrosses and 50 embryos from F_2 were cultured in each of the three replications. The same number of embryos were cultured in petriplates, as control in absence of *N. indica*. In another experiment, at least 20 embryos of each of the parents, F_1s and backcrosses and 100 embryos from F_2 were cultured with one embryo per tube for callus initiation, followed by inoculation with *N. indica* after callus initiation. The same number of tubes were also maintained as control. The cultures were incubated at 25±1°C in dark. Callusing response (in terms of per cent embryos showing callusing) and diameter of inhibition zone were recorded. Effect of *N. indica* on callus growth was observed in terms of fresh and dry weight of callus after 30 days of culturing.

Data were analysed by factorial completely randomized design. Joint scaling test [3] and generation mean analysis [4] were carried out for all the traits under investigations.

Results and Discussion

Significant variation was observed for callusing response of embryos due to generations. Callusing response was low and varied from 45.55 to 76.66 per cent among all the generations. Agarwal and Tiwari [5], Kintzois *et al.* [6] and Ozgen *et al.* [7] have also reported significant differences among genotypes for

callusing ability. Low callusing ability of embryos excised from mature grains was also reported by Bartok and Sagi [8], Chauhan and Singh [9] and Ozgen *et al.* [10]. In present study there were no significant differences for callusing response in different generations due to presence or absence of *N. indica*. It reflected that pathogen did not affect callus initiation from embryos of these generations. Maximum callusing response both in presence (76.66) and in absence (75.55) of *N. indica* was observed in backcross HD29 x HD2329/HD29 backcross was less showing that the pathogen affected the growth of the callus to more extent as compared to the resistant parent, F_1 and backcross of F_1 with resistant parent.

Three parameter model indicated that both additive and dominance effects were significant for callusing response (both in presence and in absence of *N. indica*) and for fresh and dry weight (in presence of

Table 1. Callusing response, fresh weight, dry weight and diameter of inhibition zone formed by embryos in different generations of the cross HD29 x HD2329

Generations	Callusing response		Fresh weight (mg)			Dry weight (mg)		Diameter of Relative inhibition	
	In presence of *N. indica*	In absence of *N. indica*	In presence of *N. indica*	In absence of *N. indica*	Relative weight+(%)	In presence of *N. indica*	In absence of *N. indica*	Relative weight+(%)	Inhibition zone (cm)
HD29(P_1)	54.44*	55.55*	106.40*	148.75	71.52	6.92*	9.81	70.54	3.70*
HD2329 (P_2)	45.55*	45.55*	85.11*	127.58*	66.71	5.61	9.56	58.68	2.28*
HD29 x HD2329 (F_1)	69.99*	68.88*	106.71*	155.33*	68.69	7.08*	10.58*	66.91	2.54*
HD29 x HD2329 (F_2)	73.33*	71.10*	92.72	162.37*	57.10	6.19	11.14*	55.56	2.82
HD29 x HD2329/ HD29 (BC_1)	76.66*	75.55*	81.37	128.29*	71.22	5.58	8.49*	65.72	3.23*
HD29 x HD2329/ HD2329 (BC_2)	64.44	66.77	77.41*	145.20	53.31	5.45	9.87	55.21	2.37*
Mean	64.07	63.90	93.29	144.58		6.14	9.91		2.92
CD for genotypes		4.27		5.75		0.58	0.20		
CD for treatment		N. S.		3.32		0.33			
CD for genotype x treatment		N. S.		8.13		0.82			

* *Significantly different from mean

+=Weight in presence of *N. indica* in relation to that in absence of *N. indica*

$$\left[\frac{\text{Weight in presence of } N.\ indica}{\text{Weight in absence of } N.\ indica} \times 100\right]$$

(Table 1). Arya [1] and Tandon *et al.* [2] also reported that *N. indica* had no effect on callus initiation in resistant and susceptible genotypes.

Significant variations were observed due to generations, treatment and genotype x treatment interaction for fresh weight and dry weight of callus. This indicated that the fresh and dry weight of calli are affected significantly by the pathogen. The observations on fresh weight and dry weight indicated that among generations the minimum effect of *N. indica* was in F_1 and maximum in backcross HD29 x HD2329/ HD2329 (BC_2) due to HD2329, the susceptible parent.

A clear inhibition zone was formed around each of the embryos showing callusing (including those from susceptible genotypes), in all the six generations of the crosses. Generations differed significantly for the diameter of inhibition zone. It was maximum (3.70 cm) in HD29, the resistant genotype. Relative fresh and dry weight of callus in susceptible parent and in *N. indica*). Magnitude of dominance effects was more than additive effects (Table 2). The additive-dominance model was found to be inadequate for callusing response, fresh weight and dry weight as indicated by Chi-square showing the presence of epistatic interactions. Six parameter model showed that in presence of *N. indica*, addditive (12.233) and additive x dominance (15.559) effects were significant for callusing response. Their magnitude was also greater than other effects. In absence of *N. indica* only additive effects (18.890) were significant (Table 3). In presence of *N. indica* additive (13.960), dominance (-22.365) and dominance x dominance gene effects (100.690) were significant for fresh weight of calli. Opposite signs of (h) and (l) indicated that duplicate type of epistasis was present. Only additive (16.910) and dominance x dominance (129.170) gene effects were found to be significant in absence of *N. indica*.

Table 2. Genetic parameters for callusing response, fresh weight, dry weight and inhibition zone shown by embryos in the cross HD29 x HD2329 using three-parameter model

Character	m	(d)	(h)	Chi-square
Callusing frequency				
In presnece of *N. indica*	56.057	5.371*	21.398**	17.944**
In absence of *N. indica*	51.407	5.167*	29.505**	10.918**
Fresh weight				
In presence of *N. indica*	91.362	6.806**	13.475**	60.591**
In absence of *N. indica*	140.560	5.431	6.040	29.527**
Dry weight				
In presence of *N. indica*	6.089	0.694**	0.973*	8.109*
In absence of *N. indica*	9.398	0.360*	0.145	108.322**
Diameter of inhibition zone	2.997	0.828**	–0.420	2.643^{NS}

*Significant at 5 per cent; **Significant at 1 per cent

In case of dry weight, dominance (-1.882) and dominance x dominance (7.312) effects were significant in presence of *N. indica*. Duplicate type of interactions were detected. In absence of *N. indica* all types of genetic effects were non-significant except dominance x dominance effects (11.674). Only additive gene effects (0.860) were significant for diameter of inhibition zone in both three and six parameter model. Chi-square value indicated the adequacy of additive-dominance model for diameter of inhibition zone. The inhibition zone is formed by some chemical which do not allow growth of the pathogen and thus provides resistance to mature grain. As additive effects were significant in present investigations selection might be helpful for improving resistance against the Karnal bunt pathogen.

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Table 3. Genetic parameters for callusing response, fresh weight, dry weight and inhibition zone shown by embryos in the cross HD29 x HD2329 using six-parameter model

Character	m	(d)	(h)	(I)	(j)	(l)	Type of epistasis
Callusing frequency							
In presence of *N. indica*	73.330	12.233*	8.85	–11.114	15.559**	–13.107	-
In presnece of *N. indica*	71.106	18.890**	8.344	0.008	7.780	–45.568	
Fresh weight							
In absence of *N. indica*	92.720	13.960**	–22.365**	–33.320	6.630	100.690**	Duplicate
In absence of *N. indica*	162.370	16.910**	–92.005	–102.500	–54.990	129.170*	-
Dry weight							
In presence of *N. indica*	6.193	0.127	–1.882*	–2.694	–1.062	7.312*	Duplicate
In absence of *N. indica*	11.146	1.383	–6.969	–7.858	–3.016	11.674**	-
Diameter of inhibition zone	8.820	0.860**	–0.469	–0.068	0.137	0.169	-

*Significant at 5 per cent; **Significant at 1 per cent