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Inheritance of Gene Conferring Resistance to Rust (*Melampsora lini*) Disease of Linseed (*Linum usitatissimum* L.) in North West Himalayas

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A B S T R A C T

The genetics of resistance against rust disease caused by *Melamspora lini* in linseed or flax was studied in F_1, F_2, BC_1 and BC_2 generations of a susceptible variety T-397, crossed with a resistant variety Surbhi. On the basis of the segregating ratio obtained in F_2 and backcross generations of the cross, T-397 × Surbhi i.e., (3:1) in F_2 and (1:1) in BC_1 revealed that single dominant gene is responsible for resistance against rust in these linseed genotypes under study.

Introduction

Linseed (*Linum usitatissimum* L.) belongs to the genus Linum is one of the earliest crop cultivated for its seeds and fibre. Almost every part of the linseed plant is utilized commercially either directly or after processing. Being an important oilseed crop, its average productivity in India is very low, because of various factors viz., narrow genetic base, non-availability of high yielding varieties and resistance to biotic and abiotic stresses, etc.

Rust, wilt, alternaria blight and powdery mildew are major diseases associated with it. Out of these diseases, rust is the most serious disease of linseed. *Melamspora lini* the fungal pathogen responsible for rust disease on flax is of interest for both economic and scientific reasons. It can cause severe losses in seed yield as well as reducing fibre quality in flax plants grown for linen production; From the scientific view point, *M. lini* came to prominence in 1942 when Harold Flor reported the results of an inheritance study which demonstrated that single allelic gene pairs determine the avirulence/virulence phenotype on host lines with particular resistance genes, which led him to propose his now famous 'gene-for-gene' hypothesis.

Since effective chemical control of this disease is not available, use of resistant cultivars have been suggested The information on inheritance of the rust resistance is important to decide the breeding strategies in linseed crop therefore to breed stable resistant cultivars against rust it is imperative to know the genetics and gene responsible for resistance against this disease. Hence the present study was conducted to gather the information on underlying genetic mechanism of resistance of linseed plants to the pathogen, *Melampsora lini.*

Materials and Methods

During summer 2015 (off season) the cross (T-397 × Surbhi) was attempted at HAREC, Kukumseri (Lahaul & Spiti) to produce sufficient F_1 seed. In normal crop season at Palampur, i.e *rabi* 2015-16 the F_1s were advanced to F_2 and simultaneously F_1s were back crossed with the parents to generate BC_1 and BC_2. During off season in summer 2016 at HAREC, Kukumseri more F_1, BC_1 and BC_2 generations were generated, selfed to produce B_1s and B_2s. A field trial was conducted comprising of parents, F_1s, back crosses (BC1 and BC2) and F_2s in Compact Family Block Design with three replications during *rabi* 2016-17 in the Experimental Farm of Shivalik Agricultural Research and Extension Centre (SAREC), Kangra (H.P.). *As Kangra is the hot spot for linseed rust in Himachal Pradesh. The plot size consisted of row length of 2.5 m having row to row and plant to plant distance of 30 cm and 5 cm respectively. The non segregating generations (Parents and F_1s) were grown in single row of 2m length. The segregating F_2 generations were grown in six rows and BC_1 and BC_2, were grown in four rows. Scale by (Kumar and Gupta 1999) was used to evaluate linseed genotypes for disease reaction to rust.

Results and Discussion

In the present study single cross combination *viz.*, T-397 x Surbhi was screened to study the inheritance against rust resistance at (SAREC) Kangra in artificial disease epiphytotic conditions which were created in experiments for the rust disease using "infector row technique" with T-397 (check variety) planted after every row of test material as well as on border around the field to maintain the effective inoculum load. In order to encourage disease pressure, artificial inoculation with spraying of spore suspension was also done, during *rabi* 2016-17.

Table.1

Grade	Disease (% area of leaves)	Symptoms	Disease reaction
0	Free from disease	No pustule formation	Highly resistant (HR)
1	1 to 10	Few scattered and scanty pustules seen after careful searching	Resistant (R)
2	11 to 25	Pustules common and seen early on plants	Moderately resistant (MR)
3	26 to 50	Pustules very common	Moderately susceptible (MS)
4	51 to 75	Pustules extensive on whole plant, defoliation and drying of leaves	Susceptible (S)

Table.1 Disease reactions of parents their F_1's and segregating generations of the linseed to rust (*Melamspora lini*)

S.No.	Generations	Total no. of plants	No. of Observed plants		Ratio tested	No. of expected plants		Observed χ^2 Value	P value
			Resistance	Susceptible		Resistance	Susceptible		
1	P_1	52	0	52	-				
2	P_2	45	45	0	-				
3	F_1	44	44	0	-				
4	BC_1	49	26	23	1:1	24.5	24.5	0.18	0.67
5	BC_2	47	47	0	-				
6	F_2	164	120	44	3:1	121.5	40.5	0.40	0.53

The segregation of resistant and susceptible plants in F_2 generation of cross T-397 x Surbhi, revealed the good fit to 3:1 ratio (Table.2). These results were confirmed by the back cross generations which fitted well to 1:1 ratio. This confirmed that a single dominant gene is responsible for resistance against rust. Earlier reported by Srinivasachar and Seetharam (1971), Kutuzova (1978), Kamthan *et al.*, (1991) and Lawrence *et al.*, (2007) resistance to rust governed by single dominant gene. The results on rust resistance inheritance are in conformity with earlier workers.

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