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Inheritance of seedling and adult plant resistance to *Alternaria* leaf spot in safflower (*Carthamus tinctorius* L.)

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Abstract

The present study on safflower (*Carthamus tinctorius* L.) was undertaken to workout inheritance pattern of seedling as well adult plant resistance to alternaria leaf spot caused by *Alternaria carthami*. Two genetically male sterile lines, GMS-104 and GMS-105, susceptible to leaf spot, were crossed with a resistant accession GMU-1825. Evaluation of the parents and the F_1, F_2, BC_1 and BC_2 derived from the two crosses under polyhouse condition, showed that the seedling resistance was monogenic recessive. The adult plant resistance under field condition, was under the control of two duplicate loci where atleast one locus at homozygous recessive condition confers the adult plant resistance.

Key words : Safflower, alternaria, resistance, inheritance

Introduction

Among the oil seed crops safflower (*Carthamus tinctorius* L.) is a major *rabi* crop cultivated in India. Leaf spot caused by *Alternaria carthami* Chow, is a major disease of safflower [1] which causes severe damage to the crop grown under favourable disease development in *rabi* situation. The yield losses due to leaf spot are estimated to the extent of 17.3 per cent [2]. Almost all the released varieties of safflower show susceptibility to either seedling or adult plant and or to both leafspot disease. Out of 5183 accessions screened for resistance to the disease only forty four accessions showed tolerance/resistance to the disease [3]. No efforts have been documented for understanding the genetics of seedling and adult plant resistance to leaf spot, collectively. Thus the present investigation was under taken to study seedling as well adult plant resistance to *Alternaria* leaf spot in safflower.

Material and methods

Two genetically male sterile lines of safflower, susceptible to *Alternaria* leaf spot *viz.*, GMS-104 and GMS-105 were crossed with a resistant accession GMU-1825, during *rabi* 1997-98. In the subsequent *rabi* season, sufficient quantity of seeds of the parents and F_1, F_2, BC_1 and BC_2 generations was developed.

Screening for seedling resistance to *Alternaria* leaf spot under epiphytotic conditions was carried out under polyhouse conditions at the Plant Tissue Culture Laboratory, M.P.K.V., Rahuri. The experiment was conducted by following the protocool described by Harrigan [4]. Briefly, the seeds were dibbled in portrays, each of which had sixteen cavities. These cavities were filled with soil and in each cavity 3-4 seeds were dibbled. These portrays were kept in polyhouse to have uniform germination and congenial conditions for disease development. In addition, portrays containing susceptible local genotypes were also placed around the experimental portrays. A spore suspension containing 25×10^4 of *Alternaria carthami* per ml was applied on two week old seedlings, to have rapid and maximum disease development [5]. When the seedlings from the trays containing mixture of susceptible local genotypes showed 100% disease development, the test seedlings were scored as either resistant or susceptible. The seedlings showing even a single spot of the disease were treated as susceptible while the seedlings free from the disease were treated as resistant.

The six generations developed of the two crosses each, were also evaluated separately for adult plant resistance to *Alternaria* leaf spot under field conditions. Early sowing on 17th September, was adopted as it provides natural conditions for disease development [6]. The fungus was isolated from diseased leaf samples collected and stored during the previous season. To have maximum disease infestation a spore spray of 25×10^4 spores/ml was applied on the stage [7]. A mixture of susceptible local genotypes was also planted around the experimental material, when the plant population attained rossette stage. The disease intensity was recorded when the susceptible rows showed 100% disease development. The neighbouring categories were merged to have segregation in resistant or susceptible category [8], where I and II as resistant and III, IV and V categories were treated as susceptible.

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Results and discussion

The inheritance of seedling resistance to *Alternaria* leaf spot was studied in two crosses, *viz.*, GMS-104 × GMU-1825 and GMS-105 × GMU-1825. The female parents GMS-104 and GMS-105 recorded susceptible reaction while male parent recorded resistant reaction against the disease. The F_1 seedlings of both the crosses recorded susceptible reaction. The segregation in F_2 of both the crosses indicated a good fit to the ratio of 3 susceptible : 1 resistant (Table 1), the BC_2 generation showed good fit for the ratio of 1 susceptible: 1 resistant, as indicated by the χ^2 values. The segregation pattern of F_2 and BC_2 observed in the present studies indicated that the seedling resistance to *Alternaria* leaf spot in safflower was under the control of a single gene where susceptibility was dominant over resistance. However, the χ^2 test confidence level of F_2 of the cross GMS-105 × GMU-1825 was low, which suggests additional experimentation for conformation of the results.

Table 1. Inheritance of seedling resistance to Alternaria leaf spot in safflower

Parent/ Generation	No. of plants observed	Segregation		Expected ratio	X^2	P-range
		Susceptible	Resistant			
Cross-I : GMS-104 × GMU-1825						
GMS-104	54	54	-	-	-	-
GMU-1825	50	-	50	-	-	-
F_1	64	64	-	-	-	-
F_2	384	291	93	3:1	0.125	0.80-0.70
BC_1	48	48	-	-	-	-
BC_2	47	24	23	1:1	0.021	0.90-0.80
Cross-II : GMS-105 × GMU-1825						
GMS-105	06	60	-	-	-	-
GMU-1825	55	-	55	-	-	-
F_1	58	58	-	-	-	-
F_2	357	274	83	3:1	0.58	0.50-0.30
BC_1	50	50	-	-	-	-
BC_2	54	29	25	1:1	0.296	0.70-0.50

The six generations of the two crosses were also screened for adult plant resistance to *Alternaria* leaf spot under field conditions. The female parents GMS-104 and GMS-105 showed highly susceptible reaction (V) to *Alternaria* leaf spot, while the male parent GMU-1825 showed highly resistant reaction (I) to the diseases. The F_1s of both the crosses recorded highly susceptible reaction (V) to the disease indicating complete dominance of susceptibility over resistance. After merging the categories, F_2 population of both the crosses segregated in the ratio of 9 susceptible : 7 resistant plant, while BC_2 generation of both the crosses segregated in to 1 susceptible : 3 resistant plants (Table 2). The segregation observed in F_2 and BC_2 of both the crosses fit the ratio of 9:7 and 1:3 respectively, as indicated by the χ^2 values. However, the confidence level of χ^2 test for F_2 of the cross GMS-105 × GMU-1825 was low which suggests additional experimentation for conformation of the results. Thus, the results of the present studies indicated that the adult plant resistance to *Alternaria* leaf spot was under the control of two duplicate loci where atleast one of them at homozygous recessive condition confers the adult plant resistance. However, the earlier reports [9, 10] on resistance to *Alternaria* leaf spot in safflower indicated that the resistance is monogenically dominant and derived from *Carthamus lanatus* L.

Table 2. Inheritance of adult plant resistance to Alternaria leaf spot in Safflower

Parent/ Generation	No. of plants observed	Segregation		Expected Ratio	X^2	P-range
		Susceptible	Resistant			
Cross-I: GMS-104 × GMU-1825						
GMS-104	60	60	-	-	-	-
GMU-1825	60	-	60	-	-	-
F_1	60	60	-	-	-	-
F_2	227	130	97	9:7	0.096	0.80-0.70
BC_1	132	132	-	-	-	-
BC_2	148	30	118	1:3	1.765	0.20-0.10
Cross-II : GMS-105 × GMU-1825						
GMS-105	52	52	-	-	-	-
GMU-1825	58	-	58	-	-	-
F_1	60	60	-	-	-	-
F_2	232	137	95	9:7	0.740	0.50-0.30
BC_1	155	155	-	-	-	-
BC_2	136	34	102	1:3	0.157	0.95-0.90

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