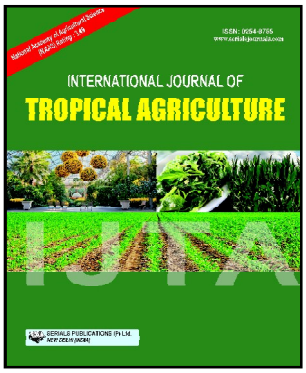

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Studies on Host Plant Resistance in Pea against Pea Leaf Miner, *Chromatomyia horticola* (Goureau)

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Abstract: *Chromatomyia horticola* Goureau (pea leaf-miner) is a major and regular pest of pea, which is amenable to control control by chemical insecticides. However, there are limitations and hazards associated with insecticidal application. Host plant resistance (HPR) has been viewed as an important component of IPM.in the present studies, ninety-two pea germplasm were screened against pea leaf miner and the biophysical and biochemical basis of resistance was studied. The results revealed that six pea genotypes (DPP 25G, DPPLMR 41, JI 1766 (2), JP 179, LMR 100, S143) exhibited high resistance (Infestation index <0.80); nineteen as resistant and seventeen as moderately resistant) to the pest. Total sugars and total free amino acids were significantly positively correlated while total phenols were negatively correlated with leaflet infestation and population of immature stages. The hybridization experiments involving resistant parents and popular varieties revealed that the progeny of cross involving DPPLMR 41 as resistant parent exhibited desirable level of resistance alongwith good horticultural traits.

INTRODUCTION

Pea leaf-miner, *Chromatomyia horticola* Goureau is a major and regular pest of pea, having more than 127 known host plants in India (Singh and Mavi, 1982). In Himachal Pradesh more than 20 per cent avoidable losses in pea grain yield have been reported beyond 40 per cent infestation (Mehta *et al.*, 1994). Sharma and Kashyap (1998) also observed 40 per cent infestation as economic threshold level for leaf-miner in pea grown for vegetable purpose. This pest is amenable to control by chemical insecticides (Dash, 1990; Khajuria and Sharma, 1995; Mehta *et al.*, 1995). However, there are obvious limitations and hazards associated with insecticidal application in

vegetables like objectionable pesticide residues, development of resistance to insecticides, and hazards to natural enemies which restrict their use in pest control programme. Host plant resistance (HPR) has been viewed as an important component of IPM. The studies on HPR in pea for the management of pea leaf miner are very limited. Hence comprehensive studies were conducted for the screening of pea germplasm for resistance to pea leaf miner in pea.

MATERIALS AND METHODS

Studies were conducted to evaluate pea germplasm for resistance to *C. horticola* under field and laboratory (screen-house) conditions in the mid hills of Himachal Pradesh. Besides these the biophysical and biochemical basis of resistance in pea germplasm against *C. horticola* were also determined. Hybridization experiments were conducted and inferences were drawn. The details of experiments are as under:

a) Field screening: The trials on screening of pea genotypes for resistance to pea leaf miner were laid out in randomized block design with three replications under field conditions A total of ninety two pea genotypes was procured from different sources (CSK Himachal Pradesh Krishi Vishvavidyayaya, Palampur; IARI, New Delhi; NBPGR, New Delhi) for the present studies. The recommended package of practices for raising the crop was followed, except for insect-pest management. Observations on total number of leaflets per plant and those infested by pea leaf miner per plant and population of maggots and pupae per plant were recorded twice during March, coinciding with the peak period of activity of the pest. Data was expressed as mean per cent leaflet infestation and mean population of maggots and pupae per plant and subjected to statistical analysis. The data was further used to work-out the infestation index as per formula given by Mehta *et al.* (1998).

$$\text{Infestation index} = \frac{\log [1 + \text{Mean no. of larvae and pupae/ plant x \% leaflet infestation}]}{100}$$

Based on the infestation index, pea genotypes were grouped in five categories as given hereunder.

Category	*Infestation index*
Highly Resistant	<0.80
Resistant	0.80-1.00
Moderately Resistant	1.01-1.20
Susceptible	1.21- 1.40
Highly Susceptible	>1.40

(b) Screen-house screening: Based on results of previous two years studies, selective pea genotypes (n=20) belonging to different categories (representing highly resistant, resistant, moderately resistant, susceptible and highly susceptible group of pea genotypes) were screened against pea leaf miner under screen-house conditions. Pea plants were raised in the pots and were exposed to very high population of leaf miner adults, replicating five times. The leaflet infestation, population of immature stages and leaflet punctures per plant were the criterion followed for screening the germplasm.

(c) Biochemical basis of Resistance

Biochemical analysis: Various biochemical characters of pea leaves were determined to find out their relationship with leaf miner infestation, population and infestation index of *C. horticola*. For the study, 29 pea genotypes representing highly resistant, resistant, moderately resistant, susceptible and highly susceptible genotypes were selected on the basis of two years studies. The pea leaflets were dried in hot air oven at a temperature of 50°C were powdered in a grinder and used for biochemical analysis in laboratory.

Total sugar: Total sugar content in the leaves of pea genotypes was determined by the method suggested by Dubois *et al.* (1956).

Total free amino-acids: Total free amino-acids content in leaves was determined by the method described by Jayaraman (1981).

Total phenol: Total phenol content in leaves of different genotypes of pea was estimated as suggested by Bray and Thorpe (1954).

The data of all the biochemical characteristics was related to leaflet infestation, population and infestation index of *C. horticola* by working correlation studies.

(d) Hybridization: The crosses were attempted involving susceptible and resistant parent based on the infestation during the second year of observation. The parents were Arkel, DPPLMR 41, Lincoln and LMR 100 and the crosses were attempted as Lincoln x DPPLMR 41, Arkel x DPPLMR 41, Lincoln x LMR 100 and Arkel x LMR 100, Arkel x LMR 100. LMR 100 and Lincoln were used as male parents. The F_2 population was raised along with parents. The observations were recorded on the leaflet infestation of the parents and F_2 population as well as their horticultural traits.

RESULTS AND DISCUSSION

a) Field Screening of Pea Genotypes for Pea Leaf miner Resistance

The perusal of data presented in Table 1 revealed no variety to be free from attack of pea leaf miner. The minimum leaflet infestation was recorded in S 143 and LMR 100 (15.44 and 16.73 %, respectively) while mean maggot population was minimum in S 143 and JI 1766 (2) (7.8 and 8.6 maggot and pupa population per plant). Screening of fifty-seven pea germplasms against pea leaf miner carried out by Bhatia *et al.* (1994) also revealed no line to be recording zero maggots/pupa per plant, and two lines recorded 1-20 maggots/pupa per plant were categorized as resistant.

Table 1
Relative leaflet infestation, population of pea leaf miner and infestation index (leaflet basis) in pea genotypes against *C. horticola*

Genotype	*Mean*		
	*Leaflet infestation (%)**	*Population/plant***	*Infestation index (leaflet basis)*
Accacia	49.01(44.42)	117.3(10.87)	1.77
Arkel	42.19(39.88)	65.5(7.42)	1.25
Azad Pea	34.73(35.99)	52.0(6.99)	1.21
Bonneville	33.08(34.65)	82.3(8.06)	1.21
BP 87	59.20(50.36)	116.7(10.85)	1.85
C 400	45.07(42.14)	133.0(11.57)	1.78
DP 362	57.37(49.22)	92.3(9.65)	1.73
DPP 102	29.47(32.51)	41.3(6.35)	1.12
DPP 102 DY	55.22(47.98)	205.0(14.35)	2.06
DPP 102(T)	45.27(42.09)	37.7(6.16)	1.22
DPP 106	35.93(36.75)	32.8(5.73)	1.11
DPP 107	37.09(36.78)	33.9(5.49)	1.12
DPP 107T Dy	34.80(35.81)	35.3(5.83)	1.07
DPP 107T (WY)	35.75(36.32)	33.3(5.60)	1.11

contd. table 1

Genotype	Mean		
	Leaflet infestation (%)*	Population/plant**	Infestation index (leaflet basis)
DPP 110	47.25(43.07)	116.8(10.16)	1.63
DPP 113Dy	38.15(37.95)	51.5(7.02)	1.28
DPP 113T Ry	37.65(37.83)	45.3(6.80)	1.26
DPP 120	35.11(38.26)	63.5(7.61)	1.35
DPP 127	45.34(42.18)	59.9(7.67)	1.44
DPP 127 (R)	36.44(36.77)	40.3(6.30)	1.19
DPP 127W	35.74(36.30)	32.5(5.62)	1.05
DPP 13T	43.84(41.15)	53.2(6.94)	1.30
DPP 137	34.47(35.11)	24.2(4.96)	0.97
DPP 19	51.90(46.07)	38.3(6.24)	1.32
DPP 25G	24.08(28.64)	13.0(3.64)	0.59
DPP 26G	35.48(36.00)	34.8(5.63)	1.07
DPP 4	44.10(41.74)	68.0(7.93)	1.49
DPP 62	36.86(37.11)	36.7(5.94)	1.13
DPP 80	30.37(33.14)	26.4(5.10)	0.92
DPP LMR 41	24.29(29.04)	16.9(4.14)	0.69
EC 381853	32.90(34.46)	24.3(4.92)	0.93
EC 381854	32.46(34.33)	24.2(4.90)	0.92
EC 381855	29.54(32.28)	24.2(4.87)	0.88
EC 381856	42.36(40.27)	42.7(6.41)	1.27
EC 381857	36.55(36.83)	49.7(7.09)	1.27
EC 381858	46.63(43.01)	80.0(8.82)	1.57
EC 381860	29.18(32.05)	20.0(4.47)	0.80
EC 381861	29.09(32.17)	21.1(4.49)	0.81
EC 381862	34.44(35.66)	23.0(4.71)	0.93
EC 381864	41.65(40.12)	45.9(6.67)	1.29
EC 381865	32.13(33.95)	22.1(4.68)	0.88
FC 2	29.76(32.99)	42.3(6.58)	1.13
Im 25	39.62(38.77)	60.7(7.46)	1.38
JI 1210	43.53(40.84)	36.5(6.06)	1.22
JI 1412	42.04(40.20)	64.7(7.85)	1.43
JI 1542	54.92(47.83)	65.6(7.97)	1.54
JI 1559	44.64(41.90)	48.3(7.02)	1.35
JI 1569	36.71(37.22)	38.4(6.00)	1.18
JI 1766 (1)	40.84(39.33)	119.4(9.56)	1.42
JI 1766 (2)	29.88(33.01)	8.6(2.92)	0.53

contd. table 1

Genotype	*Mean*		
	*Leaflet infestation (%)**	*Population/plant***	*Infestation index (leaflet basis)*
JI 2431	49.47(44.67)	121.0(11.02)	1.78
JI 2433	38.41(38.04)	24.3(4.91)	1.00
JI 2436	28.39(31.96)	29.5(5.22)	0.94
JI 2437	38.95(38.44)	49.4(6.95)	1.29
JI 2439	41.45(40.05)	33.7(5.88)	1.17
JP 141	29.71(33.01)	33.3(5.79)	1.04
JP 15	33.30(35.19)	62.7(7.95)	1.34
JP 179	21.56(26.49)	13.7(3.70)	0.56
JP 825	52.75(46.57)	58.0(7.67)	1.50
JP 885	44.48(41.81)	100.0(10.05)	1.66
Kinnauri	29.63(32.52)	28.9(5.23)	0.93
KS 156	47.27(43.41)	75.3(8.72)	1.56
KS 215	51.36(45.77)	91.0(9.58)	1.68
KS 221	33.91(34.92)	54.5(7.16)	1.29
KS 268	31.15(33.77)	32.7(5.79)	1.05
Lincoln	37.61(37.59)	45.8(6.41)	1.19
LMR 100	16.73(23.44)	13.9(3.74)	0.51
LMR 20	22.65(28.33)	23.3(4.93)	0.80
LMR 4	32.02(34.22)	24.5(4.93)	0.92
Mater Ageta	42.42(40.47)	22.8(4.80)	1.01
Mithi Phali	33.64(35.35)	27.5(5.22)	0.99
NDVP 10	46.91(43.17)	113.8(10.02)	1.63
NDVP 12	45.53(42.39)	73.4(7.74)	1.42
NDVP 250	51.67(45.94)	28.0(5.36)	1.19
NDVP 8	45.39(42.24)	40.3(6.31)	1.28
NDVP 9	51.20(45.67)	75.3(8.74)	1.60
Palam Priya	35.44(35.79)	27.0(5.11)	0.97
Pb 87	53.54(46.98)	48.0(6.90)	1.42
PHPMR 1	46.26(42.83)	65.3(8.14)	1.49
PMR 4	36.11(36.43)	139.8(10.56)	1.54
S 143	15.44(22.74)	7.8(2.93)	0.32
Sel 82	35.97(36.54)	26.7(5.12)	1.01
Sugar Giant	34.60(35.53)	25.7(5.03)	0.97
T-10	40.12(38.87)	43.0(6.48)	1.25
UU 11	50.83(45.54)	46.3(6.83)	1.39
UU 12	38.04(37.82)	24.1(4.87)	0.98

contd. table 1

Genotype	Mean		
	Leaflet infestation (%)*	Population/plant**	Infestation index (leaflet basis)
VP 5	43.98(41.52)	61.0(7.86)	1.44
VP 8005	38.30(38.21)	70.3(8.45)	1.45
VP 87	38.18(38.00)	31.2(5.58)	1.11
VP 8902	39.99(38.92)	44.2(6.63)	1.27
VP 9003	31.03(33.34)	47.3(6.72)	1.20
VRP 7	40.97(39.78)	98.7(9.97)	1.62
VRP 8	41.64(40.16)	75.0(8.70)	1.51

Data represents mean of three years

* Figures in parentheses are the angular transformed values

** Figures in parentheses are the square root transformed values

Rating of pea genotypes: Based on the mean infestation index for three consecutive years, DPP 25G, DPPLMR 41, JI 1766 (2), JP 179, LMR 100, S143 were rated as highly resistant to pea leaf miner (Infestation index <0.80) (Table 2). Nineteen genotypes were rated as resistant, seventeen as moderately resistant, twenty-three as susceptible and twenty-seven as highly susceptible.

(b) Screenhouse screening: Observations on the leaflet infestation in the selected pea genotypes under laboratory screenhouse conditions revealed that the highest infestation was in DPP 120 (47.61%) being at par to Lincoln, Arkel, Azad Pea and Bonneville (Table 3). Lowest infestation was found in JI 1766(2) being at par to DPPLMR 41, LMR 100 and Sel 82. Population of leaf miner was maximum

Table 2
Categorization of pea genotypes for resistance to pea leaf miner

Category	Infestation index	Genotype(s)
Highly Resistant	<0.80	DPP 25G, DPPLMR 41, JI 1766 (2), JP 179, LMR 100, S143
Resistant	0.80-1.00	DPP 80, DPP 137, EC 381853, EC 381854, EC 381855, EC 381860, EC 381861, EC 381862, EC 381865, EC 381860, JI 2433, JI 2436, Kinnauri, LMR 4, LMR 20, Mithi Phalli, Palam Priya, Sugar Giant, UU 12,
Moderately Resistant	1.01-1.20	DPP 26G, DPP 127W, DPP 107 TDy, DPP 127(R), DPP 127W, DPP 62, FC 2, JI 1569, JI 2439, JP 141, KS 268, Lincoln, Matar Ageta, NDVP 250, Sel 82, VP 87, VP 9003
Susceptible	1.21- 1.40	Arkel, Azad Pea, Bonneville, DPP 13T, DPP 120, DPP 102(T), DPP 113Dy, DPP 113TRy, DPP 120, DPP 19, EC 381856, EC 381857, EC 381864, Im 25, JI 1210, JI 1559, JI 2437, JP 15, KS 221, NDVP 8, T 10, UU 11, VP 8902
Highly Susceptible	>1.40	Accacia, BP 87, C 400, DP 362, DPP 102Dy, DPP 110, DPP 127, DPP 4, EC 381858, JI 1412, JI 1542, JI 2431, JI 1766(1), JP 825, JP 885, KS 156, KS 215, NDVP 9, NDVP 10, NDVP 12, Pb 87, PHPMR1, PMR 4, VP 5, VP 8005, VRP 7, VRP 8

(24.8/plant) in Lincoln which was at par to LMR 4, Sugar Giant, Matar Ageta and DPP 120. However, leaflet punctures per plant were maximum in DPP 120 (74.75/plant) being at par to LMR 4, DPP 25G, Arkel, Mithi Phali, Sugar Giant, Kinnauri, JI 2436 and EC 381855. The infestation index varied from 0.35 to 1.08 being minimum in JI 1766(2) and maximum in Lincoln.

Table 3
Screening of different pea genotypes against *C. horticola* under laboratory (screenhouse) conditions

Genotypes	*Leaflet infestation (%)*	*Population (maggots and pupae) per plant*	*Leaflet punctures/ plant*	*Infestation index*
Arkel	44.19	17.5	64.50	0.94
Azad Pea	47.35	13.0	20.75	0.85
Bonneville	42.79	13.0	22.00	0.82
DPP 120	47.61	19.3	74.75	1.01
DPP 25G	21.71	16.5	51.00	0.66
DPP 80	21.23	14.3	31.75	0.60
DPPLMR 41	17.65	15.3	32.75	0.57
EC 381855	23.27	13.3	44.75	0.61
EC 381862	22.98	17.0	39.50	0.69
JI 1766(2)	12.08	10.3	6.00	0.35
JI 2436	27.65	16.5	64.50	0.75
Kinnauri	21.84	16.0	44.50	0.65
Lincoln	44.43	24.8	36.75	1.08
LMR 100	14.70	15.5	34.75	0.52
LMR 4	33.33	23.0	71.25	0.94
Matar Ageta	28.07	20.0	15.25	0.82
Mithi Phalli	21.62	11.5	52.75	0.54
Palam Priya	20.89	15.5	32.25	0.63
Sel 82	15.21	12.0	13.25	0.45
Sugar Giant	23.75	19.5	44.00	0.75
CD (P=0.05)	6.55	6.12	34.36	

(c) Biochemical basis of Resistance

Biochemical analysis: Analysis of various biochemical characters revealed total sugar content in leaves of different pea genotypes to vary between 0.62-2.88 mg/g, total amino-acid content varied between 0.18-44 mg/g; while total phenols varied between 1.03-28.95 mg/g (Table 4). Total sugars and total free amino-acids were found to be significantly positively correlated while total phenols were negatively correlated with leaflet infestation by leaf-miner.

(d) Hybridisation: in the present studies the resistant genotypes to pea leaf miner were identified. These resistant genotypes were crossed with popular pea varieties (Arkel, Lincoln). At the peak period of activity of the pest, observations on the leaflet

Table 4
Biochemical constituents of pea genotypes in relation to *C. horticola* infestation

Genotypes	*Total sugars (mg/g)*	*Total free amino acids (mg/g)*	*Total phenols (mg/g)*
Arkel	0.72	0.30	15.02
Azad pea	1.97	0.30	16.32
Bonneville	0.91	0.42	8.57
DPP 102 T	1.44	0.18	11.61
DPP 127W	1.45	0.26	23.92
DPP120	1.94	0.34	16.89
DPP 127R	1.46	0.28	6.03
DPP 26G	1.01	0.26	5.76
EC 381853	1.25	0.28	6.39
EC 381860	0.77	0.41	6.00
EC 381856	0.66	0.24	1.03
JI 1412	1.91	0.39	8.33
JI 1542	1.46	0.39	2.73
JI 1766(1)	1.87	0.39	15.06
JI 2437	1.41	0.44	8.91
Kinnauri	0.96	0.21	12.62
LMR 100	0.64	0.27	24.11
LMR 4	1.54	0.39	26.71
Mithi Phali	1.44	0.36	8.90
NDVP 12	1.73	0.33	4.53
Palam Priya	1.17	0.24	5.03
PHPMR	2.40	0.38	7.30
DPPLMR 41	0.62	0.28	10.36
PMR 9	0.91	0.40	5.73
Sugar Giant	1.84	0.25	20.30
Sel 82	2.30	0.24	18.11
T 10	2.01	0.34	24.35
UU 11	2.88	0.23	28.95
UU 12	1.61	0.34	17.20
'r'			
Leaflet infestation	0.487*	0.039	-0.193
Population	0.022	0.376	-0.312
Infestation index	0.344	0.201	-0.278

* Significant at 5% level of significance

infestation in the F_2 population of the different crosses revealed that the infestation ranged from 0.18-31.05 per cent in the cross Lincoln x DPPLMR 41, 0.58-32.89 per cent in Arkel x DPPLMR41, 2.50-30.14 in Lincoln x LMR 100 and 0.58-38.62 in Arkel x LMR 100 (Table 5). The data revealed that population derived from the crosses involving LMR 100 as the male parent exhibited lower leaflet infestation as compared to other crosses. Although hybrid population involving LMR 100 as male parent exhibited lower leaflet infestation yet the growth habit

Table 5
Leaflet infestation in parents and F_2

Parent/Crosses	*Range (%)*	*Mean (%)*	*Remarks (horticultural traits)*
Arkel	14.05-32.23	19.96	Good pod character, white flowers, medium height
DPPLMR 41	12.75-26.99	17.22	Good pod character, white flowers, medium height
Lincoln	15.00-38.39	30.78	Good pod character, white flowers, medium height
LMR 100	7.46-19.71	11.14	Tall plants, purple flowers, small pod, small seeds
Lincoln x DPPLMR 41	0.18-31.05	21.42	Good pod character, bold seeds, white flowers, medium height
Arkel x DPPLMR 41	0.58-32.89	23.93	Good pod character, white flowers, medium height
Lincoln x LMR 100	2.50-30.14	11.28	Majority of plants were tall, had purple flowers, small sized pods
Arkel x LMR 100	0.58-38.62	14.67	Majority of plants were tall, had purple flowers, small sized pods

Plate 1: Damage by Pea Leaf-Miner

and horticultural attributes of these populations were inferior to the hybrid population which involved DPPLMR 41 as resistant parent. The progeny of cross involving DPPLMR 41 as resistant parent exhibited desirable level of resistance along with horticultural traits, further investigations can yield better varieties.

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