

PATHOGENIC AND MORPHOLOGICAL VARIABILITY OF *Plasmopara halstedii*, THE CAUSAL AGENT OF DOWNY MILDEW IN SUNFLOWER

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SUMMARY

Isolates of *P. halstedii* collected from different parts of Karnataka, Maharashtra and Andhra Pradesh belong to a single race, i.e., race 100. Based on virulence pattern, they can be grouped into five different groups, A, B, C, D and E. Bangalore isolate was most virulent and Bidar isolate was least virulent. Morphological variations existed among the isolates with regard to the size of sporangiophores and sporangia. Sporangiophores were longer Dharwad isolate and sporangia were larger in Mysore and Latur isolates.

Key words: *Plasmopara halstedii*, downy mildew, pathogenic variability

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important source of vegetable oils and it keeps gaining popularity because of its high oil percentage and quality, short duration and thermophotinsensitiveness. More than 30 diseases have been identified on sunflower (Gulya *et al.*, 1994). Among these, downy mildew caused by *Plasmopara halstedii* (Farl.) Berl. and de Toni is the most destructive one (Kolte, 1985). Existence of physiologic races in *P. halstedii* is evident from reports of several workers from different parts of the world (Abdullah, 1983; Patil and Mayee, 1990). However, there is no proper information available about race pattern of *P. halstedii* and hence an attempt was made to generate information about physiologic races of *P. halstedii*.

MATERIAL AND METHODS

Twelve isolates were collected from different places and designated Ph 1 to Ph 12 (Table 1). These isolates were maintained and multiplied on the susceptible cul-

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tivar “Morden” using the radicle inoculation method. To segregate the race patterns, these isolates were inoculated on 15 international host differentials *viz.*, HA 300, RHA 266A, RHA 325 R, HA 61, RHA 274R, HA 335, HA 337, RHA 340R, DM2, HIR34, HAR, HAR5, DM4, DM5 and DM6. Seeds of host differentials were germinated in rolled paper towels. When radicles were about 3-4 mm in size, they were atomizer-sprayed with a fresh sporangial suspension prepared in sterile water. Inoculated seeds in the rolled paper towels were incubated at a temperature of 15°C for 48 h and symptom development was observed.

Table 1: Designations of the twelve *Plasmopara halstedii* isolates

No.	Locality of collection of isolates	Designation of isolate
1	Gadag	Ph 1
2	Bangalore	Ph 2
3	Dharwad	Ph 3
4	Mysore	Ph 4
5	Narendra	Ph 5
6	Latur	Ph 6
7	Hyderabad	Ph 7
8	Bailhongal	Ph 8
9	Davanagere	Ph 9
10	Haveri	Ph 10
11	Bidar	Ph 11
12	Parabhani	Ph 12

Virulence index of *P. halstedii* isolates

Virulence index was calculated by inoculating the susceptible cv. Morden. Observations were made on percent disease incidence and latent period required for expression of symptoms. Further, virulence index for each isolate was calculated using the following formula.

$$\text{virulence index} = \text{percent incidence} \times \frac{1}{\text{latent period}}$$

RESULTS AND DISCUSSION

It is evident from Table 2 that all of the collected isolates successfully produced the disease on HA300, which has no resistance genes. All isolates produced disease on true leaves of HA300. All other differentials were free from infection on true leaves although sporulation was observed on HA335 and HAR5 at the cotyledon stage. The obtained reaction was similar to race 100 or European race 1 (Table 3). It can be noted that the reaction was similar in all isolates collected, which is an indication that all the isolates belong to a single race, *i.e.*, race 100. This may be due to a limited spread of the pathogen, its homothallic nature and the narrow

genetic base of the sunflower genotypes grown in India. Similarly, Patil and Mayee (1990) reported that the sunflower downy mildew isolate from Latur was found to be the European race 1 (race 100).

Table 2: Reaction of different *Plasmopara halstedii* isolates on host differentials of sunflower

Sl. No.	Differential	Isolate											
		Ph 1	Ph 2	Ph 3	Ph 4	Ph 5	Ph 6	Ph 7	Ph 8	Ph 9	Ph 10	Ph 11	Ph 12
1	HA 300	S	S	S	S	S	S	S	S	S	S	S	S
2	RHA 266 R	R	R	R	R	R	R	R	R	R	R	R	R
3	RHA 325 R	R	R	R	R	R	R	R	R	R	R	R	R
4	HA 61	R	R	R	R	R	R	R	R	R	R	R	R
5	RHA 274 R	R	R	R	R	R	R	R	R	R	R	R	R
6	HA 335	R	R	R	R	R	R	R	R	R	R	R	R
7	HA 337	R	R	R	R	R	R	R	R	R	R	R	R
8	RHA 340 R	R	R	R	R	R	R	R	R	R	R	R	R
9	DM 2	R	R	R	R	R	R	R	R	R	R	R	R
10	HI R 34	R	R	R	R	R	R	R	R	R	R	R	R
11	HA R4	R	R	R	R	R	R	R	R	R	R	R	R
12	HA R5	R	R	R	R	R	R	R	R	R	R	R	R
13	DM 4	R	R	R	R	R	R	R	R	R	R	R	R
14	DM 5	R	R	R	R	R	R	R	R	R	R	R	R
15	DM 6	R	R	R	R	R	R	R	R	R	R	R	R

Table 3: List of international host differentials of sunflower selected for race identification studies, genes present and their reactions to the identified races of *Plasmopara halstedii*.

No.	Differential	Resistant gene/s present	Race reaction						
			1	2	3	4	5	6	7
1	HA 300	-	S	S	S	S	S	S	S
2	RHA 266 R	PI1	R	S	S	S	S	S	S
3	RHA 325 R	PI2, PIb	R	R	S	S	S	S	R
4	HA 61	PI2, 3 +?	R	R	S	S	S	R	R
5	RHA 274 R	PI2, 9, PIb	R	R	S	S	S	R	R
6	HA 335	PI6 +?	R	R	R	R	R	R	R
7	HA 337	PI7 +?	R	R	R	R	R	R	R
8	RHA 340 R	PI8 +?	R	R	R	R	R	R	R
9	DM 2	PI2, 5	R	R	R	S	S	S	S
10	HI R 34	PI4 +?	R	R	S	S	S	R	R
11	HA R4	PIf +?	R	R	R	R	R	R	R
12	HA R5	PIg +?	R	R	R	R	R	R	R
13	DM 4	PIc +?	R	R	R	R	S	R	S
14	DM 5	PId +?	R	R	R	R	S	R	R
15	DM 6	PIe +?	R	R	R	S	S	R	R

Table 4: Morphological variations among *Plasmopara halstedii* isolates

No.	Isolate	Sporangiophore length (μm)	Sporangiophore width (μm)	Sporangial size (μm)
1	Gadag (<i>Ph</i> 1)	487-770 (602)	5.00-12.50 (9.05)	12.50-27.50 $\times$ 12.50-17.50 (21.16 $\times$ 18.00)
2	Bangalore (<i>Ph</i> 2)	460-690 (595)	6.50-13.50 (8.95)	14.30-26.30 $\times$ 14.15-28.61 (20.65 $\times$ 17.97)
3	Dharwad (<i>Ph</i> 3)	575-675 (620)	7.50-10.00 (8.63)	17.50-25.00 $\times$ 15.00-20.65 (21.00 $\times$ 18.16)
4	Mysore (<i>Ph</i> 4)	525-650 (581)	10.00-15.00 (12.16)	17.50-27.50 $\times$ 17.50-22.50 (25.16 $\times$ 19.33)
5	Narendra (<i>Ph</i> 5)	325-650 (485)	7.50-10.0 (8.12)	17.50-27.50 $\times$ 15.00-20.00 (20.83 $\times$ 17.66)
6	Latur (<i>Ph</i> 6)	557-612 (595)	10.00-12.50 (11.05)	22.50-40.00 $\times$ 15.00-22.50 (25.17 $\times$ 17.67)
7	Hyderabad (<i>Ph</i> 7)	460-695 (580)	6.50-13.50 (8.92)	18.15-28.45 $\times$ 15.00-20.00 (22.30 $\times$ 17.50)
8	Bailhongal (<i>Ph</i> 8)	325-690 (565)	6.00-13.55 (8.15)	18.35-24.50 $\times$ 16.10 $\times$ 21.60 (21.85 $\times$ 19.35)
9	Davanagere (<i>Ph</i> 9)	470-630 (570)	5.00-12.5 (8.95)	14.65-27.30 $\times$ 15.00-21.00 (20.10 $\times$ 18.16)
10	Haveri (<i>Ph</i> 10)	430-685 (565)	7.50-10.00 (8.30)	17.85-26.50 $\times$ 15.89-21.50 (20.53 $\times$ 18.65)
11	Bidar (<i>Ph</i> 11)	470-630 (585)	5.00-13.00 (9.00)	15.00-25.65 $\times$ 14.65 $\times$ 21.30 (21.63 $\times$ 18.01)
12	Parbhani (<i>Ph</i> 12)	470-630 (565)	10.00-15.00 (11.05)	14.30-27.50 $\times$ 15.00-22.50 (20.65 $\times$ 17.67)

Numbers in parentheses are mean values.

Table 5: Virulence index (percent incidence $\times$ latent period⁻¹) of different *Plasmopara halstedii* isolates

No.	Isolate	Virulence index *
1	Gadag (<i>Ph</i> 1)	8.60
2	Bangalore (<i>Ph</i> 2)	12.11
3	Dharwad (<i>Ph</i> 3)	7.79
4	Mysore (<i>Ph</i> 4)	10.17
5	Narendra (<i>Ph</i> 5)	7.72
6	Latur (<i>Ph</i> 6)	9.81
7	Hyderabad (<i>Ph</i> 7)	10.20
8	Bailhongal (<i>Ph</i> 8)	7.85
9	Davanagere (<i>Ph</i> 9)	8.69
10	Haveri (<i>Ph</i> 10)	7.92
11	Bidar (<i>Ph</i> 11)	6.26
12	Parbhani (<i>Ph</i> 12)	8.90
	SEm $\pm$	0.24
	CD (1%)	0.70

*Average of three replications

Morphological variability

Mean sporangiophore length was highest in Dharwad (*Ph* 3) isolate (620 μm). The sporangiophore length ranged between 325 and 770 μm . Sporangiophore width was largest in Mysore (*Ph* 4) isolate. Sporangial size varied from $12.50 \times 12.50 \mu\text{m}$ to $40.0 \times 22.50 \mu\text{m}$. The mean sporangial size was highest in Mysore (*Ph* 4) and Latur (*Ph* 6) isolates (Table 4).

Virulence index

Results shown in Table 5 indicated that Bangalore (*Ph* 2) isolate was most virulent among the isolates tested with a virulence index of 12.11, followed by Hyderabad isolate (*Ph* 7) with a virulence index of 10.20. Bidar isolate was least virulent, recording the lowest virulence index of 6.26. Based on the virulence pattern of the isolate, the isolates were grouped into five groups as shown below.

Virulence group	<i>P. halstedii</i> isolate
Group A	<i>Ph</i> 2
Group B	<i>Ph</i> 4, <i>Ph</i> 6, <i>Ph</i> 7
Group C	<i>Ph</i> 1, <i>Ph</i> 9, <i>Ph</i> 12
Group D	<i>Ph</i> 3, <i>Ph</i> 5, <i>Ph</i> 8, <i>Ph</i> 10
Group E	<i>Ph</i> 11

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**ESTRE LA PATOGENOCIDAD Y VARIABILIDAD
MORFOLÓGICA EN *Plasmopara halstedii*, AGENTE
CAUSAL DEL DOWNY MILDEW DEL GIRASOL**

RESUMEN

Las aislaciones de *P. halstedii* provenientes de diferentes partes de Karnataka, Maharashtra y Andhra Pradesh pertenecen a una sola raza (raza 100). Sobre la base de patrones de virulencia, éstas pueden ser agrupadas en cinco diferentes grupos denominados A, B, C, D y E. El aislamiento de Bangalore fue el más virulento mientras que el de Bidar fue el de menor virulencia. Se observaron variaciones morfológicas entre aislamientos en relación al tamaño de los esporangióforos y los esporangios. El aislamiento de Dharwad presentó los esporangióforos más largos mientras que los aislamientos de Mysore y Latur presentaron los esporangios más grandes.

**ÉTUDE DE LA VARIABILITÉ PATHOGÈNE ET
MORPHOLOGIQUE DE LA SORTE *Plasmopara halstedii*,
CAUSE DE LA ROUILLE CHEZ LE TOURNESOL**

RÉSUMÉ

Des isolats de *P. halstedii* collectés dans différentes parcelles de Karnataka, Maharashtra et Andhra Pradesh appartiennent à une seule race, à savoir la race 100. La quantification de l'agressivité a conduit à l'identification de 5 groupes (A à E): l'isolat de Bangalore a été le plus agressif, et celui de Bidar le moins agressif. Des variations de longueur des sporangiophores et des sporanges ont été notées: la longueur des sporangiophores de l'isolat de Dharwad était la plus importante, tandis que les tailles des sporanges des isolats de Mysore et Latur étaient les plus importantes.