HOST RESISTANCE AND AGGRESSIVENESS OF A₁ AND A₂ MATING TYPES OF PHYTOPHTHORA INFESTANS IN POTATOES

P.H. Singh*1, B.P. Singh2, Lokendra Singh3, S.K. Kaushik and Vinay Bhardwaj1

ABSTRACT: Studies on the effect of host resistance on P. infestans aggressiveness revealed that mostly A₁ mating type was more aggressive than A₂ mating type. However, in some cases aggressiveness varied with host background. The aggressiveness of A₂ was more on seedlings of 10 crosses, whereas that of A₁ was more on seedlings of 6 crosses. The performance of mixture of A₁ and A₂ mating types also varied with host background. The aggressiveness of the mixture was, in general, higher than A₁ or A₂ alone on potato cultivars but its effect on seedlings of different crosses was not similar. No statistical differences were observed in aggressiveness of the two mating types when tested on germplasm accessions using detached leaves and tuber slice tests. It is concluded that aggressiveness of the two mating types varies with host background and the germplasm accessions need to be evaluated using both the mating types to select parents with durable host resistance for use in resistance breeding programme.

INTRODUCTION

Phytophthora infestans (Mont.) de Bary causing late blight of potato is heterothallic in nature and requires two mating types, A₁ and A₂, for sexual reproduction. Historically, A₂ mating type was restricted to central Mexico only, whereas A₁ mating type was known to occur throughout the world. As a result of several migrations during 1970's (3) the new strain (A₂ mating type) got introduced throughout the world in 1980's, including India (9). Studies carried out on the implications of the introduction of the new strain of P. infestans especially with regard to the durability of host resistance and disease epidemiology (1, 3, 13) indicated that the new strain is more aggressive than the old strain, so much so that the old strain has altogether been displaced or is at the verge of displacement in several regions (2, 4, 7, 8, 10). Aggressiveness is conditioned by several factors including weather and host resistance. Studies have been conducted on the effect of weather parameters on aggressiveness (5) but, information on the response of host background in potatoes to mating types is scanty. The present studies were designed to elicit information on this aspect.

MATERIALS AND METHODS

Materials

Ten potato cultivars, 20 segregating populations (F₁C₁), 15 germplasm accessions (CP numbers) and 19 clones from R-gene free B population were used for evaluating the aggressiveness of A₁ and A₂ mating types of P. infestans (Table 1).

Inoculum

One isolate each of A₁ and A₂ mating types belonging to race 1, 2, 3, 4, 5, 7, 8, 10, 11 was multiplied on potato tuber slices at 18±1°C. The zoosporangial suspension was prepared by dislodging the sporangia from...
tuber surface using sterile distilled water. The zoospores were released by incubating the zoosporangial suspension at 12°C for 90 minutes and the inoculum concentration was calibrated to $6 \times 10^4$ zoospores/ml using a haemocytometer.

**Aggressiveness**

Aggressiveness of the two mating types was assessed on the materials listed in Table 1 using seedlings/whole plant, detached leaf and tuber slice methods.

**Whole plant method:** Three plants each of 10 commercial cultivars having different grades of resistance (Table 1) were raised in the glasshouse and were transferred to the late blight screening chamber 40 days after planting. The pots were grouped into three sets. Set I was inoculated with A$_1$, set II with A$_2$ and set III with a mixture of A$_1$ and A$_2$ mating types. Fifteen leaves of each plant were inoculated using the filter paper discs dipped in zoospore suspension. The inoculated plants were incubated at 18±1°C and ≥90% RH under dark for two days. Thereafter, the chamber was illuminated by fluorescent light (120-140 μ moles m$^{-2}$ S$^{-1}$) for three days. Comparative fitness/aggressiveness of the two mating types was estimated by measuring the lesion area using following formula:

$$\text{Lesion area} = \pi/4 \ ab; \text{where } a = \text{length and } b = \text{breadth of the lesion.}$$

**Seedling method:** Fifty seedlings/tray (three trays/cross combination) were raised in the glasshouse during 1999-2001 representing 20 cross combinations. After six weeks, the trays were transferred to late blight screening chamber and mass inoculated by zoospore suspension of the two mating types and their mixture as explained above. Six days after incubation, blight infection was recorded as percent seedlings killed in each tray.

The aggressiveness of the two mating types was evaluated using detached leaf method as per details of Umaerus and Lihnell (12). Similarly, aggressiveness was evaluated using tuber slice method as per method described by Kaushik et al. (6).

**RESULTS AND DISCUSSION**

The two mating types showed significant variation in their aggressiveness on whole plants of different potato varieties tested (Table 2). Aggressiveness of A$_2$ mating type was comparatively higher on almost all the cultivars irrespective of their grade of resistance as compared to A$_1$ mating type. Comparative aggressiveness of the two mating types vis-à-vis their mixture revealed that aggressiveness of the mixture was, in general, higher than the aggressiveness of A$_1$ mating type. Similar trend was observed when the same set of varieties was tested using detached leaf method. However, no definite trend was observed when the aggressiveness of the two mating types was evaluated using tuber slice method. The aggressiveness of A$_2$ mating type was highest on tuber slices of cv. Kufri Chipsona 1 (Lesion area 11.67 cm$^2$ and 7.67 cm$^2$ in respect of A$_2$ and A$_1$ mating types respectively), whereas that of A$_1$ mating type was highest on tuber slices of cv. Kufri Jyoti (Lesion area 9.30 cm$^2$ and 7.06 cm$^2$ in respect of A$_1$ and A$_2$ mating types respectively).

There was no definite trend in the aggressiveness of the two mating types on the segregating populations studied. The aggressiveness varied with the host
Table 2. Comparative aggressiveness of $A_1$ and $A_2$ mating types on cultivars having different grades of late blight resistance

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Detached leaf method</th>
<th>Tuber slice method</th>
<th>Whole plant method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$A_1^*$</td>
<td>$A_2^*$</td>
<td>Mix*</td>
</tr>
<tr>
<td>Kufri Jawahar</td>
<td>4.2</td>
<td>4.6</td>
<td>4.9</td>
</tr>
<tr>
<td>Kufri Chipsona-I</td>
<td>5.3</td>
<td>6.1</td>
<td>4.3</td>
</tr>
<tr>
<td>Kufri Chipsona-II</td>
<td>3.1</td>
<td>3.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Kufri Lalima</td>
<td>1.1</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Kufri Badshah</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Kufri Kanchan</td>
<td>1.0</td>
<td>1.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Kufri Megha</td>
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<tr>
<td>Kufri Sutlej</td>
<td>1.3</td>
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<td>1.0</td>
</tr>
<tr>
<td>Kufri Jyoti</td>
<td>1.6</td>
<td>2.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Kufri Chandramukhi</td>
<td>9.5</td>
<td>7.5</td>
<td>8.7</td>
</tr>
</tbody>
</table>

LSD (0.05) Cultivar 0.77 1.18 0.53 Mating type NS 0.57 0.11 Cultivar × mating type NS 2.04 NS

*$A_1 = A_1$ mating type; $A_2 = A_2$ mating type; Mix = mixture of $A_1$ and $A_2$ mating types

Resistance & aggressiveness of $P. infestans$

The aggressiveness of $A_1$ mating type was more on seedlings of 10 cross combinations (CP 2370 x EX/A 680-16, CP 2378 x EX/A 680-16, CP 2346 x HB/83-39, CP 3255 x Katahdin, CP 3255 x CP 2132, CP 2110 x CP 2132, CP 3276 x CP 2132, CP 3072 x EX/A 680-16, CP 2110 x HB/83-39 and CP 3187 x EX/A 680-16) whereas that of $A_2$ mating type was more in case of 6 cross combinations namely, CP 2384 x EX/A 680-16, Kufri Jyoti x EX/A 680-16, CP 3272 x CP 2132, D 79-56 x CP 2183 and CP 3243 x Katahdin (Fig. 1). Similarly, the aggressiveness of mixture of $A_1$ and $A_2$ was more on seedlings of four crosses (CP 3072 x HB/83-39, CP 2000 x EX/A 680-16, CP 3276 x HB/83-39 and CP 2110 x EX/A 680-16). However, in case of seedlings of cross combination CP 2333 x HB/83-39, the aggressiveness of the two mating types as well as their mixture was equal.

There was no significant difference between the two mating types when evaluated on B population and germplasm accessions.

It was observed by Tooley et al. (11), Chycoski and Punja (1) and Fry (3) that $A_2$ mating type was comparatively more aggressive and was responsible for recurrence of late blight epiphytotics in Europe and America. Present studies, however, tend to suggest that the host background conditions the aggressiveness of the two mating types and as such no definite trend could be observed. The germplasm accessions, therefore, need to be evaluated using both the mating types in order to select parents with durable host resistance for use in late blight breeding programmes.

Fig. 1. Comparative aggressiveness of $A_1$, $A_2$ mating types and their mixture on cross combinations.
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LITERATURE CITED


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