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SECONDARY HOMOTHALLISM IN THE EGYPTIAN POPULATION OF PHYTOPHTHORA INFESTANS

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ABSTRACT

A three year study was conducted during the 2002, 2003, and 2004 growing seasons where blighted potato tubers and foliage were sampled from fields in different governorates (El-Minia; El-Gharbia; El-Behera; EI-Sharkia; El-Minofia) in Egypt. Out of 96 *P. infestans* isolates recovered in the first year (2002), only three isolates were oosporic of the secondary homothallic phenotype (SHP). In the second year (2003), four more SHP isolates were detected among 115 *P. infestans* isolates made. While in the third year (2004), seven isolates out of 118 were revealed. This constituted 3.1%, 3.4%, and 5.9% for the three years of the study, respectively. The SHP colonies were characterized, on V8 medium, by their waxy appearance, the lack of the aerial hyphae and the cultures were packed full with oospores. The isolates were still pathogenic despite the lack of viable sporangia. Propagations made from single zoospores and single hyphal tips of the analyzed SHP field isolates segregated A1 and A2 mating type colonies. This indicated that the secondary homothallic phenotype in the Egyptian population of *P. infestans* was a heterokaryon (or a heteroplasmon) of the A1 and A2 mating types that could segregate where new strains of *P. infestans* could be evolved. Occurrence of the oospores in this phenotype was a circumstantial evidence that mating does occur in the field. The increasing frequency of the SHP isolates, revealed in the present study (3.1%-5.9%), with its high oospore viability (37.4%) indicated that the threat posed by the interaction between A1 and A2 mating type isolates is real and creation of new more vigorous strains of *P. infestans* via this mechanism could not be excluded.

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***Keywords*: *Phytophthora infestans*,** potato, secondary homothallism, mating type.

INTRODUCTION

Phytophthora infestans, the causal agent of late blight of potato and tomato, was classified as a heterothallic fungus with two mating types, designated Al and A2 mating types, and amphigynous antheridium (Gallegly and Galindo, 1958; Savage *et al.*,1968). It was generally accepted that single cultures of A1 or A2 mating type were normally unable to form oospores unless paired with the other mating type on a suitable medium (Levin *et al*., 2001). However, some isolates of *P. infestans* were reported to form oospores in abundance in a single culture in different parts of the world (Vartanian and Endo, 1985; Mosa *et al*., 1989; Shattock *et al*.,1990; Ko, 1994; Pipe *et al*., 2000; Adame and Ristaino, 2004). This phenotype was referred to as homothallic (Vartanian and Endo, 1985; Niederhauser, 1991); secondary homothallic (Mortimer *et al*., 1977; Alexopoulos *et al*., 2000), the oosporic phenotype (Fyfe and Shaw, 1992), self-fertile (Tantius *et al.*, 1986; Pipe *et al*., 2000), or the A1A2 phenotype (Ko, 1994). Nature of this phenotype was studied in a number of *Phytophthora* species (Mortimer *et al*.,1977; Niederhauser, 1991; Fyfe and Shaw, 1992; Pipe *et al*., 2000) to establish whether it was a novel homokaryon genotype, a heterokaryon consisted of Al and A2 genotypes, or a mixture of A1 and A2 mating types hyphae. Occurrence of this phenotype in the field was considered by Shattock *et al*. (1990) as a circumstantial evidence that mating does occur in the field. This could be responsible for creating new strains of *P. infestans* that could constitute a threat to potato cultivation, in Egypt and all over the world (Shattock *et al.*, 1990; Ko, 1994; Pipe *et al*., 2000; Levin *et al.*, 2001; Adame and Ristaino, 2004).

The present study, therefore, was conducted to (i) reveal frequency of this phenotype in the Egyptian population of *P. infestans*, (ii) monitor the population dynamics of this phenotype, (iii) investigate characteristics of this phenotype, (iv) reveal nature of this phenotype and (v) evaluate the possible threat posed by this phenotype and its oospores to potato cultivation in Egypt.

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MATERIALS AND METHODS

Isolation and identification of the SHP isolates of *P. infestans.*

During the three years of 2002, 2003, and 2004 blighted potato tubers and foliage were sampled from fields in different governorates (EI-Minia; El-Gharbia; El-Behera; El-Sharkia; El-Minofia) in Egypt. Isolation and identification of the SHP field isolates were conducted according to Mortimer *et al*. (1977) and Pipe *et al*. (2000). Isolates were maintained on V8 medium (Ko, 1994) and if necessarily were stored for short period under sterile mineral oil. Ten of the SHP field isolates, representing the three years of the study and the different surveyed regions, were randomly taken and used in the following studies**:**

Pathogenicity.

Pathogenicity characteristics *i.e.,* time from inoculation to necrosis, time from inoculation to sporulation, lesion extension rate, and yield of sporangia were investigated using the detached leaflets technique (Al-Kherb *et al*., 1995). The tested SHP cultures, on V8, were flooded with sterile distilled water (20 ml/plate) with gentle rubbing with L-shaped glass bar to harvest sporangia. Sporangial suspension of each isolate was adjusted to $2x10^4$ sporangia/ml, chilled under 12°C for two hours and used to inoculate potato leaflets cv. Rossette with centric droplets of 0.03 ml. The inoculated leaflets were placed in a growth room at 18°C with 16 h. white fluorescent illumination and investigated at six hours intervals to score time to the first signs of necrosis and the first appearance of sporangia. Then, they were investigated daily to score the lesion extension rate until an isolate fully colonized the whole leaflet, hence, leaflets were washed in a certain amount of distilled water to harvest sporangia which microscopically counted to determine the yield of sporangia according to Fyfe and Shaw (1992).

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Characteristics of the recovered SHP isolates of *P. infestans*.

Plates of V8 medium were concentric inoculated with single plugs (5-mm in diameter) of seven-day-old culture of the tested SHP field isolates. Four replicate plates were conducted for each isolate and incubated at 18°C in darkness. Then, plates were subjected to the following investigations:

- **Colony morphology:** Morphology of the developed colonies of the tested SHP field isolates were investigated ten days after inoculation.
- **Growth rate**: This was conducted as the daily increase (mm/ day) in colony diameter until an isolate fully colonized the V8 plates.
- **Yield of sporangia:** Sporangia of ten-day-old-cultures of the tested isolates on V8 medium were harvested as previously described and counted under light microscope according to Fyfe and Shaw (1992).
- **Stability of the SHP field isolates:** Subculturing of the tested SHP field isolates was conducted on fresh V8 medium at one month intervals for six months. Inoculated plates were incubated at 18°C in darkness and monitored for any segregation.
- **Yield** of **oospores:** Culture plug (2-cm in diameter) containing oospores was excised from three-week-old V8 culture of each tested SHP isolate and blended in 20 ml sterile distilled water to obtain the oospore suspension. A 0.01 ml of the oospore suspension was investigated under 10x light microscope and oospores were counted. Five counts were conducted for each oospore suspension and mean yield of oospores was calculated (Pittis and Shattock, 1994).
- **Oospore abortion:** Oospores had disorganized contents were considered aborted (Rutherford and Ward, 1985). The same slide investigated above for yield of oospores were re-investigated under 40x light microscope for the aborted oospores. Five counts were conducted for each oospore suspension.
- **Oospore viability:** A 5 ml of the previously obtained oospore suspension was mixed with equal volume of 2M NaCI solution. Oospores responded to saline solution and plasmolysed were considered viable (Flier *et al*., 2001). A 0.01 ml of oospore suspension in saline solution was investigated under 40x light microscope for the

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plasmolysed oospores, in five counts for each oospore suspension.

- **Oospore germination:** A 10 ml of each oospore suspension was filtered through 20-um-pore nylon filters. Collected oospores were treated according to Pittis and Shattock (1994) and re-suspended in 5 ml sterile de-ionized water. A 0.5 ml of the resultant oospore suspension was spread over a thin-layer plate of V8 medium and incubated at 18°C under blue filter with background of continuous cool-white fluorescent light (Ko, 1994). Number of germinated oospores was recorded weekly for six weeks by investigating the plates under dissecting microscope.

Propagations from single zoospores and single hyphal tips.

Analysis of the SHP field isolates was conducted using single zoospore progeny and hyphal tip technique according to Fyfe and Shaw (1992) and Pipe *et al*. (2000) as follows:

Sporangia of seven-day-old culture of the SHP field isolates were harvested and chilled, as described earlier, for the release of zoospores. A 0.5 ml of the zoospore suspension was plated on a thin-layer-plate of rye-A medium (Caten and Jinks, 1968). Germination of the plated zoospores was monitored daily under dissecting microscope. Germinated zoospores (100 of each SHP isolate) were individually transferred to fresh rye-A plates and incubated at 18°C.

For hyphal tip propagation analysis, thin-layer plates of clarified rye-A medium (Caten and Jinks, 1968) were inoculated with culture plugs of the tested SHP isolates and incubated at 18°C until the hyphae had grown to 2-3 cm. Hyphal tips (100 for each single isolate) were excised on agar block under dissecting microscope and individually transferred to fresh rye-A plates and incubated at 18°C.

Mating types of the developed colonies, through the hyphal tip and single zoospore propagations, were determined against E14 *P. infestans* tester as described by Al-Argawy (2001). The E14 *P. infestans* tester as well as the ISM2 check isolate was kindly supplied by D. S. Shaw, University of Wales, UK.

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Statistical analysis: The obtained data were statistically analyzed according to Gomez and Gomez (1984) on the American Costat software.

RESULTS

The recovered SHP field isolates.

Isolates of the secondary homothallic phenotype (SHP) of *P. infestans* were detected in all of the three years (2002; 2003; 2004) of the present study (Fig. 1 & Table 1). However, They were detected in 2, 3, and 4 governorates (Fig. 1), in the successive three years respectively, out of the five governorates (El-Minia; El-Gharbia; El-Behera; El-Minofia; El-Sharkia) surveyed each year. This was in 2, 3, and 5 fields out of 21, 39, and 46 fields investigated. Three SHP isolates were detected among 96 *P. infestans* isolates made in the first year (2002), while in the second and the third year (2003; 2004) four and seven isolates were revealed out of 115 and 118 *P. infestans* isolates, respectively. This constituted 3.1%, 3.4%, and 5.9% in the three years, and 4.1% of the total 329 isolates recovered (Table 1).

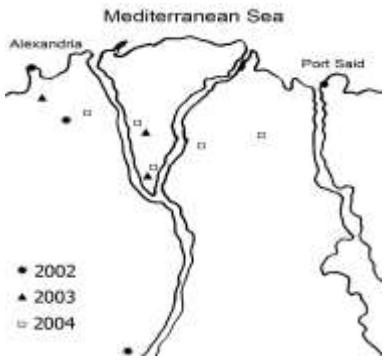

Fig. 1: Locations where the SHP isolates of *P. infestans* were recovered during the 2002, 2003, and 2004 growing seasons from different governorates in Egypt.

Pathogenicity.

The recovered SHP field isolates of *P. infestans* were all pathogenic to the cv. Rossette of potato, however, the isolates varied in their pathogenicity characteristics (Table 2). Time to necrosis ranged between 39.9 and 56.7 h. on potato leaves, while sporulation was occurred 62.5-79.6 h. after inoculation. Lesion extension rate ranged between 2.6 mm and 6.4 /day, while yield of sporangia was 376 - 1173 for the cm^2 of the infected leaf area (Table 2).

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Table (1): Frequency of SHP isolates of *P. infestans* recovered during the 2002, 2003, and 2004 growing seasons from different governorates in Egypt.

Year of isolation	Governorates	Fields	Isolates	% of SHP isolates
2002	2/5 [a]	2/21 [b]	3/96 [c]	3.1
2003	3/5	3/39	4/115	3.4
2004	4/5	5/46	7/118	5.9
Total		10/106	14/329	4.1 [d]

[a] Number of governoates where SHP isolates recovered/Total number of governorates surveyed, *i.e.* El-Minia; El-Gharbia; El-Behera; El-Minofia; El-Sharkia. [b] Number of fields where SHP isolates recovered/ Total fields investigated. [c] Number of SHP isolates/Total number of isolates recovered. [d] Mean percentage of SHP isolates recovered.

Table (2): Pathogenicity and pathogenicity characteristics of SHP field isolates of *P. infestans* recovered during 2002-2004 growing seasons from different governorates in Egypt.

Isolate code No.	Location & Governorate	Pathog-enicity	Time to necrosis (hours)	Time to sporulation (hours)	Lesion extension (mm/day)	Yield of sporangia (/cm^2)[a]
1/2002	El-Minia/M	+	47.3±4. 3 [b]	69.7±7.9	4.8±1.8	1062±215
2/2002	Dalangat/B	+	51.7±6.1	79.6±5.8	2.6±1.4	415±86
3/2003	Kafr Daw./B	+	44.5±4.9	71.8±5.2	4.1±2.2	1173±219
4/2003	El-Kalifa/G	+	39.9±5.8	64.2±6.4	4.4±2.6	585±94
5/2003	Tala/F	+	42.6±3.7	68. 4±5.4	2.8±1.4	795±72
6/2004	Tala/F	+	48.4±5.2	72.3±4.8	3.8±1.9	919±164
7/2004	Salhia/S	+	52.3±6.2	66.7±6.9	4.7±2.5	376±69
8/2004	Nakaria/S	+	56.7±4.3	78.2±4.5	6.4±2.9	691±108
9/2004	H. Eissa/B	+	49.8±3.9	64.9±5.6	3.7±1.9	728±91
10/2004	Kafr-Zaya./G	+	41.7±2.8	62.5±4.5	4.9±2.7	1046±298
ISM2(contr.)	-	+	42.6±3.6	66.2±4.4	4.3±1.3	726±186
Mean			47.4	69. 8	4.2	779

Assessment based on five replicates. + = Pathogenic. [a] Mean number of sporangia /cm^2 of plant leaflet. [b] Standard deviation. ISM2 is a standard SHP isolate obtained from the *Phytophthora* laboratory, University of Wales, UK, and used as a control. M = El-Minia, B = El-Behera, G = El-Gharbia, F = El-Minofia, S = El-Sharkia.

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Characteristics of the SHP field isolates of *P. infestans*.

Colonies of the SHP field isolates of *P. infestans* on V8 medium exhibited waxy appearance, lacked the aerial hyphae and the cultures were packed full with oospores (Fig. 2 a&b). The ten SHP field isolates analysed were stable (fertile) over the whole period of the study (Table 3). However, after several transfers, nine of the ten SHP isolates tested segregated self-sterile sectors of either A1 or A2 mating type (Fig. 2a & Table 3). The tested SHP field isolates of *P. infestans* varied in the radial growth rate as it ranged between 4.3 mm/day and 6.7 mm/ day and also in the yield of sporangia (6.3 - 21.7 x 10^3/ plate) on the V8 medium (Table 3).

(a) **(b)**

Fig. 2: a). Colony morphology of the SHP isolate, 9/2004, and segregatoin of self-sterile sector (SSC.) of A1 mating type. b). Oospores formed in abundance in SHP isolate, 10/2004, of *P. infestans*.

Table (3): Characteristics of the SHP field isolates of *P. infestans* recovered during the 2002-2004 growing seasons from different governorates in Egypt.

Isolate code No.	Stability	Segregated sector	Radial growth (mm/day)	Yield of sporangia ($x10^3$/ plate)
1/2002	+	A1	4.9±1.9*	13.7±2.1
2/2002	+	A1	6.4±2.1	11.6±2.7
3/2003	+	A1	5.8±1.8	21.7±3.4
4/2003	+	A1	6.7±2.2	13.5±1.9
5/2003	+	A2	4.5±1.1	18.1±3.1
6/2004	+	A1	5.4±1.8	6.3±1.2
7/2004	+	-	4.3±1.5	14.6±3.2
8/2004	+	A1	6.1±2.3	9.4±1.8
9/2004	+	A1	5.1±1.7	11.5±2.3
10/2004	+	A2	4.9±1.3	17.4±4.3
ISM2(contr.)	+	A1	5.2±2.1	13.2±2.9
Mean			5.4	13.8

Assessment based on five replicates of V8 medium plates. * Standered deviation.
+ = isolate is stable, *i.e.* remained fertile over subcultering for six months.
- = no segregation was occurred.

Characteristics of oospores of the SHP field isolates.

The tested SHP field isolates of *P. infestans* considerably varied in their content of oospores (Fig. 3) produced *in vitro* in V8 cultures. Yield of oospores produced ranged between 974 and 3296 per 1-cm-diameter disc of the V8 cultures. Percentage of aborted oospores (Fig. 3b) ranged between 12.7% and 33.1% with a tendency was almost parallel to the yield of oospores. Percentage of viable oospores (Fig. 3c) ranged between 12.9% and 56.1%. The oospore germination, however, was as low as 1.7%-5.8% with a trend approximately similar to percentage of oospore viability (Table 4).

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Fig. 3: a). Normal oospore, b). aborted oospore showing disorganized oogonial contents, and c). viable oospore showed plasmolysis in 2M NaCl solution, 10/2004 SHP isolate of *P. infestans*.

Table (4): Characteristics of oospores of SHP field isolates of *P. infestans* recovered during 2002-2004 growing seasons from different governorates in Egypt.

Isolate code No.	Yield of oospores [a]	% Oospore abortion	% Oospore viability	% Oospore germination
1/2002	2485±675[b]	32.2±5.1	44.1±4.3	3.5±1.9
2/2002	1396±381	19.1±3.6	33.7±2.9	2.3±1.2
3/2003	974±235	16.1 ±2.7	36.2±2.3	2.8±1.6
4/2003	2983±1053	21.7±4.3	12.9±1.9	1.7±1.1
5/2003	3296±1187	33.1±4.6	43.8 ±2.8	4.2±2.7
6/2004	1181±616	19.5±2.2	42.4±3.1	2.6±1.3
7/2004	2392±1096	28.5±5.2	29.1±2.2	2.4±1.8
8/2004	1318±511	12.7±2.3	56.1±4.8	3.9±1.7
9/2004	2515±842	21.9±3.4	52.4±3.8	5.8±2.1
10/2004	3129±612	18.2±2.7	23.2±2.5	3.1±1.4
ISM2(contr.)	1883±368	19.2±3.9	32.7±2.1	2.1±0.6
Mean	2167	22.3	37.4	3.2

Assessment based on five replicates, [a] Mean number of oospores produced in 1-cm diameter of V8 medium disc. [b] Standard deviation.

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Propagations from single zoospores and single hyphal tips.

Cultures derived from single zoospores of the analysed SHP field isolates were mostly self-sterile A1s (Table 5). However, two isolates, *i.e.* 4/2003; 10/2004, out of the ten isolates analysed yielded approximately equal frequencies (49%:48% ; 50:48, respectively) of the A1 and A2 mating type colonies. Meantime, progenies of the isolates analysed yielded low frequency (1-4%) of SHP colonies (Table 5). Single hyphal tips of the analysed SHP isolates segregated A1s and A2s in a manner approximately similar to the single zoospore segregation. The SHP colonies also occurred but at frequency of 1-6 % (Table 5).

Table (5): Percentage of segregation of analysed SHP field isolates of *P. infestans* recovered during the 2002-2004 growing seasons from different governorates in Egypt.

Isolate	Method of propagation					
	Single zoospores			Single hyphal tips		
	A1	A2	SHP	A1	A2	SHP
1/2002	84	14	2	87	9	4
2/2002	67	31	2	72	24	4
3/2003	96	2	2	92	6	2
4/2003	49	48	3	50	44	6
5/2003	74	22	4	97	2	1
6/2004	81	16	3	72	23	5
7/2004	-	-	-	62	32	6
8/2004	91	8	1	96	1	3
9/2004	67	29	4	68	28	4
10/2004	50	48	2	52	46	2
ISM2(contr.)	49	48	3	49	47	4
Mean	73.2	24.2	2.6	74.8	21.5	3.7

- = no zoospores were released.

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DISCUSSION

The oosporic cultures or the so called the secondary homothallic phenotype (SHP) of *P. infestans* were detected in all of the three years (2002; 2003; 2004) of the present study where potato was intensively cultivated in Egypt. This was in frequencies of 3.1%, 3.4%, and 5.9% for the three successive years, respectively. Occurrence of the SHP isolates in Egypt was not unexpected as it has been recorded in different parts in Europe (Tantuis *et al.,* 1986; Shattock *et al.,* 1990; Ko, 1994, Pipe, *et al*., 2000) from which Egypt routinely imports potato seeds for summer plantation. It had been also reported in USA, Japan, Australia, and Mexico in similar frequencies (Vartanian and Endo, 1985; Mosa *et al.,* 1989; Niederhauser,1991; Adame and Ristaino, 2004)

All the SHP isolates were pathogenic despite the lack of abundant sporangia. Culture of the SHP isolates exhibited a waxy appearance on the V8 medium, unlike the fluffy cotton appearance of the A1 and A2 colonies, and the cultures were packed full with oospores. This was in harmony with the results of Mortimer *et al*. (1977), Fyfe and Shaw (1992), and Pipe *et al*. (2000).

Nature of the SHP isolates has been studied in a number of *Phytophthora* species. Niederhauser (1991) suggested a homokaryotic nature in his Mexican SHP isolates of *P. infestans* as self-fertility transmitted through the uninucleate zoospores. However, Mortimer *et al.* (1977) indicated a heterokaryotic nature in his *P. drechsleri* isolates.

The present study, however, revealed that the analysed SHP isolates segregated A1 and A2 mating type colonies through the zoospore and hyphal tip propagation. This indicated that such Egyptian SHP isolates were heterokaryons (or heteroplasmons), *i.e.* somatic hybrids of A1 and A2 mating type hyphae. Supporting this view that heterokaryosis was documented in several *Phytophthora* spices (Layton and Kuhn, 1990; Pipe *et al*., 2000; Cook, *et al*., 2003). Hyphal fusion and somatic recombination were also demonstrated in

P. infestans (El-Refai, 1990; El-Farnawany and Amer, 1999). This was in harmony with Shaw (1991)" s view that this phenotype was a somatic hybridization of A1 and A2 mating type hyphae. Somatic hybridization and heterokaryosis were suggested (Kuhn, 1991) to be principal mechanisims for a proposed parasexual cycle in *P. infestans*. Besides, according to the Shaw (1991)'s view, the involved oospores of this phenotype is a result of matings between A1 and A2 mating type hyphae. Hence, genetic recombination was expected and the evolution of new races through any of these mechanisms could not be excluded. Such new races could constitute a threat to potato cultivation. The increasing frequency of the SHP *P. infestans* isolates occurred (from 3.1% to 5.9%) in the present study with its high oospore viability (37.4%) may indicate that the threat is real and the creation of new more aggressive strains of *P. infestans* via this mechanism should be considered. These results were supported by several investigators (Ko, 1994, Drenth *et al.*, 1995, Hanson and Shattock, 1998; Pipe *et al*., 2000; Smart *et al*., 2000; Levin *et. al.*, 2001; Cook *et al*., 2003; Ghimire *et al*., 2003; Adame and Ristaino, 2004). More studies are needed for a better understanding for nature of this phenotype and the factors and mechanisms affecting its oospore formation, viability, and germination in nature to avoid a sudden outbreak of unexpected epidemics of *P. infestans*.

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الملخص العربى

التماثل الثانوى للثالوس فى عشيرة فطر الفيتوفثورا إنفستانز بجمهورية مصر العربية

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فى دراسة عن مدى تواجد وطبيعة الطراز "الثالوس ثانوى التماثل(SHP)" فى عشيرة فطر الفيتوفثورا إنفستانز، مسبب مرض اللفحة المتأخرة فى البطاطس، فى مصر، جمعت نباتات بطاطس مصابة باللفحة المتأخرة على مدى الأعوام 2002، 2003 ، 2004 وذلك من محافظات المنيا، الغربية، البحيرة، الشرقية، المنوفية. تم الكشف عن ثلاث عزلات من الطراز SHP بين 96 عزلة من فطر الفيتوفثورا إنفستانز تم عزلها فى العام الاول من الدراسة (2002)، و فى العام الثانى (2003) كشف عن 4 عزلات SHP بين 115 عزلة، بينما فى العام الثالث (2003) تم الكشف عن 7 عزلات بين 118 عزلة، وعلية شكل الطراز SHP 3.1% ، 3.4% و 5.9% من عشيرة فطر الفيتوفثورا إنفستانز للسنوات الثلاث على التوالى. تميزت مزارع عزلات الطراز SHP (على بيئةV8) بمظهرها الشمعى والإفتقار للنمو القطنى و بمحتواها المرتفع من الجراثيم البيضية، كما أظهرت العزلات ثباتاً حيث لم تفقد خصوبتها على مدى الفترة المختبرة (6 أشهر) وكذا القدرة على إحداث المرض على أوراق نباتات البطاطس (صنف Rossette). أظهرت دراسة طبيعة هذا الطراز، من خلال تكنيك دراسة طبيعة أطراف الهيفات والجراثيم السابحة المفردة أحادية الانوية، أن هذا الطراز فى العزلات المصرية عبارة عن ميسليوم متباين الانوية Heterokaryon من الطرازين A1 و A2 فقد أعطت العزلات عند تحليلها كلا الطرازين ولكن بنسب غلب عليها الطراز A1 فى العزلات العشرة المختبرة كما أيد ذلك أن أغلب العزلات (9 من10) أعطت قطاعات لانعزالات لأى من الطرازين فى مراحل من تجديد المزرعة. كما أن الجراثيم البيضية المصاحبة لهذا الطراز تشكل دليلاً على حدوث التزاوج بين الطرازين A1 و A2 مما يجعل هذا الطراز SHP ، الذى وجد أن نسبته تتزايد من عام لاخر (3.1%-5.9%) وكذا الانعزالات التى تحدث به والجراثيم البيضية الموجودة به بما لها من حيوية عالية (37.4%) ، قد يشكل مصدراً لسلالات جديدة من فطر الفيتوفثورا إنفستانز مما يهددً زراعات البطاطس بمصر.