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Comparison of the Turkish pathotypes of *Synchytrium endobioticum* causing wart disease of potato with Ukrainian pathotypes

Patates siğil hastalığına neden olan *Synchytrium endobioticum*'un Türkiye patotiplerinin Ukrayna patotipleri ile karşılaştırılması

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ABSTRACT

Potato Wart Disease (PWD) caused by *Synchytrium endobioticum* is a serious disease restricting potato yield in the infested areas, which has a limited distribution in the world. The main approach to control the disease is to restrict its dissemination by legislative measures and growing of resistant varieties in the infested areas. In this study, pathotypes of fourteen isolates collected from Nevşehir (7), Niğde (5) and Kayseri (2) provinces of Turkey, and multiplied were determined according to Zelya and Melnik (2007) by using Ukranian differential potato varieties of Poliska rojeva, Svitanok kyivskiy, Volovetska, Kobza, Nesabudka, Kosin-95, Barbara, Bojedar which are used for Ukrainian pathotypes. In this way pathotypes of Turkey were compared with Ukranian pathotypes. Because two of the isolates (Nevşehir 1 and 5) were also tested before and were not assigned any of the European pathotypes. The other isolates used in the study were obtained later on. None of the isolates belonged to the Ukrainian pathotypes but 7 pathotypes were differentiated by Ukrainian differentials. These isolates also did not hold the characteristics of Czech pathotypes according to the relevant literature.

INTRODUCTION

Synchytrium endobioticum (Schilb.) Percival, the agent of potato wart disease, is an A2 pest for the EPPO region and the most important quarantine pathogen of the potato. The pathogen mainly attacks the underground parts of the potato plant but stems, leaves and flowers can also be infected (EPPO 2017) and crop losses may amount up to 50-100% (Hampson 1993, Melnik 1998). Once the pathogen has been introduced to a field of potato cultivation, the whole crop may be devastated and unmarketable. Moreover, introduction into the soil not only renders the crop unusable but the soil itself cannot be used for further crop production due to the longevity of the fungus (Anonymous 2018).

Fourty three pathotypes of *S. endobioticum* have been identified in Europe so far and five of them, namely 1(D1), 2(G1), 6(O1), 8(F1) and 18(T1) occur while some of them are not exist (Baayen et al. 2006, EPPO 2004). On the other hand, five pathotypes; 1(D1), 11(M1), 13(R2), 18(Yasinya), 22(Bystres), one being the same as European, occur in

Ukraine. The pathotypes described so far are Netherlands, Germany, Czech Republic, and Ukraine origin. Usually different pathotypes are present in different countries and various differential varieties are used for pathotype identification although a standard differential set is accepted in Europe (Baayen et al. 2006).

According to European Economic Community (EEC) Council Directive 69/464/CEE (Anonymous 1969) resistant varieties are proposed to be sown around the infested areas in order to prevent the spread of PWD. For this, pathotypes of the PWD have to be known since the resistance of the varieties change with the pathotypes.

Pathotypes of PWD have not been extensively determined in Turkey. In 2005-2007, pathotypes of four isolate; one from Ordu (1) and 3 from Nevşehir (3), were determined by using two different methods; Glynne-Lemmerzahl and Spieckermann and the differential varieties of Tomensa, Sorka, Saphir, Desiree, Miriam, Sissi, Karolin, Ulme, Belita. With this study; Ordu isolate was designated as European pathotypes 1(D1) and one of the Nevşehir isolates as 6(O1)/18(T1). The remaning two isolates from Nevşehir did not show the characteristics of the any European pathotypes and proposed to be named as 38(Nev) (Çakır et al. 2009). After this report, PWD has spread in the infested areas and to the neighbour provinces of Niğde and Kayseri. The possibility of arising new pathotypes not belonging to the European pathotypes has lead us to compare the possible pathotypes with the Ukrainian pathotypes.

With this study, pathotypes of two isolates tested before and 12 new isolates collected from three provinces were searched for by using Ukrainian differential set for PWD in collaboration with Ukrainian Scientific-Research Plant Quarantine Station (UAAS), Chernivtsi Region, Ukraine. Since some of the Turkey's pathotypes did not match any of the European pathotypes (Çakır et al. 2009) and Ukraine is an important potato producing country having different pathotypes than Europe.

MATERIALS AND METHODS

Pathotypes of 14 isolates of PWD collected from Nevşehir (7), Niğde (5) and Kayseri (2) provinces of Turkey were compared with five Ukrainian pathotypes [1(D1), 11(M1), 13(R2), 18(Yasinya), 22(Bystres)] by using Zelya and Melnik (2007) method. With the surveys carried out the above mentioned provinces, potato tubers were checked by following a zigzag pattern. From fourteen locations, fresh wart tissues were collected from diseased tubers and their locations were given in Table 1. Since the occurence of PWD is restricted two or three plants at the beginning of the infestation the isolates were obtained from those infected plants. The warts were removed from the infected parts and the material was admitted as one isolate from that field. The infected tissue from each field was propagated on Agria or Marfona potato varieties in laboratory and compost of each sample was prepared by Spieckermann method, which was admitted as one isolate of PWD (Spieckermann and Kothoff 1924). Inoculation of Ukranian differential varieties was made according to Zelya and Melnik (2007) method but instead of fresh warts the compost of the isolates used.

According to this method, an intact eye bud of every Ukrainian differential potato variety; Poliska rojeva, Prolisok, Svitanok kyivskiy, Volovetska, Kobza, Nesabudka,

Table 1. The locations of the isolates of *Synchytrium endobioticum* collected from Nevşehir, Niğde and Kayseri provinces

Nevşehir 1 Nevşehir/Kaymaklı county	Nevşehir 8 Nevşehir/Merkez Çardak village Eneği boğazı location	Niğde 2 Niğde/Merkez Gölcük village Yatmış location	Kayseri 1 Kayseri/Yeşilhisar Derbentbaşı village
Nevşehir 5 Özlüce village Kaymaklı	Nevşehir 9 Nevşehir/Merkez Çardak village, Çekirge location	Niğde 3 Niğde Merkez Gölcük village Yatmış location	Kayseri 2 Kayseri/Yeşilhisar Gülbayır village
Nevşehir 6 Nevşehir/Merkez Kaymaklı Özlüce border	Nevşehir 10 Nevşehir/Merkez Çardak village, Eneği boğazı location	Niğde 4 Niğde Merkez Gölcük village Bulduk location	
Nevşehir 7 Nevşehir/Merkez Derinkuyu county Güneyce village Yılancıbaşı location	Niğde 1 Niğde/Merkez Ağcaşar village	Niğde 5 Alay county Yalvaç ruins	

Kosin-95, Barbara and, Bojedar (Table 2), was selected and the eye field was sealed with Vaseline + paraffin (1+1) filled with water (Figure 1a) then eye fields were inoculated by 2-3 g of compost prepared according to Spieckermann test method (Figure 1b) The other eyes were removed from the tuber. For every potato variety, nine tubers were used and this was repeated three times, totally 36 eye fields were evaluated. The potato varieties P85 145-5 hybrid or Lorh, known to be susceptible against all of the pathotypes of PWD were used as controls for the tests.

The inoculated tubers were kept at 11-13 °C in dark for 24 hours, then transferred to at 17-18 °C in a climatic chamber (Zelya and Melnik 2007), for 2-2.5 months by moistening daily until the test completed. Reactions of potato varieties were determined by using the scale given in Table 3 (Saltykova and Yakovleva 1976).

The reactions of Turkish isolates against *S. endobioticum* were compared with the reactions of the Ukrainian differential potato varieties given in Table 4.

Table 2. Differential potato varieties used for identification of the pathotypes of *Synchytrium endobioticum* and the reactions of Ukrainian pathotypes

Potato varieties	Pathotypes/Reactions				
	1	**11**	**13**	**18**	**22**
Poliska rojeva	S	S	S	S	S
Prolisok	R	S	S	S	S
Svitanok kyivskiy	R	S	S	S	S
Volovetska	R	R	S	S	S
Kobza	R	S	S	R	S
Nesabudka	R	S	S	S	R
Kosin-95	R	S	R	R	S
Barbara	R	S	S	R	R
Bojedar	R	R	R	R	R

R: Resistant, S: Susceptible

Figure 1. Experimental design showing the pathotype differentiation of *Synchytrium endobioticum*. a) Filling the eye fields encircled with vaseline + paraffin (1+1) with water, b) Addition of compost to the watered area

Table 3. The disease rating used to assign the pathotypes of *Synchytrium endobioticum* according to Saltykova and Yakovleva (1976) scale

Group 1 (resistant)	Necrosis on infected sprouts, solitary sori (maximum five on each sprout)
Group 2 (resistant)	Late localized necrosis or general necrosis, scattered or dense sori without necrosis
Group 3 (susceptible)	Deformed sprouts and warts usually present

RESULTS AND DISCUSSION

Reactions of Ukrainian potato differentials against fourteen *S. endobioticum* isolates collected from Nevşehir (7), Niğde (5) and Kayseri (2) provinces and tested as described by Zelya and Melnik (2007) are given in Table 4.

As indicated in Table 4, none of the reactions produced by 14 isolates of *S. endobioticum* on Ukrainian differential varieties match to the reactions produced by Ukrainian pathotypes. The fourteen Turkish isolates can be assigned to seven different pathotypes. Two isolates from Kayseri belong to two pathotypes, based on only reactions on one potato variety, Volovetska. One of the isolate from Nevşehir, isolate 10, produced identical reaction with the isolate 1 of Kayseri.

The rest of the Nevşehir isolates formed 3 pathotypes; three of them (1, 5, 6), two of them (7, 8) and one of them belonging different pathotypes. Niğde isolates also produced two different reaction groups then the ones of Kayseri and Nevşehir. The two groups formed by Niğde isolates are also differentiated by only on potato variety, Kosin-95.

Some of the differential varieties used in Poland are also used in Check republic to determine the pathotypes of *S. endobioticum* (Baayen et al. 2006). For instance, the variety Barbara is used in both of the countries and produces susceptible reaction against the Check pathotypes of 11, 13, 15, 17, 19, 23, 24, 25, 30, 32, 33, 34, 37, 16, 28, 29, 31, 35, 36, 26, 27. All of the Turkish isolates, on the other hand, produced resistant reaction on this variety. This shows

Table 4. Reactions of Ukrainian pathotypes and Turkish *Synchytrium endobioticum* isolates on Ukrainian differential potato varieties

Ukrainian differential varieties	Reactions of Ukrainian pathotypes					Reactions produced by Turkey's isolates of *S. endobioticum*													
						Kayseri isolates		Nevşehir isolates							Niğde isolates				
	1	11	13	18	22	**2**	**1**	**10**	**1**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**
Poliska rojeva	S	S	S	S	S	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Prolisok	R	S	S	S	S	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**
Svitanok kyivskiy	R	S	S	S	S	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Volovetska	R	R	S	S	S	**S**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**S**	**S**	**S**	**S**	**S**	**S**
Kobza	R	S	S	R	S	**R**	**R**	**R**	**S**	**S**	**S**	**R**	**R**	**S**	**S**	**S**	**S**	**S**	**S**
Nesabudka	R	S	S	S	R	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**R**	**R**	**R**	**R**	**R**
Kosin-95	R	S	R	R	S	**R**	**R**	**R**	**S**	**S**	**S**	**S**	**S**	**S**	**R**	**R**	**S**	**S**	**S**
Barbara	R	S	S	R	R	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**
Bojedar	R	R	R	R	R	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**

S; Susceptible, R; Resistant

that some Turkish pathotypes also do not match Check pathotypes.

The potato variety Saphir is used as a differential variety both in Europe and outside of Europe. With the previous work in Turkey, this variety was found to have susceptible reaction against Nevşehir and Niğde isolates while it showed resistant reaction to 1, 4, 5, 6, 7, 8, 9, 10, 18, 20, 16, 28, 29, 35, 36, and 27 Check pathotypes. While the variety Desiree showing resistant reaction to European pathotypes it shows susceptible reaction to Check pathotypes of 2, 4, 5, 6, 8, 9, 10 and 18. When these results are compared with the reactions of Check pathotypes, according to Baayen et al. (2006) reactions of Turkish isolates do not also match to Check pathotypes.

With the study carried out in the years 2005-2007, one isolate from Ordu (Ordu 1) was assigned to European pathotypes 1 (D1) the other isolate Nevşehir (1) was assigned to two different pathotypes by the European differentials at two different tests in two years as 6(O1) or 18(T1). Two isolates from Nevşehir, Nevşehir (2) and Nevşehir (3) did not match any of the European pathotypes by the tests done in two years and the isolates were named as Nev38 (Çakır et al. 2009). It is known that various climatic conditions and Solanaceous weed hosts of *S. endobioticum,* such as *Solanum nigrum* and *Hyoscyamus* spp., *S. dulcamara*, *Physalis* spp. play important role in the formation of new pathotypes (Melnik 1998). Occurrence of the weeds, *Solanum nigrum, Hyoscyamus* spp. and *S. dulcamara* frequently in the infested areas suggest that new pathotypes can be formed in those areas of Turkey, which is climatically quite different than the potato growing areas of Europe. With the studies carried out at two potato fields in Derinkuyu (Nevşehir) in 2014, Çakır (2017) determined two pathotypes of *Synchytrium endobioticum*, pathotype 2(G1) and 18(T1), the latter also being found previously in Turkey. With the studies conducted in Turkey, it can be stated that all the Europen pathotypes are present in Turkey after the declaration made by EPPO that pathotype 8(F1) is identical with pathotype 18(T1). Pathotypes, especially in recently contaminated fields should be investigated. In order to determine and bred resistant potato varieties against PWD, pathotypes should be searched regularly.

ÖZET

Synchytrium endobioticum'un neden olduğu Patates Siğil Hastalığı (PSH), dünyada sınırlı bir dağılıma sahip olan, bulaşık alanlarda patates üretimini sınırlandıran önemli bir hastalıktır. Hastalığın kontrol altına alınmasında ana yaklaşım; hastalığın yasal tedbirlerle yayılmasını kısıtlamak ve bulaşık alanlar etrafında dayanıklı çeşitlerin yetiştirilmesidir. Bu çalışmada, ülkemizde PSH ile bulaşık olan Nevşehir (7), Niğde (5) ve Kayseri (2) illerinden toplanarak çoğaltılan on dört izolatın patotipleri; Ukrayna'da mevcut patotiplerin ayrılmasında kullanılan patates varyeteleri Poliska rojeva, Svitanok kyivskiy, Volovetska, Kobza, Nesabudka, Kosin-95, Barbara, Bojedar kullanılarak, Zelya and Melnik (2007) yöntemi ile belirlenmiştir. Bu şekilde Türkiye izolatları ile Ukrayna patotipleri karşılaştırılmıştır. Çünkü araştırmamızda ele alınan izolatlardan ikisi (Nevşehir 1 ve 5) daha önce test edilmiş ve Avrupa patotiplerinin hiç birine uymadığı belirlenmiştir. Çalışmada ele alınan diğer izolatlar ise sonra elde edilmiştir. Çalışma sonucunda izolatların hiçbirinin Ukrayna patotipleri ile benzerlik göstermediği, ancak birbirinden farklı 7 patotipe ayrıldığı belirlenmiştir. Bu patotiplerin yapılan literatür değerlendirmesine göre Çek patotiplerinin özelliklerini de taşımadığı belirlenmiştir.

Anahtar kelimeler: Patates siğil hastalığı, *Synchytrium endobioticum*, Ukrayna ayırıcı çeşitleri, Türkiye patotipleri

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