Host Range And Host (Un)Specificity Of Different Isolates Of *Polymyxa betae*

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Summary

Five soil samples were taken from sugar beet growing areas in France (3), England (1) and Czech Republic (1). Sugar beet, *Chenopodium album*, *C. murale*, *C. ficifolium*, *Portulaca oleracea*, and *Amaranthus retroflexus* as possible hosts of specific formae speciales were sown in these samples. After six weeks roots of baiting plants were checked for the presence of *P. betae* cystosori. If they were not found every two weeks other plants were checked. Roots containing cystosori were harvested and homogenized in water. The homogenates were used to inoculate the same plants host in sand cultures. Using this method we obtained *P. betae* isolates from sugar beet and *C. murale* from all soil samples and two isolates from *C. album*. Roots of plants were used for the enrichment of *P. betae* population in sand. Then all host species were sown in these sands and roots of plants were checked as described above. Sugar beet and *C. murale* were infected in all soils. *C. ficifolium* and *C. album* were infected in three soils; *A. retroflexus* in one soil and *P. oleracea* has never been infected. On the contrary, after the enrichment of population of given isolate in sand all other hosts were always infected with two exceptional cases of *A. retroflexus* only. It means that there is almost no host specificity of different isolates. In different trials seeds of potential host species were sown into soil containing *P. betae*. The procedure was similar as described above. Some new host of *P. betae* were found.

Introduction

Soil protist *Polymyxa betae* described as a sugar beet parasite by Keskin (1964) is important as a vector of some viruses infecting sugar beet occurring almost worldwide where it is grown, namely *Beet yellow vein virus* (BNYVV), *Beet soilborne virus* (BSBV), and *Beet virus Q* (BVQ). Especially BNYVV causes very serious losses of sugar if resistant varieties are not used on contaminated fields (e.g. Putz, 1982). Other viruses could enhance the losses caused by BNYVV even when this was proved in pot trials only (Prillwitz and Schlösser, 1992). *P. betae* has rather wide host range. It includes according to Keskin (1964) *Beta vulgaris*, *B. vulgaris cicla*, *Chenopodium bonus henricus*, *C. capitatum*, *C. foliosum*, *C. album*, *C. sandwicheanum*, *Spinacia oleracea*, *Salsola kali*, and *Atriplex hortensis*. Later on, Ivanovic et al. (1983) added these plants: *Amaranthus retroflexus*, *C. quinoa*, *C. hybridum*, *Montia perfoliata* and *Stellaria media*. Barr and Asher (1992) and Hugo et al. (1996) found some new hosts from *Papaveraceae* and *Silenaceae* families. Subikova and Bojnansky described some object resembling cystosori also in roots of some asteraceous species. Recently the host range of *P. betae* was extended by Legreve et al. (2005).

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Certain differences in ability to infect other plant species were found in some *P. betae* isolates. For instance, according to Barr (1979) isolate from *C. album* doesn´t infect sugar beet, *A. retroflexus*, and *Kochia scoparia*. Goffart et al. (1989) tested 7 European *P. betae* isolates. All of them infected sugar beet, fodder beet and spinach, four of them infected *C. murale*, two infected *C. album* and none was able to infect *Portulaca oleracea*. This species is described as a host from Japan (Abe and Ui, 1986) and isolate from it is rather specific for this host. On the other hand Gerik and Duffus (1987) haven´t found so high specificity of *P. betae* isolates. As great differences among these reports exist we wanted to make the situation clearer.

Materials and methods

Five soil samples were taken from sugar beet growing areas in France (3 –Northern France, Oise, Bourgogne), South-East England and Czech Republic. Sugar beet, *Chenopodium album*, *C. murale*, *C. ficifolium*, *Portulaca oleracea*, and *Amaranthus retroflexus* as possible hosts of specific formae speciales were sown in these samples. After six weeks roots of baiting plants were checked for the presence of *P. betae* cystosori by light microscope. And results were recorded. Roots containing high numbers of cystosori were harvested and homogenized in distilled water by using pestle and mortar. The homogenates were used to inoculate the same host plants. So, each obtained isolate was multiplied in this way. Using this method we obtained *P. betae* isolates from sugar beet and *C. murale* from all five soil samples and two isolates from *C. album*. In other plant species/soil combinations the number of cystosori was not high enough to enable further study. Roots of plants were used for enrichment of *P. betae* population in the sand. Then all host species were sown in these sands and roots of baiting plants were checked as described above.

In separate trials host range of *P. betae* was further studied. Two soil samples were taken from sugar beet growing area in Central Bohemia. Tested plant species from belonging to the families of *Chenopodiaceae*, *Amaranthaceae*, and *Caryophyllaceae* as the most probable hosts were sown into these soils. Roots of baiting plants were checked as described above with the same repeating and/or resowing of seeds if cystosori were not found. Altogether more than 30 species were tested.

Results and discussion

Sugar beet and *C. murale* were heavily infected in all 5 soils. *C. ficifolium* and *C. album* were infected in three soils; *A. retroflexus* in one soil and *P. oleracea* has never contained cystosori. On the contrary, after the enrichment of population of given isolate in sand all other hosts were always infected with two exceptional cases of *A. retroflexus* only. It means that there is almost no host specificity of different isolates of *P. betae* (Table 1). Thus the differences in host range of different isolates described by other authors (Goffart et al., 1989) could be simply caused by attractiveness of various plant species. In the case of less attractive host the number of cystosori is low and so they are difficult to be observed under microscope. Infection pressure could also play significant role. Without enrichment we were not able to find infection of some species in some soils (*A. retroflexus*) but after the

enrichment it was infected by at least one isolate from each soil (either from sugar beet or from *C. murale*). Unfortunately we were not able to obtain population from *A. retroflexus* strong enough to be used for infection of other species and verify whether it is really specific for this host. *P. betae* isolates capable to infect *P. oleracea* probably occur in Japan and maybe in the USA only, as no infection of this plant species has yet been found in Europe (this study, Goffart et al., 1989).

Table 1. Host specifity of P. betae isolates obtained from various soils and hosts.
1-5 number of soil sample; Bv *Beta vulgaris* (species from which the isolate was obtained), Cm *Chenopodium murale*, Ca *C. album;* + cystosori found, - cystosori not found, 0 not tested

isolate / baiting species	Bv5	Bv4	Bv3	Bv2	Bv1	Cm5	Cm4	Cm3	Cm2	Cm1	Ca5	Ca4
Beta vulgaris	0	0	0	0	0	+	+	+	+	+	+	+
C. murale	+	+	+	+	+	0	0	0	0	0	+	+
C. ficifolium	+	+	+	+	+	+	+	+	+	+	+	+
C. album	+	+	+	+	+	+	+	+	+	+	0	0
A. retroflexus	-	+	+	+	+	+	-	+	+	+	+	+

Among all tested plant species for host range of *P. betae* sugar beet and spinach served as control species. In all cases they were very readily infected. Almost the same results were obtained with three subspecies of *B. vulgaris*: *maritima*, *macrocarpa*, and *orientalis*. Further good hosts are *C. murale*, *C. quinoa*, and *C. amaranticolor*. They were infected in most cases and usually contained high numbers of cystosori. *C. vulvaria*, *C. album*, *C. gigantheum*, *C. polyspermum*, *C. glaucum* and *C. urbicum* were infected in about 50 % of cases and usually contained smaller numbers of cystosori. Only exceptionally and in small amounts cystosori were found in *A. lividus*, *A. blitum*, *A. hybridus*, *C. botrys*, *Atriplex rosea*, and *Arenaria procera*. *A. blitioides*, *C. ambrosioides*, *C. schraderianum*, *C. ugandae, Axyris amaranthoides*, *Atriplex sagittata*, *Atriplex calotheca*, *Stellaria graminea*, *Minuartia laricifolia*, *Petrorhagia saxifragae*, *Cerastium lanatum*, *Celosia argentea* and *Beta patellaris* have never contained the cystosori and can be regarded as non hosts and/or very poor hosts (Table 2). The question is how they could be infected after the enrichment. In any case, for such host range studies it would be useful to use some other method for the detection of *P. betae* (PCR) to be sure that in the case of low number of cystosori it is really infection by *P. betae*. Moreover, in some plant species plasmodia or zoosporangia could be present but without cystosori. PCR could reveal such "hidden" infections. Such tests were done by Legreve et al. (2005) recently.

Table 2. Tested plants as hosts and not hosts of *P. betae*

Very good hosts	Sugar beet, spinach *B. vulgaris* ssp. *macrocarpa* *maritima* *orientalis*
Good hosts	*C. murale* *C. quinoa* *C. amaranticolor*
Medium hosts	*C. vulvaria* *C. album* *C. gigantheum* *C. polyspermum* *C. glaucum* *C. urbicum*
Bad hosts	*A. lividus* *A. blitum* *A. hybridus* *C. botrys* *Atriplex rosea* *Arenaria procera*

Non hosts and/or very poor hosts	*A. blitioides* *C. ambrosioides* *C. schraderianum* *C. ugandae* *Axyris amaranthoides* *Atriplex sagittata* *Atriplex calotheca* *Stellaria graminea* *Minuartia laricifolia* *Petrorhagia saxifragae* *Cerastium lanatum* *Celosia argentea* *Beta patellaris*

To our knowledge, some of the above mentioned species have never been listed before as hosts of *P. betae*: *A. lividus, A. blitum, Arenaria procera, Atriplex rosea, C. urbicum, C. gigantheum,* and *C. glaucum* and can thus be regarded as new hosts.

المدى العائلي والعوائل الغير محددة لعزلات مختلفة من فطر *Polymyxa betae*

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الملخص

خمس عينات تربة جمعت من أماكن كانت تزرع بمحصول بنجر السكر من فرنسا 3 عينات, بريطانيا عينة واحدة و تشيكيا عينة واحدة. *Amaranthus retroflexus, Portulaca oleracea, C.ficifolium, C. murale, Chenopodium album*, Sugar beet استخدمت كعوائل نباتية زرعت في تلك التربة. بعد 6 أسابيع اخدت جذور تلك النباتات الصائدة و تم الكشف عن وجود جراثيم الفطر بولي مكسا بيتي باستخدام الميكروسكوب الضوئى. في الجذور التي لم تظهر فيها الجراثيم تم تكرار الكشف عنها مرة أخري بعد كل أسبوعين .

الجذور المحتوية علي جراثيم الفطر حصدت و سحقت بإضافة الماء المقطر, استخدمت العصارة لاعداء نفس النوع من النباتات المزروعة في تربة خالية من الفطر. باستخدام هده الطريقة تحصلنا علي عزلات الفطر من بنجر السكر و *C. murale* من كل عينات التربة و عزلتين من *C.murale*.

جذور النباتات استخدمت لتلقيح التربة بمجتمعات الفطر بولي مكسا بيتي في التربة ثم زرعت كل أنواع العوائل النباتية في تلك الأنواع من التربة و جذور النباتات المزروعة تم الكشف عنها كما ذكر سابقا. بنجر السكر و *C.murale* أصيبت تلك النباتات في كل أنواع التربة بالفطر, *C. ficifolium* و *C. album* أصيبت في ثلاث أنواع من التربة بالفطر فقط و *A. retroflexus* أصيبت هدا النبات في تربة واحدة بالفطر و *P.oleracea* لم تصاب أبدا بالفطر. و علي النقيض بعد التلقيح بالفطر للحصول علي عزلات من التربة كل العوائل الاخري كانت مصابة باستثناء حالتين فقط في *A.retroflexus* وهدا يعني انه في الغالب لا توجد عوائل محددة لعزلات مختلفة. أنواع مختلفة من العوائل الجديدة للفطر بولي مكسا بيتي وجدت في هده الدراسة لأول مرة.

الكلمات المفتاحية: الفطر بولي مكسا بيتي, المدي العائلي, تربة, عزلات فطر, جذور نباتات

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