An Investigation on Clubroot Disease (*Plasmodiophora brassicae* Wor.) Races in The Black Sea Region of Turkey

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Abstract: The races of the cabbage clubroot disease (*Plasmodiophora brassicae* Wor.) in the Black Sea region of Turkey were determined in this study. Some species belonging to cruciferous family, European Clubroot Differential set, isolates of the cabbage clubroot disease and cabbage areas in Ordu province were used as material. According to studies by using European Clubroot Differential Set and host rape (*Brassica napus*) it was found that there were ECD 16/31/31 race and pathotype 1 respectively in the Black Sea region of Turkey. This was first record for Turkey.
Key words: Cruciferous, *Plasmodiophora brassicae* races

Karadeniz Bölgesinde Lahana Kök Ur Hastalığının Irkları (*Plasmodiophora brassicae* Wor.) Üzerinde Bir Araştırma

Özet: Bu araştırmada Karadeniz Bölgesinde lahana kök ur hastalığının (*Plasmodiophora brassicae* Wor.) ırkları araştırılmıştır. Lahanagiller familyasına ait bazı türler, Avrupa Irk Ayrım Seti, lahana kök ur hastalığının izolatları ve Ordu ilindeki lahana yetiştirme alanları çalışmada materyal olarak kullanılmıştır. Avrupa Irk Ayrım Seti ve konukçu olarak kolza kullanılarak yapılan araştırmalara göre Karadeniz Bölgesinde ECD 16/31/31 ırkının ve patotip 1 in bulunduğu tespit edilmiştir. Bu Türkiye için ilk kayıttır.
Anahtar kelimeler: Lahanagiller, *Plasmodiophora brassicae*, ırklar

1. Introduction

Cabbage clubroot disease (*Plasmodiophora brassicae* Wor.) has been harmful at Ordu, İstanbul and İzmir provinces in the Black Sea region of Turkey. It hasn't been seen in the other provinces of the Black Sea region so far (Anonymous, 1995; 2010). But some warnings regarding presence of clubroot disease in Giresun and Trabzon provinces have been announced by official institutions in the last one year. Ordu province has a good potential in respect to cabbage growing. Cabbage (*Brassica oleracea*) production in Ordu province rose to 5263 tons in 2007 (Anonymous, 2007). However one of the factors limiting cabbage production in this province is clubroot disease. In addition, cabbage clubroot disease is a potential hazard for the other provinces growing cabbage in the region because the most intensive production with total 248759 tons has been realized in the Black Sea Region of Turkey. Turkey's total production is 647678 tons (Anonymous, 2007). On the other hand, this fungal agent can infest by drainage water, animals with motion, infested soil, diseased plant parts, infested appliances, tools, seedling and plants (Walker, 1952; Porth at al, 2003).

The aim of the present study was to determine races of the clubroot disease (*P. brassicae*) in the Black Sea region.

2. Material and Methods

Some species belonging to cruciferous family, European Clubroot Differential Set, clubroot isolates, cabbage areas in Ordu province were used as material in this study. Inoculations were made according to modified Gerrick and Duffus (1988) method. According to this method plastic meshes with 7.5 cm diameter and 7.5 cm depth were filled with stream sand and disease infected soil (1:1 volume). 1000 mg gall was placed in each mesh at 2.5 cm depth. Cruciferous seeds were sown in these meshes and were covered with the same soil mixture. Meshes were irrigated and incubated at the temperature 20-25 ^{0}C. After 70 days incubation period, cruciferous roots were examined (Gerrick and Duffus, 1988). Meshes weren't irrigated 2-3 days during seedling development stage to promote zoospore formation. Infestation of growing media by

Other microorganisms was inhibited by application of 2.5 g/lt PCNB and 0.5 g/lt Metalaxyl mixture on the growing media (Campell, 1988).

Disease evaluation was made according to 0-3 scale. Scale used was as follow: 0= There was no gall formation on the roots, 1= There was only gall formation on the lateral roots. 2= There was less than 50% gall formation on the main roots, 3= There was more than 50% gall formation on the main roots (Port et al., 2003). Disease index (DI) was calculated by means of disease scale values to identify races (Dobson et al., 1983). The formula used to calculate disease index was as follow:

DI: [(n0x0)+(n1x1)+(n2x2)+(n3x3)]/[n0+n1+n2+n3]x(100/3) In this formula:

n0=plant number having 0 value according to 0-3 scale

n1= plant number having 1 value according to 0-3 scale

n2= plant number having 2 value according to 0-3 scale

n3= plant number having 3 value according to 0-3 scale

If DI was equal to 0, reaction was accepted as resistant. If DI was between the 0-33 values, reaction was accepted unknown and if DI was more than 33, reaction was sensitive. Race identification was done according to obtained reaction categories (Donald et al., 2006, Some et al., 1996). Race numbers were calculated according to race identification codes in European Differential Set and host rape (*Brassica napus*) reactions.

3. Results and Discussion

Eight clubroot isolates were collected from different parts of the Kabadüz country of Ordu province in 2006. There was no diseased sample in the other counties of Ordu province so isolate wasn't collected from the other counties of Ordu province. As material 7 white cabbages, 1 black cabbage (*Brassica oleracea var. nigra*), 1 rape (*Brassica napus*), 1 Chinese cabbage (*Brassica campestris subsp. pekinensis*) and 1 cress (*Lepidium sativum*) cultivars, total 11 cultivars, in 2006 were used to test the differences among the isolates. When the reaction of the cruciferous materials against clubroot was observed it was established that all tested materials but cress gave sensitive reaction against all tested isolates in 2006. Cress gave resistant reaction against all isolates. This data showed that there was no difference in respect to pathological among the isolates brought from Kabadüz country (Table 1). This result might be possibly originated from the reason that the disease didn't distribute in a wide area in the Black Sea region. Different isolates showing different reactions on the same hosts might be found from wider areas.

Table 1. Test plants inoculated to identify different isolates and their reactions to the clubroot disease in the year 2006

Cultivar name	Cultivar species	Firm or origin of the cultivar	Disease scale value	Reaction category
1.Fieldstar F1	White cabbage	Ayer Seed Company	3	Sensitive
2.Mostar F1	White cabbage	Ayer Seed Company	3	Sensitive
3.Santa Ayer F1	White cabbage	Ayer Seed Company	3	Sensitive
4.745 Ayer F1	White cabbage	Ayer Seed Company	3	Sensitive
5.Brunswick St.	White cabbage	May Seed Company	3	Sensitive
6.Bafra Lahanası St.	White cabbage	Bursa Seed Company	3	Sensitive
7.Dürme St.	White cabbage	Ordu province	3	Sensitive
8.Karadeniz Yaprak L. St	Black cabbage	Bursa Seed Company	3	Sensitive
9.Bristol	Rape	Black Sea Agricultural Research Institute	3	Sensitive
10.Kasumi F1	Chinese cabbage	Nickerson-Zwaan Seed Company	3	Sensitive
11.Bahar	Cress	Istanbul Seed Company	0	Resistant

In a study conducted in Germany, a set of 48 accessions comprising species of the genus *Brassica* as well as species taxonomically more distantly related to *Brassica* were inoculated with 10 ECD-coded clubroot *(Plasmodiophora brassicae)* race populations as well as a mixture of them. Up to 1998, 42 isolates of clubroot were collected in Germany and Switzerland,

especially on fields of cole crops producing companies and coded with the European Clubroot Differential (ECD) set. Race populations and their ECD codes were as follows: R1(16/0712), R2(16/14/31), R3(16/31/31), R4(17,31,13), R5(16,31,30), R6(16,13,31), R7(16,22,08), R8(16,02,30), R9(16,15,31), R10(16,03,31). In this study it was also found that some *Brassica rapa* cultivars were resistant to ECD 16/31/31 but *Brassica oleracea*, *Brassica nigra*, *Brassica napus* and *Brassica oxyrrhina* species were sensitive to ECD 16/31/31 (Scholze et al., 2002). In another study variation in pathogenicity of *Plasmodiophora brassicae* in Australia was studied using the European Clubroot Differential series of *brassica* hosts. From 41 collections of *P.brassicae* originating from important vegetable *brassica* production regions in Victoria, Western Australia, Tasmania, Queensland and New South Wales, 23 triplet codes were generated. These were more similar to populations of *P.brassicae* reported from the USA than those from Europe. It couldn't be found 16/31/31 pathotype in these studies but most common Australian pathotypes had triplet codes of 16/3/12 and 16/3/31 (Donald et al., 2006). On the other hand at least nine physiologic races or pathotypes of *P.brassicae* are known to exist and have been reported from Germany, Canada, England, the Netherlands and the United States (Sherf and MacNab, 1986). In a study, variation for virulence was examined amongst 20 field collections of *Plasmodiophora brassicae* from France. Good pathotype discrimination was obtained using a set of three cultivars of *Brassica napus*. Five pathotypes, P1, P2, P3, P4 and P5 were detected and their occurrence was unrelated to host type. The five other isolates were classified as pathotypes P3, P6 and P7 (Some et al., 1996).

In this study inoculum materials were collected from Kabadüz county of Ordu province for race identification tests in 2007. Inoculations were made on 18 materials. 15 materials from these were belonging to European Clubroot Differential Set and 3 materials were rape cultivars (*Brassica napus*) . All tested materials but some turnip (*Brassica rapa var. rapifera*) species gave sensitive reaction in race identification tests. According to studies using European Clubroot Differential set and host rape (*Brassica napus*) cultivars there was ECD 16/31/31 race and pathotype 1 respectively in the Black Sea region of Turkey in 2007(Table 2, 3). This was a first record for Turkey.

References

Anonymous, 1995. Ministry of Agriculture and Rural Affairs. General Directorate of Plant Protection and Pest Control. Plant Protection Technical Instructions. Vol 2. Ankara.

Anonymous, 2007. Agricultural Structure and Production. State Statistical Institute.

Anonymous, 2010. Ministry of Agriculture and Rural Affairs. General Directorate of Plant Protection and Pest Control. Principles of Plant Protection and Demonstration in 2010. Ankara.

Campell, R N., 1988. Cultural Characteristics and Manipulative Methods. Pages 153-165 in Viruses With Fungal

Vectors J., l. Cooper and M .J. C Asher,eds. Association of Applied Biologists,Wellesbourne,UK.

Dobson, R L., Robak, J., Gabrielson, R L., 1983. Pathotypes of *Plasmodiophora brassicae* in Washington,

Oregon and California. Plant Disease, 67: 269-271.

Donald, E C., Cross, S J., Lawrence, J M., Porter, I J. 2006. Pathotypes of *Plasmodiophora brassicae*, the cause of clubroot, in Australia. Annual of Applied Biology 148: 239-244

Gerrik, J.S., Duffus, J.E.1988. Differences in vectoring ability and aggressiveness of isolates of *Polymxa Betae*. Phytopathology 78:1340-1343

Porth, G., Mangan, F., Wick, R., Autio, W., 2003. Evaluation of Management Strategies For Clubroot Disease of Brassicae Crops. Vegetable Notes. March 2003. Volume 13, No:25 University of Massachusetts, Amherst MA (http: //www.umassvegetable. org/ newsletters /archive/ 2003/ 2003_03. pdf)

Scholze, P., Malorny, M., Dippe, R., 2002. A comparative study of reaction to clubroot (*Plasmodiophora brassicae* Wor.) by inoculating plants with single races or a race mixture. Journal of Plant Diseases and Protection. 109 (3), 217-226, 2002, ISSN 0340-8159.

Some, A., Manzaranes, M J., Laurens, F., Baron, F., Thomas, G., Rouxel, F., 1996. Variation for virulence on *Brassica napus L.* amongst *Plasmodiophora brassicae* collections from France and derived single-spore isolates. Plant Pathology 45, 432-439

Sherf, A F. and Chubb. M. N., 1986. Vegetable disease and their control, second edition.Pp.256-260. John Wiley&Sons, Inc. New York. 728 pp.

Walker, J C., 1952. Diseases of Vegetable Crops. McGraw-Hıll Book Company, Inc. New York. Toronto. London

Table 2. Plant species used as European Clubroot Differential to identify the races of Clubroot in the year 2007 and their reactions to the clubroot disease

Number of host	Name of the hosts	Race differential code	Disease index (DI)	Reaction category
20-chromosome group	*Brassica rapa*			
01	*var.rapifera* line aaBBCC	01	DI =0	Resistant
02	*var.rapifera* line AAbbCC	02	DI =0	Resistant
03	*var.rapifera* line AABBcc	04	DI =0	Resistant
04	*var.rapifera* line AABBCC	08	DI =0	Resistant
05	*var.chinensis cv. Granaat*	16	DI >33	Sensitive
38-chromosome group	*Brassica napus*			
06	Line Dc101	01	DI >33	Sensitive
07	Line Dc119	02	DI >33	Sensitive
08	Line Dc128	04	DI >33	Sensitive
09	Line Dc129	08	DI >33	Sensitive
10	Line Dc130	16	DI >33	Sensitive
18-chromosome group	*Brassica oleracea*			
11	*var.capitata cv. Badger Shipper*	01	DI >33	Sensitive
12	*var.capitata cv.Bindsachsener*	02	DI >33	Sensitive
13	*var.capitata cv. Jersey Queen*	04	DI >33	Sensitive
14	*var.capitata cv. Septa*	08	DI >33	Sensitive
15	*var.capitata cv. Verheul*	16	DI >33	Sensitive

Table 3. Rape cultivars used as race differential set in the year 2007 and their reactions to the clubroot disease

Name of the host	Disease index (DI)	Reaction category
Rape cultivars (*Brassica napus*)		
1.Nevin	DI>33	Sensitive
2.Wilhelmsburger	DI>33	Sensitive
3.Brutor	DI>33	Sensitive