10.37045/aslh-2007-0012 *Acta Silv. Lign. Hung., Spec. Edition (2007) 47-51*

Susceptibility of Different Clone Groups of Austrian Pine to *Mycosphaerella pini* E. Rostrup and *Sphaeropsis sapinea* Dyko & Sutton

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Abstract – Necrosis of needles and shoots caused by various damaging agents, have emerged about fifteen or twenty years ago in the Hungarian Austrian pine stands. Damages caused mainly *Sphaeropsis sapinea* Dyko & Sutton, *Mycosphaerella pini* E. Rostrup (its anamorph *Dothistroma septospora* /Dorog./ Morlet), and *Sclerophoma pithyophila* (Corda) Höhn, and *Cenangium ferruginosum* Fr. ex Fr. Appearance and rapid spread of the fungi may surely be attributable to the anomalies in weather conditions. Since, the prevailing conditions, according to the long term predictions, have a fair chance of becoming permanent, it seems to be rational to select resistant or less susceptible species in producing propagation material of Austrian pine in the future. This brought up the investigation on the susceptibility of those clones, which are considered as basis for the elite propagation material of Austrian pine, to individual damaging agents. The investigations were carried on clone bank of Kisunyom. The results showed the susceptibility to the damaging agents considerable differences prevailed among the clone-groups, so it has been confirmed that in the process of genetic improvement when individuals are selected for cultivation, their susceptibility to the damaging agents should also be considered.

***Sphaeropsis sapinea* / *Dothistroma septospora* / *Pinus nigra* / Austrian pine / infection / investigation of clone / resistance breeding**

Kivonat – Különböző feketefenyő klóncsoportok fogékonysága a *Mycosphaerella pini* E. Rostrup és a *Sphaeropsis sapinea* Dyko & Sutton iránt. Magyarország feketefenyő állományai az 1980-as évek közepéig erdővédelmi szempontból a legstabilabb kultúrának számítottak. Többnyire *Heterobasidion annosum* (Fr.) Bref. fertőzés, illetve lokális jelleggel szú károk fordultak elő az állományokban. Mintegy tizenöt, húsz évvel ezelőtt jelentkeztek az első komolyabb hajtás és tűelhalások melyet különböző kórokozók idéztek elő. Kezdetben a *Sphaeropsis sapinea* Dyko & Sutton majd néhány évvel később a *Mycosphaerella pini* E. Rostrup (anamorf alakja *Dothistroma septospora* /Dorog./ Morlet), és *Sclerophoma pithyophila* (Corda) Höhn fajok okoztak helyenként jelentős károkat. 1997-1998 során a *Cenangium ferruginosum* Fr. ex Fr. is megjelent és elterjedt országszerte, a különböző korú feketefenyő állományokban. A gombák megjelenése és gyors elterjedése nagy valószínűséggel az időjárási anomáliáknak köszönhető. Mivel a hosszú távú előrejelzések szerint ez az állapot állandósulhat, a jövőben a feketefenyő szaporítóanyag előállításakor célszerű lenne rezisztens vagy kevéssé fogékony fajokat szelektálni. Ez indított minket arra, hogy megvizsgáljuk az elit szaporítóanyag alapjául szolgáló feketefenyő klónok érzékenységét az egyes kórokozókkal szemben. Ezeket a kutatásokat a Kisunyomban létesített feketefenyő klón-gyűjteményben végeztük. A kutatások eredményei alapján bizonyossá vált, hogy a nemesítési eljárás

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során, a szaporítóanyag termelés céljára kiválasztandó egyedek esetében célszerű figyelembe venni a kórokozókkal szemben tanúsított érzékenységet is, mivel ebben igen nagy különbségek mutatkoznak az egyes feketefenyő klóncsoportoknál.

***Sphaeropsis sapinea* / *Dothistroma septospora* / *Pinus nigra* / feketefenyő / gombafertőzés / klónvizsgálatok / rezisztencia nemesítés**

1 INTRODUCTION

From the aspects of plant pathology, the stands of Austrian pine in Hungary had been considered as the most stable man-made plant formations till the mid 1980s. Damages caused mainly by *Heterobasidion annosum* (Fr.) Bref. and wood-beetle locally can be well identified in the stands. (Pagony 1983) The first notable necrosis of needles and shoots caused by various damaging agents, have emerged about twenty or twenty five years ago. At first, the species *Sphaeropsis sapinea* Dyko & Sutton, then a few years later the *Mycosphaerella pini* E. Rostrup (its anamorph *Dothistroma septospora* /Dorog./ Morlet), and *Sclerophoma pithyophila* (Corda) Höhn caused considerable damages at certain locations. (Szabó 1991, 1997; Koltay 1990, 1997) Some years later *Cenangium ferruginosum* Fr. ex Fr. has also appeared and dispersed in various age of Austrian pines stands. (Koltay 1999)

Appearance and rapid spread of the fungi may surely be attributable to the anomalies in weather conditions. The damaging agents emerged in the last decades are so-called degradation parasites. As a result of the stress caused by the hot and dry weather, the degraded trees have become more susceptible to these agents. (Gilmour 1981; Gibson 1979; Nicholls – Ostry 1990) Since, the prevailing conditions according to the long term predictions have a fair chance of becoming permanent, it seems to be rational to select resistant or less susceptible species in producing propagation material of Austrian pine in the future. Up to now, the needed knowledge on the Austrian pine has not been at hand yet. This brought up the investigation on the susceptibility of those clones, which are considered as basis for the élite propagation material of Austrian pine, to individual damaging agents. For the research work, the clone bank of Austrian pine established at Kisunyom, near to town Szombathely in Western Hungary, proved to be the most appropriate choice. (Varga 2000)

2 MATERIAL AND METHODS

In Hungary, the programme aimed at genetic improvement of conifers has been launched in the early 1950s with selecting and marking the stock trees. Later on, clone banks were established by collecting individuals from domestic and other foreign populations. The clone bank of Kisunyom was established in 1965-1968. Currently, there are 4 domestic and 6 European clone-groups with 680 individual clones in the collection here. (*Table 1.*) The groups were planted with different representation but with a uniform spacing of 6 by 4 metre. (Bánó 1970; Bánó – Mátyás 1987)

Table 1. Type and number of Austrian pine clones

	Hungarian clones				European clones						
Clones	101	108	104	103	YU	F	A	TR	CY	E	Total
piece	98	176	52	17	46	168	39	10	43	31	680

In 1996, a medium, then in 1997, a very intensive reddish discoloration occurred on the individuals of the clone bank. On the basis of the symptoms as well as on the collected samples is became evident that needle and shoot necrosis of the trees were caused by two damaging fungus species *Dothistroma septospora* (Dorog.) Morlet and *Sphaeropsis sapinea* Dyko & Sutton. Occurrence of the *D. septospora* on the infected trees were considerably higher than that of *S. sapinea*. The different rates of infection among the clone-groups were eye-catching even in the first stage of investigations. It lead to the conclusion that in order to reveal the susceptibility of individual clones to the infection of fungi, a very thoughtful investigation was needed.

The assessment on the conditions of infection was launched in the autumn of 1997. The rates of rubescence and needle necrosis in the crown have been established for each individuals with a 10 % accuracy. On the basis of the different symptoms caused by the two damaging species, the actual infections have been identified and the findings were analysed according to species. (*Table 2 - 3.)*

Table 2. Distribution (%) of Dothistroma pini infection

Infection	Type of clones									
(%)	101	108	104	103	YU	F	A	TR	CY	E
0	0,0	35,2	13,5	17,5	8,7	2,4	25,6	40,0	0,0	9,7
5	1,0	33,5	55,8	5,9	32,6	7,7	12,8	0,0	0,0	3,2
10	6,1	6,8	11,5	11,8	26,1	12,5	30,8	0,0	0,0	41,9
20	16,3	5,1	9,6	11,8	13,0	14,3	17,9	0,0	0,0	25,8
30	20,5	7,4	7,7	11,8	15,2	11,3	10,3	10,0	9,3	3,2
40	18,4	6,8	1,9	0,0	4,3	14,9	0,0	0,0	4,7	12,9
50	9,2	1,1	0,0	11,8	0,0	14,9	0,0	20,0	14,0	3,2
60	2,0	1,1	0,0	5,9	0,0	2,4	2,6	10,0	11,6	0,0
70	13,3	1,7	0,0	11,8	0,0	11,9	0,0	10,0	11,6	0,0
80	12,2	1,1	0,0	11,8	0,0	7,7	0,0	10,0	16,3	0,0
90	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	32,6	0,0
100	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Table 3. Distribution (%) of Sphaeropsis sapinea infection

Infection	Type of clones									
(%)	101	108	104	103	YU	F	A	TR	CY	E
0	78,6	27,8	19,2	76,5	17,4	90,5	64,1	20,0	100,0	100,0
5	21,4	10,2	28,8	23,5	60,9	9,5	15,4	40,0	0,0	0,0
10	0,0	26,7	17,3	0,0	8,7	0,0	5,1	0,0	0,0	0,0
20	0,0	6,8	13,5	0,0	2,2	0,0	2,6	0,0	0,0	0,0
30	0,0	14,2	7,7	0,0	6,5	0,0	5,1	10,0	0,0	0,0
40	0,0	5,1	9,6	0,0	4,3	0,0	0,0	20,0	0,0	0,0
50	0,0	1,1	1,9	0,0	0,0	0,0	2,6	0,0	0,0	0,0
60	0,0	0,0	1,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0
70	0,0	1,1	0,0	0,0	0,0	0,0	0,0	10,0	0,0	0,0
80	0,0	2,8	0,0	0,0	0,0	0,0	2,6	0,0	0,0	0,0
90	0,0	2,8	0,0	0,0	0,0	0,0	2,6	0,0	0,0	0,0
100	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

The basic question to be answered in the investigations was whether there were any accountable differences among the susceptibility of the clone-groups? Further, we wanted to clear up the magnitude of differences, if any, i.e. what was the range of susceptibility of the individual clone-groups to the two species of fungus. Finally, we studied within the individual clone-groups whether there was any indicative relationship between the susceptibility to the two species?

3 RESULTS AND DISCUSSION

To answer the problems, at first, on ***K*** (actually for 10 different clone groups of Austrian pine) patterns of frequency distribution represented by ***v*** classes (12 grades of infection) the test of homogeneity has been performed using a contingency table of fields ***K*** x ***v.*** As results, the following conclusions can be drawn:

In the case of *D. septospora* the calculated value $\chi^2 = 653.7$ exceeds the critical table value P 0.1% = 149.4. That means, as for the damaging agent, reactions of clone groups of Austrian pine to the actual fungus were not homogeneous, i.e. their susceptibility varied considerably.

In the case of *S. sapinea* the calculated value $\chi^2 = 494.5$ is also much more higher than the critical table value P 0.1% = 149.4. Thus, the clone-groups show up various susceptibility to this fungus too.

As next step the ***infection index*** of individual clones have been calculated. Infection index = rate of infection per cent multiplied by band of per cent (as weight). With using that formula, susceptibility of clone-groups to individual fungus species could be accounted. Ranking the clone-groups it was quite clear that *D. septospora* occurred in all of the clone-groups, but at the same time the rate of infection, which is equal to the susceptibility to the damaging agent considerable differences, prevailed among the clone-groups. Analysing the occurrence of species *S. sapinea* brought that rate of infection was less for all of the clone-groups and there were two clone-groups in which damaging agent could not be detected at all. (*Table 4.*)

Table 4. Susceptibility of clones against *Dothistroma p.* and *Sphaeropsis s.*

Type of clones	Order of Susceptibility	Infection index of *Dothistroma p.*	Order of Susceptibility	Infection index *Sphaeropsis s.*
CY	***1***	6907,0	***9,5***	0,0
101	***2***	4320,0	***7***	107
F	***3***	3723,2	***8***	47,6
103	***4***	3449,9	***6***	117,6
TR	***5***	3400,0	***1***	2000,0
E	***6***	1725,8	***9,5***	0,0
YU	***7***	1315,2	***5***	804,3
A	***8***	1192,3	***4***	897,4
108	***9***	1167,6	***2***	1818,2
104	***10***	894,2	***3***	1413,5

Finally, in studying the relation between the two species of fungus, rank correlation was calculated according to *Sperman.* The value of the rank correlation coefficient "$\boldsymbol{R}^{\text{rank}}$ " proved to be - 0.655. Its absolute value exceeded the "***R***" value of 0.631 from the table. In

accordance with this finding, a correlation seems to be existing, between the susceptibility of Austrian pine clones to the two species of fungus. Here, the minus sign illustrates that the above relation means: when a specific clone of Austrian pine is susceptible to the infection of the *D. septospora*, it tends to be more resistant to the infection of *S. sapinea* and vice versa. This trend, however, could not be confirmed properly, because, apart from other causes, the phenomena can also be understood that, as a result of an earlier attack by one of the fungus species, the other would not find enough healthy needles and shoots, or the two species may be antagonist of each other. Further investigations are needed.

On the basis of the recent research findings, it has been confirmed that in the process of genetic improvement when individuals are selected for cultivation, their susceptibility to the damaging agents should also be considered, because the clone-groups of Austrian pine have large-scale differences in this respect.

Acknowledgements: Special thanks to Hungarian Scientific Research Foundation "OTKA" for assistance. (T 026411)

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