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Can artificial wounding of beech stems induce necroses?

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ABSTRACT: The paper presents data on the induction of necroses after small injuries to beech stems caused by electrodes during measuring cambium electric resistance. Altogether 121 beech stems of tree class 1–3 (according to Kraft) were evaluated. Among 2,904 mechanical injuries in 121 stems evaluated (24 per stem), 155 injuries induced necroses, hence each 19th injury induced necrosis. Most stems (33.06%) showed one necrosis, few stems (4.96%) showed even four necroses. 28.93% of stems did not show any necrosis. In order to prevent the infection of wounds and subsequent induction of necroses the authors recommend to treat any wounds with a suitable fungicide after using an equipment causing even negligible wounds of stems.

Keywords: *Fagus sylvatica* L.; mechanical wounds of stems; induction of necroses; Central Slovakia

The causality of the origin and induction of necroses as external manifestations of beech bark disease is continuously discussed since the beginning of investigations of this problem. In general, bark wounds caused by biotic (e.g. insects, game, humans), abiotic (e.g. frost, hail, sunburn) or other factors (man in the process of management of beech stands) are considered as the main causes of induction of necroses. More authors dealt with the evaluation of significance of these factors. For example Burns and Houston (1987), Emschermann et al. (2002), Mihál and Cicák (2001), Mihalciuc et al. (2001), Schönherr (1958), Strouts and Winter (1994), Wachendorff (1983) focused on the problem of biotic factors whereas Butin (1995), Chira and Chira (1997), Funk (1937), Jonsson (2000) dealt with abiotic factors or influence of man.

In this paper we evaluated the induction of necroses after mechanical damage to beech bark caused by punctures of electrodes of an instrument for the measuring of cambium electrical resistance. However, we consider this paper as our contribution to the knowledge of the mechanism of induction of beech bark necroses after any mechanical damage.

MATERIAL AND METHODS

We selected a beech stand in the growing phase of maturing stemwood on one of the three subplots (subplot C) of the permanent research plot (PRP) Jalná. On this subplot the influence of heavy thinning from below is studied. The research plot is situated in Central Slovakia, in the Štiavnické vrchy hills, Forest Management Office Žarnovica. The stand age (at to 1 January 2004) was 81 years, western exposition, altitude 610 m a.s.l., average annual temperature 6.2°C, average annual precipitation 850 mm. A more detailed description of this PRP Jalná from the aspect of silviculture, production, mycology and health status was published by Mihál (1995) and Štefančík et al. (1991, 1996).

In 1993–1995, the cambium electrical resistance was measured on the PRP Jalná four times a year with an instrument TVM 01 manufactured in Slovakia (Štefančík 2000). The instrument works on a similar principle like Shigometer. Each measurement of electrical resistance led to the wounding of the stem which was caused by punctures of two needle-like electrodes. In this way, 8 wounds a year

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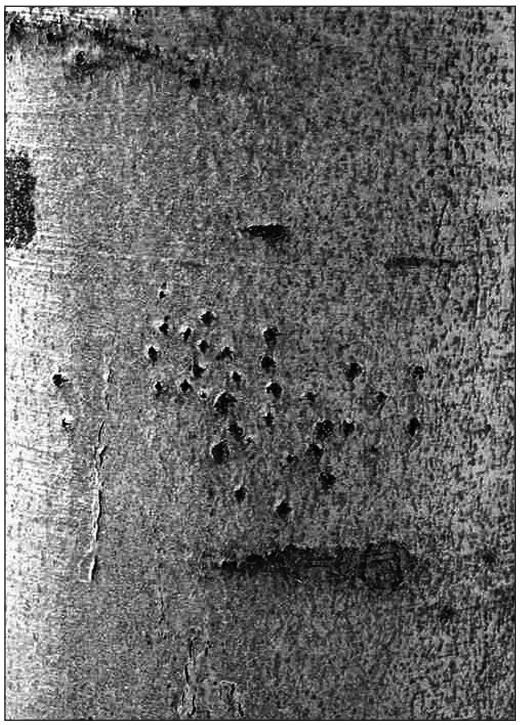

Fig. 1. Remaining traces of damage to bark after punctures of electrodes of the instrument TVM 01 for the measurement of cambium electrical resistance

Fig. 2. Induction of necrosis in the place of mechanical damage to bark by electrodes of the instrument TVM 01

were made in each stem and 24 wounds during three years (Fig. 1).

After repeated evaluation of the beech bark necrotic disease on subplot C in 2004, we observed that some small mechanical wounds having been caused by the electrodes during the measuring of electrical resistance induced necroses on the stems (Fig. 2).

In total, we evaluated 121 beech stems of tree class 1–3 (according to Kraft) on which we established the number of induced necroses and their external quantitative characteristics – length and width. From the length and width we calculated the surface of each necrosis as its third external quantitative characteristic. The surface was calculated according to the formula for the area of ellipsis, which fits the geometrical form of necroses in the best way (Fig. 2).

RESULTS AND DISCUSSION

Table 1 shows the numbers of necroses induced in the places of mechanical wounds caused by electrodes during the measuring of cambium electrical resistance. The maximum number of necroses per stem was 4. The frequency of stems with four or lower number of necroses is given in Fig. 3. This figure shows that most stems (33.06%) had one necrosis. Less frequent (4.96%) were the stems with four necroses. The frequency of stems without any necrosis was 28.93%, hence more than one quarter of the stems examined. This fact indicates that not every wound must inevitably cause the induction of necrosis. It is confirmed by the almost identical frequency (24.94%) of stems without necrotic disease calculated from a set of 5,193 beeches of tree class 1–3 examined in 54 localities from the whole of Slovakia (Cicák, Mihál 2002). Our comparison is based on the presumption that it is almost excluded that a beech stem could avoid any biotic (insects, game, man) or abiotic (frost, hail, freezing) wound during its growth.

Out of the number of 2,904 mechanical wounds on 121 stems examined (on average 24 wounds

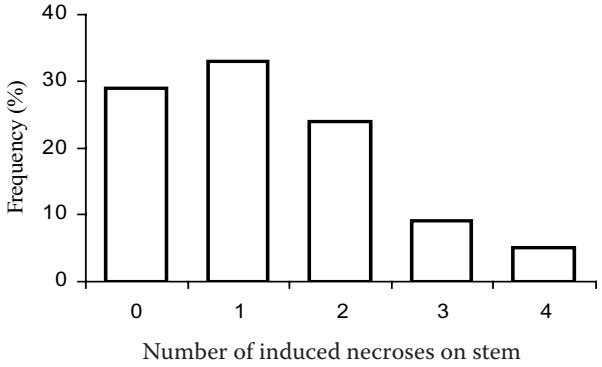

Fig. 3. Frequency of stems with necroses induced by mechanical damage to bark by electrodes of the instrument TVM 01

Fig. 4. *Nectria galligena* Bres. apud Strasser – a parasitic fungal pathogen causing necrotic disease of beech bark

per stem) only 155 wounds caused the induction of necroses. In this way, 1.28 (= 5.34%) induced necroses fell on 24 wounds caused by electrodes per stem. In other words, each 19th wound caused the induction of necrosis.

The species of the genus *Nectria* (Fr.) Fr. are considered to be the most significant fungi causing necrotic disease of beeches. During the investigations on the PRP Jalná we identified the following species by the method *in vivo*: *Nectria cinnabarina* (Tode: Fr.) Fr., *N. coccinea* (Pers.) Fr., *N. cosmariospora* Ces. et De Not. and *N. galligena* Bres. apud Strasser. The most virulent species was *N. galligena* (Fig. 4). The induction of necroses caused by the fungi of the genus *Nectria* on wounded stems or roots after the installation of a telephone cable was already described by Funk (1937). Infections of wounds, which were caused by frost, insects, humans or game, by fungi of the genus *Nectria* are supposed to cause the induction of necroses (Butin 1995; Jonsson 2000; Michalciuc et al. 2001; Strouts, Winter 1994). However, in the literature contradictory opinions can be found. For example Dengler (1997) showed by investigations of natural (woodpecker) and simulated artificial wounds that these wounds did not cause any necroses. Similarly, we also observed the damage to beech bark caused by woodpeckers, but in all cases

Fig. 5. Remaining traces of damage to beech bark by woodpeckers

we observed only remaining traces that did not lead to the induction of necroses (Fig. 5). However, in the case of mechanical wounds caused by man our exact observations contradict Dengler's statements. His statement represented a polemic note to the paper by Klein (1997). Dengler (l.c.), however, did not give the number of stems with simulated or natural wounds he evaluated. Neither did he give the number of wounds and the time of his observations. Our observations show that it is necessary to evaluate a large number of stems in order to confirm the hypothesis that necroses are induced after stem wounding.

The values of external quantitative parameters of necroses are given in Table 1. As evident from this table, the maximum length recorded was 30.0 cm while the minimum length was 2.2 cm. Maximum width of necroses was 9.1 cm and minimum width 1.0 cm. The largest surface was 214.41 cm^2, minimum 1.73 cm^2.

Table 1. The number of necroses induced after mechanical wounds of beech bark by electrodes during the measuring of cambium electrical resistance with the instrument TVM 01 and their external quantitative characteristics

External quantitative characteristics of necrosis	Statistic characteristic		
	maximum	minimum	mean ± standard error
Number (n)	4	0	1.28 ± 0.10
Length (cm)	30.00	2.20	4.78 ± 0.22
Width (cm)	9.10	1.00	2.45 ± 0.10
Area (cm^2)	214.41	1.73	11.33 ± 1.54

The observations confirmed a very important fact. Everybody who uses any equipment causing even seemingly negligible wounds of stem should treat them with a suitable fungicide to prevent infections. Similarly, the parts of equipment causing the wounds should be disinfected. The induction of necroses, their potential spreading as well as subsequent deterioration of timber will be prevented in this way.

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Môžu byť umelé mechanické poranenia kmeňov buka príčinou tvorby nekróz?

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ABSTRAKT: Príspevok prináša poznatky o indukcii nekróz po drobných poraneniach kmeňov buka elektródami, ktoré vznikli pri meraní elektrického odporu kambia. Celkom bolo vyhodnotených 121 kmeňov buka 1. až 3. stromovej triedy (podľa Krafta). Z počtu 2 904 mechanických poranení na 121 hodnotených kmeňoch (24 poranení na jednom kmeni) 155 poranení bolo príčinou indukcie nekróz. Každé 19. poranenie vyvolalo indukciu nekróz. Najvyššia frekvencia kmeňov

(33,06 %) bola s jednou nekrózou. Najnižšia frekvencia kmeňov (4,96 %) bola so štyrmi nekrózami. Kmene, na ktorých nedošlo k indukcii nekróz, mali 28,93% frekvenciu. Autori príspevku doporučujú po použití akejkoľvek prístrojovej techniky, ktorá za sebou zanecháva aj tie najmenšie poranenia kmeňov, ošetriť rany vhodným fungicídnym prípravkom, aby sa predišlo infekcii rán a následne indukcii nekróz.

Kľúčové slová: *Fagus sylvatica* L.; mechanické poranenie kmeňa; indukcia nekróz; stredné Slovensko

Kauzalita vzniku a indukcie nekróz ako vonkajšieho prejavu nekrotického ochorenia kôry buka je od začiatku výskumu stále diskutovaná. Za najhlavnejšie príčiny indukcie nekróz sa všeobecne považujú poškodenia kôry biotickými faktormi (napr. hmyz, lesná zver, človek), abiotickými faktormi (napr. mráz, ľadovec, spála) a inými činiteľmi (napr. človekom v procese managementu bukových porastov).

V príspevku sa autori venujú hodnoteniu indukcie nekróz po mechanickom poškodení kôry kmeňov buka, ktoré bolo spôsobené vpichmi elektród prístroja na meranie elektrického odporu kambia.

Vybrali sme bukový porast v rastovej fáze dospievajúcej kmeňoviny na jednej z troch čiastkových plôch (čiastková plocha C) trvalej výskumnej plochy (TVP) Jalná. Na čiastkovej ploche sa skúma vplyv silnej podúrovňovej prebierky. V rokoch 1993 až 1995 sa na TVP Jalná štyrikrát ročne meral elektrický odpor kambia (EOK) prístrojom TVM 01 vyrobeným na Slovensku. Každé meranie elektrického odporu znamenalo dve mechanické poranenia kmeňa, ktoré vznikli po pichnutí dvoch ihiel elektród. Ročne na každom kmeni vzniklo 8 a za tri roky 24 mechanických poranení (obr. 1).

Výsledky počtu zistených nekróz, ktoré sa indukovali v miestach mechanických poranení kmeňov elektródami po meraní EOK, sú uvedené v tab. 1. Maximálny počet indukovaných nekróz na jednom kmeni bol štyri. Hodnoty frekvencie kmeňov so štyrmi a nižším počtom nekróz sú uvedené na obr. 3, z ktorého vidieť, že najvyššia frekvencia kmeňov (33,06 %) bola s jednou nekrózou. Najnižšiu frekvenciu (4,96 %) mali kmene so štyrmi nekrózami. Kmene, na ktorých nedošlo k indukcii nekróz, mali 28,93% frekvenciu, čo je viac ako jedna štvrtina hodnotených kmeňov. Z toho vidieť, že nie každé poranenie musí byť príčinou indukcie nekrózy.

Z počtu 2 904 mechanických poranení na 121 hodnotených kmeňoch (24 poranení na jednom kmeni) len 155 poranení bolo príčinou indukcie nekróz. Na 24 poranení elektródami na jednom kmeni tak pripadá 1,28 indukovaných nekróz, čo je 5,34 %, teda každé 19. poranenie vyvolalo indukciu tvorby nekrózy.

Za najvýznamnejšie parazitické huby, spôsobujúce nekrotické ochorenie buka, sa považujú druhy rodu *Nectria* (Fr.) Fr. Počas doby výskumu sme na TVP Jalná determinovali metódou *in vivo* tieto druhy: *Nectria cinnabarina* (Tode: Fr.) Fr., *N. coccinea* (Pers.) Fr., *N. cosmariospora* Ces. et De Not. a *N. galligena* Bres. apud Strasser. Najviac virulentný bol druh *N. galligena* (obr. 4).

Hodnoty externých kvantitatívnych parametrov uvádzame v tab. 1. Ako z nej vidieť, maximálna dĺžka, ktorú sme namerali, bola 30 cm a minimálna 2,2 cm. Maximálna šírka nekrózy bola 9,1 cm a minimálna 1 cm. Najväčšia nameraná plocha bola 214,41 cm^2, minimálna 1,73 cm^2.

Pozorovania potvrdili jeden veľmi dôležitý poznatok. Každý, kto používa akúkoľvek prístrojovú techniku, ktorá za sebou zanecháva aj tie najmenšie poranenia kmeňov, by mal rany ošetriť vhodným fungicídnym prípravkom, aby sa predišlo infekcii agens. Rovnako to platí aj pre časti prístrojovej techniky, ktoré poranenia spôsobujú. Týmto sa predíde indukcii nekróz ako aj ich možnému rozširovaniu a následne znehodnoteniu drevnej hmoty.

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