Mountain ash (*Sorbus aucuparia* L.) root system morphogenesis

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ABSTRACT: An analysis is made of the root system morphogenesis and architecture in several tens of European mountain ash trees aged up to 60 years at seven different sites. Although the root system variability is considerable, certain dependences can be derived. European mountain ash forms an anchoring root system. Limiting factors of the root system morphogenesis are the groundwater table (roots do not penetrate into soil horizons affected by underground water), prevailing direction of wind (elliptic root system develops in the wind direction), and the slope (in the uphill direction the roots are shorter, exhibit the more or less horizontal growth and reach into deeper soil horizons than roots growing in the downhill direction). An unambiguous correlation was found between the rooting depth of anchor roots and the number and reach of lateral roots (the longer the anchors, the fewer the lateral roots and the smaller their reach). The shorter the anchor roots, the more intensive the branching of not only the anchors themselves but also of superficial roots.

Keywords: mountain ash; root system; morphogenesis

Mountain ash is one of the forest tree species that were paid no greater attention for a long time. It is only in the last twenty years that the concern has been increasing in connection with the use of mountain ash for establishing the stands of substitute woody species in air-polluted areas and for improving the biodiversity of forest stands. Mountain ash occurs nearly in all forest types; but there is not enough exact information on the development and architecture of its root system although the root system is considered to be a tree "groundwork" that is affected earliest and most by any natural or anthropogenic stress. The objective of the project was to analyze the morphogenesis of mountain ash root system at different sites.

There are seemingly enough data on ecological requirements and morphological and silvicultural features of mountain ash available at present that were obtained from the assessment of experimental plots and from practical experience. However, most of the studies are focused only on the assessment of the aboveground parts with data on the root system morphogenesis, architecture and properties being rather sporadic. If the data do exist – especially in dendrological literature – it is usually just a general description, often with no ecological conditions taken into account in which the root system was developing, which might be the reason for the frequently occurring controversial characteristics.

The root system of European mountain ash is usually described as a typically anchoring (MAYER 1977; NAMVAR, SPETHMANN 1985; AAS 1997; MÖßMER, AMMER 1994; POLOMSKI, KUHN 1998) or as a relatively flat anchoring root system (LEMME, PRIEN 1994), and is also characterized by other authors as rather superficial (CHMELAŘ 1983; VOLNÁ, POSPÍŠIL 1989) or shallow (KAPPER 1952; SVOBODA 1957).

Mountain ash is a part of mountain forest communities where it often regenerates on rotting wood; that is why it can sometimes exhibit stilt roots (SVOBODA 1957; CHMELAŘ 1983). According to NAMVAR and SPETHMANN (1985), mountain ash shows a strong inclination to the formation of adventitious roots and shoots. Development of sprouts on shallow lateral roots is mentioned by BECHSTEIN (1821 in LEDER, HILLEBRAND 1997) and KAPPER (1952).

According to some sources, mountain ash exhibits intensive rooting in the upper soil (NAMVAR, SPETHMANN 1985; VOLNÁ, POSPÍŠIL 1989). Nevertheless, data on the depth of its roots are controversial. While AMANN (1954) describes mountain ash as a species with deeply penetrating roots, MAYER (1977) ranks it among the tree species with medium-deep root systems. A similar characteristic is presented by VÁLEK (1977), according to whom the roots reach as deep as to about 100 cm. CHMELAŘ (1983)

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claims that the mountain ash root system reaches the depth only when young and gradually becomes superficial. As mentioned by KREUTZER (1961), the reached depth of roots is considerably affected by the site character. According to this author, mountain ash on Pseudogleys can be characterized as shallow-rooting (root depth max. 60 cm). The author observed numerous thin branches springing out from the shallow lateral roots that did not reach deep and were responsible for a somewhat denser rooting only within the top 20 cm of the upper soil. He takes European mountain ash for a species endangered by the lack of oxygen and by waterlogging. Its roots at water-affected sites are dying and – according to the author's opinion – their penetration into lower soil layers cannot be expected. Similarly, MÖßMER and AMMER (1994) mention that mountain ash trees on water-affected soils exhibited an intensive growth of roots in the uppermost soil layers but only a low tendency to penetrate into greater depths. This corresponds well with the statement of KAVKA (1995) that mountain ash develops a weaker root system on heavy and wet soils where its roots die soon. The relatively shallow root system on Pseudogleys is also mentioned by NAMVAR and SPETHMANN (1985) and MAYER (1977).

According to BECHSTEIN (1821 in LEDER, HILLEBRAND 1997), mountain ash forms a "four foot deep and even deeper taproot of large diameter". The occurrence of taproot was also described by VOLNÁ and POSPÍŠIL (1989). KAVKA (1995) observed a short taproot in mountain ash, with numerous branches and with lateral roots reaching – according to the author – a great depth but with poor branching. The short and strongly branching taproot in mountain ash in general was also described by HIEKE (1978). On the other hand, VÁLEK (1977) described the mountain ash root system with a conspicuous taproot reaching to a depth of 1.80 m at the age of 20 years.

In contrast to the controversial data concerning the root depth, the majority of authors agree that the lateral roots of mountain ash are usually shallow (AAS 1997) and their horizontal reach is considerable. BECHSTEIN (1821 in LEDER, HILLEBRAND 1997) and AMANN (1954) describe mountain ash with far reaching and shallow running lateral roots. SVOBODA (1957) observed mountain ash trees growing at high elevations with roots running far to sides or forming a dense tangle on boulders. Apart from these general statements there are also some concrete data to be found in literature. SVOBODA (1937) recorded the mountain ash roots growing over the surface up to the distance of 5 m from the stem. VÁLEK (1977) describes mountain ash as a species with roots of medium length, reaching to the distance ranging between 3.0–6.5 m from the stem. The mountain ash root system analysis was also attempted at by MÖßMER and AMMER (1994) but the roots penetrated into rock slits and it was difficult to isolate them in their full length, which made any detection of their horizontal reach impossible.

There are only a few detailed data on the mountain ash root system architecture. At studying a 17 years old tree of 11 cm at d.b.h., VÁLEK (1977) found out that the root system consisted of 6 superficial roots of diameters ranging between 4/8–6/6 cm that were arranged radially along the slope at a depth of 10 to 15 cm. The roots had numerous thin and flexible branches. There were 9 root branches of 3.0–1.5 cm in diameter running down from the superficial skeletal roots and from the stump bottom that split into numerous other strands at a distance of 30 cm and terminated their depth growth after having met with flat boulders. The author claims that the mountain ash roots avoid solid obstacles in the soil by passing them from two or even from three sides with another root branch being shot to a depth of up to 55 cm, which makes the tree firmly anchored. As stated by MÖßMER and AMMER (1994), the information on the mountain ash root system architecture is still missing.

MATERIAL AND METHODS

The mountain ash root system morphogenesis was studied at the following seven different sites:

Site 1

Forest District LČR Svitavy, altitude 360 m, forest altitudinal vegetation zone 3, flat terrain.

Typical Gleysol, acid mor; horizons – O 0–10 cm, Alg 10–20 cm, Go 20–35 cm, Gr 35–95 cm, Cg 95–150 cm.

Site 2

Forest District LČR Svitavy, altitude 420 m, forest altitudinal vegetation zone 3, flat terrain.

Arenic, podzolized Cambisol, moder; horizons – O 0–8 cm, Ale 8–16 cm (skeleton 5%), Bvs_1 16–35 cm (skeleton 8%), Bvs_2 35–51cm (skeleton 20%), C_1 51–190 cm.

Site 3

Forest District LČR Svitavy, altitude 480 m, forest altitudinal vegetation zone 4, flat terrain.

Cambisol Rendzina; horizons – O 0–3 cm, Al 3–21 cm (skeleton 15%), Bv 21–61cm (skeleton 35%), Bvg 61–84 cm (skeleton 70%), B/C 84–130 cm (skeleton 85%).

Site 4

Forest District LČR Svitavy, altitude 420 m, forest altitudinal vegetation zone 3, flat terrain.

Typical Pseudogley; horizons – O 0–5 cm, Al 5–14 cm (skeleton 15%), El 14–47 cm, Bm 47–77 cm, Bm/Cg 77–140 cm.

Site 5

Forest District LČR Svitavy, altitude 480 m, forest altitudinal vegetation zone 4, slope 25%.

Cambic Pararendzina; horizons – O 0–3 cm, Al 3–15 cm (skeleton 30%), Bv 15–35 cm (skeleton 55%), Bvca 35–55 cm (skeleton 60%), Cca 55–80 cm (skeleton 80%).

Site 6

Forest District LČR Ostravice, altitude 1,120 m, forest altitudinal vegetation zone 7, slope 30%. Typical Cambisol, mesotrophic, slightly gleyed; horizons – O 0–9 cm, Al 9–29 cm (skeleton 20%), Bv_1 29–69 cm (skeleton 65%), Bv_2 69–92 cm (skeleton 75%), C/B 92–110 cm (skeleton 80%), C_1 110–140 cm (skeleton 35%, sandstone mastic).

Fig. 1. Tapering stems of mountain ash seedlings

Fig. 2. Mountain ash root system – development of adventitious roots

Site 7

Forest District LČR Ostravice, altitude 1,100 m, forest altitudinal vegetation zone 7, slope 30%.Typical Podzol; horizons – O 0–8 cm, Ae 8–12 cm (skeleton 20%), Ep 12–20 cm (skeleton 35%), Bs_1 20–68 cm (skeleton 50%), Bs_2 68–85 cm (skeleton 70%), C_1 85–110 cm (skeleton 90%).

Root systems were analyzed at each site; the minimum being 15 trees at the age ranging between 1 year and 10 years and 4 trees at the age ranging from 20 to 60 years.

All trees were assessed for their whole root systems, the analyses being mostly destructive with the root systems lifted manually by an archaeological method. Only in two cases (Site 6) the root system architecture was detected by a non-destructive method (soil georadar).

With using the non-destructive method of soil georadar, a transmitter localized on the soil surface sends out electromagnetic waves into the soil that are in return received back again. The method helps to make a record of the soil profile cross-section that is being further depicted by means of additional instrumentation. Registered and plotted can be not only the objects but also the soil layers. The geophysical measurement itself was carried out by the georadar system Pulse EKKO 1000 manufactured by Sensors and Software, which in combination with screened aerials of 450 MHz made it possible to detect roots with diameters over about 1 cm to a depth of 2.5 m. The geophysical measurement and interpretation of results were made in cooperation with the company Geofyzika, a. s., Brno. The measurements were conducted in a network of profiles distant 25 cm from each other, running in two mutually perpendicular directions: along the line perpendicular to the contour, and along the contour line. The distance of measuring points (measurement step) in all profiles was 5 cm.

All analyzed trees occurred in mixed stands. However, the sampling was made only from relatively solitary standing trees with the surrounding trees growing at a distance of min. 4 m.

RESULTS

A relatively large number of analyzed root systems made it possible to generalize the results as follows:

ROOT SYSTEM DEVELOPMENT IN JUVENILE PHASE

- The results apply to all analyzed sites.
- The mountain ash seed will germinate and root only at a place with no continuous weed cover. Seedlings very often grow directly in or in the immediate vicinity of decomposing wood matter (root, branch). Although a larger part of the mountain ash trees grow on glades, some seedlings were also found under the closed stand.
- Young seedlings and plantlets root through and form true roots only in horizon Of_2. Adventitious roots are formed in horizons Of_2 and Of_1 and penetrate through them. Further development of (both true and adventitious) roots consists in penetrating horizon Oh in which they do not branch but root through the lower horizons. The roots principally never enter water-affected horizons; in these conditions, mountain ash develops only a flat root system from its young age. The development of dominant taproot was not detected in any of the cases.
- If the seedlings grow on the slope, a greater part of roots grow against the slope and they are also longer in this direction.
- The majority of mountain ash seedlings have stems not vertically running in their lower parts. Thin stems are pressed against the soil surface by forest weeds and snow weight (and motion) and are partly covered with weeds and litterfall. The oppression and consequent stem deformation repeat several times, which sometimes results in the stem deflection that can be as great as several tens of centimeters. The stem crookiness – nearly at all times running along the line perpendicular to the contour – was found in the majority of mountain ash trees growing on the slope but it also occurred in ash trees growing in the flat terrain (Fig.1).

Fig. 3. Mountain ash root system (typical Gleysol)

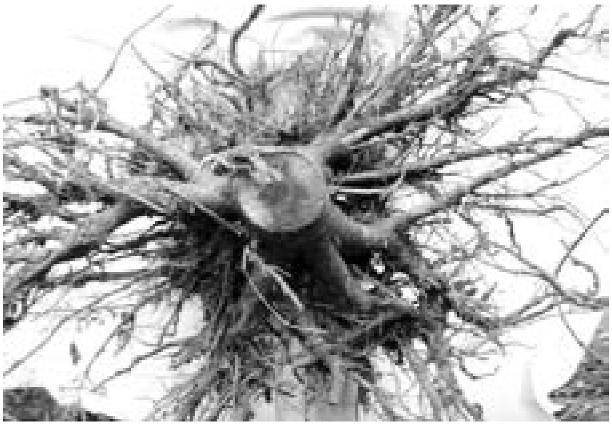

Fig. 4. Distribution of lateral roots in mountain ash (typical Gleysol)

– Thanks to the stem coverage with organic matter the covered part shows development of adventitious stems; then it seems visually that mountain ash grows as a shrub or that there are more trees growing out of one place. The stem coverage also stimulates a considerable development of adventitious roots. It is possible to make a statement that a larger part of the root system in many trees is formed by the adventitious roots (Fig. 2).

ROOT SYSTEM ARCHITECTURE IN MATURE TREES

The study of root systems in mature trees did not reveal any principal differences between the root system architecture of 20 years and 60 years old trees. However, principal differences were found in the architecture of root systems at different sites with limiting factors affecting the root system architecture being groundwater table, prevailing wind direction and terrain gradient.

ROOT SYSTEMS IN THE FLAT TERRAIN

Typical Gleysol (Site 1)

– Roots show a dense pattern only in horizon O (i.e. rooting depth is about 10 cm) – Fig. 3. There is a considerable amount (several tens) of superficial lateral roots growing out of the stem base in all directions that exhibit a very intensive branching within a distance of about 1 m from the stem (Fig. 4). Some 30 lateral roots reach farther from the stem base in all directions from a distance of 1–3 m. There are some 10 roots reaching farther from a distance of 3–6 m from the stem base in all directions. Over 6 m from the stem base there are another 2 or 3 roots whose reach is up to 8–9 m.

– From a distance of approximately 1 m from the stem base the branching of lateral roots occurs at intervals of 30 cm with the prevailing type of branching being bundles.

– This indicates that the root system developing on Gleysols is extremely superficial, of approximately circular projection, with lateral roots reaching to about 6 m.

Arenic Cambisol (Site 2)

– Vertical roots (anchor roots) shoot out from the stem base or from the lateral roots of large diameters (to a distance of about 50 cm from the stem) and penetrate through the soil horizons to a depth of about 100 cm (horizon C_1). The anchors branch only sporadically, the main type of branching being forks (Fig. 5).

Fig. 5. Moderate forking of anchoring roots (arenic Cambisol)

Fig. 6. Intensive branching of anchoring roots (Cambisol Rendzina)

- There are some 20 lateral roots shooting from the stem base in all directions, some 8 roots growing farther at a distance of 1–3 m from the stem base in all directions, and 2 to 3 roots growing farther than 3 m from the stem base (their reach being up to 7 m).
- The branching of lateral roots is by about 50 cm with the prevailing branching type being bundle branching and with occasionally occurring anchors (whose reach is up to 30 cm).
- This indicates that the root system developing at the given site is anchoring with lateral roots reaching up to 3 m.

Cambisol Rendzina (Site 3)

- The mountain ash root system architecture at this site is identical to that at Site 2 with the only differences consisting in the rooting depth of anchors and in the reach of lateral roots (anchor roots penetrate only to 60 cm – horizon Bv; lateral roots reach up to about 4 m from the stem base). Another difference is the intensive branching of anchors (Fig. 6).

Typical Pseudogley (Site 4)

– The mountain ash root system architecture at this site is identical to that at Site 3 with the only difference consisting in the depth reach of anchors where the rooting to a depth of up to about 50 cm (horizon El) was made possible thanks to the groundwater table (Fig. 7).

GENERAL COMMENTS ON THE ARCHITECTURE OF ROOT SYSTEM IN THE FLAT TERRAIN

It is only a superficial root system that develops in the flat terrain with high groundwater table (Gleysols). If the groundwater table is situated lower, an anchoring root system develops with the varying reach of lateral roots. The rooting depth of anchors is absolutely and unambiguously limited by the groundwater table level. An unambiguous correlation was found out between the rooting depth and the number and reach of lateral roots (the longer the anchors, the fewer the lateral roots and the smaller their reach). It was also found out that the shorter the anchors, the more intensive the branching of not only the anchors themselves but also the branching of superficial roots.

The shorter the anchors, the more intensive their branching into bundles and multiple forks (Fig. 8). The branching of lateral roots is nearly always in form of bundles (the most efficient way of branching). There is one dominant (large-diameter) root in a bundle that reaches farthest; other roots are considerably thinner, reach to a distance of about 80 cm and exhibit repeated bundle branching at their ends (Fig. 9).

The root system projection of sheltered (from wind protected) trees is approximately circular. End parts (tips) of lateral roots branch into a multiple bundle or turn in a geotropically positive direction where they grow as deep as the anchors and repeatedly exhibit bundle branching again (Fig. 10). The root system projection of wind-endangered trees is elliptic (with shorter axis against the wind) with lateral roots against and along the wind turning in a positive geotropic direction at a distance of about 1 m from the stem base, reaching the rooting depth of anchors, their diameter being often considerably larger and their branching frequency higher than in the anchors themselves.

Interesting is a finding that the longer lateral roots never grow in a straight direction (straight line) but are slightly undulating.

ROOT SYSTEMS ON THE SLOPE

- Regarding the fact that the root systems at sites under study were not affected by the groundwater table, their architecture is identical for all analyzed sites (Sites 5, 6, 7).
- The root system is of elliptic projection ca. 5 × 3 m up to 7 × 4 m, elongated in the direction following the line perpendicular to the contour; the stem base is situated eccentrically. The roots running into the slope are shorter than the roots growing along the slope (difference of about 1.5 m). Similarly, the number of roots growing into the slope is lower than the number of roots growing along the slope (by about 3 times).

Fig. 7. Mountain ash root system (typical Pseudogley)

Fig. 8. Bundle branching of anchoring roots

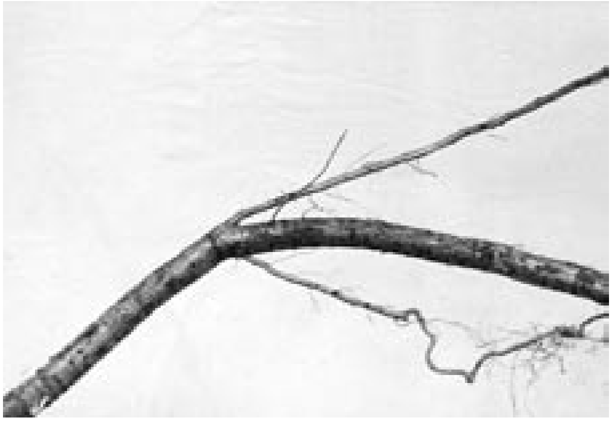

Fig. 9. Bundle branching of lateral roots

Fig. 10. Branching of the end part of lateral root

– The roots growing along the slope are considerably longer and grow parallelly to the soil surface, their depth being about 1 m. The roots growing into the slope are shorter and grow horizontally (growing through into the slope), i.e. they often reach greater soil depths than the roots growing along the line perpendicular to the contour. All roots show conspicuous fork branching (Fig. 11).
– The roots growing along the contour line form a universally developed root system from the stem base – they grow plagiotropically or positively geotropically (anchors) and penetrate through the soil horizons to a depth of about 1 m. Also these roots branch into forks (Fig. 12).
– It was also found out in the root systems of mountain ash trees growing on the slope that 2 to 3 plagiotropically growing roots (usually growing along the slope) reach to a distance of 9 m from the stem base.

GENERAL COMMENTS ON THE ROOT SYSTEM OF MOUNTAIN ASH

The mountain ash does not develop roots of large diameters (i.e. roots with the diameter over 3 cm). Although there are some large-diameter roots at the stem base (also the character of buttresses), they branch into considerably thinner roots at a max. distance of 1 m from the stem base.

The root diameter changes only slowly; for example, the roots growing 9 m from the stem base had nearly identical diameters at a distance of 2 m and 7 m from the stem base.

The cross-section of roots along their entire length is circular.

The mountain ash roots are very flexible and elastic from the viewpoint of physical characteristics (e.g. these parameters can hardly be achieved in spruce or beech).

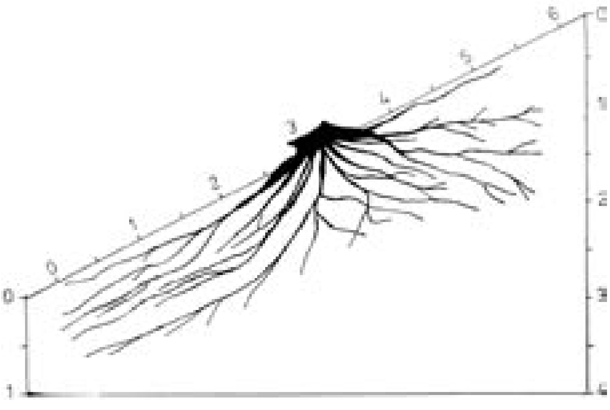

Fig. 11. Root system of mountain ash growing on the slope – profile along the line perpendicular to the contour

DISCUSSION

The root system formation in a tree species is a result of the intensity, periodicity and direction of root growth. According to KÖSTLER et al. (1968), the genetically conditioned shape of the root system can often be hardly recognized in older trees since it is modified by a combined action of many factors. The growth of roots is affected by the aboveground parts themselves but primarily by the site conditions.

Most literary sources claim the mountain ash root system to be anchoring, with planary lateral roots and dominant vertical roots (MAYER 1977; NAMVAR, SPETHMANN 1985; AAS 1997; POLOMSKI, KUHN 1998, etc.). This type of root system occurred in mountain ash trees growing at most sites chosen by us. The depth reach of anchoring roots at the particular sites differed and ranged from ap-

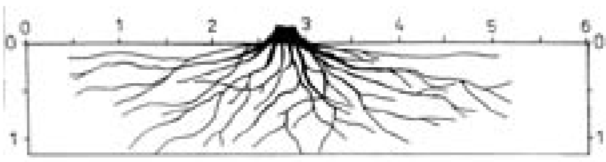

Fig. 12. Root system of mountain ash growing on the slope – profile along the contour line

prox. 100 cm (Site 2 – arenic Cambisol) to 50 cm (Site 4 – typical Pseudogley). The penetration depth of anchors on Pseudogleys corresponds with the data published by KREUTZER (1961), who described the reach of anchors in mountain ash trees aged 30 and 37 years at a similar site in Bavaria to be ranging from 50 to 55 cm. The root system developing on typical Gleysol (Site 1) was entirely flat with no apparent anchoring roots. It follows from the above-mentioned facts that the groundwater table is one of the main factors affecting the root system development. KREUTZER (1961) includes mountain ash in a group of tree species endangered by water-logging (oxygen deficiency). The trees growing on the slope did not exhibit the development of a typically anchoring root system although some anchoring roots were observed at these sites (Sites 5, 6 and 7).

Interesting is the finding that the anchor roots reach a depth of max. 1 m even in the case when deeper rooting is not prevented by either groundwater table or impermeable soil layers. VÁLEK (1977) characterized the mountain ash root system as medium-deep, with the depth reach of roots about 100 cm. It appears that the depth can be conditioned genetically although some deviations can occur even in this case. The latter author recorded a taproot in a mountain ash tree of 20 years, reaching to a depth of 1.80 m. The authors experienced a similar finding when digging out a mountain ash tree in a sandstone pit whose root system was as deep as 3.5 m (not mentioned in the paper).

Some authors claim that the mountain ash forms the taproot (BECHSTEIN 1821 in NAMVAR, SPETHMANN 1985; VOLNÁ, POSPÍŠIL 1989; KAVKA 1995). The results of our analyses showed that there were only about 20% of trees up to 10 years of age with root systems including a larger-diameter anchor that could be considered as a taproot. Nevertheless, no dominant anchors were found in older trees.

Most authors agree that the lateral roots of mountain ash are shallow spreading and usually arranged radially around the stem base. We found out that their number can be considerably high (e.g. there were several tens of them shooting from the stem base on typical Gleysol, twenty on arenic Cambisol). VÁLEK (1977) does not mention the number of lateral roots to be that high, which can result either from different methodology (choice of diameter as a starting point for including the roots into the assessment) or from different site character and related total rooting depth. As shown in our analyses, the number and reach of lateral roots are affected by the length of anchoring roots. The deeper the reach of anchors, the lower the number and smaller horizontal reach of lateral roots. The finding can partly explain the differences in literary data on the reach of lateral roots: e.g. from 3 to 6.5 m according to VÁLEK (1977), 5 m according to SVOBODA (1937). Our measurements revealed that the length of lateral roots at different sites ranged from 3 to 9 m.

In all analyses we found out 2 to 3 roots markedly exceeding the reach of other lateral roots. SVOBODA (1937) noticed that "a mountain ash tree, dwelling with its main roots firmly in the ground, shoots a long-reaching strand-like root across the surface to a rotting log distant up to 5 m, in which it will branch, grow through in order to nearly suck it out". However, in our case the occurrence of several considerably longer lateral roots did not relate to the occurrence of rotting wood. Although we have no plausible explanation for this fact for the time being, it seems that the roots are not an important component of the system of mechanical stability.

From the very beginning, the root system of mountain ash must provide for mechanical stability of the tree to resist snow movement, particularly along the slope. This is why nearly all roots of the plant at the developmental stage of seedling are oriented towards the line perpendicular to the contour (up the hill). At the older age when the mechanical stability of the tree is ensured by the firm network of anchoring and horizontally into the slope growing roots, there are also roots that develop in parallel to the soil surface growing down the hill, whose major function is to provide for tree nutrition.

All analyses were made on the relatively solitary standing trees whose root systems were not significantly affected by the root systems of other trees. As it followed from the study of root systems in the mixed forest, the root system architecture of mountain ash can also be affected to a great extent by allelopathic relations within the rhizosphere (PALÁTOVÁ, MAUER 2001).

The variability and adaptability of mountain ash root system leading to the ensuring of tree mechanical stability are remarkable. Not only the rooting depth, the reach and type of lateral root branching, physical properties of root wood, but also the undulating character of lateral roots make it possible to mountain ash to resist even the heavy gusts of wind without windthrows. The waves stretch out and there are only local disruptions of small-diameter roots within the bundle. All these findings (certainly along with the mountain ash crowns being relatively thin) corroborate the generally known fact that windthrows in mountain ash occur only in the case that the tree root system is infested by fungal pathogens.

CONCLUSION

A statement can be made on the basis of analyzing the root systems of several tens of mountain ash trees (aged up to 60 years and growing at different sites) that the variability of root system architecture is considerable in the species, which applies both to the rooting depth and to the reach, type and frequency of lateral root branching. The main limiting factors of morphogenesis are groundwater table, prevailing wind direction and gradient. From the viewpoint of the root system architecture, mountain ash is a very elastic tree species that develops such a type of root system at any site that can ensure its mechanical stability very efficiently.

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Morfogeneze kořenového systému jeřábu ptačího (*Sorbus aucuparia* L.)

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ABSTRAKT: V práci je analyzována morfogeneze a architektonika kořenového systému několika desítek stromů jeřábu ptačího ve věku do 60 let na sedmi rozdílných stanovištích. I když je variabilita kořenového systému značná, lze vyvodit jisté závislosti. Jeřáb vytváří kotevní kořenový systém. Limitujícími faktory morfogeneze kořenového systému jsou hladina podzemní vody (kořeny nepronikají do půdních horizontů ovlivněných spodní vodou), převažující směr větru (ve směru větru se vytváří eliptický kořenový systém) a sklon terénu (ve směru po svahu kořeny rostou rovnoběžně s půdním povrchem; ve směru proti svahu jsou kořeny kratší, rostou víceméně vodorovně a pronikají do hlubších půdních horizontů než kořeny rostoucí po svahu). Byla zjištěna jednoznačná korelace mezi hloubkou prokořenění kotvami a počtem a dosahem laterálních kořenů (čím delší jsou kotvy, tím méně je laterálních kořenů a mají menší dosah). Čím jsou kotvy kratší, tím intenzivněji se větví nejen kotvy, ale i povrchové kořeny.

Klíčová slova: jeřáb ptačí; kořenový systém; morfogeneze

Na sedmi rozdílných stanovištích nacházejících se na LS Lesů České republiky Svitavy a Ostravice byla sledována morfogeneze kořenového systému několika desítek stromů jeřábu ptačího ve věku 1–60 let. Všechny sledované stromy rostly ve smíšených porostech. K analýzám byly vybírány pouze stromy relativně samostatně stojící. Kořenové systémy byly ve většině případů vyzvednuty ručně – archeologickým způsobem, pouze na jednom stanovišti byla u dvou stromů achitektonika kořenového systému zjišťována nedestruktivním způsobem – pomocí půdního georadaru.

Analýzy kořenových systémů jeřábu prokázaly, že:

– Kořenový systém semenáčků mladých rostlin vytváří četné adventivní kořeny.
– U mladých rostlin nebyla pozorována tvorba dominantního kůlového kořene.
– Architektonika kořenového systému dvacetiletých a šedesátiletých stromů se významně neliší.

– Kořeny jeřábu nikdy nepronikají do horizontů ovlivněných vodou.
– Jeřáb nevytváří silné kořeny (tzn. kořeny silnější než 3 cm). U báze kmene se sice silné kořeny tvoří, ale nejdéle ve vzdálenosti 1 m od báze kmene se tyto kořeny větví v kořeny podstatně slabší.
– Tloušťka kořenů se mění jen pozvolna; např. u kořenů prorůstajících 9 m od báze kmene byla jejich tloušťka ve vzdálenosti 2 a 7 m od báze kmene téměř shodná.
– Kořeny mají po celé své délce kruhový průřez.
– Průmět kořenového systému stromů rostoucích na rovině je přibližně kruhový, u stromů vystavených větru je eliptický.
– Kořenový systém stromů rostoucích ve svahu má eliptický průmět, protažený směrem po spádnici. Báze kmene je položena excentricky.
– Z hlediska fyzikálních charakteristik jsou kořeny jeřábu velmi ohebné a pružné (např. smrk nebo buk se v těchto parametrech jeřábu nevyrovná).

Kořenový systém jeřábu je značně variabilní, a to jak v hloubce prokořenění, tak v dosahu, typu a frekvenci větvení laterálních kořenů. Limitujícími faktory morfogeneze jsou výška hladiny spodní vody, převažující směr větru a sklon terénu. Z hlediska architektoniky kořenového systému je jeřáb velmi plastickou dřevinou, která na každém stanovišti vytváří takový typ kořenového systému, který velmi účinně zajistí jeho mechanickou stabilitu.

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