

## DEFORMATION OF SCOTS PINE ROOT SYSTEM IN YOUNG PLANTATION AND THE THREAT BY ROOT PATHOGENS

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**Abstract.** Deformation of root system because of flattening, rolling up or injuries during planting are the main causes which predispose the trees to parasitic infections, particularly in case of unfavourable weather conditions occurrence (drought, low temperatures). The objective of the presented work was the determination of the occurrence of pine root deformations in young Scots pine and to verify the presence of root pathogens. Observations were carried out on 20 areas localized in Scots pine stands of Ia class, from which 301 pieces of infected roots were collected. The obtained results confirmed the occurrence of root deformations. It was found that a high percentage of trees had deformed root systems caused by faulty methods of planting which might have contributed to the predisposition of the new trees in the period after planting.

**Key words:** root system, Scots pine, *Armillaria*, deformation

### INTRODUCTION

Deformation of root systems caused by flattening, rolling up or injuries are the main factors exerting an influence on the subsequent predisposition to diseases, particularly in case of weather anomalies occurrence (drought, low temperatures). This fact may refer even to 70% of trees which died in their young age [Sierota 1997 a]. This problem is still actual, however, the state of knowledge referring to this aspect is not adequately investigated and there is a lack of publication dealing with it. Next to the faulty development of the root system, another reason of this situation are incorrect procedures during planting. Density of trees (reaching in the past up to 20 thousand cuttings per ha favored quick contacts of roots in the stand. Additionally, during plantation, there frequently happens that the roots of the cuttings get rolled up being caused by the occurrence of a plough sole which gives an additional stress to the trees [Sierota 2001]. In such cases, the function of the tap root is taken over by numerous lateral roots which spread horizontally increasing thereby the susceptibility of trees to infection by root pathogens and to harmful external

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conditions (drought, ground frost). In result of the stress induced by root deformation, the cuttings are infested by root pathogens. In stands, actually the most serious infection diseases of root systems are: brown root caused by the fungus *Heterobasidion annosum* (Fr.) Bref, or by *Armillaria* spp. (Fr.Fr.) Staude. Both diseases may occur because of epiphytosis. A mass attack of the diseases and the persistent character of it may lead to the overcoming of the resistance barriers of the plant, a quick settlement of the plant tissues by pathogens and the death of the whole tree organism. In forest communities, such disease development is expressed by an infection of many tree organisms and in many trees at the same time leading to the death of whole stands [Sierota 1997 b]. This causes enormous economic losses and, what is still worse, the inoculum of the pathogen may remain active for many decades causing damages in tree stands.

The objective of the presented work was the determination of the degree of morphological deformation of Scots pine roots in Ia class age infected by root pathogens, the elaboration of a deformation scale and the identification of fungi responsible for the dying of trees in selected areas.

## MATERIAL AND METHODS

Observations were carried out in the years 2005-2007 on the area of the Experimental Forest District Zielonka (compartment 20f, 31c, 35c, 36c, 43h, 47k, 62d), as well as, for comparison and verification purposes, the same was done on the area of the Experimental Forest District Siemianice (compartment 8b, 9l, 18g, 116a), on the area of the Forest District Szczecinek (compartment 174f) and the Forest District Złotów (compartment: 4a, 15d, 46d, 46n, 90d, 93b). Totally observations were carried out on 20 areas localized in Scots pine stands in the age of 4-8 years, from which 301 pieces of infected tree rots were collected. During tree stand estimation, all trees were selected on which symptoms of tree root pathogens were found. Dead pine were dug out, the cause of their death was determined and the position of roots in the ground was preliminary estimated.

Additionally, in the compartments of the Experimental Forest District Zielonka, roots of live trees (without disease symptoms) were sampled as well (10 per in each separation) and they made 50% of the roots sampled earlier. Their sampling consisted in the digging out of the whole root system with the help of a spade, the roots were numbered and transported to the laboratory. There, they were segregated into roots without any deformations and roots with visible deformations. Subsequently, the causes of tree dead were determined. For this purpose, mycelium was isolated from roots and the pathogens was identified.

## RESULTS

On the basis of the position of the main root and of the lateral roots, it was found that there occurred seven different forms of root systems (Table 1) including two forms without a visible main root and five forms a visible main root. Among 301 roots taken from dead trees, 93% represented roots with deformations. The greatest number of roots was characterized by symptoms accepted in the classification as second degree of deformation, i.e. without a visible main root and with numerous lateral roots. In the Forest

Table 1. Degree of root deformation  
Tabela 1. Stopnie zniekształceń systemów korzeniowych

Degree of deformation Stopień zniekształcenia	Deformation type, form of root system Rodzaj zniekształcenia, forma systemu korzeniowego
Without a visible main root – Bez widocznego korzenia głównego	
1	with two lateral branches z dwoma bocznymi odgałęzieniami
2	with numerous lateral branches (more than two) z licznymi bocznymi odgałęzieniami (więcej niż dwoma)
With a visible main root – Z widocznym korzeniem głównym	
3	vertically bent – wygiętym pionowo
4	laterally bent – wygiętym bocznie
5	coiled – zawiniętym
6	bent with bent lateral – wygiętym oraz wygiętymi korzeniami bocznymi
7	Regularly shaped (no damages) – prawidłowo ukształtowanym (brak uszkodzeń)

District Zielonka, 61% infected roots were found, in the Experimental Forest District Siemianice, where cutting with covered root system were used, 12% were infected. In the Złotów Forest District, infected roots made 63%. In the remaining percentages, the share of roots without disease symptoms did not exceed 20% on area of all studied localities. Among the trees infected by root pathogens, only 8% had a correctly developed root system in the separations of the Experimental Forest District Zielonka. In the remaining Forest District, such cases were not recorded. Trees without symptoms of infection by pathogens (in the 2nd degree of classification) were characterized by less deformed root systems and they made 40% while 22% showed a complete absence of deformations. Figure 1 presents the participation degree of root deformation in all areas.

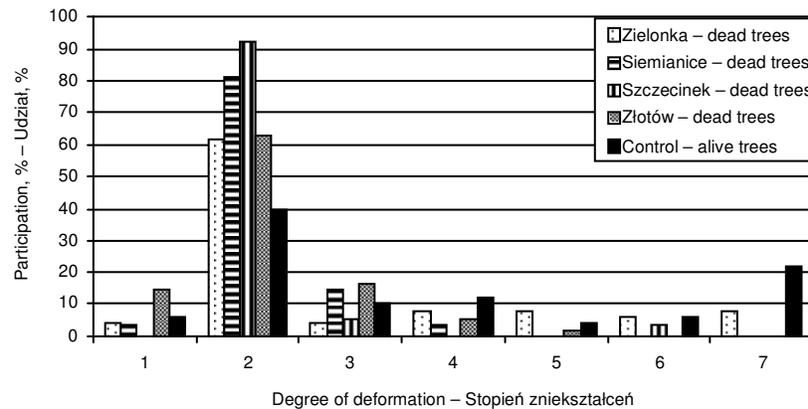


Fig. 1. Percentage participation of roots in the particular deformation degrees on the areas  
Rys. 1. Udział stopni zniekształceń korzeni na powierzchniach

The main cause of tree dying in the studied tree stands was the *Armillaria ostoyae* (81% of cases). The *Heterobasidion annosum* was identified in 13% of roots of the analysed trees. In the remaining cases, the reason of dying was not identified.

## DISCUSSION

Root examination of trees in young plantation confirmed the occurrence of the phenomenon of root deformation. On the basis of the obtained results, one can state that a very high percentage of trees showed very deformed root system caused by incorrect planting which might have contributed to the predisposition to disease. Sierota [1997 a] called attention to the fact that root deformation constitutes a factor favoring tree infestation by pathogens. This factor is particularly important in weather anomalies. This situation is also caused by the method of soil preparation and the method of tree plantation. In Poland, the soil is commonly prepared by ploughing in furrows and slit planting with planting bar [Kocjan 1994]. However, this method does not insure a correct positioning of the roots during planting causing additionally injuries of rhizomorphs (on areas where *Armillaria ostoyae* occurs). In the injured place, from the mother rhizomorph, there develop many new rhizomorphs which are significantly thinner. They grow quicker and are able to infect actively the tree roots [Sierota 2001]. The age in which the pines were infected also predisposed the trees to the infection by *Armillaria ostoyae*. It was earlier reported by Łakomy [1998] and by Szewczyk [2005].

Summing up the study results, it can be concluded that only a small percentage of the analysed tree roots showed no deformations indicating that the planting technique exerted a significant effect. It must be stressed that for more than a decade, trees have been planted by workers of a Forest Service Institution, who are not properly trained in the planting techniques and they are not aware of the possible negative consequences. Next to the use of a proper planting method, also a special bio-gel can be applied with which the roots are covered before planting. This gel protects the roots against drying and at the same time constitutes some kind of a ballast to the roots preventing their rolling up and this helps them to be better located in the hole in which they have been inserted. Furthermore, on areas with *Armillaria ostoyae*, particular attention should be paid to avoid injuries to rhizomorphs.

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## **DEFORMACJA SYSTEMU KORZENIOWEGO SOSNY ZWYCZAJNEJ W UPRAWACH A ZAGROŻENIE PRZEZ PATOGENY KORZENI**

**Streszczenie.** Deformacja systemów korzeniowych na skutek ich spłaszczenia, podwinięcia lub uszkodzenia podczas sadzenia jest głównym czynnikiem predysponującym na infekcje pasożytnicze, zwłaszcza po wystąpieniu anomalii pogodowych (susza, niskie temperatury). Celem pracy było określenie nasilenia występowania zniekształceń korzeni sosny w uprawach oraz obecności w nich patogenów korzeni. Obserwacje przeprowadzono łącznie na 20 powierzchniach, zlokalizowanych w drzewostanach sosnowych Ia klasy wieku, z których pobrano 301 sztuk korzeni porażonych drzew. Uzyskane wyniki potwierdziły występowanie zjawiska deformacji korzeni. Stwierdzono, że duży odsetek drzew ma zdeformowane systemy korzeniowe na skutek błędnego sadzenia, mogącego mieć wpływ na predyspozycję chorobową sadzonek w okresie po wprowadzeniu w uprawie.

**Słowa kluczowe:** deformacja korzeni, sosna, *Armillaria*

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