

## **SURVIVABILITY OF SCOTS PINE DURING THE PERIOD OF 5 YEARS FROM THE CULTIVATION ESTABLISHMENT IN RELATION TO THE WAY OF THE PREPARATION OF THE CLEAR-CUT SURFACE FOR REGENERATION**

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**Abstract.** The survivability of a 5-year old Scots pine cultivation is strongly influenced by the ways of soil preparation and methods of management of the post clear-cut residues. The highest Scots pine survivability was determined on the cultivation established on surfaces on which post clear-cut residues were left, irrespective of the way these residues were treated. A significantly worse survivability was found on surfaces on which branches with needles were either burnt or removed altogether. On the other hand, the best method of soil preparation from the point of view of pine tree survivability was ploughing ridges using a rotary tiller. Ploughing furrows using LPz-75 and U-162 ploughs was found to reduce significantly the survivability of pine trees.

**Key words:** Scots pine, pine cultivation, pine survivability

### **INTRODUCTION**

Investigations on the optimum way of preparation of clear-cut surfaces for regeneration carried out for many years failed to elaborate recommendation which would indicate a single method of management of post clear-cut residues and one way of soil preparation as the best one to carry out definite forest cultivation. It turns out that the same way of soil preparation applied in different conditions yields different levels of success performance and the observed differences between different methods of preparation of the clear-cut surface disappear with the passage of time [Mucha et al. 1985, Sienkiewicz 1992, Fraszewski 1994, Sobczak 1996]. Ceitel et al. [2003] found that the way of soil preparation before the establishment of a pine cultivation exerts a significant impact both on the growth as well as the survivability of seedlings. In addition, also the method of felling residue management has a strong influence on the restoration success and

growth of cultivations [Gornowicz et al. 2004, Pilarek et al. 2004]. The knowledge about the effect of the way of the post-clear cut surface preparation on the forest restoration success is particularly essential in the case of Scots pine – the most frequent forest tree species regenerated artificially in Poland with regard to the fresh coniferous forest site type as this tree species occupies one fourth of the total forested area in Poland [Raport... 2005].

The objective of this research project was to determine the effect of different methods of the clear-cut residue management and the way of soil preparation on the survivability of Scots pine during the five-year period following cultivation establishment.

## RESEARCH METHODOLOGY

Experiments were carried out on a clear-cut surface situated in the region of the Kalisz Pomorski Forest District in the 321a sub-compartment. The 90-year old pine stand, which was growing on the fresh coniferous forest site type, was felled in the first quarter of 1999. On the obtained 2.80 ha felling site, the following five different methods of management of the clear-cut residues in three replications were applied:

- leaving the post-felling residues intact
- removal of the post-felling residues from the surface
- burning the residues
- chopping the post-felling residues and leaving them on the surface
- chopping the post-felling residues and mixing them with the mineral soil.

The post felling residues were comminuted using for this purpose a chopper developed by Piórkowski, eng., whereas a disk-plough was employed to mix the chopped branches and needles with the mineral soil.

In the autumn of 1999, the soil on the experimental surface was prepared for planting using the following three methods:

- ploughing furrows with the LPz-75 plough
- ploughing furrows with the active U-162 plough
- ploughing up ridges using a plough-miller.

The furrow bottoms were softened with the assistance of a forest subsoiler L-01 as modified by Piórkowski eng., and before making ridges, the soil surface was ploughed using a disk plough.

The experimental surface was divided into plots with different management methods of the post felling residues and ways of soil preparation employing a block system with three replications and random distribution of the examined factors.

The entire experimental area was regenerated artificially in April 2000 using one-year old Scots pine seedlings planted at  $1.5 \times 0.6$  m spacings.

The survivability evaluation of Scots pine seedlings was conducted in September 2000, 2002 and 2004. The performed observations comprised 25% of the entire experimental area (every fourth row of trees), with the exception of the extreme rows.

The obtained research results were subjected to statistical analyses. In order to determine the influence of the applied methods of post-clear cutting residue management as well as the way of soil preparation on the survivability of pine cultivation, the obtained results were subjected to the analysis of variance and when the examined factors

exerted a significant effect on the pine seedling survivability, additionally the authors carried out a test of significance of differences of the mean values using Duncan's method.

## RESULTS

The determined mean Scots pine survivability 5 years after planting on the post-felling surface ranged from 71.4% on plots with burnt post-clear cutting residues and soil preparation into furrows using the U-162 active plough to 88.9% – in the case of plots where the post-felling residues were chopped and mixed with the mineral soil followed by ploughing furrows using the LPz-75 plough (Table 1). Poor survivability values of Scots pine were determined on the experimental surfaces from which the post-felling residues were either removed altogether or which were burnt and the soil was prepared by ploughing furrows either using the active plough or the LPz-75 plough. Higher pine survivability was recorded on plots where the soil was prepared into ridges

Table 1. Mean pine tree survivability in the 5-year cultivation as affected by the method of post-felling residue management and the way of soil preparation

Tabela 1. Średnia przeżywalność sosny w pięcioletniej uprawie ze względu na zastosowane metody zagospodarowania pozostałości zrębowych i sposoby przygotowania gleby

Methods of post-felling residue management Metody zagospodarowania pozostałości zrębowych	Mean Scots pine survivability in relation to the way of soil preparation, % Średnia przeżywalność sosny w zależności od zastosowanego sposobu przygotowania gleby, %		
	furrows – LPz-75 bruzdy – LPz-75	furrows – active plough bruzdy – pług aktywny	ridges – rototiller wałki – pługofre- zarka
	Leaving post-felling residues intact on the surface Pozostawienie resztek pozrębowych w całości	85.9	83.9
Removal of post-felling residues from the surface Usunięcie pozostałości zrębowych z powierzchni	79.2	77.9	85.2
Burning post-felling residues on the surface Spalenie pozostałości zrębowych na powierzchni	75.8	71.4	88.6
Chopping post-felling residues and leaving them on the surface Rozdrobnienie resztek pozrębowych i pozostawienie ich na powierzchni	80.1	86.8	88.4
Chopping post-felling residues and mixing them with mineral soil Rozdrobnienie pozostałości i mieszanie ich z glebą mineralną	88.9	86.3	86.7

using a rotary tiller. In fact, when this way of soil preparation was employed, the applied methods of the post-felling residue management exerted no significant impact on the survivability of Scots pines. It can be assumed that the mixing of mineral soil with forest litter using a rototiller exerted a positive influence on tree survivability. This thesis is further corroborated by the obtained high mean Scots pine survivabilities ranging from 86.3% to 88.9% following the comminution of the post-felling residues and mixing them with mineral soil.

The performed statistical analysis revealed that during the experimental five-year period, pine survivability was the highest on plots where the post-felling residues were left on the soil surface intact or when they were chopped and either left on the soil surface or mixed with the mineral soil (Table 2). After the first, third and fifth year of cultivation, the mean pine survivability did not differ statistically significantly as a result of the application of the above three methods of post-felling management. Significantly different pine survivabilities (by 3% – after the 1st year and by 7% – after the 3rd and 5th years) were determined in the treatments when branches with needles were burnt on the felling surface or when the residues were removed from the surface. Leaving the organic matter (post clear-cut residues) on the felling site exerted a clear positive influence on pine survivability.

Table 2. Duncan's test results concerning the significance of differences between pine survivability in relation to the method of post-felling residue management  
Tabela 2. Zestawienie wyników testu Duncana istotności różnic między przeżywalnością sosny w zależności od metod zagospodarowania pozostałości zrębowych

Age of cultivation Wiek uprawy	Method of residue management and pine survivability, % → direction of survivability increase Metoda zagospodarowania pozostałości zrębowych i przeżywalność sosny, % → kierunek wzrostu przeżywalności				
	S	U	R+Z	P	R
1	94.6	95.7	97.8	98.1	98.6
3	79.2	81.6	86.0	86.0	90.3
5	78.6	80.4	85.0	85.1	87.3

P – leaving post-felling residues, U – removal of post-felling residues, S – burning post-felling residues on the surface, R – comminution of post-felling residues, R+Z – comminution of post-felling residues and mixing them with mineral soil, ●—● difference non-significant.

P – pozostawienie resztek pozrębowych, U – usunięcie pozostałości zrębowych, S – spalenie pozostałości na powierzchni, R – rozdrobnienie pozostałości zrębowych, R+Z – rozdrobnienie pozostałości i zmieszanie ich z glebą mineralną, ●—● różnica nieistotna.

During the five-year experimental period, also the way of soil preparation was found to have a significant impact on the Scots pine survivability. The trait was found the highest in the treatment where the soil was prepared into ridges using the rototiller

(Table 3). After the 3rd and 5th year of cultivation, the survivability of pine trees growing on ridges was significantly higher (by 7% and 5%, respectively) in comparison with the survivability of trees growing in furrows made by LPz-75 and U-162 ploughs.

Table 3. Duncan's test results concerning the significance of differences between pine survivability in relation to the way of soil preparation

Tabela 3. Zestawienie wyników testu Duncana istotności różnic między przeżywalnością sosny w zależności od sposobu przygotowania gleby

Age of cultivation Wiek uprawy	Way of soil preparation and pine survivability, % → direction of survivability increase Sposób przygotowania gleby i przeżywalność sosny, % → kierunek wzrostu przeżywalności		
	LPz-75	Pa	Pf
1	96.3	96.9	97.5
3	81.7	82.7	89.5
5	81.3	82.0	86.6

LPz-75 – furrows ploughed with the LPz-75 plough, Pa – furrows ploughed with the U-162 active plough, Pf – ridges ploughed using a rototiller, ●—● difference non-significant.

LPz-75 – bruzdy wyorane pługiem LPz-75, Pa – bruzdy wyorane pługiem aktywnym U-162, Pf – wałki naorane pługofrezarką, ●—● różnica nieistotna.

## CONCLUSIONS

The obtained research results allowed the authors to draw the following conclusions and generalizations:

1. Both the methods of post-felling residue management and ways of soil preparation employed in this study exerted a significant influence on the pine survivability during the 5-year period of pine cultivation.

2. The highest survivability was recorded in the treatments where the felling residues were left on the surface, irrespective of how they were treated afterwards. A significantly lower pine survivability – by 3% after the first year of cultivation and by 7% after the third and fifth years – were determined in the treatments when branches with needles were burnt on the felling surface or when the residues were removed from the surface.

3. The best way of soil preparation with regard to pine survivability was making ridges using a rototiller. Significantly lower pine tree survivability (by 7% after the first year of cultivation and by 5% – after five years) was determined after ploughing furrows employing LPz-75 and U-162 ploughs.

4. The obtained research results indicate that, in conditions of the fresh coniferous forest site type, leaving the organic matter (post clear-cut residues) on the felling site exerted a clear positive influence on pine survivability in the five-year cultivation. The mixing of the post-felling residues with mineral soil at the stage of their management (chopping branches and mixing them with soil) or soil preparation (ploughing ridges using a rototiller) also had a positive influence on pine survivability. The success performance of Scots pine trees depends on the first years following cultivation establishment, hence the soil conditions during this period (nutrient availability and soil softening) exert a direct impact on seedling survivability in the cultivation.

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## PRZEŻYwalność SOSNY ZWYCZAJNEJ W OKRESIE 5 LAT OD ZAŁOŻENIA UPRAWY W ZALEŻNOŚCI OD SPOSOBU PRZYGOTOWANIA POWIERZCHNI POZRĘBOWEJ DO ODNOWIENIA

**Streszczenie.** Na przeżywalność pięcioletniej uprawy sosnowej istotny wpływ mają sposoby przygotowania gleby i zastosowane metody zagospodarowania pozostałości zrębowych. Największą przeżywalność sosny stwierdzono na uprawie założonej na powierzchniach z pozostawionymi resztkami pozrębowymi, niezależnie od sposobu traktowania tych resztek. Istotnie mniejszą przeżywalność sosny odnotowano na powierzchniach, na

których spalono gałęzie z igliwem bądź też usunięto pozostałości zrębowe z powierzchni. Z kolei najlepszym sposobem przygotowania gleby pod względem przeżywalności uprawy okazało się naoranie wałków pługofrezarką. Wyoranie bruzd pługami LPz-75 i U-162 spowodowało, że przeżywalność sosny była istotnie mniejsza.

**Słowa kluczowe:** sosna zwyczajna, uprawa sosnowa, przeżywalność sosny

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