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Differentiation of selected traits of trees growing at different distances from strip-roads

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Abstract: Cutting a strip-road leads to disruption of the canopy and results in an increased inflow of light to crowns of trees growing in the direct vicinity of the strip-road, which changes growing conditions of trees. The objective of the research was to assess the differentiation of DBH values, tree heights, crown base heights, crown lengths, knot diameters, taper and ovality values on trees growing in the neighbourhood of strip roads. The investigations were carried out in a 34-year-old pine stand in the Notecka Forest, where the strip roads had been cut parallel to the tree rows 7 years before. The measurements covered all trees growing in 3 rows closest to the strip road, and – as control –trees in the row half way between the strip roads. The DBH values, heights and ovalities (at BDH) were measured on all trees growing on both sides of the strip road, and the taper values as well as knots were measured on a 4-meter long stem bottom part, in course of measurements carried out on model trees. The results showed differentiation of biometric features of trees, however no differences in shape defect values and knots were observed. The largest DBH values were found for the trees growing adjacent to the strip roads, however they were statistically significantly larger than DBH diameters of trees growing half way between the strip roads only. The trees adjacent to the strip roads were lower in height than those rowing further away from the strip roads, but their crowns were longer and lower set in. Statistically significant differences for tree heights were found for the middle zone only, in the case of the crown base, relative to all three zones, and in the case of crown lengths – relative to zones 2 and 3. The results showed that knots facing the strip road had larger diameters than those facing the stand (for distances of up to 1.5 m from the strip roads the differences were statistically significant), and this phenomenon was true for all distance zones.

Key words: strip roads, biometrical traits, taper, ovality, knots

INTRODUCTION

The dynamic rise of the number of harvesters, observed in recent years in Poland (Skarżyński and Brzózko 2010, Nowacka and Moskalik 2012, Sowa et al. 2013) resulted in the increase in use of these machines in intermediate cuttings. Their use in young tree stands is coupled with increased risk of damage to the forest environment (Sauter and Busmann 1994, Gapšyté 2003, Suwała 2003). In order to counteract this, the moving of machines should be limited to permanent routes – strip roads (Rzadkowski 1995). Today, the role of strip roads is not limited to transportation operations only, but they more frequently serve as places where wood is processed by harvesters, which makes them an important element of wood harvesting technologies in intermediate cuttings (Suwała 2006, Jodłowski 2009, 2010). It should be remembered that the basic purpose of establishing strip roads is to contain damage to the tree stand (Więsik 1995), and their use should not be limited to the most technologically advanced methods, as according to the present regulations, strip roads should always be used, even in horse skidding (Rzadkowski 1995, 1997).

Strip roads are characterized by two basic parameters: their width and the distance between them. The width of a strip road depends on the width of the machine to be used, and the distance is related to the technology of wood harvesting and extraction (Jodłowski 2010). Apart from that, strip roads take in practice the form of more or less straight lines (affected by the tree stand and terrain conditions) going parallelly or perpendicularly to the tree rows. It should be stressed, that a general rule for strip roads in Poland states that they should go perpendicularly to the tree rows (if they are recognizable) (Rzadkowski 1997).

Cutting a strip road causes changes in tree growth conditions in the closest neighbourhood. This is caused by increased influx of light to the crowns of the nieghbouring trees, which results in their increased growth (Horák and Novák 2009, Wallentin and Nilsson 2011, Stemspki 2013). The interest of researches studying this subject is often focused on the effects of strip roads on biometrical traits of trees, rather than on other features, like e.g. indicators of technical wood quality of standing trees (shape defects, knots) (Giefing et al. 2003).

The objective of the investigation was to assess the differentiation of basic biometrical traits (dbh, tree height, the height of crown base and the crown length) and of diameters of konts, taper and ovality of trees growing in direct neighbourhood of strip roads.

AREA AND RESEARCH METHODS

The investigations were carried out in spring 2015 in the Notecka Forest, in a 34-year old pine stand, growing on fresh conifer site of quality 1. The average dbh and height values of the stand were 11 cm and 13 m, respectively, and the stand density coefficient was 0.9. In the stand two cutting operations, within the early thinning regime were carried out, the first was coupled with the cutting of strip roads (parallelly to tree rows) in 2008, and the other took place in spring 2013.

The analysed traits were measured on trees growing in four distance zones, the first three were determined by the tree rows related to the strip roads (directly by the strip road, 1.5 m and 3 m away from the strip road), the fourth zone was half distance between the strip roads (the control zone). The breast height diameter (dbh), tree height and tree crown base measurements were carried out in each zone on 60 trees (on 30 trees on each side of the strip road) while the taper and knots were measured on 20 model trees selected according to the Draudt method. The diameter measurements were carried out with a caliper, with an accuracy of 0.5 cm, in the West-East (perpendicularly to the strip roads) and North-South (parallelly) directions. The diameter measurements were taken at a height of 0.1 m and 4 m above ground. The tree heights and tree crown base heights were measured with the Suunto height gauge, with an accuracy of 0.25 m. The knots were assessed on the bottom 4 meter long part of the stem and their diameters were measured with an electronic slide caliper, with an accuracy of 0.1mm.

Following the measurements, the average values of the traits were calculated. In the case of knots, three sets of results were established: the average from all measurements, the average from knots facing the strip road and the average from knots facing the interior of the tree stand. In the case of ovalities, apart from the average values, the participation of trees with ovalities and with ovalities in the N-S and in W-E directions in the whole population were calculated. The statistical analysis of the results was focused on the assessing the significance of differences of the traits measured between the rows. Depending on the results of the coherence with the normal distribution (Shapiro-Wilk test) the one-way ANOVA or its non parametric counterpart (Kruskal-Wallis test) were used. In case of significant results of the analysis of variance, the Tukey's post hoc test was conducted, while the Kruskal-Wallis' test was followed by multiple comparisons. The significance of differences between the diameters of knots facing the strip road and facing the tree stand were tested with the U Mann-Whitney test. As for the ovalities (all and those in N-S and W-E directions), their statistical relations to the distance from the strip roads were tested (Chi-square test). All statistical calculations were conducted with the application Statistica v. 12.

RESULTS

Tree growing in the tree row 1 had the largest dbh values and they were smaller in height that those growing deeper in the stand. They also had the longest and lower based crowns (Tab. 1)

Tab. 1. Average values of biometrical traits and test probabilities (p) of differences between rows

Row	Diameter at breast height (cm) (p=0.0149)	Height (m)		Crown length (m) (p=0.0001)
		Tree	Crown base	
		(p=0.00)		
1	15.54	12.73	5.15	7.58
2	14.76	12.80	5.73	7.07
3	14.86	13.17	6.06	7.10
Control	14.20	13.43	6.71	6.72

The statistical analysis of the results from biometrical measurements showed statistically significant differences between rows (Tab. 1) They referred to the following rows:

- Diameter at breast height: between row 1 and the control zone,

- Tree height: between row 1 and the control zone and between row 2 and the control zone,

- Crown base height: between row 1 and all other rows, between row 2 and the control zone, between 3 and the control zone,

- Crown length: between rows 1 and 2, and between row 1 and the control zone.

In the case of taper, ovalities and knots no statistically significant differences between rows were found. The largest taper and ovality values were found on trees from the middle (control) zone, and in the case of knots – in the zone 2. However, both the shape defects as well as the knots showed little differences compared to other zones (Tab. 2).

Tab. 2. Average values for shape defects and knots and test probability values for differences between rows

Row	Taper (cm/m) (p=0.238932)	Ovalities (cm) (p=0.9693)	Knots (mm) (p=0.3018)
1	1.53	0.69	12.57
2	1.44	0.66	12.60
3	1.49	0.67	12.10
Control	1.65	0.70	12.58

The analysis of the diameters of knots facing the strip roads and the interior of the stand showed that, regardless of the distance to the strip road, the knots facing the strip road had larger diameters and they were statistically significant in the case of zone 2 (p=0.0206).

In the course of the investigation no relations between the presence of ovalities and the distance from the strip roads were found (p=0.627842). Also, no differences in the frequency of occurence between ovalities in the N-S and E-W directions and the distance from the strip roads were confirmed (p=0.283061), however a steady increase in the presence of the N-S ovalities with increasing distance from the strip roads was observed.

DISCUSSION

The investigations showed an influence of strip roads on the biometrical traits analysed. Trees growing closest to the strip roads were the thickest, lowest and had the longest and lowest set crowns. This was caused by an increased influx of light to these trees. However, it should be noted that the values of the analysed biometrical traits did not differ considerably between the trees at the strip roads and those growing in rows more distant from the strip roads, which would have been confirmed by statistically significant differences between rows 1 and 2, and consequently all the other rows. During the research, such a situation was observed in the case of the crown base and crown lengths only.

The increased influx of light on trees adjacent to the strip road should result in their larger growth in thickness, which, seven years after cutting the strip roads, should result in larger dbh values. Admittedly, the dbh values of trees adjacent to the strip roads were the largest, but the difference from the dbh of tree in the row 2 being less than 1 cm was statistically insignificant. Similar results (larger dbh values but statistically insignificant) were reported by Kremer and Matthies (1997). On the other hand, investigations carried out by Stempski (2013) in similar trees stand conditions, five and ten years after cutting the strip roads showed considerably larger (1.5 - 2 cm), statistically significant differences between trees growing directly at strip roads and those more distant, regardless of the distance to the strip road. It should be stressed that the strip roads reported here, were cut perpendicularly to the tree rows.

The research showed that the trees growing directly at the strip roads had the lowest heights. The differences, though statistically insignificant, compared to trees in row 2, were quite noticeable. The results confirm the opinion on the decreased growth in height, resulting from an increased light influx. Similar results were reported by Giefing et al. (2003), in their investigations into the effects of strip roads cut at the time of late cleanings on, among other parameters, tree height. Also, Horák and Novák (2009) confirmed this in their investigations in spruce stands. Stempski (2013) however, reported slightly larger height values on trees making used of the increased influx of light.

As the results for tree heights were consistent with the view on the effects of the increased light influx on the lowering of the growth in height, so the results on the height of the crown base confirmed the opinion on the effects of the lowering of stand density on the process of shedding lower branches. In the case of this trait the differences were the largest, as the crowns on trees adjacent to the strip roads were set statistically significantly lower that on trees in all the other distance zones. Lower crown bases resulted in significantly longer crowns, compared to trees growing further away from the strip roads, which was also confirmed by Giefing et al. (2003), Horák and Novák (2009) and Stempski (2013) in their investigations (also for the height of the crown base).

The research showed a considerable prevalence of ovalities in the N-S direction, and the frequency of the occurrence of trees with such ovalities increased with growing distance from the strip road. Similar results, related to the increased prevalence of trees with N-S ovalities were reported by Stempski (2013), however the share of trees with ovalities decreased, as the distance from the strip road grew larger. As a result, it is rather difficult to seek the effect of strip roads on this defect. The explanation should rather be the prevailing westerly winds, leading to wider yearly rings on the eastern side, which was also reported by Józefaciukowa and Laurow (1974).

Disrupting the forest canopy caused by cutting the strip road slowed down the process of shedding branches by trees, which resulted in lower crown bases. Theoretically speaking, it should also cause an increase in thickness on branches facing the strip road (Varmola and Salminen 2004) leading to larger diameters of the knots. In the investigations reported here, the knots facing the strip road had larger diameters indeed, but it was true for all the distance zones, so it was not caused by the presence of the strip road.

CONCLUSIONS

1. Trees growing directly at the strip road had larger diameters at breast height, lower heights, longer crowns with lower crown bases compared to trees deeper in the stand.

2. The investigations did not confirm differences in taper and ovalities resulting from the distance from the strip road. The distance from the strip road did not affect the occurrence of these defects.

3. Similarly to the case of shape defects, knots on trees adjacent to the strip roads did differ from those on other trees. Diameters of knots facing the strip road were

larger than those facing the interior of the stand, and that was true for all distance zones.

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